



Data Summary for the Boundary Layer Ingesting Inlet/Distortion Tolerant Fan Experiment

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Abstract

This report presents a large dataset from the Boundary Layer Ingesting Inlet / Distortion Tolerant Fan (BLI²DTF) test performed in the NASA Glenn 8- by 6-foot Supersonic Wind Tunnel in 2016. Data are presented as plots for key operating conditions and in an accompanying data package containing databases for both steady and high-response measurements.

Nomenclature

Abbreviations	
AATP	Advanced Air Transport Project
AIP	Aerodynamic Interface Plane
AIPRRA	Aerodynamic Interface Plane Rotating Rake Array
BLI ² DTF	Boundary Layer Ingesting Inlet / Distortion Tolerant Fan
FE	Fan-stage Exit
FEGV	Fan Exit Guide Vanes
FERRA	Fan-stage Exit Rotating Rake Array
PEDS	Peak Efficiency at Design Speed
TAE	Total Analytical Error
TSTA	Tunnel Station (i.e. axial location in test section)
US-ASCII	United States American Standard Code for Information Interchange
VAN	Variable Area Nozzle
Terminology	
AIP Phase 1	Configuration with the AIP spool and AIP rakes installed
AIP Phase 2	Configuration with the AIP spool installed without rakes
AIP Phase 3	Configuration without the AIP spool
Symbols	
P _S	Static Pressure
P _{SHR}	High Response Static Pressure
P _T	Total Pressure
P _{THR}	High Response Total Pressure
T _T	Total Temperature
U	Axial Velocity
U _{FS}	Freestream Axial Velocity
W	Absolute Weight Flow
W _C	AIP-Corrected Weight Flow, $W \frac{14.696 \text{ (psia)}}{P_T} \sqrt{\frac{T_T}{518.67 \text{ (R)}}}$
η _{a,s}	Fan Stage Adiabatic Efficiency

Data Rights

The data from the Boundary Layer Ingesting Inlet / Distortion Tolerant Fan (BLI²DTF) experiment are non-proprietary; distribution is unrestricted. The geometry of the propulsor is deemed Sensitive But Unclassified (SBU). Its dissemination is restricted per NASA Interim Directive 1600.55. The geometry is not presented in this report or its accompanying databases.

Introduction

The use of Boundary Layer Ingestion (BLI) for aeropropulsion offers potential propulsive efficiency benefits by taking advantage of the low-momentum flow of the boundary layer to reduce the energy required to produce thrust.^{1, 2, 3, 4} NASA, the United Technologies Research Center, and others designed a BLI propulsor and tested it in the 8- by 6-foot Supersonic Wind Tunnel (8x6 SWT) at the NASA Glenn Research Center.^{5, 6} This report presents a large volume of data from the test. Data are presented as a set of dashboards containing plots of key variables for selected readings and a data package containing databases of steady and high response (i.e. acquired at 10,000 to 100,000 Hz) data for a much larger set of variables and readings. The objective of this report is to present the data; therefore very little detail of the data acquisition and reduction methodology or interpretation of the results is presented here. The reader is directed to the references for more detail on those topics.

Experiment Overview

The BLI²DTF experiment was performed in November and December of 2016 in the 8x6 SWT. The experimental apparatus comprised a raised floor with boundary layer control devices and an integrated short inlet/fan system representing an embedded BLI propulsion system, Figure 1. The raised floor provided a flat surface on which a boundary layer could form and a volume into which the propulsor could be embedded⁷. A replaceable set of boundary layer thickening pins and a bleed system (Figure 2) provided a means of adjusting the boundary layer entering the propulsor to match that typical of a large hybrid wing body transport aircraft. A set of floor-mounted vanes (Figure 2) reduced the influence of tunnel corner vortices on the experiment.

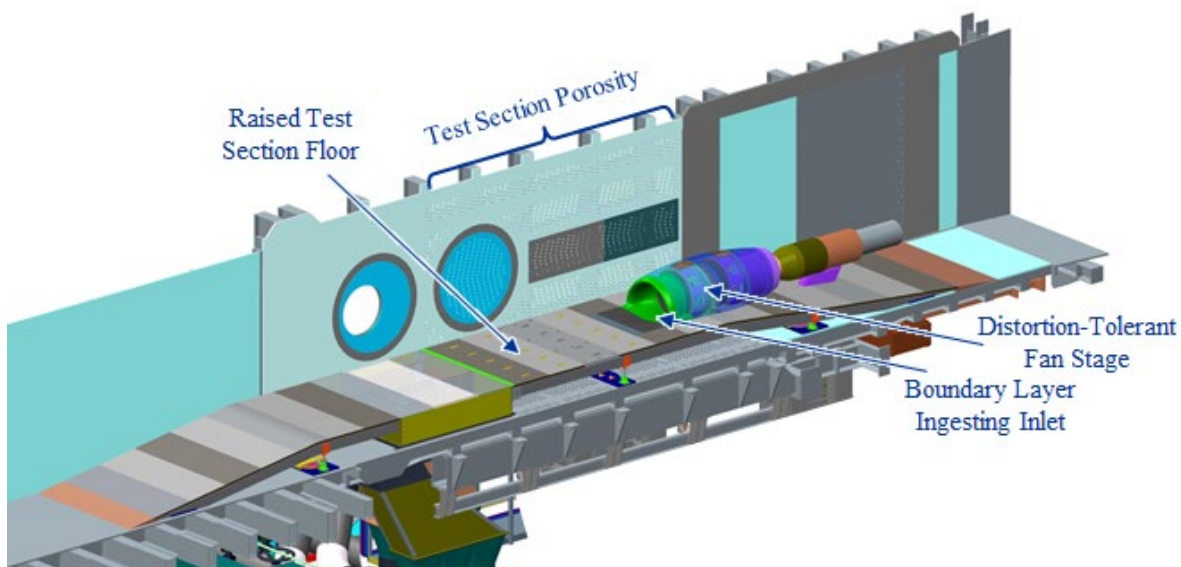


Figure 1. BLI²DTF Experiment Overview

The propulsor (Figure 3) contained a distortion-tailored inlet with pre-entry diffusion ramp and a single-stage fan with no core stream, supported by a compressed-air-powered drive system and a translating plug nozzle to control back pressure on the fan stage. The inlet was designed concurrently with the fan stage to deliver the lower-energy flow to the fan while minimizing the adverse effects of the flow field distortion. The fan stage consisted of an 18-blade rotor and a 48-blade exit guide vane assembly. The fan stage was designed for a 1.33 stage pressure ratio at Aerodynamic Interface Plane (AIP)-corrected speed of 11,387 RPM.

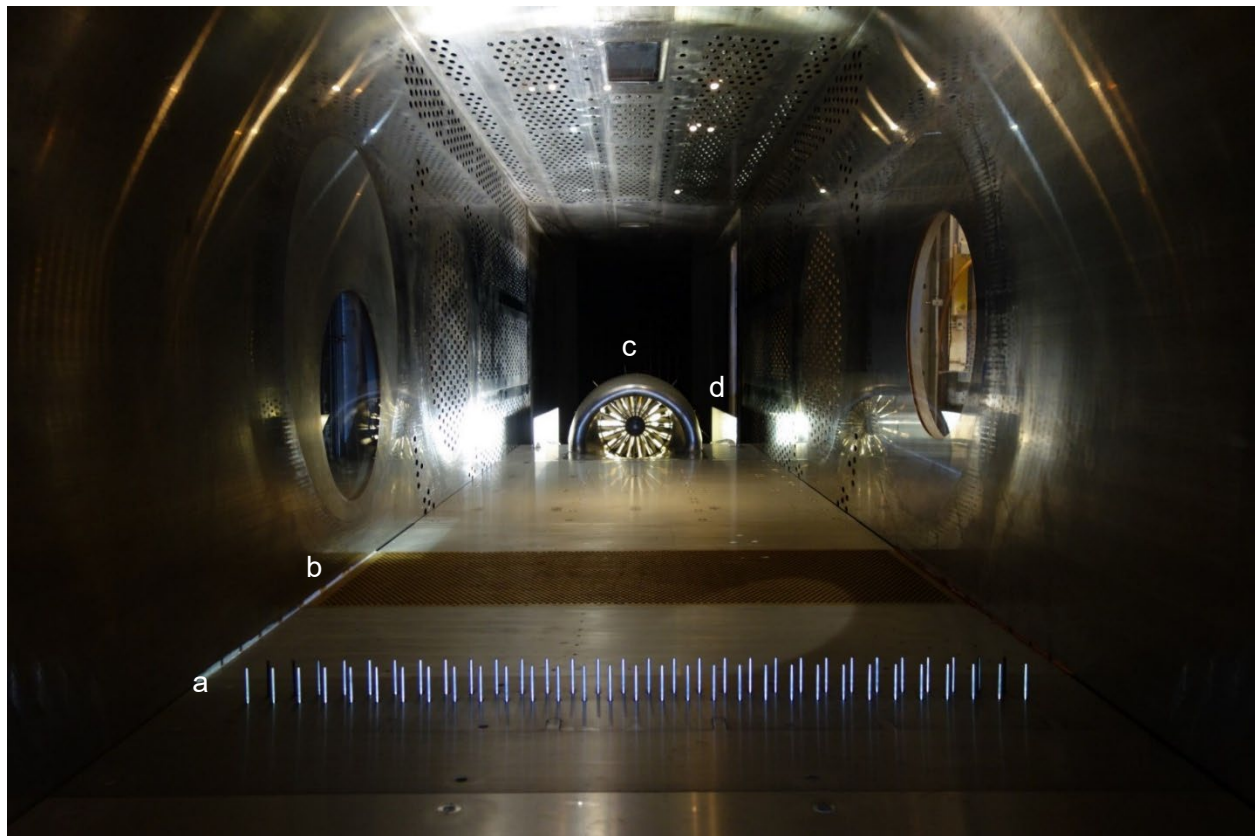


Figure 2. View of BLI²DTF Experiment, Showing a) Boundary-Layer-Thickening Pins, b) Boundary-Layer Bleed Zone, c) Propulsor, and d) Tunnel Vanes

The test consisted of 17 run days (referred to as “runs”), eight of which were dedicated to checkout and establishing safe operating procedures for the fan (“fan clearance” runs). In the remaining runs, measurements of the performance of the inlet and the fan at key operating conditions and exploration of the near-stall region of the operating envelope were performed. Several configurations were tested, the most notable being three configurations of the AIP region (Figure 4): phase 1 with the AIP spool and AIP rakes installed, phase 2 with the AIP spool installed without rakes, and phase 3 with the AIP spool removed. The inlet near-throat rakes could be used with any of these configurations but were only used with the phase 2 and 3 configurations. Appendix A gives greater detail about the test runs. A log of the readings is included with the steady database.

The experiment primarily focused on design conditions of Mach 0.78 freestream velocity, 100% of raised floor design bleed flow, which produced a 4.82" thick^A (i.e. 99% U/U_{FS}) boundary layer, 100% of design corrected fan speed at 11,387 RPM, and nozzle throat area at 87.5% of max nozzle throat area. This point was labeled the Peak Efficiency at Design Speed (PEDS) point^B. Variations of fan speed and nozzle area defined additional points of primary interest.

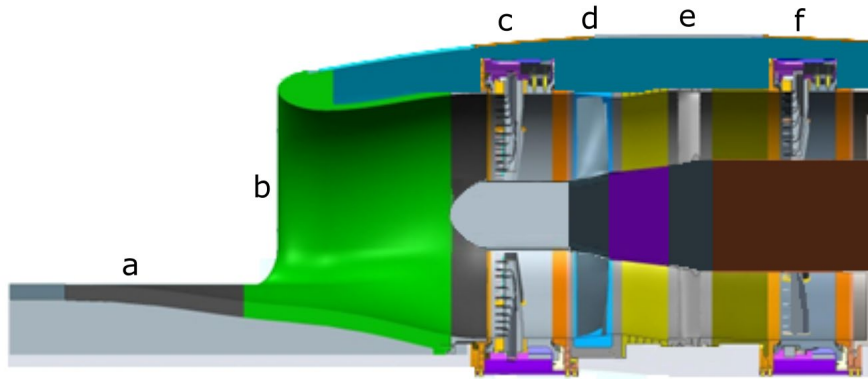


Figure 3. Cross-section of BLI2DTF Propulsor, Showing a) Inlet pre-entry diffusion ramp, b) inlet, c) AIPRRA, d) Fan, e) Exit Guide Vanes, and f) FERRA

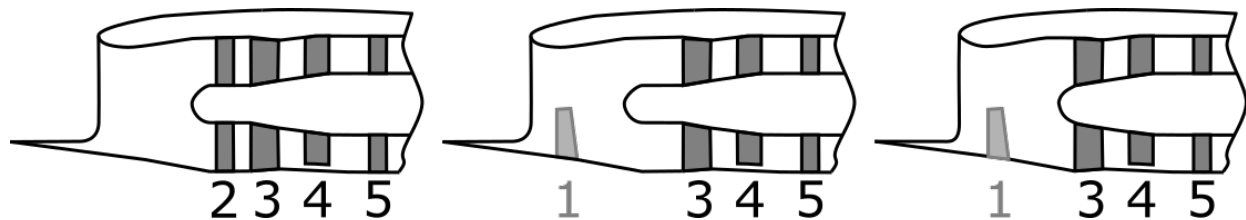


Figure 4. AIP Phases, Showing 1) Inlet Near-Throat Rakes, 2) AIPRRA Rakes, 3) Fan Rotor, 4) Exit Guide Vanes, and 5) FERRA Rakes

Instrumentation

The research rig (Figure 5) and facility (Figure 6) were heavily instrumented as summarized in Appendix B. This instrumentation included extensive static pressure measurements (both

^A The 4.82" design boundary layer thickness was chosen to match the ratio of boundary layer thickness to fan-diameter on the N2A-EXTE hybrid wing body aircraft design. Further details on the N2A-EXTE and the modeling of that aircraft in this experiment can be found in reference 6.

^B The PEDS point was referred to in previous papers as the aerodynamic design point or ADP. The authors feel this name is misleading as this point was determined during testing by finding the point at design speed where the estimated efficiency peaked, rather than choosing an operating condition a priori based on the fan design process.

steady and high response), total pressures, total temperatures, bleed flow rates, fan blade tip clearance, fan blade strain, fan speed, nozzle position, and various measurements for facility health monitoring. VAN throat area was calculated per Davis⁸, equation 21. The measurements of fan blade strain were recorded on a separate data acquisition system and are not included in this report or accompanying databases. Facility health monitoring and other non-research measurements are similarly not included.

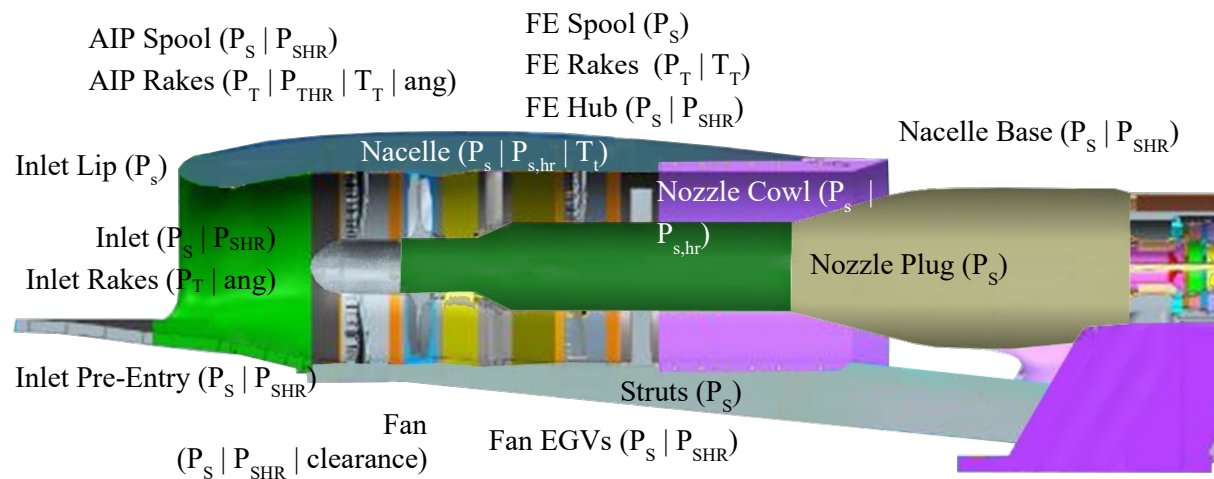


Figure 5. Rig Research Instrumentation

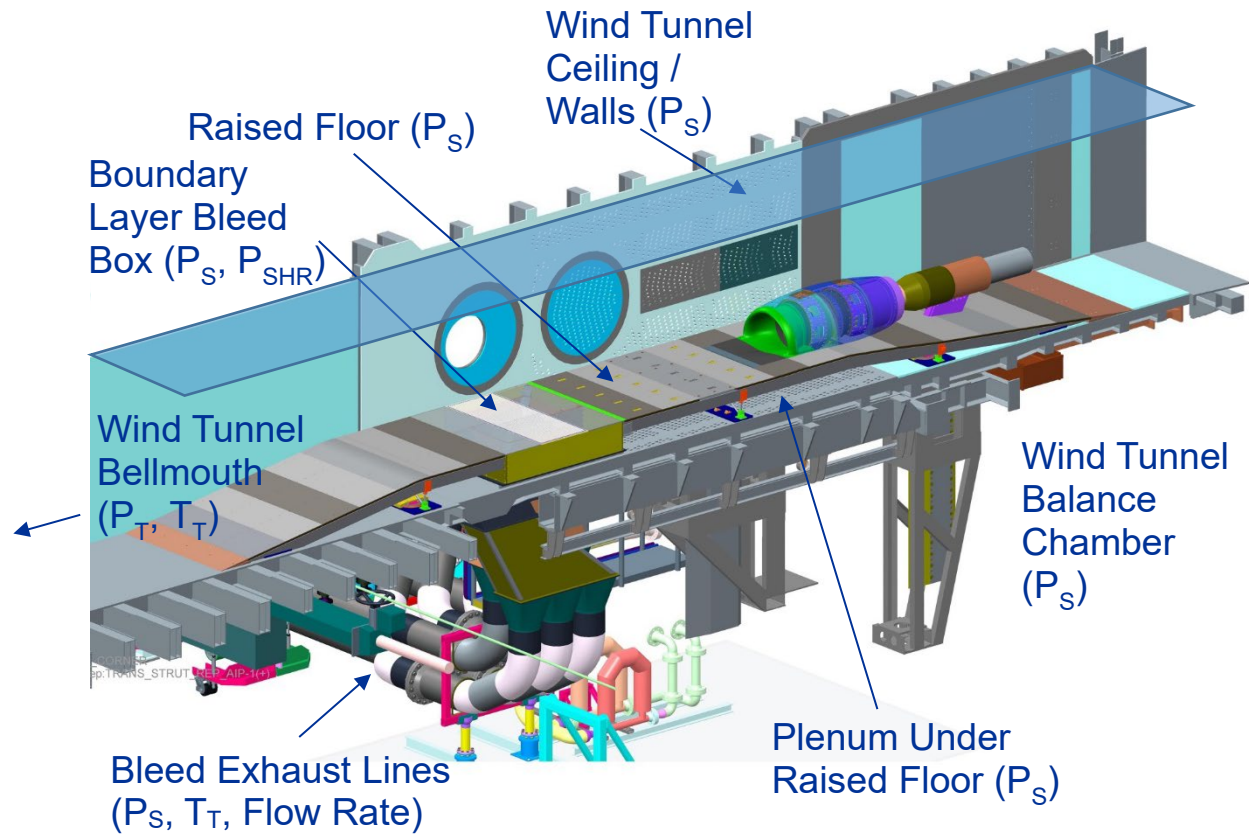


Figure 6. Facility Instrumentation

Two rotating rake arrays (RRAs),⁹ an eight-rake array upstream of the fan rotor at the AIP (array referred to as the AIPRRA) and a nine-rake array at the Fan-stage Exit (FE, array referred to as the FERRA), were used to survey the flow field at a resolution higher than could be achieved with fixed instrumentation. Table 1 summarizes the AIP surveys acquired, while Table 2 summarizes the FE surveys. The angles of the rake arrays reference the position of rake 1, with 0° at top dead center and positive angles in the counterclockwise direction, forward looking aft.

Table 1: Summary of AIP Surveys

Escort Reading	# Scans	First Angle	Last Angle	Increment	Comments
461	20	0°	95°	5°	Condition 2 – PEDS Point
478	39	0°	95°	3°	Condition 2 – PEDS Point
481	20	0°	95°	5°	Condition 12 – 88.5% Nozzle Point
485	20	0°	95°	5°	Condition 11 – 90% Nozzle Point
488	20	0°	95°	5°	Condition 9 – 92% Nozzle Point
499	20	0°	95°	5°	Condition 14 – 86.5% Nozzle Point
501	20	0°	95°	5°	Condition 15 – 85% Nozzle Point
504	20	0°	95°	5°	Condition 3 – 97.5% Speed Point

Escort Reading	# Scans	First Angle	Last Angle	Increment	Comments
506	20	0°	95°	5°	Condition 4 – 95% Speed Point
508	20	0°	95°	5°	Condition 5 – 87.5% Speed Point
510	20	0°	95°	5°	Condition 8 – 70% Speed Point
529	20	0°	95°	5°	Condition 1 – 102.5% Speed Point
531	20	0°	95°	5°	Condition 16 –126.1% Bleed Point
533	20	0°	95°	5°	Condition 17 –82% Bleed Point
535	7	0°	90°	15°	99.6% Speed, 87.2% Nozzle small change point
537	7	0°	90°	15°	99.6% Speed, 87.8% Nozzle small change point
544	7	0°	90°	15°	100.4% Speed, 87.2% Nozzle small change point
546	7	0°	90°	15°	100.4% Speed, 87.8% Nozzle small change point
548	20	0°	95°	5°	Condition 13 – 87% Nozzle Point
550	5	0°	20°	5°	~90% Nozzle Point, aborted survey
551	20	0°	95°	5°	Condition 10 – 91.3% Nozzle Point

Table 2: Summary of FE Surveys

Escort Reading	# Scans	First Angle	Last Angle	Increment	Zero Degree Scan	Comments
247	42	-100°	105°	5°	21	
280	42	-100°	105°	5°	21	Condition 2 – PEDS Point
328	42	-100°	105°	5°	21	
464	23	-100°	10°	5°	21	Condition 2 – PEDS Point
479	42	-100°	105°	5°	21	Condition 2 – PEDS Point
482	21	-100°	100°	10°	11	Condition 12 – 88.5% Nozzle Point
486	21	-100°	100°	10°	11	Condition 11 – 90% Nozzle Point
489	21	-100°	100°	10°	11	Condition 9 – 92% Nozzle Point
500	21	-100°	100°	10°	11	Condition 14 – 86.5% Nozzle Point
502	21	-100°	100°	10°	11	Condition 15 – 85% Nozzle Point
505	21	-100°	100°	10°	11	Condition 3 – 97.5% Speed Point
507	21	-100°	100°	10°	11	Condition 4 – 95% Speed Point
509	21	-100°	100°	10°	11	Condition 5 – 87.5% Speed Point
511	21	-100°	100°	10°	11	Condition 8 – 70% Speed Point
530	21	-100°	100°	10°	11	Condition 1 – 102.5% Speed Point
532	21	-100°	100°	10°	11	Condition 16 –126.1% Bleed Point
534	21	-100°	100°	10°	11	Condition 17 –82% Bleed Point
536	11	-100°	100°	20°	6	99.6% Speed, 87.2% Nozzle small change point
538	11	-100°	100°	20°	6	99.6% Speed, 87.8% Nozzle small change point
545	11	-100°	100°	20°	6	100.4% Speed, 87.2% Nozzle small change point
547	11	-100°	100°	20°	6	100.4% Speed, 87.8% Nozzle small change point
549	11	-100°	100°	20°	6	Condition 13 – 87% Nozzle Point
552	11	-100°	100°	20°	6	Condition 10 – 91.3% Nozzle Point
577	42	-100°	105°	5°	21	Condition 2 – PEDS Point
579	42	-100°	105°	5°	21	Condition 9 – 92% Nozzle Point

Escort Reading	# Scans	First Angle	Last Angle	Increment	Zero Degree Scan	Comments
629	42	-100°	105°	5°	21	88.5% Nozzle Point, bleed setting error
630	42	-100°	105°	5°	21	90% Nozzle Point, bleed setting error
631	42	-100°	105°	5°	21	86.5% Nozzle Point, bleed setting error
632	43	-100°	105°	5°	21	Two scans at +15 deg
637	42	-100°	105°	5°	21	Condition 15 – 85% Nozzle Point
638	42	-100°	105°	5°	21	Condition 3 – 97.5% Speed Point
645	42	-100°	105°	5°	21	Condition 4 – 95% Speed Point
653	42	-100°	105°	5°	21	Condition 5 – 87.5% Speed Point
654	42	-100°	105°	5°	21	Condition 8 – 70% Speed Point
655	42	-100°	105°	5°	21	85% Speed Point
662	42	-100°	105°	5°	21	Condition 1 – 102.5% Speed Point
663	42	-100°	105°	5°	21	Condition 17 – 82% Bleed Point
664	42	-100°	105°	5°	21	Condition 16 – 126.1% Bleed Point
665	21	-100°	100°	10°	11	99.6% Speed, 87.2% Nozzle small change point
666	21	-100°	100°	10°	11	99.6% Speed, 87.8% Nozzle small change point
667	21	-100°	100°	10°	11	100.4% Speed, 87.2% Nozzle small change point
668	21	-100°	100°	10°	11	100.4% Speed, 87.8% Nozzle small change point
669	42	-100°	105°	5°	21	Condition 13 – 87% Nozzle Point
670	42	-100°	105°	5°	21	Condition 10 – 91.3% Nozzle Point
694	21	-100°	100°	10°	11	97.5% Nozzle Point
695	22	0°	100°	5°	1	Condition 14 – 86.5% Nozzle Point, two scans at +0 deg
696	21	-100°	100°	10°	11	Condition 12 – 88.5% Nozzle Point
697	21	-100°	100°	10°	11	Condition 11 – 90% Nozzle Point
708	42	-100°	105°	5°	21	PEDS Point
936	22	-100°	100°	10°	11	Mach 0.12, low bleed point, two scans at +90 deg
946	42	-100°	105°	5°	21	80% Speed, 81.5% Nozzle Point, two scans at +90 deg
957	42	-100°	105°	5°	21	85% Speed, 84% Nozzle Point
961	21	-100°	100°	10°	11	87.5% Speed, 81.5% Nozzle Point
988	21	-100°	100°	10°	11	PEDS Point

Data Sources

Several data acquisition systems were used in the BLI²DTF experiment. This report presents data acquired by two of these systems, the Escort^C system used to acquire and process steady

^C Escort is a legacy data acquisition and reduction system developed at NASA Glenn.
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measurements, and the high-response Dewetron data system used to acquire the high response measurements.

Three Dewetron dynamic data acquisition systems were configured and used throughout the test program to simultaneously acquire a total of 113 channels of high response research test data. Two of these systems, designated Dewetrons #1 and #2 were Dewe-Book-PCI-64 models featuring Dewe-Orion-1624 data acquisition boards which supported a maximum of 64 input data channels each. Dewetron #1 was used to record the time varying total and static pressure measurements made by the AIPRRA, and the static pressure in each of the segmented raised floor bleed chambers. Dewetron #2 was set to record the BLI inlet internal static pressure distribution as well as an assortment of external propulsion nacelle, fan duct, nozzle and key fan drive system accelerometer measurements that were driven by distortion ingestion. Dewetron #3, was a Dewe-43 model which featured the same electronics as the Dewe-Book-PCI-64 systems albeit with fewer channels. It was used to record the over-the-rotor static pressure measurements needed to detect fan stall as well as fan mechanical speed and synchronizing one-per-rev signals. These systems provided high resolution (24-bit), high speed (i.e. up to 200kS/s per channel) and high accuracy (0.002 dB inter channel gain mismatch) recording of the BLI2DTF test data. Each channel featured its own sigma-delta anti-alias filter that was automatically internally set to one-half the sampling frequency. Instrumentation channels were allocated to these units in accordance with data acquisition rate, type and functional grouping requirements to facilitate post test data reduction while minimizing the overall size of the resulting database.

Uncertainty

Several performance measures are calculated from the steady data. Calculated total analytical error¹¹ values (TAE) for these parameters are listed in Table 3.

Table 3. Maximum Total Analytical Error (TAE) for Performance Parameters, from Reference 10

	Survey	Snapshot
AIP P_T	0.051 PSIA	0.051 PSIA
AIP T_T	0.54 R	0.60 R
FE P_T	0.051 PSIA	0.211 PSIA
FE T_T	0.52 R	2.33 R
W_C	0.47 lbm/s	4.41 lbm/s
$\eta_{a,s}$	3.1%	5.0%

Methods

Three types of readings were acquired using the Escort steady data acquisition system: snapshot, continuous, and survey. A snapshot reading is a record of a short period in time, recorded as the average of 10 acquisitions at 1-second intervals. A continuous reading records a series of un-averaged 1-second scans. A survey reading is a recording of multiple snapshots, each taken at a different position of one of the rotating rake arrays. The data in the steady

database was selected for its research relevance. Channels used for rig health monitoring, spare channels, and channels which duplicated data in other channels, as well as diagnostic readings taken when the rig was not operating and readings which did not meet research quality standards were not included in the database.

To provide performance data for the dashboards, steady survey data was assembled and processed as described in reference 10. For a limited number of conditions shown in red in the table in Appendix C, survey data was not collected, so an equivalent snapshot reading was used instead. For these snapshot readings, the GI Near sparse data enhancement method¹² was used to estimate performance values.

High response data were acquired in parallel with Escort steady state data readings throughout the test program. All three Dewetron systems were automatically triggered simultaneously with Escort steady state data acquisition for a set record length. The record length was nominally set for 30 seconds to ensure that representative peak values of BLI inlet total pressure distortion were captured. Due to some imprecision in the interfacing electronics associated with the steady state data acquisition system, the actual record length varied slightly by an insignificant amount.

High response data were acquired at different rates by the respective Dewetron data acquisition systems and were adjusted throughout the duration of the wind tunnel test program as needed. Data recorded by Dewetrons #1 and #2 were acquired at lower rates than Dewetron #3 which was used to record the much higher frequency aerodynamic response of individual fan blades to the incident distorted BLI flow. These settings are provided in Appendix A for the entire test program inclusive of the seventeen test conditions reported herein.

Dashboards

Seventeen operating conditions, listed in Appendix C, were selected for presentation in this report. The dashboards in Appendix D present data for seventeen test conditions for freestream Mach number of 0.78. These conditions include the PEDS point, and sets of variations from the PEDS point in fan corrected speed (7 points), fan-stage-exit-corrected flow (7 points), or raised floor bleed rate, which generates two variants of ingested boundary layer thickness (2 points). Appendix C comprises a table of the conditions organized in three sections reflecting the three sets of variations. To remind the reader that the PEDS point is common to all three sets of variations, it is repeated in Appendix C. While the PEDS point was acquired more than once during the experiment, the results were highly consistent. Therefore, it is not repeated in Appendix D. In all plots, pressures and temperatures are normalized to freestream total pressure and temperature.

Dashboard D.x.1 presents A) a table of conditions and reading numbers for the D.x dashboards; B) A fan map which shows the location of the D.x dashboard data, denoted by a star; C) normalized static pressure for various pressure taps external to the nacelle; D) normalized static pressure along the centerline of the inlet (top and bottom surfaces); and E) normalized static pressure from the inlet throat rakes.

Dashboard D.x.2 presents plots from the AIPRRA and FERRA surveys: A) normalized total pressure contours at the AIP; B) normalized total temperature contours at the AIP; C) normalized total pressure contours at the FE; D) normalized total temperature contours at the FE; and E) AIP swirl angle at two radial locations.

Dashboard D.x.3 presents inlet static pressures (time domain) from the 21 inlet high-response pressure transducers.

Dashboard D.x.4 presents spectra (frequency domain) of the same 21 inlet high-response pressure transducers.

Dashboard D.x.5 (D.2.7 for the PEDS point) presents AIP total pressures (time domain) from the 40 AIPRRA high-response pressure transducers.

Dashboard D.x.6 (D.2.8 for the PEDS point) presents AIP distortion intensities for the five rings of AIPRRA high-response pressure transducers. The first column shows radial distortion intensities in the time domain. The second column shows circumferential distortion intensities in the time domain. The third column shows circumferential vs. radial distortion intensities.

Dashboard D.2 contains 10 additional figures of high-response pressure data. These plots were very similar for other points and are not shown for those points in Appendix D, but the data is available in the high-response database.

Dashboard D.2.5 presents over-the-rotor normalized static pressure (time domain) for four leading edge high-response pressure transducers and five trailing edge high-response pressure transducers for the PEDS point.

Dashboard D.2.6 presents over-the-rotor normalized static pressure spectra (frequency domain) for the same nine leading-edge and trailing-edge high-response pressure transducers for the PEDS point.

Dashboard D.2.9 presents normalized static pressure (time domain) for eight AIP case high-response pressure transducers for the PEDS point.

Dashboard D.2.10 presents normalized static pressure spectra (frequency domain) for the same eight AIP case high-response pressure transducers for the PEDS point.

Dashboard D.2.11 presents normalized static pressure (time domain) for the six raised floor bleed plenum high-response pressure transducers for the PEDS point.

Dashboard D.2.12 presents normalized static pressure spectra (frequency domain) for the same six raised floor bleed plenum high-response pressure transducers for the PEDS point.

Dashboard D.2.13 presents normalized static pressure (time domain) for the four external nacelle high-response pressure transducers for the PEDS point.

Dashboard D.2.14 presents normalized static pressure spectra (frequency domain) for the same four external nacelle high-response pressure transducers for the PEDS point.

Dashboard D.2.15 presents normalized static pressure (time domain) for the three FERRA hub, two nozzle throat, and two nozzle exit high-response pressure transducers for the PEDS point.

Dashboard D.2.16 presents normalized static pressure spectra (frequency domain) for the same three FERRA hub, two nozzle throat, and two nozzle exit high-response pressure transducers for the PEDS point.

Databases

The database package consists of two databases, one for steady data, and one for unsteady data. The package includes two files which apply to both databases: 1) a readme file, and 2) a listing of individual instruments with locations (except where those locations reveal geometric details which are SBU). Both of these files are in United States American Standard Code for Information Interchange (US-ASCII) format, the former a text document, and the latter a comma separated values (CSV) file. The databases are available by contacting one of the following points of contact: Frank Kaufhold, Subproject Manager for Propulsion Technologies, Advanced Air Transport Technology (AATT) Project; Julia Stephens, Chief Technologist for Propulsion, AATT; or Julie Dudek, Chief, Inlets and Nozzles Branch.

Steady Database

The steady database consists of three files: 1) the database, 2) an index to the variables, and 3) an index to the readings which lists each reading number in the database and a summary of test conditions. All of these files are in US-ASCII CSV format. The database contains 864 readings (each of which contains one or more records, for a total of 28,162 records) by 990 variables (each of which contains one or more channels for a total of 5,771 channels). Each row in the database holds a record and each column holds a channel.

High Response Database

The high-response database consists of six files for each of the seventeen conditions listed in Appendix C. One pair of files exists for each of the three dynamic data acquisition system recordings. Each pair of files includes a header file written in US-ASCII text format and a corresponding multiplexed data file written in IEEE 754¹³ binary format. The header file provides an ordered listing of the sampled channels, sample rate, time of data acquisition and engineering units information.

To allow practitioners to use the tools and techniques of their choosing in processing the data, the high response BLI2DTF experiment database is provided in its raw form. In order to provide insight into the data that were acquired prior to users' data analysis, processed results are provided in the dashboards in Appendix D.

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Appendix A Run Summary

Run	Date	Steady Data System	High Response Data System		Description	AIP Spool	AIP Rakes	Inlet Rakes	Tunnel Vanes
		Rdgs	Rdgs	Sample Rates, kHz					
1	4-Nov-16	131-142	8-22	10-10-50	AIP spool in, no AIP rakes, no inlet rakes. Checkout run with wing blowers. 130 Escort readings were taken during prior computing checks, so test starts with 131.	✓			✓
2	7-Nov-16	143-196	26-81	10-10-50	AIP spool in, no AIP rakes, no inlet rakes. Fan clearance run.	✓			✓
3	8-Nov-16	197-252	82-181	10-10-50	AIP spool in, no AIP rakes, no inlet rakes. Fan clearance run.	✓			✓
4	10-Nov-16	253-273	182-202	10-10-50	AIP spool in, no AIP rakes, no inlet rakes. Fan clearance run.	✓			✓
5	14-Nov-16	274-310	204-288	10-10-50	AIP spool in, no AIP rakes, no inlet rakes. Fan clearance run.	✓			✓
6	15-Nov-16	311-332	299-361	10-10-50	AIP spool in, no AIP rakes, inlet rakes installed. Fan clearance run.	✓		✓	✓
7	16-Nov-16	333-365	363-396	10-10-50	AIP spool in, no AIP rakes, inlet rakes installed. Fan clearance run.	✓		✓	✓
8	18-Nov-16	366-465	400-542	10-10-50	AIP spool with rakes installed, no inlet rakes. Fan clearance run.	✓	✓		✓
9	21-Nov-16	466-493	543-728	10-10-50	AIP spool with rakes installed, no inlet rakes. Cruise mapping run.	✓	✓		✓
10	22-Nov-16	494-539	729-947	10-10-50	AIP spool with rakes installed, no inlet rakes. Cruise mapping run.	✓	✓		✓
11	23-Nov-16	540-561	948-1019	10-10-50	AIP spool with rakes installed, no inlet rakes. Cruise mapping run.	✓	✓		✓
12	2-Dec-16	562-617	1020-1084	10-10-50	No inlet rakes, AIP spool or AIP rakes. Short inlet clearance and cruise mapping run.				✓
		618-623	1085-1091	10-20-50					
13	5-Dec-16	624-635	1092-1105	10-50-50	No inlet rakes, AIP spool or AIP rakes. Cruise mapping run (continued).				✓
		636-636	1106-1107	10-50-100					
		637-638	1108-1110	10-50-50					
		639-656	1111-1128	10-50-100					
14	6-Dec-16	657-703	1129-1177	10-50-100	No inlet rakes, AIP spool or AIP rakes. Cruise mapping run (continued) including explorations nearer to stall line.				✓
15	8-Dec-16	704-929	1178-1405	10-50-100	Inlet rakes installed, AIP spool and rakes out. Cruise mapping run.			✓	✓
16	9-Dec-16	930-983	1406-1458	10-50-100	Inlet rakes installed, AIP spool and rakes out. Miscellaneous explorations: wind off, bleed variations, Mach sensitivity.			✓	✓
17	9-Dec-16	984-1009	1459-1484	10-50-100	Inlet rakes installed, tunnel vanes out, AIP spool and rakes out. Vane effects run.			✓	

Appendix B Instrumentation Summary

Subsystem	Location	Measurement Type	Inst. Qty	Goes To	Name ^D	AIP-1	AIP-2	AIP-3
Raised Floor	Surface	Static Pressure (Steady-State), PSIA	132	Escort	PSRF@# # = 01-08 or 13-26	X	X	X
Raised Floor	Surface	Static Pressure (Steady-State), PSIA	2	Escort	PSRFB18A, PSRFQ18A	X	X	X
Raised Floor Plenum	Under-side surface	Static Pressure (Steady-State), PSIA	9	Escort	PSRP(1-9)	X	X	X
Bleed Box	4" upstream of bleed holes	Static Pressure (Steady-State), PSIA	18	Escort	PSRF@# # = 10 or 11 only	X	X	X
Bleed Box	Mid-panel fore/aft	Static Pressure (Steady-State), PSIA	12	Escort	PSRF@# # = 9 or 12 only	X	X	X
Bleed Box	Plenums	Static Pressure (Steady-State), PSIA	6	Escort	PSBP@	X	X	X
Bleed Box	Plenums	Static Pressure (High Response), PSIA	6	Escort	PDBP@	X	X	X
Bleed System	8" Lines	Static Pressure (Steady-State), PSIA	6	Escort	PSBA8(1-6)	X	X	X
Bleed System	12" Lines	Static Pressure (Steady-State), PSIA	6	Escort	PSBA12(1-6)	X	X	X

^D In the variable names, the symbol "@" represents an alphabetic character and the symbol "#" represents one or more digits

Subsystem	Location	Measurement Type	Inst. Qty	Goes To	Name ^D	AIP-1	AIP-2	AIP-3
Bleed System	16" Lines	Static Pressure (Steady-State), PSIA	6	Escort	PSBA16(1-6)	X	X	X
Bleed System	8" Lines	Thermocouple	6	Escort	TBA8(1-6)	X	X	X
Bleed System	8" Lines	Flow Rate, lbm/s	6	Escort	WFBA8(1-6)	X	X	X
Inlet Pre-Entry	Surface	Static Pressure (Steady-State), PSIA	20	Escort	PSIR(1-20)	X	X	X
Inlet Lip	5 rows of 5 roughly equidistant circumferentially	Static Pressure (Steady-State), PSIA	25	Escort	PSIL(1-25)	X	X	X
Inlet	Surface	Static Pressure (Steady-State), PSIA	100	Escort	PSII(1-100)	X	X	X
Inlet	Surface	Static Pressure (High Response), PSIA	13	Dewetron	PDIN(1-13)	X	X	X
Inlet Near-Throat Rakes	5 rakes	Total Pressure (Steady-State), PSIA	42	Escort	PT20(1-42)	X	X	X
Inlet Near-Throat Short (Type 2) Rakes	2 of 5 rakes	Flow Angularity Probe (5-Hole, Steady-State), PSIA	10	Escort	P520(1-10)	X	X	X
Inlet Near-Throat Wall	Surface	Static Pressure (Steady-State), PSIA	8	Escort	PSIT(1-8)	X	X	X
AIP Spool	Case surface	Static Pressure (Steady-State), PSIA	8	Escort	PSAIPO(1-8)	X	X	
AIP Spool	Case surface	Static Pressure (High Response), PSIA	8	Dewetron	PDAIPO(1-8)	X	X	
AIPRRR Rake	AIP plane	Total Pressure (Steady-State), PSIA	32	Escort	PTAIPE#	X		

Subsystem	Location	Measurement Type	Inst. Qty	Goes To	Name ^D	AIP-1	AIP-2	AIP-3
AIPRRRA Rake (Prati probe)	AIP plane	Total Pressure in Prati Probe (Steady-State), PSIA	40	Escort	PTAIDE#	X		
AIPRRRA Rake (Prati probe)	AIP plane	Total Pressure in Prati Probe (High Response), PSIA	40	Dewetron	DPTAIP#	X		
AIPRRRA Rake (Cobra probe)	AIP plane	Cobra Probe (3-Hole, Steady-State), PSIA	24	Escort	P3AIP(1-24)	X		
AIPRRRA Rake	AIP plane	Thermocouple	8	Escort	TTAIP(1-8)	X		
Fan Stage	Case surface between fan and EGVs	Static Pressure (Steady-State), PSIA	40	Escort	PSFDO(1-40)	X	X	X
Fan Stage		Static Pressure (High Response), PSIA	6	Dewetron	PDFS(1-3)	X	X	X
Fan		Clearance Sensors	8	BTCMS -> Escort	CAP(1-8)	X	X	X
FEGV	Near leading / trailing edge of vanes	Static Pressure (Steady-State), PSIA	16	Escort	PSVLEO(1-8) PSVTEO(1-8)	X	X	X
FEGV	Near trailing edge of vanes	Static Pressure (High Response), PSIA	4	Dewetron	PDVTEO#	X	X	X
FERRA Casing		Static Pressure (Steady-State), PSIA	9	Escort	PS16OE(1-9)	X	X	X
FERRA Rake	FE plane	Total Pressure (Steady-State), PSIA	54	Escort	PT16E(1-54)	X	X	X

Subsystem	Location	Measurement Type	Inst. Qty	Goes To	Name ^D	AIP-1	AIP-2	AIP-3
FERRA Rake	FE plane	Thermocouple	52	Escort	TT16E(1-52)	X	X	X
FERRA Hub	FE plane	Static Pressure (Steady-State), PSIA	9	Escort	PS16IE(1-9)	X	X	X
FERRA Hub	FE plane	Static Pressure (High Response), PSIA	3	Dewetron	PD16I#	X	X	X
Nozzle Strut Supports	Narrowest part of passage midway between struts	Static Pressure (Steady-State), PSIA	5	Escort	PSSTO(1-5)	X	X	X
VAN Cowl	Nozzle duct	Static Pressure (Steady-State), PSIA	5	Escort	PSZDO(1-5)	X	X	X
VAN Cowl	Nozzle throat	Static Pressure (Steady-State), PSIA	5	Escort	PSZTO(1-5)	X	X	X
VAN Cowl	Nozzle exit	Static Pressure (Steady-State), PSIA	5	Escort	PSZEO(1-5)	X	X	X
VAN Cowl	Nozzle throat and exit	Static Pressure (High Response), PSIA	4	Dewetron	PDZTO(1-2), PDZEO(1-2)	X	X	X

Subsystem	Location	Measurement Type	Inst. Qty	Goes To	Name ^D	AIP-1	AIP-2	AIP-3
VAN Plug		Static Pressure (Steady-State), PSIA	28	Escort	PSZPI(1-28)	X	X	X
VAN Plug		Linear Variable Differential Transformer, in	2	Escort	NOZPOS, NOZPOSX	X	X	X
Nacelle	Surface	Static Pressure (Steady-State), PSIA	32	Escort	PSNC(1-32)	X	X	X
Nacelle	Surface	Static Pressure (High Response), PSIA	3	Dewetron	PDNC(1-3)	X	X	X
Nacelle	Single element rakes	Thermocouple	5	Escort	TTNC(1-5)	X	X	X
Nacelle Base	Surface	Static Pressure (Steady-State), PSIA	9	Escort	PSNCB(1-9)	X	X	X
Nacelle Base	Surface	Static Pressure (High Response), PSIA	1	Dewetron	PDNCB	X	X	X
Balance/Telemetry		Static Pressure (High Response), PSIA	4	Dewetron	PDFB(1-4)?	X	X	X
Balance/Telemetry		Fan Speed (180 pulses/rev), RPM	2	Dewetron	180REV	X	X	X
Drive Rig		Fan Speed (1 pulse/rev), RPM	2	Dewetron	1REV, 1REVS	X	X	X
Drive Rig		Fan Speed (60 pulses/rev), RPM	1	Escort	RPM	X	X	X
Tunnel	Ceiling	Static Pressure (Steady-State), PSIA	31	Escort	PCEIL(1-31)	X	X	X
Tunnel	Ceiling, downstream	Static Pressure (Steady-State), PSIA	8	Escort	PCEILD(1-8)	X	X	X
Tunnel	Mostly on ceiling	Static Pressure (Steady-State), PSIA	9	Escort	PROW1(1-6)	X	X	X
Tunnel	Ceiling	Static Pressure (Steady-State), PSIA	10	Escort	PROW2(1-10)	X	X	X
Tunnel	South wall centerline	Static Pressure (Steady-State), PSIA	22	Escort	PWALL(1-31)	X	X	X

Subsystem	Location	Measurement Type	Inst. Qty	Goes To	Name ^D	AIP-1	AIP-2	AIP-3
Tunnel	Walls	Static Pressure (Steady-State), PSIA	2	Escort	PWALL1N, PWALL1S	X	X	X
Tunnel	Balance Chamber	Static Pressure (Steady-State), PSIA	4	Escort	PSBAL(1-4)	X	X	X
Tunnel	Bellmouth	Total Pressure (Steady-State), PSIA	8	Escort	PTBM(1-8)	X	X	X
Tunnel	Bellmouth	Thermocouple	4	Escort	TTBM(1-4)	X	X	X

Appendix C Dashboard Conditions and Data Sources

					AIP Phase I (AIP Rakes In)			AIP Phase III (No AIP Spool)			
#	Freestream Mach Number (MO)	% Speed Corrected (PctRPMc)	Nozzle % Open (PctNoz)	% Bleed Rate (WFBA8T/ 11.1 lbm/s)	AIP Survey or Snapshot Reading	High Response Reading	FE Survey or Snapshot Reading	FE Survey or Snapshot Reading	High Response Reading	Inlet Throat Rakes In	Comment
					Points at constant nozzle position/exit-corrected flow (a.k.a. "the Arrow")						
D.1	0.78	102.5%	87.5%	100.0%	529	872	530	662	1134	770	102.5% Speed Point
D.2		100.0%			478	556	464	577	1043	708	PEDS point
D.3		97.5%			504	774	505	637	1108	724	97.5% Speed Point
D.4		95.0%			506	794	507	638	1109	725	95% Speed Point
D.5		87.5%			508	814	509	645	1117	728	87.5% Speed Point
D.6		80.0%			450	484	450	654	1125	730	80% Speed Point
D.7		75.0%			453	487	453	606	1072	731	75% Speed Point
D.8		70.0%			510	835	511	653	1124	732	70% Speed Point
					Points on the 100% speed line (a.k.a "the Bow")						
D.9		100.0%	92.0%		488	704	489	579	1045	713	92% Nozzle Point
D.10			91.3%		551	991	552	670	1142	No Data	91.3% Nozzle Point
D.11			90.0%		485	683	486	630	1170	715	90% Nozzle Point
D.12			88.5%		481	638	482	629	1169	No Data	88.5% Nozzle Point
D.2			87.5%		478	556	464	577	1043	708	PEDS point (duplicate)
D.13			87.0%		548	966	549	669	1141	718	87% Nozzle Point
D.14			86.5%		499	733	500	695	1167	767	86.5% Nozzle Point
D.15			85.0%		501	753	502	632	1100	720	85% Nozzle Point
						Bleed Variations					
D.16	87.5%		126.1%	531	892	532	664	1136	No Data	126% Bleed Point	
D.2		100.0%	478	556	464	577	1043	708	PEDS point (duplicate)		
D.17		82.0%	533	912	534	663	1135	No Data	82% Bleed Point		

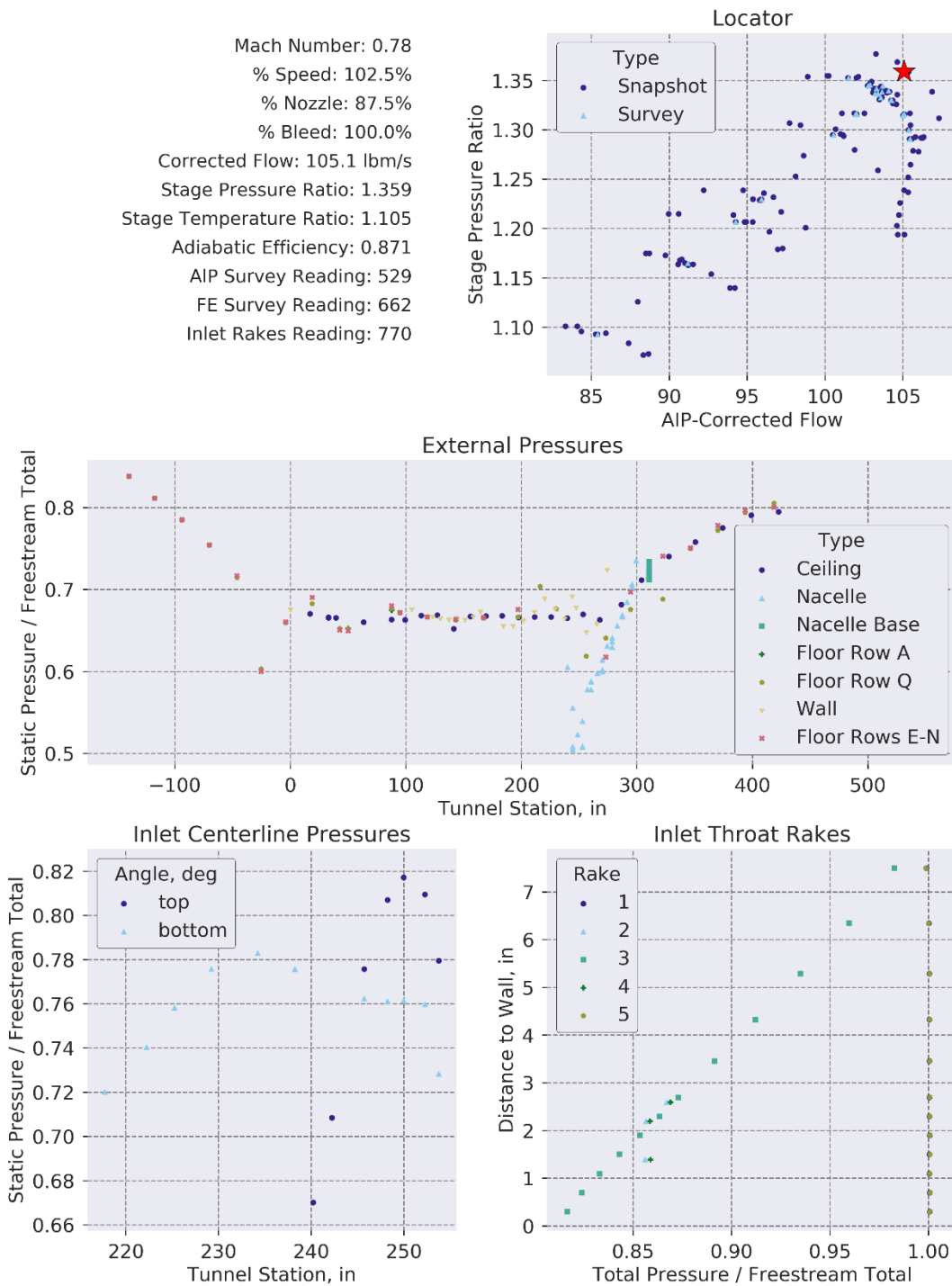
Appendix D Dashboards for Survey Points

The dashboards on the following pages are organized and labeled D.1.X through D.17.X (where X is the page within the dashboard) corresponding to the line numbers D.1 through D.17 in Appendix C. Each dashboard, except D.2 has six pages, two of steady data and four of high-response data. Dashboard D.2 has additional high-response pages which are not repeated for other dashboards because they are not visibly different at other conditions. The locator plot in the upper right of Dashboards D.N.1 indicates with a star the location of the condition on the fan map.

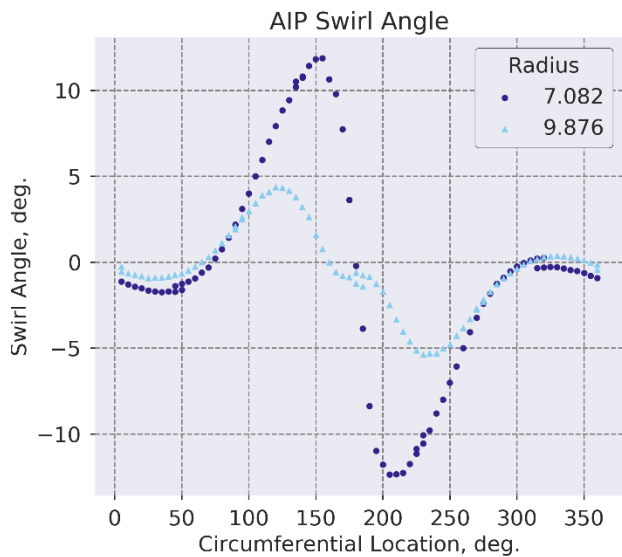
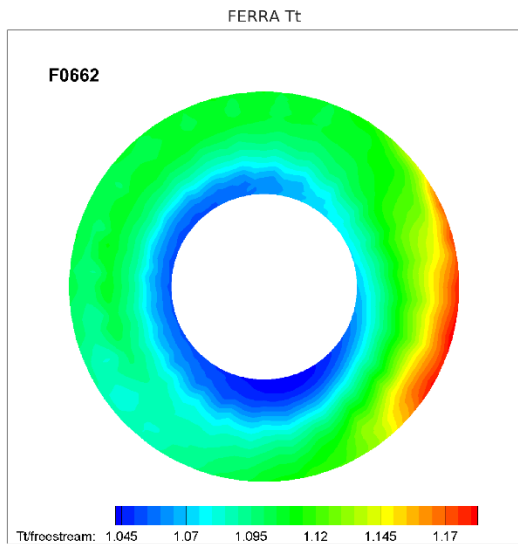
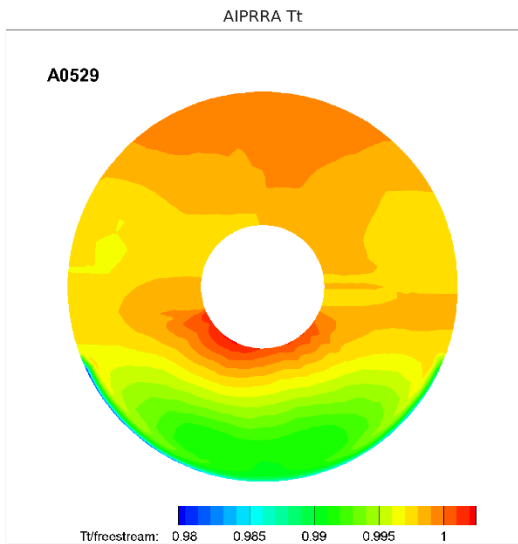
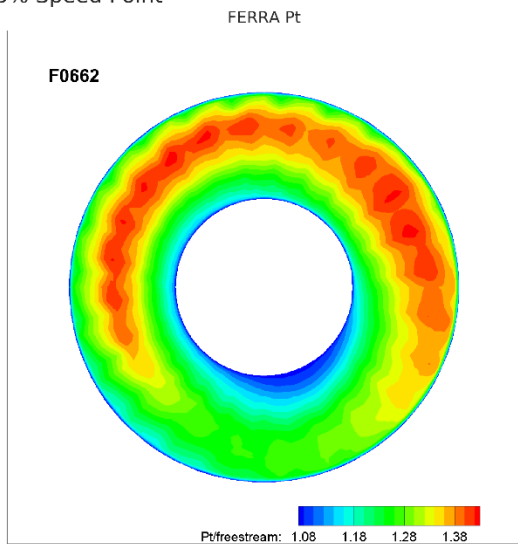
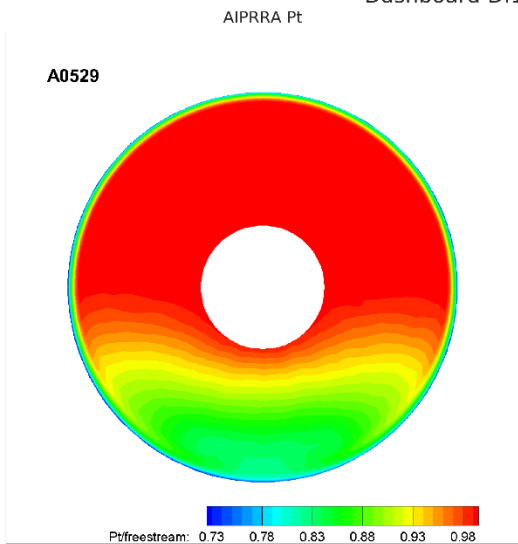
The plots of AIP and FE conditions on Dashboards D.N.2 are based on the AIP Phase I configuration for AIP data and AIP Phase III configuration for FE data. The FE surveys for AIP Phase I look nearly identical to those of AIP Phase III, except the pressure values are slightly lower due to the wakes from the AIPRRA rakes.

The spectra plots on Dashboards D.N.4 and D.N.6 are based on the AC component of the signal, i.e. they are not power spectra.

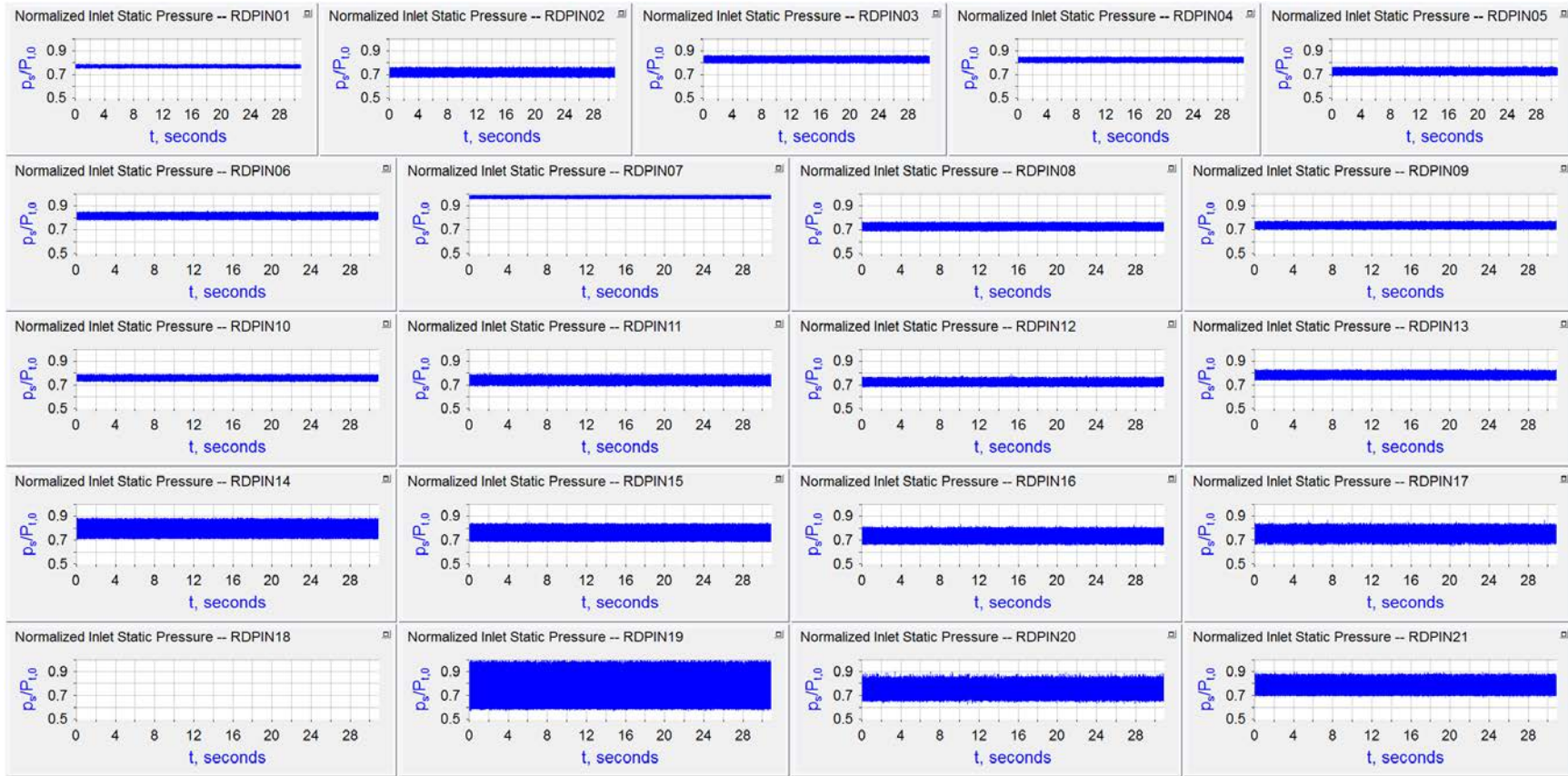
Dashboard D.1.1: 102.5% Speed Point



Dashboard D.1.2: 102.5% Speed Point

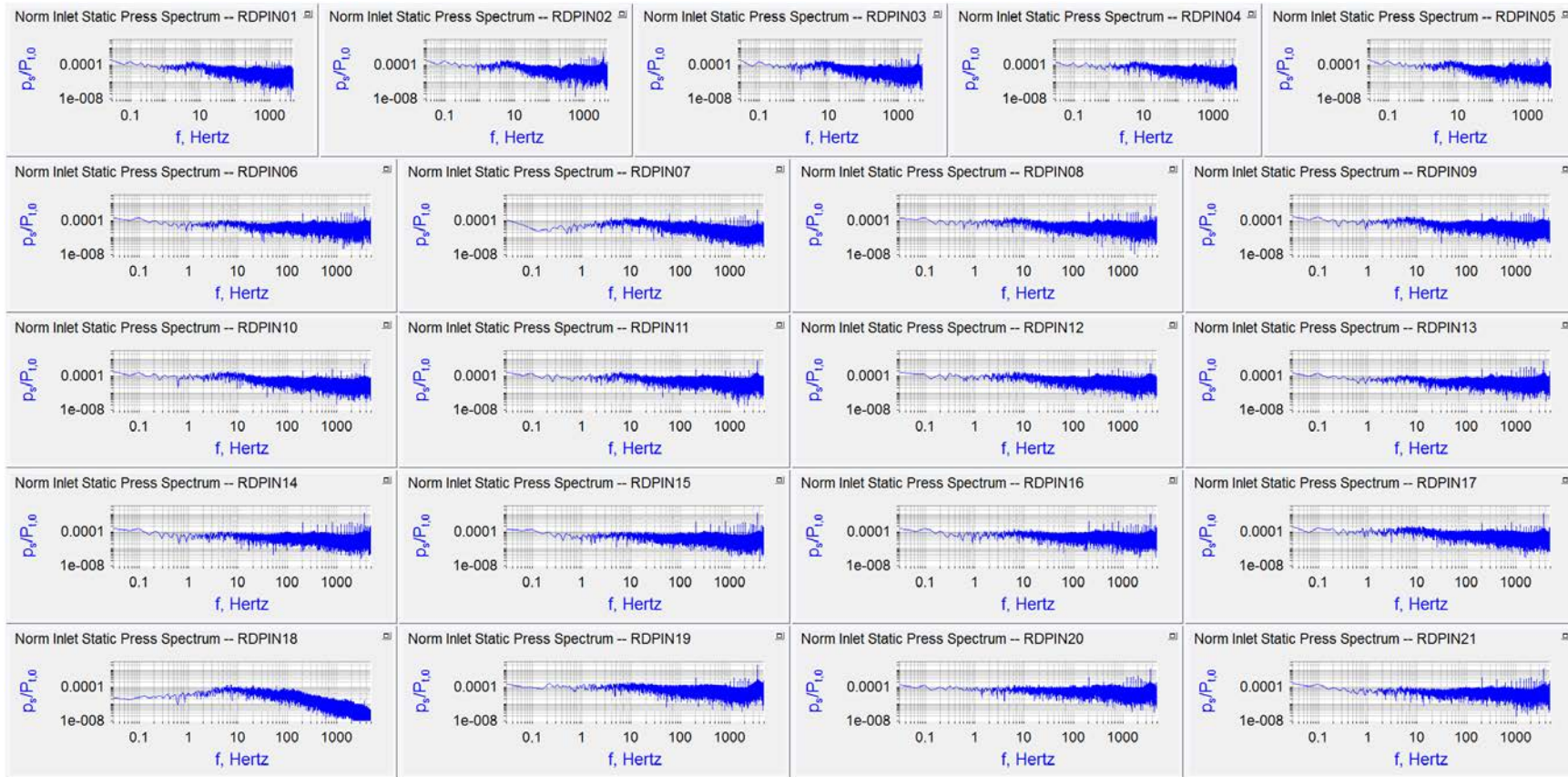


Dashboard D.1.3: 102.5% Speed Point, AIP-3



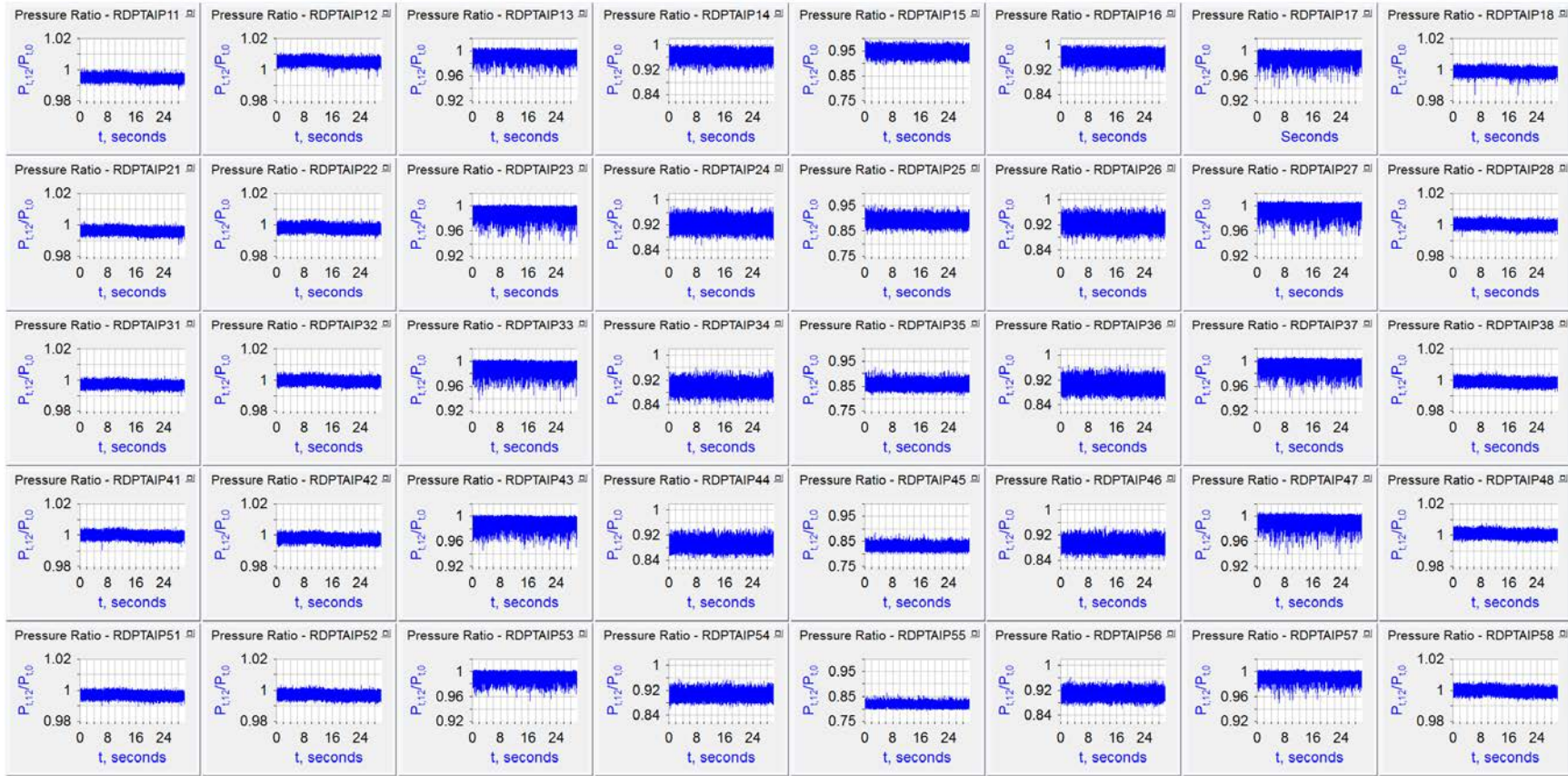
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=102.5\%$, $A_{10}=87.5\%$)

Dashboard D.1.4: 102.5% Speed Point, AIP-3



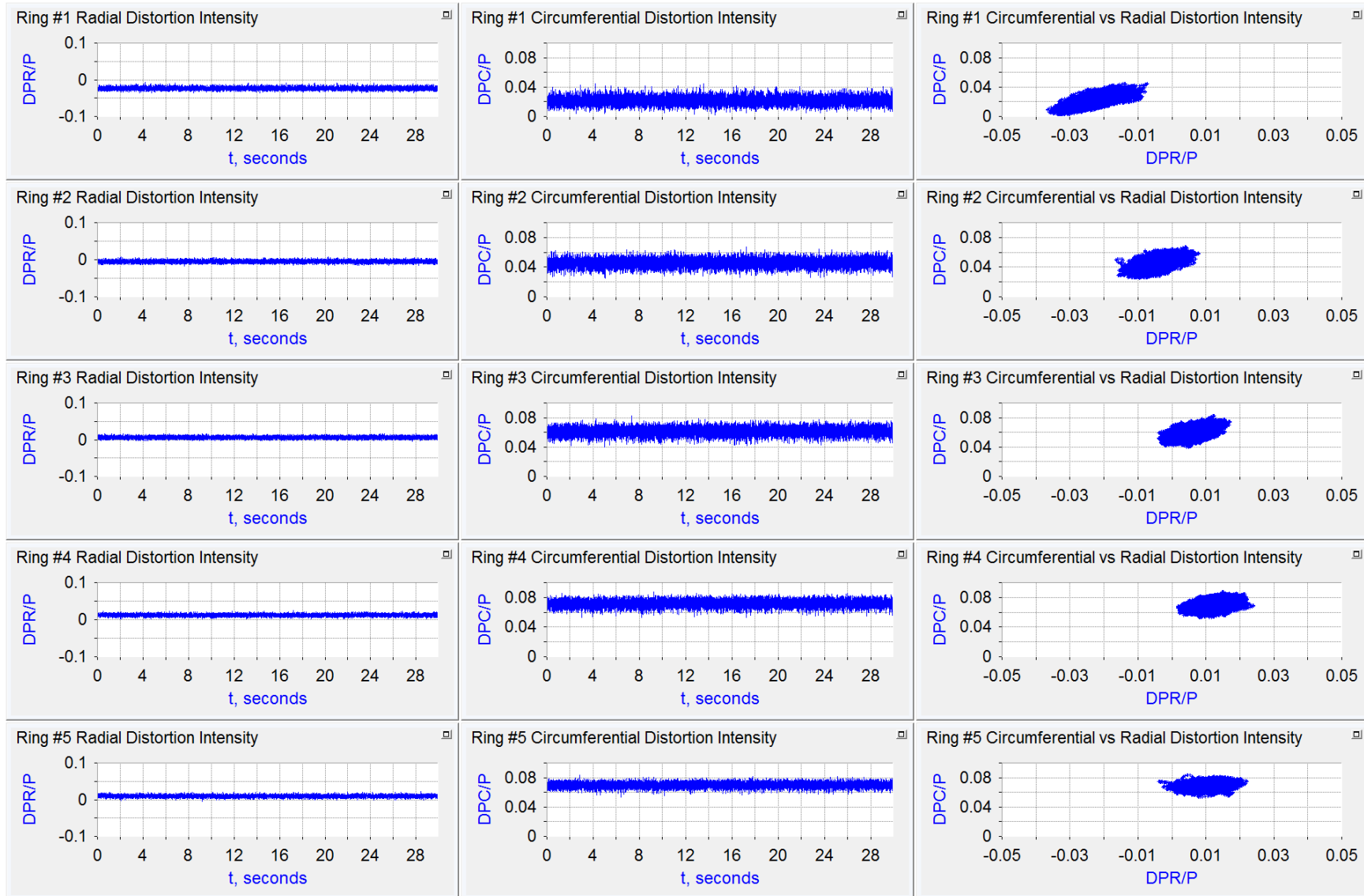
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=102.5\%$, $A_{19}=87.5\%$)

Dashboard D.1.5: 102.5% Speed Point, AIP-1



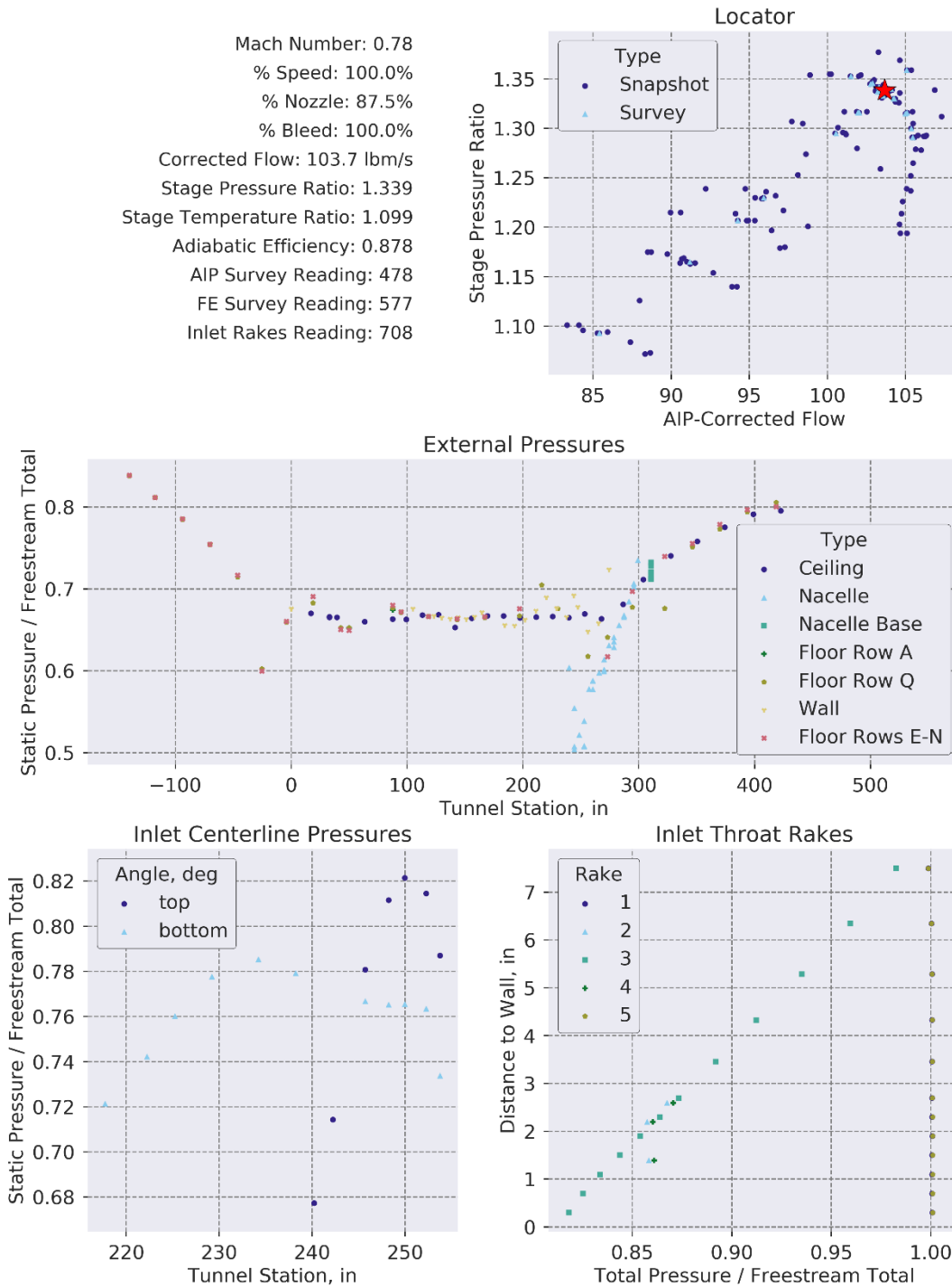
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=102.5\%$, $A_{19}=87.5\%$)

Dashboard D.1.6: 102.5% Speed Point, AIP-1

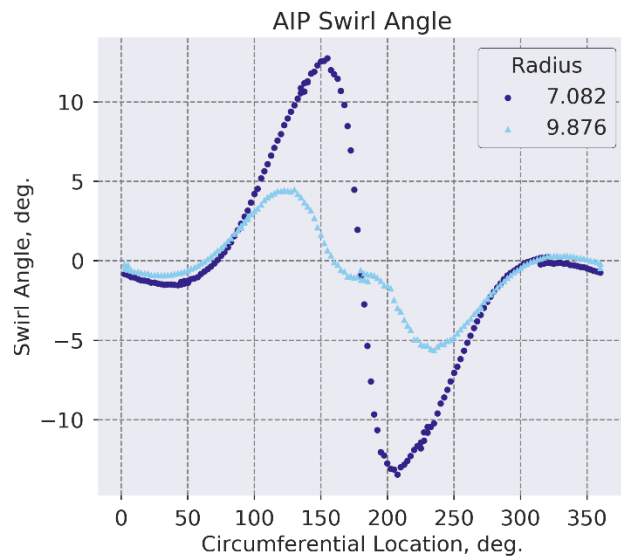
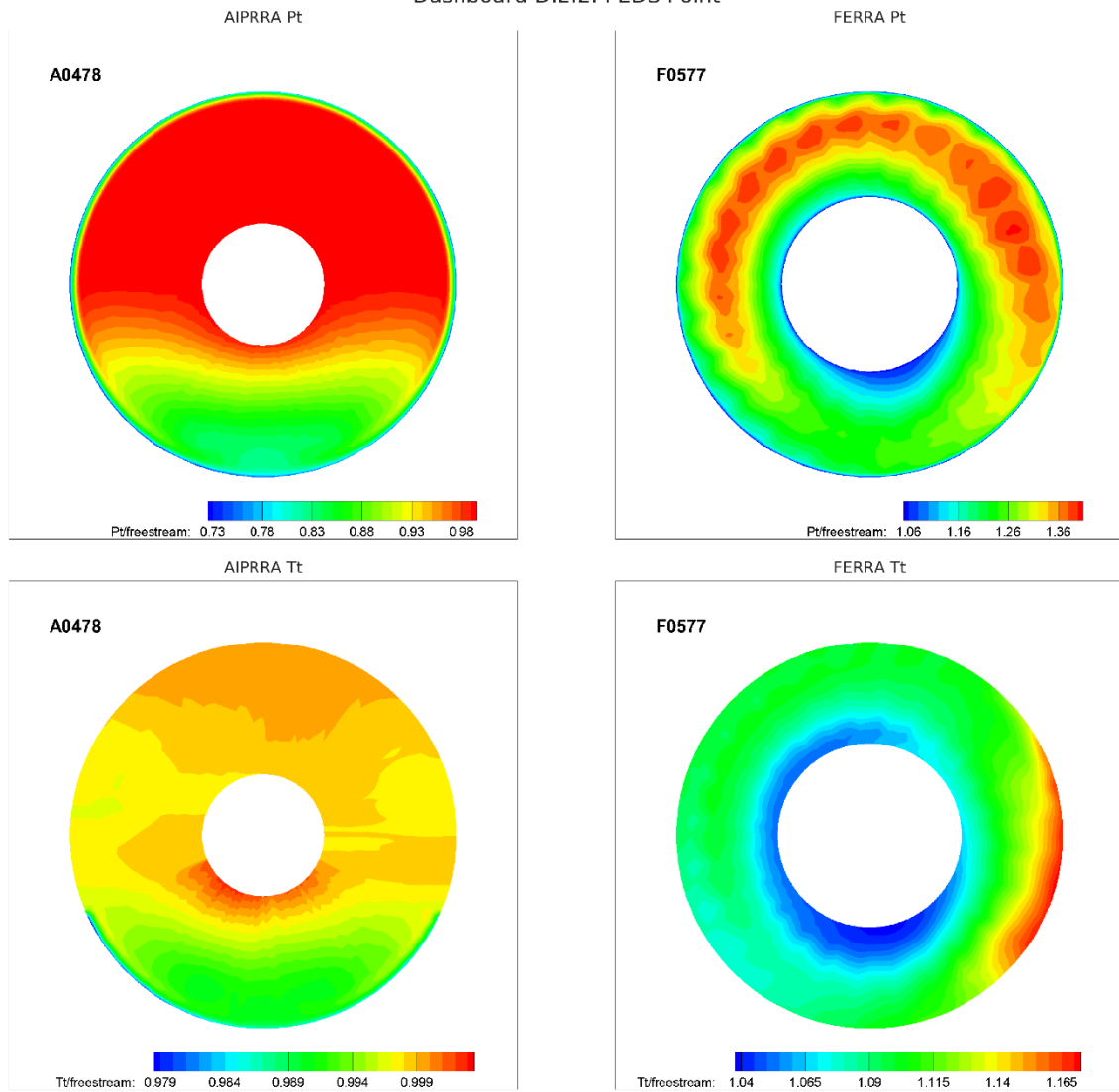


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=102.5\%$, $A_{19}=87.5\%$)

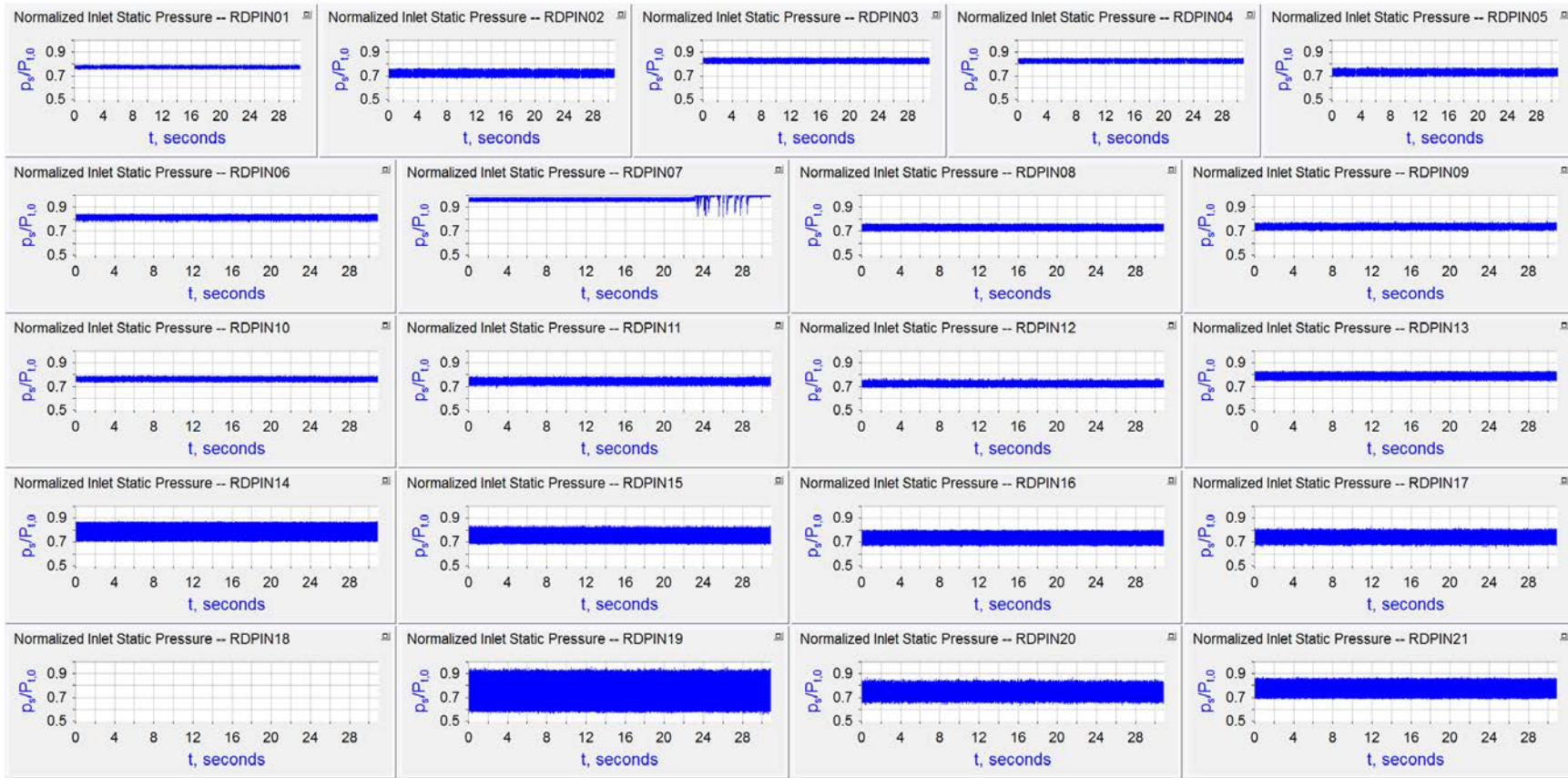
Dashboard D.2.1: PEDS Point



Dashboard D.2.2: PEDS Point

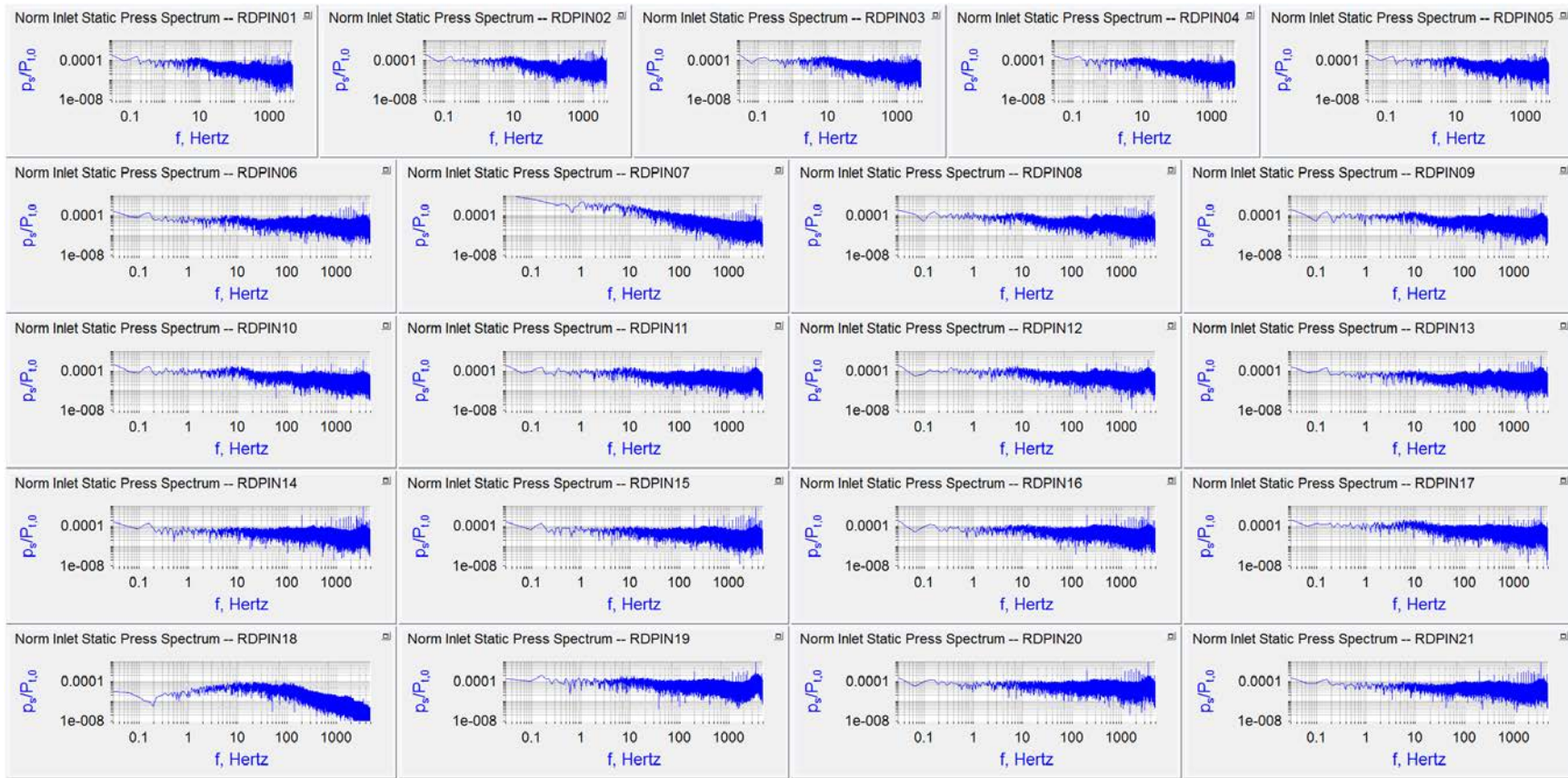


Dashboard D.2.3: PEDS Point, AIP-3



Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.4: PEDS Point, AIP-3



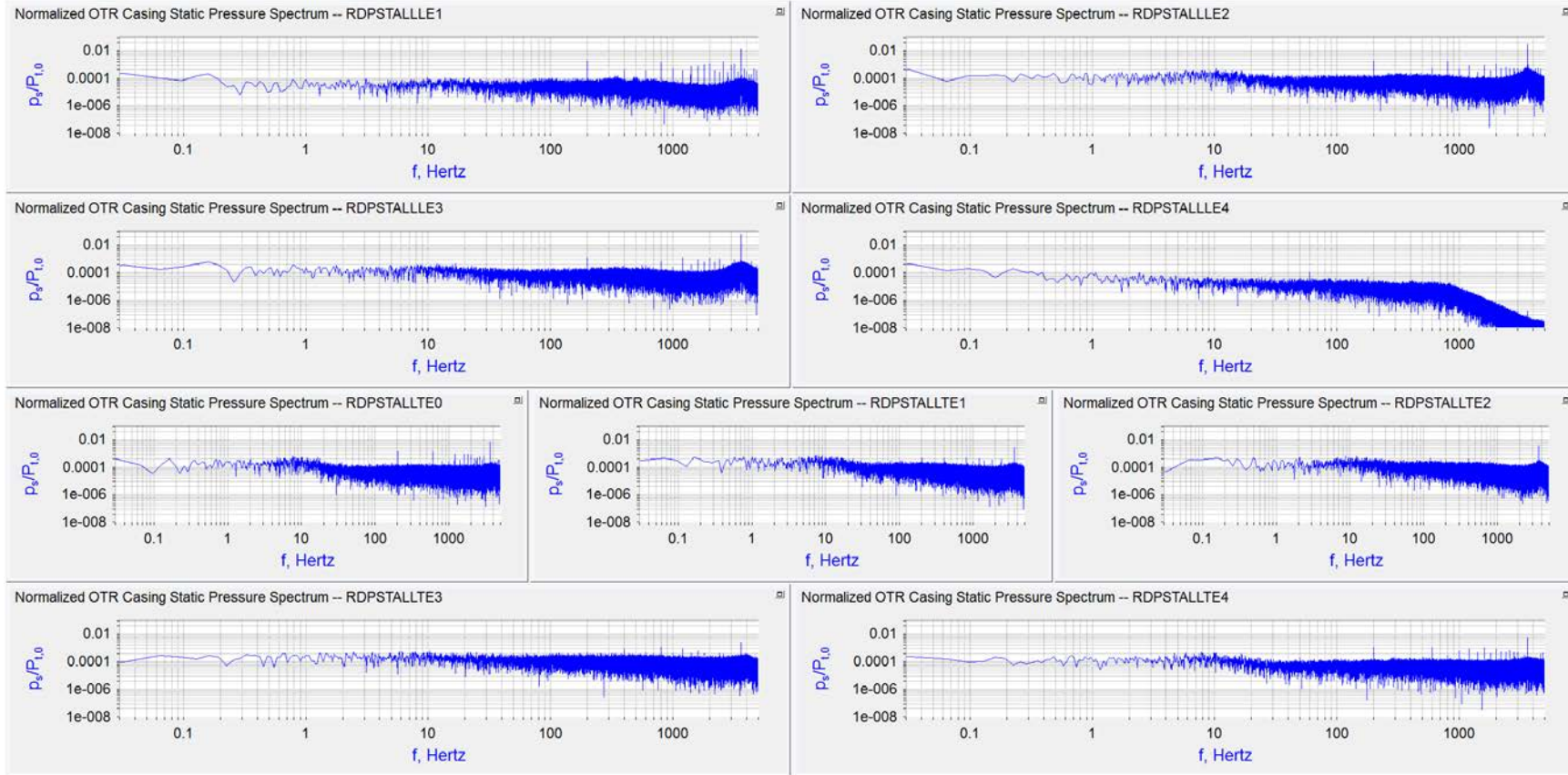
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.5: PEDS Point, AIP-3



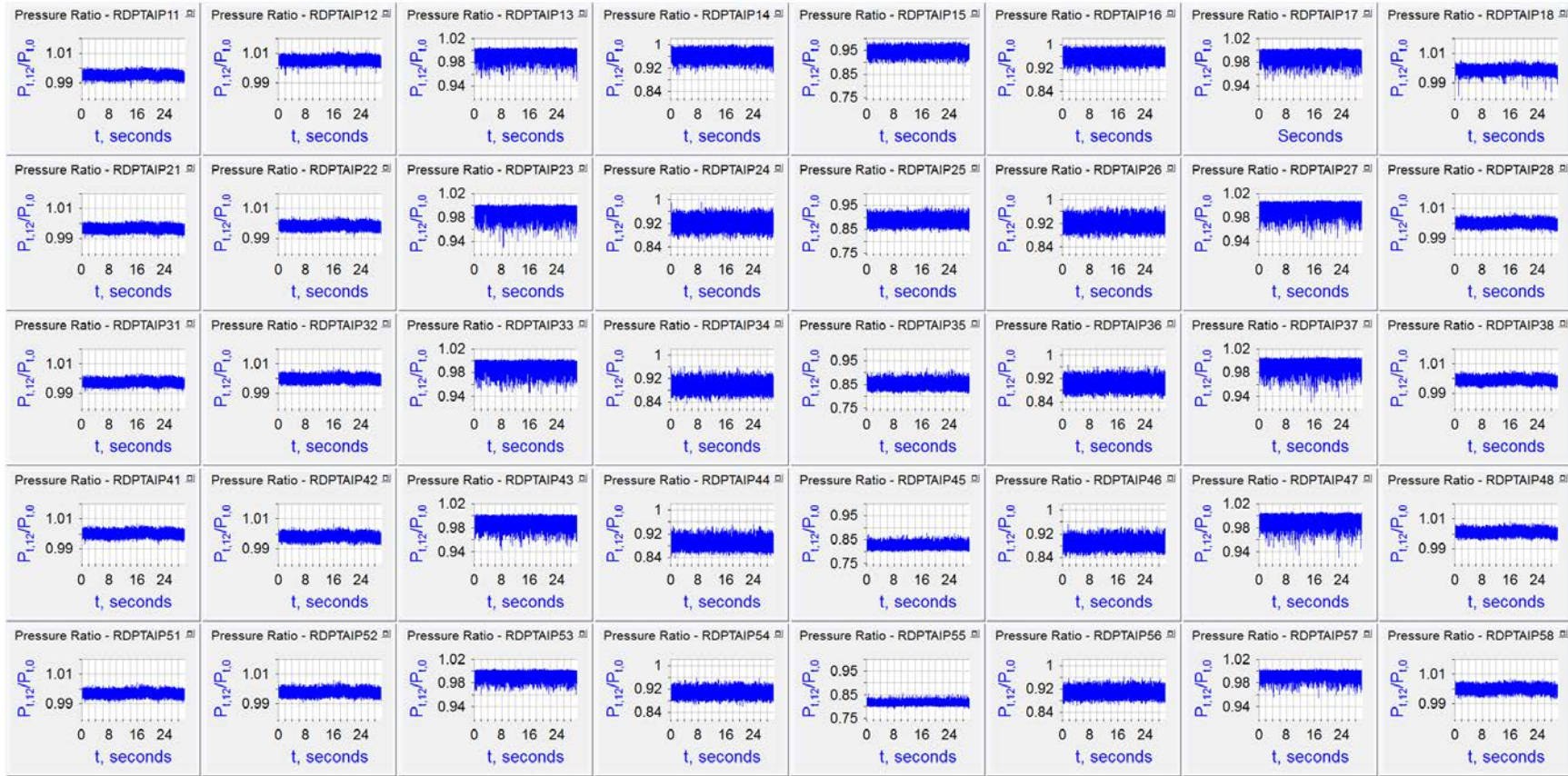
Measured High Response Over-The-Rotor Static Pressure (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{10}=87.5\%$)

Dashboard D.2.6: PEDS Point, AIP-3



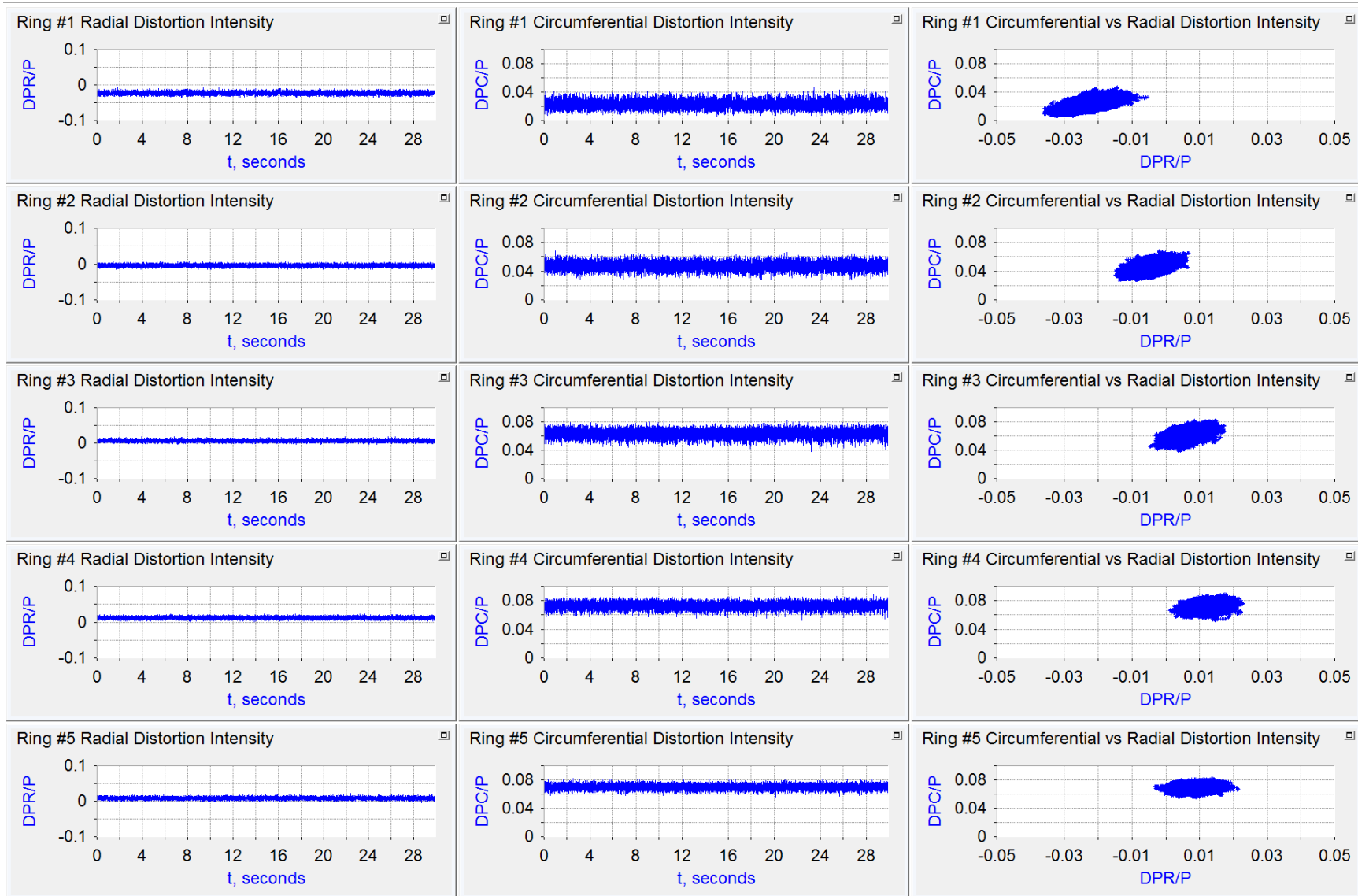
Measured High Response Over-The-Rotor Static Pressure Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.7: PEDS Point, AIP-1



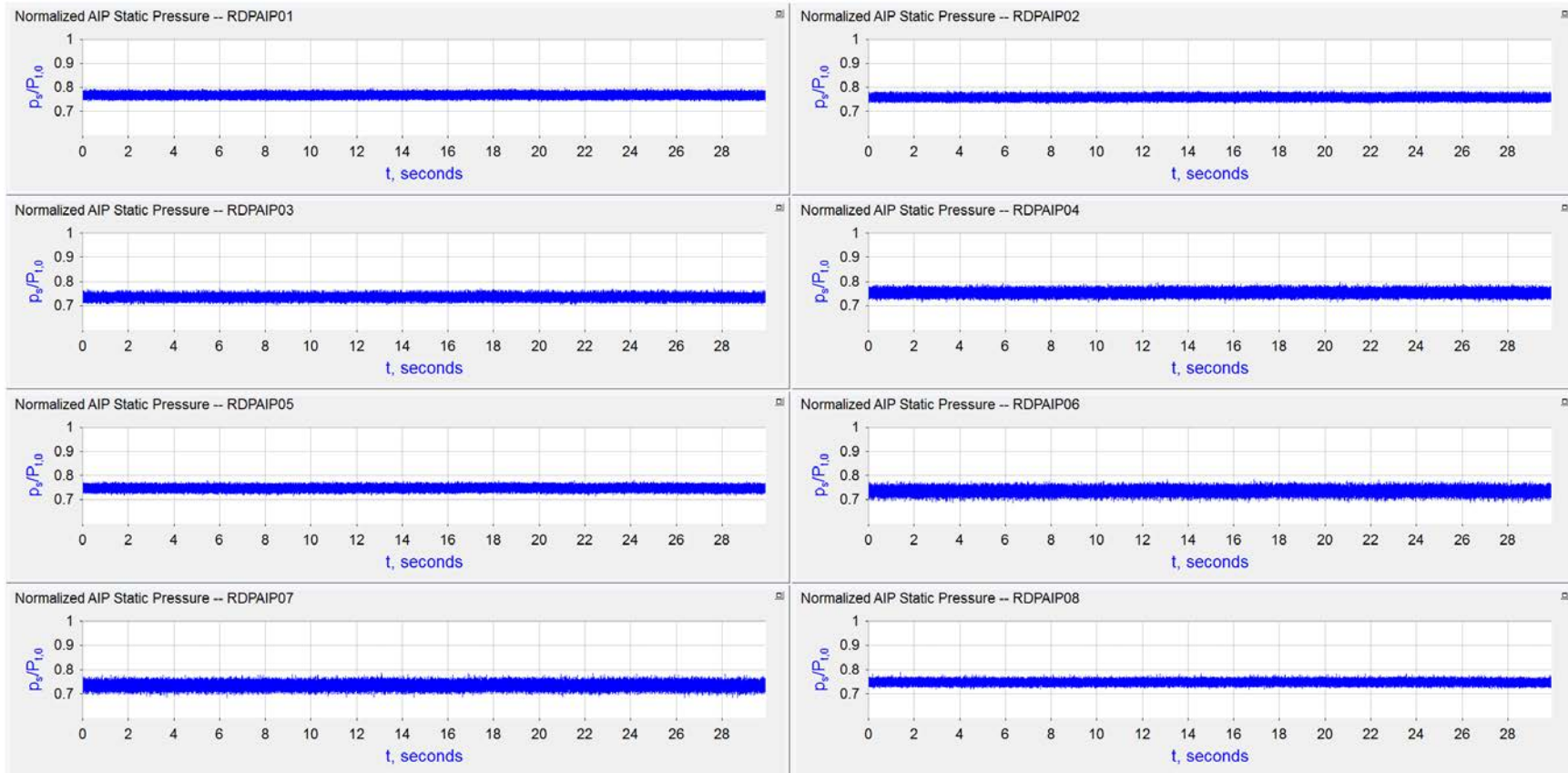
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.8: PEDS Point, AIP-1



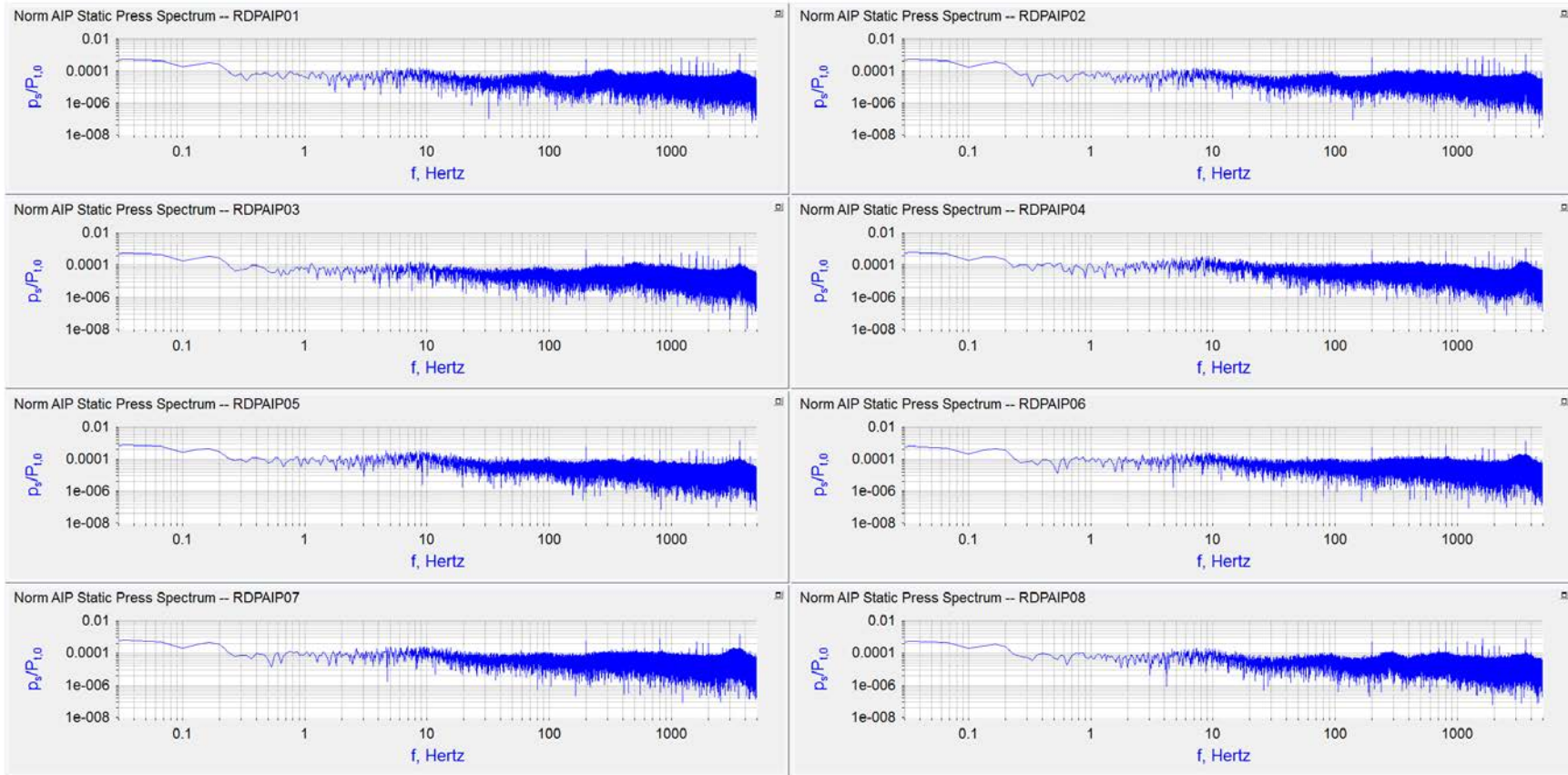
Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.9: PEDS Point, AIP-1



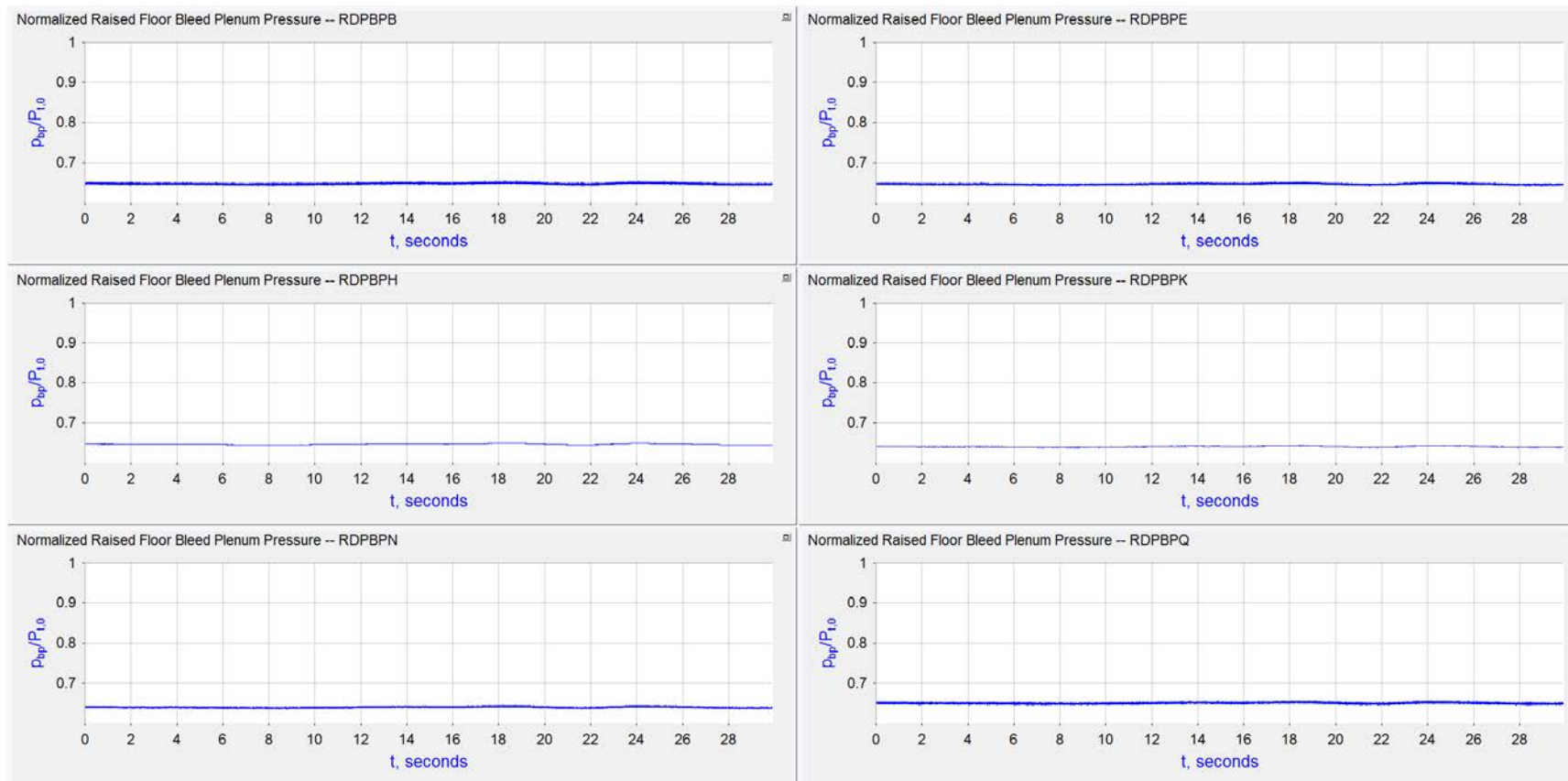
Measured High Response AIP Static Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.10: PEDS Point, AIP-1



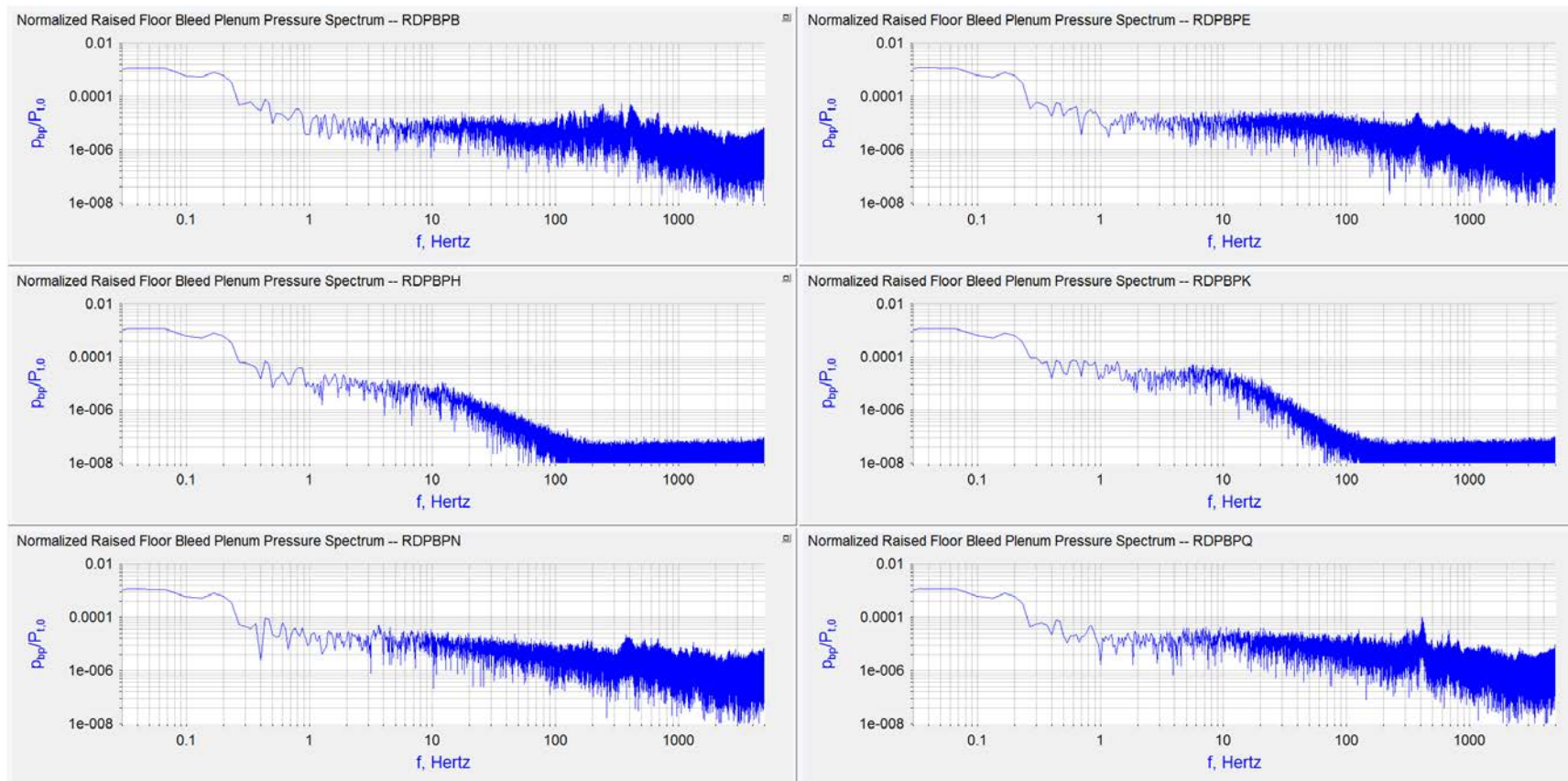
Measured High Response AIP Static Pressure Distribution Spectra (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.11: PEDS Point, AIP-1



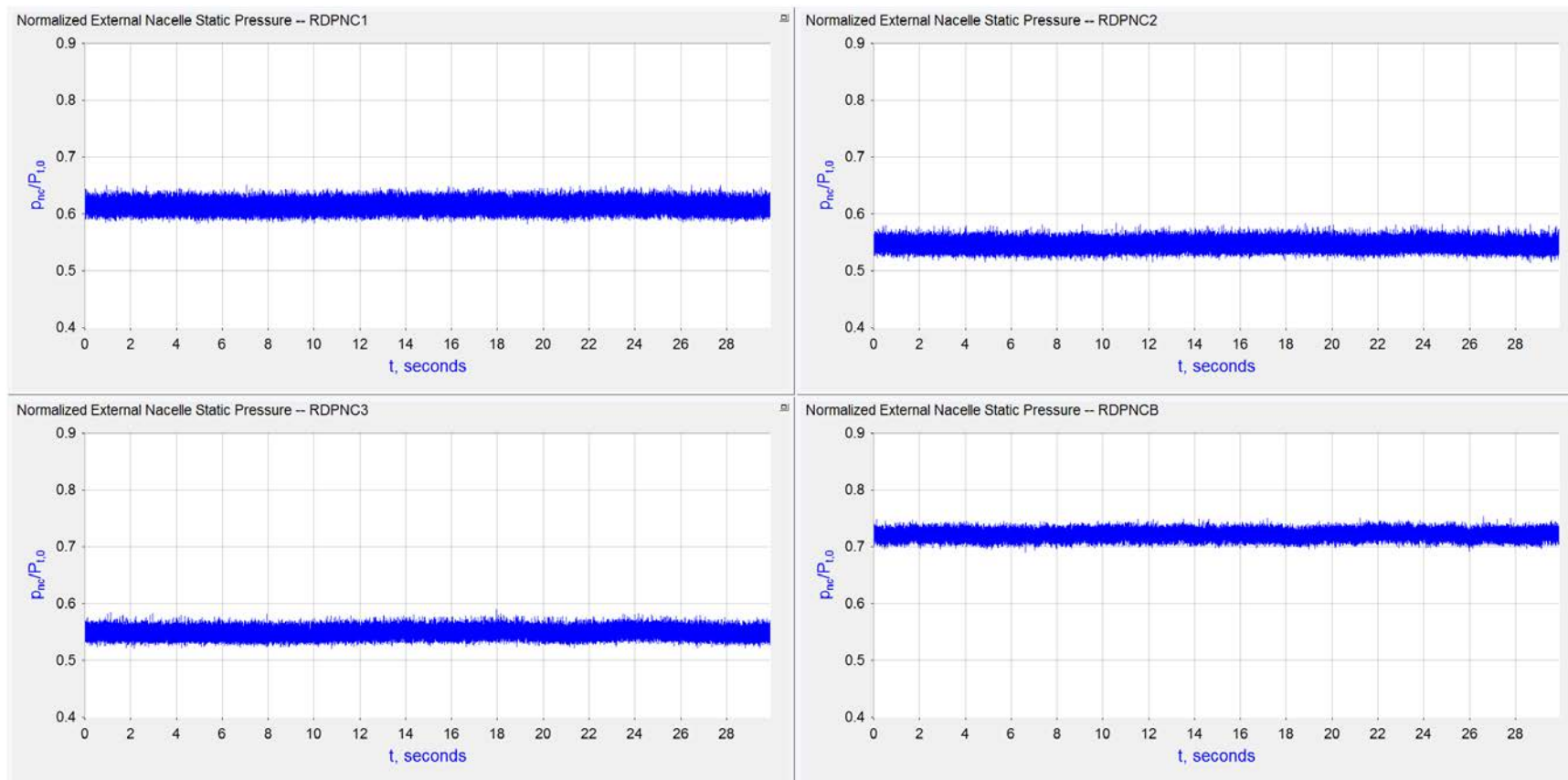
Measured High Response Raised Floor Bleed Plenum Pressure (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.12: PEDS Point, AIP-1



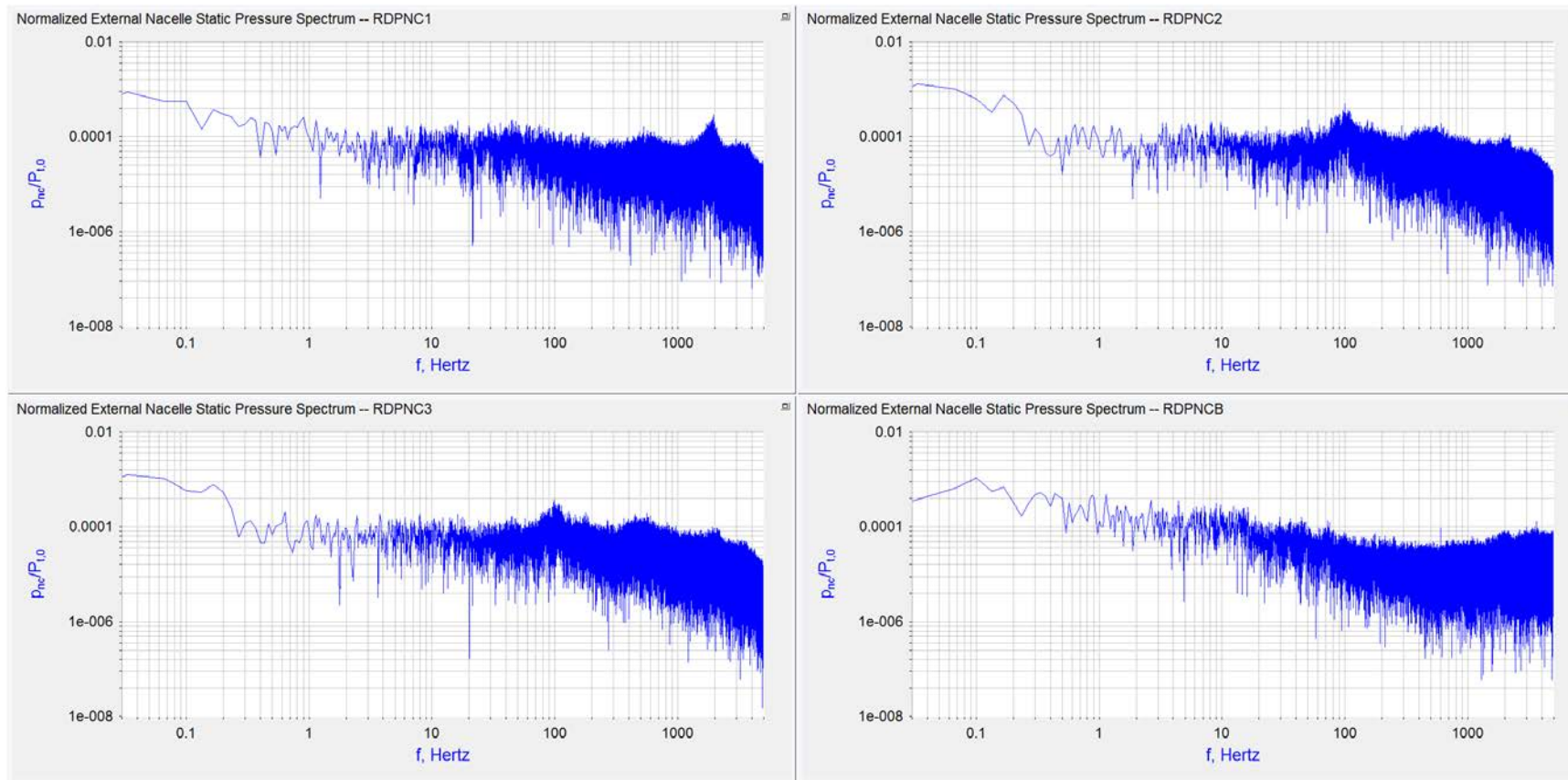
Measured High Response Raised Floor Bleed Plenum Pressure Spectra (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.13: PEDS Point, AIP-1



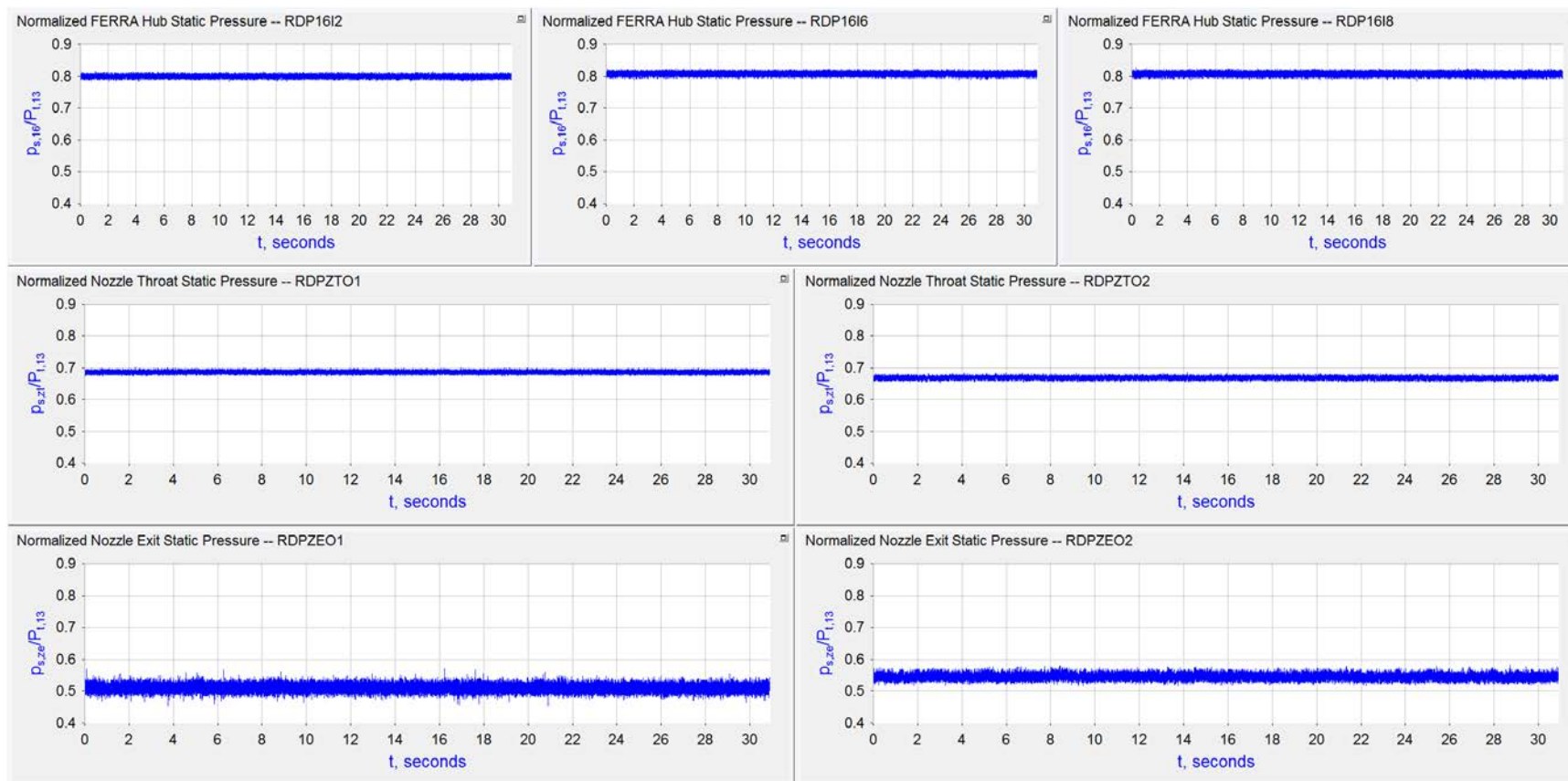
Measured High Response External Nacelle Static Pressure (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.14: PEDS Point, AIP-1



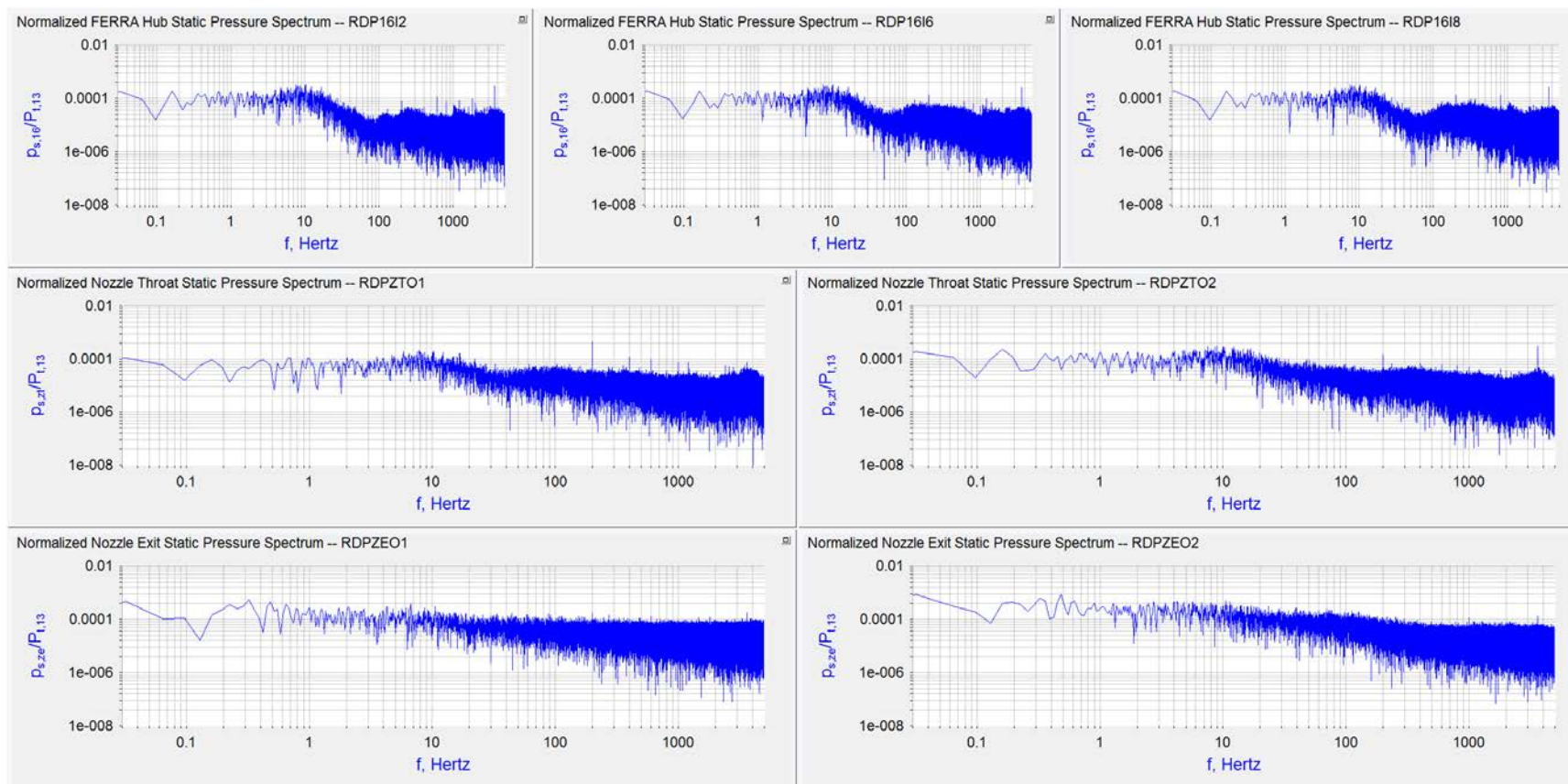
Measured High Response External Nacelle Static Pressure Spectra (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.15: PEDS Point, AIP-1



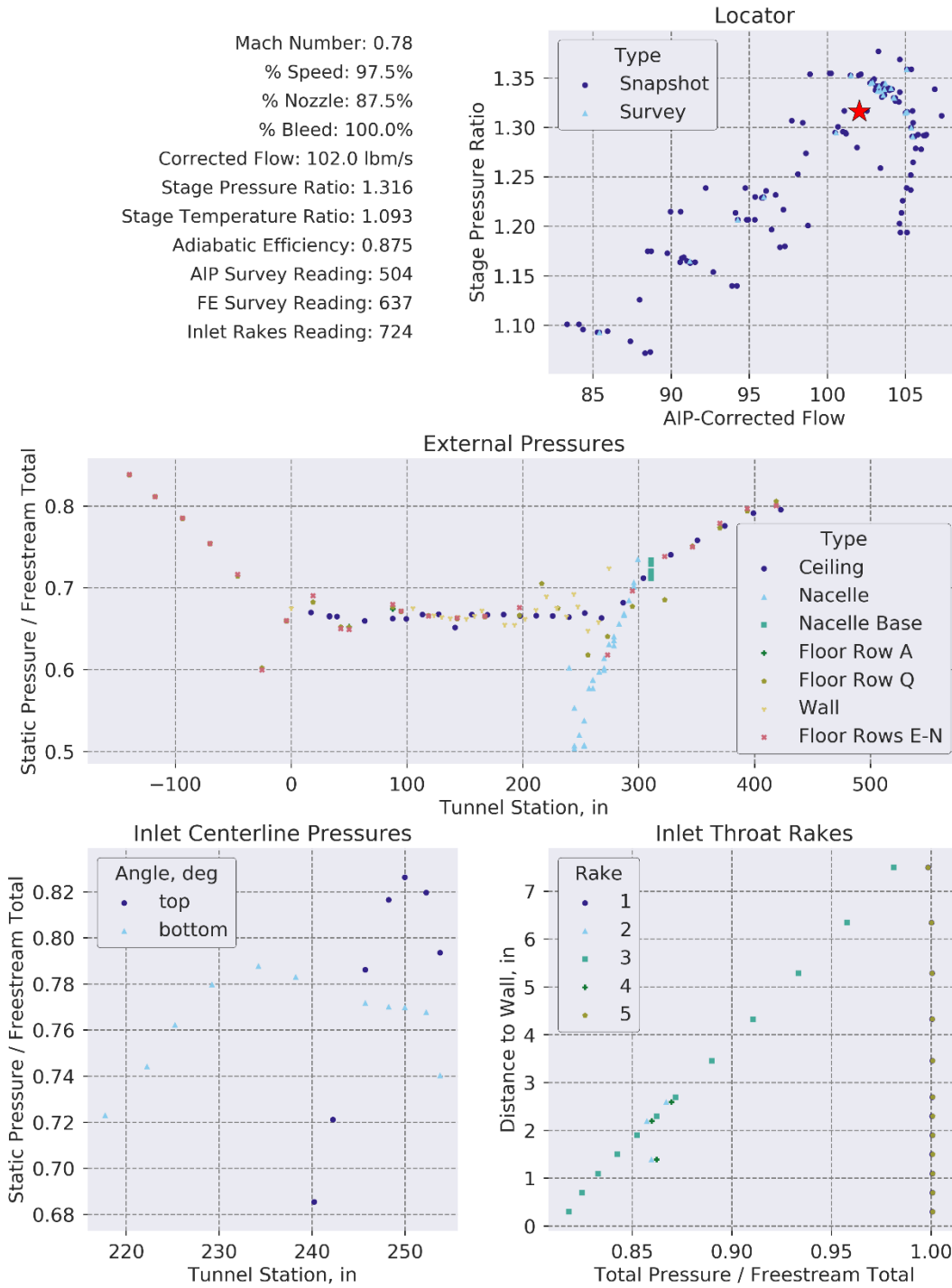
Measured High Response Fan Duct and Nozzle Static Pressure (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.2.16: PEDS Point, AIP-1

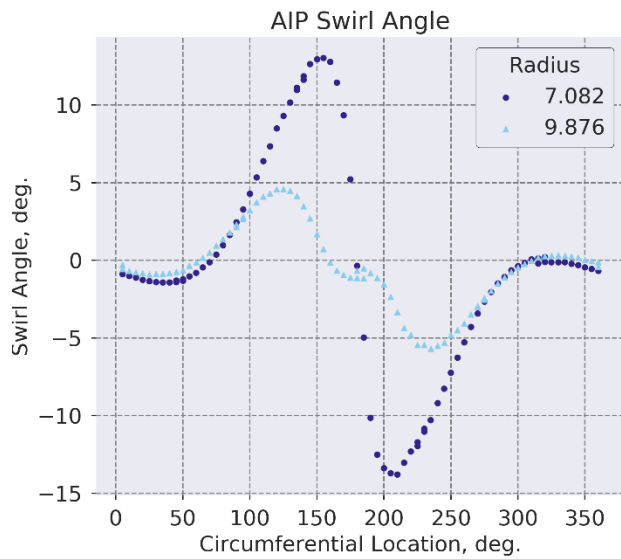
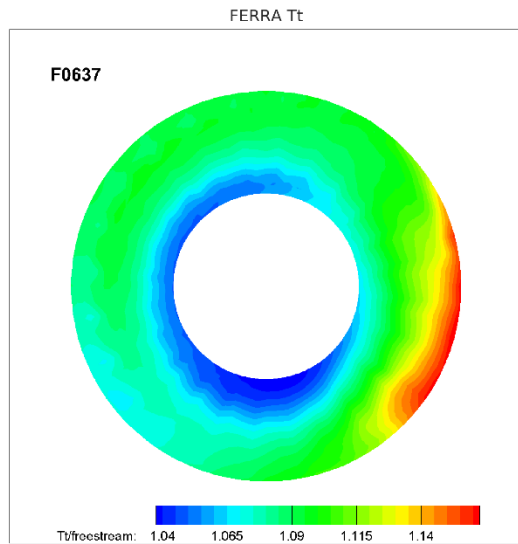
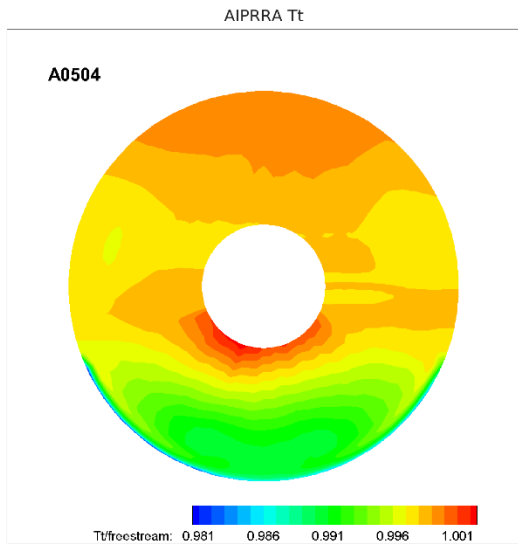
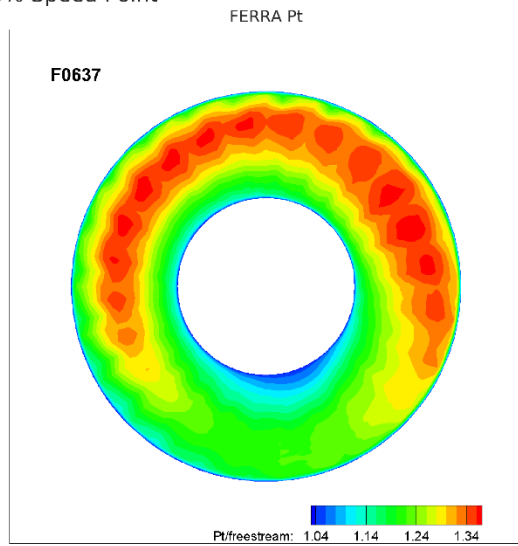
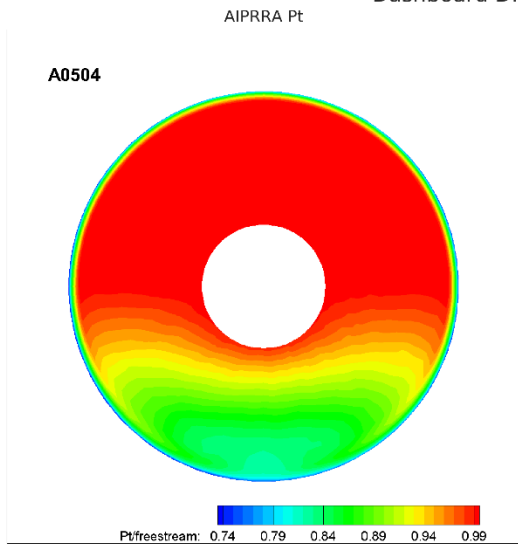


Measured High Response Fan Duct and Nozzle Static Pressure Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.5\%$)

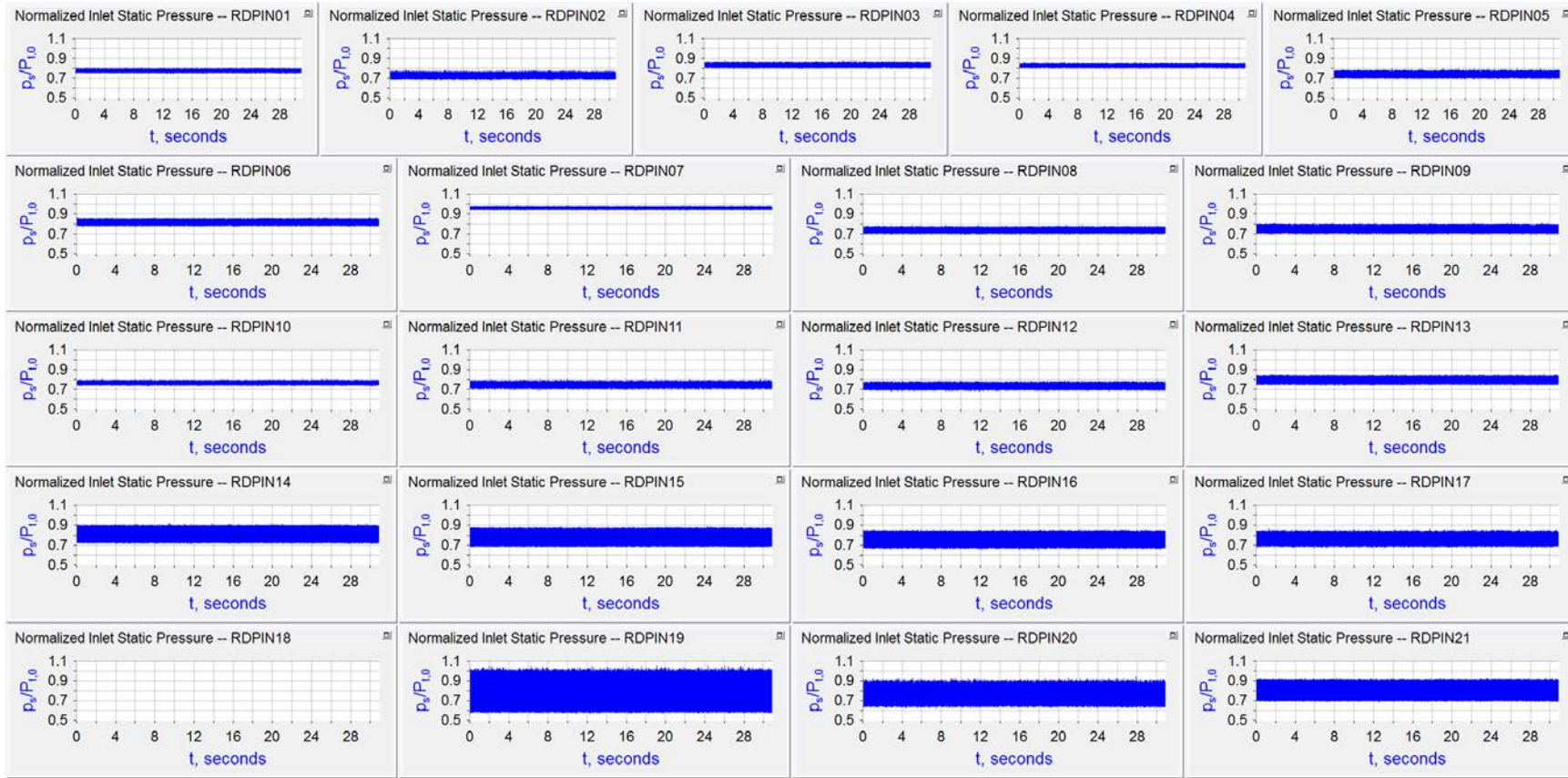
Dashboard D.3.1: 97.5% Speed Point



Dashboard D.3.2: 97.5% Speed Point

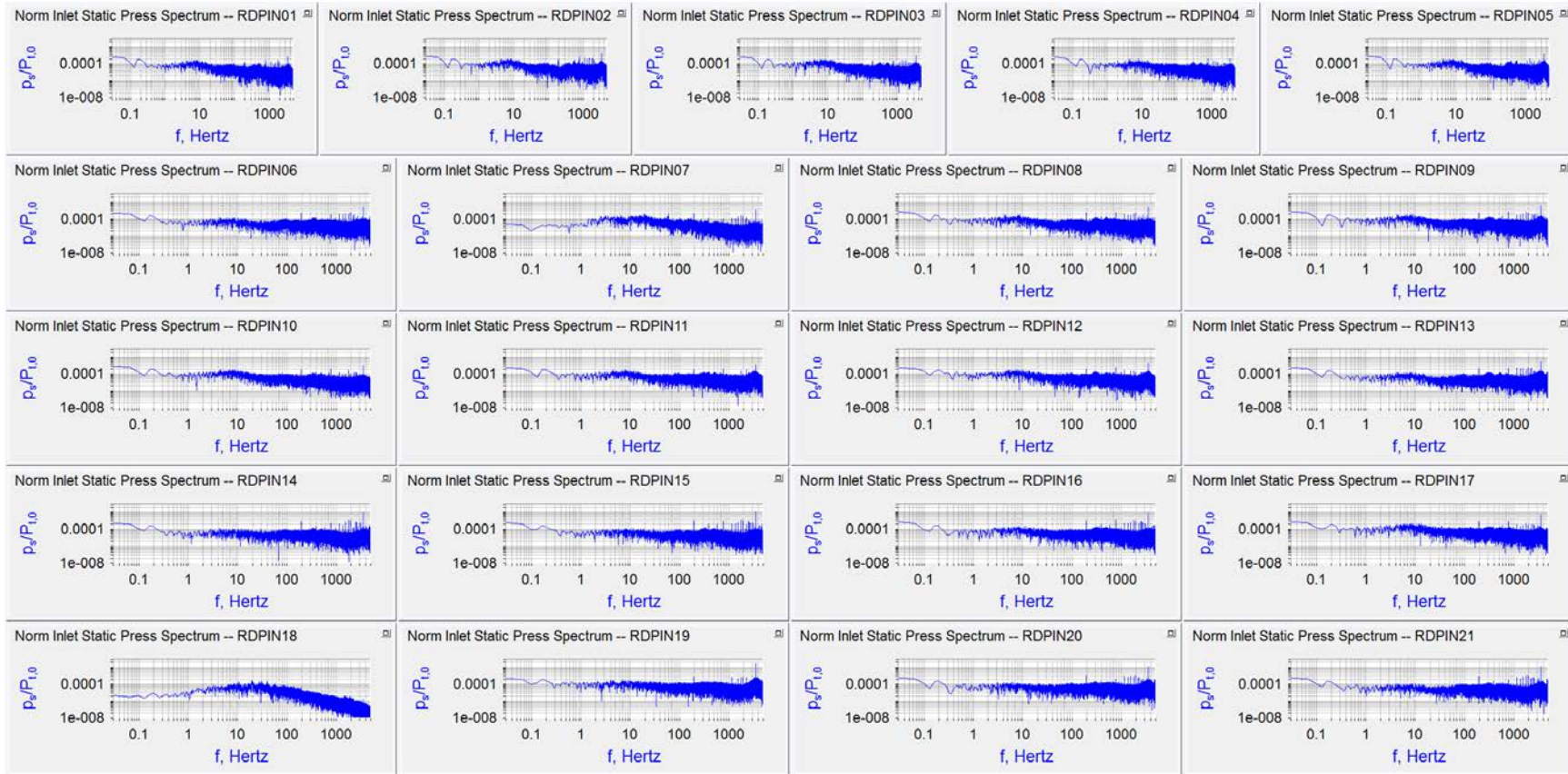


Dashboard D.3.3: 97.5% Speed Point, AIP-3



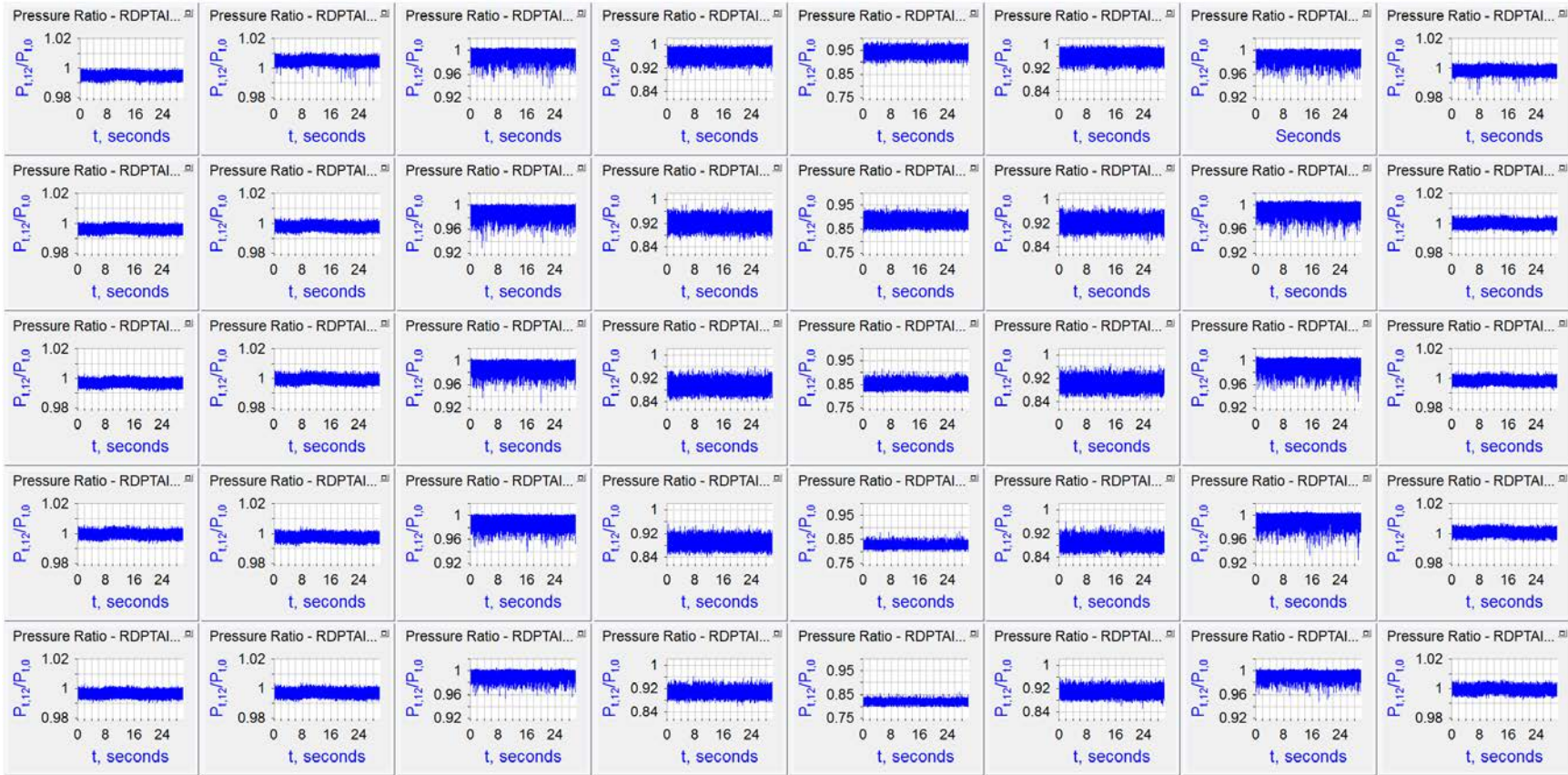
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=97.5\%$, $A_{19}=87.5\%$)

Dashboard D.3.4: 97.5% Speed Point, AIP-3



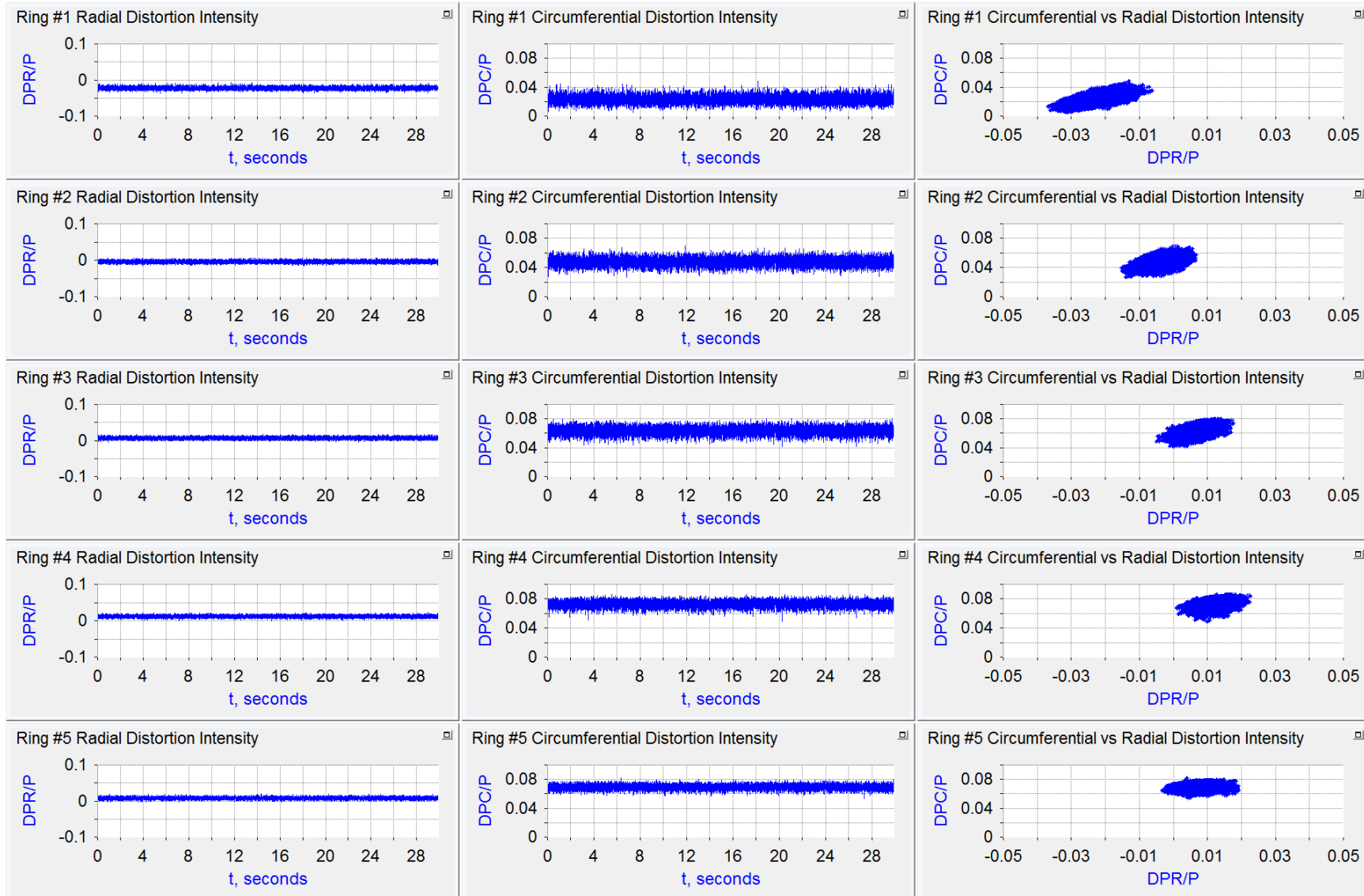
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=97.5\%$, $A_{19}=87.5\%$)

Dashboard D.3.5: 97.5% Speed Point, AIP-1



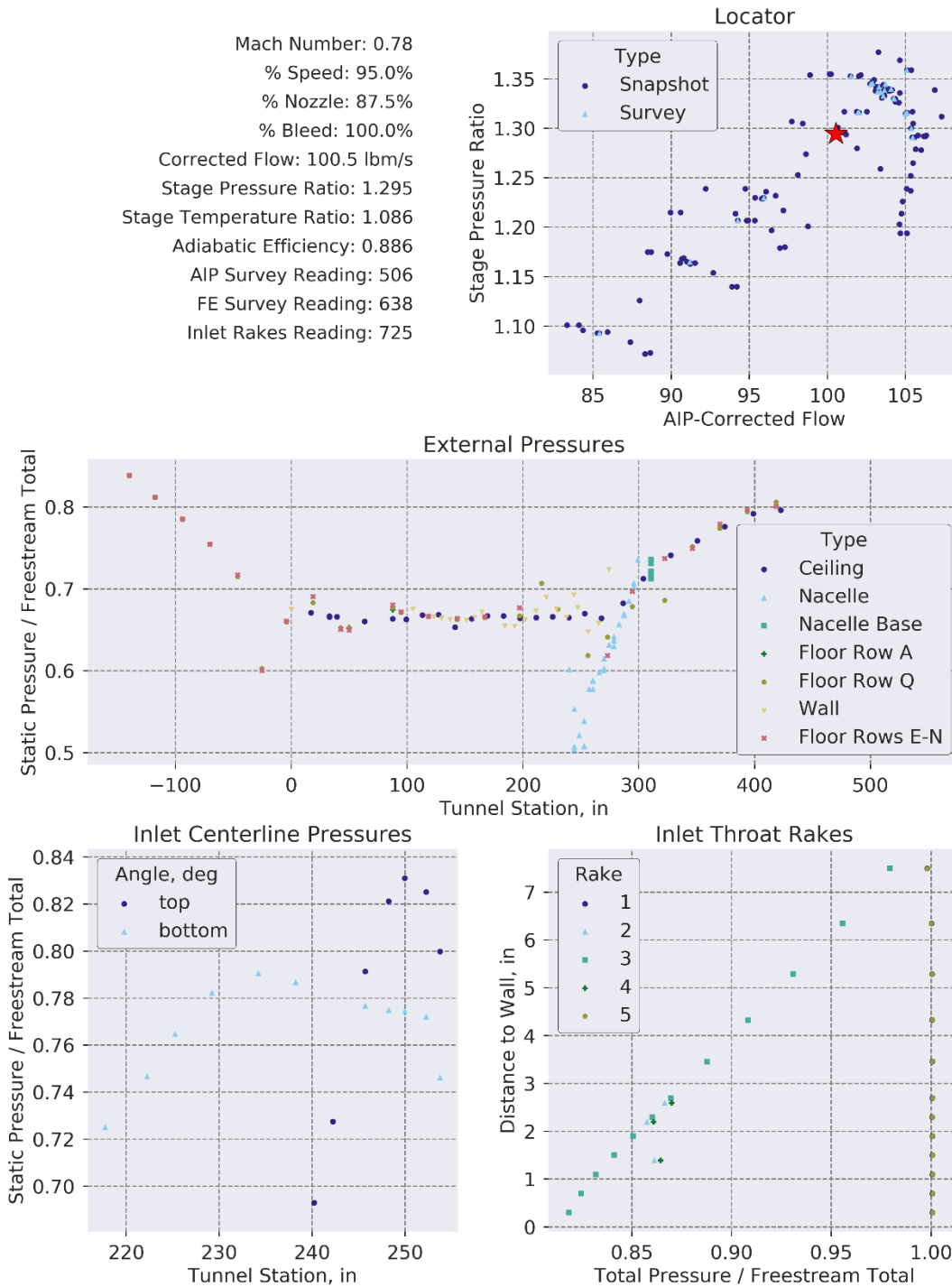
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=97.5\%$, $A_{19}=87.5\%$)

Dashboard D.3.6: 97.5% Speed Point, AIP-1

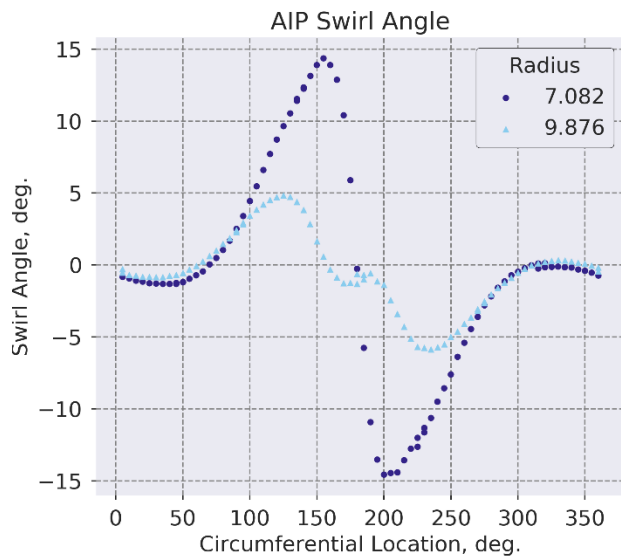
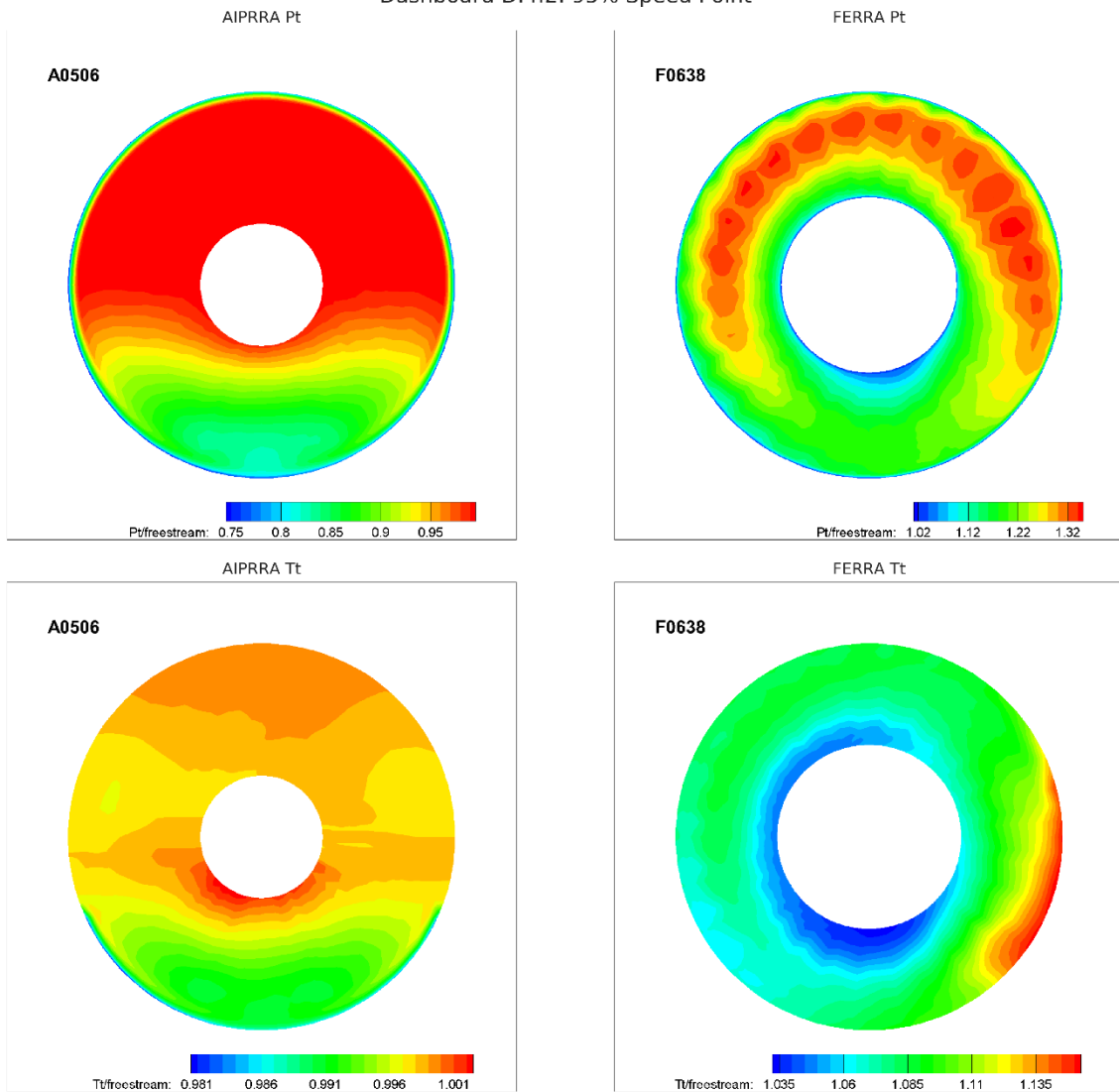


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=97.5\%$, $A_{19}=87.5\%$)

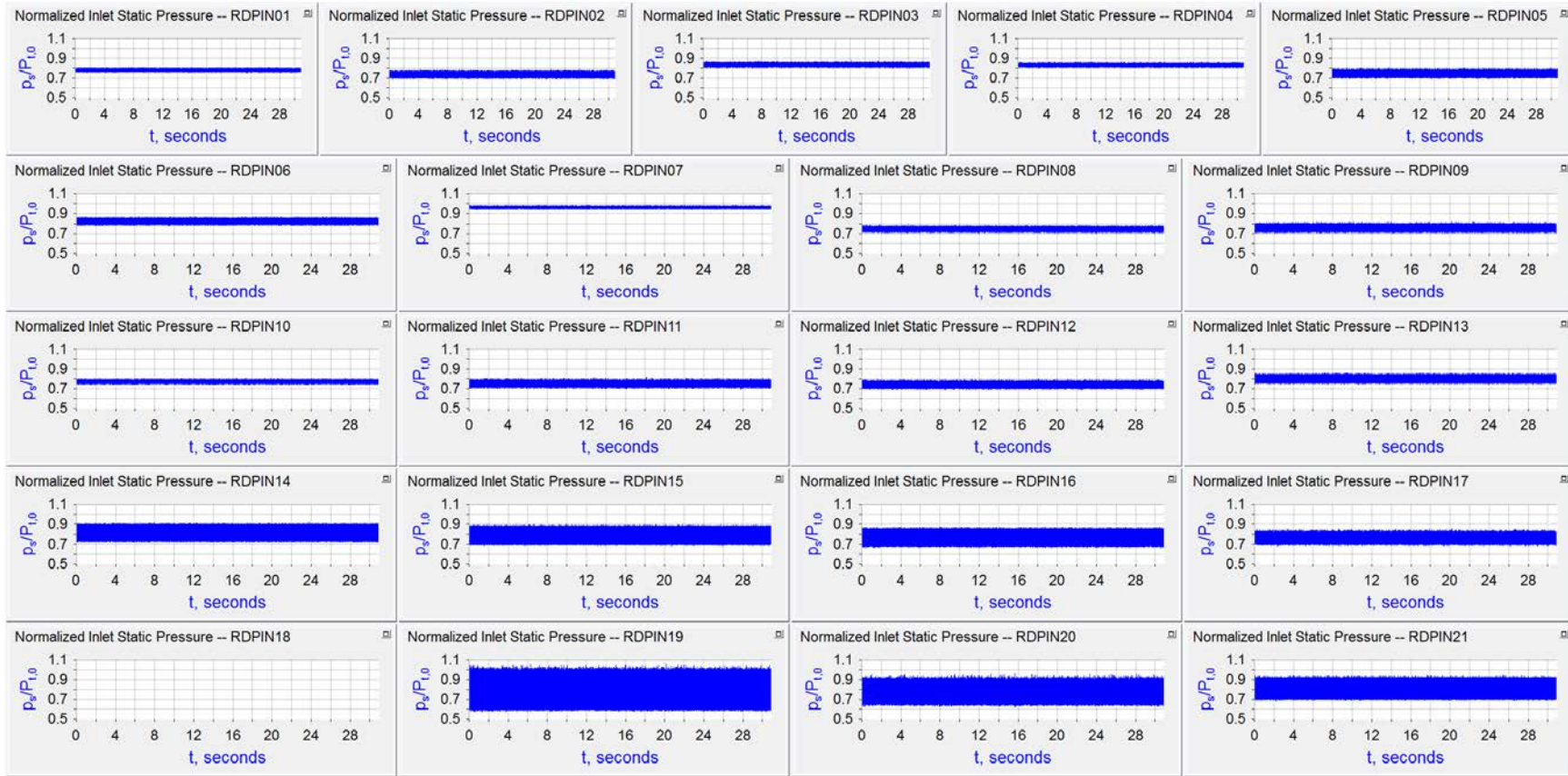
Dashboard D.4.1: 95% Speed Point



Dashboard D.4.2: 95% Speed Point



Dashboard D.4.3: 95% Speed Point, AIP-3



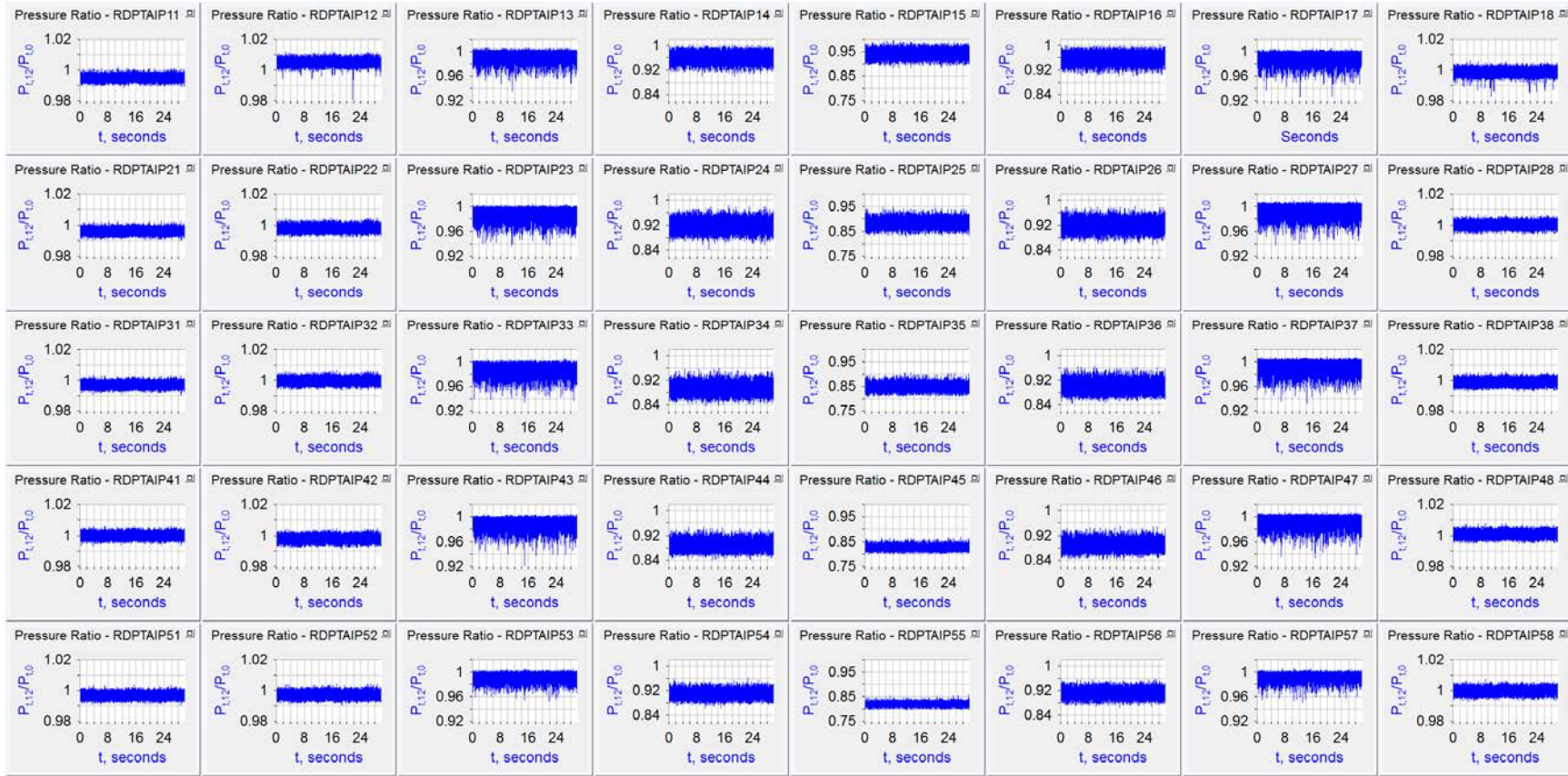
Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=95\%$, $A_{19}=87.5\%$)

Dashboard D.4.4: 95% Speed Point, AIP-3



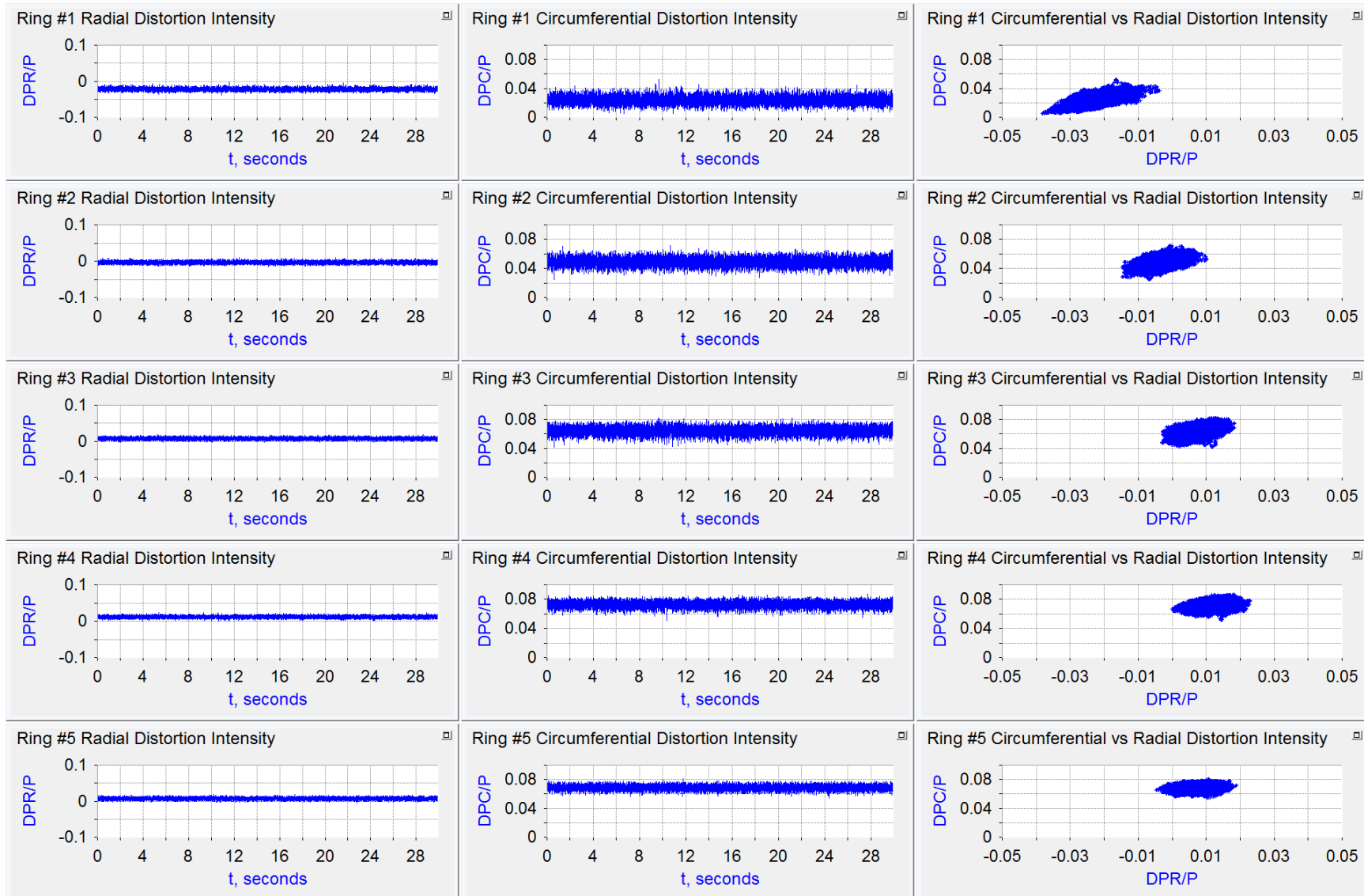
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=95\%$, $A_{19}=87.5\%$)

Dashboard D.4.5: 95% Speed Point, AIP-1



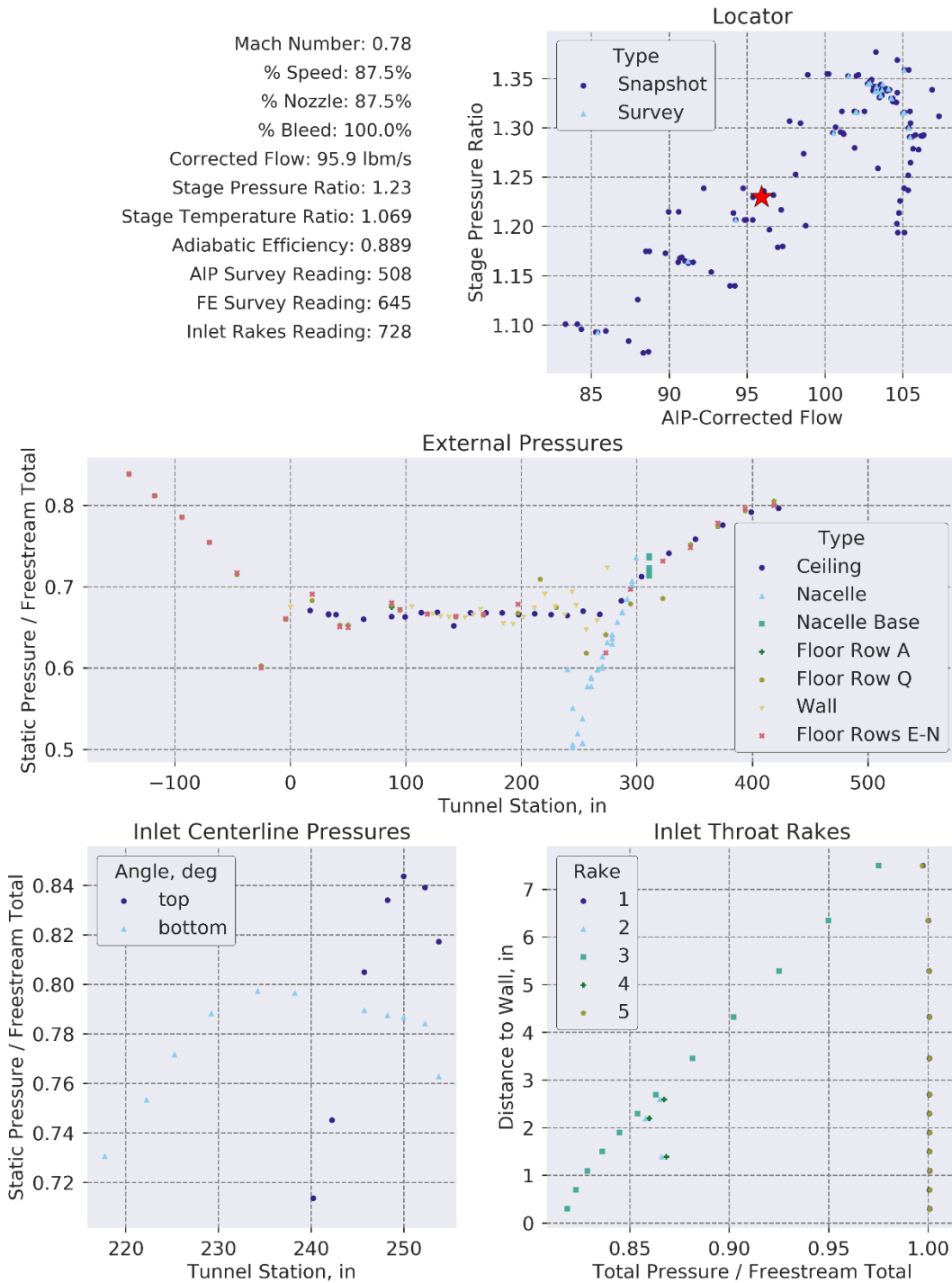
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=95\%$, $A_{19}=87.5\%$)

Dashboard D.4.6: 95% Speed Point, AIP-1

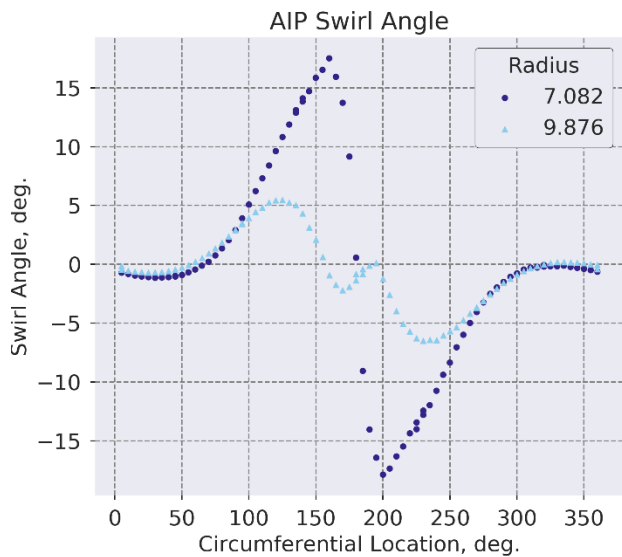
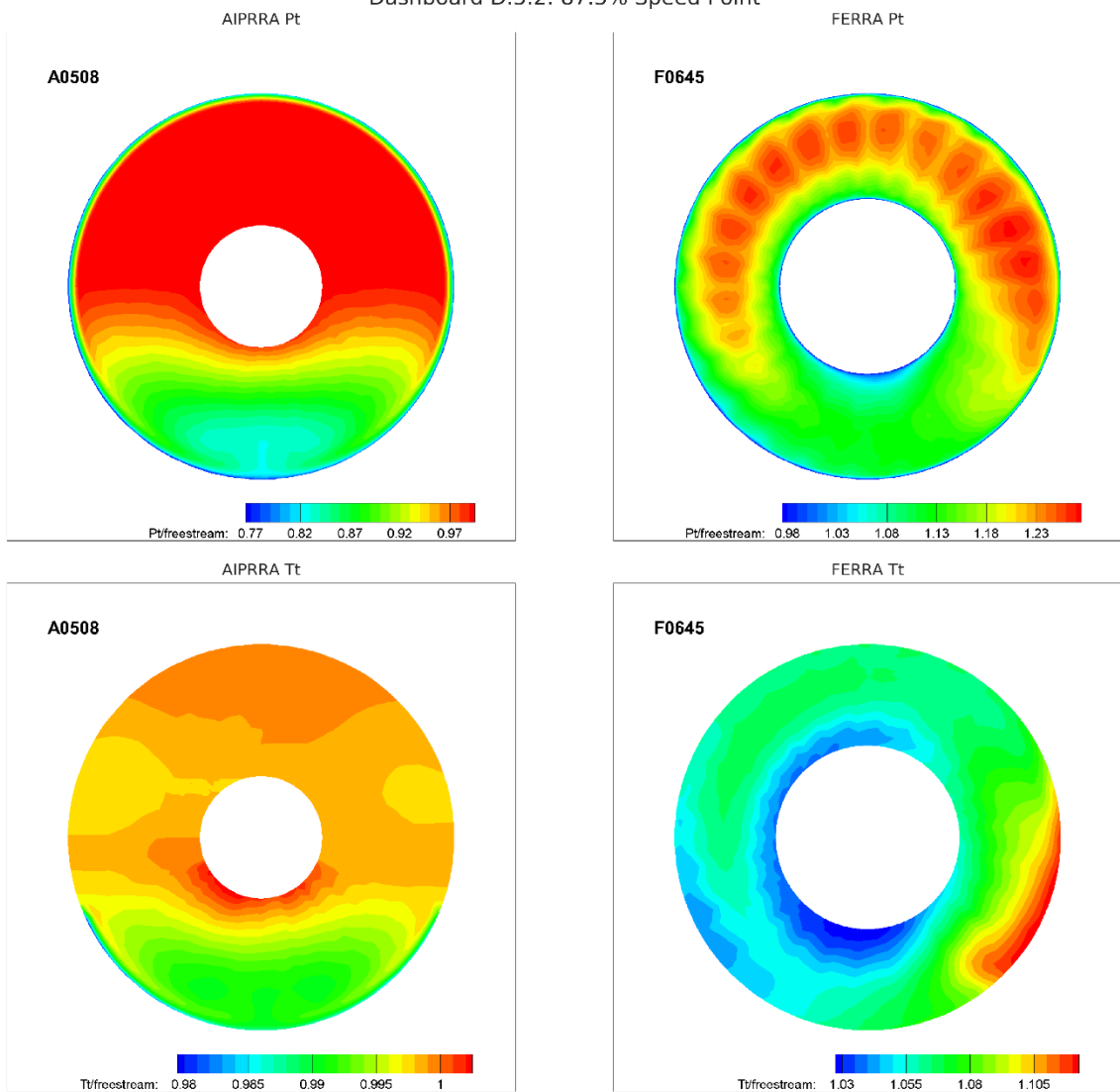


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=95\%$, $A_{19}=87.5\%$)

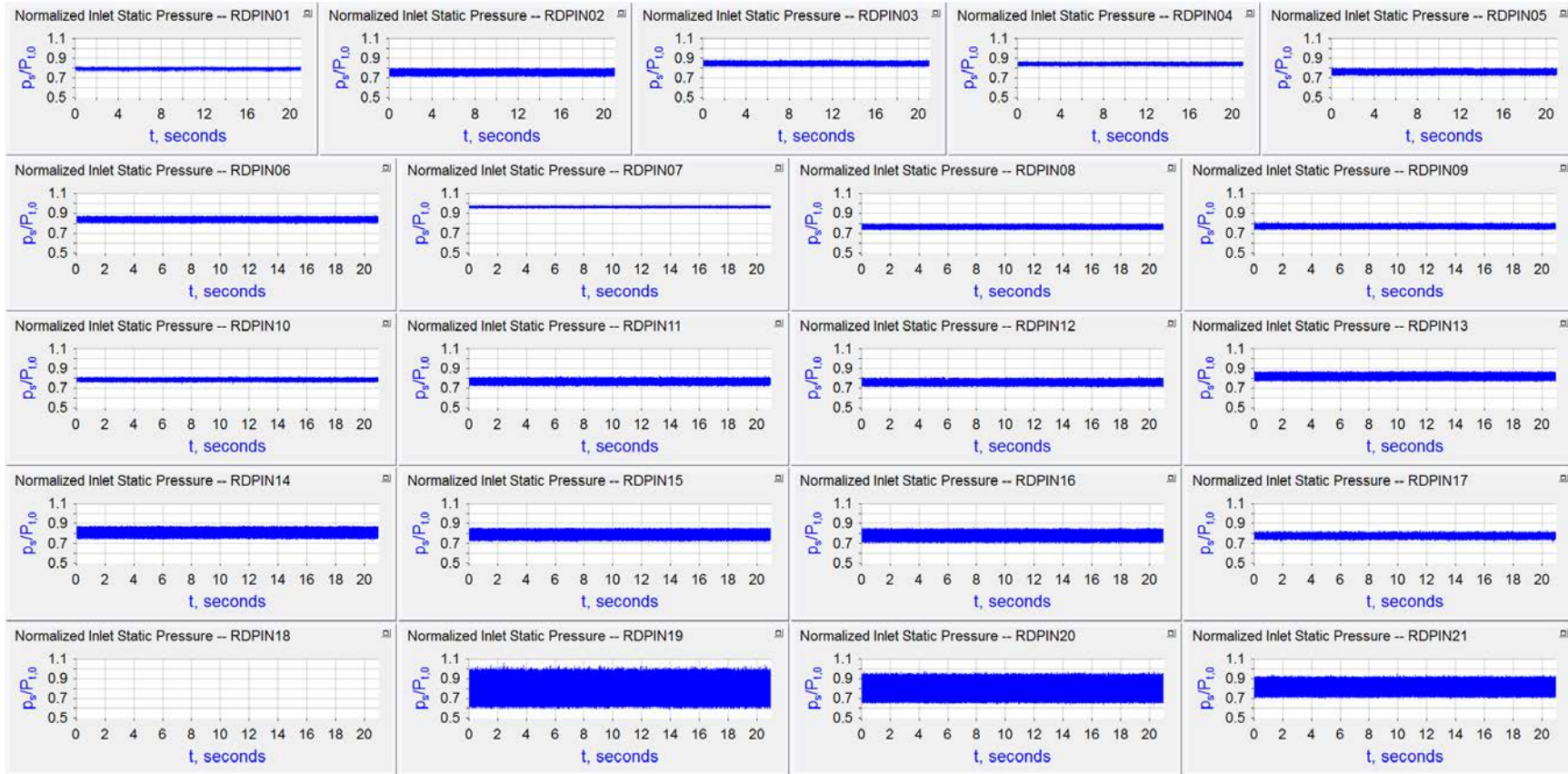
Dashboard D.5.1: 87.5% Speed Point



Dashboard D.5.2: 87.5% Speed Point

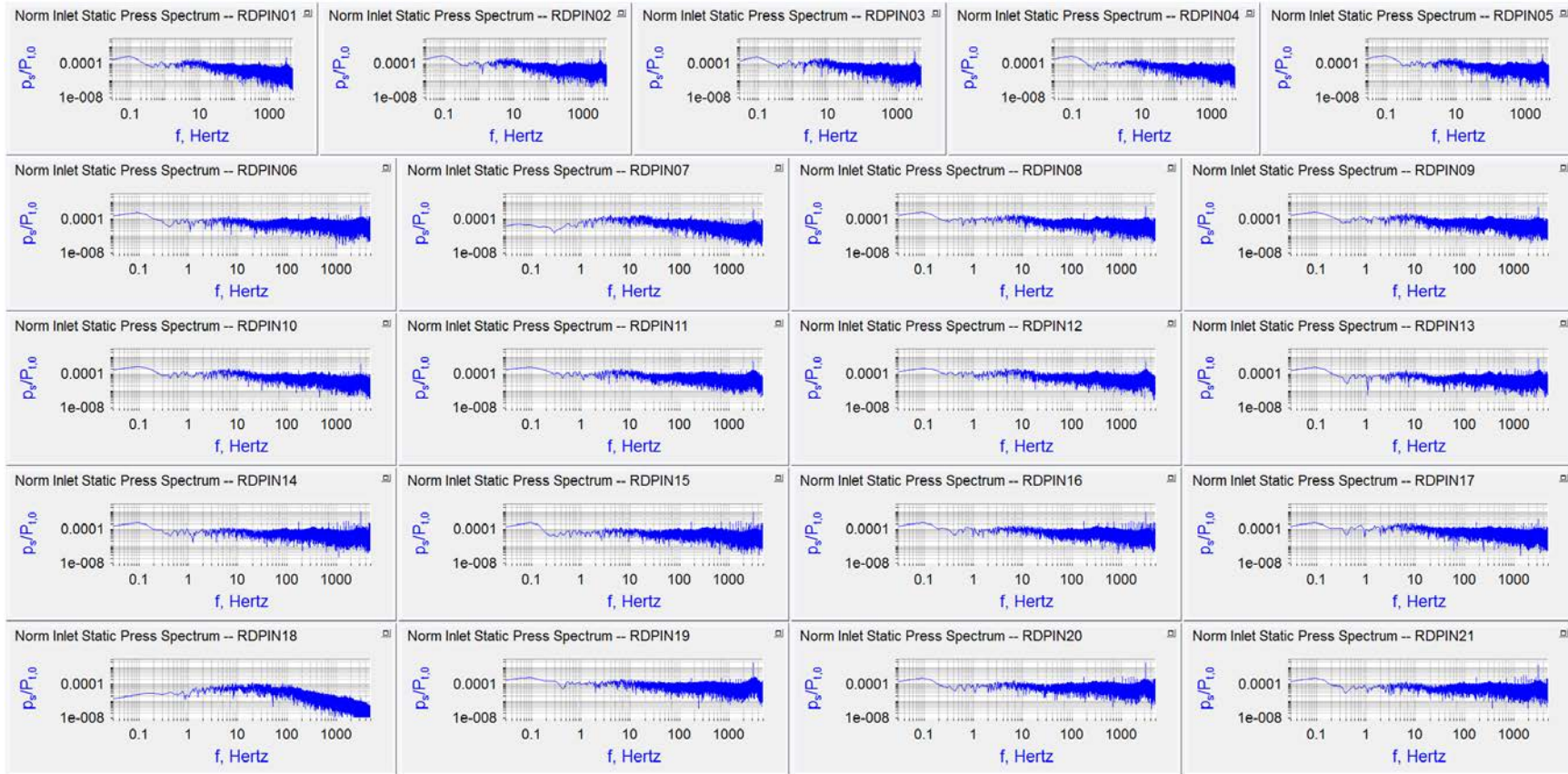


Dashboard D.5.3: 87.5% Speed Point, AIP-3



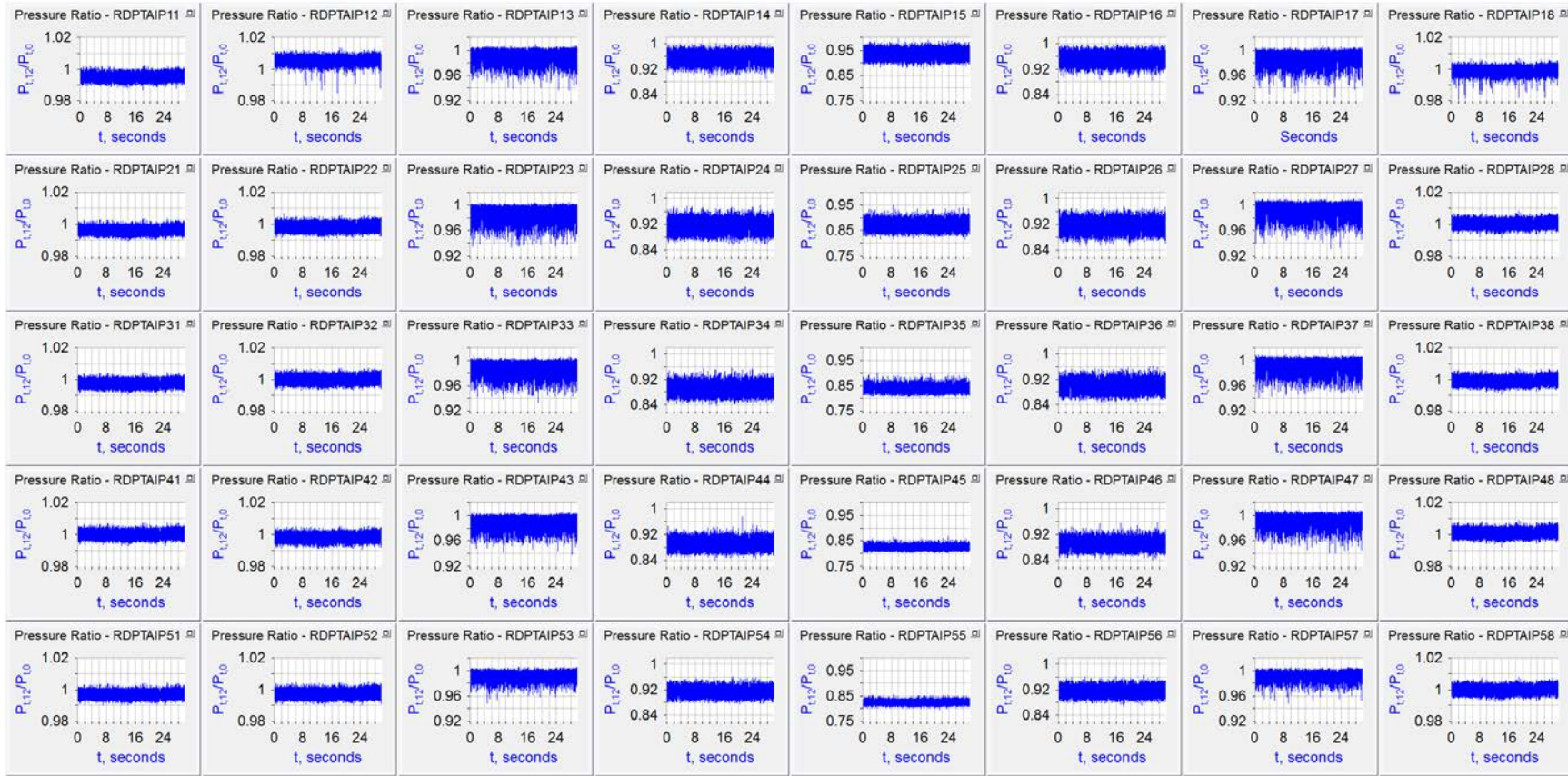
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=87.5\%$, $A_{19}=87.5\%$)

Dashboard D.5.4: 87.5% Speed Point, AIP-3



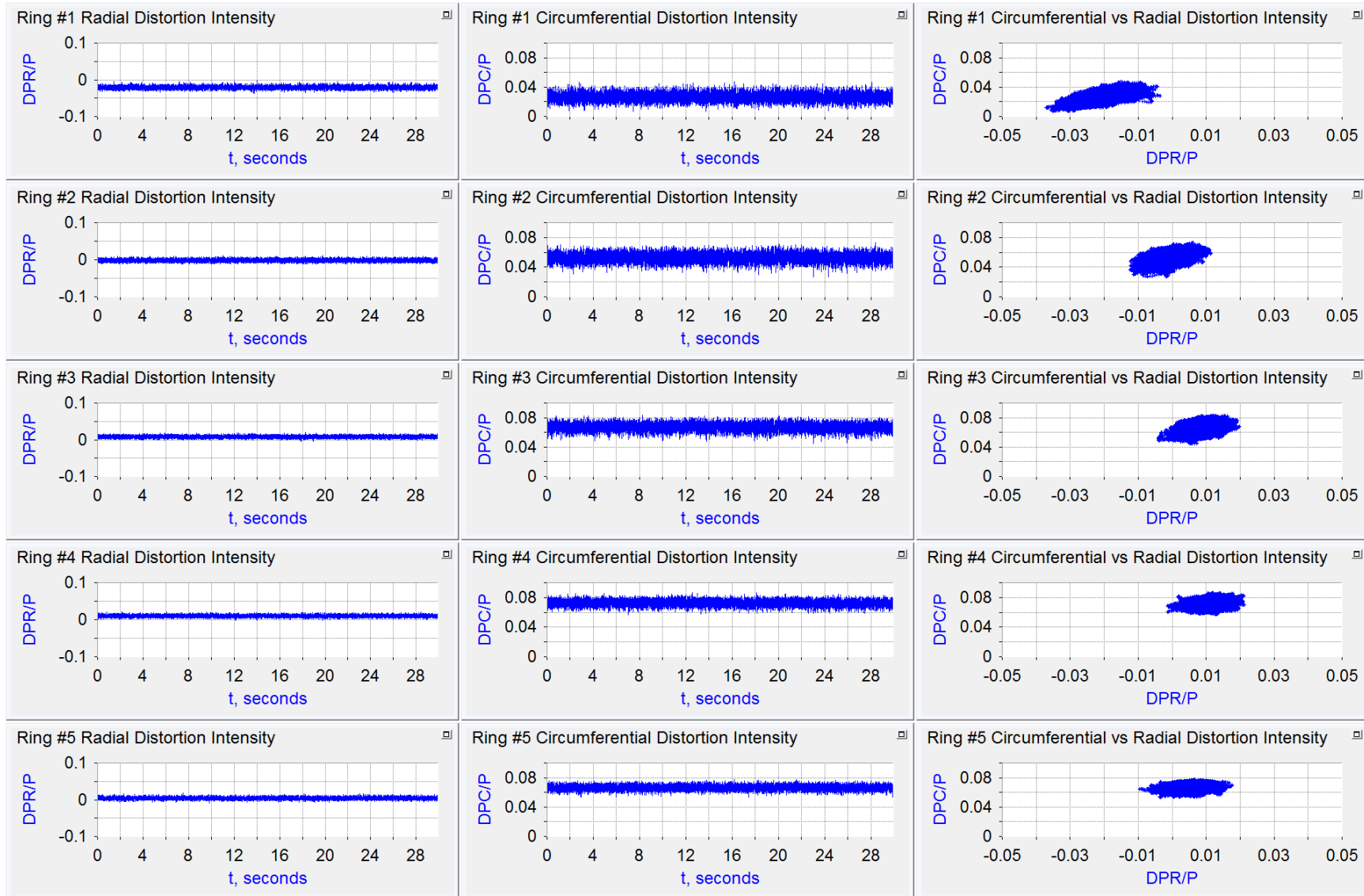
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=87.5\%$, $A_{19}=87.5\%$)

Dashboard D.5.5: 87.5% Speed Point, AIP-1



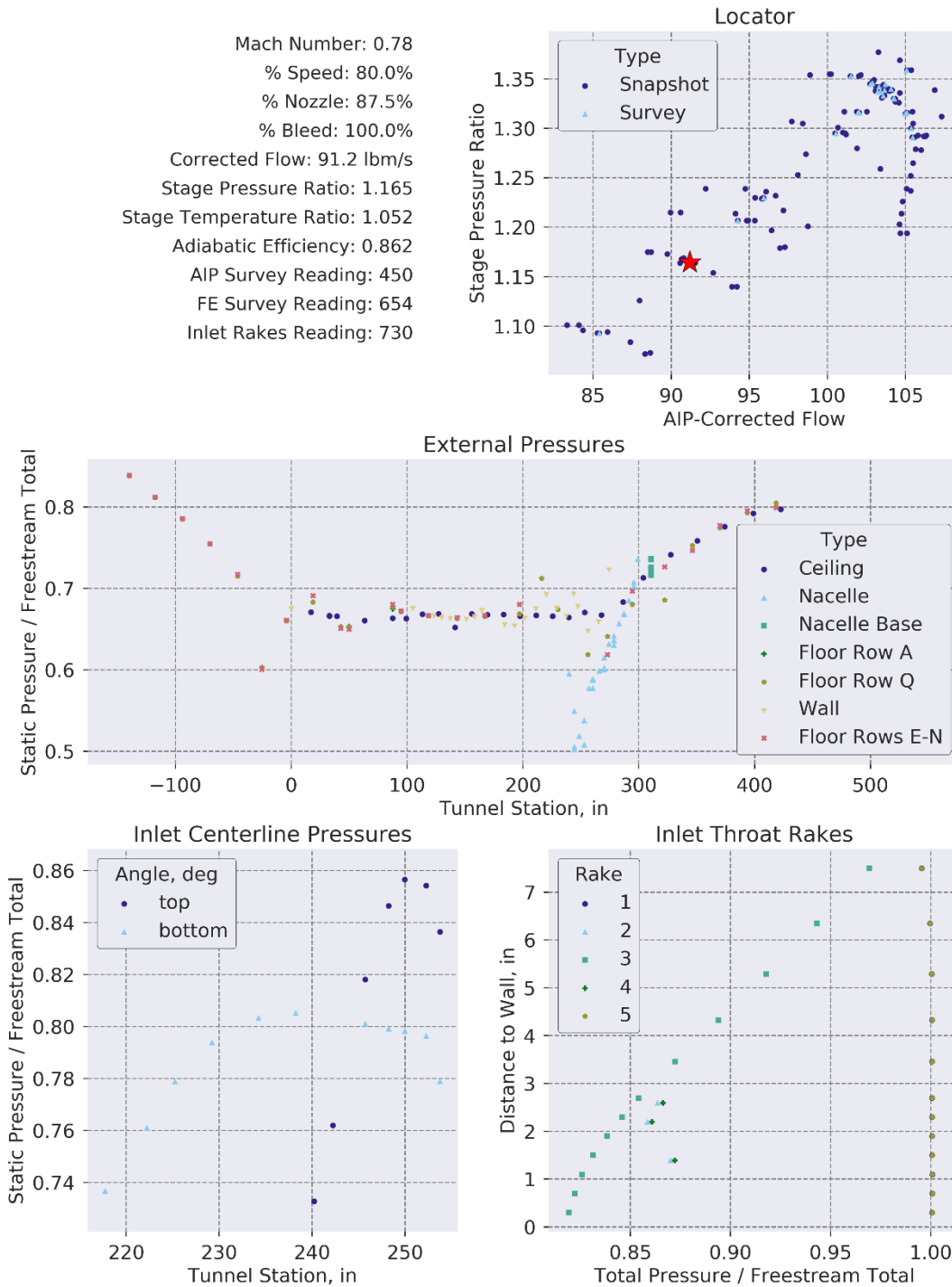
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=87.5\%$, $A_{19}=87.5\%$)

Dashboard D.5.6: 87.5% Speed Point, AIP-1

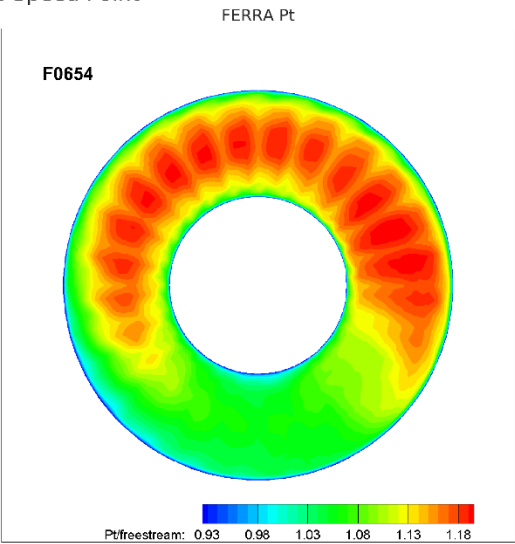


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=87.5\%$, $A_{19}=87.5\%$)

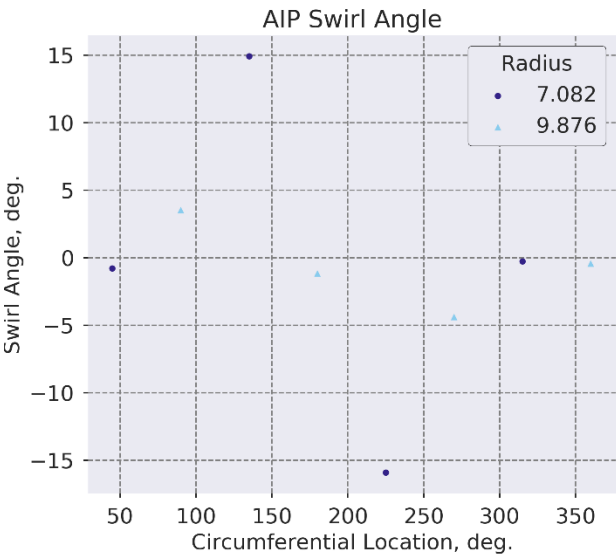
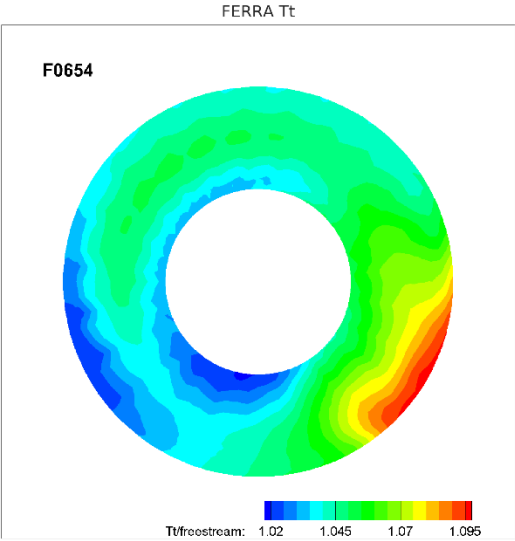
Dashboard D.6.1: 80% Speed Point



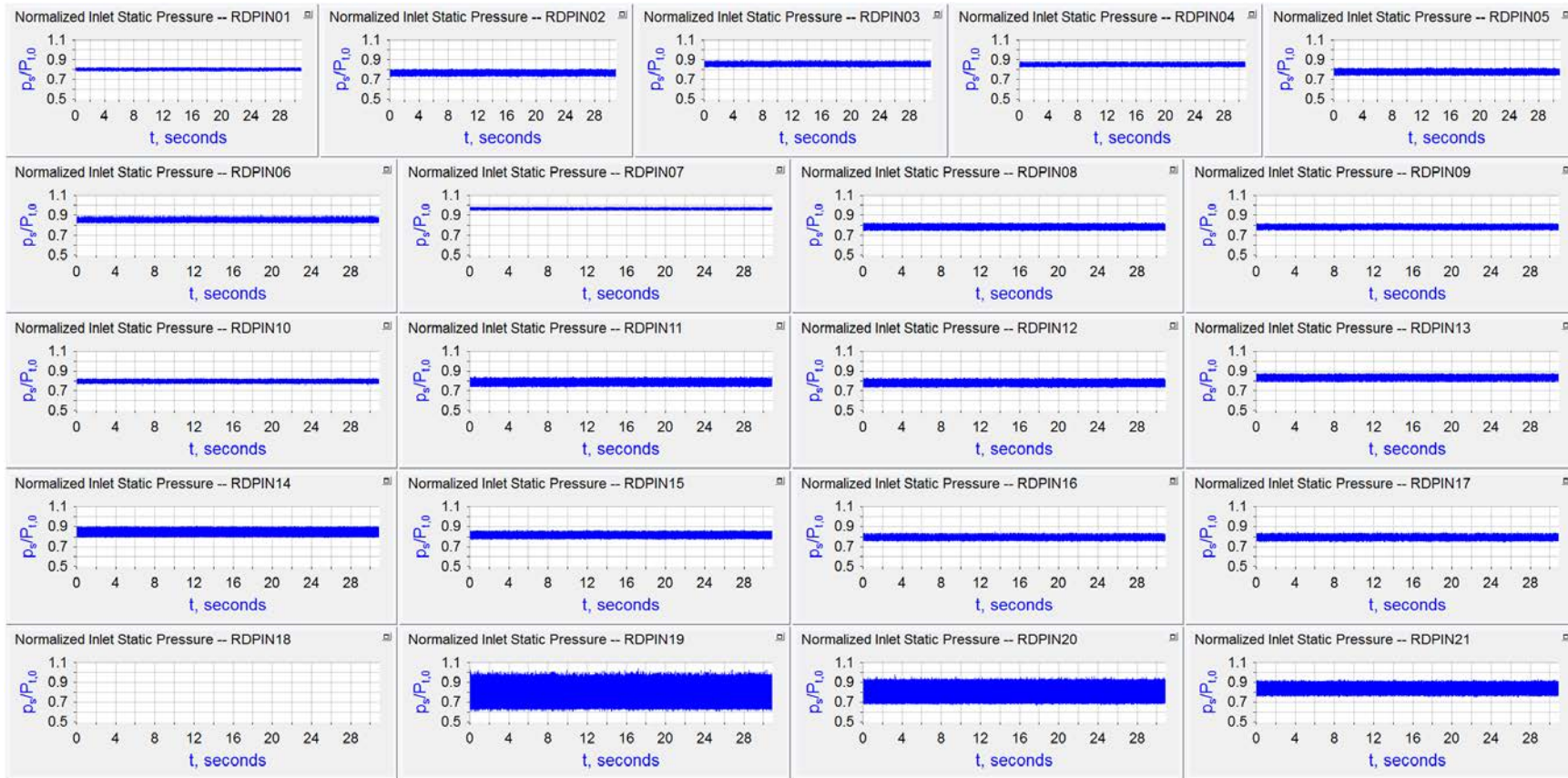
AIPRRA Pt
No Data



AIPRRA Tt
No Data

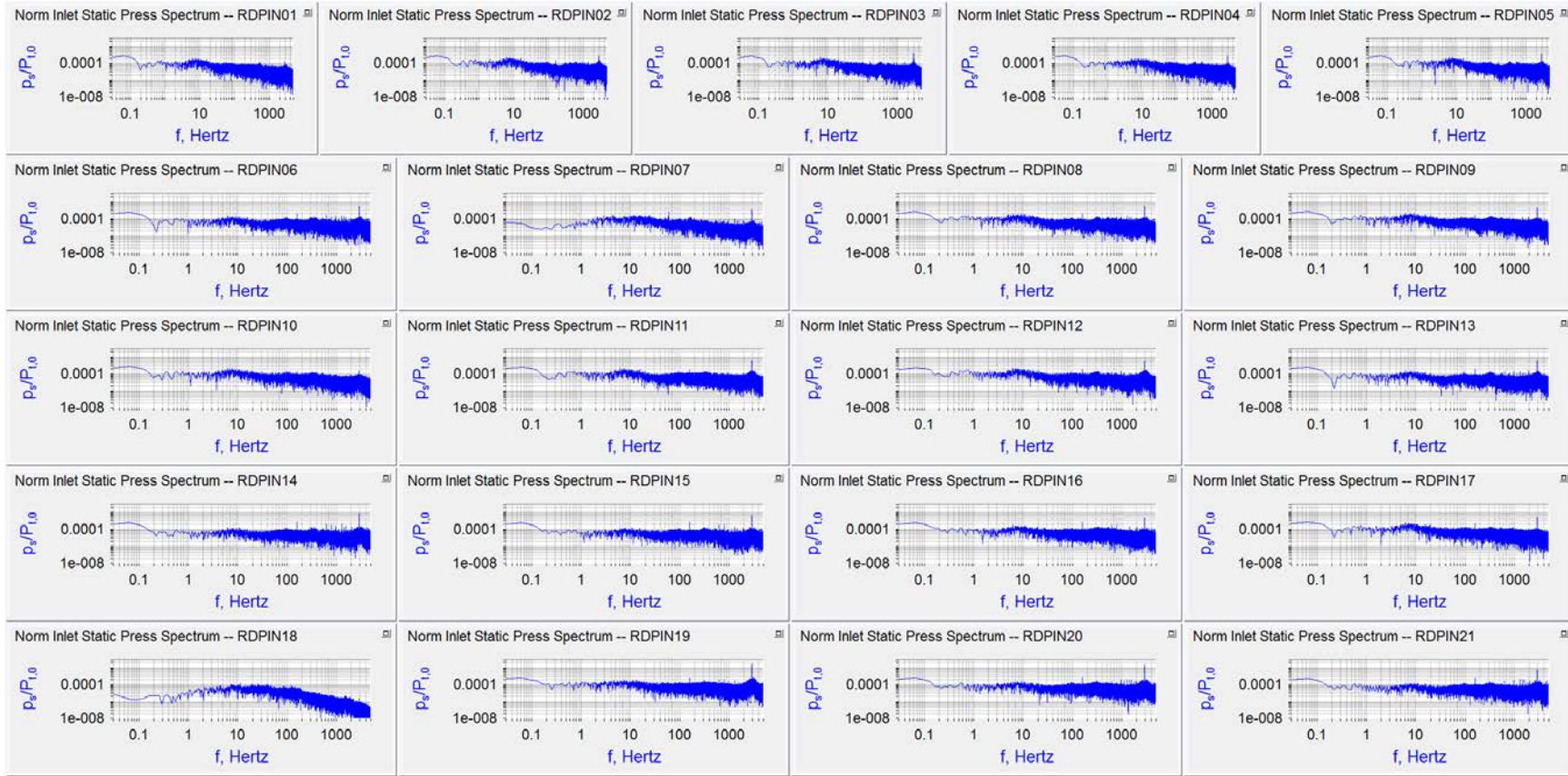


Dashboard D.6.3: 80% Speed Point, AIP-3



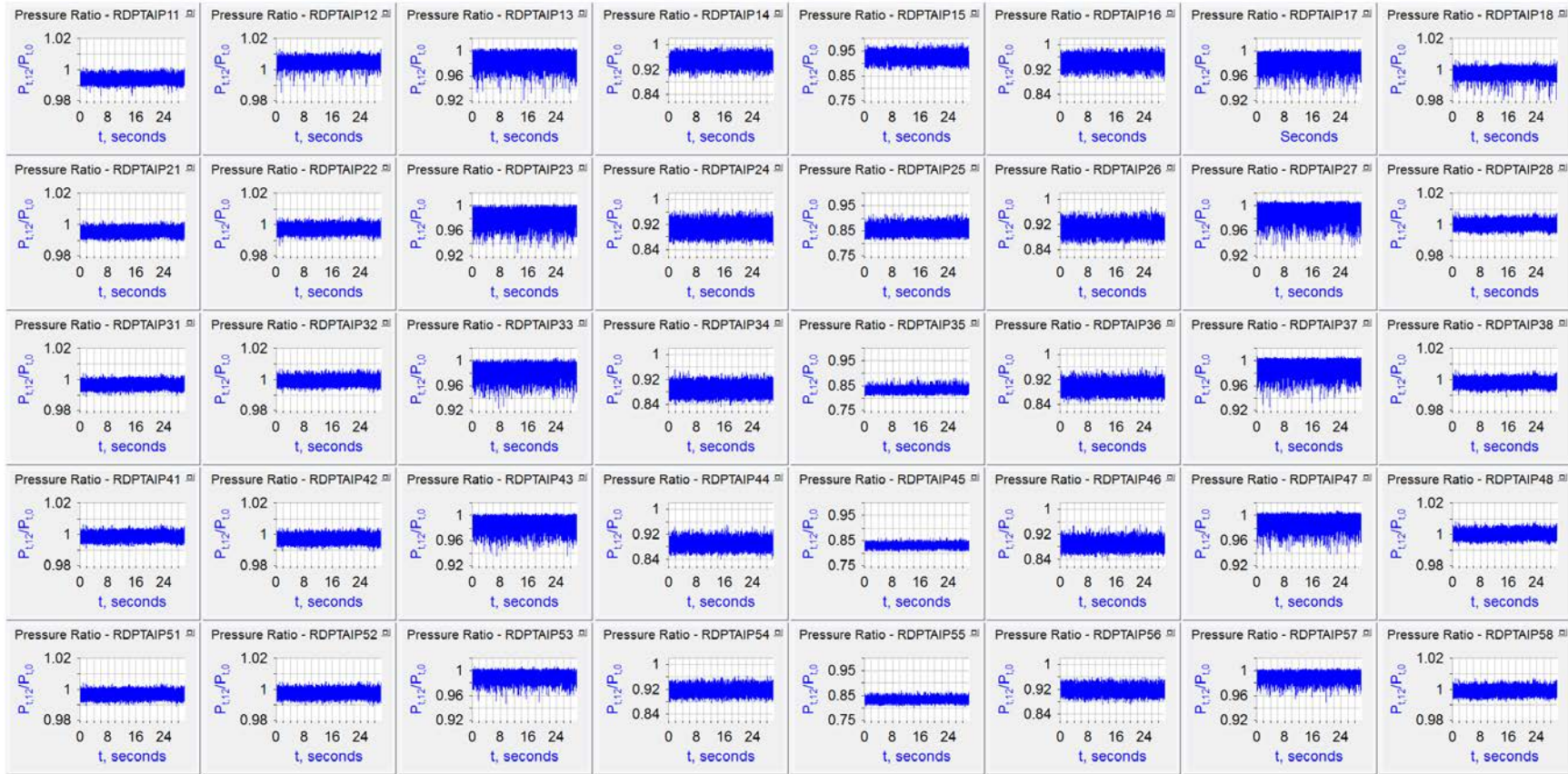
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=80\%$, $A_{19}=87.5\%$)

Dashboard D.6.4: 80% Speed Point, AIP-3



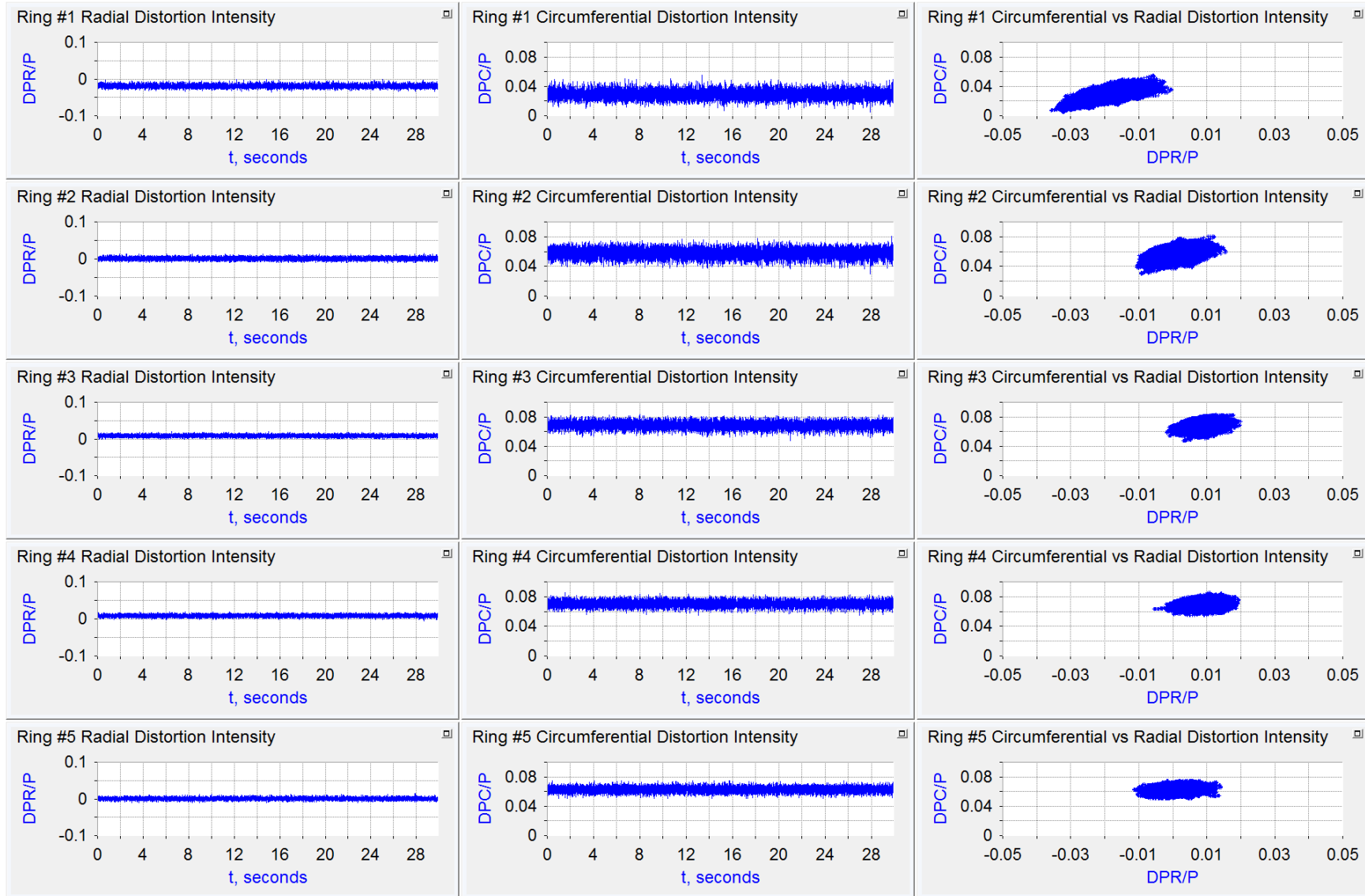
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=80\%$, $A_{19}=87.5\%$)

Dashboard D.6.5: 80% Speed Point, AIP-1



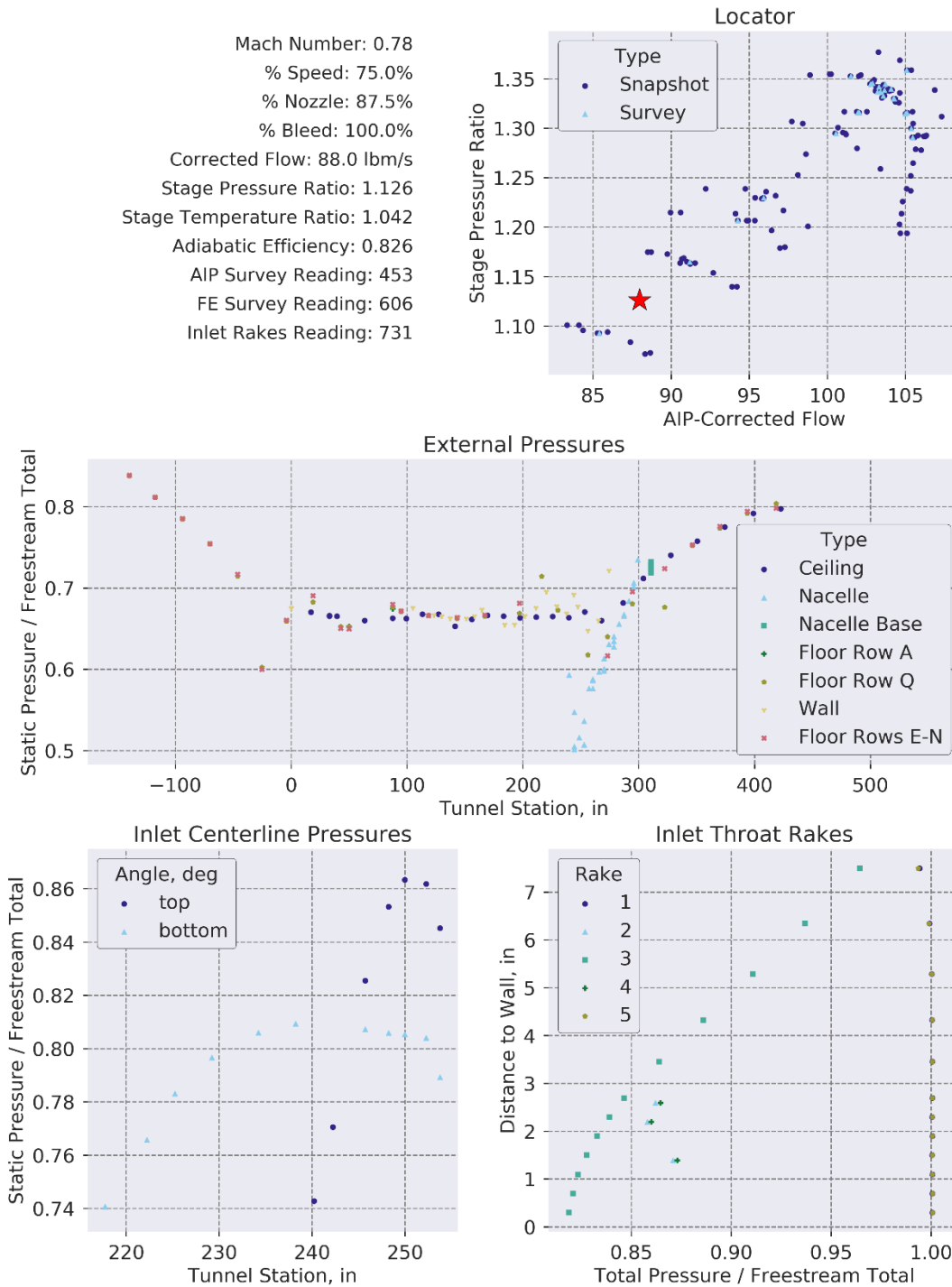
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=80\%$, $A_{19}=87.5\%$)

Dashboard D.6.6: 80% Speed Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=80\%$, $A_{19}=87.5\%$)

Dashboard D.7.1: 75% Speed Point

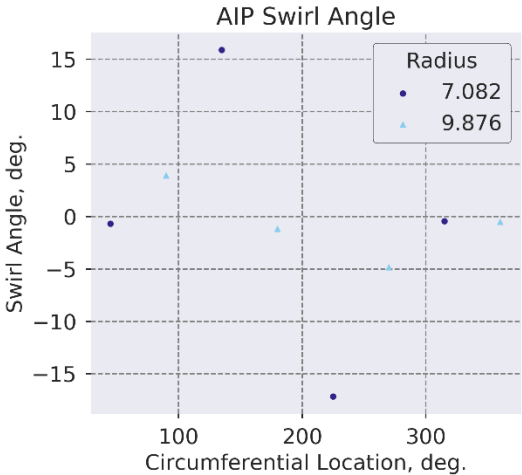


AIPRRA Pt
No Data

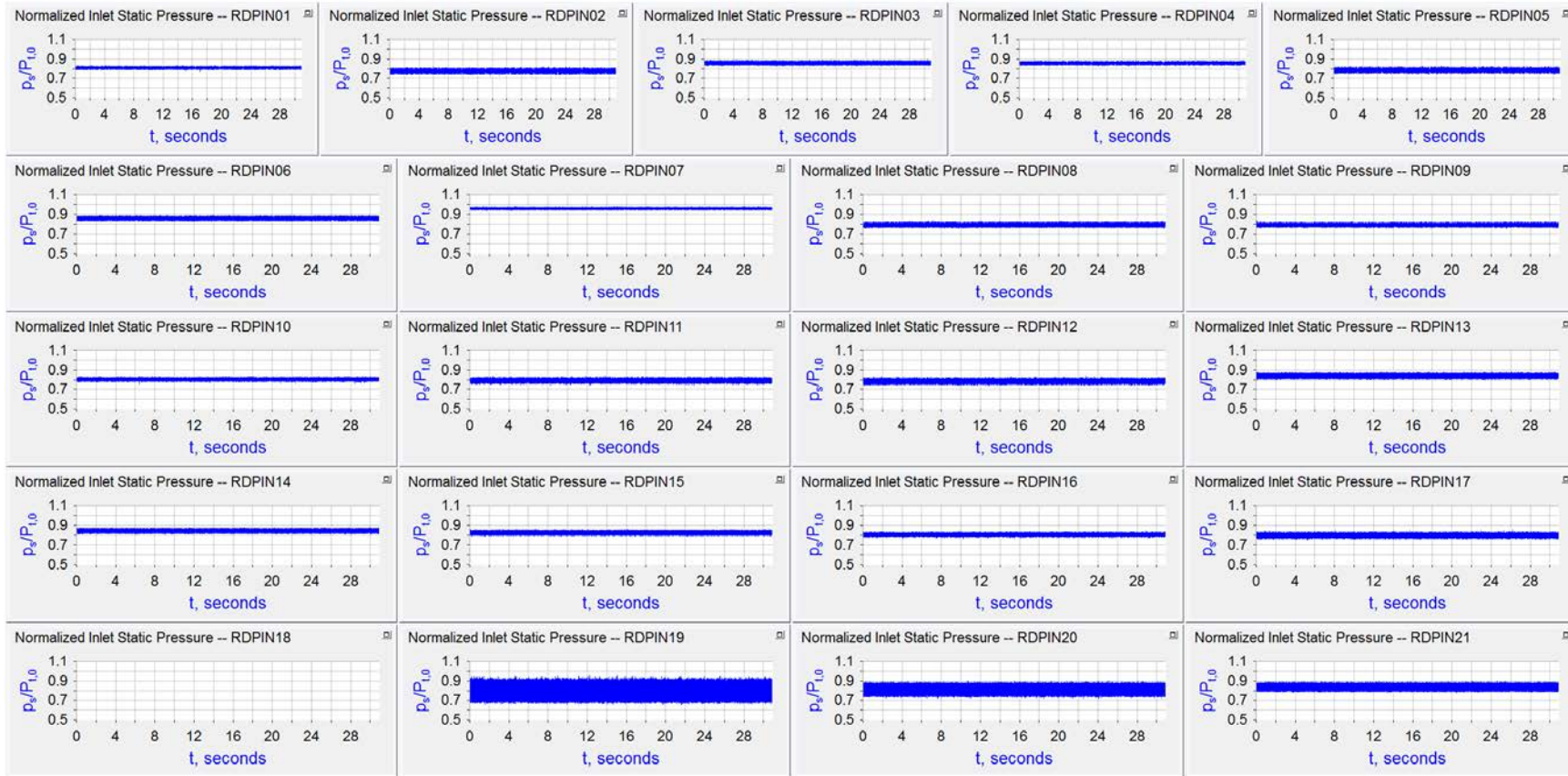
FERRA Pt
No Data

AIPRRA Tt
No Data

FERRA Tt
No Data

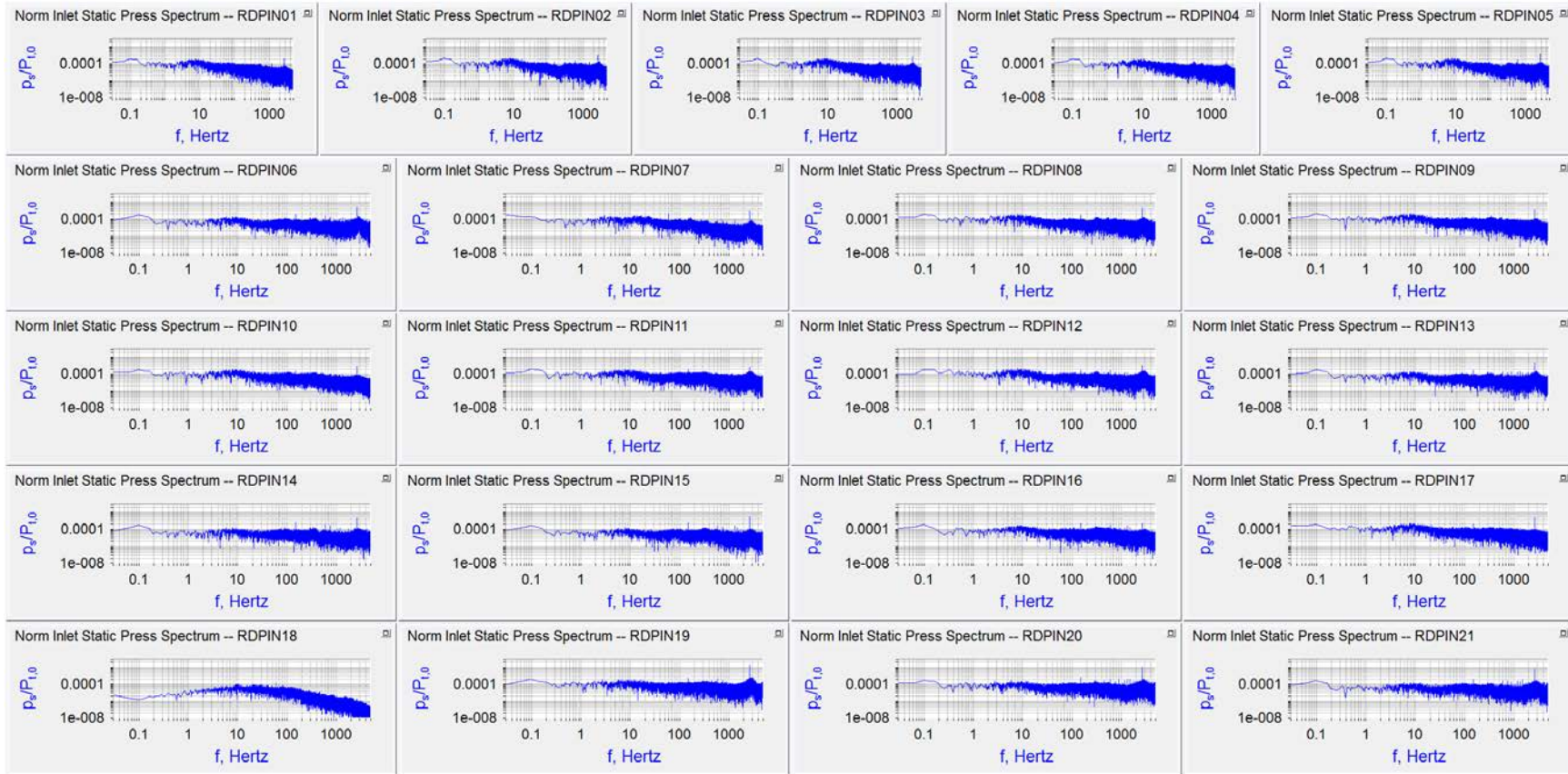


Dashboard D.7.3: 75% Speed Point, AIP-3



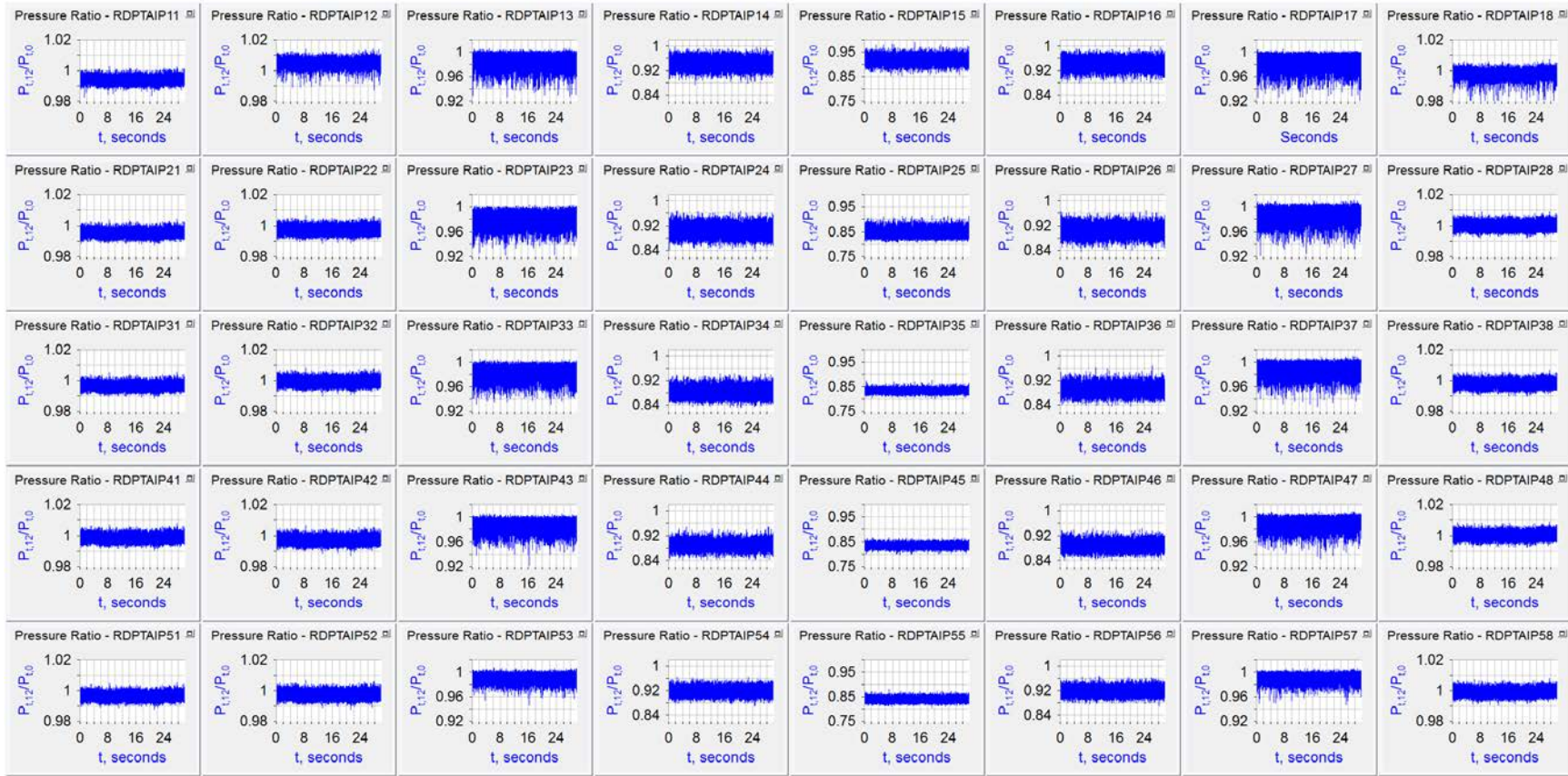
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=75\%$, $A_{19}=87.5\%$)

Dashboard D.7.4: 75% Speed Point, AIP-3



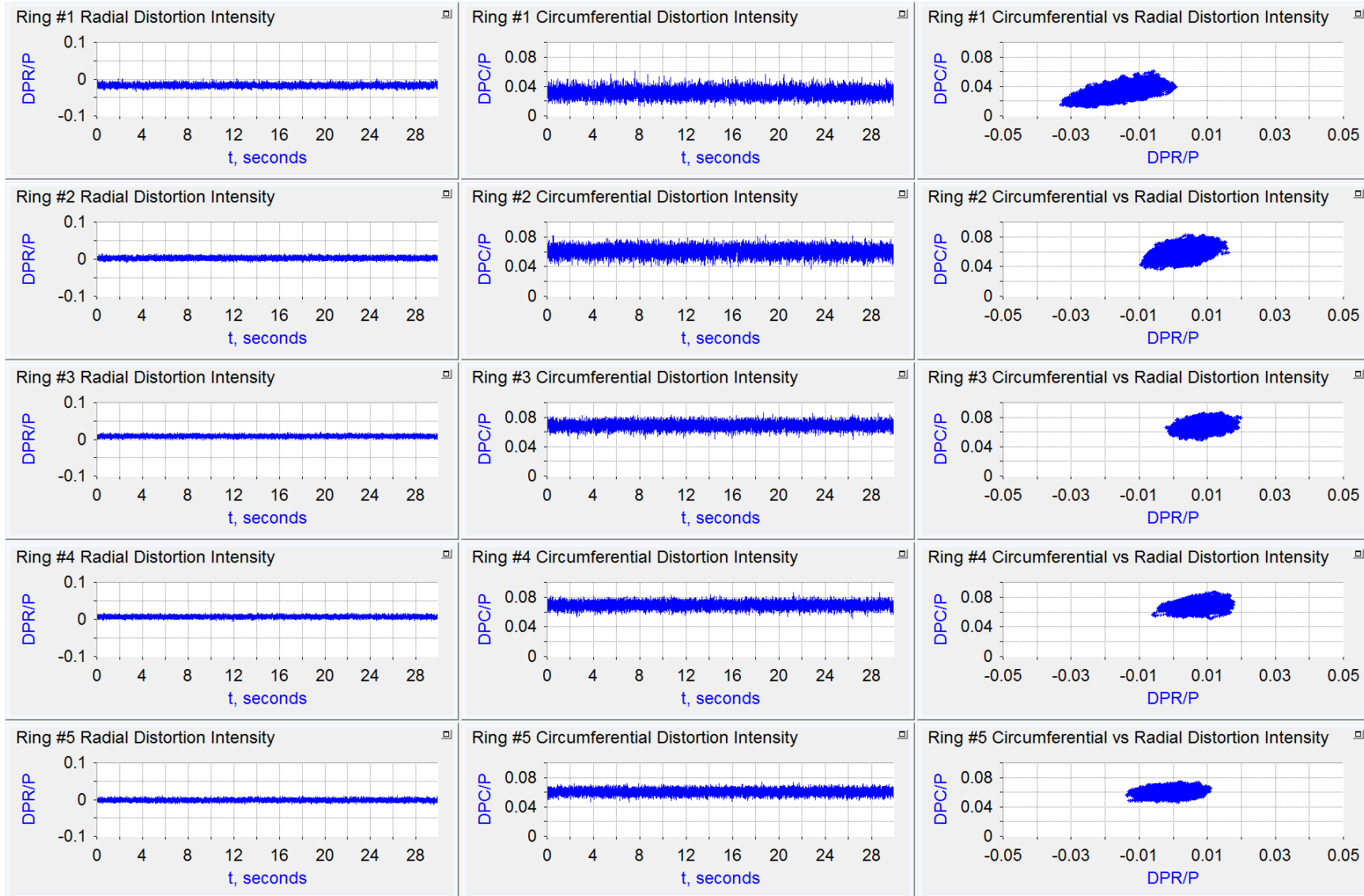
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=75\%$, $A_{19}=87.5\%$)

Dashboard D.7.5: 75% Speed Point, AIP-1



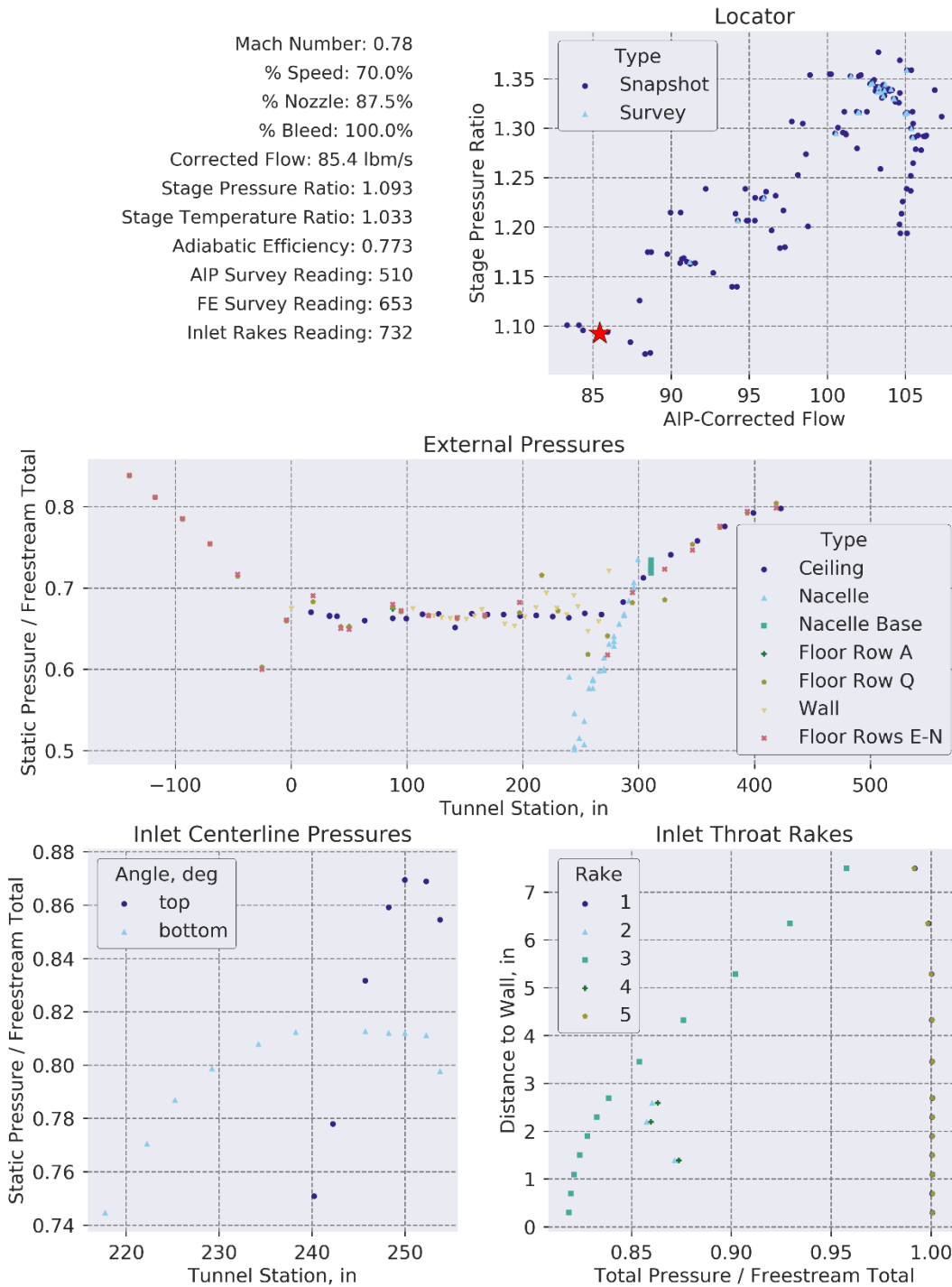
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=75\%$, $A_{10}=87.5\%$)

Dashboard D.7.6: 75% Speed Point, AIP-1

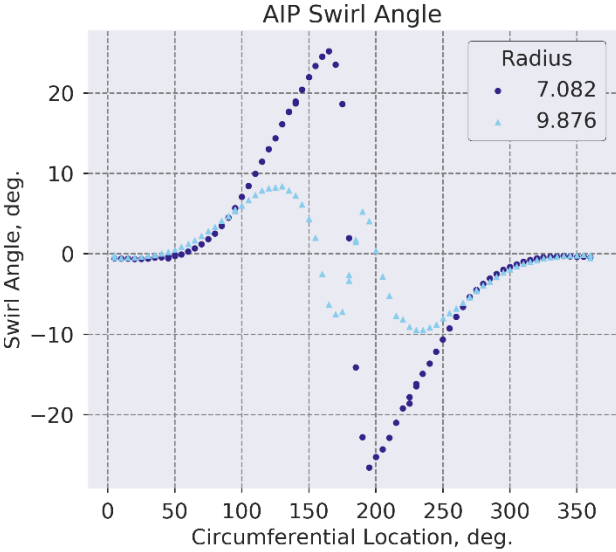
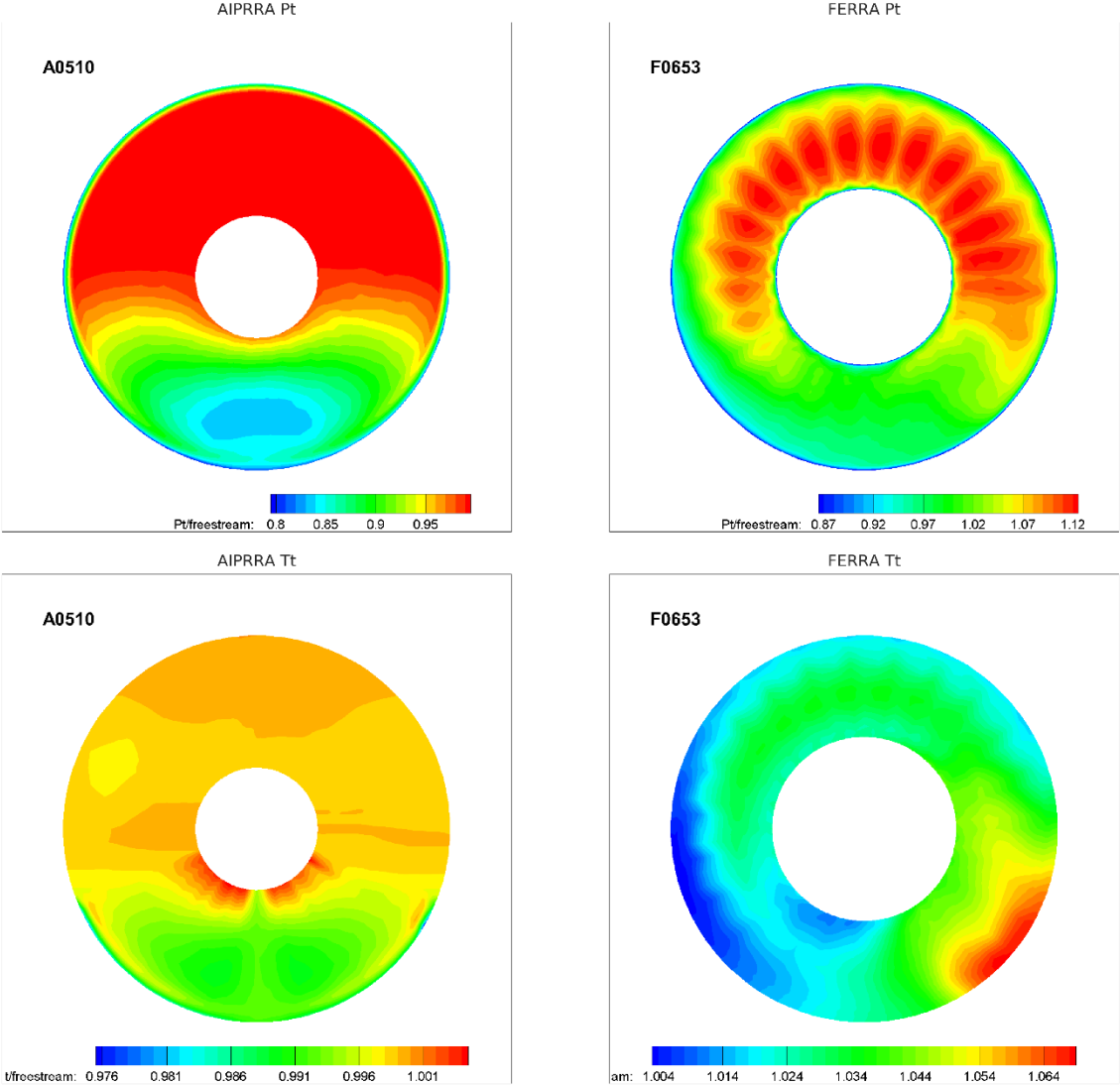


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=75\%$, $A_{19}=87.5\%$)

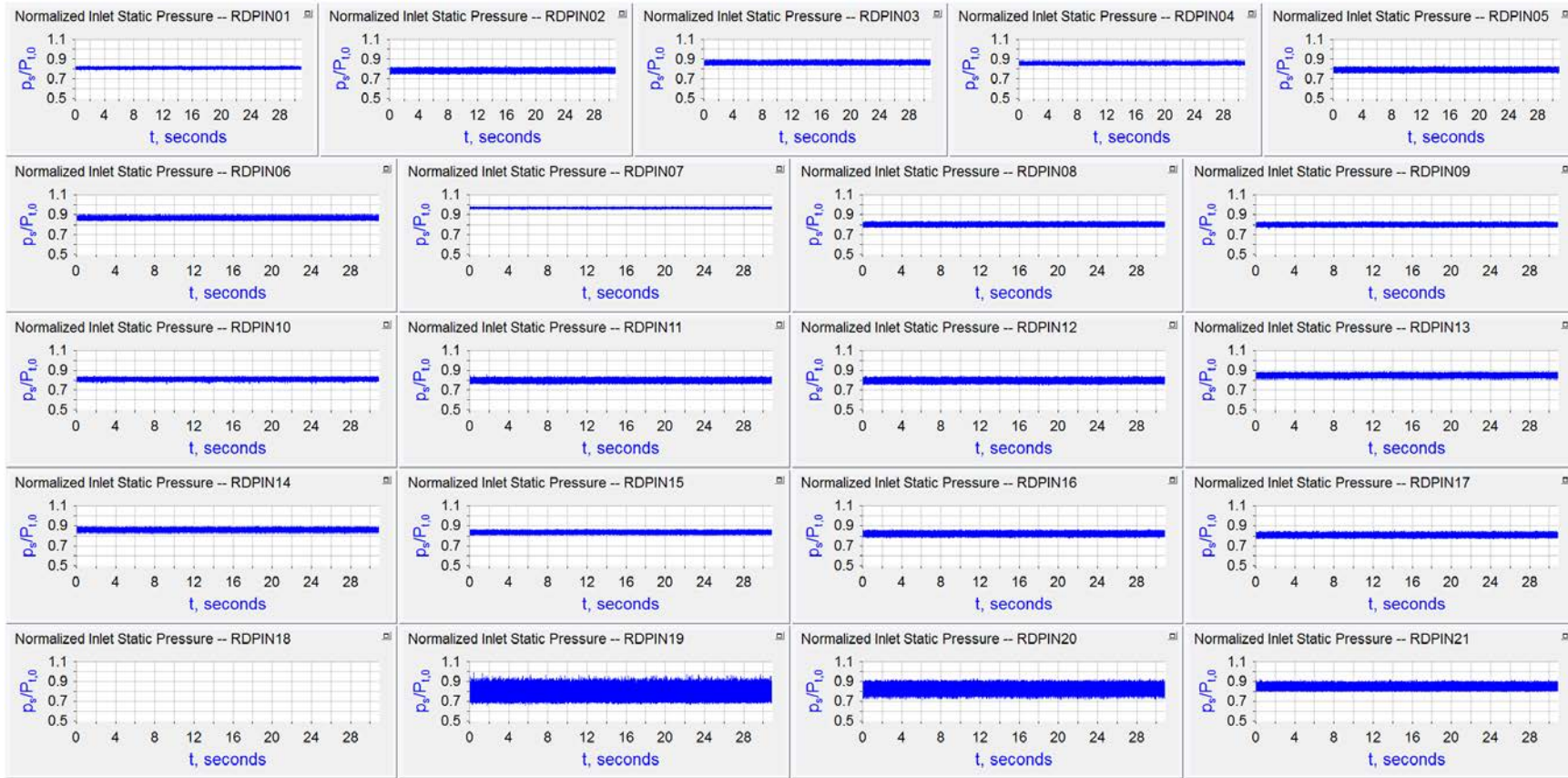
Dashboard D.8.1: 70% Speed Point



Dashboard D.8.2: 70% Speed Point

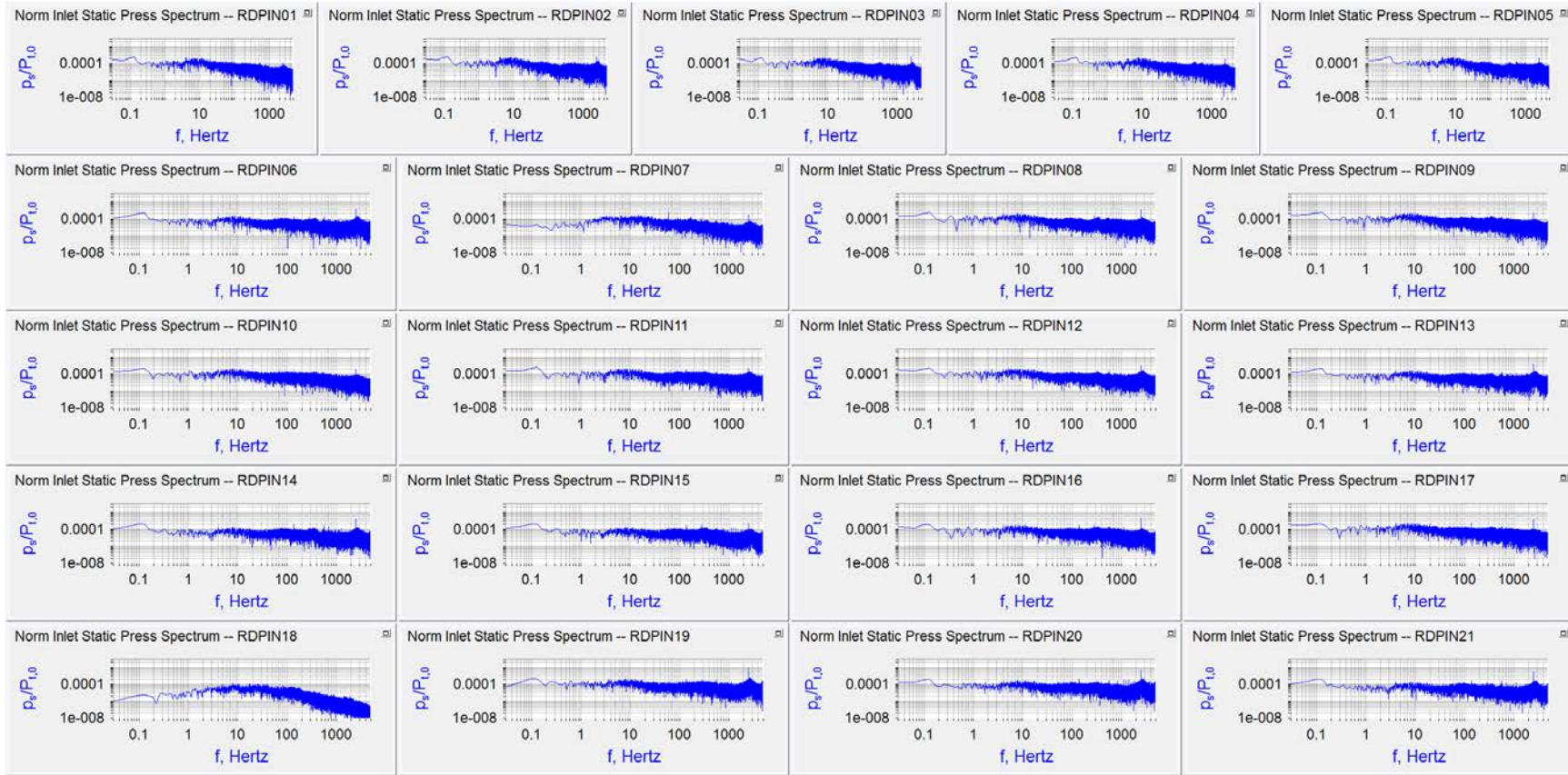


Dashboard D.8.3: 70% Speed Point, AIP-3



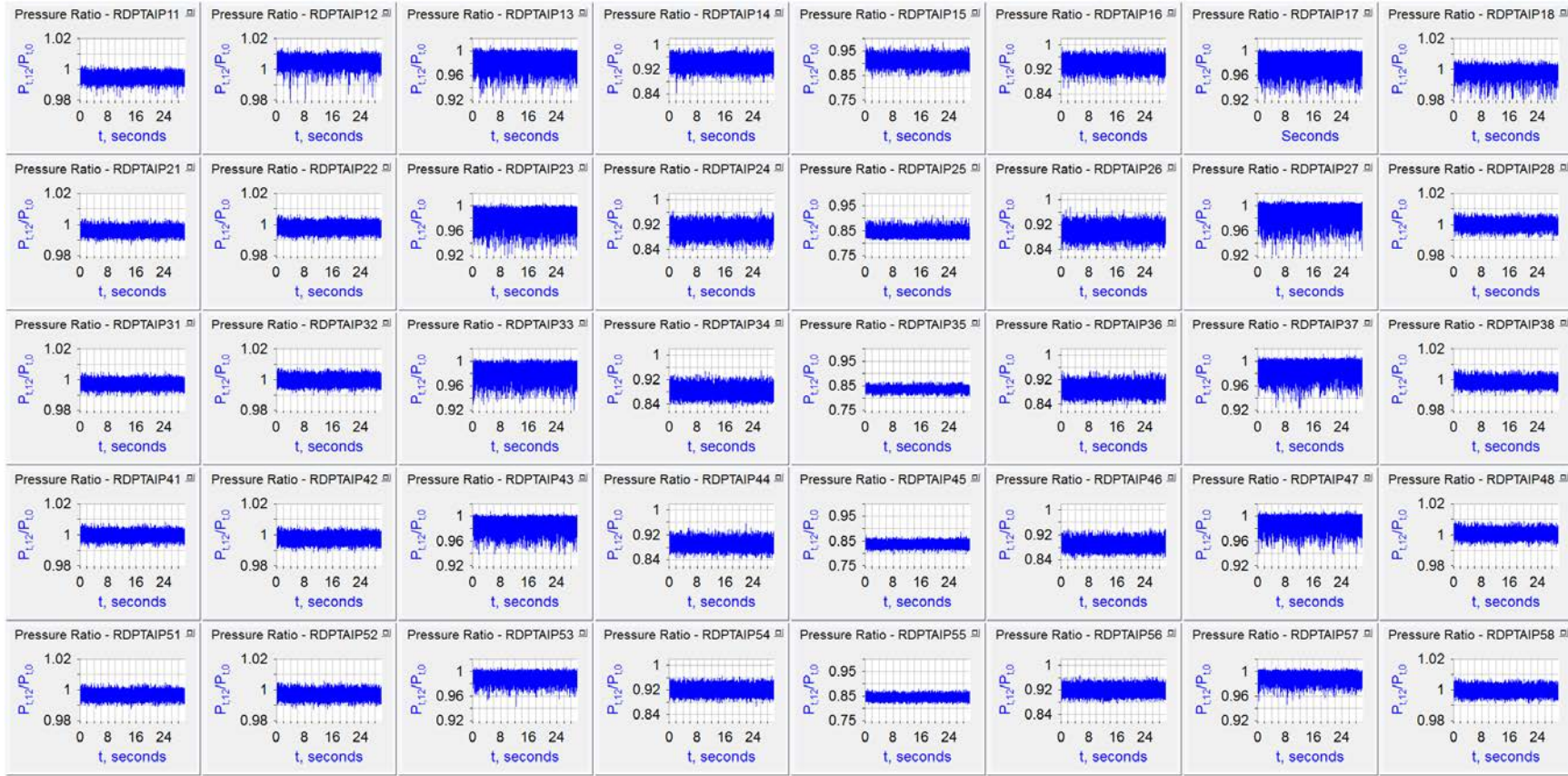
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=70\%$, $A_{19}=87.5\%$)

Dashboard D.8.4: 70% Speed Point, AIP-3



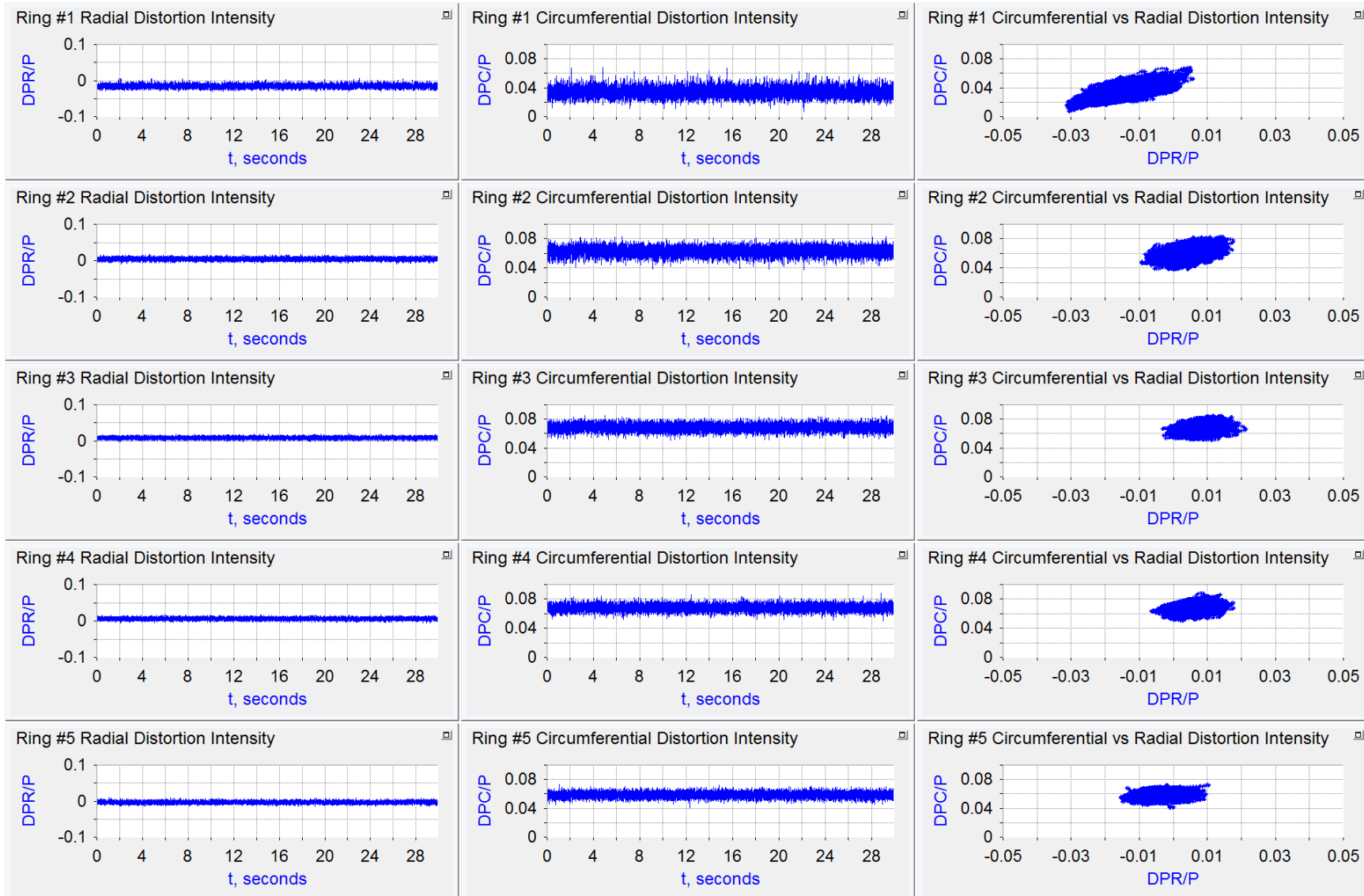
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=70\%$, $A_{19}=87.5\%$)

Dashboard D.8.5: 70% Speed Point, AIP-1



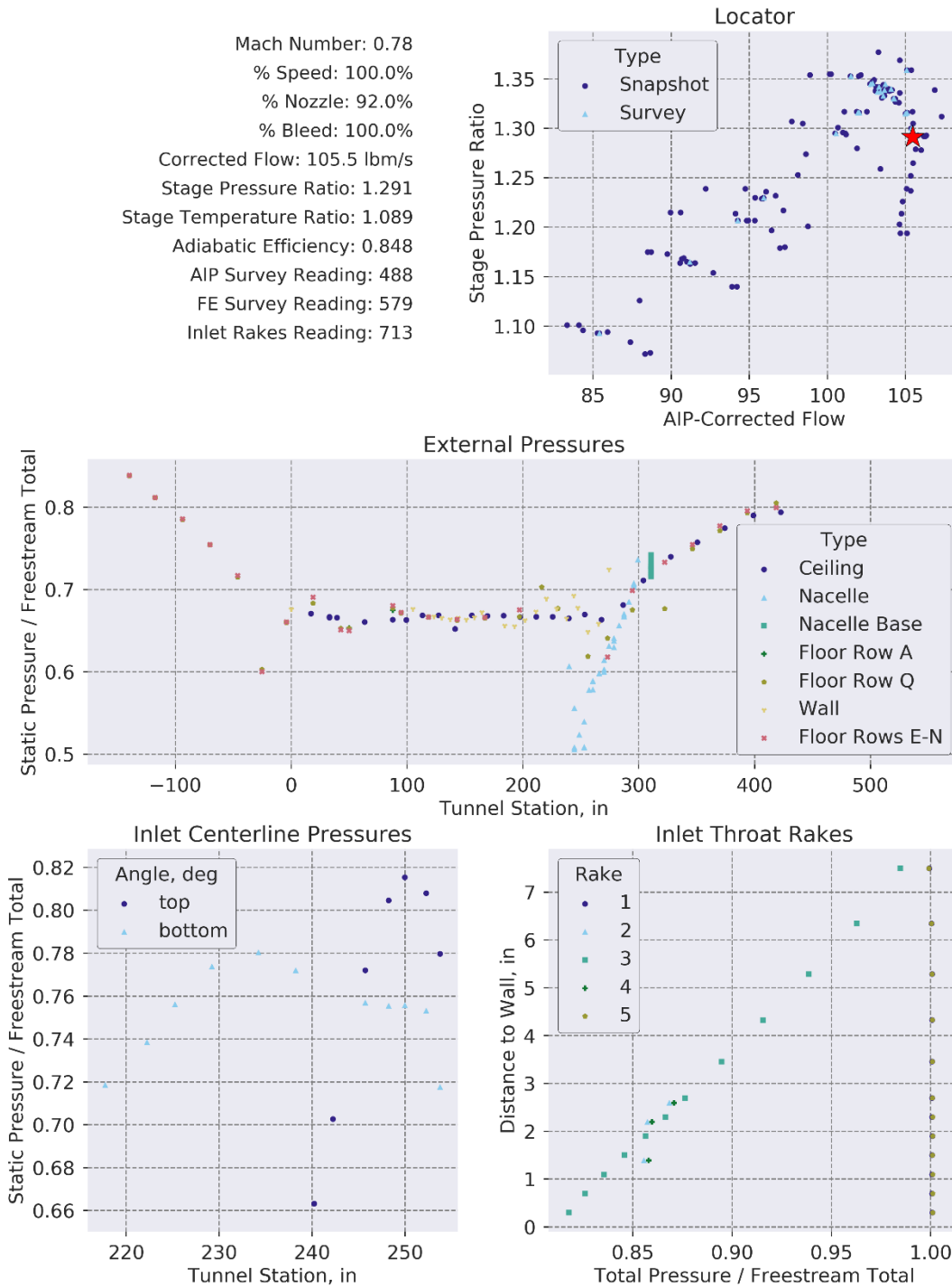
Measured High Response AIP Total Pressure Distribution (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=70\%$, $A_{19}=87.5\%$)

Dashboard D.8.6: 70% Speed Point, AIP-1

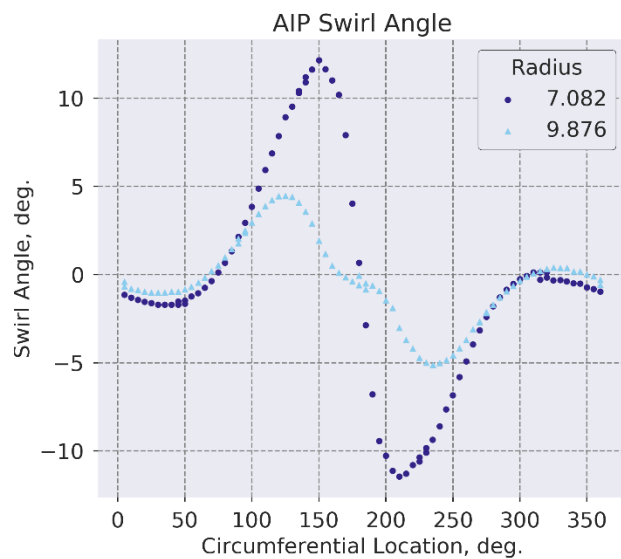
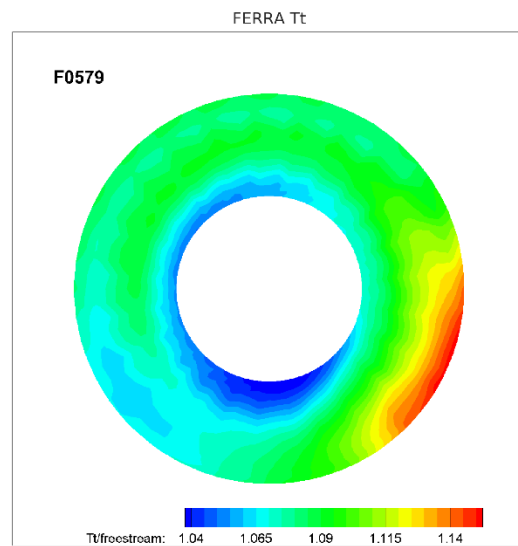
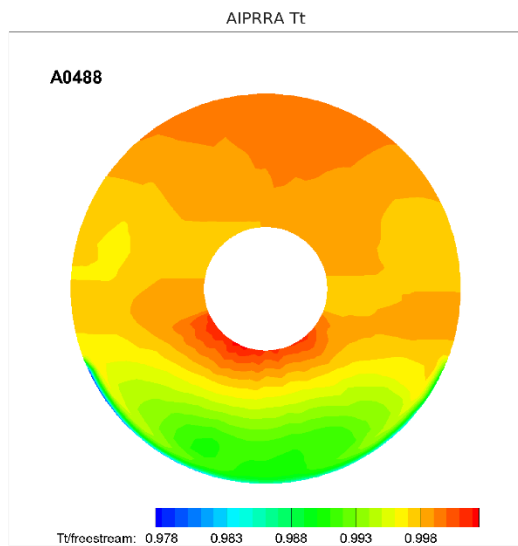
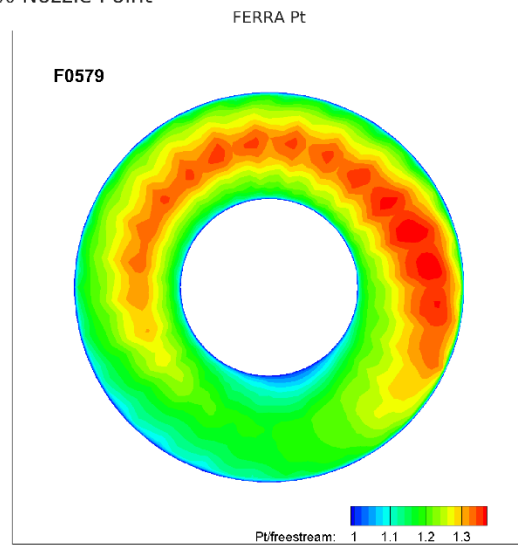
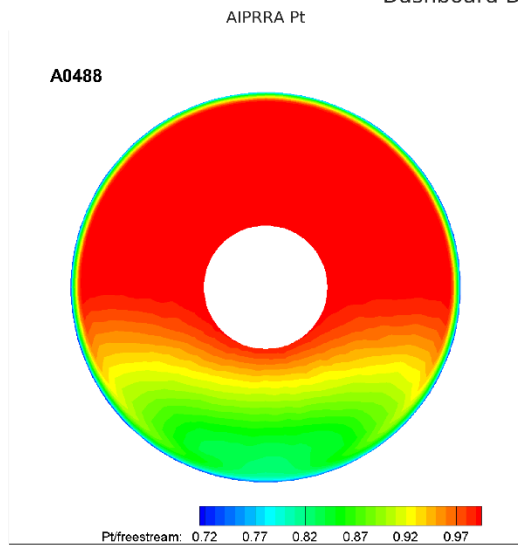


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=70\%$, $A_{19}=87.5\%$)

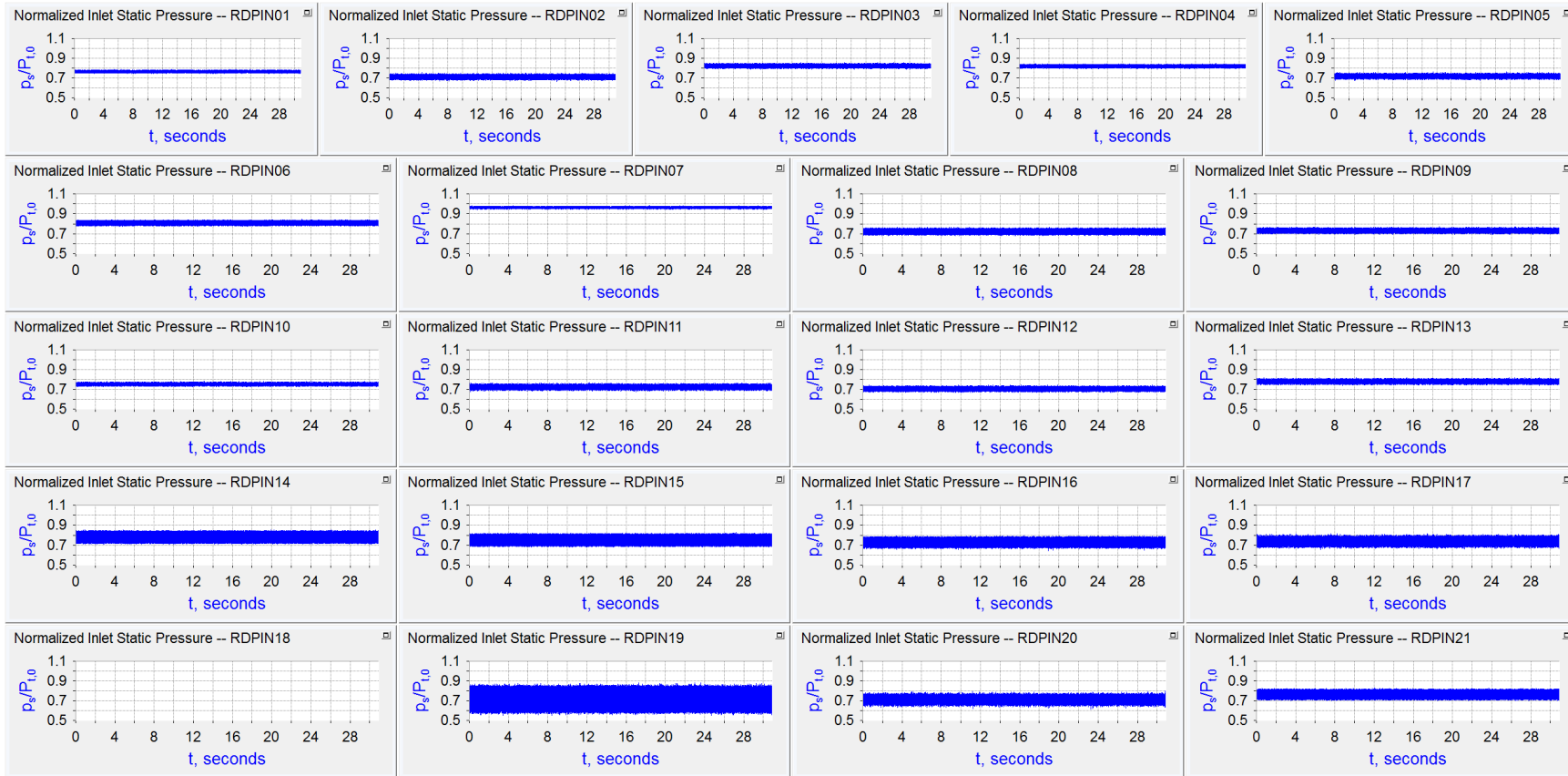
Dashboard D.9.1: 92% Nozzle Point



Dashboard D.9.2: 92% Nozzle Point

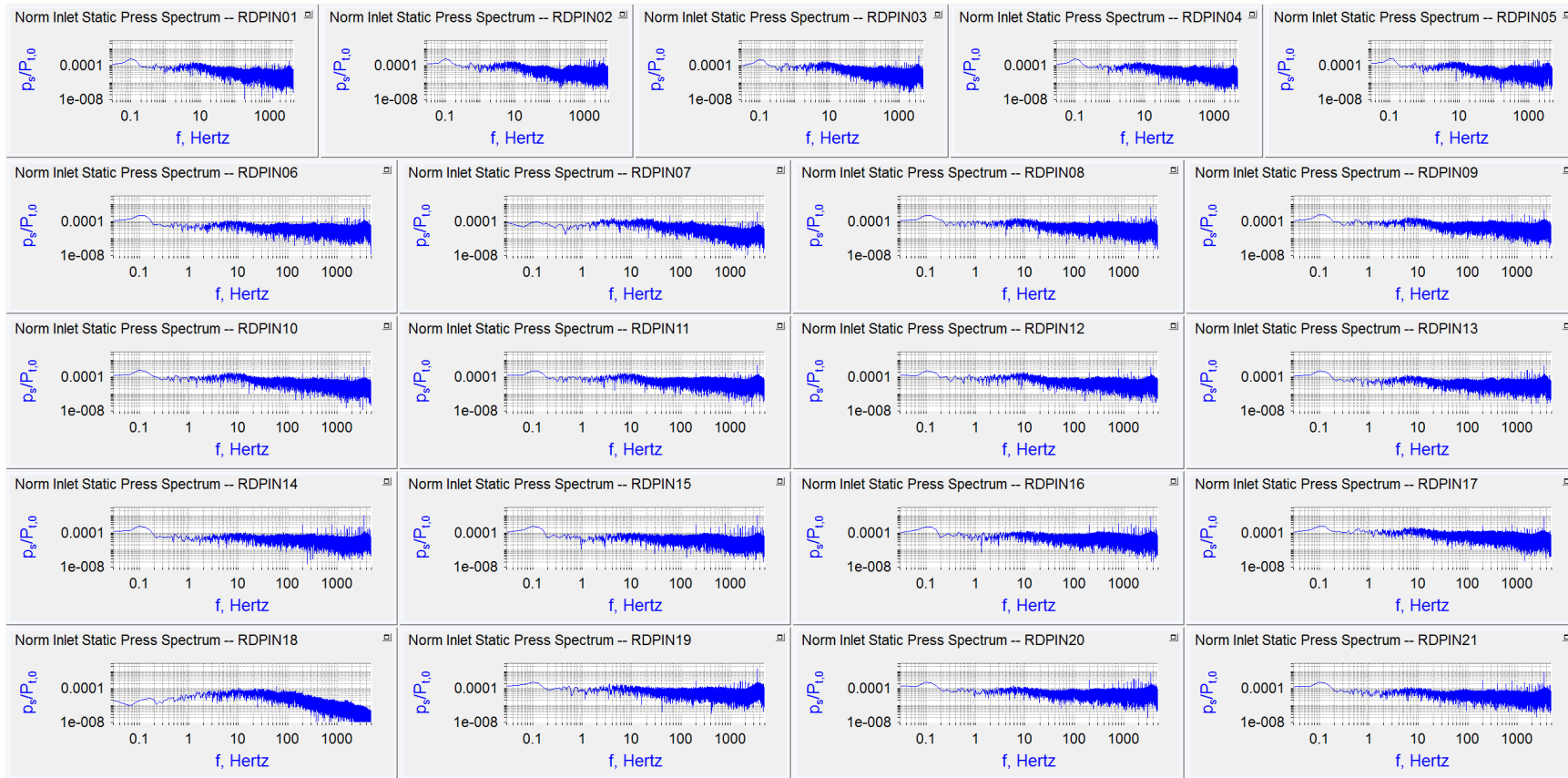


Dashboard D.9.3: 92% Nozzle Point, AIP-3



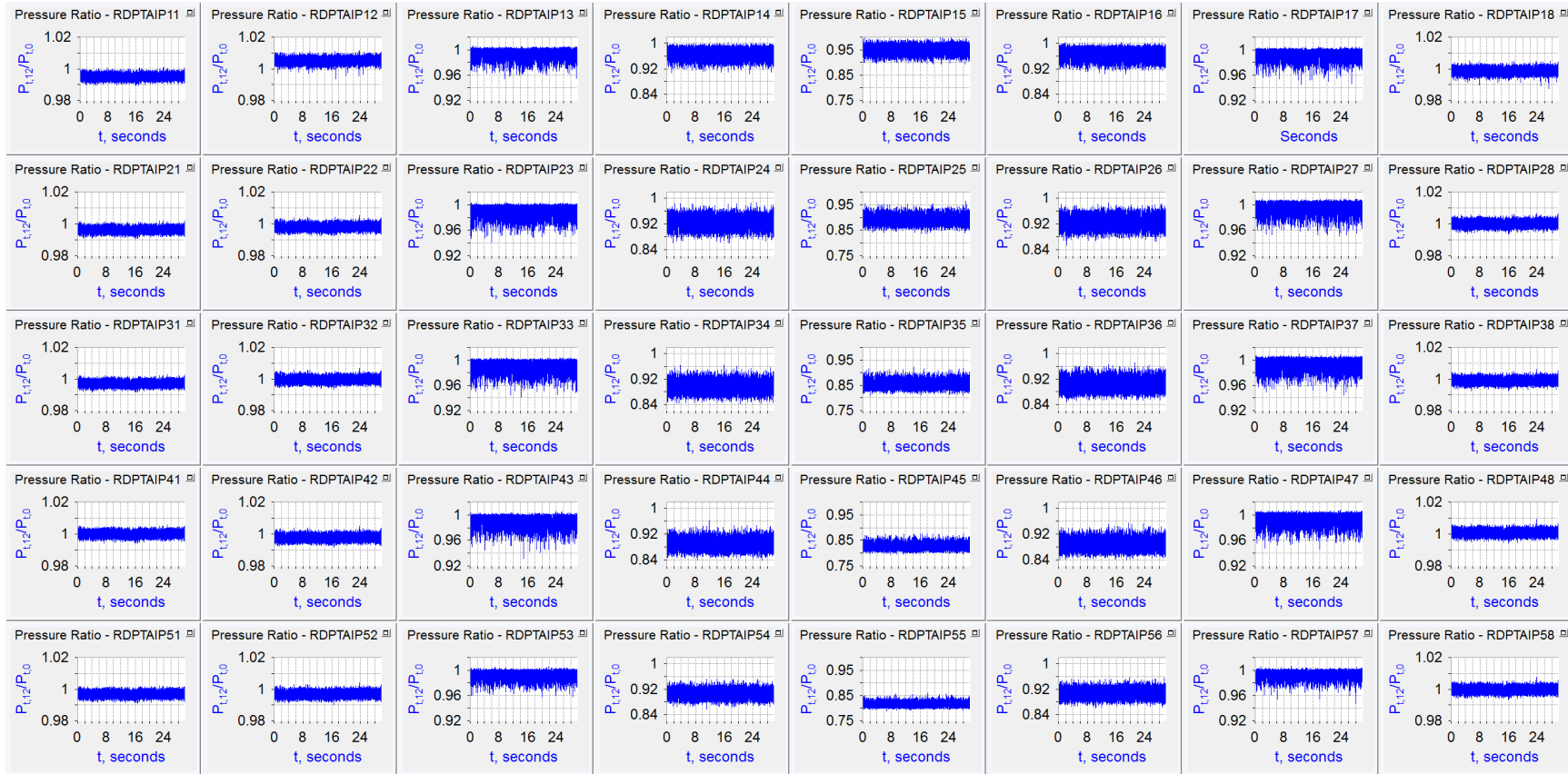
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=92.0\%$)

Dashboard D.9.4: 92% Nozzle Point, AIP-3



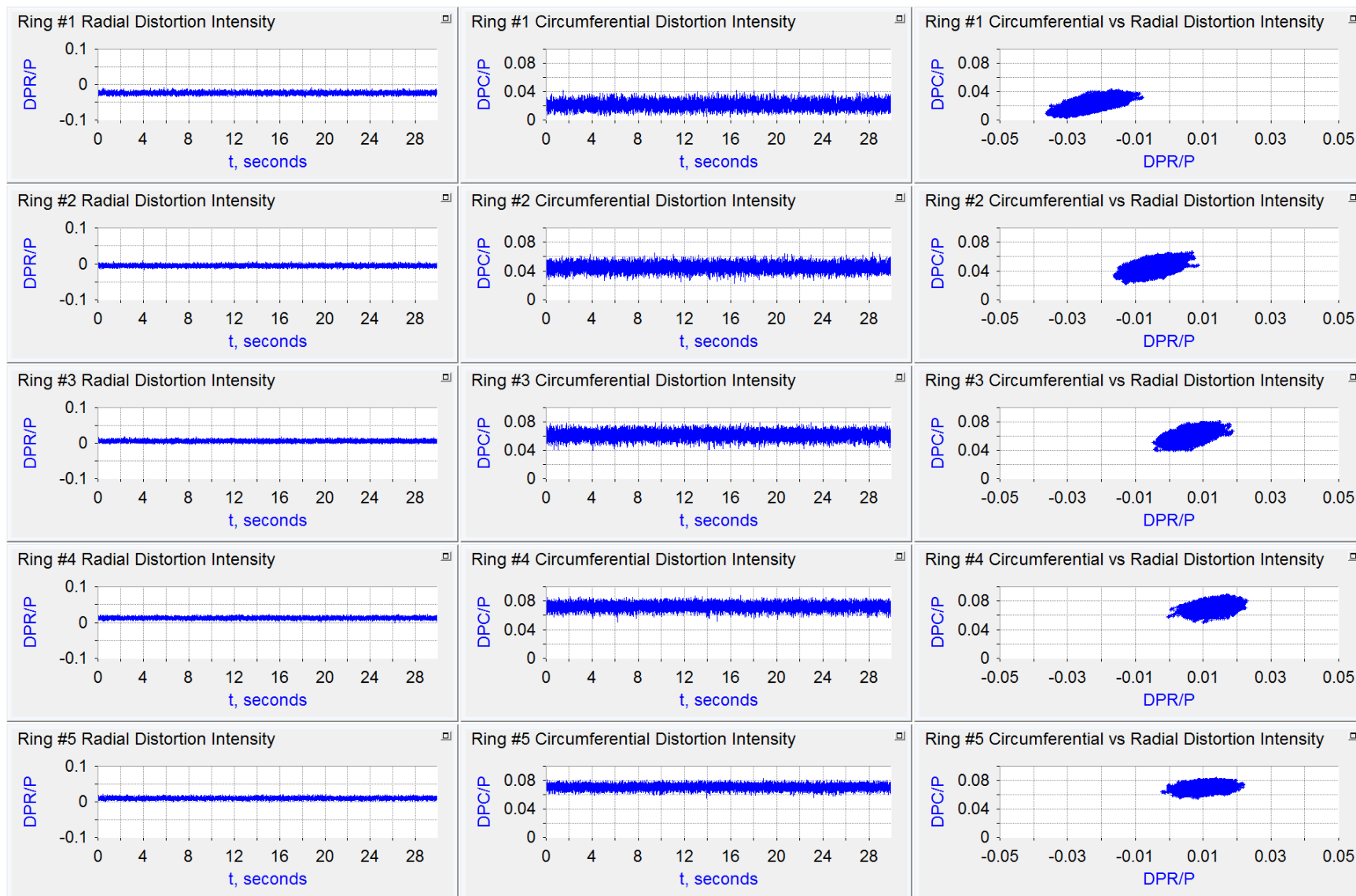
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=92.0\%$)

Dashboard D.9.5: 92% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=92.0\%$)

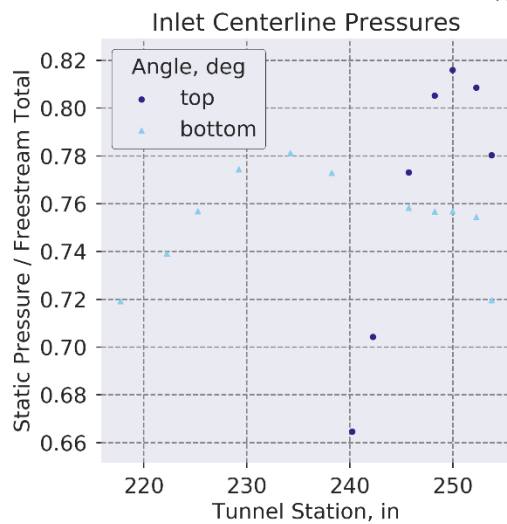
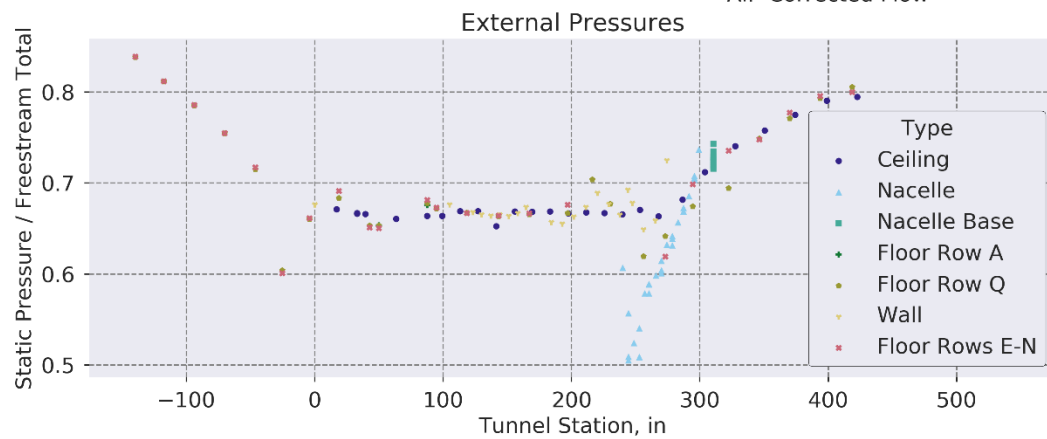
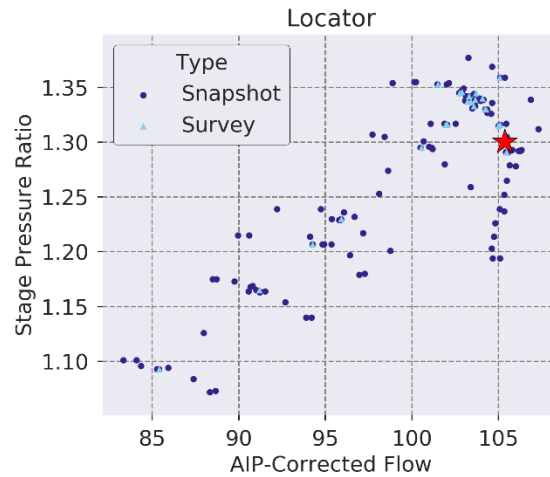
Dashboard D.9.6: 92% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=92.0\%$)

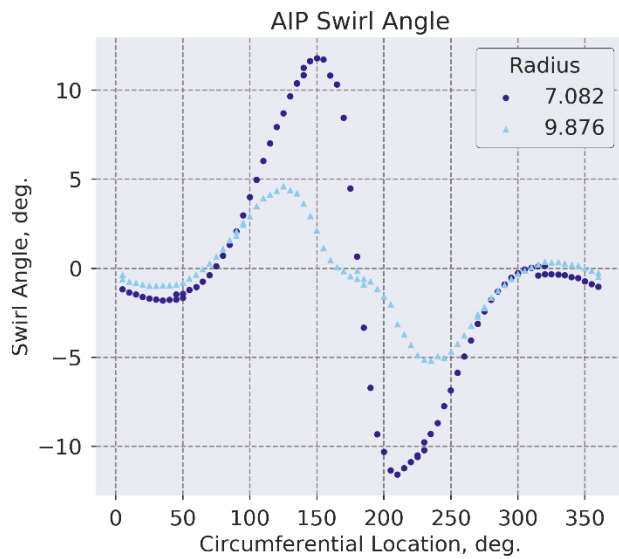
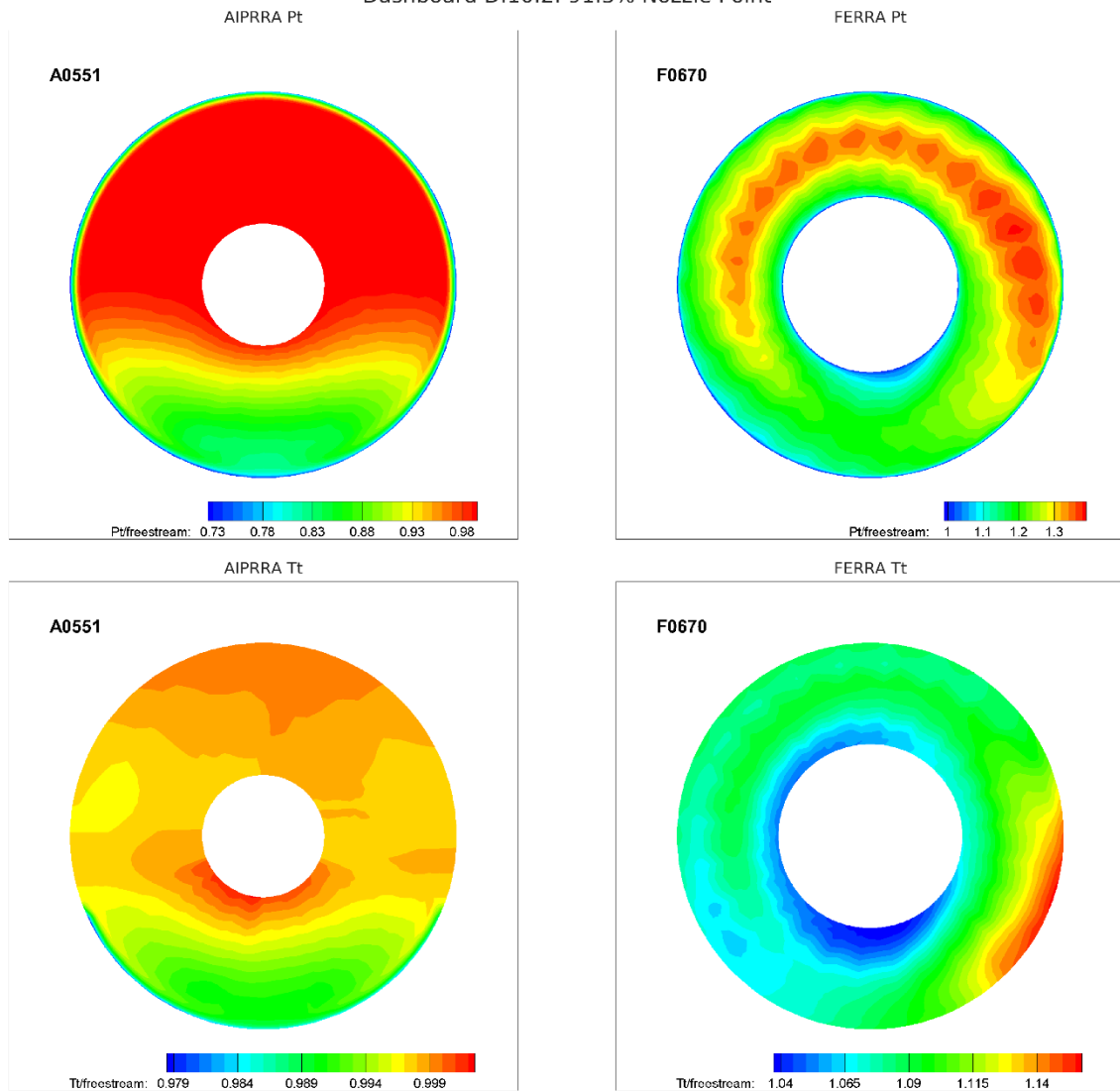
Dashboard D.10.1: 91.3% Nozzle Point

Mach Number: 0.78
 % Speed: 100.0%
 % Nozzle: 91.3%
 % Bleed: 100.0%
 Corrected Flow: 105.4 lbm/s
 Stage Pressure Ratio: 1.3
 Stage Temperature Ratio: 1.091
 Adiabatic Efficiency: 0.859
 AIP Survey Reading: 551
 FE Survey Reading: 670
 Inlet Rakes Reading: No Data

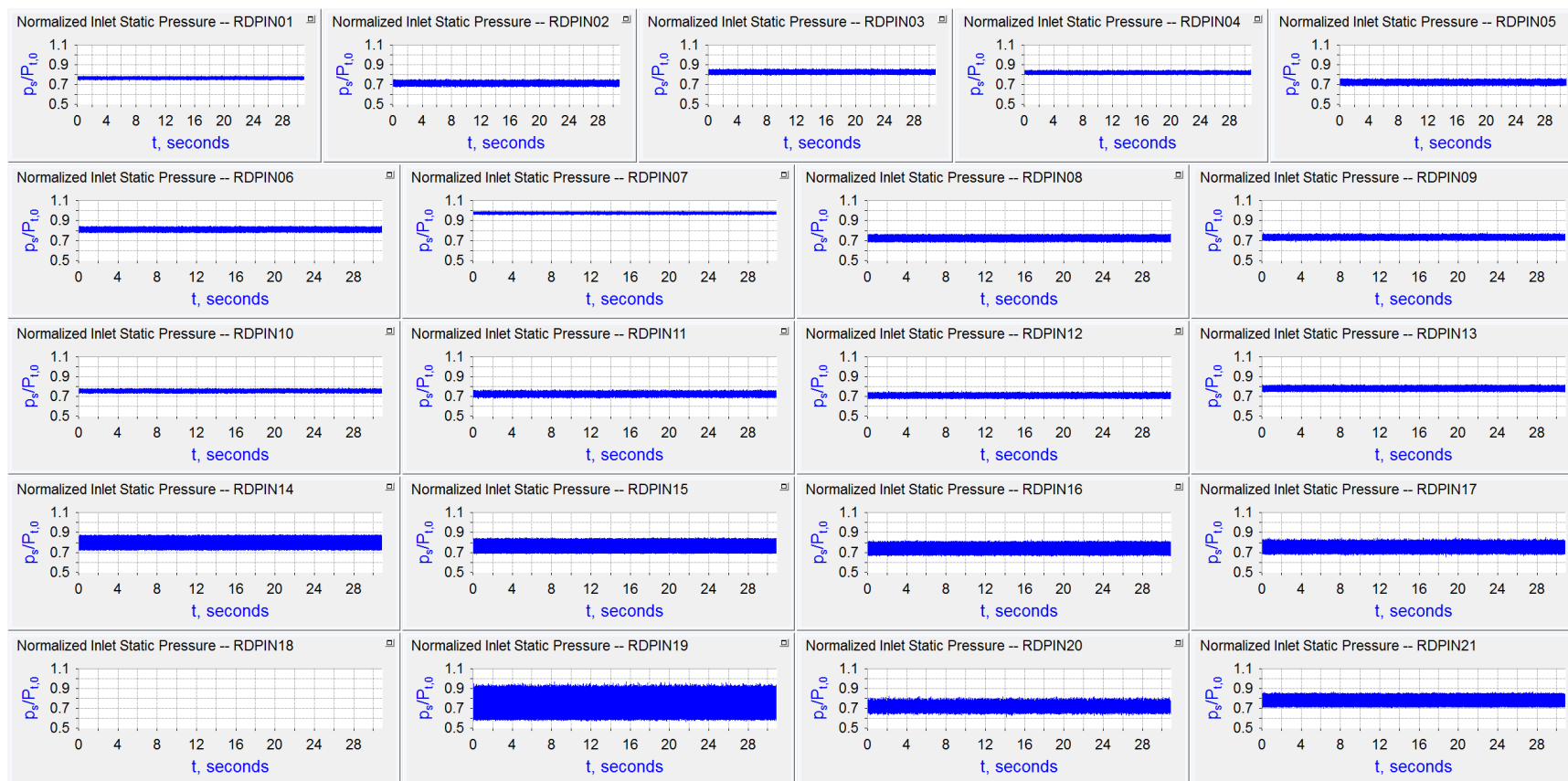


Inlet Throat Rakes
No Data

Dashboard D.10.2: 91.3% Nozzle Point

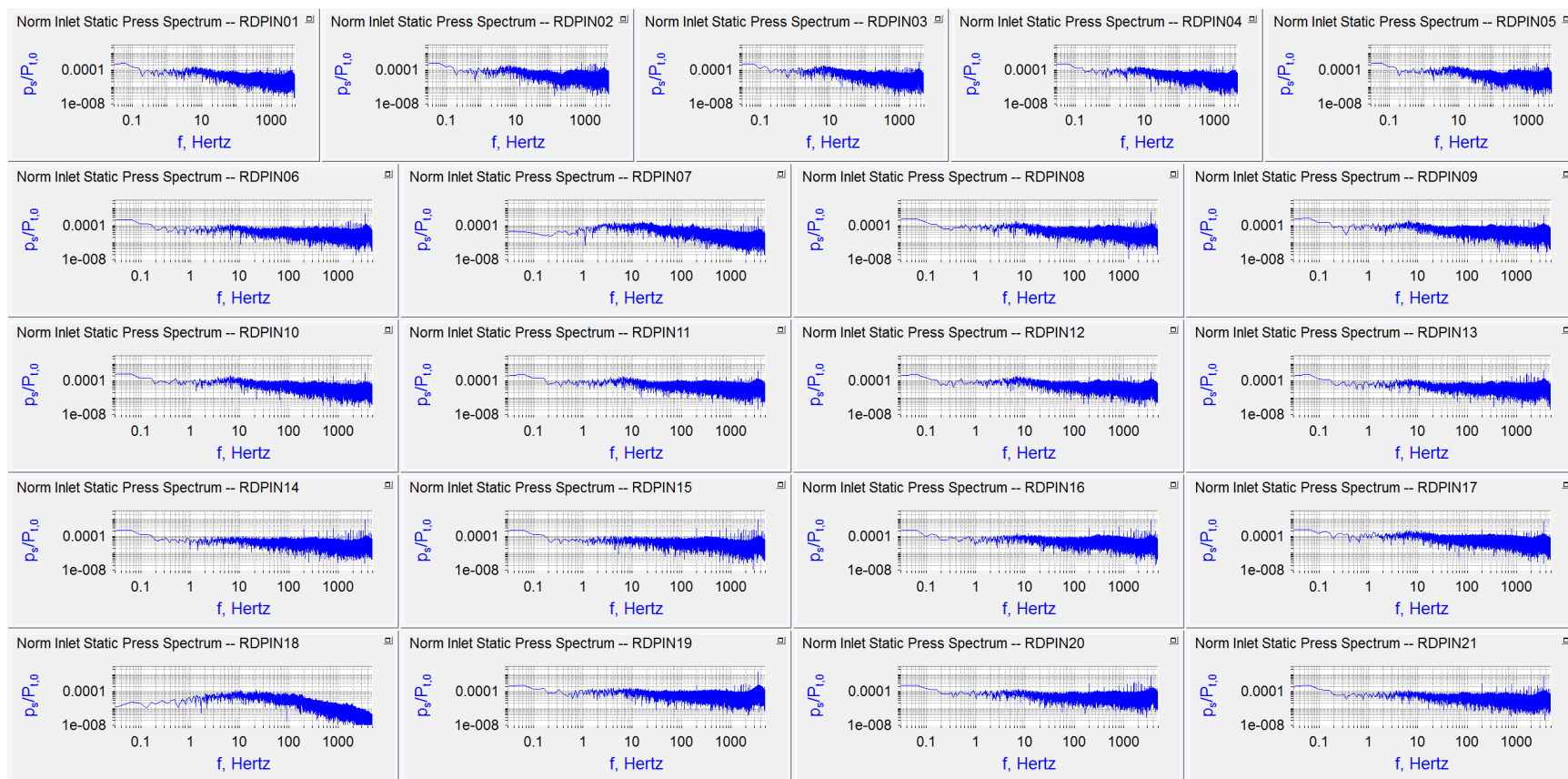


Dashboard D.10.3: 91.3% Nozzle Point, AIP-3



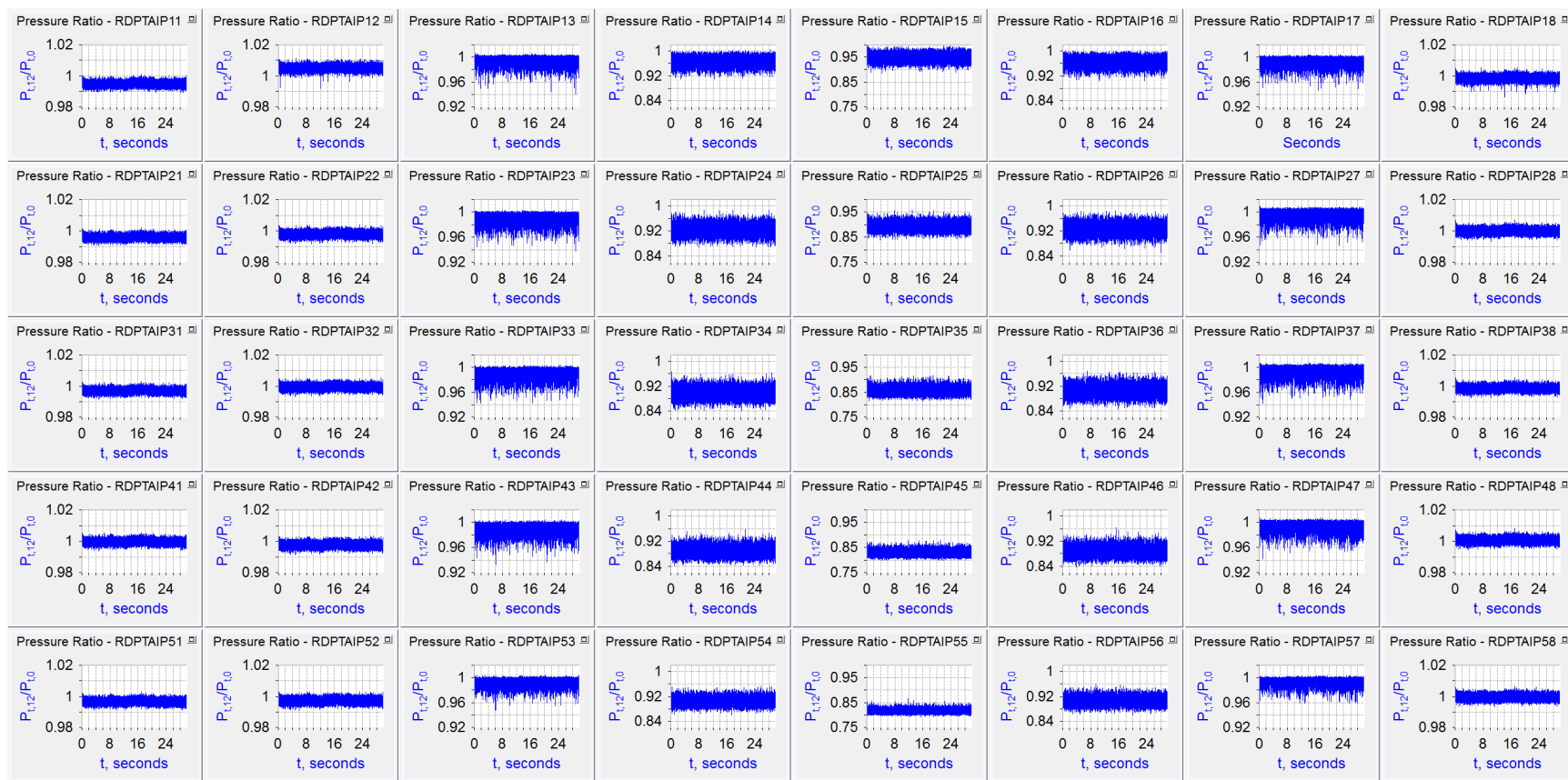
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=91.3\%$)

Dashboard D.10.4: 91.3% Nozzle Point, AIP-3



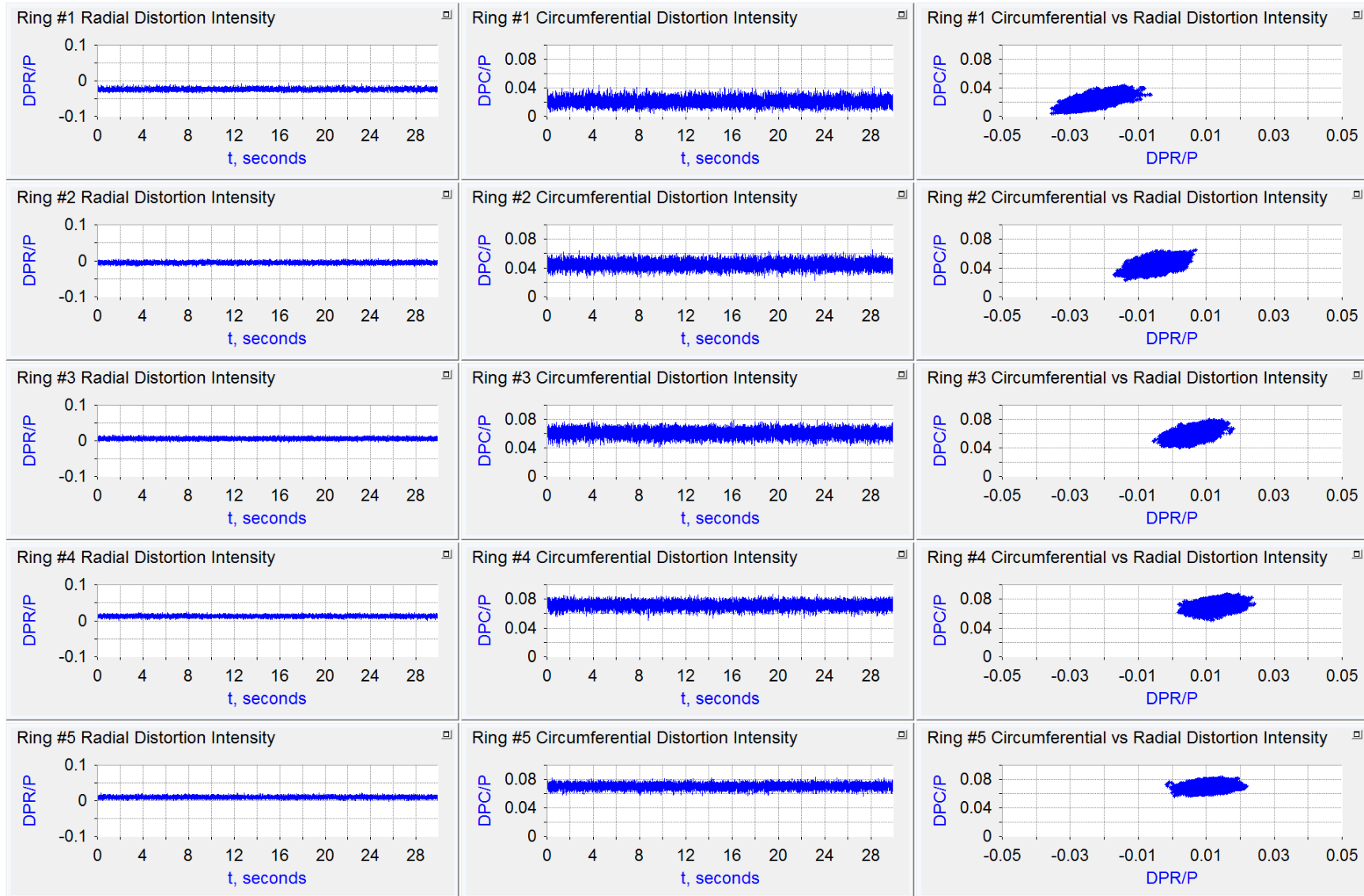
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=91.3\%$)

Dashboard D.10.5: 91.3% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{I9}=91.3\%$)

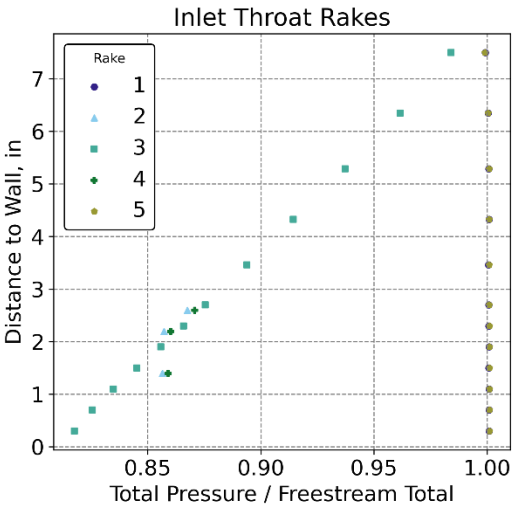
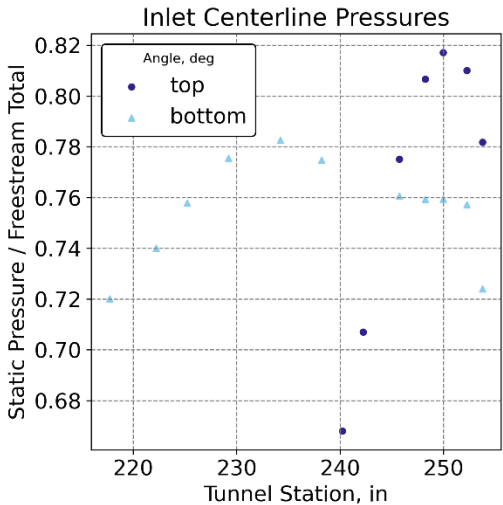
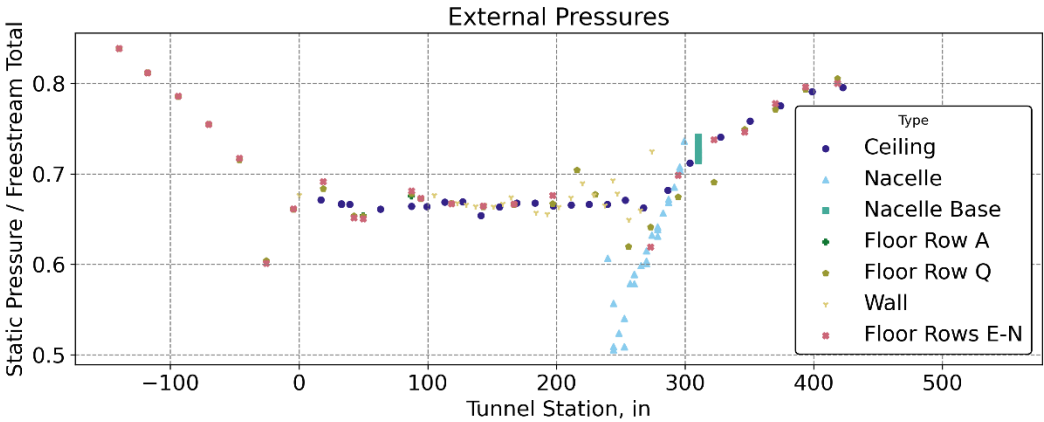
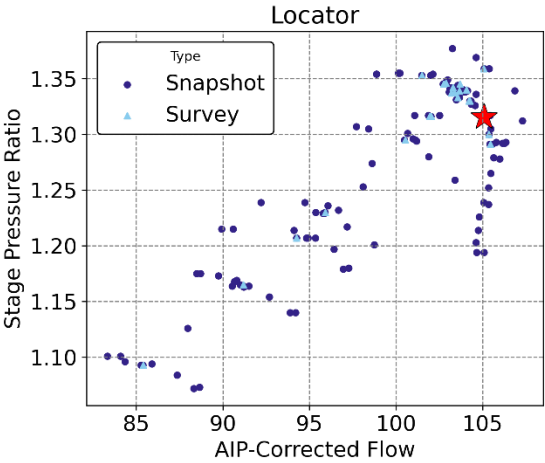
Dashboard D.10.6: 91.3% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{g_9}=91.3\%$)

Dashboard D.11.1: 90% Nozzle Point

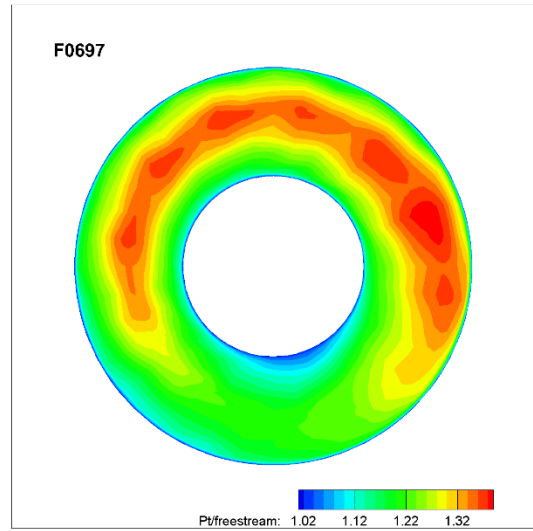
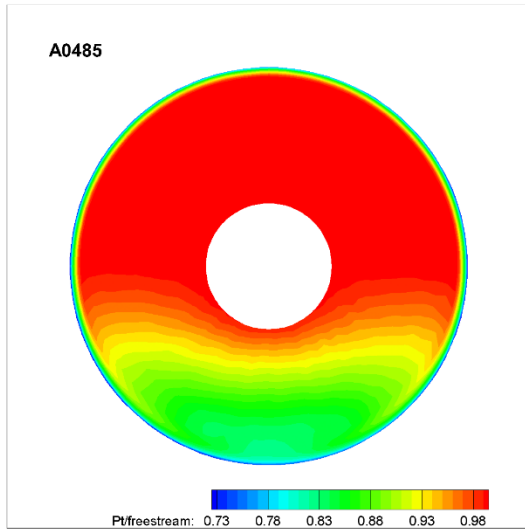
Mach Number: 0.78
% Speed: 100.0%
% Nozzle: 90.0%
% Bleed: 100.0%
Corrected Flow: 105.1 lbm/s
Stage Pressure Ratio: 1.316
Stage Temperature Ratio: 1.094
Adiabatic Efficiency: 0.87
AIP Survey Reading: 485
FE Survey Reading: 697
Inlet Rakes Reading: 715



Dashboard D.11.2: 90% Nozzle Point

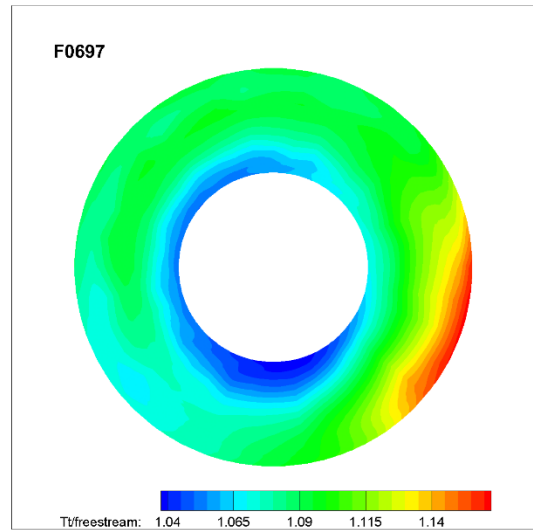
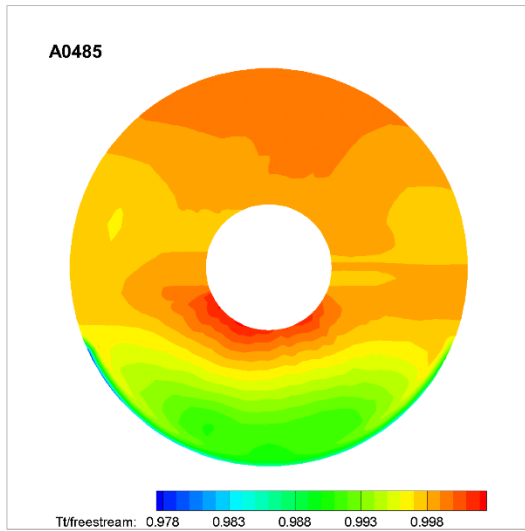
AIPRRA Pt

FERRA Pt

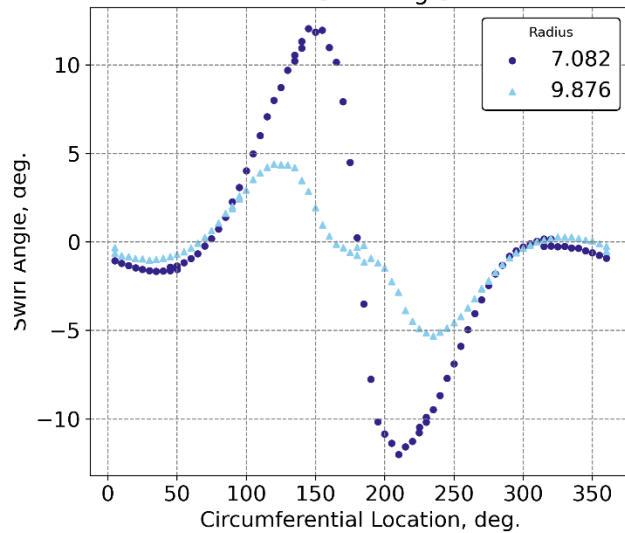


AIPRRA Tt

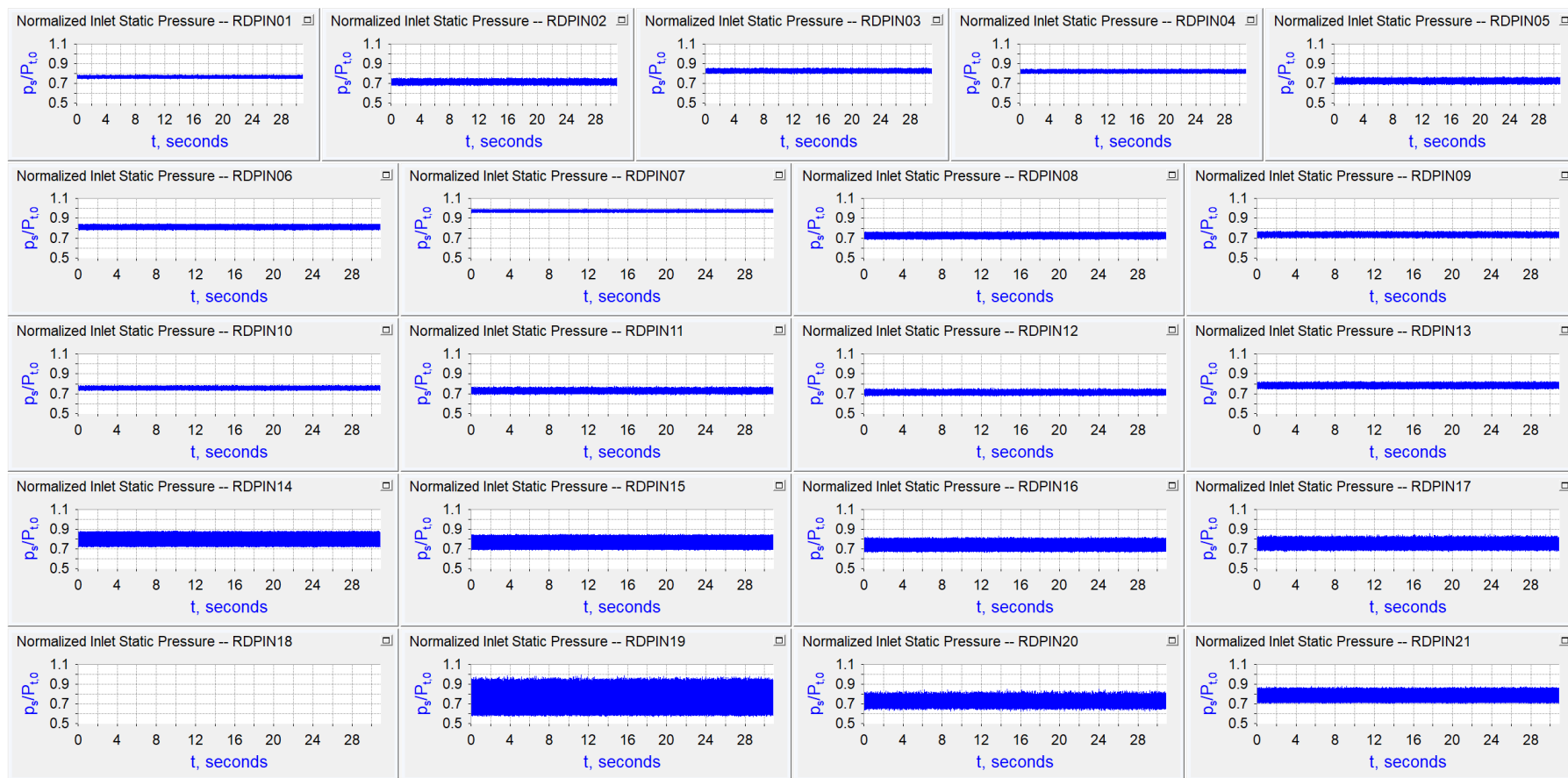
FERRA Tt



AIP Swirl Angle

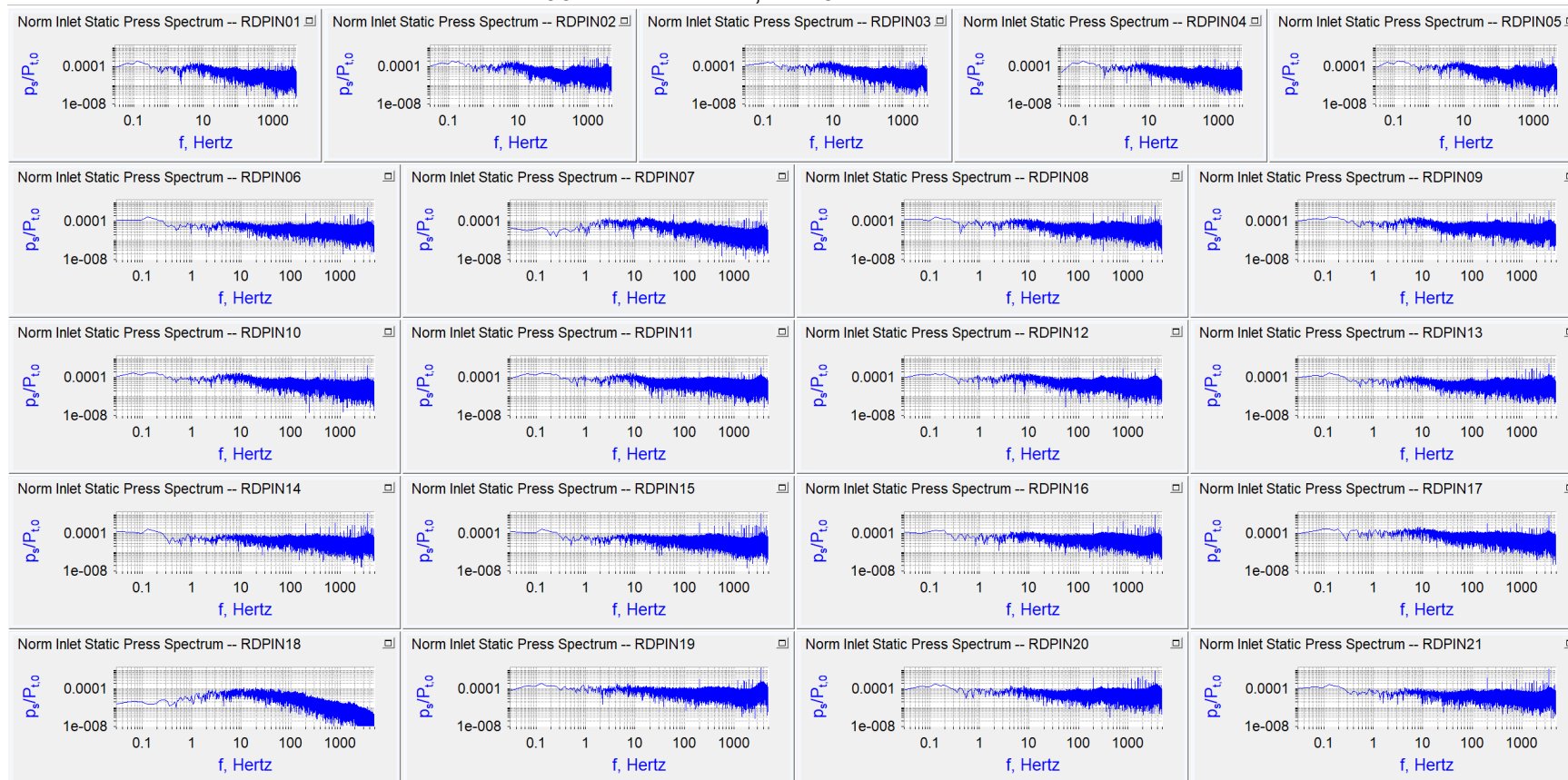


Dashboard D.11.3: 90% Nozzle Point, AIP-3



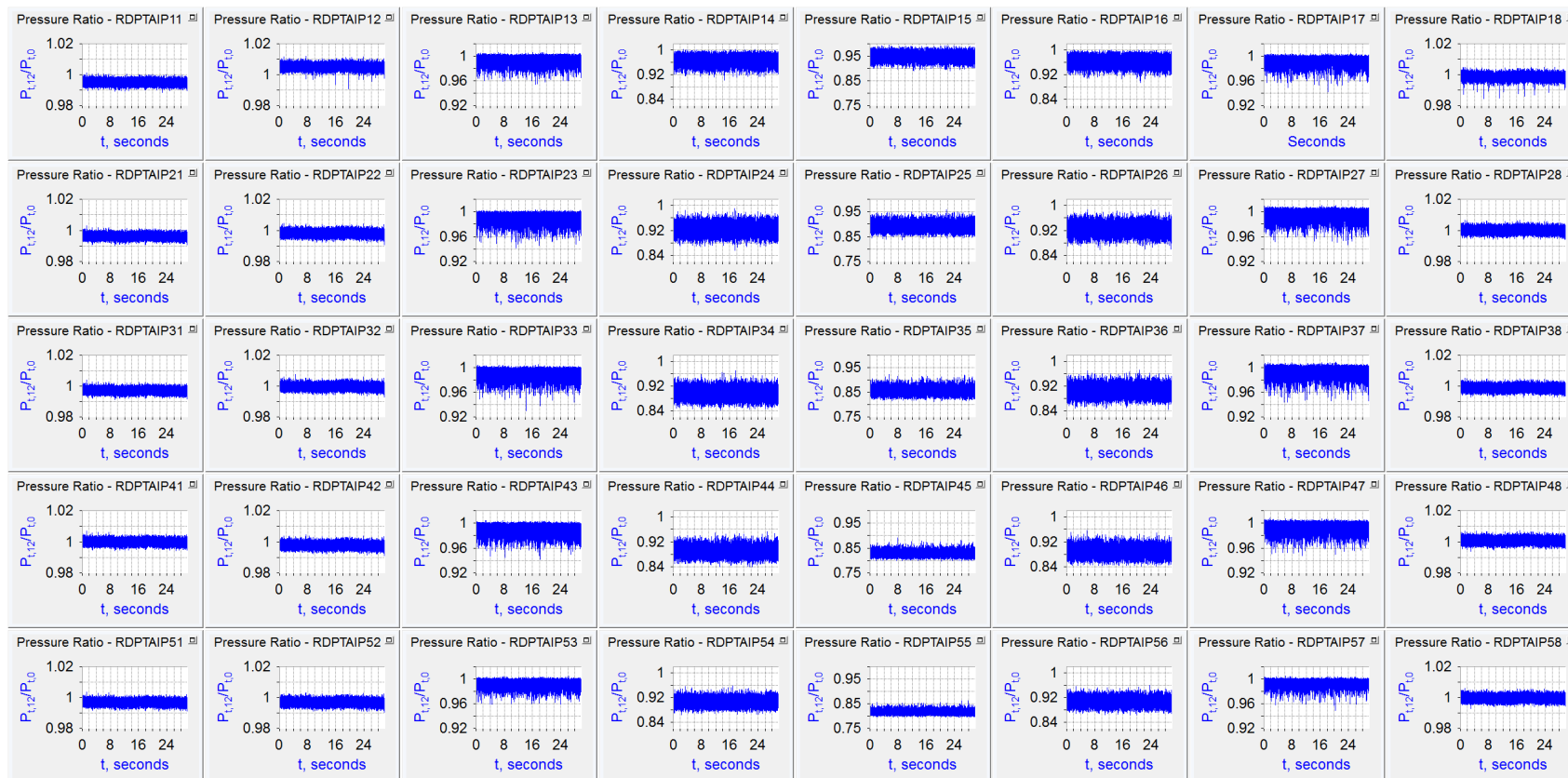
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=90.0\%$)

Dashboard D.11.4: 90% Nozzle Point, AIP-3



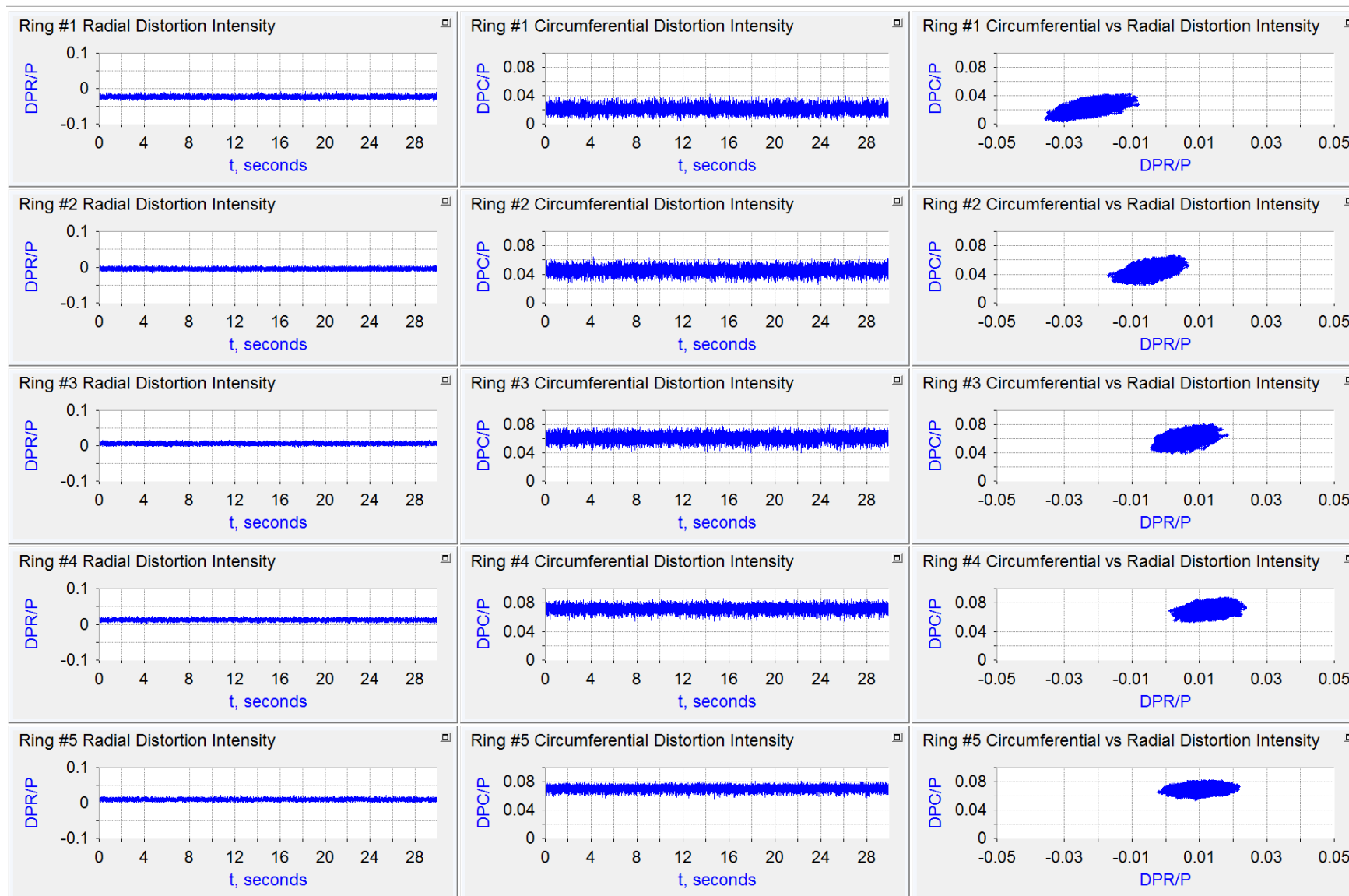
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=90.0\%$)

Dashboard D.11.5: 90% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=90.0\%$)

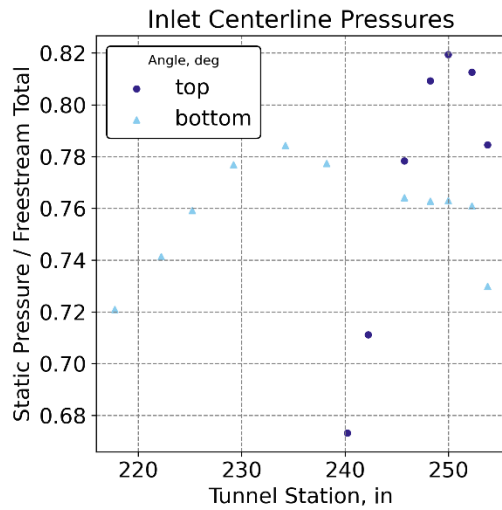
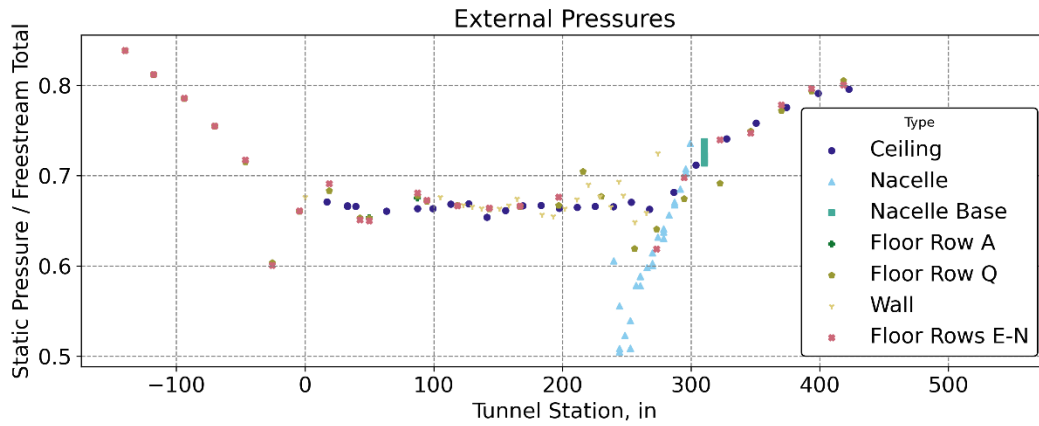
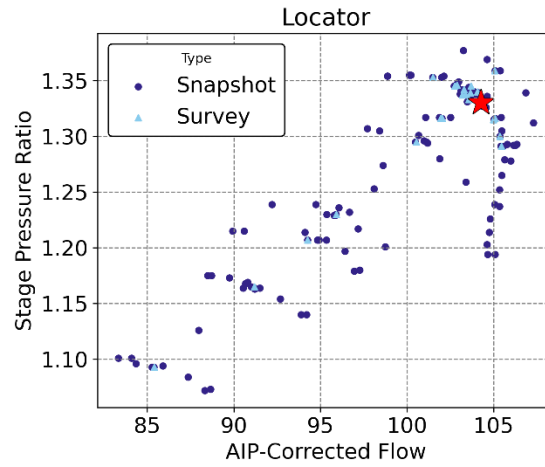
Dashboard D.11.6: 90° Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=90.0\%$)

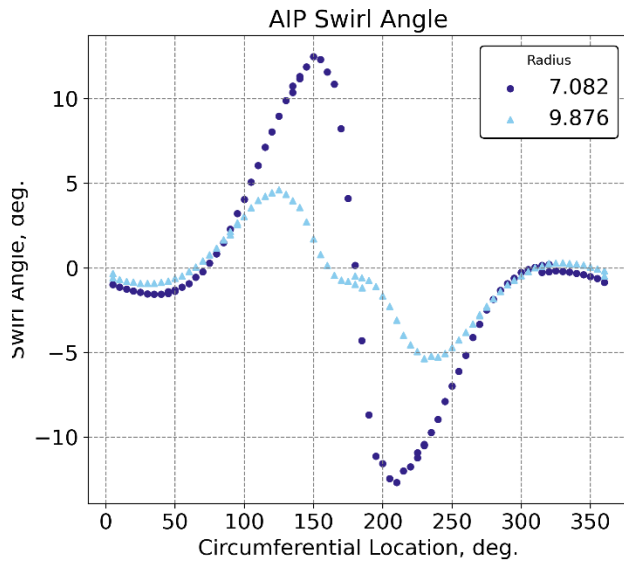
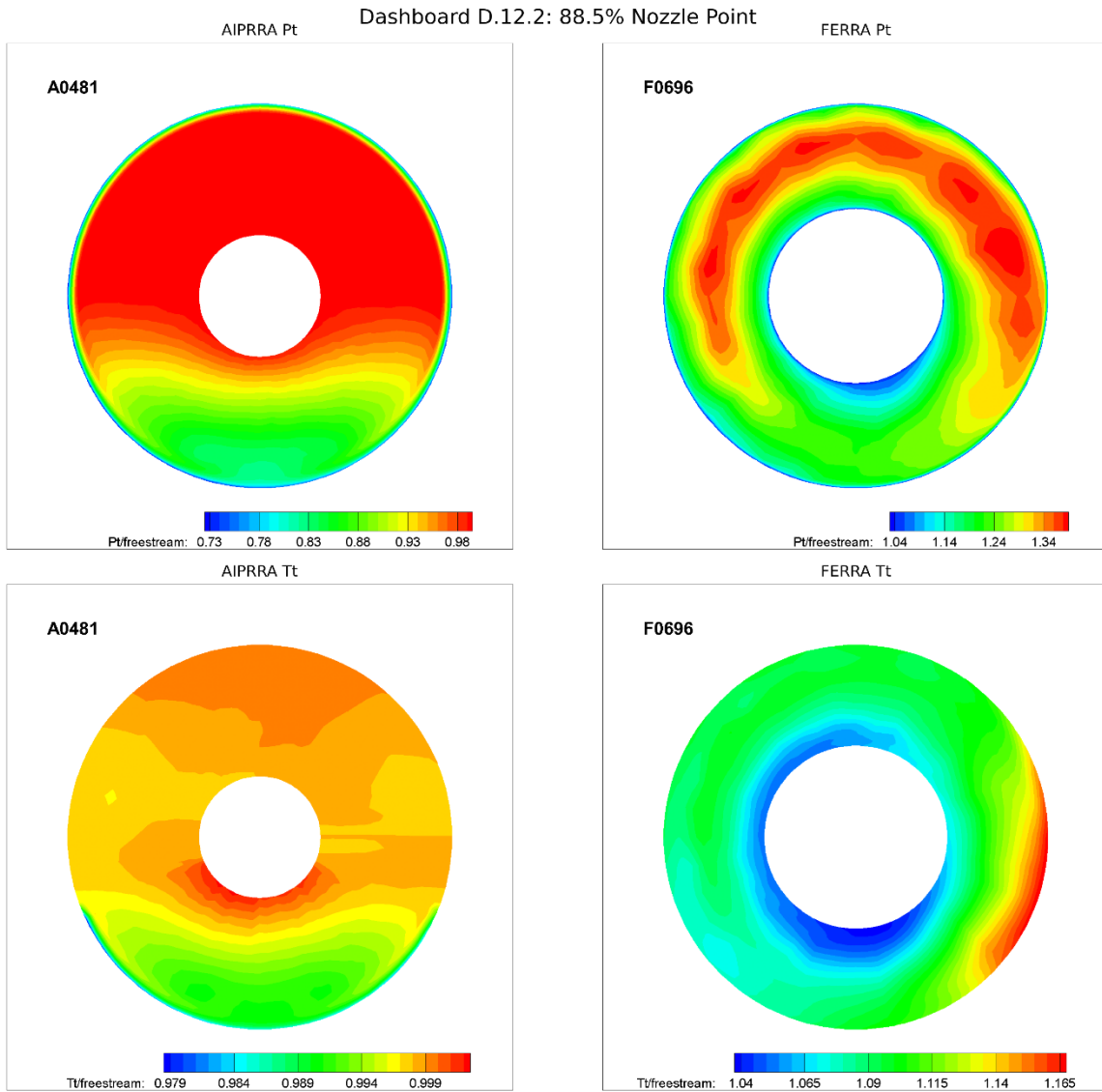
Dashboard D.12.1: 88.5% Nozzle Point

Mach Number: 0.78
% Speed: 100.0%
% Nozzle: 88.5%
% Bleed: 100.0%
Corrected Flow: 104.3 lbm/s
Stage Pressure Ratio: 1.33
Stage Temperature Ratio: 1.097
Adiabatic Efficiency: 0.876
AIP Survey Reading: 481
FE Survey Reading: 696
Inlet Rakes Reading: No Data

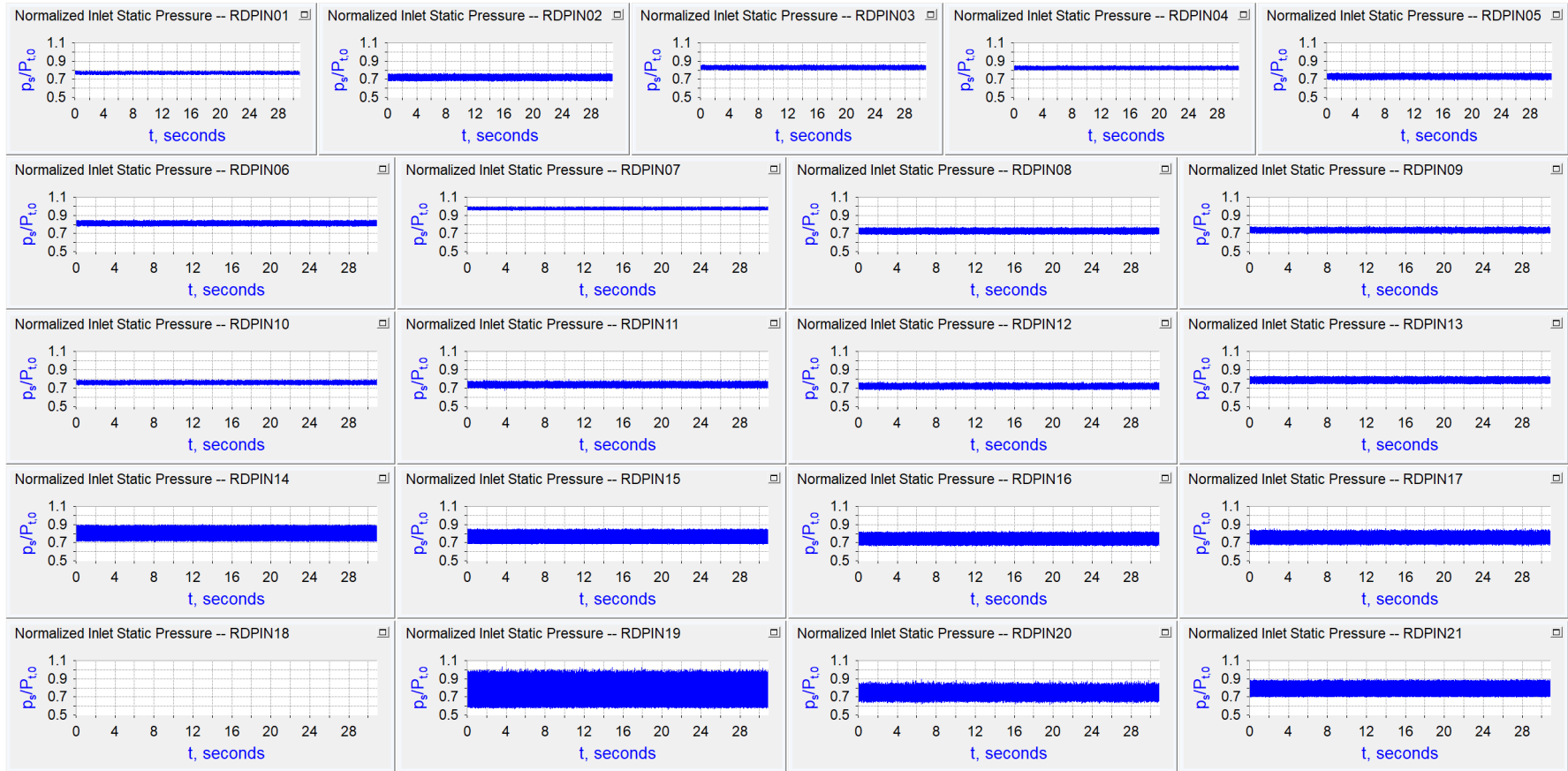


Inlet Throat Rakes
No Data

Dashboard D.12.2: 88.5% Nozzle Point

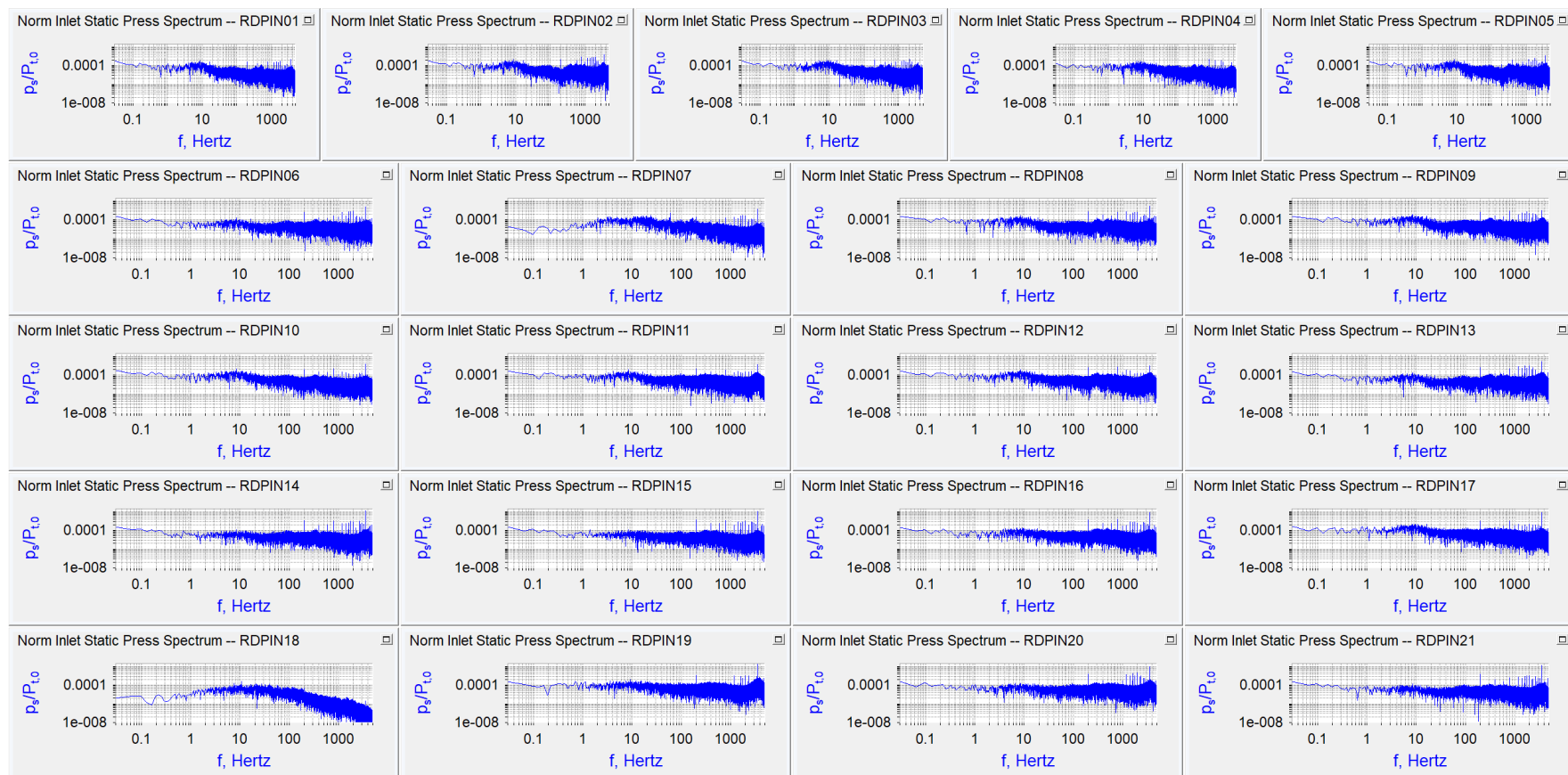


Dashboard D.12.3: 88.5% Nozzle Point, AIP-3



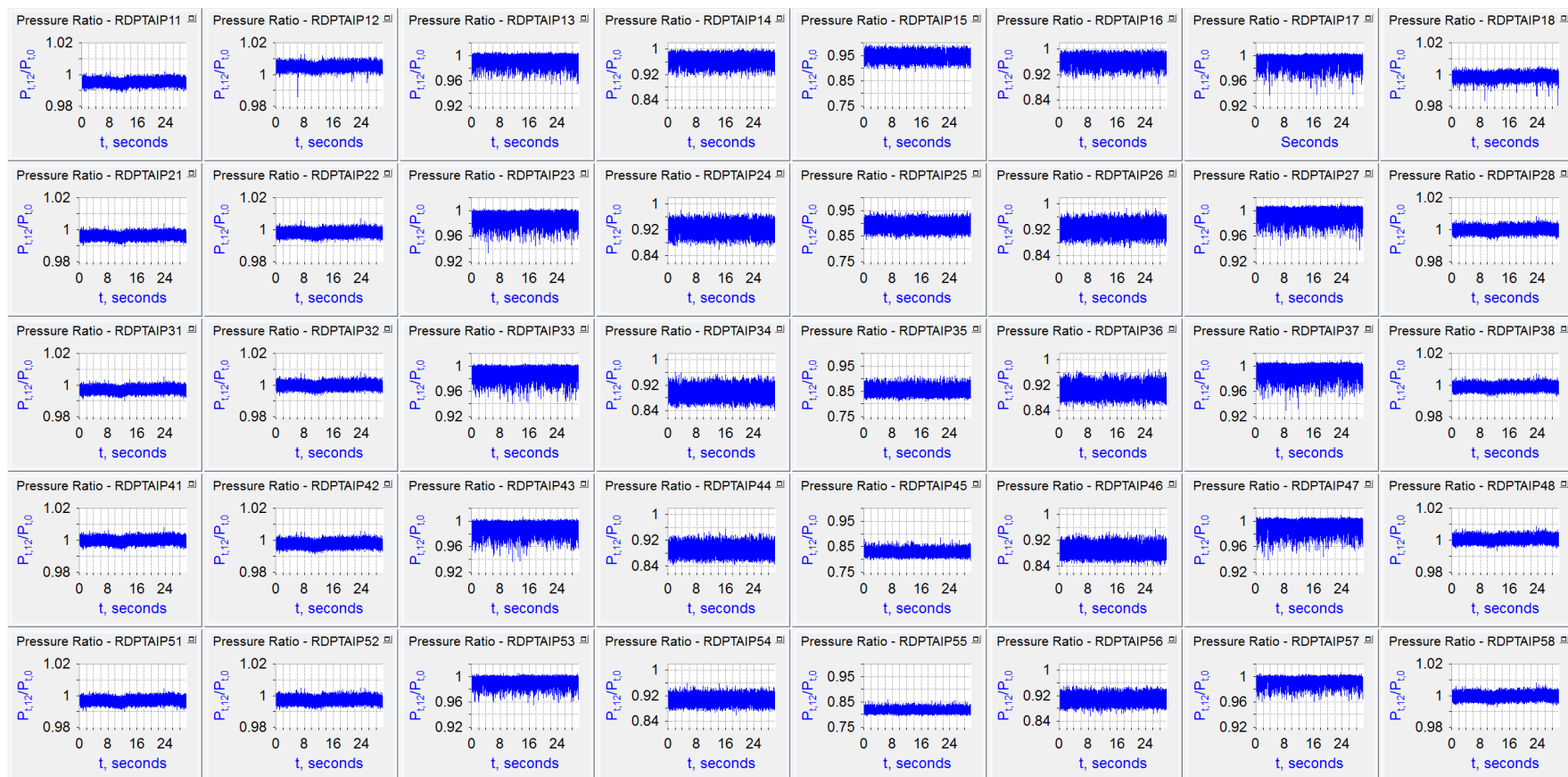
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=88.5\%$)

Dashboard D.12.4: 88.5% Nozzle Point, AIP-3



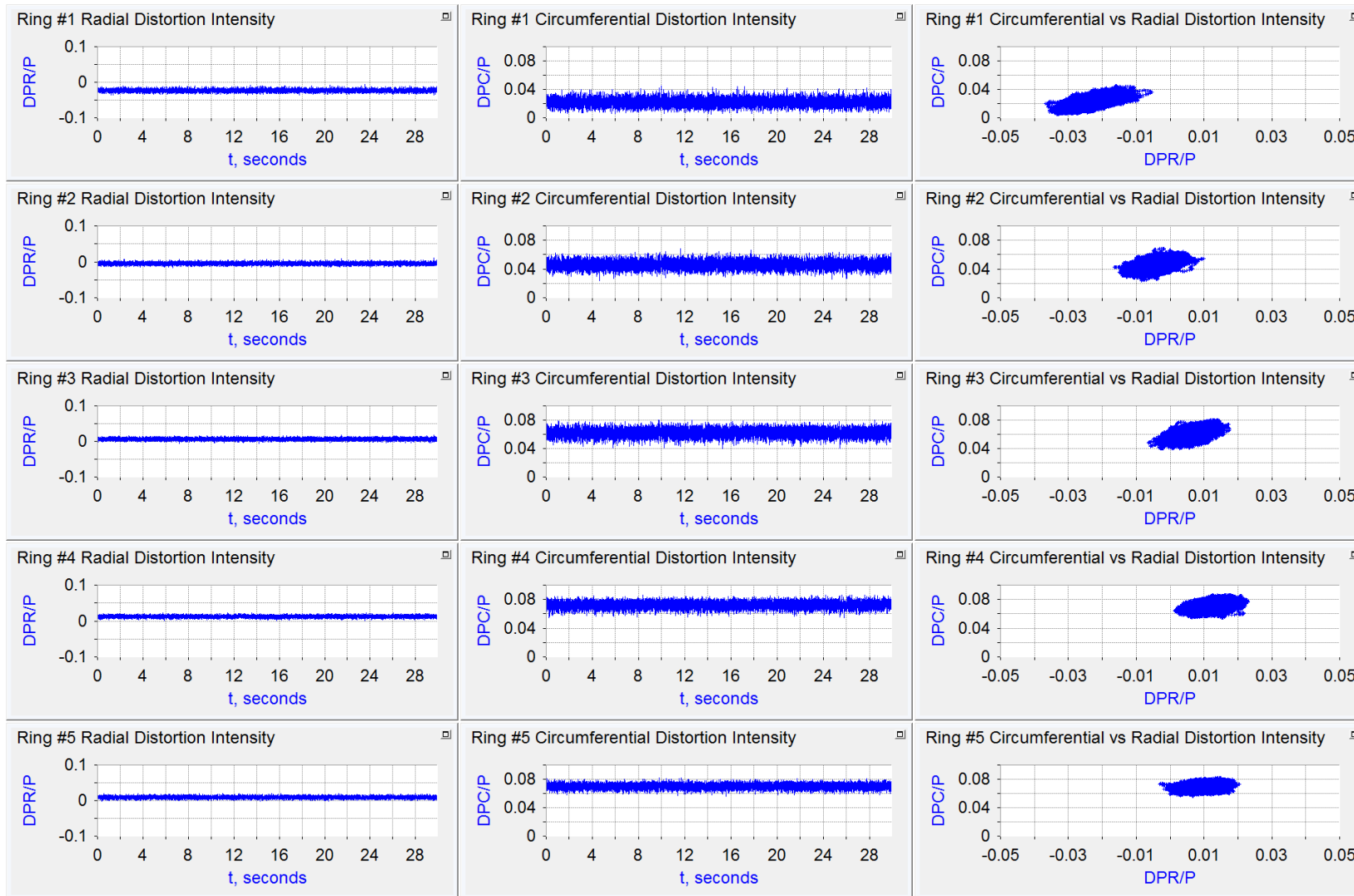
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=88.5\%$)

Dashboard D.12.5: 88.5% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=88.5\%$)

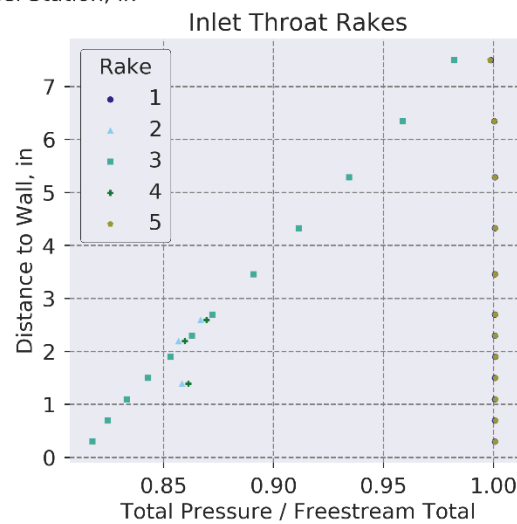
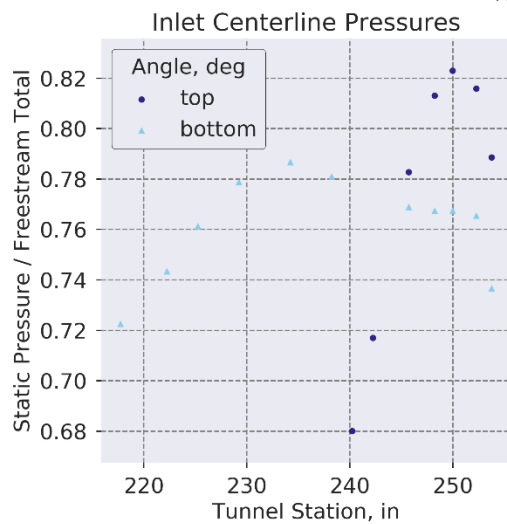
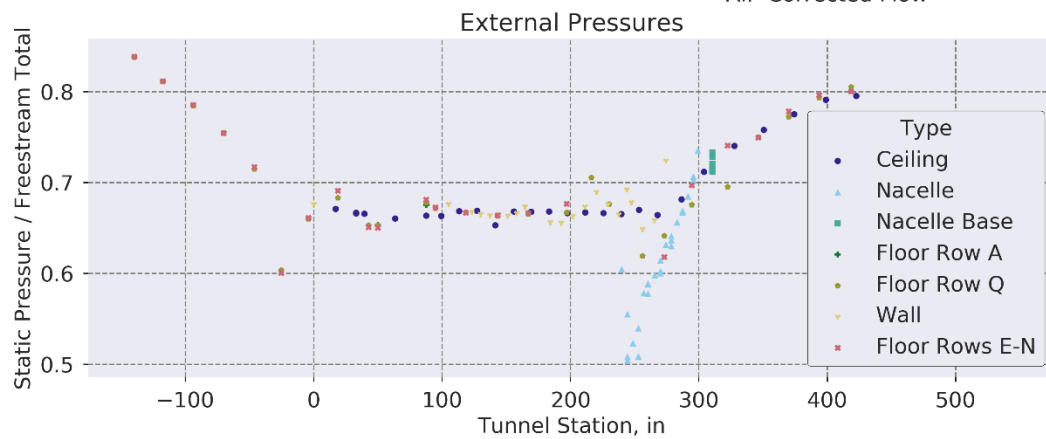
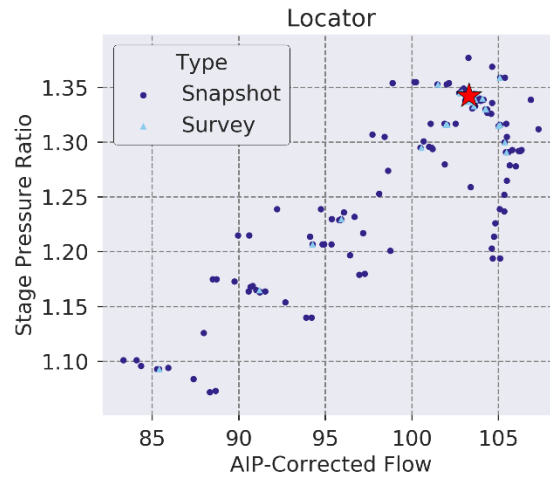
Dashboard D.12.6: 88.5% Nozzle Point, AIP-1



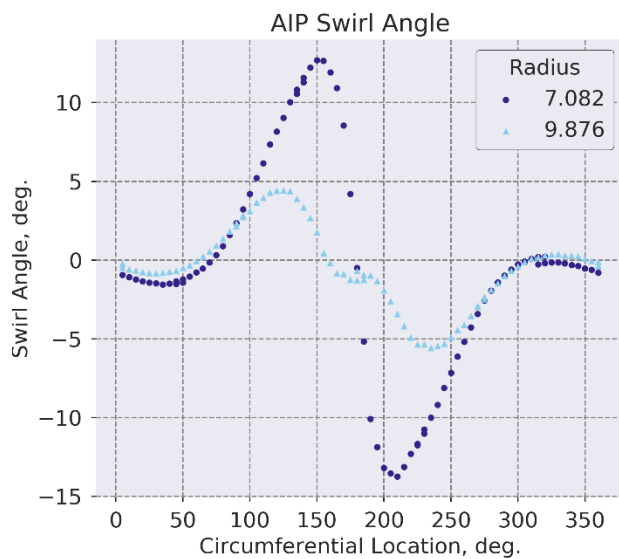
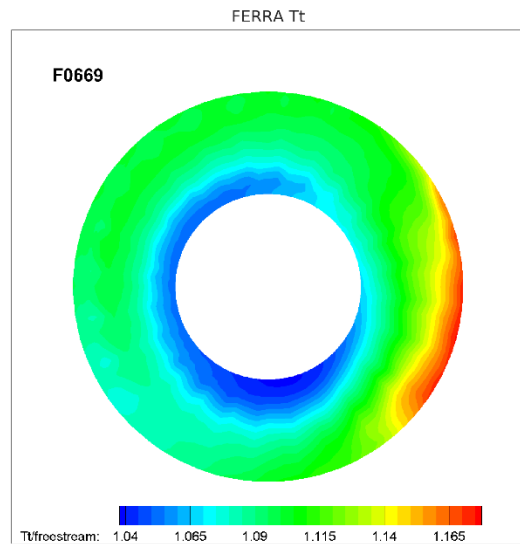
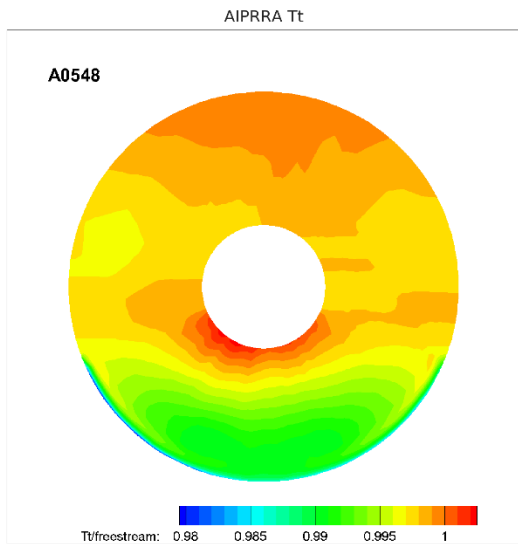
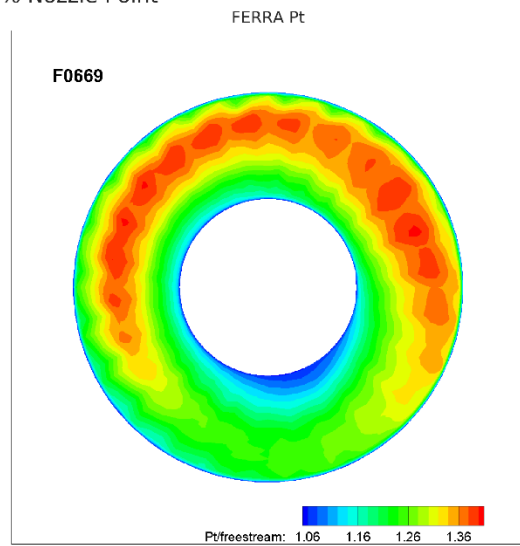
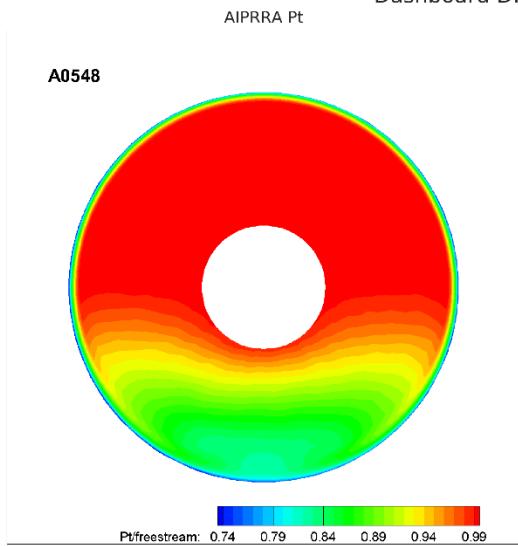
Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=88.5\%$)

Dashboard D.13.1: 87% Nozzle Point

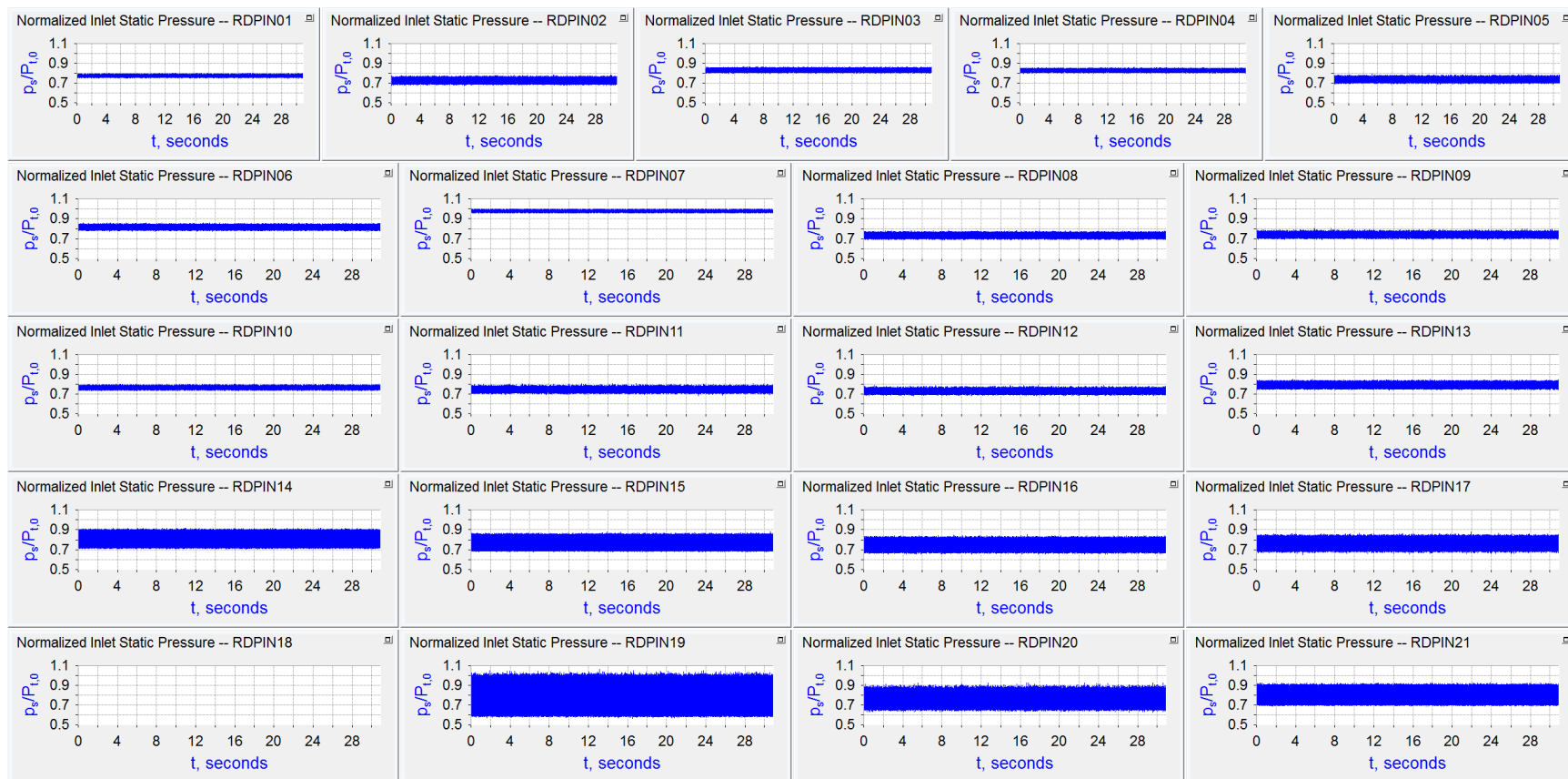
Mach Number: 0.78
 % Speed: 100.0%
 % Nozzle: 87.0%
 % Bleed: 100.0%
 Corrected Flow: 103.3 lbm/s
 Stage Pressure Ratio: 1.342
 Stage Temperature Ratio: 1.1
 Adiabatic Efficiency: 0.877
 AIP Survey Reading: 548
 FE Survey Reading: 669
 Inlet Rakes Reading: 718



Dashboard D.13.2: 87% Nozzle Point

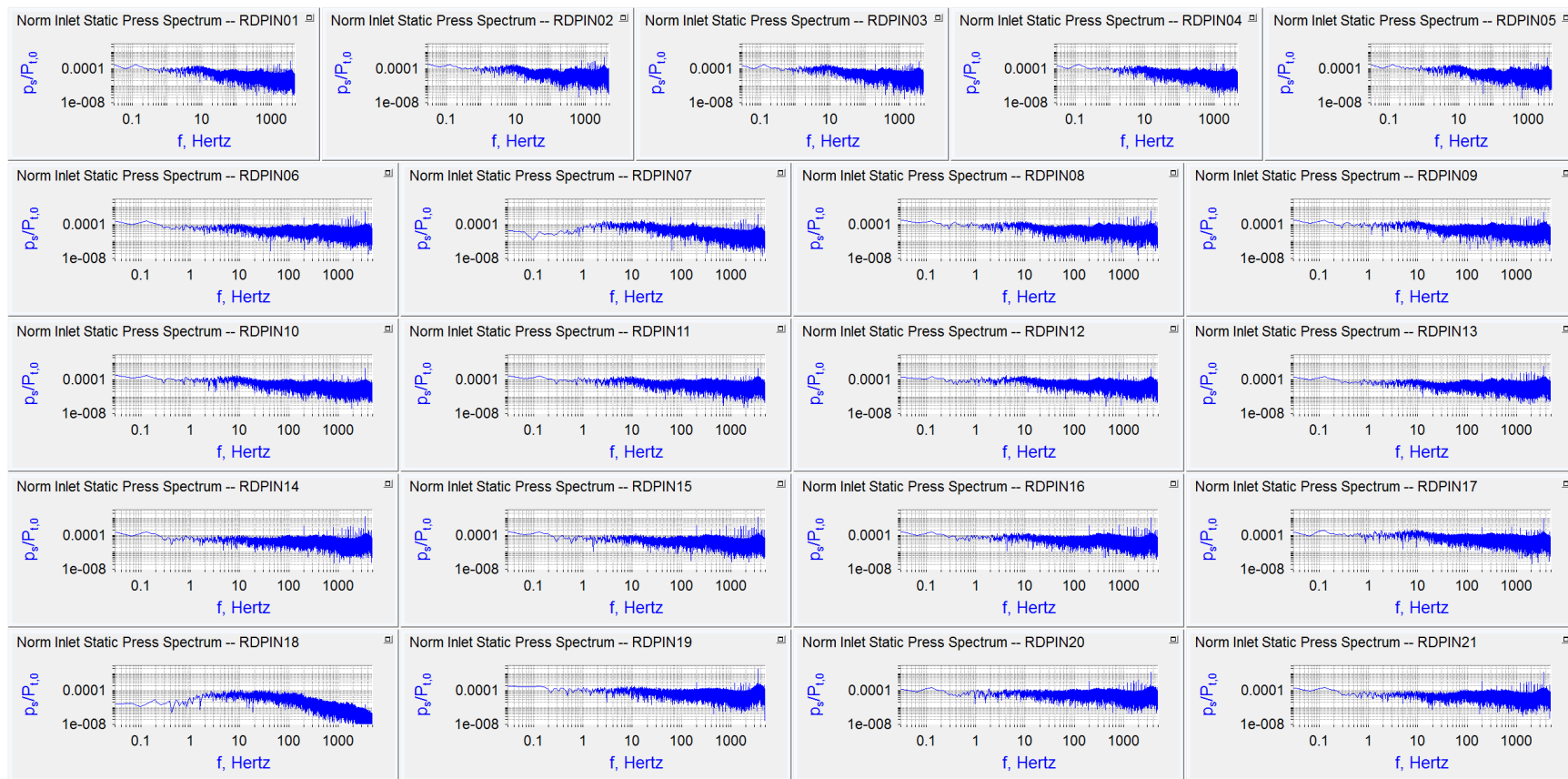


Dashboard D.13.3: 87% Nozzle Point, AIP-3



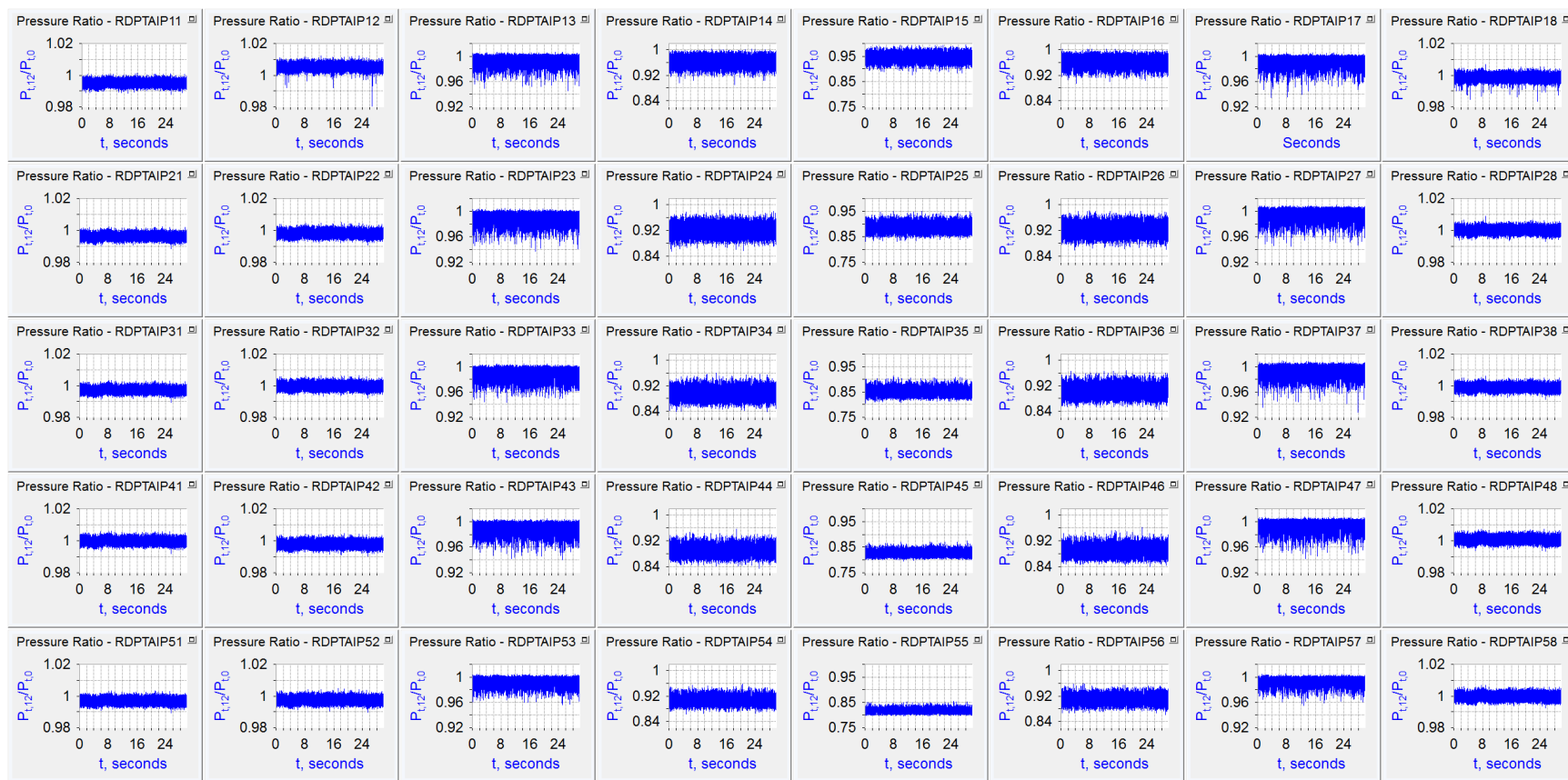
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=87.0\%$)

Dashboard D.13.4: 87% Nozzle Point, AIP-3



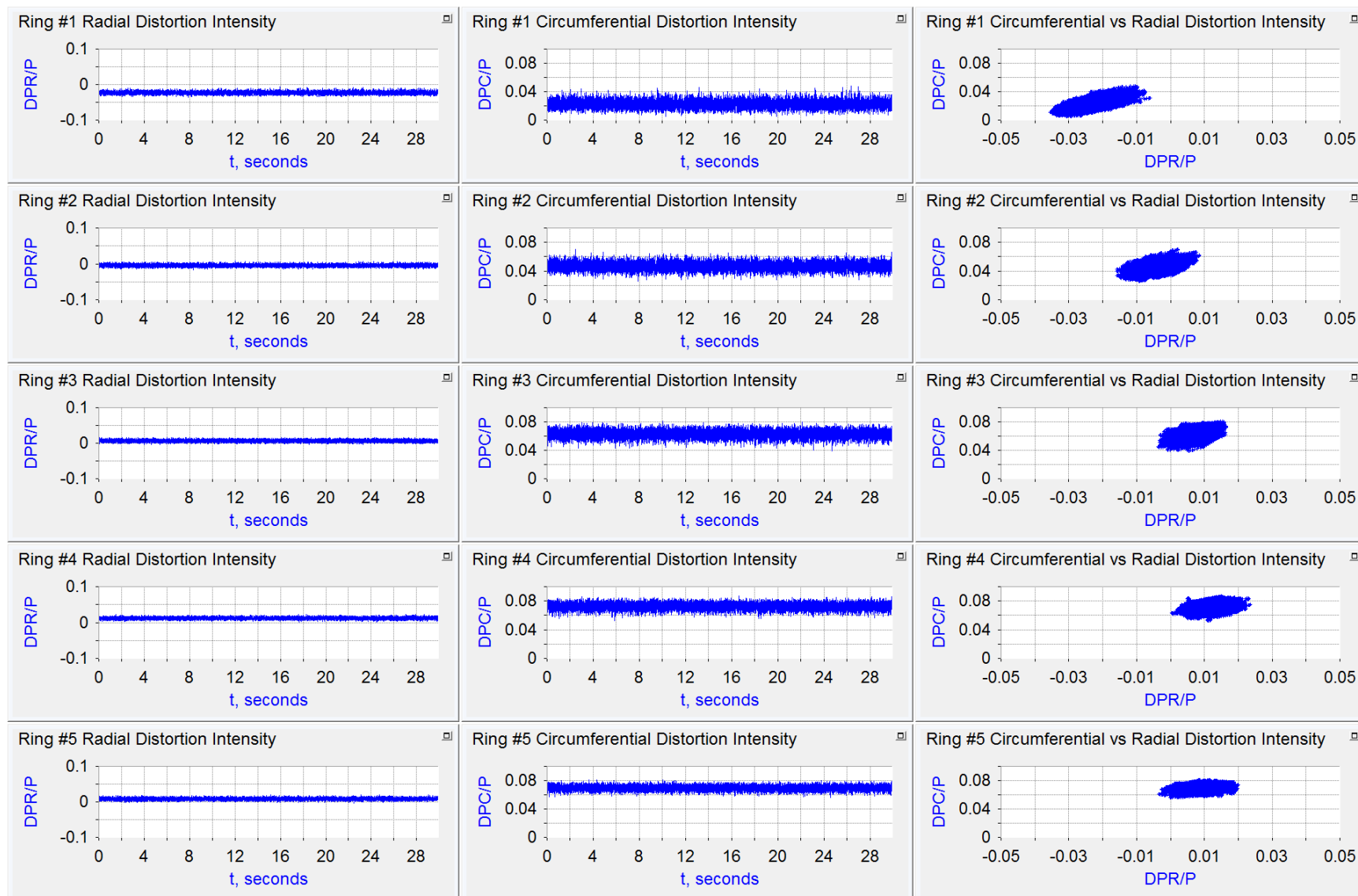
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=87.0\%$)

Dashboard D.13.5: 87% Nozzle Point, AIP-1



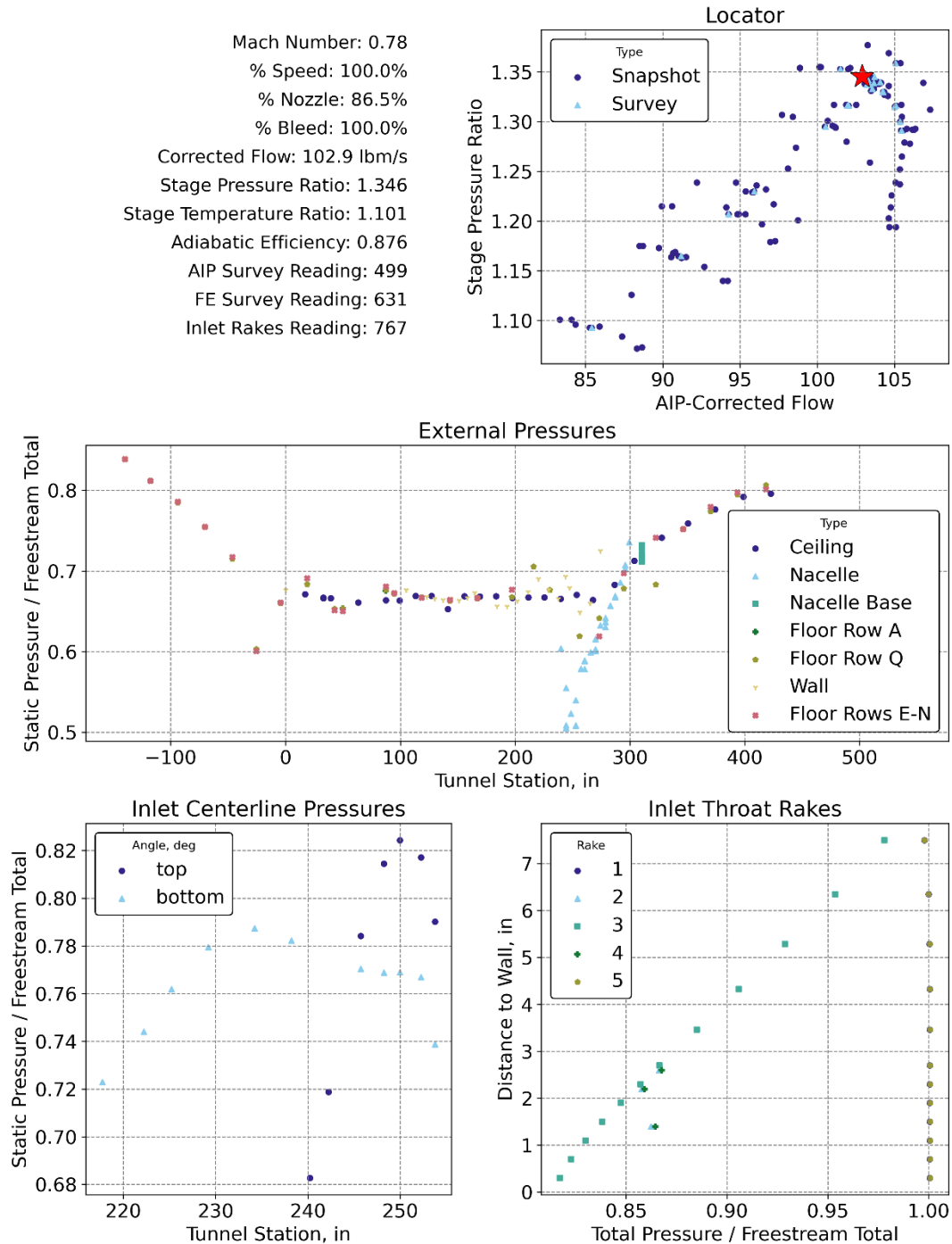
Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=87.0\%$)

Dashboard D.13.6: 87% Nozzle Point, AIP-1

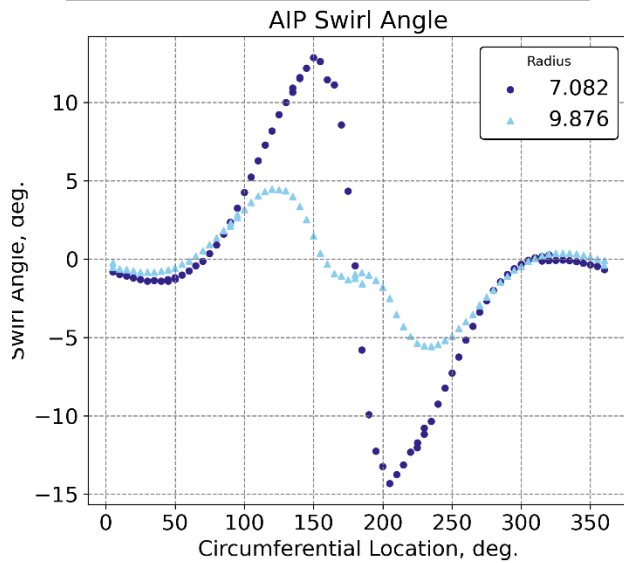
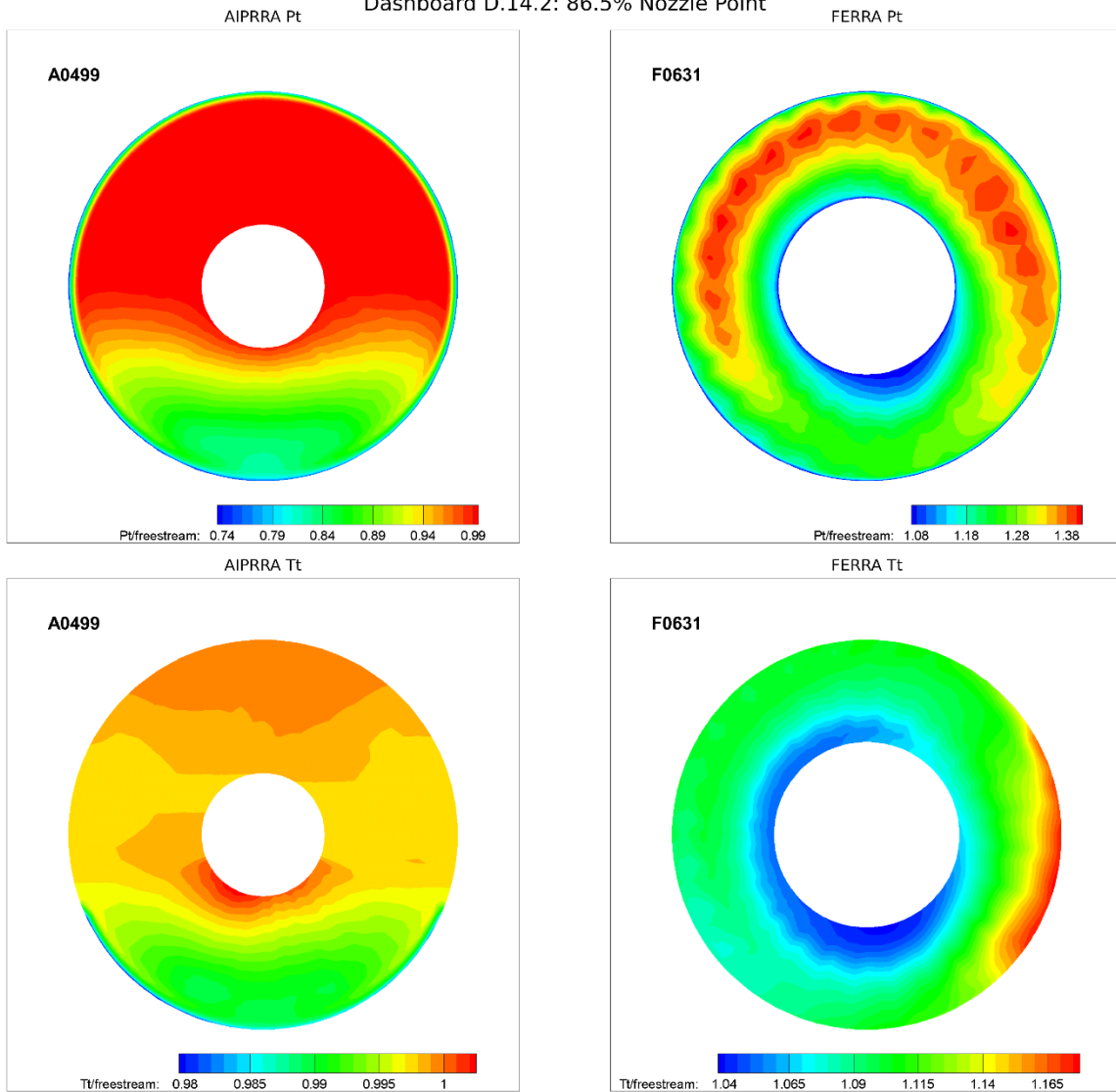


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=87.0\%$)

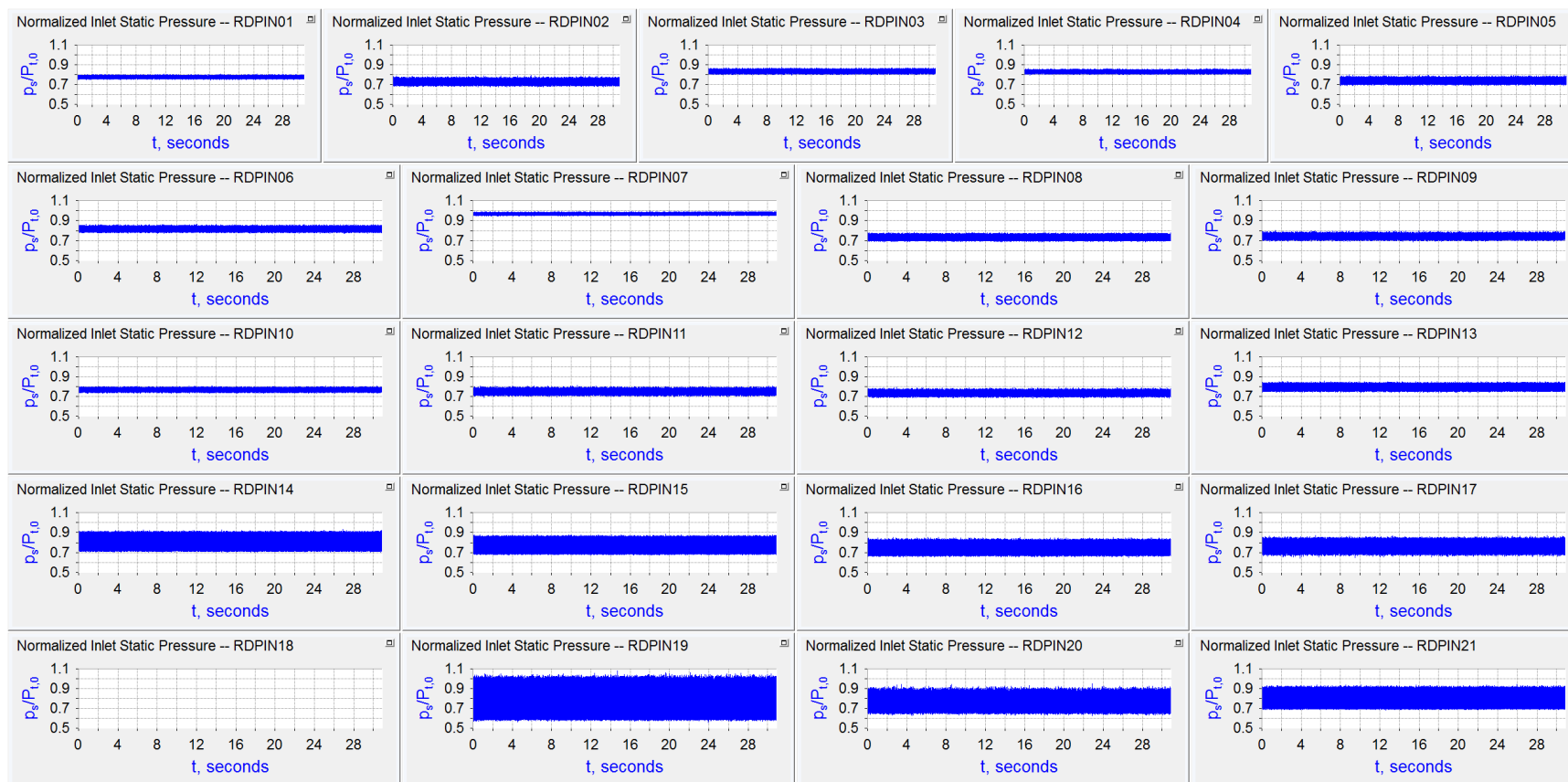
Dashboard D.14.1: 86.5% Nozzle Point



Dashboard D.14.2: 86.5% Nozzle Point

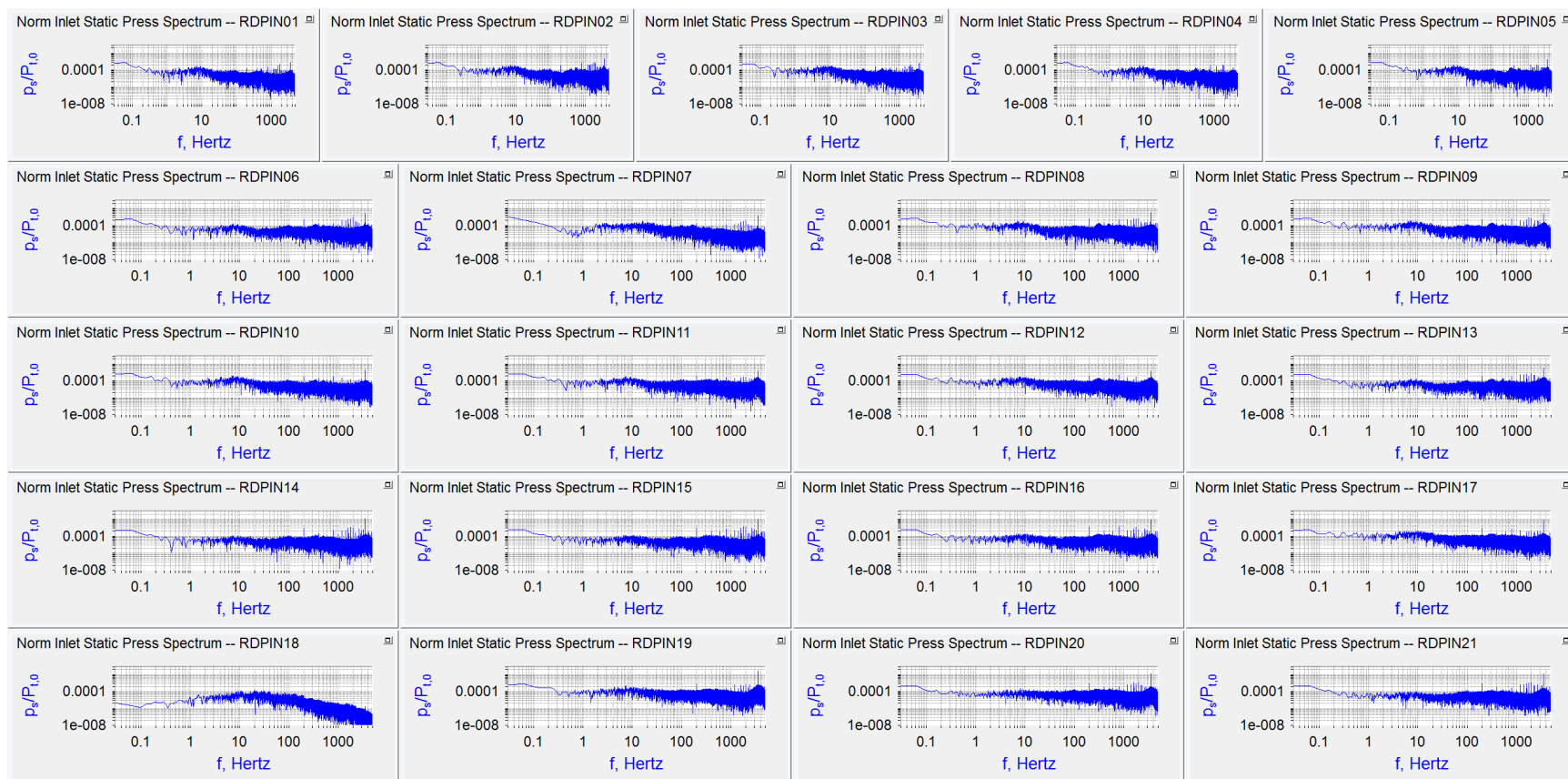


Dashboard D.14.3: 86.5% Nozzle Point, AIP-3



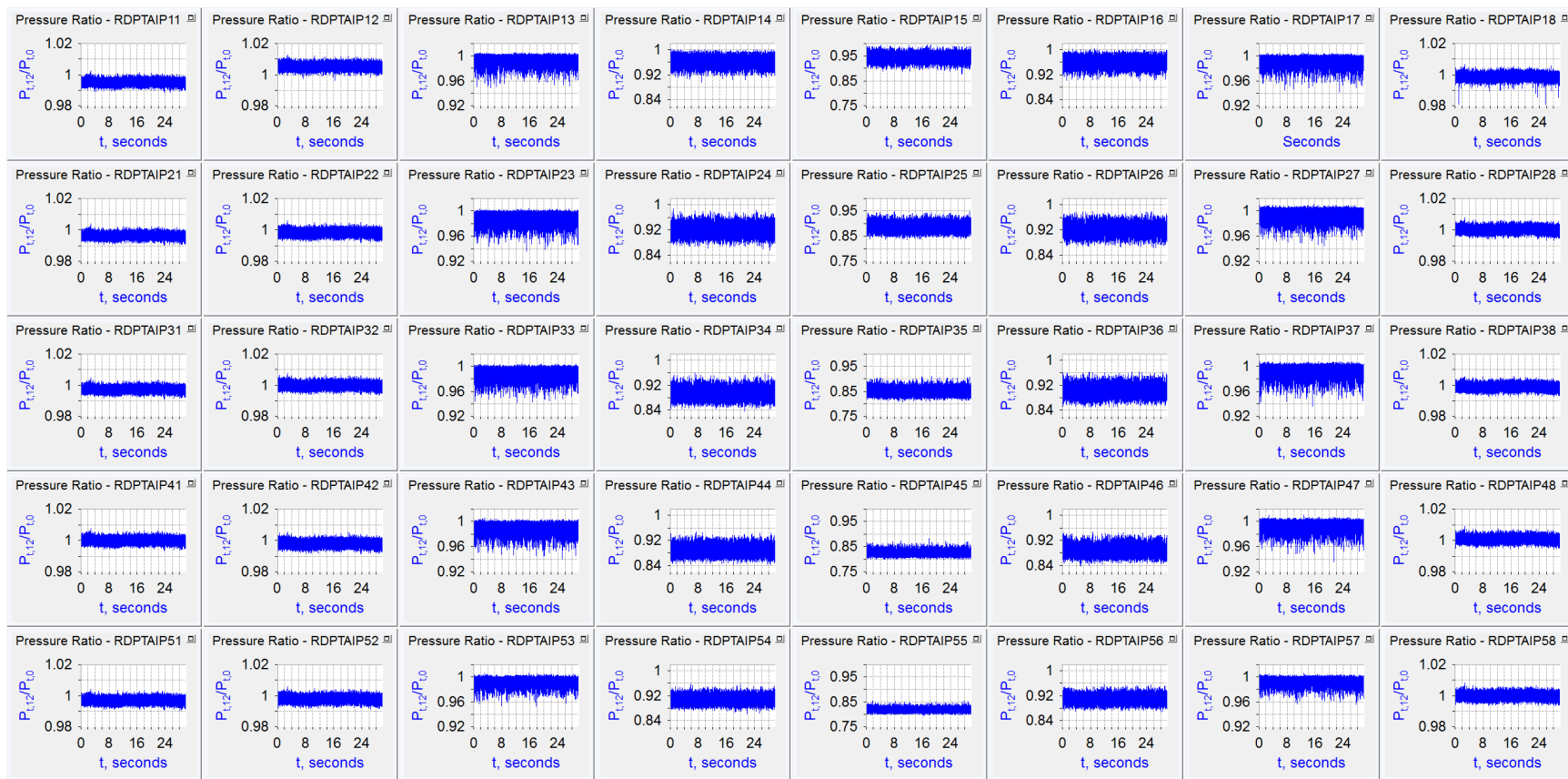
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=86.5\%$)

Dashboard D.14.4: 86.5% Nozzle Point, AIP-3



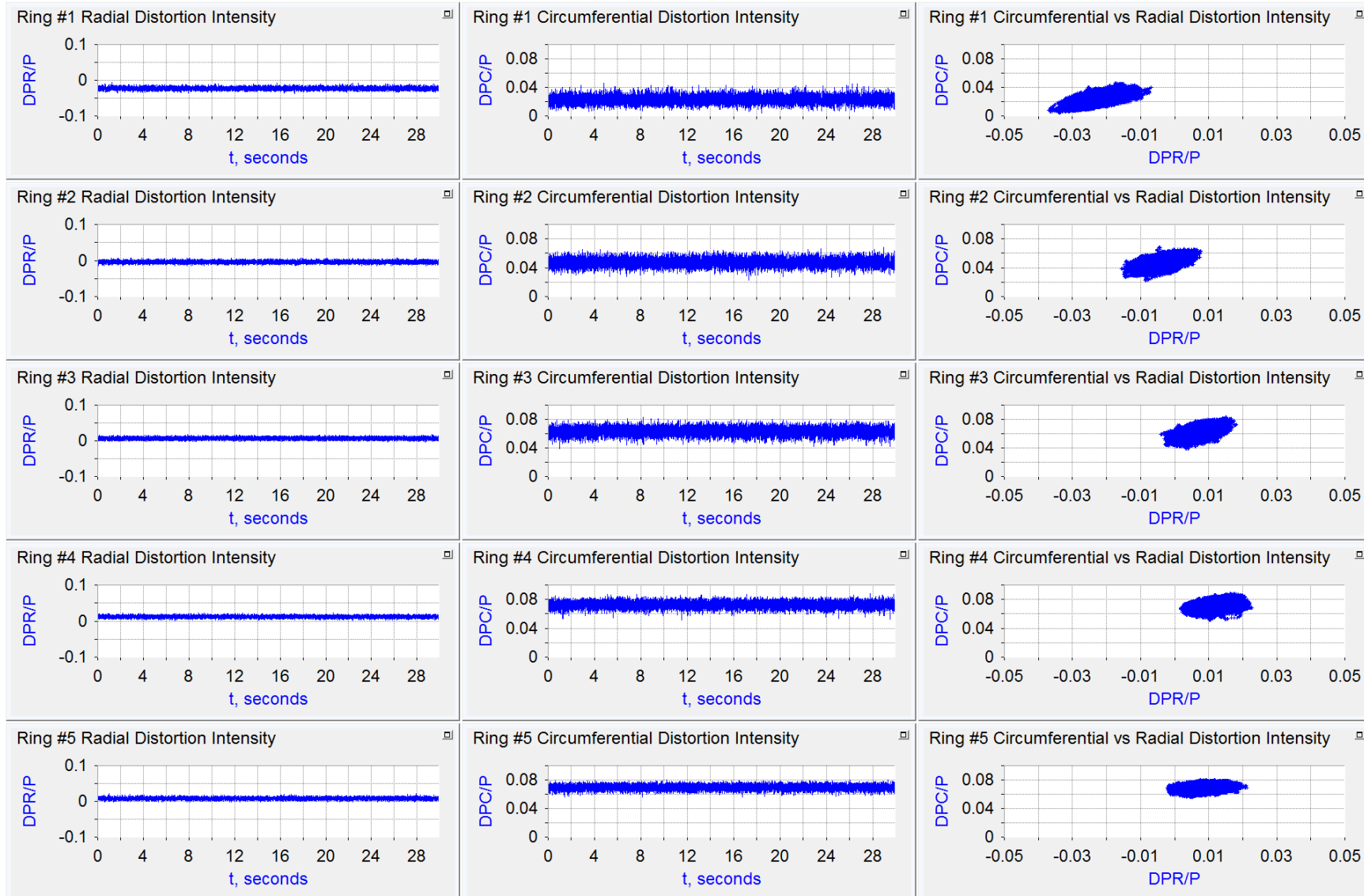
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=86.5\%$)

Dashboard D.14.5: 86.5% Nozzle Point, AIP-1



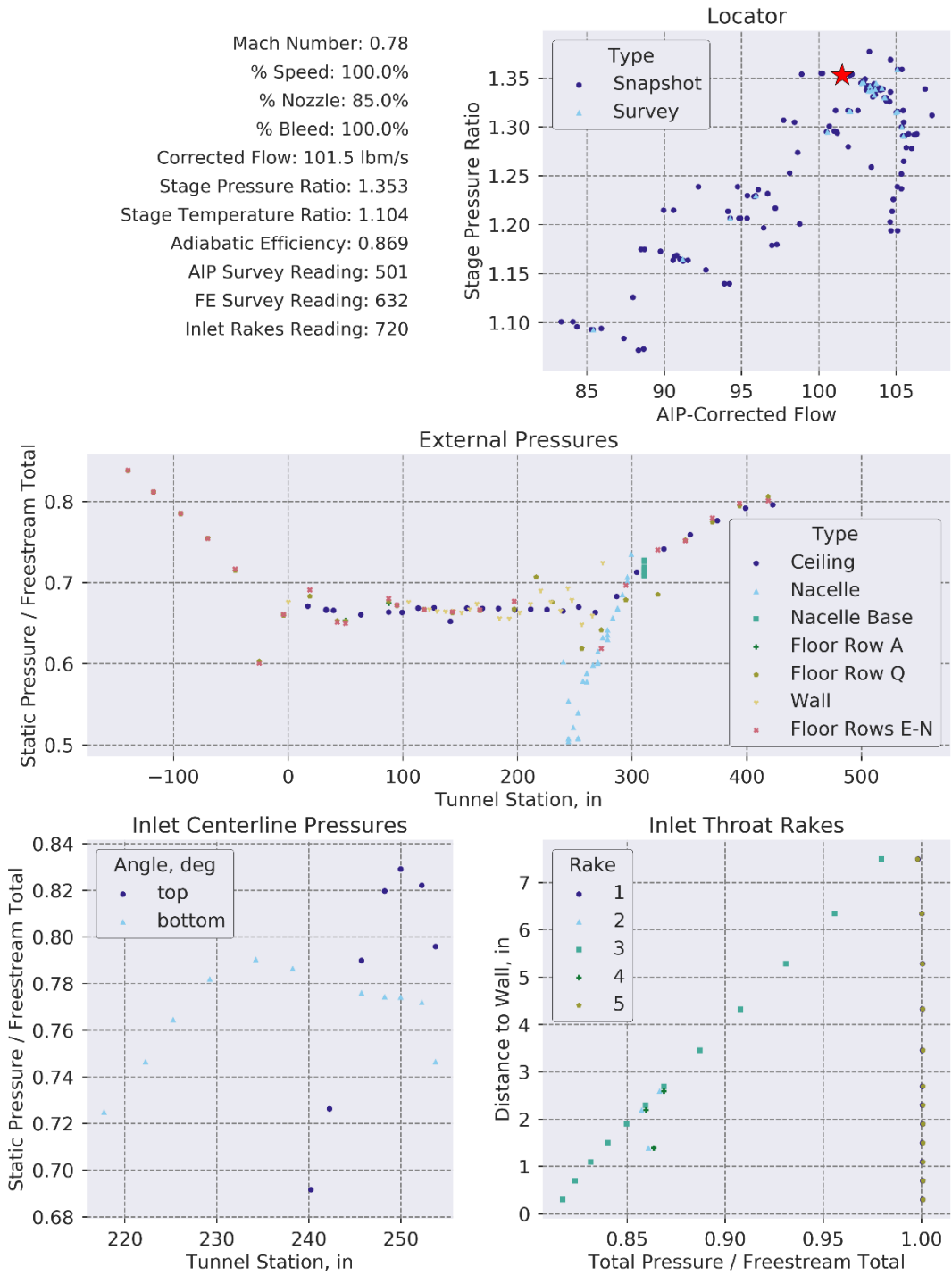
Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=86.5\%$)

Dashboard D.14.6: 86.5% Nozzle Point, AIP-1

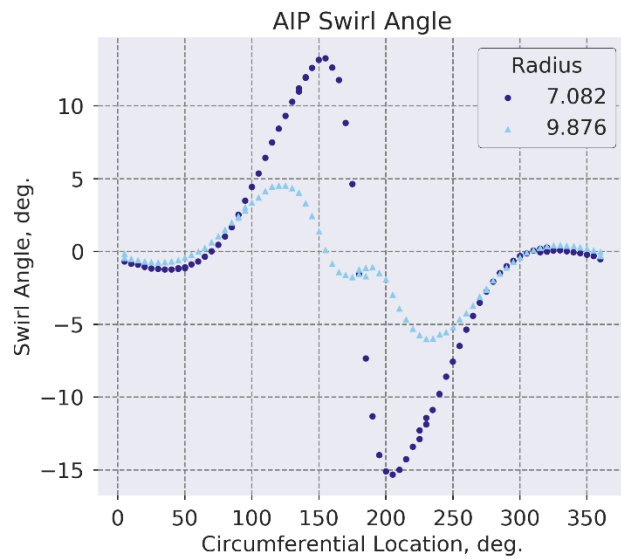
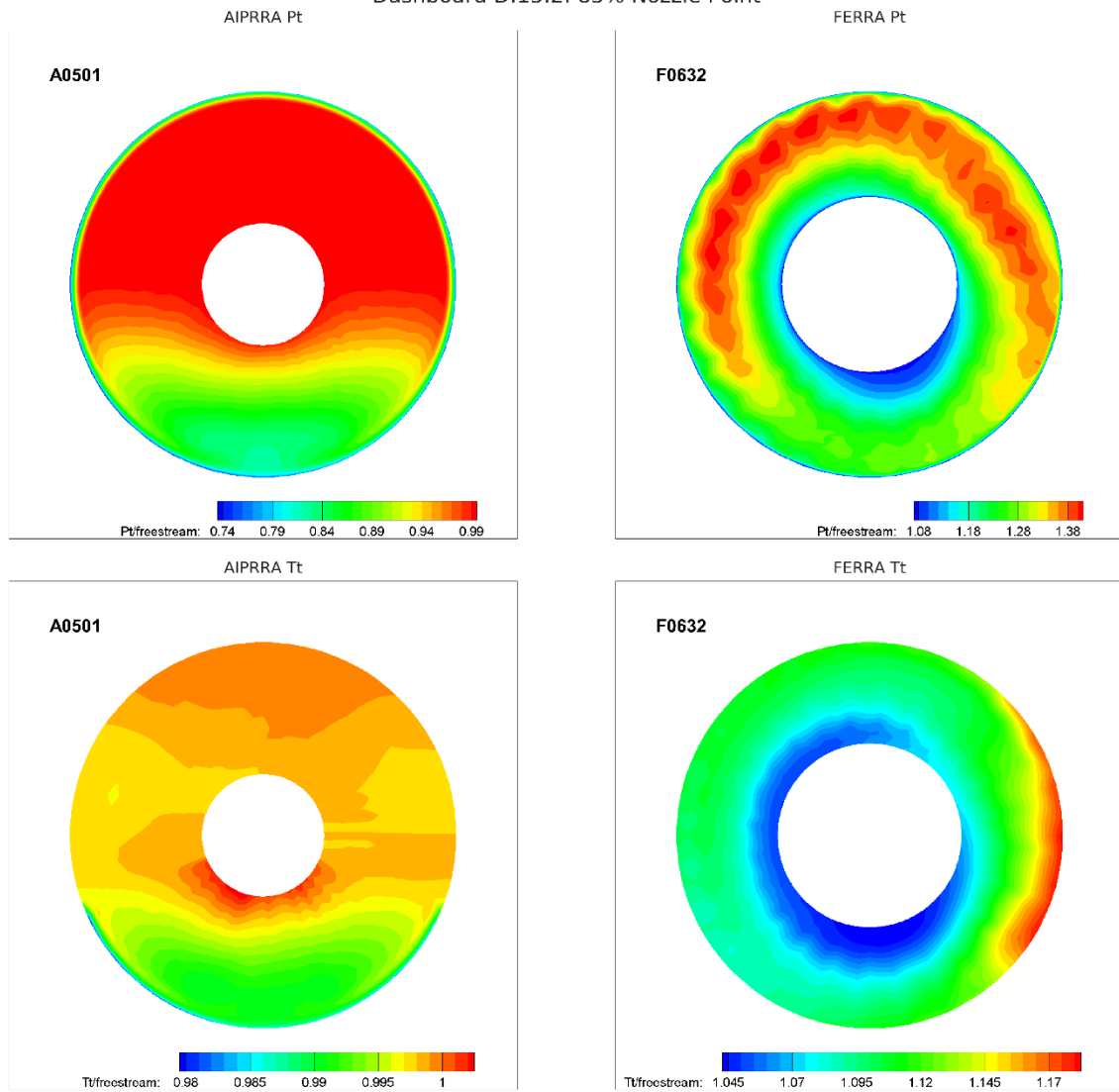


Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=86.5\%$)

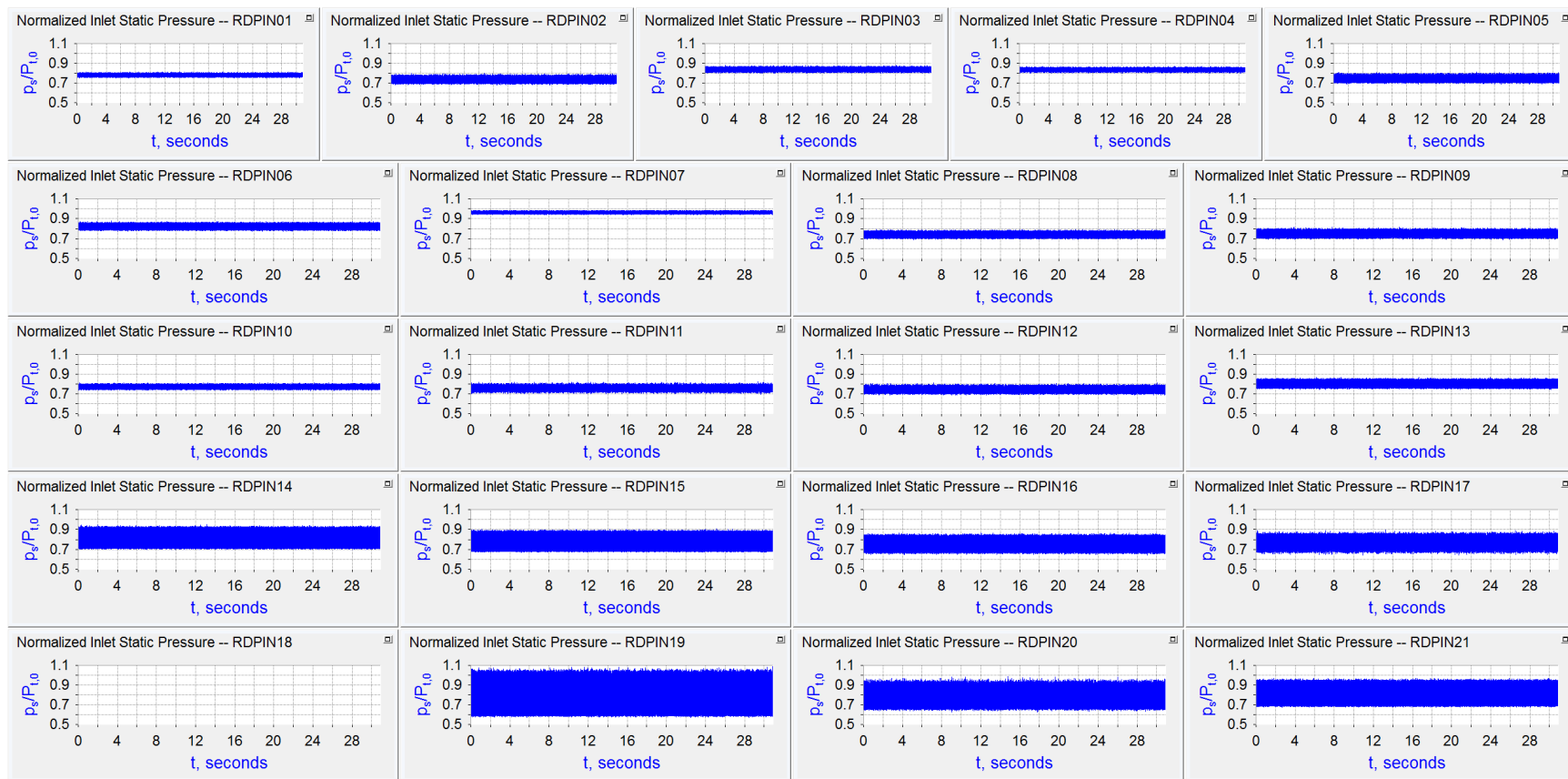
Dashboard D.15.1: 85% Nozzle Point



Dashboard D.15.2: 85% Nozzle Point

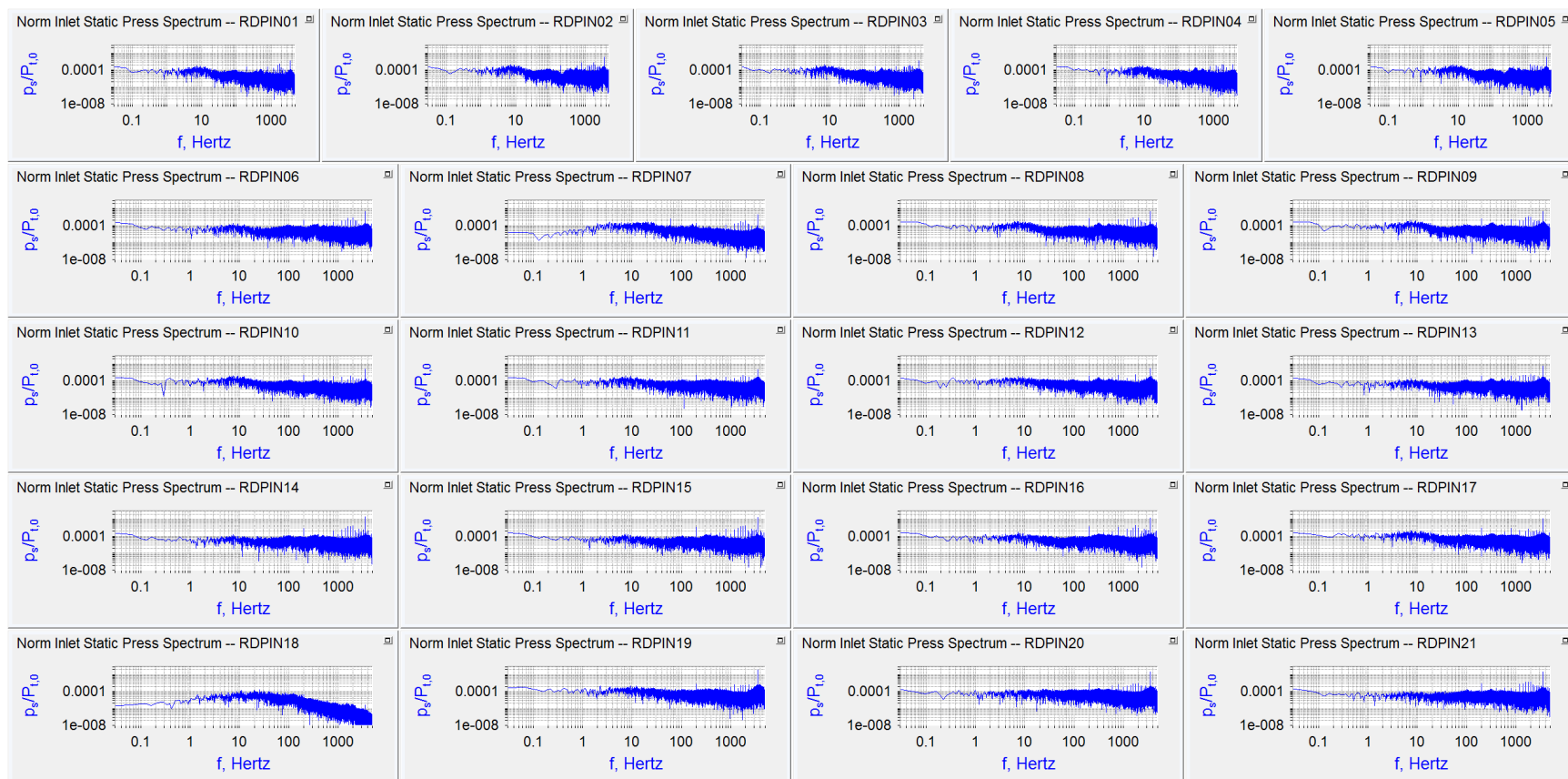


Dashboard D.15.3: 85% Nozzle Point, AIP-3



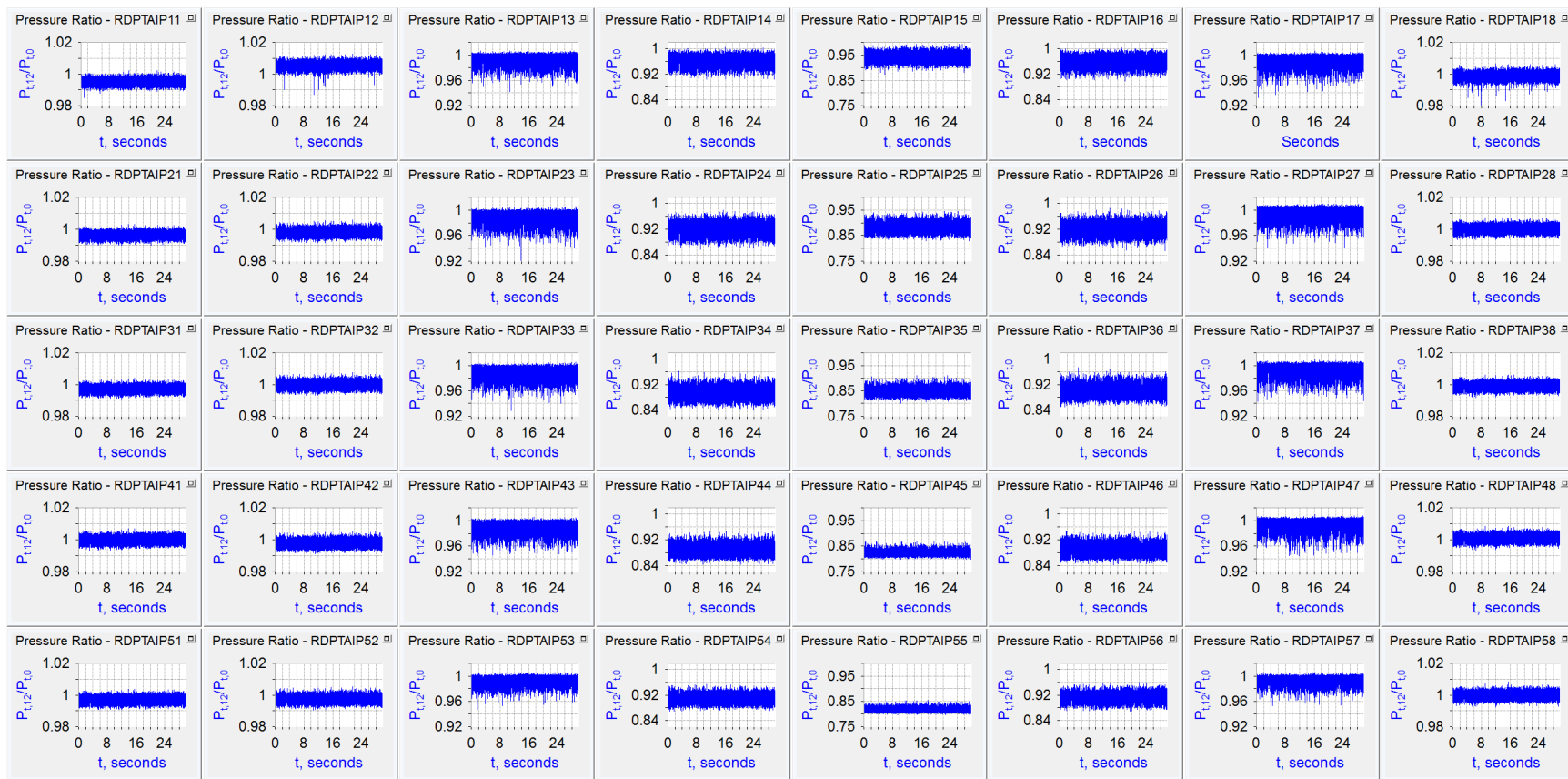
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{i9}=85.0\%$)

Dashboard D.15.4: 85% Nozzle Point, AIP-3



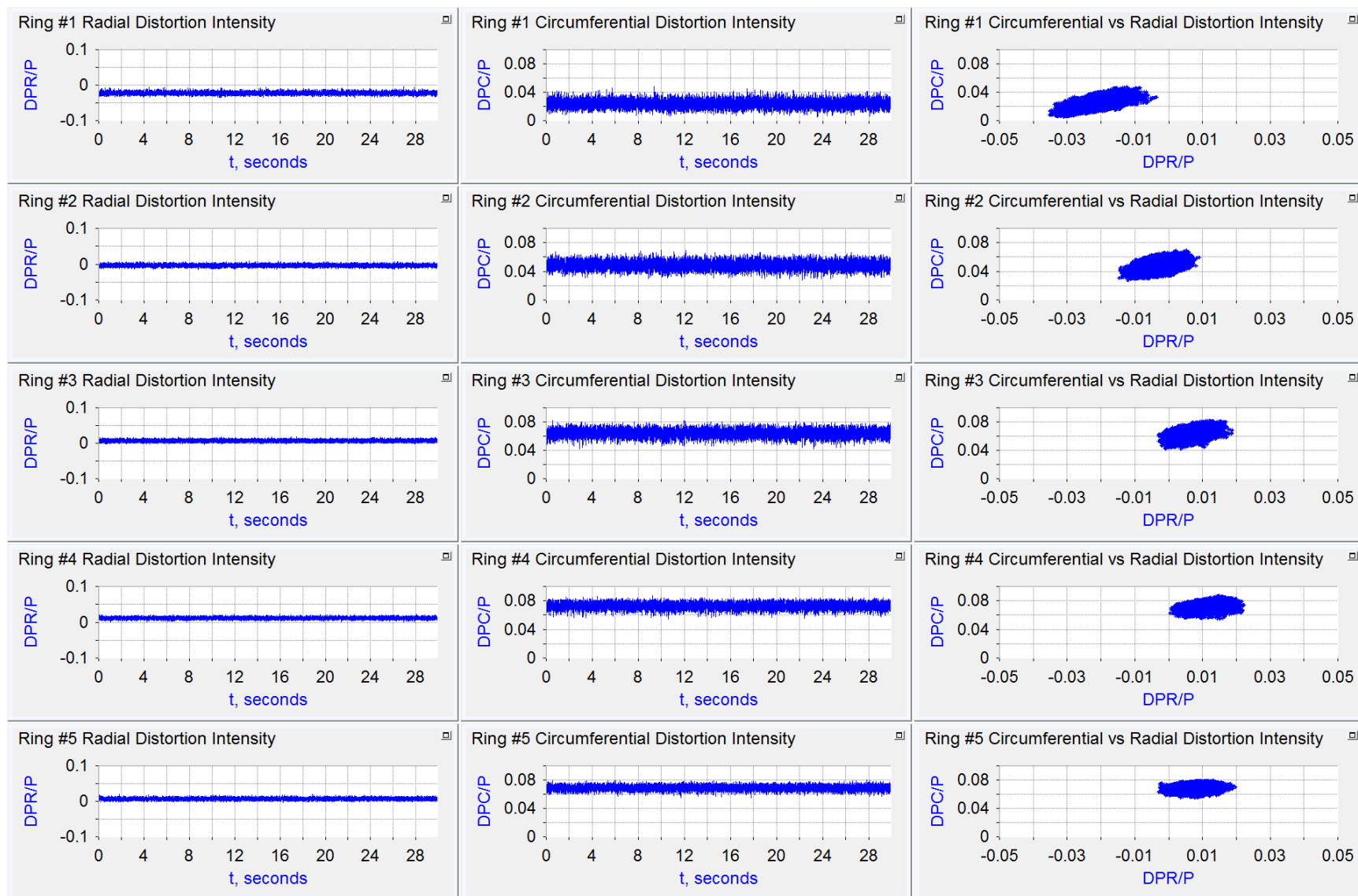
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=85.0\%$)

Dashboard D.15.5: 85% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=85.0\%$)

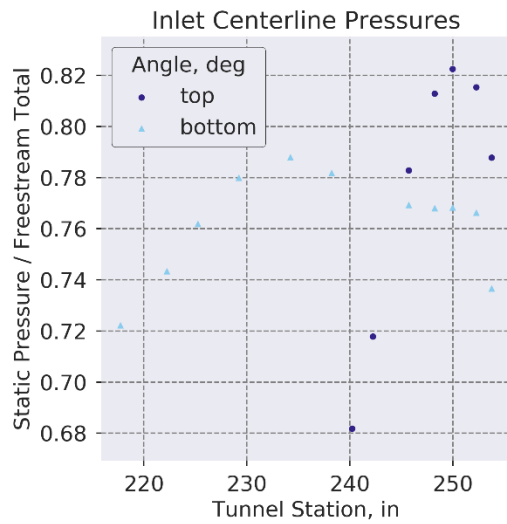
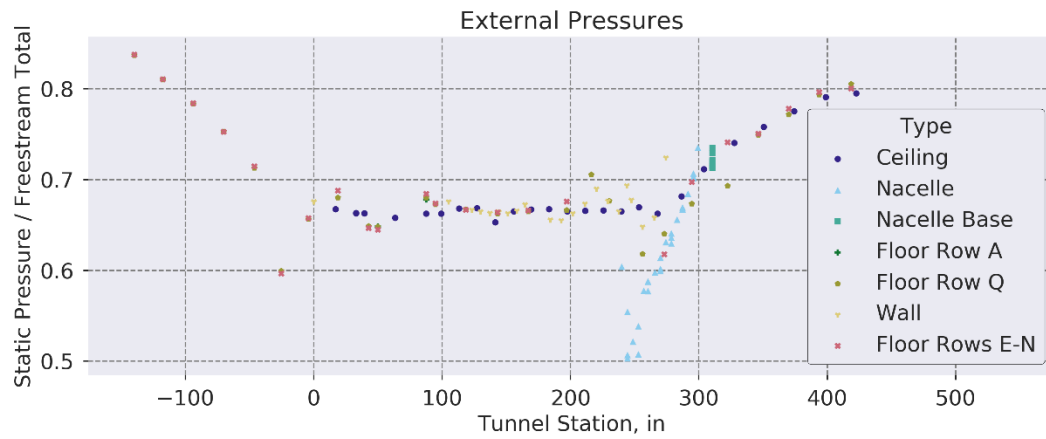
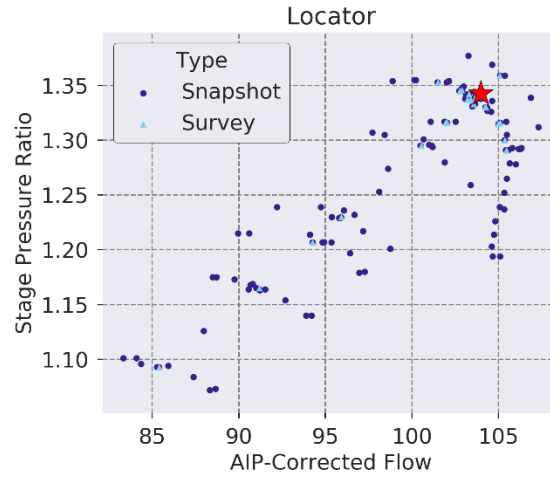
Dashboard D.15.6: 85% Nozzle Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.82''$, $N_c=100\%$, $A_{19}=85.0\%$)

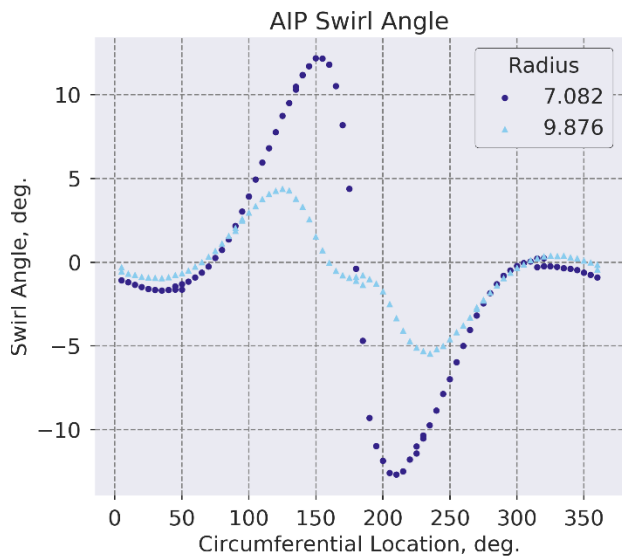
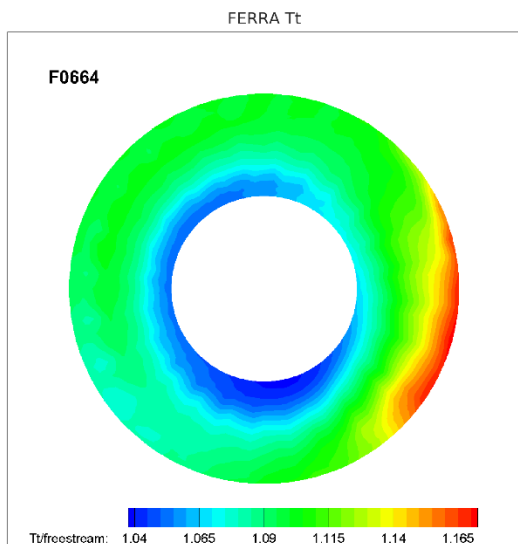
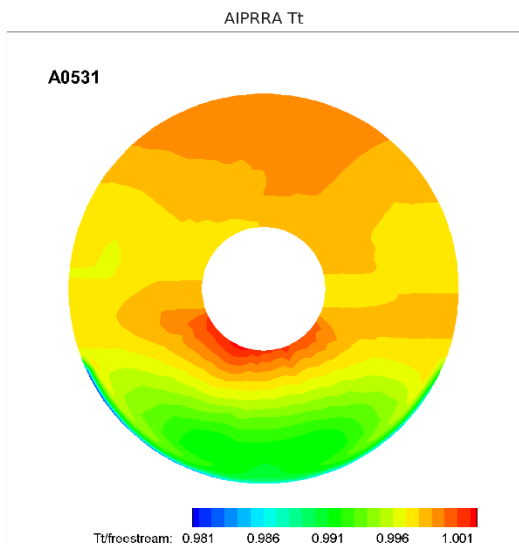
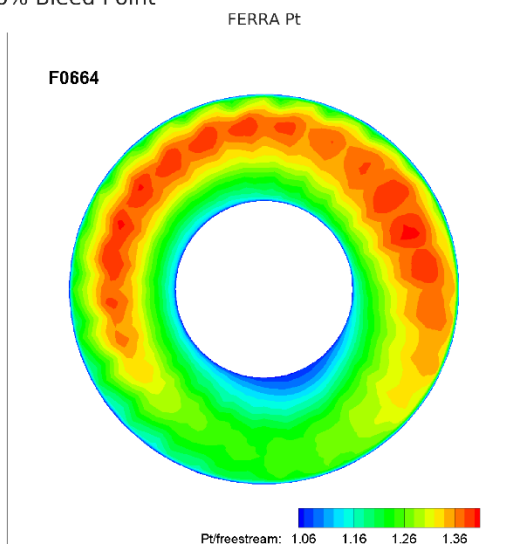
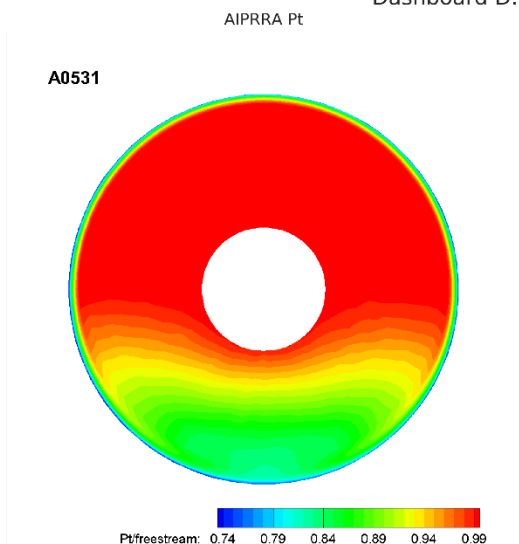
Dashboard D.16.1: 126% Bleed Point

Mach Number: 0.78
 % Speed: 100.0%
 % Nozzle: 87.5%
 % Bleed: 126.1%
 Corrected Flow: 104.0 lbm/s
 Stage Pressure Ratio: 1.343
 Stage Temperature Ratio: 1.099
 Adiabatic Efficiency: 0.884
 AIP Survey Reading: 531
 FE Survey Reading: 664
 Inlet Rakes Reading: No Data

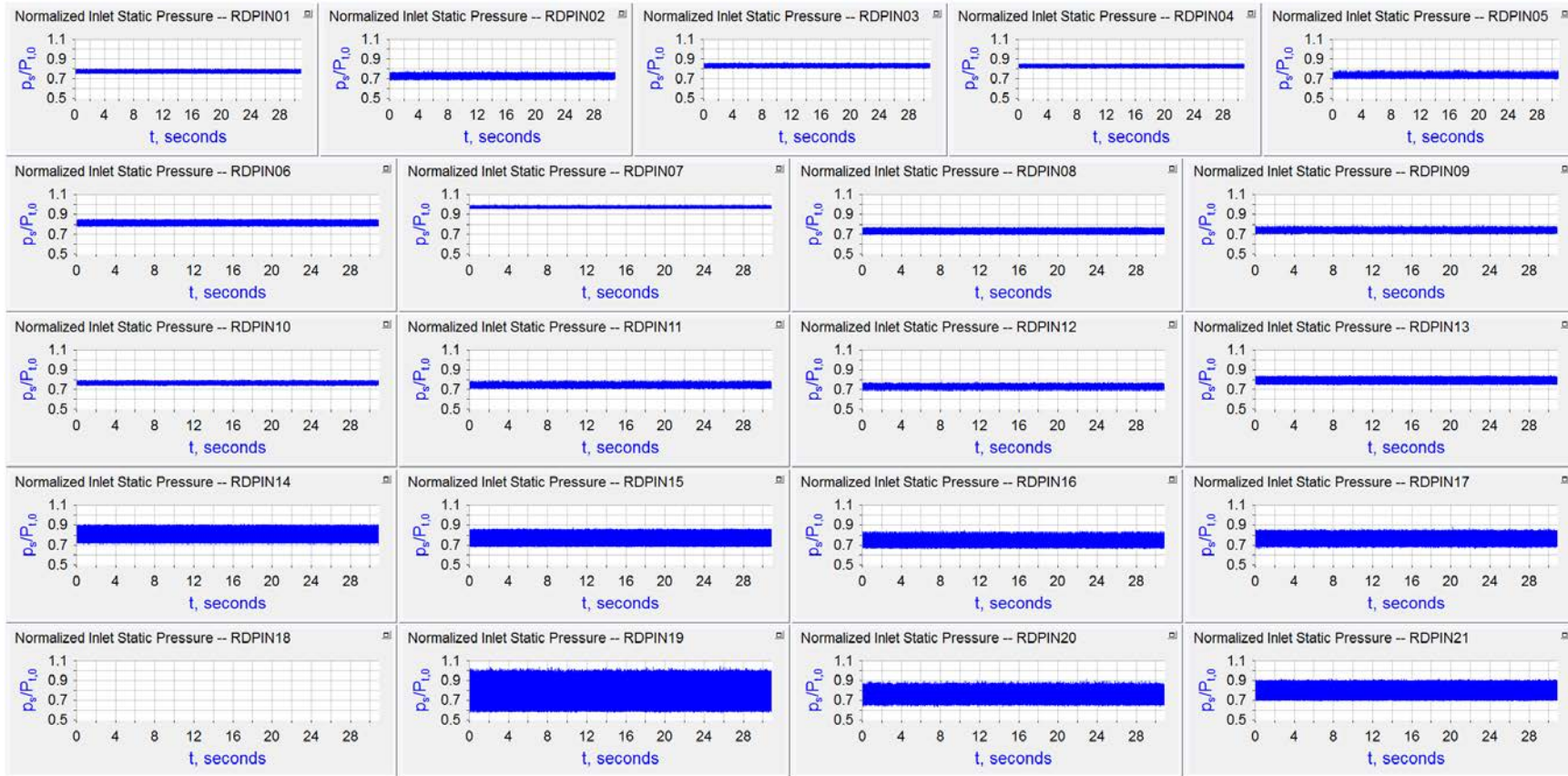


Inlet Throat Rakes
No Data

Dashboard D.16.2: 126% Bleed Point

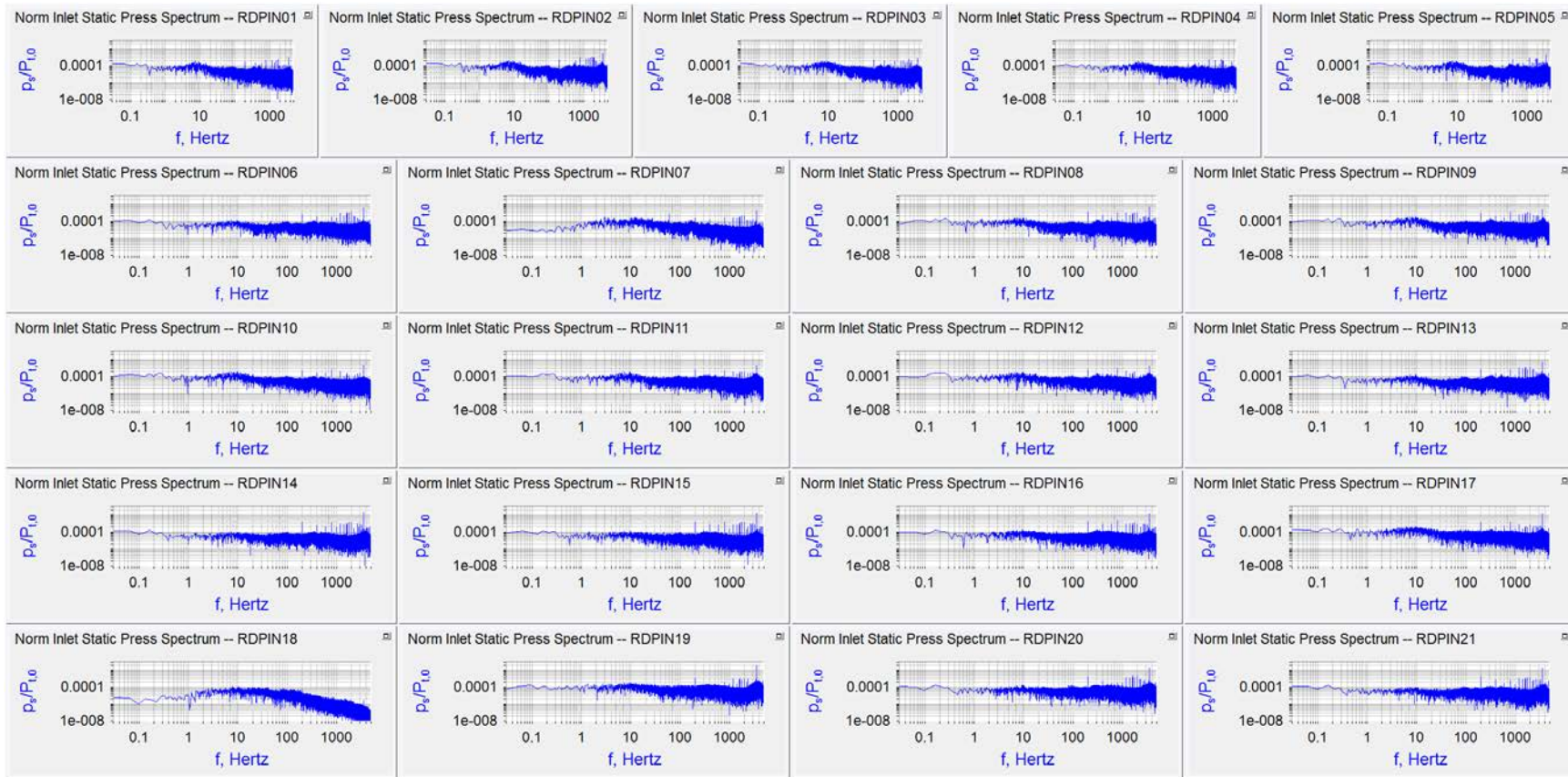


Dashboard D.16.3: 126% Bleed Point, AIP-3



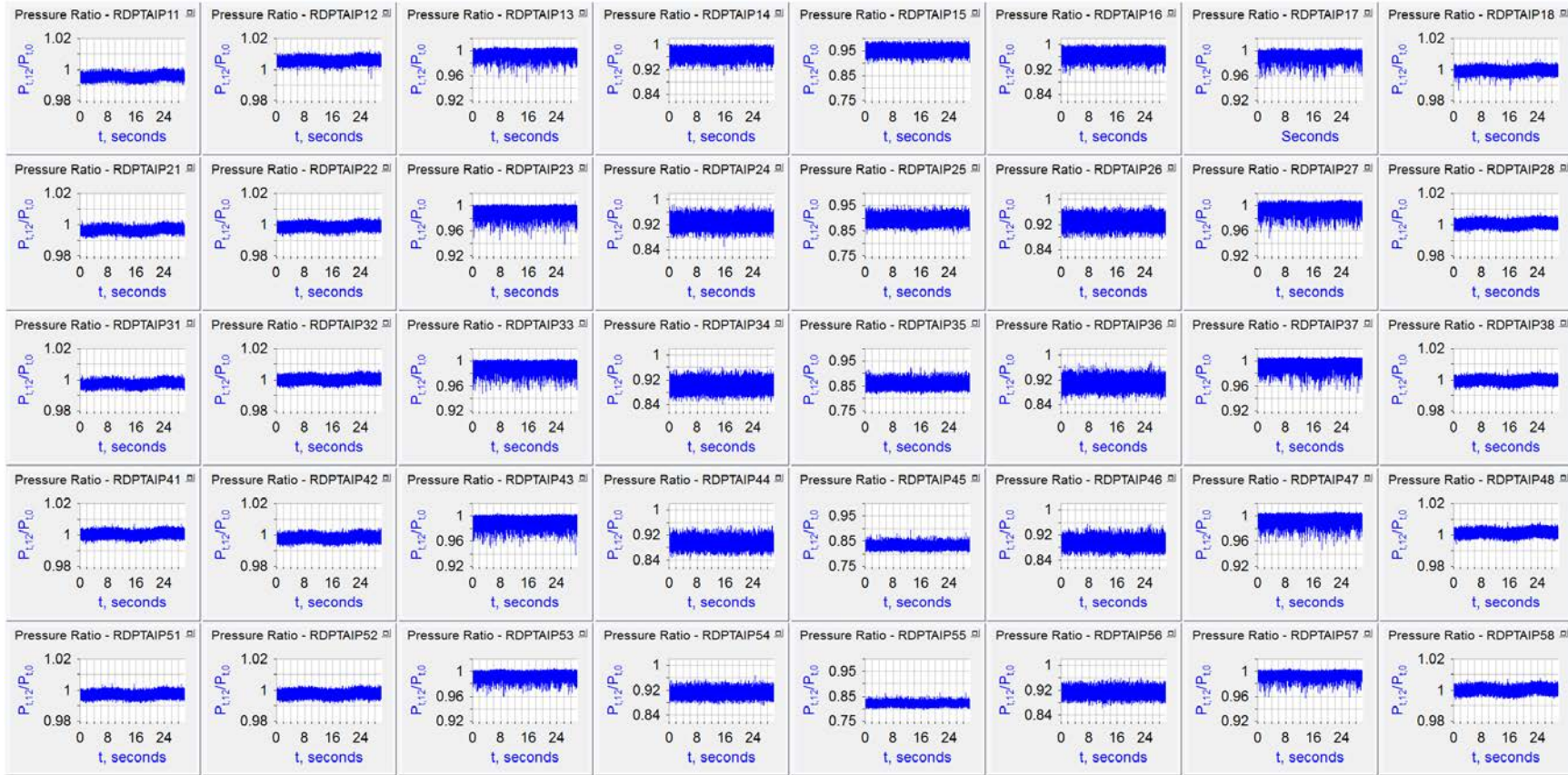
Measured High Response Inlet Static Pressure Distribution (AIP-III, $M=0.78$, $\delta=4.66''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.16.4: 126% Bleed Point, AIP-3



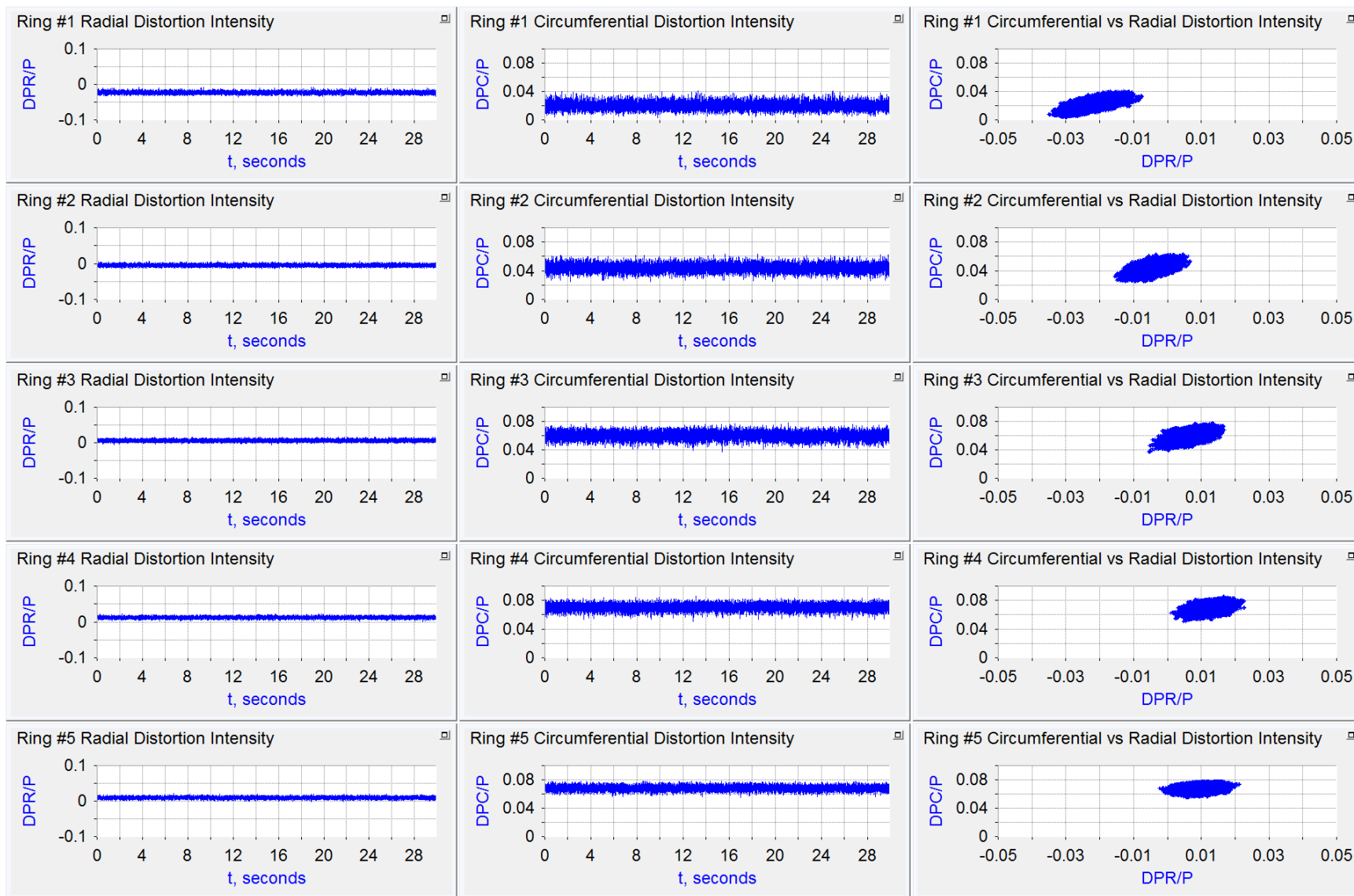
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.66''$, $N_c=100\%$, $A_{19}=87.5\%$)

Dashboard D.16.5: 126% Bleed Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.66''$, $N_c=100\%$, $A_{19}=87.5\%$)

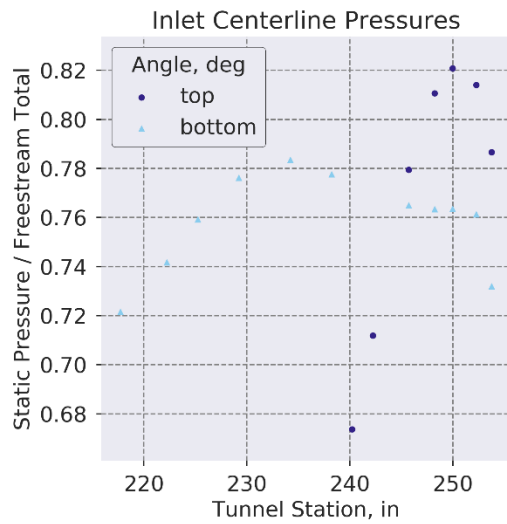
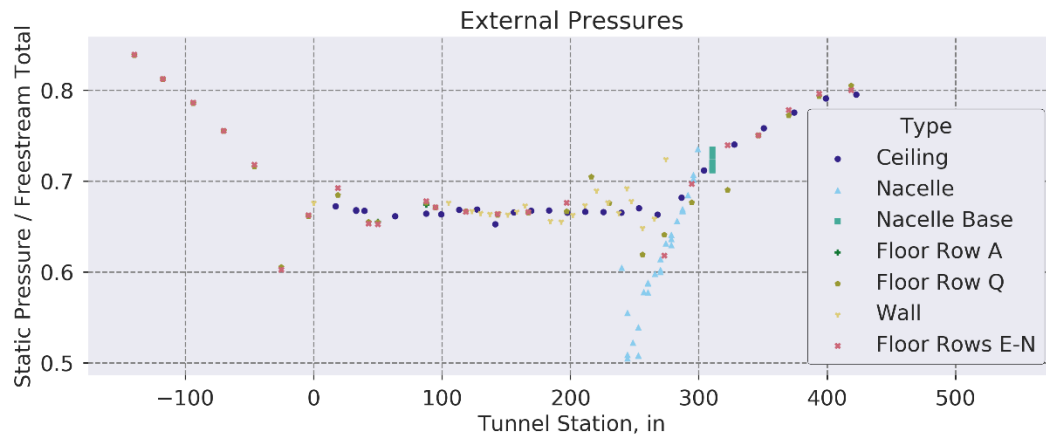
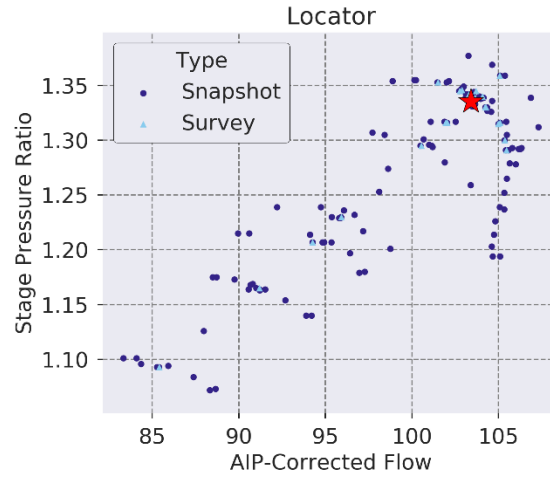
Dashboard D.16.6: 126% Bleed Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.66''$, $N_c=100\%$, $A_{19}=87.5\%$)

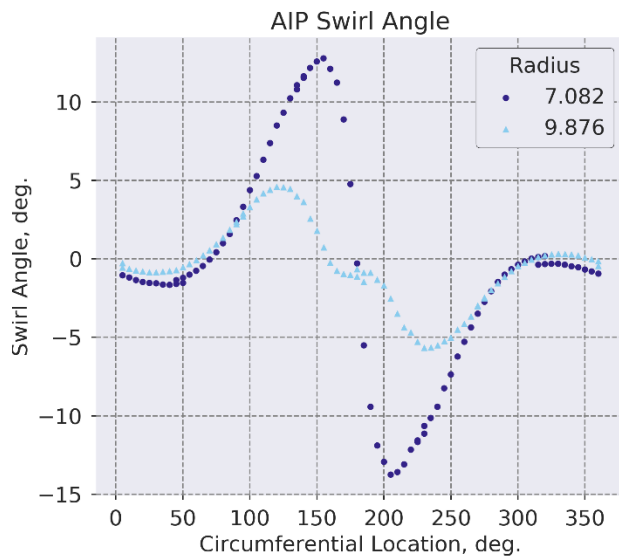
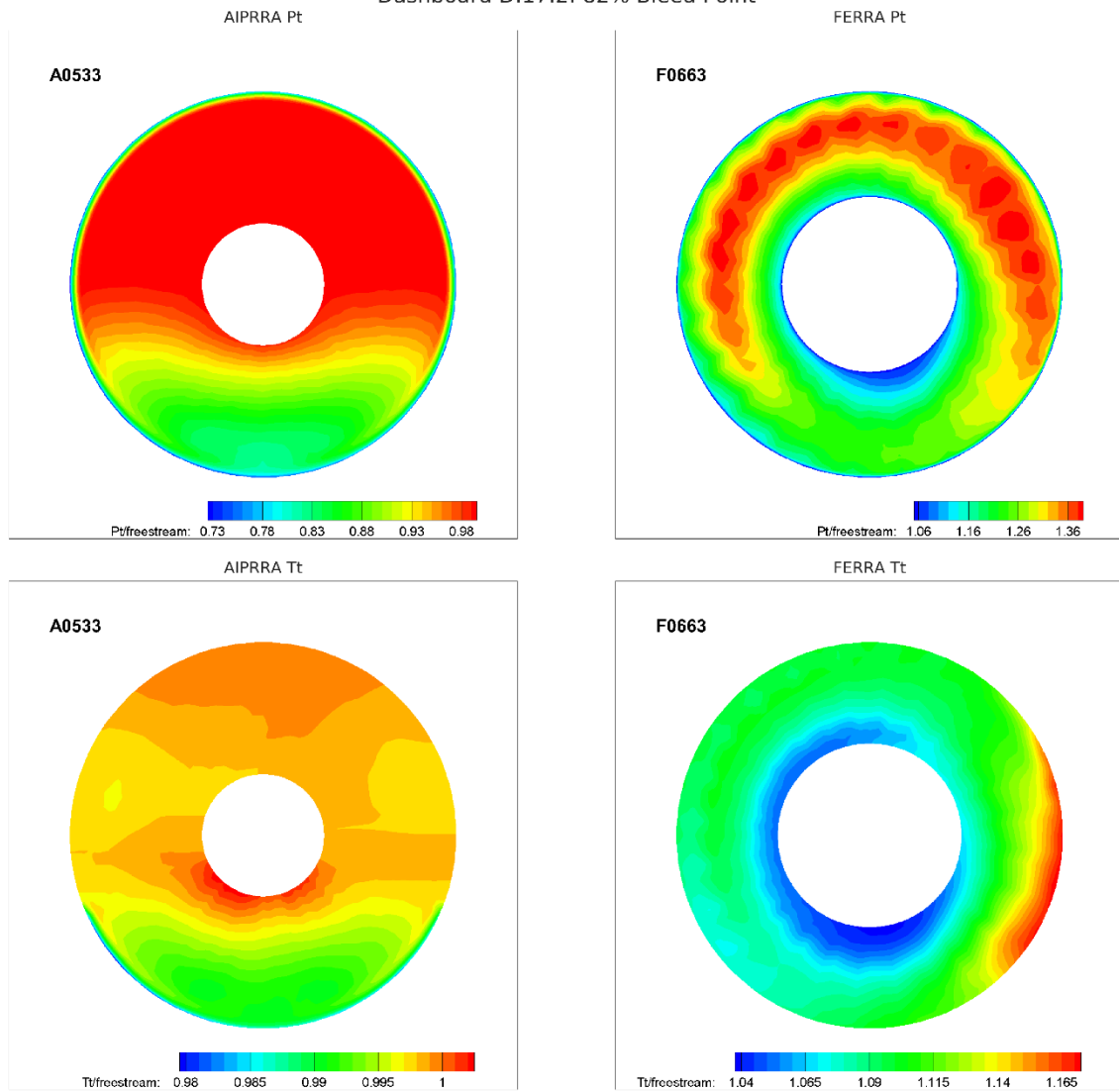
Dashboard D.17.1: 82% Bleed Point

Mach Number: 0.78
 % Speed: 100.0%
 % Nozzle: 87.5%
 % Bleed: 82.0%
 Corrected Flow: 103.4 lbm/s
 Stage Pressure Ratio: 1.335
 Stage Temperature Ratio: 1.099
 Adiabatic Efficiency: 0.871
 AIP Survey Reading: 533
 FE Survey Reading: 663
 Inlet Rakes Reading: No Data

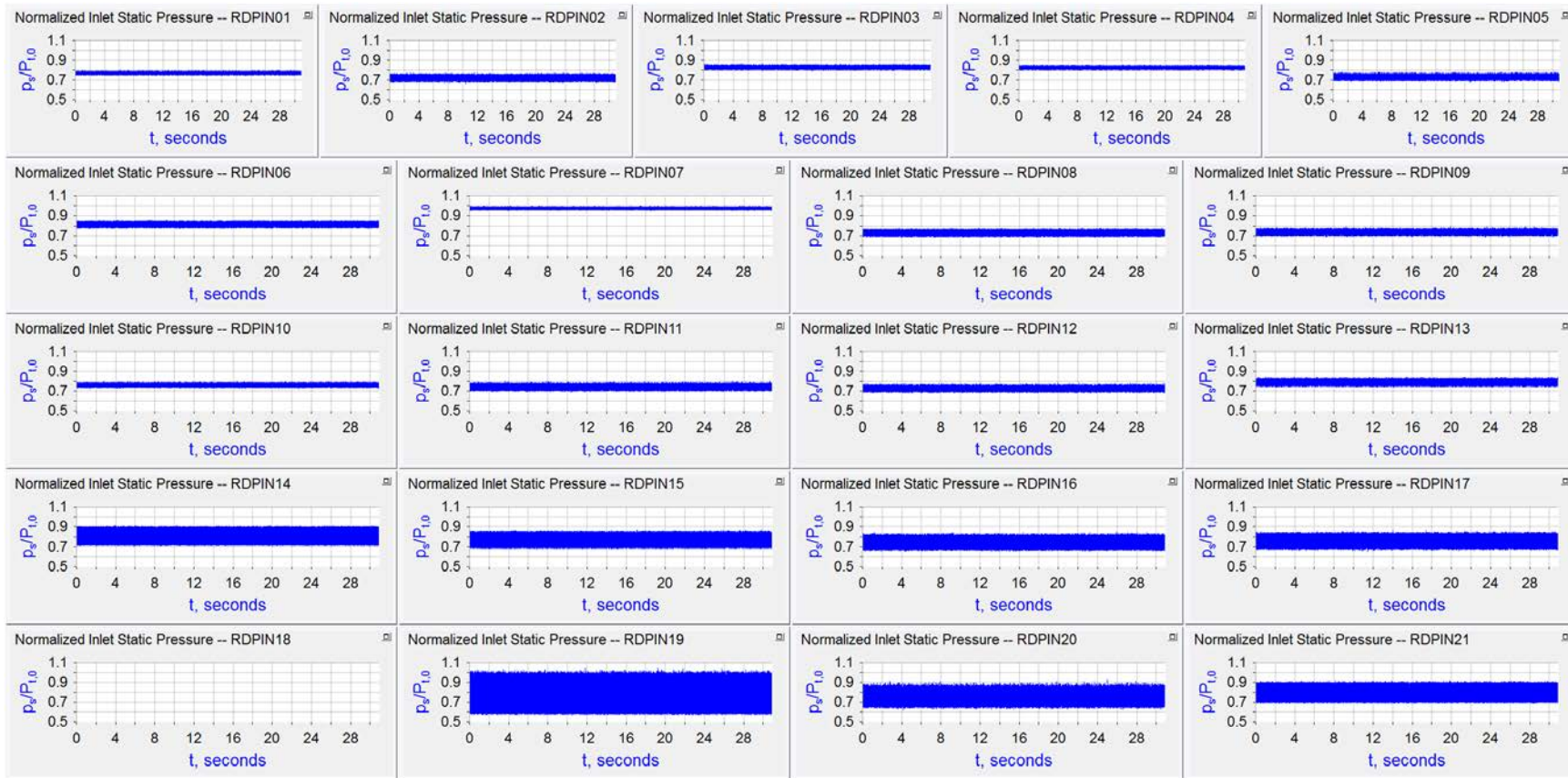


Inlet Throat Rakes
No Data

Dashboard D.17.2: 82% Bleed Point

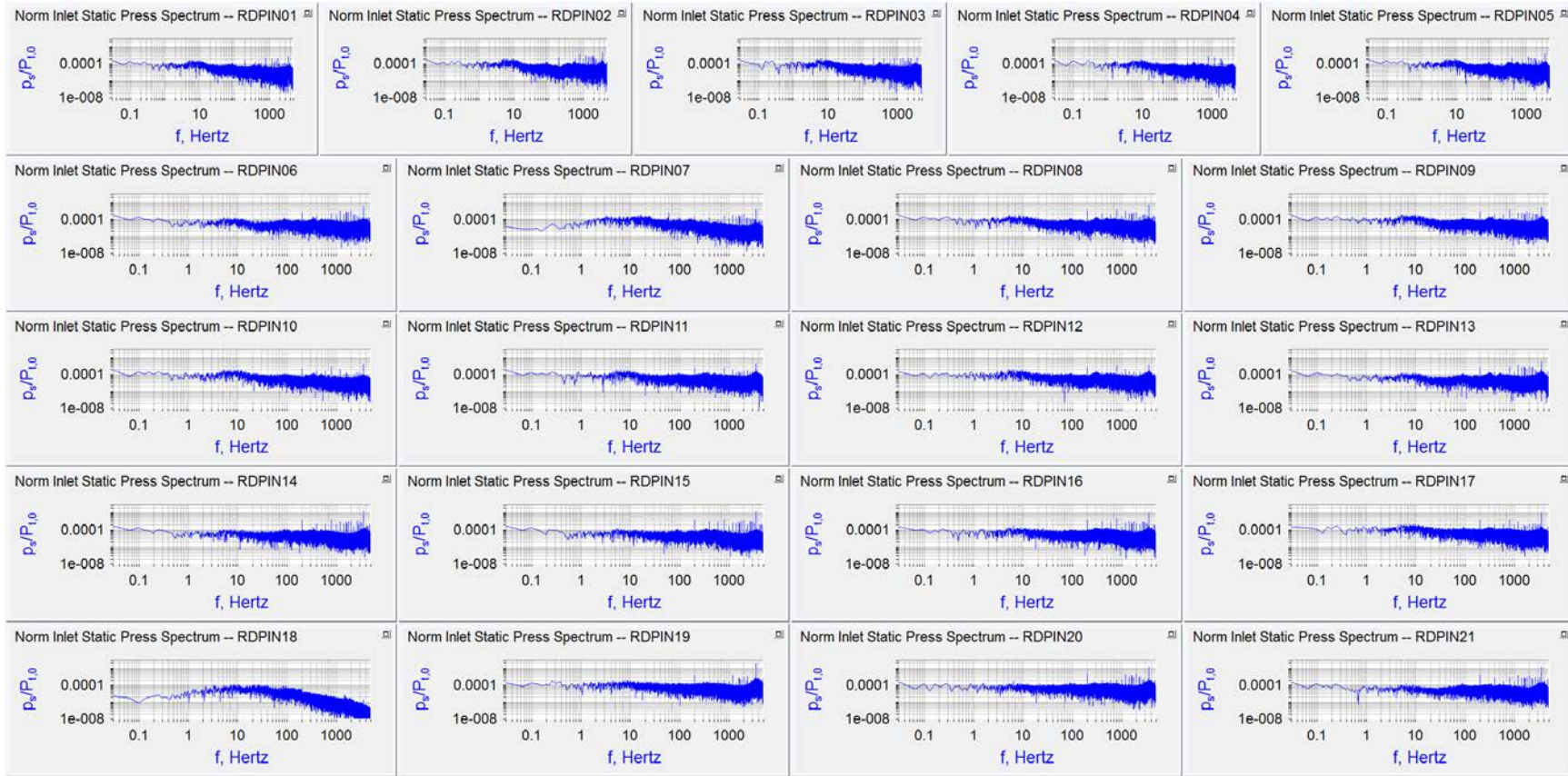


Dashboard D.17.3: 82% Bleed Point, AIP-3



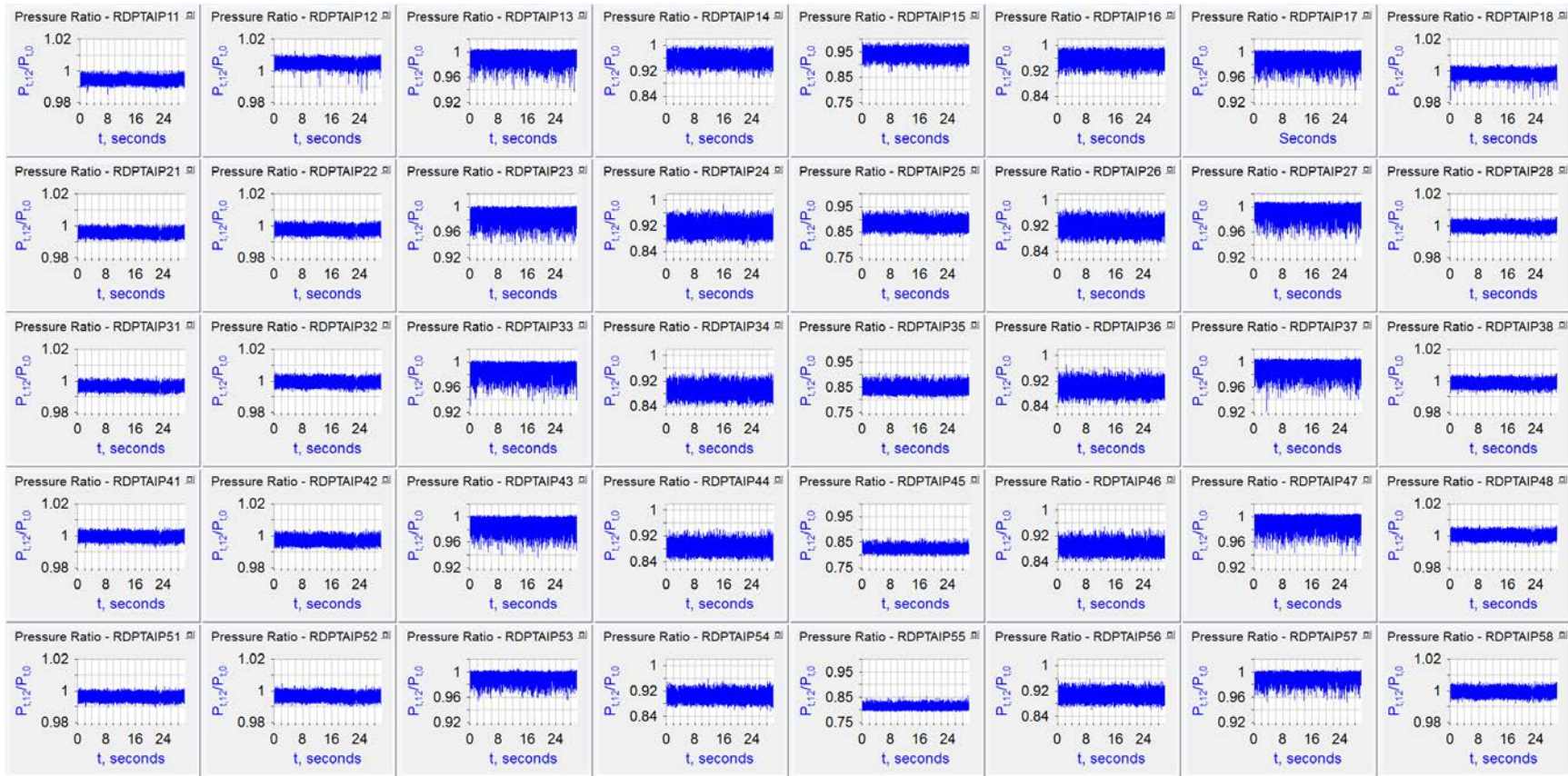
Measured High Response AIP Total Pressure Distribution ($M=0.78$, $\delta=4.98''$, $N_c=100\%$, $A_{10}=87.5\%$)

Dashboard D.17.4: 82% Bleed Point, AIP-3



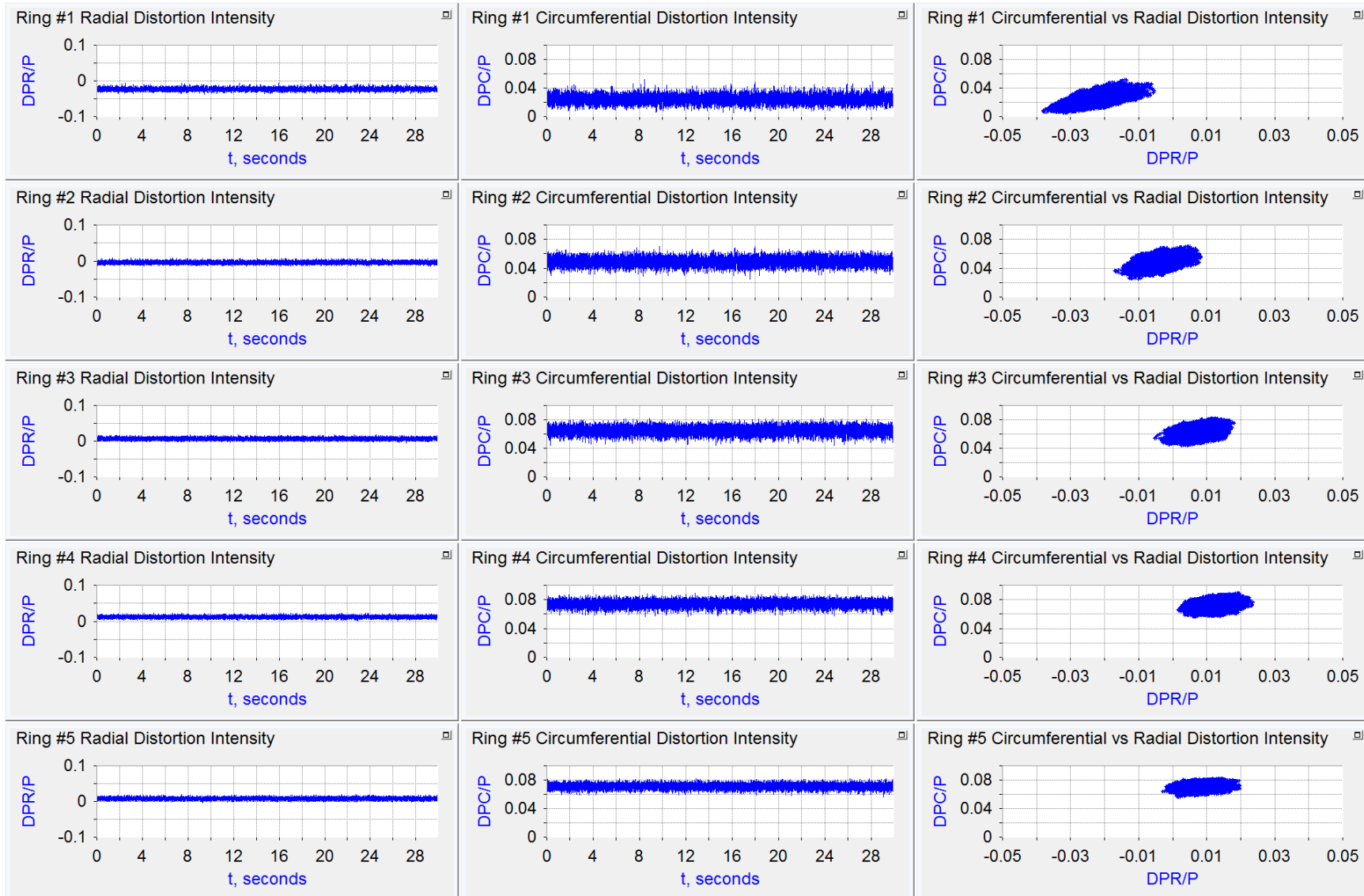
Measured High Response Inlet Static Pressure Distribution Spectra (AIP-III, $M=0.78$, $\delta=4.98''$, $N_c=100\%$, $A_{10}=92.0\%$)

Dashboard D.17.5: 82% Bleed Point, AIP-1



Measured High Response AIP Total Pressure Distribution Time Histories (AIP-I, $M=0.78$, $\delta=4.98''$, $N_c=100\%$, $A_{19}=92.0\%$)

Dashboard D.17.6: 82% Bleed Point, AIP-1



Measured High Response AIP Total Pressure Distortion Intensities (AIP-I, $M=0.78$, $\delta=4.98''$, $N_c=100\%$, $A_{19}=87.5\%$)

