



National Aeronautics and
Space Administration
John H. Glenn Research Center

Combustion and Reacting Systems for Exploration

Workshop on

Strategic Research to Enable NASA's Exploration Missions

*June 22 - 23, 2004
Marriott Downtown at Key Center
Cleveland, Ohio USA*



National Aeronautics and
Space Administration
John H. Glenn Research Center

Strategic Research to Enable NASA's Exploration Missions

June 22 - 23, 2004

Combustion and Reacting Systems in Reduced Gravity *Cleveland, OH*

The President has redirected NASA's mission to be exploration-based instead of our traditional science / earth application



The President's Vision



1. Return the Shuttle to safe flight as soon as practical, based on CAIB recommendations
2. Use Shuttle to complete ISS assembly
3. Retire the Shuttle after assembly complete (2010 target)
4. **Focus ISS research to support exploration goals; understanding space environment and countermeasures**
5. Meet foreign commitments
6. Undertake lunar exploration to support sustained human and robotic exploration of Mars and beyond
7. Series of robotic missions to Moon by 2008 to prepare for human exploration
8. Expedition to lunar surface as early as 2015 but no later than 2020
9. **Use lunar activities to further science, and test approaches (including lunar resources) for exploration to Mars & beyond**
10. Conduct robotic exploration of Mars to prepare for future expedition
11. Conduct robotic exploration across solar system to search for life, understand history of universe, search for resources
12. Conduct advanced telescope searches for habitable environments around other stars
13. **Demonstrate power, propulsion, life support capabilities for long duration, more distant human and robotic missions**
14. Conduct human expeditions to Mars after acquiring adequate knowledge and capability demonstrations
15. Develop a new Crew Exploration Vehicle; flight test before end of decade; human exploration capability by 2014
16. Separate cargo from crew as soon as practical to support ISS; acquire crew transport to ISS after Shuttle retirement
17. Pursue international participation
18. Pursue commercial opportunity for transportation and other services



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Combustion and Reacting Systems in Reduced Gravity

Where does combustion fit in?

--in a variety of reacting systems

1. Spacecraft Fire Prevention, Detection, and Suppression

2. Advanced Life Support

Air/water revitalization (Sabatier, Bosch), Waste management (Incineration)

3. In Situ Resource Utilization (ISRU)

Fuel / consumables from regolith / atmosphere

4. Extra vehicular Activity

Air revitalization, Power systems (MEMS scale combustors)

5. In-situ Fabrication and Repair

SHS

Of these we have the lead responsibility in Fire Safety



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Funding

How will funding work?



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Funding

How will funding work?

I wish I knew

Anticipate a mixture of curiosity driven research (old NRA model) and directed research to meet roadmap goals

NRA research will focus on research supporting exploration

Directed research will be product driven and aligned with roadmaps and schedules – expect a mixture in intramural and extramural research, funding process will likely involve multiple mechanisms



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Fire Safety Research Plan Development

We have long argued relevance to SFPDS

We have now been told to deliver a product (fish or cut bait)

We are constrained by the availability of upmass and test facilities, we need to be resourceful in our approach

Experiments must be carefully developed to make efficient use of flight opportunities **and meet schedule milestones**

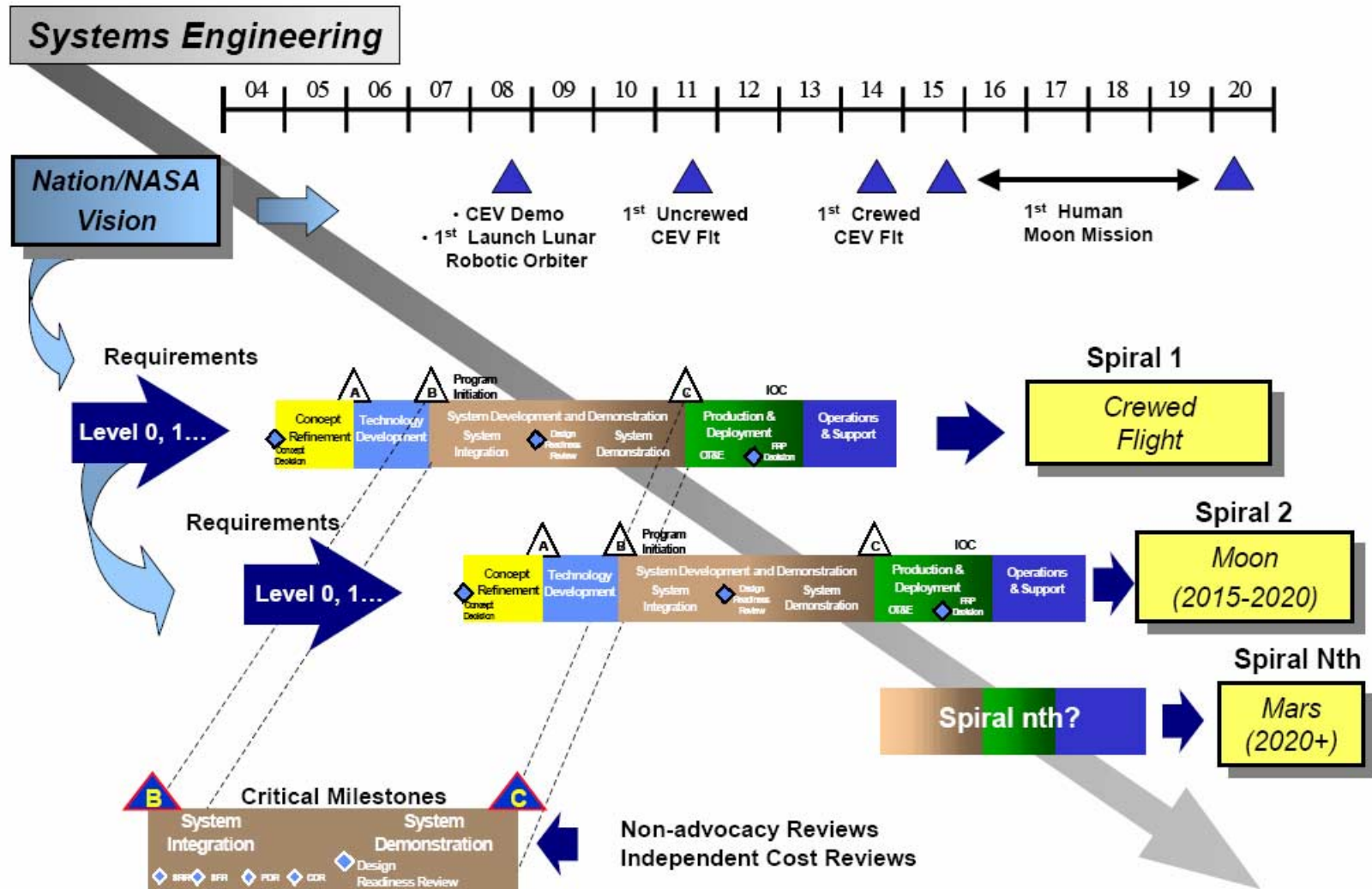
To be efficient, we need to start with a clean plate but we don't want to throw out good, relevant, work unnecessarily

At this point decisions have not been made, **no one is "in" or "out"**

Such decisions will be made based upon an integrated plan



Project Constellation (Crew Exploration Vehicle)





Major Milestones



- **2008: Initial flight test of CEV**
- **2008: Launch first lunar robotic orbiter**
- **2009-2010: Robotic mission to lunar surface**
- **2011 First Unmanned CEV flight**
- **2014: First crewed CEV flight**
- **2012-2015: Jupiter Icy Moon Orbiter (JIMO)/Prometheus**
- **2015-2020: First human mission to the Moon**

Based on POP Assembly Sequence (RTF March 2005)
and BPPE POP 2004 Guidelines 3/15/04

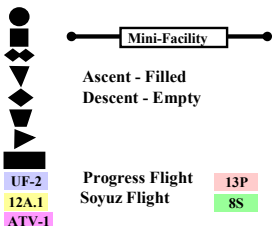
GRC/BPRPO ISS Utilization Traffic Model

	2004												2005												2006												2007													
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D		
Increment	8				9	9				10	10		10	10	11	11				11	12		12		12	13	13				13	13		14	14		14	14	15	15				15	15	16	16			
Russian Flt.	13P			8S	14P	15P			9S	16P			17P	10S						11S							12S							13S						14S							15S			
ATV Flight															ATV-1																		ATV-2															ATV-3		
ISS Flight															LF-1	ULF-1.1				12A		12A.1	13A	13A.1	15A 10A					ULF-2	1E			UF-3	IJ/A		1J	3R	UF-5											
Facilities													HRF-2	MELFI																CIR	FSL	FIR	HHR-2																BTF	
Combustion Integrated Rack Payloads																																																		
Fluids Integrated Rack Payloads																																																		
ExPRESS Rack or Stand-Alone or FSL Payloads																																																		
Microgravity Science Glovebox Payloads																																																		
Non-GRC Payloads																																																		
Acceleration Measurement Payloads																																																		

TO BE MANIFESTED

DAFT-1	CFE - CL1
DAFT-2	CFE - ICF
DAFT-3	CFE - VG
DAFT-4	InSPACE-2
BCAT-3 Batteries	

Legend:
 CIR
 FIR
 MSG-G1
 MSG-P1
 ER
 MSRR
 FSL
 Stand-Alone
 MPLM Flight
 Spacehab Flight
 ATV Flight



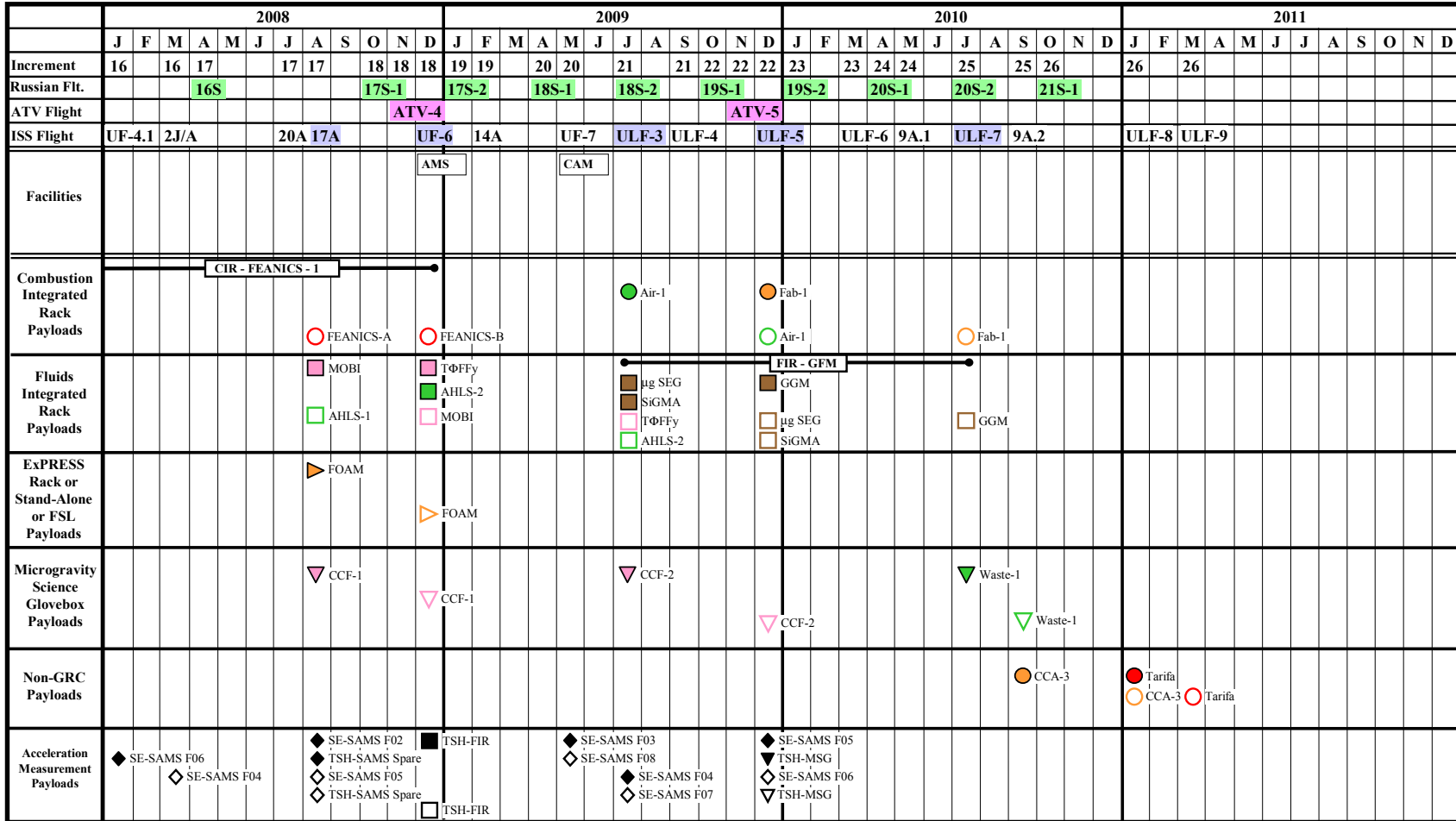
Acronyms:
 CIR - Combustion Integrated Rack
 FIR - Fluids Integrated Rack
 MSG - Microgravity Science Glovebox
 ER - ExPRESS Rack
 MSRR - Materials Science Research Rack
 FSL - Fluids Science Laboratory
 FEANICS - Flow Enclosure Accommodating Novel Investigations in Combustion of Solids
 BXF - Boiling Experiment Facility
 LMM - Light Microscopy Module
 GFM - Granular Flow Module
 CCA - Commercial CIR Apparatus
 HRF - Human Research Facility
 MELFI - Minus Eighty Laboratory Freezer
 EMCS - European Modular Cultivation System
 WORF - Window Observational Rack Facility
 SpaceDRUMS - Space Dynamically Responding Ultrasound Matrix System
 HHR - Holding Habitat Rack
 MARES - Muscle Atrophy Research and Exercise System
 LSG - Life Sciences Glovebox
 BTF - Biotechnology Facility
 Cryo Freezer - Cryogenic Freezer
 RFR - Refrigerator Freezer
 AMS - Alpha Magnetic Spectrometer
 CAM - Centrifuge Accommodations Module

Advanced Life Support Systems	Low Gravity & Exploration Research
Fire Prevention, Detection, & Suppression	In-Situ Fabrication & Repair
Advanced Environmental Monitoring & Control	In-Situ Resource Utilization
Advanced Extra Vehicular Activity	Fundamental Science

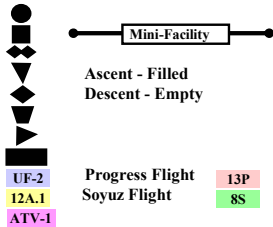
Notes:
 1) InSPACE will conduct additional operations during Increment 9
 2) SAMS has a Thinkpad and hard drives going up on ULF-1
 3) PCS has data disks returning on 13A.1, 15A, and ULF-2
 4) CSLM-2 has 4 SC/SPUs each going up on 12A, 12A.1, and 13A.1 and hardware returning on ULF-2

Based on POP Assembly Sequence (RTF March 2005)
and BPPE POP 2004 Guidelines 3/15/04

GRC/BPRPO ISS Utilization Traffic Model



- Legend:**
 CIR
 FIR
 MSG-GI
 MSG-P1
 ER
 MSRR
 FSL
 Stand-Alone
 MPLM Flight
 Spacehab Flight
 ATV Flight



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Notes:



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Fire Safety Research Plan Development

We are building a new-comprehensive plan for SFPDS and need to vet it with the community

At this point we have draft end products and associated questions / objectives.

Approach will be a combination of ground-based testing, modeling and flight validation, we expect integrated teams to address the issues

We need your input on the validity and completeness of the questions and the associated approaches to address them.