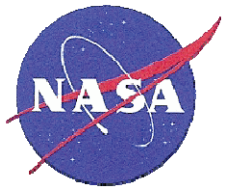
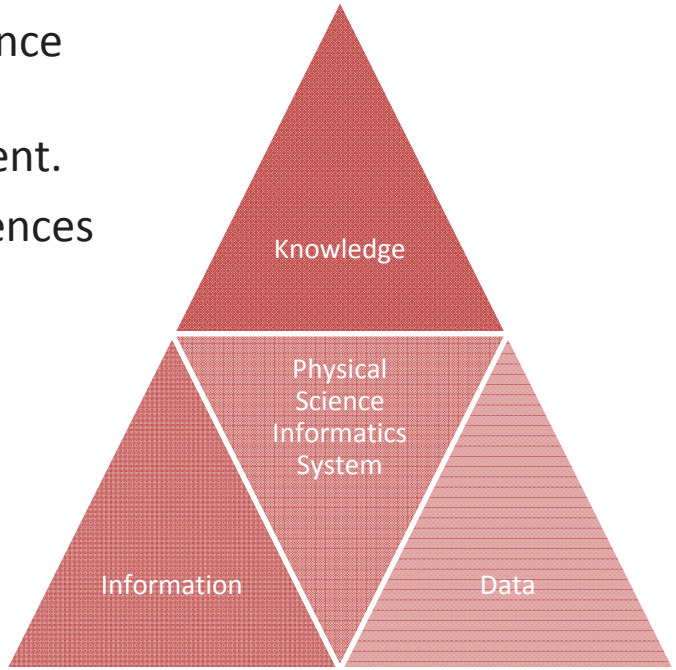


Physical Science Informatics:
Providing Open Science Access to Microheater Array Boiling Experiment Data

John McQuillen
Robert D. Green
Ben Henrie
Teresa Miller
Fran Chiaramonte

Objective

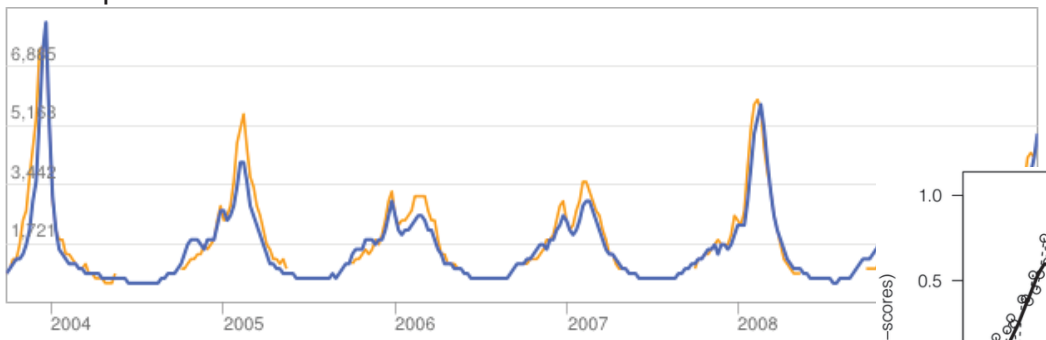
- Physical Science Informatics system implements Office of Science and Technology Policy (OSTP) memorandum, Feb. 22, 2013 entitled "Increasing Access to the Results of Federally Funded Scientific Research" by enabling multiple researchers simultaneous, **open-science,** access to synergistically build upon ISS data.
- Maximize the value of this important data by mass disseminating past, current, and future ISS physical science data to the broad science, engineering, and STEM community including industry, academia, and government.
- Accelerate from ideas to state-of-the-art of physical sciences research and to products, publications, and patents.

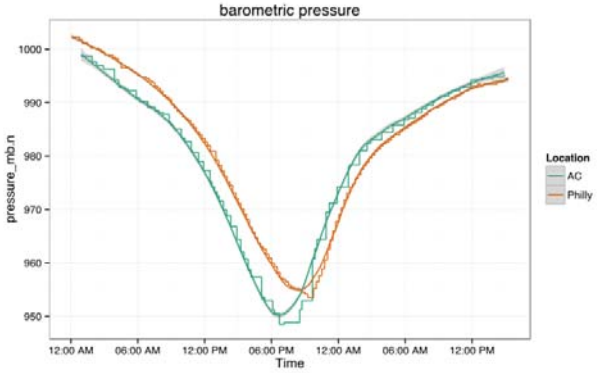


Open Science Examples

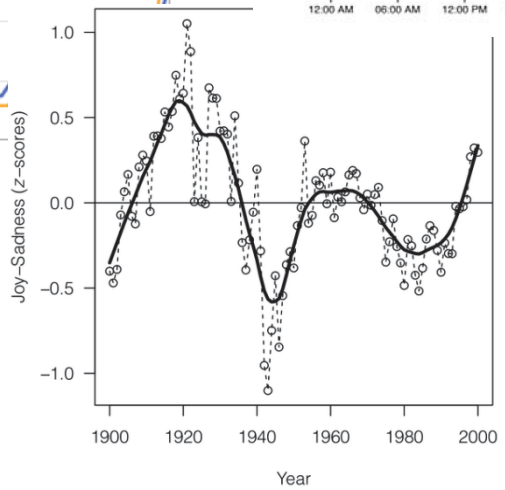
- Data science: A new emerging field with the goal of "extracting meaning from data and creating data products". [definition courtesy of Wikipedia.]
- Has emerged as a new field to glean knowledge and new understanding from the large volume and diversity of data being published or available and accessible on the internet.
- Examples:

- Tracking Hurricane Sandy: Barometric pressure data from local weather stations, available on-line, accurately track the storm's path.

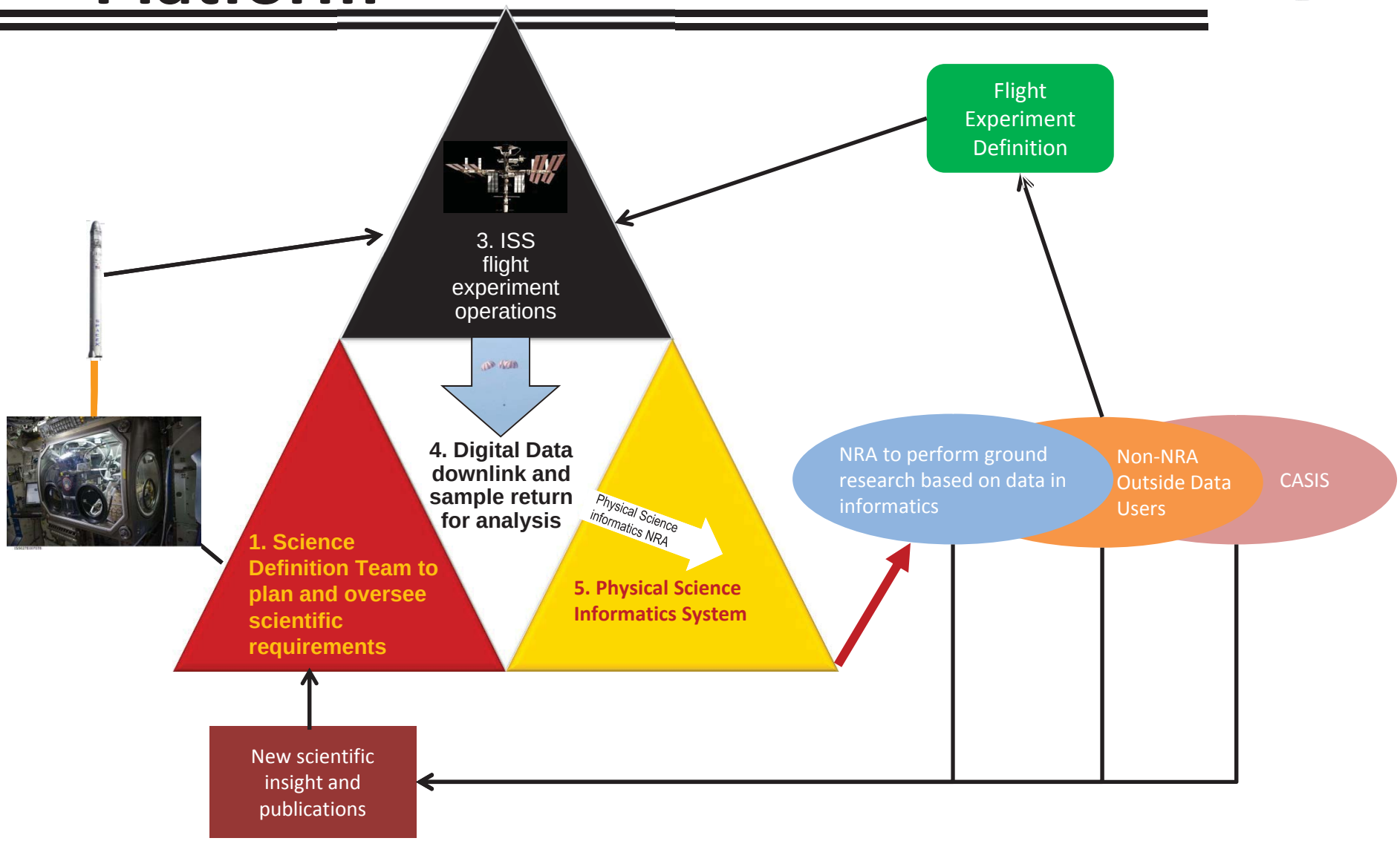




- Google researchers discovered close relationship between searches on flu-related topics and spread of influenza. Published in Nature Vol 457, 19 February 2009, doi:10.1038/nature07634
- Human behavior researchers using Google n-gram database (data from Project Gutenberg) found evidence for distinct historical periods of positive and negative moods in 20th century books.



Open Science Campaign Platform*



*Marshall Porterfield – based on the ISS Science Campaign White Paper 2013

BXF Overview

The Boiling eXperiment Facility was installed in the Microgravity Science Glovebox (MSG):

- Two distinct experiments:
  - Micro-heater Array Boiling Experiment (MABE) PI: Prof. Jungho Kim, University of Maryland
  - Nucleate Pool Boiling Experiment (NPBX) PI: Prof. Vijay K. Dhir, University of California at Los Angeles
- *Normal*-perfluorohexane, C_6F_{14}, as the test fluid
- Operated between pressures of 60 to 244 kPa and temperatures of 35 to 60 °C.
- Measured Pressure and bulk fluid temperature.
- Acquired standard rate video.

Timeline

- BXF was delivered to the ISS aboard ULF-5, which launched in February, 2011.
- BXF was installed on Tuesday March, 22.
- Week 1: Hardware setup and checkout, MABE and NPBX heater characterizations
- Weeks 2 and Week 3: MABE and NPBX test points .
- On Monday, April 11, anomalous pressure readings tripped the BXF safety circuit, halting operations. Attempts to restart/reset/recycle BXF did not correct these readings and BXF was shut down.
- By this point MABE completed 260 of 540 tests. NPBX completed less than half of planned tests.
- On-orbit troubleshooting was performed via ground-control.
- Limited NPBX operations could still be performed without failed power bus.
- BXF was removed from MSG and returned on ULF-7.

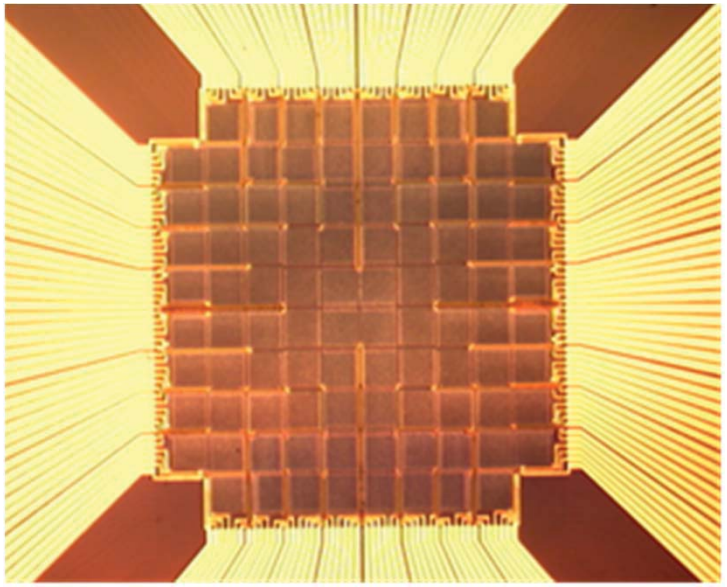
ESA Astronaut Paulo Nespoli installing BXF in MSG

Microheater Array Boiling Experiment (MABE)

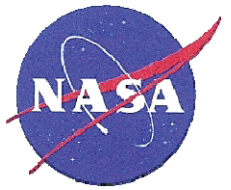
Determined the local boiling heat transfer mechanisms in microgravity for nucleate and transition boiling and the critical heat flux by examining the position of the liquid and vapor adjacent to the heater.

MABE was incorporated two 96-element microheater arrays, to measure localized heat fluxes while operating at a constant temperature.

- **2.7 by 2.7 mm (not acquired)**
- **7.0 by 7.0 mm**



Physical Science Informatics Platform



- **Accessibility** - Available to the national and international user community, using popular devices such as iPhone, iPad, Android, PC, Mac, Linux with web-based Google like search capability
- **Collaboration** - Allow for data to data links, and provide researchers the ability to comment about the data in either private or public discussions
- **Generate metric and usage reports** - Track usage for NASA managers and the science definition teams in planning, gap analysis, data ranking, student (undergraduate and graduate) impact, and for future system improvement.
- **Security and Access Controls** - Access controls will protect the data according to the data agreement and to support security controls for SBU, International Traffic in Arms Regulations (ITAR), company proprietary, or Export Administration Regulations (EAR), data system will need to be on a NASA moderate security plan
- **Export tools** are available to through a set of web services so that a variety of research tools can be used to analyze the data.

Requesting Access

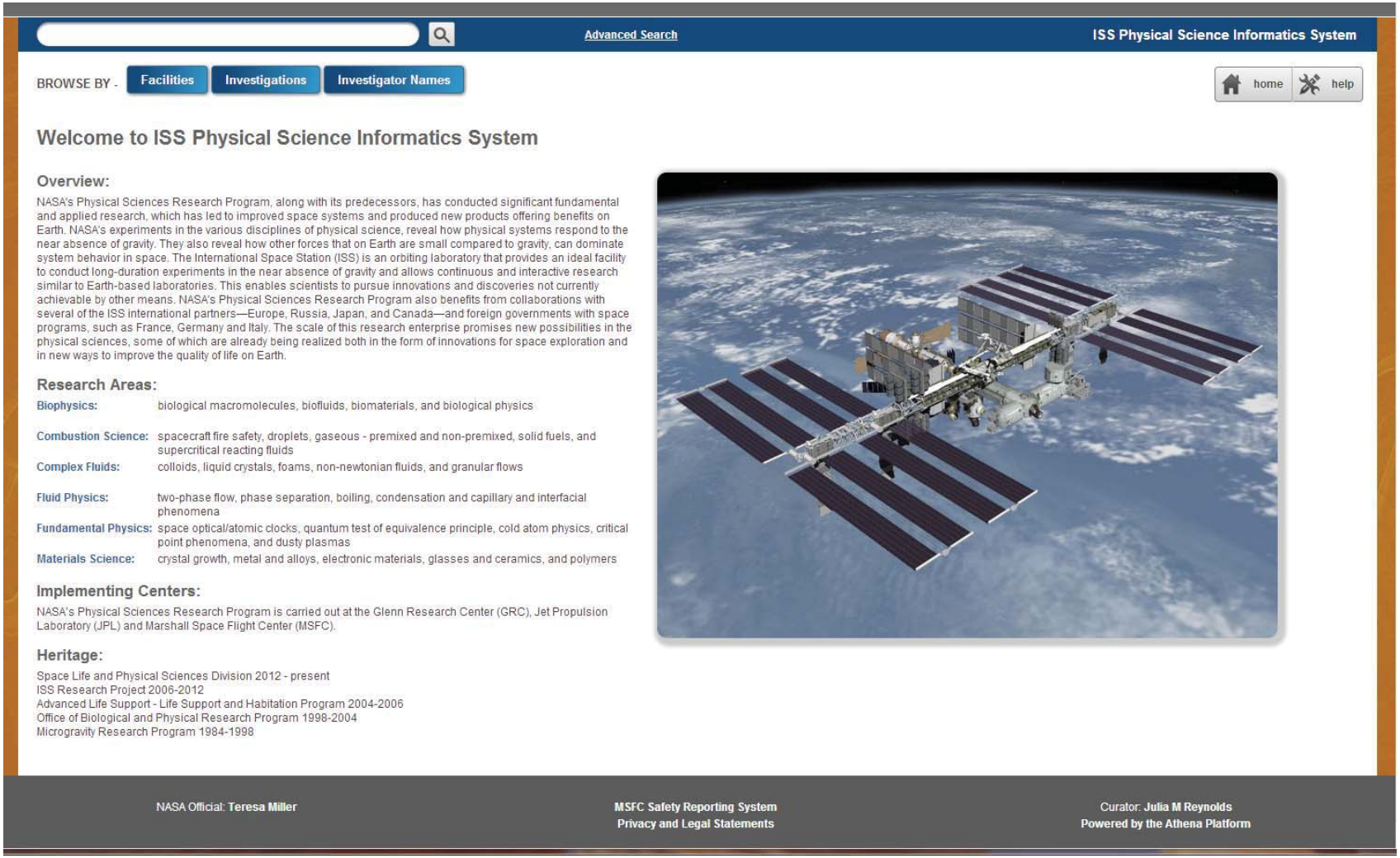
Website access requires a USERID and Login.

Submit form at http://psi.nasa.gov/Request.aspx:

- First, Middle and Last Name
- Phone
- Email
- Organization
- Address
- City
- Country
- State
- Postal Code
- Citizenship
- Company
- Manager's Information
  - First and Last Name
  - Phone
  - Email
- Projects (NASA tracks who uses the database and what they use it for. Ultimately, this is one metric used to warrant continuation of this resource)
- Justification

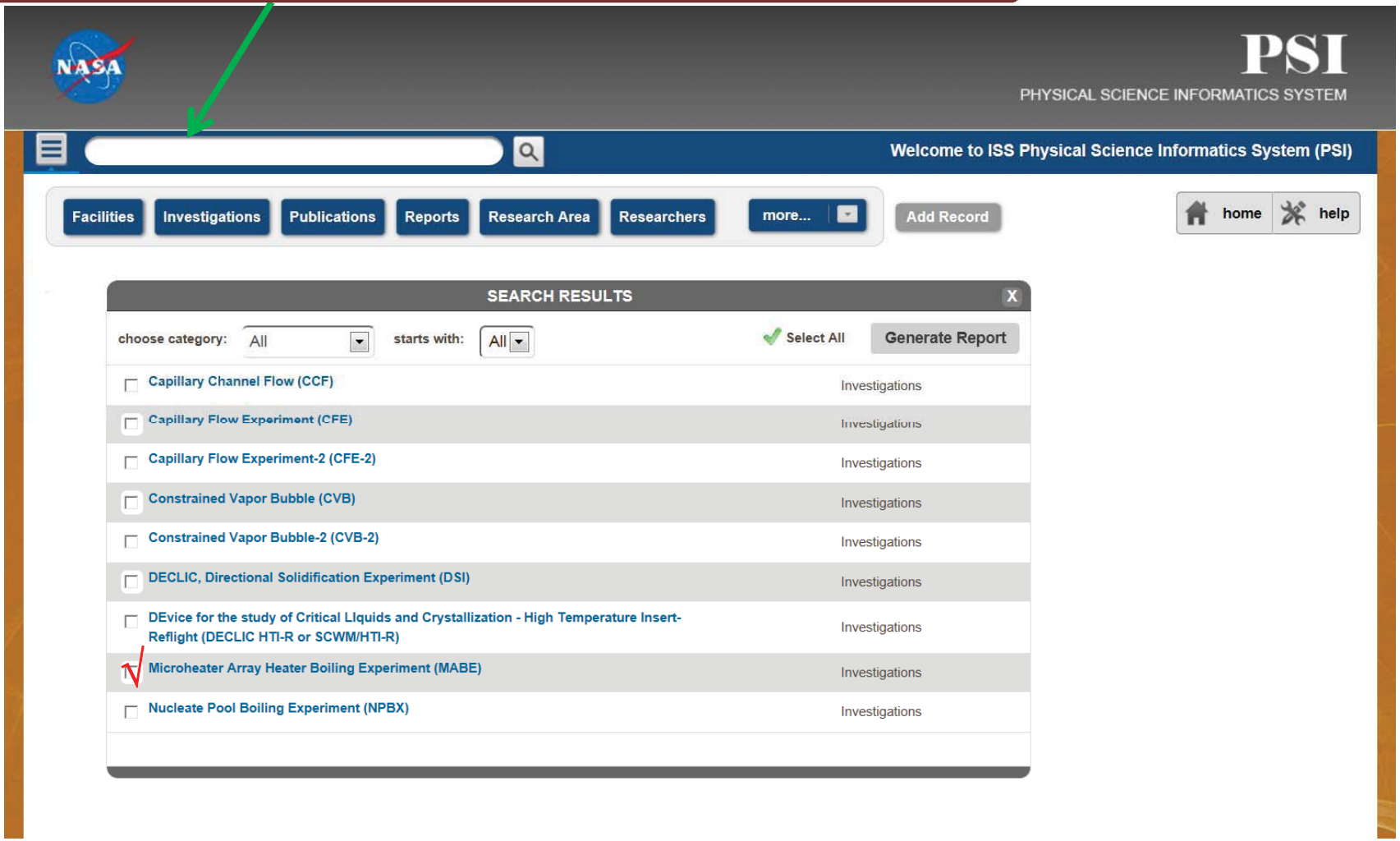
PSI Introduction Page

URL http://psi.nasa.gov

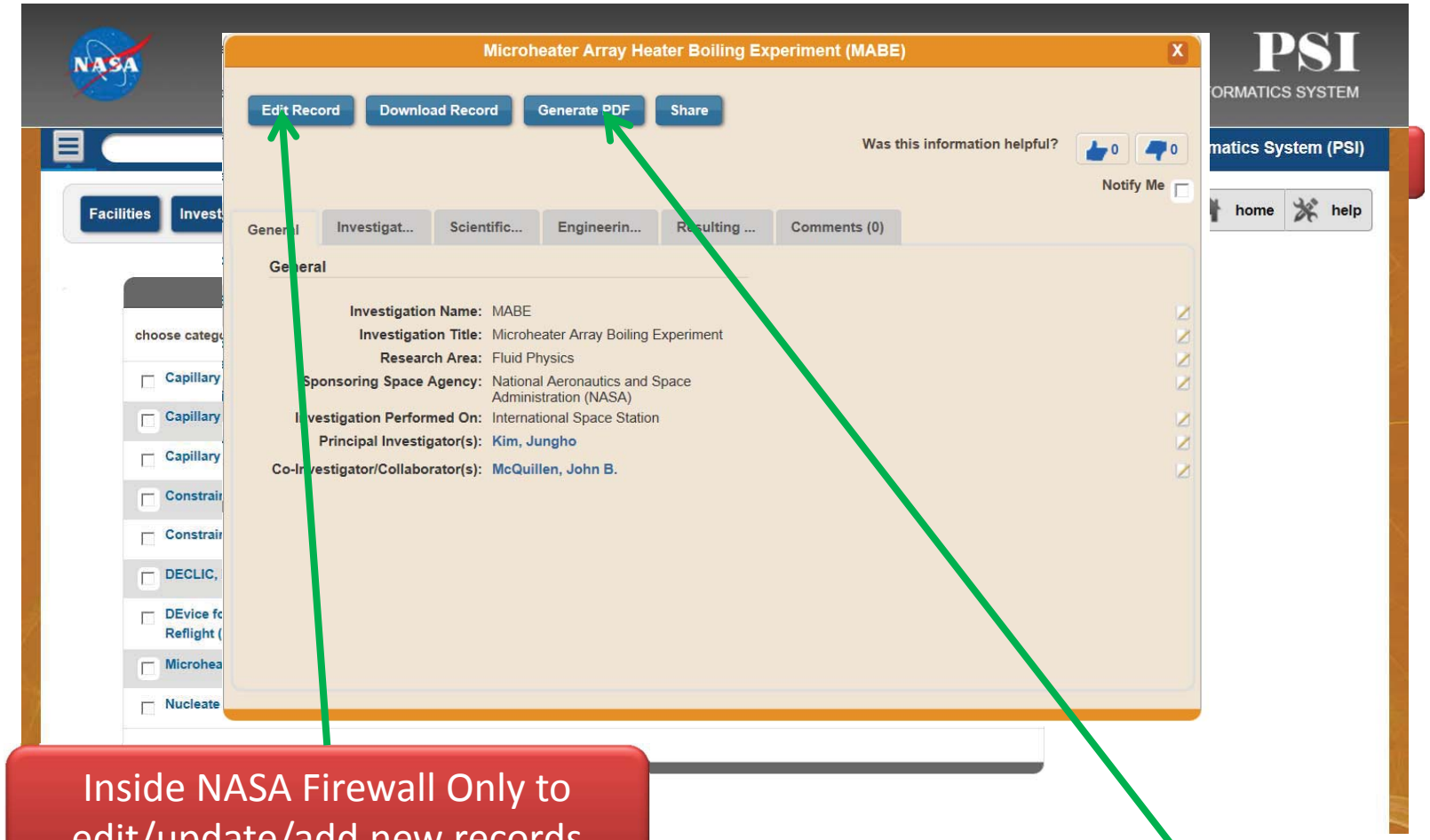


Investigations Page

General Search, searches all records and attached files



Experiment Record

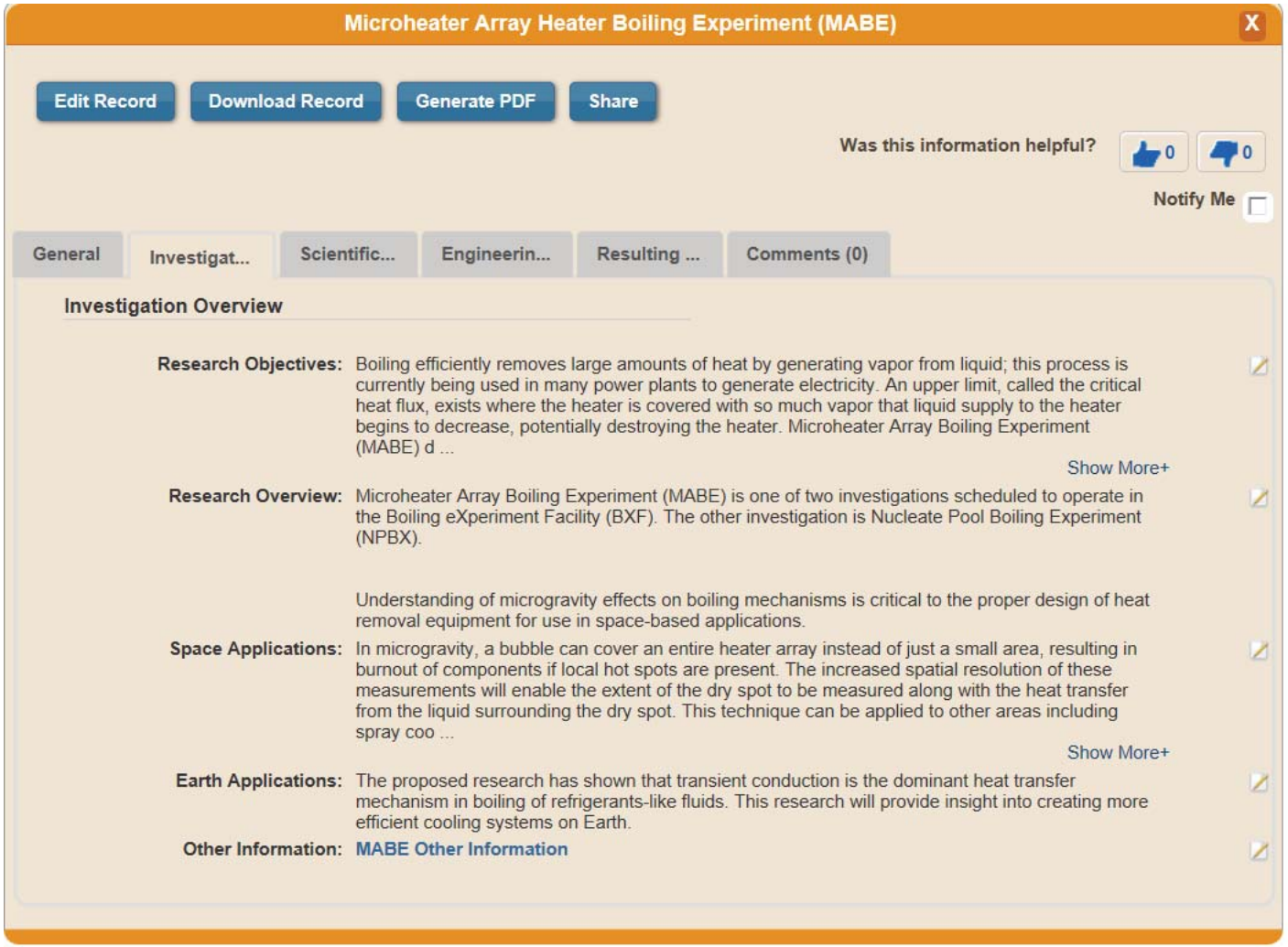


Inside NASA Firewall Only to edit/update/add new records

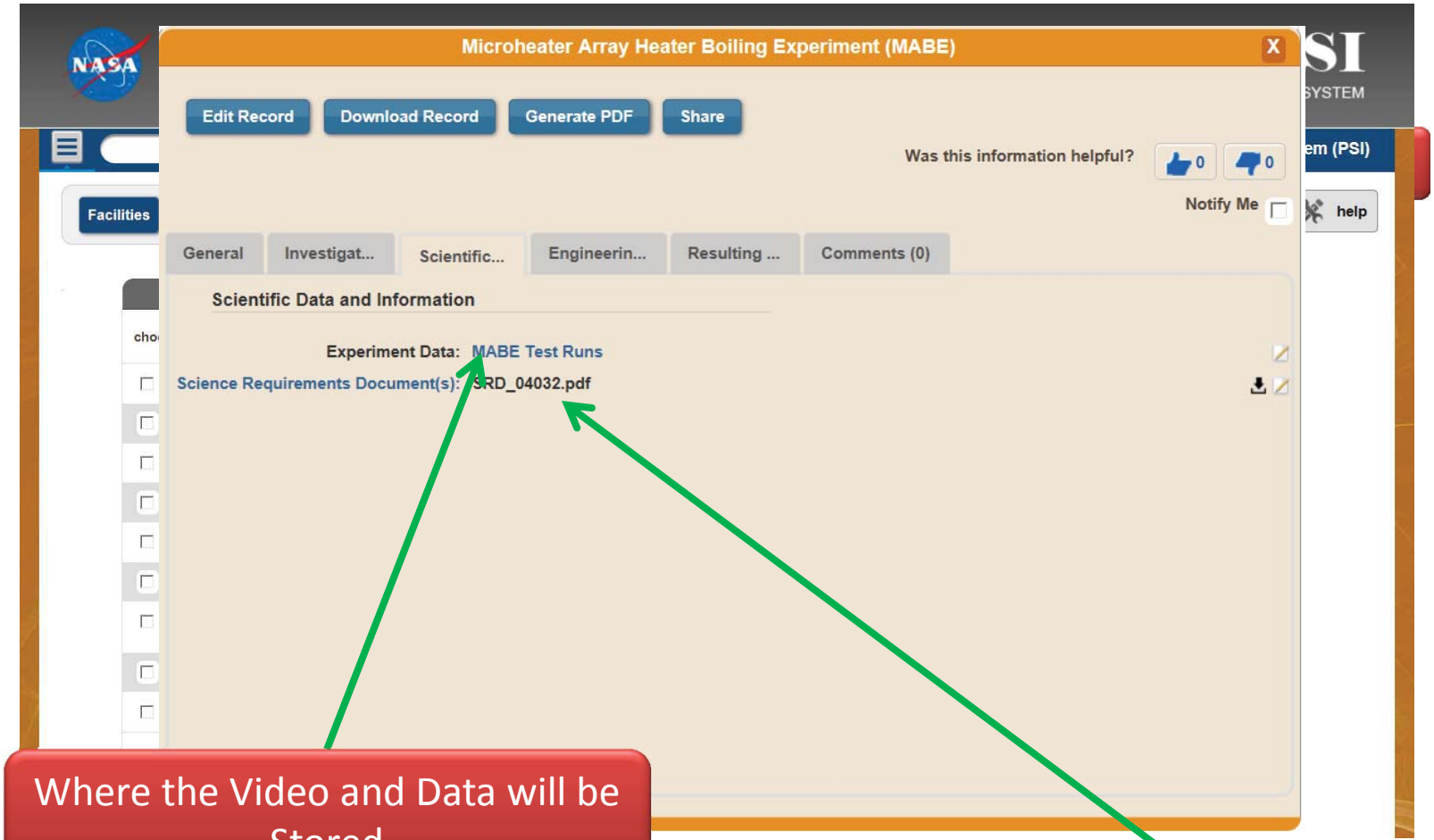
Export reports to excel or PDF

Generate reports to compare data or identify data gaps

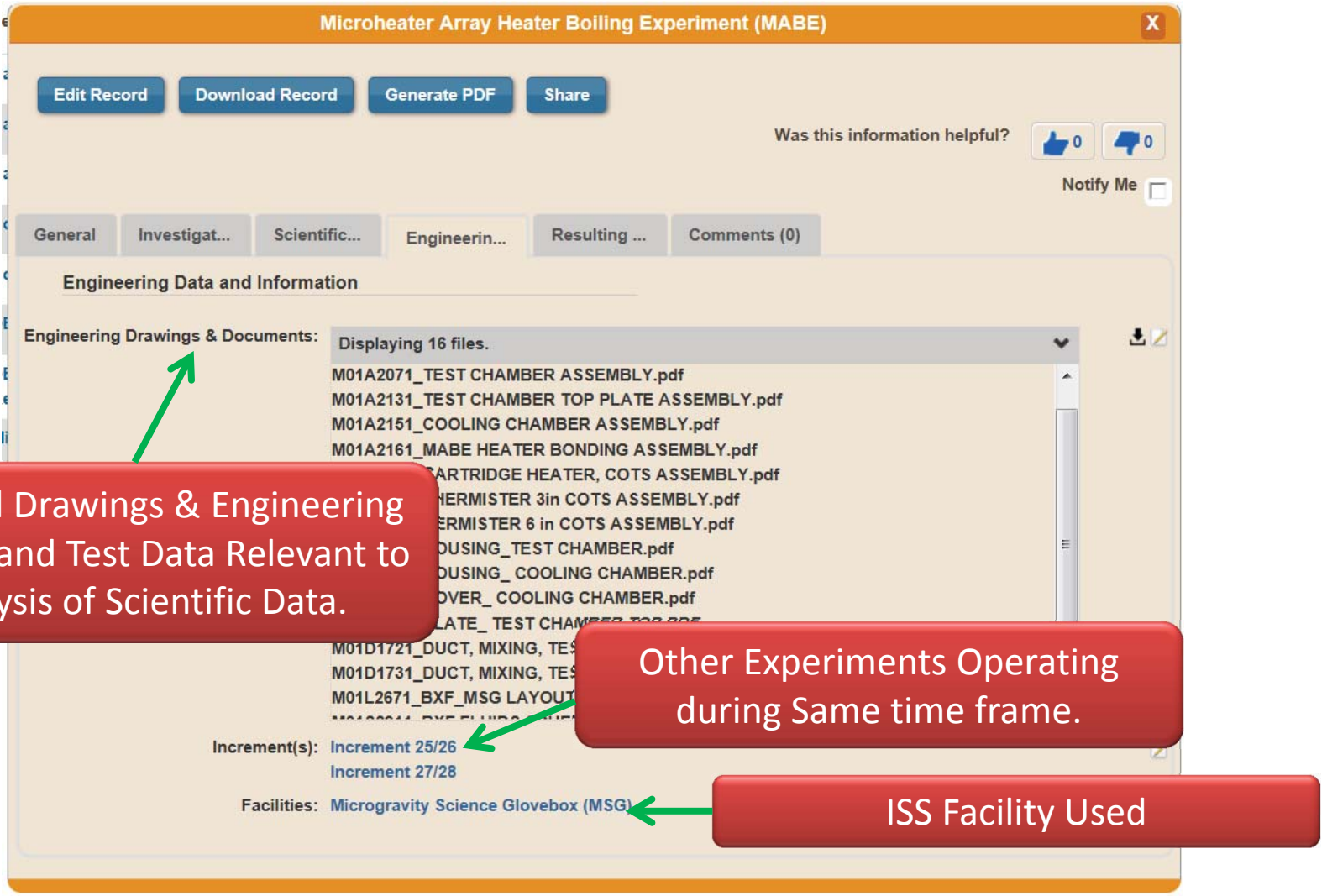
Investigation Overview Tab



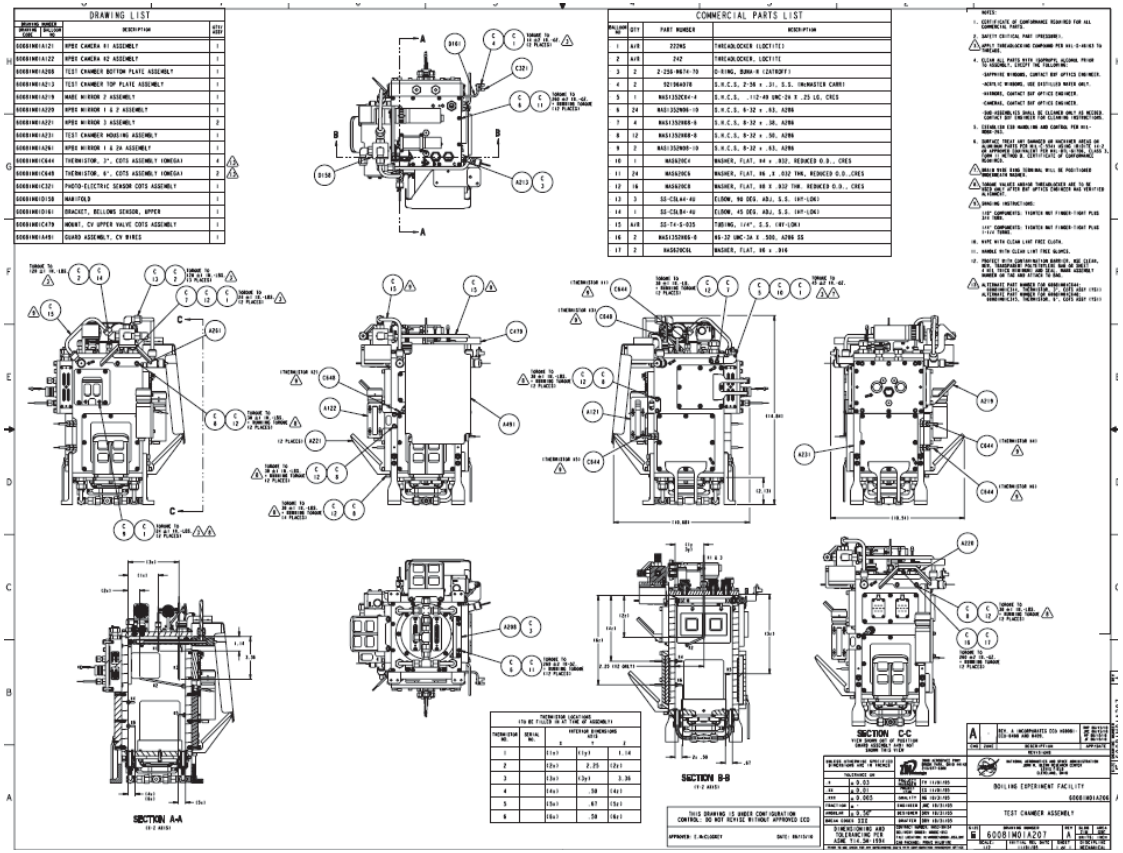
Scientific Data and Information



Engineering Data And Information



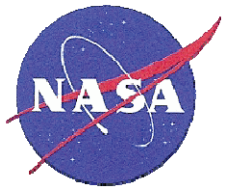
Engineering Data



Note:

- Units are typically in SAE (inches, pounds, etc.)
- BXF had several hundred drawings, analyses, reports, etc.
- Only those files that are needed for interpretation of science data (for example position of sensors) have been entered.
- Other files can be requested.
- Some files will not be entered; for example, drawings related to hardening of high-speed camera because of proprietary nature.

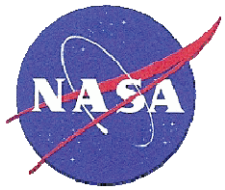
Current Engineering Data Online



Drawing No.	Title	Rationale
60081M01A207	TEST CHAMBER ASSEMBLY	Overall Assembly
60081M01A213	TEST CHAMBER TOP PLATE ASSEMBLY	Position of Pressure Sensor Taps
60081M01A215	COOLING CHAMBER ASSEMBLY	Positioning of Heater Arrays and Backside Cooling
60081M01A216	MABE HEATER BONDING ASSEMBLY	Positioning of Heater Arrays
60081M01C311	CARTRIDGE HEATER, COTS ASSEMBLY	Bulk Fluid Heater
60081M01C314	THERMISTER, 3", COTS ASSEMBLY	Bulk Fluid Temperature Sensor
60081M01C315	THERMISTER, 6", COTS ASSEMBLY	Bulk Fluid Temperature Sensor
60081M01D110	HOUSING, TEST CHAMBER	Test Chamber
60081M01D169	HOUSING, COOLING CHAMBER	Backside Cooling Chamber
60081M01D171	PLATE, TEST CHAMBER TOP	Top of Test Chamber
60081M01D172	DUCT, MIXING, TEST CHAMBER, STRAIGHT	Annular Tube for Bulk Fluid Heater
60081M01D173	DUCT, MIXING, TEST CHAMBER, ANGLE	Annular Tube for Bulk Fluid Heater
60081M01L267	BXF/MSG LAYOUT	All Components
60081M01S291	BXF FLUIDS SCHEMATIC FLIGHT SYSTEM	Fluid System Schematic
	BXF Critical Design Review Charts	

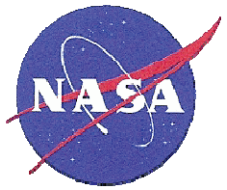
Publications and Other Results

Plans



- PSI Database becomes publicly available during October 2014.
- Limited Data for MABE is on-line.
  - Drawings
  - Reports
  - Links to publications
  - “Raw” Excel Spreadsheets for MABE Test Cases
  - Downlinked Video
- Data to be posted:
  - Processed Local Heat Transfer Coefficient
  - Synchronized Video Data (Side View and Through Array)

Comments, Suggestions



MABE Specific:

- Types of Data to see
- Format of Data

PSI Database

- Presentation Format

Comments, Suggestions

- Who to contact:
  - MABE: John.B.McQuillen@nasa.gov
  - Informatics Science: Robert.D.Green@nasa.gov
  - Database: Ben.Henrie@nasa.gov