AIM Mission Perspectives on Staying Within the Box

Presented at

The PI-Team Masters Forum - 4

By

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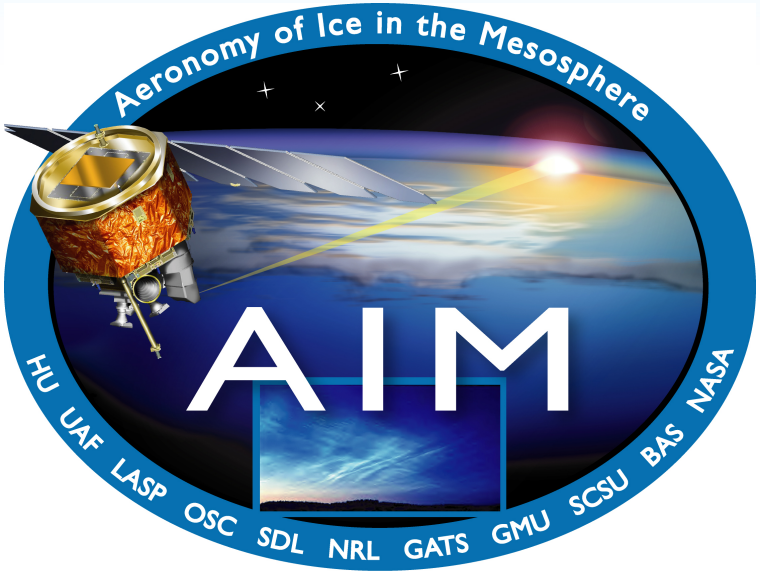
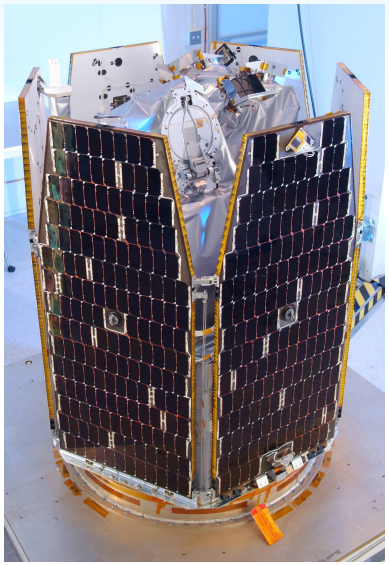
Aeronomy of Ice in the Mesosphere (AIM)

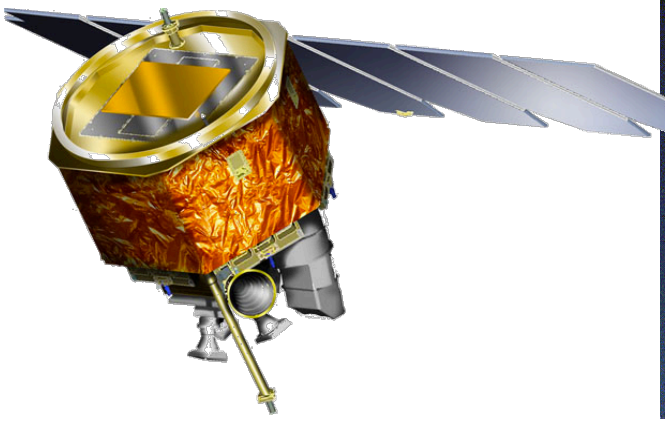
- **Three instruments**
  - **Solar Occultation (SOFIE)**
  - **Panoramic UV nadir imaging (CIPS)**
  - **In-situ dust detection (CDE)**

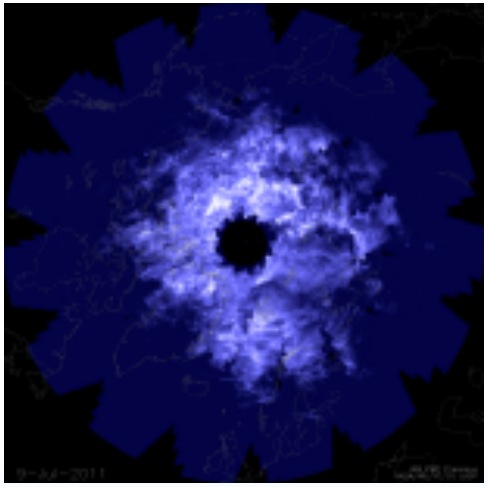


Why do noctilucent clouds form and vary?

AIM was launched from VAFB by a Pegasus XL rocket







NH cloud on July 8, 2011

- Launched April 25, 2007 at 1:26:03 PDT
- Near perfect 600 km orbit
- Observatory is working well; excellent data being returned
- Significant new insights about NLCs
- Operations approved through 2014

Staying within the Box

Experiences during the AIM development

Sometimes, the box can become quite small and require drastic steps

AIM Selection Debrief August 20, 2002

- Serious skepticism about cost and schedule
- Will not confirm unless mission is within cost cap
- Inadequate funded schedule reserve
- Other Concerns
  - Low mass margin
  - SOFIE instrument immaturity
  - RS300 spacecraft immaturity
- The TMC panel noted that there is room to descope

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AIM team reaction to the SOMA TMC August 2002 debrief

- The briefing caused us to think introspectively
- We started challenging our baseline design
- Ways to reduce mass and power were sought
- Pondered decisions that would reduce cost but maintain science
- Considered use of existing spacecraft and other spacecraft approaches
- Alternative ways to get to orbit were studied

These studies resulted in a series of actions including some that were drastic. All actions saved resources.

"I find that the harder I work,
the more luck I seem to have."

Thomas Jefferson

Timeline of major AIM actions taken after the August 2002 debrief

CSR	Change	Action Date (2003)	Risk Reduction
SOFIE mass 50kg	Streamlined design, better science; - 12 kg	March 15	Mass
First build spacecraft	5th generation spacecraft	June 3	Cost, mass
Four science instruments	SHIMMER removed, science impact	June 6	Cost, mass, data volume
IPA	Removed	June 15	Cost, mass
New LV contract	Use existing contract	June 19	Cost
CDE new development	Use New Horizons SDC copy	July 25	Cost, schedule
Six CIPS cameras	Four cameras, small science impact	August 1	Cost, mass, data volume

after August 2002 debrief and before confirmation

CSR	Change	Action Date	Risk Reduction
Use Pegasus HAPS to trim orbit	Remove HAPS	Feb 2004	Cost
Total overall estimated resource savings		$ 10.7 M 61 kg	-----

AIM actions after the August 2002 debrief to get within and stay within the box

- Actively pursued alternate spacecraft bus starting in October 2002
- Pursued Minotaur launch vehicle from Nov 2002 to June 2003; potentially significant cost savings
- Replaced SOFIE steering mirror with a rigid mirror in 2006
- Replaced baseline gyros with more expensive but more reliable and more capable units in Oct 2003

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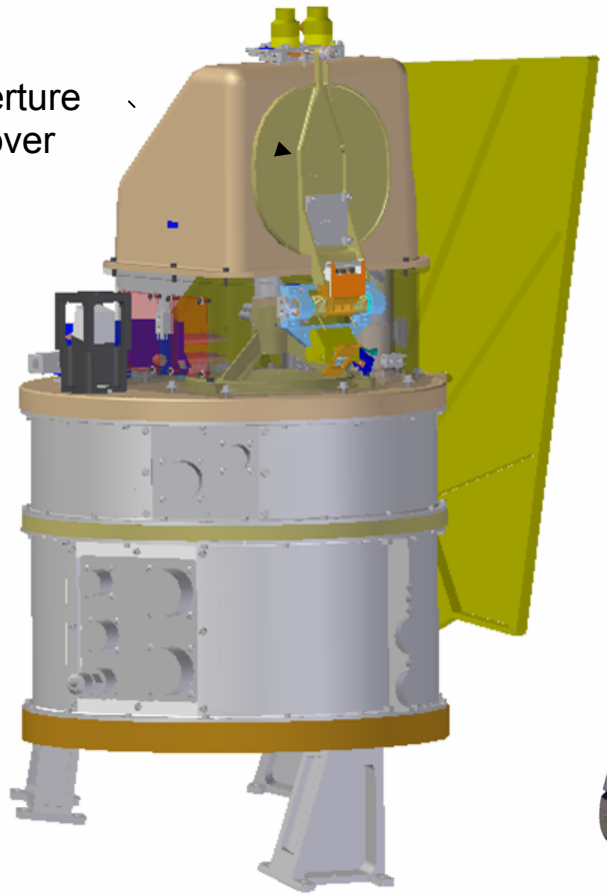
AIM S/C event history (Aug 2002 to June 2003)

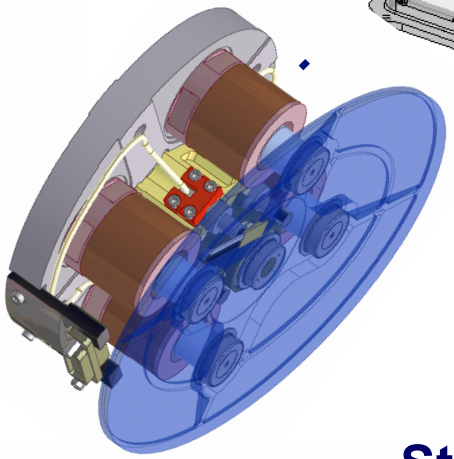
- PI requested Ball VP to conduct a detailed RS300 bus cost review in Sept., 2002. Other cost reviews occurred later in the development.
- Started investigating other spacecraft options in late Oct. 2002 and continued to work with Ball to seek resolution
- In May 2003, AIM funded OSC to do a detailed feasibility study for flying AIM alone on the VCL bus or a LEOStar bus with positive results
- Worked with NASA HQ from late Oct., 2002 until March 2003 trying to secure the VCL bus
- Code Y would not commit to providing VCL bus to AIM mission
- RS300 cost review May 23, 2003
- RFP briefing from Orbital for a "SORCE like" spacecraft in June 2003

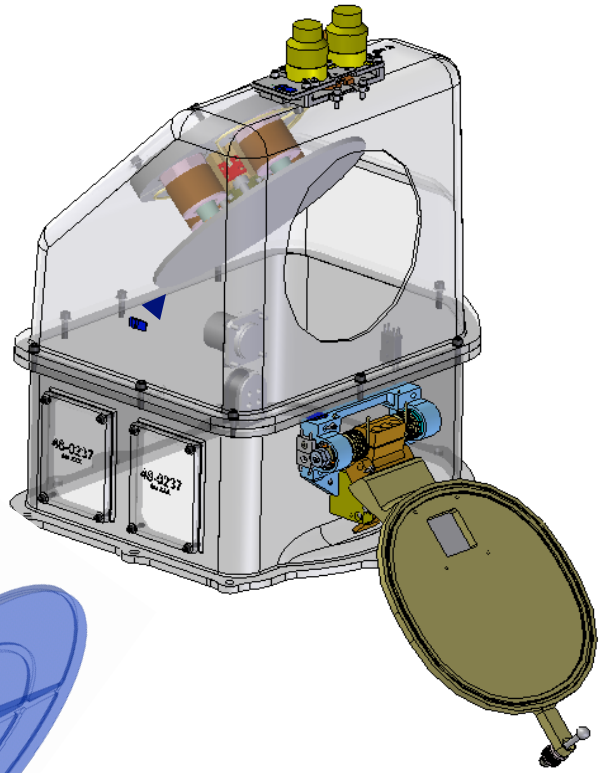
Changed spacecraft vendor in June 2003

- **Significant Risk Reduction: Medium to high risk missions unlikely to be confirmed – use heritage hardware where possible.**

SOFIE instrument showing the Steering Mirror Assembly







Steering Mirror Assembly

An alternative to the SMA was in place as a backup approach

- Concern existed about the SMA actuator bonds to the back side of the mirror surface
- A "ghost" SMA was built by the vendor to allow more in-depth evaluation of the strength of the bond
- A rigid mirror backup approach with the spacecraft doing the SOFIE pointing was evaluated
- A rigid mirror was purchased, integrated and tested early in the SOFIE development in anticipation of problems
- Detailed science analyses were conducted and a rigid mirror approach was considered acceptable although not ideal

SOFIE Steering Mirror Assembly position sensor broke during observatory vibration

Four Options

- Repair the flight Steering Mirror Assembly (SMA)
- Replace the flight SMA with a redesigned system
- Implement a caging mechanism for the SMA
- Replace the SMA with a Rigid Mirror Mount and rely on the spacecraft for pointing

At this point in time the scheduled Nov 2006 launch was 5 months away – not possible to make it

Launch actually occurred only 10 months after this anomaly!

Replaced SOFIE steering mirror with a rigid mirror in July 2006

- Always be prepared with a carefully considered backup or descope plan in the event of unforeseen major issues

AIM key factors for staying within the box

- Recognize the wisdom and advice of the TMC panel
- Place high importance on cost as well as science
- Have a very thorough knowledge of requirements and hold them sacrosanct
- Anticipate problems before they occur
- Plan backup approaches and work arounds
- Make timely decisions
- Never lose sight of the mission science goal