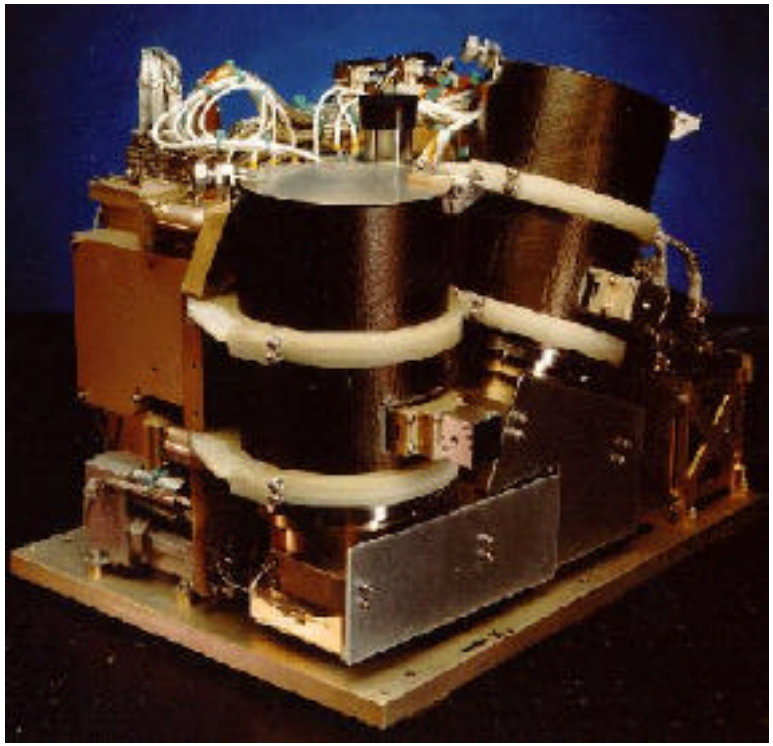
Potential Canadian Contributions to the NGST NIRCAM Instrument

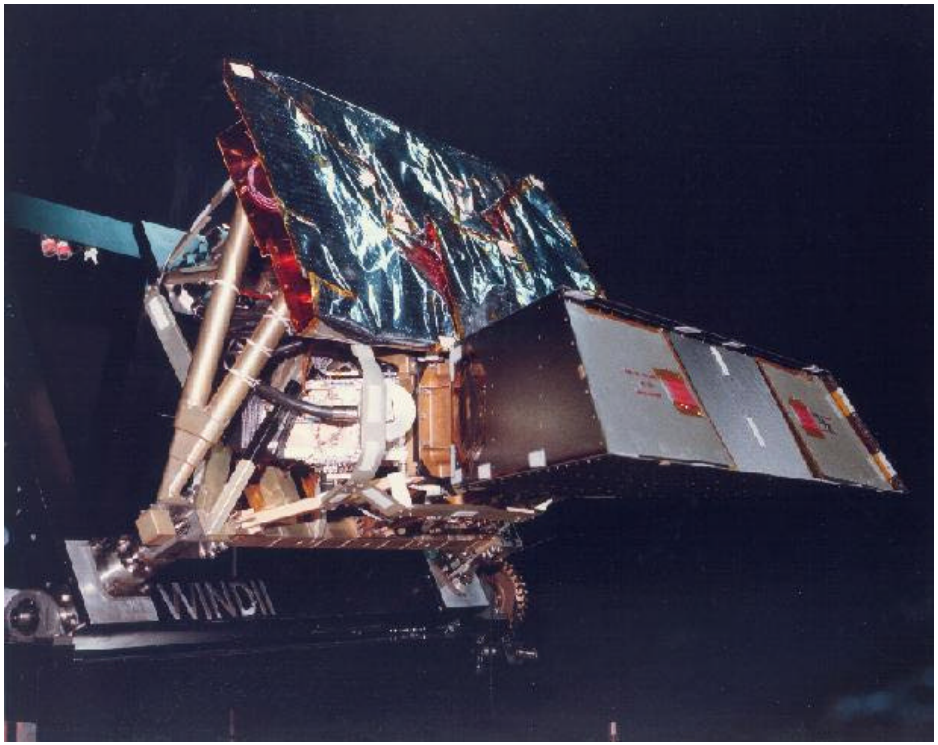
1) Heritage, Example Instruments & Capabilities
2) Possible NIRCAM Contributions

Canadian Space Agency Agence spatiale canadienne

Example: CSA Space Science Instruments



- UV Auroral Imagers
  - Viking: 1986, Freja: 1992, UVAI: 1996, IMAGE: 2000
  - Wide-angle imager, cooled CCD's



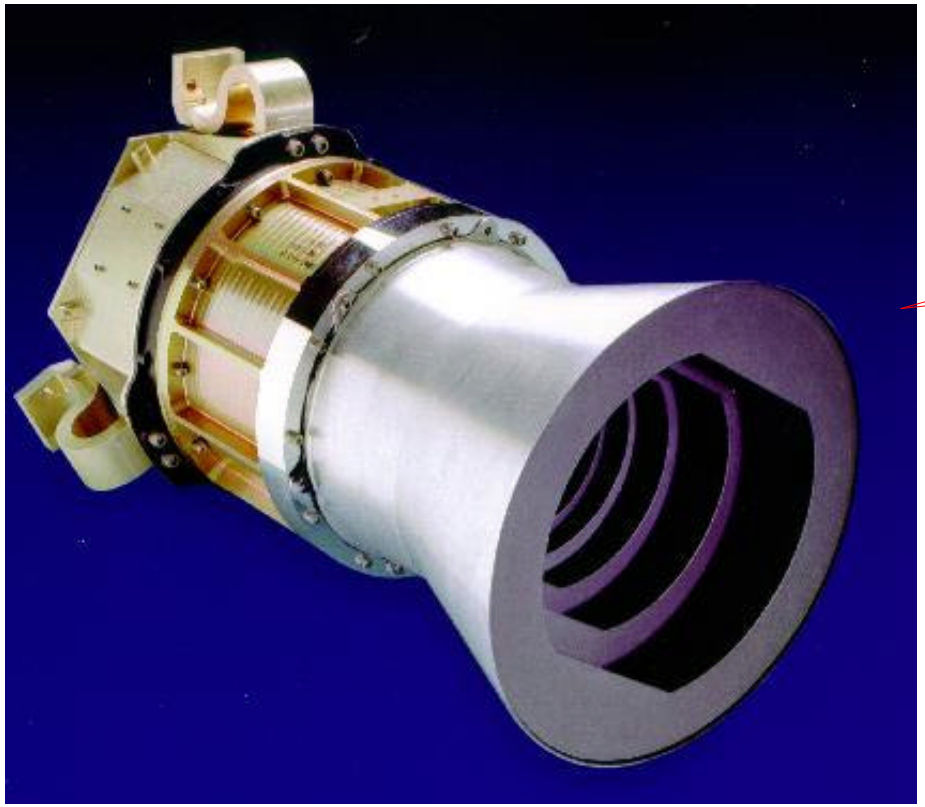
- WINDII, UARS 1991
  - Wind Imaging Interferometer
  - Thermo-electrically cooled CCD
  - Still operational

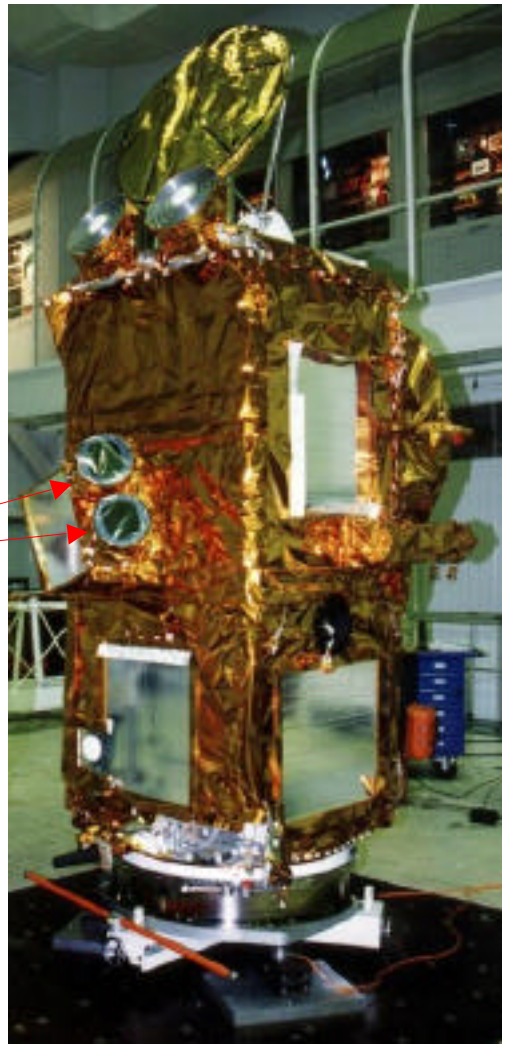
Canadian Aerospace Industry Capability Example: CALTRAC® – Star Tracker

- Characteristics:
  - Autonomous attitude determination (quaternion)
  - high motion rate (<12 º/s)
  - moderate accuracy applications (18'' NEA).
- Fully flight qualified as of December 2000, including flight software.
- Six delivered: Alcatel (2), Astrium (2), Lockheed Martin (2)
- Five currently in or starting production: CSA (1), Alenia (2), Alcatel (2).
- Developed by EMS Technologies with support from CSA
- Heritage from EMS's experience on CSA Space Science projects
  - Optics from Viking/UVAI/Freja
  - Controller from TPA (on Japan's Nozomi mission to Mars)
  - CCD readout and centroiding algorithms (patented) from an Acquisition and Tracking Sensor developed for ESA's OISL programs
  - Star recognition algorithm implemented during CCD readout: Starpoint (patented)

Canadian Aerospace Industry Capability Example: CALTRAC® – Star Tracker

- Engineering Model flown in 2000 on STS-101 and STS-106
- Near Term launches: Genesis (July 30th), JASON (August 10th, shown at right)





Canadian Aerospace Industry Capability Example: FUSE Fine Error Sensor

- FOV 19 x 19 arcminutes
- Detector:
  - CCD; modified SITe SIA003A, 1024x1024 backside-illuminated
  - Masked to 512x512
  - 2-stage thermo-electric cooler, operating at -30C
- Pixel Size 24 microns
- Plate Scale 2.55 arcsec/pixel
- NEA (typical) < 0.15 arcsec
- PSF 5 arcsec FWHM
- Exposure Time 0.048 - 300 sec
- Subimage Size 3 - 25 pixels square
- Centroid Rate
  - six 10x10 subimages @ 1 Hz, exposure time = 0.4 sec
  - four 16x16 subimages @ 1 Hz, exposure time = 0.4 sec
  - six 16x16 subimages @ 0.5 Hz, exposure time = 1.2 sec
- Real-time processing:
  - dark current subtraction, bad pixel masking, cosmic ray removal, thresholding

Complete Space Instrument Development Capabilities

- Systems Design
  - Requirements flowdown; performance modeling; interface control
- Optical Design
  - Raytrace / performance modeling (ZEMAX-EE)
  - Stray light analysis (TRACEPRO)
- Mechanical Design
  - Structural design & analyses (NASTRAN FEM)
  - Thermal design & analyses (TMG)
- Electrical / Electronics Design
  - Analog design (Readout electronics)
  - Digital Design (Controllers, FPGA's, VHDL tools)
  - Power Supply design (EMC analysis and test)
- Software Design
  - Flight software standards
- Environmental Test Facilities
  - CSA's David Florida Laboratories: Vibration, Shock, TVAC, EMC etc. testing
- Product Assurance
  - EEE Parts
  - Materials & Processes Engineering & Control
  - Quality Control: inspections / traceability / CCA assembly to NASA standards

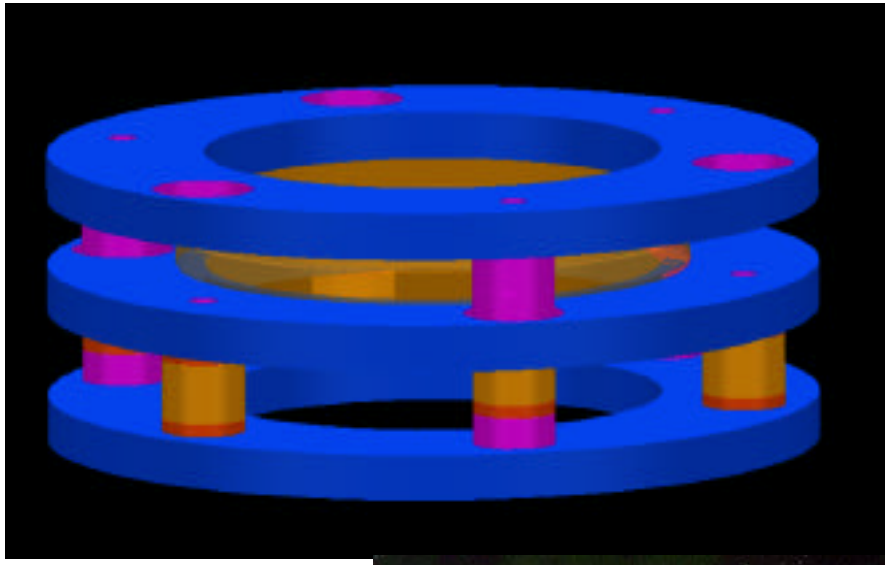
Potential CSA NIRCAM Contributions

Potential Canadian NIRCAM Contributions

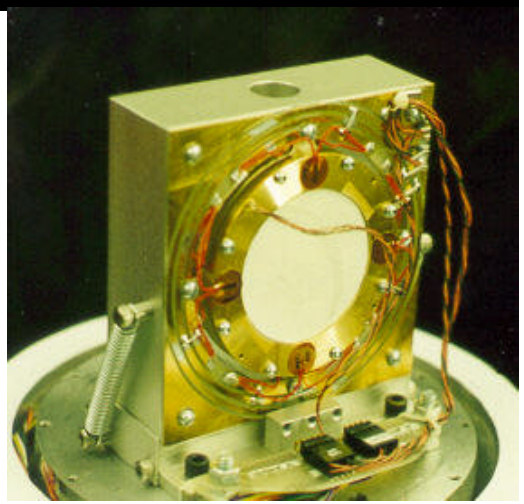
- Tunable Fabry-Perot Etalons
  - Low-voltage piezo actuators
  - With or without displacement sensor feedback control
  - Wide field of view (for R ~ 500 and above).
- Filter Wheel
  - motors, bearings, thermal control, encoders, drive electronics
  - Interference and fixed etalon filters
- Focusing Mechanisms
  - Piezo-electric steppers
  - Voice-coil / flexure systems
- Optics
  - Ni-plated aluminum or beryllium alloy diamond turned mirrors
  - Refractive or reflective optical components for wavefront sensing
- Structures
  - aluminum or beryllium alloys
- Calibration Sources
  - diffusers, blackbodies, LED's, spectral lamps
- Others

Example: Tunable Fabry-Perot Etalon

- Unique wide angle tunable narrow-band filter under development for a 9 µm wind imaging interferometer
- Low-Voltage Piezo-electric actuators
- < 150K operation
- Temperature compensated gap
- Robust design
- Solid germanium etalons to minimize spectral shift with incident angle
- Positional feedback via capacitive displacement sensors: developed and used on the Canadarm2 on the International Space Station

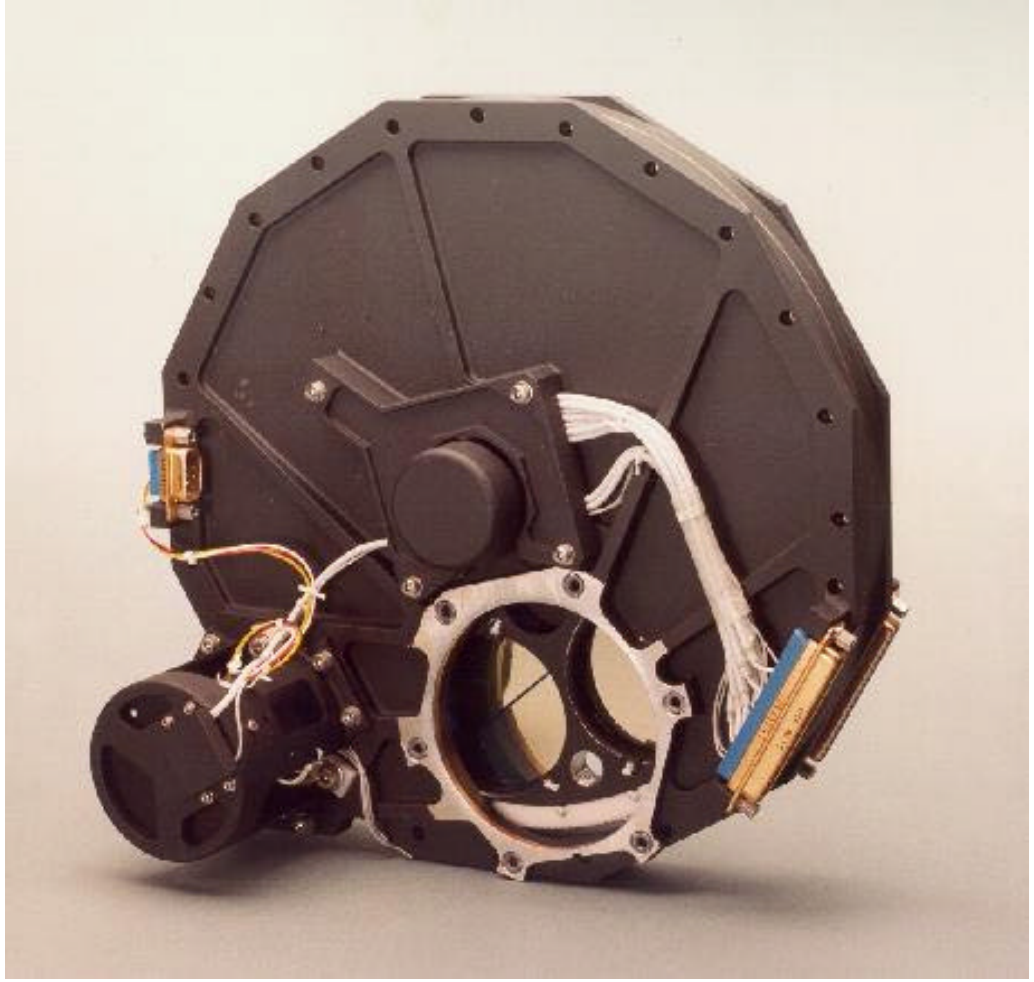


Inset: A Prototype solid germaninum etalon undergoing cryogenic testing



Example: WINDII Filter Wheel

- 8 position: interference filters & fixed Fabry-Perot etalons
- Temperature controlled
- 10 years of continuous on-orbit operation
- 1 million actuations in ground lifetime testing
- More than 1 million on-orbit actuations



Canadian Space Agency Agence spatiale canadienne