Instrumentation Projects in Canada

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NRC Astronomy Technology: Our Mission

Astronomy Technology at NRC Herzberg is

- a science driven effort
- that develops and delivers innovative technology, instrumentation, and observatory facilities
- in support of the NRC mandate to operate and administer astronomical observatories on behalf of the Government of Canada

Astronomy Technology creates value for Canadian astronomers by providing innovative astronomy technology, instrumentation, and observatory facilities for them to access for scientific research

NRC Astronomy Technology: Our Resources

- Critical mass of human, infrastructure, and financial resources:
    - 2 sites - Victoria and Penticton, with well established special purpose laboratories
    - ~60 staff - engineers, scientists, technicians, and support staff – matrix organization
- Stable budget baseline, plus project funding
- Healthy collaborative framework, domestic and international, institutional and industry

Advanced Technologies for Astronomy

- Spectrographs
- Adaptive Optics and Wavefront Sensors
- Digital Signal Processing
- Composite Material Dish Antennae
- Real-Time Computing
- Cryogenic Receivers
- Control Software
- Plus many others …

Canada France Hawaii Telescope (CFHT)

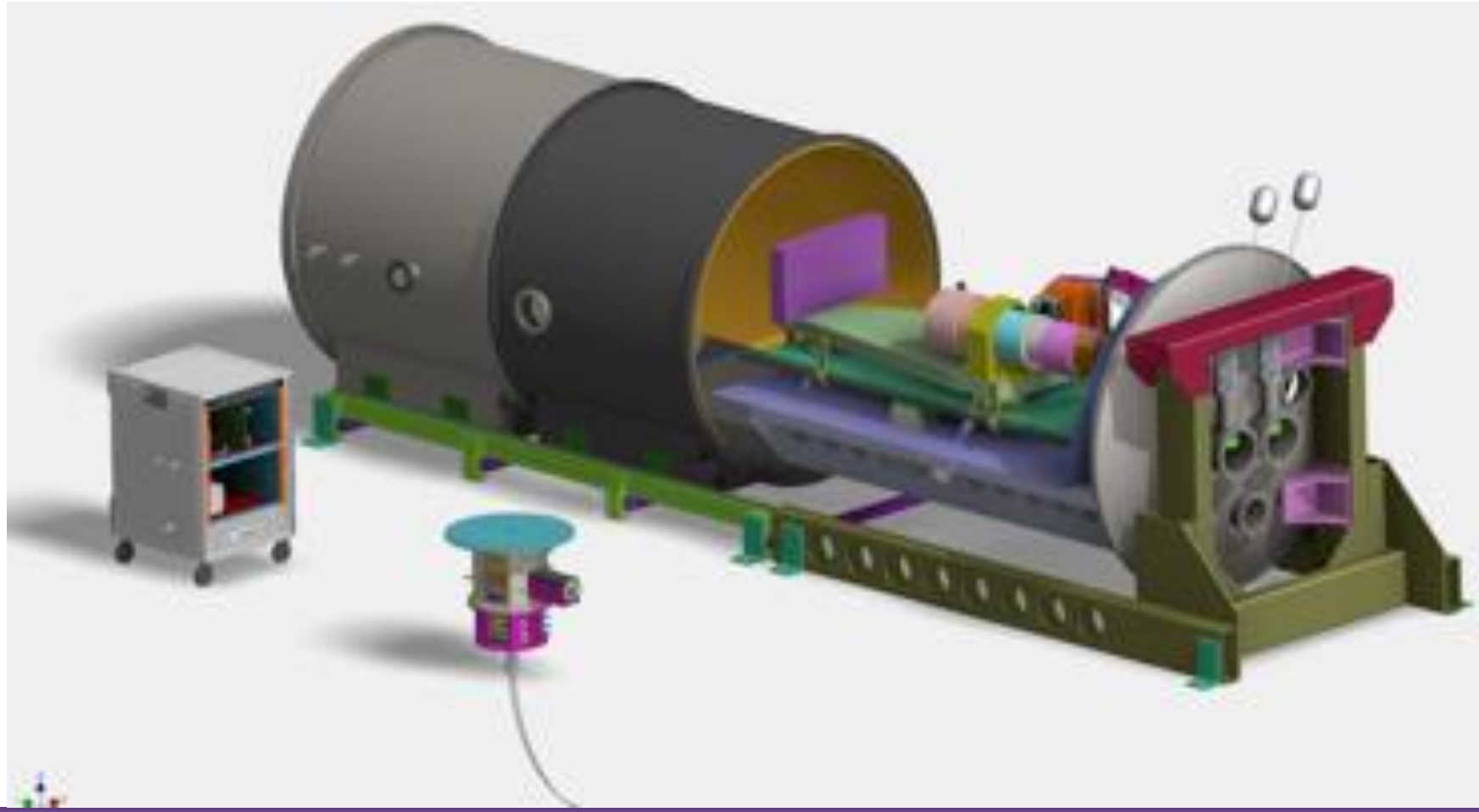
- 3.6 meter optical/IR telescope
- 1979, Mauna Kea, Hawaii
- Canada, France, Hawaii + new partners

Current projects

- SPIRou hires IR spectropolarimeter
- NIRPS hires IR spectrograph
- MSE studies

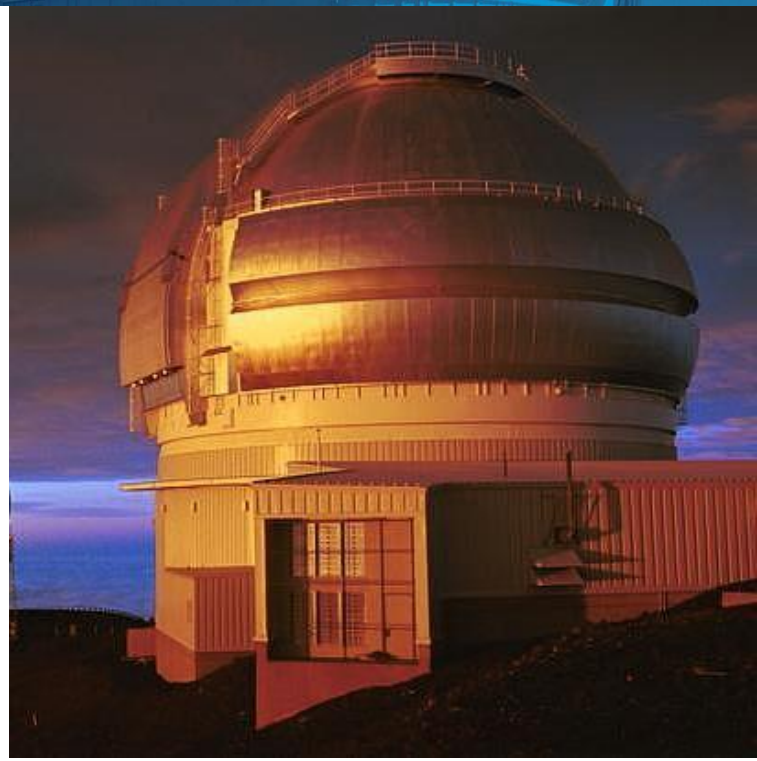
SPIRou Infrared High Resolution Spectropolarimeter

PIs: Rene Doyon, U Montreal, Jean Francois Donati, IRAP Toulouse



Gemini Observatories

- Twin 8 meter optical/IR telescopes
- 2000, Mauna Kea, Hawaii
- 2001, Cerro Pachon, Chile
- US, Canada, Chile, Brazil, Argentina

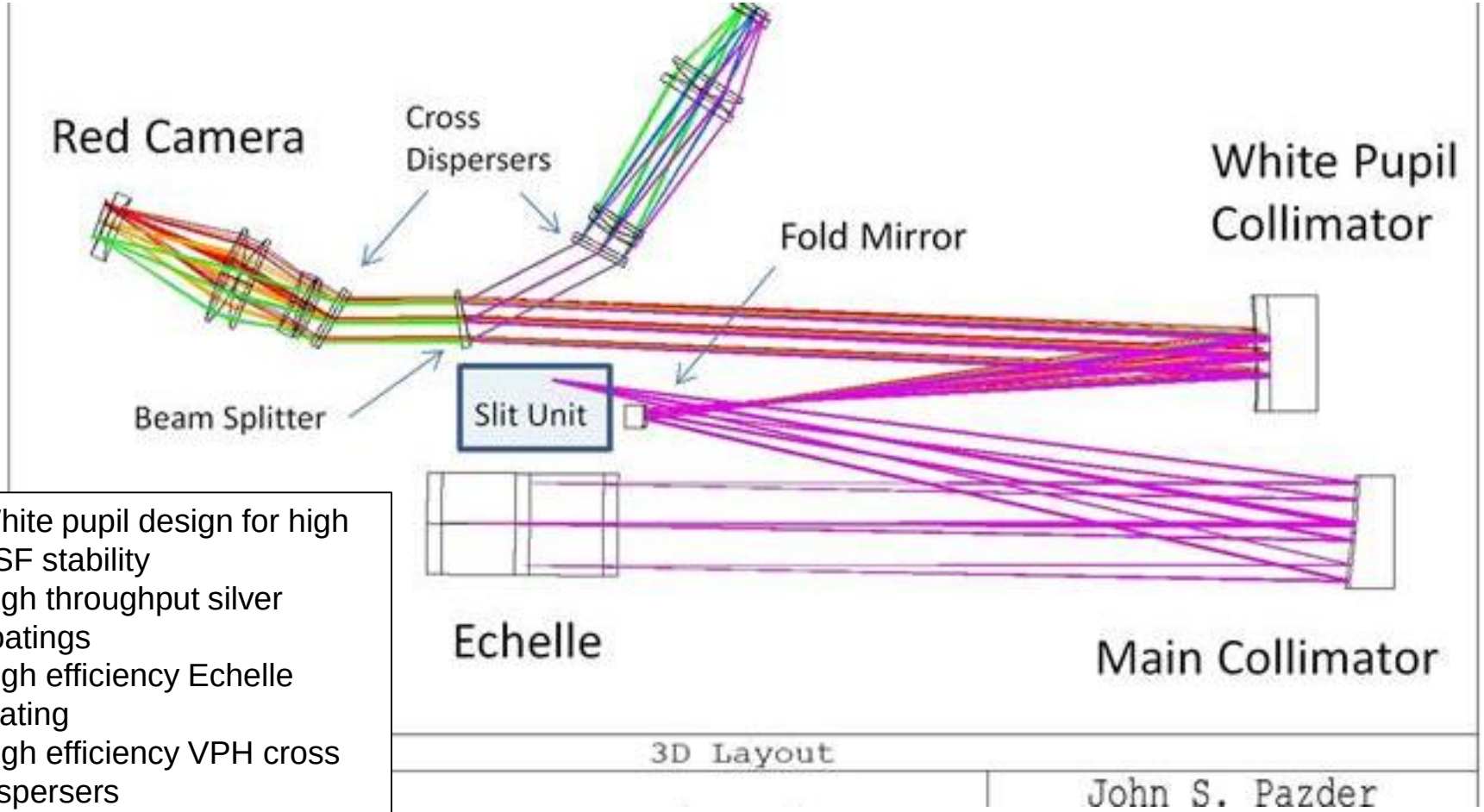


Current projects

- GHOST high-resolution optical spectrograph
- GIRMOS
- Gemini Planet Imager move

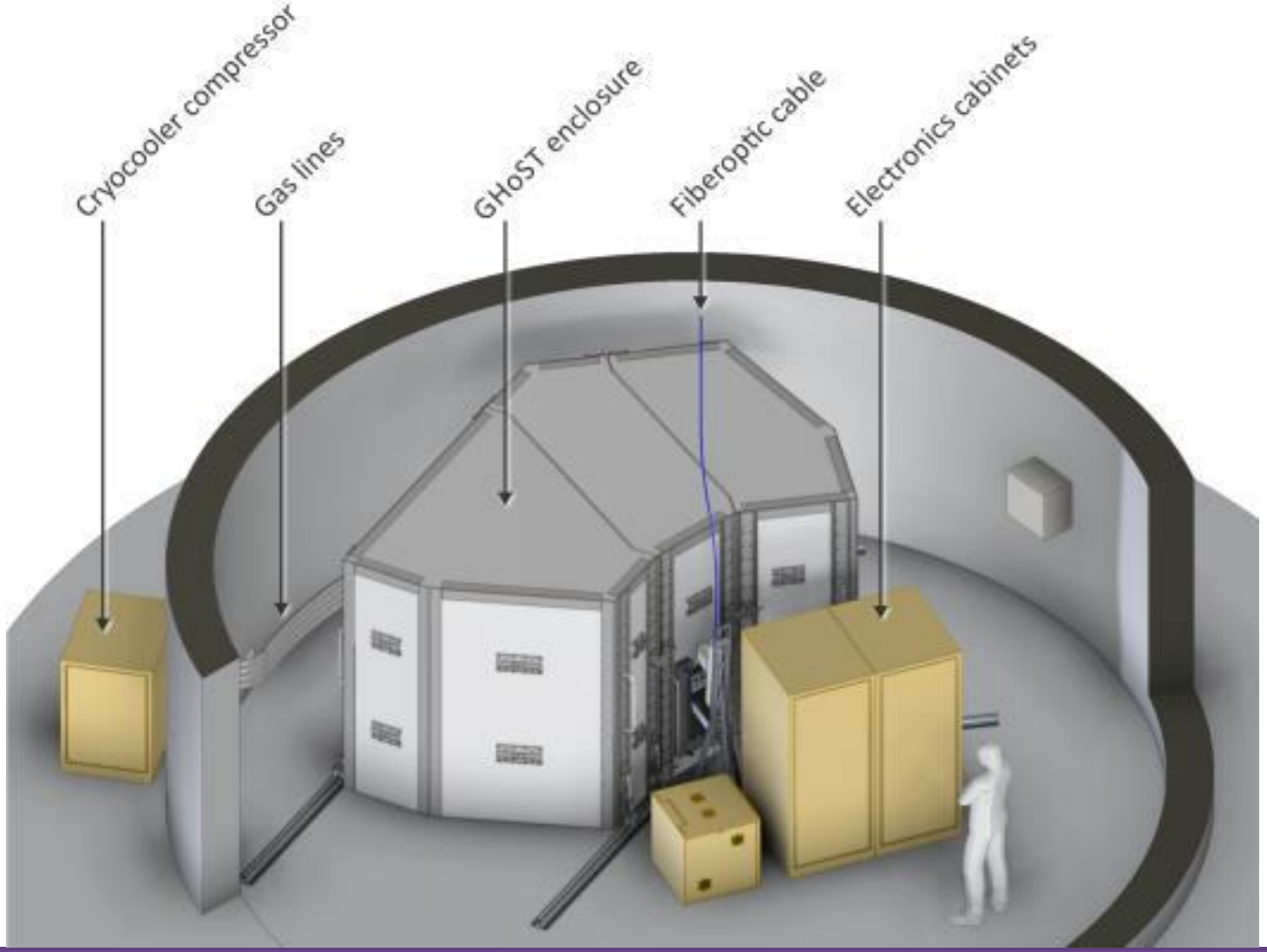
Gemini Hires Optical Spectrograph (GHOST)

Partner institutions: AAO, ANU, Gemini and NRC



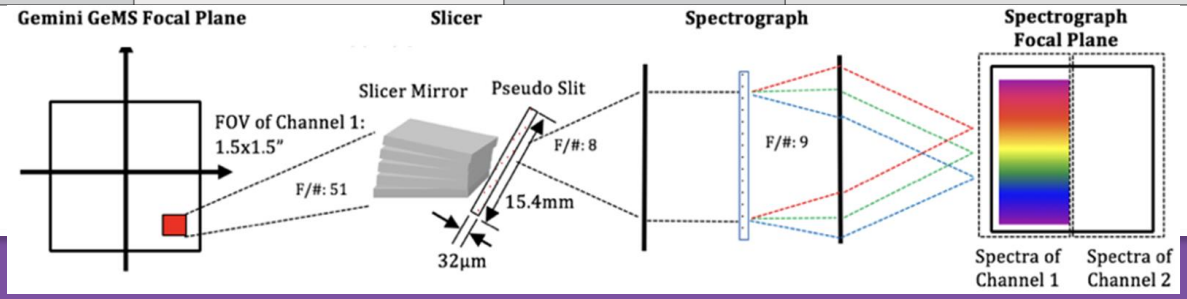
- White pupil design for high PSF stability
- High throughput silver coatings
- High efficiency Echelle grating
- High efficiency VPH cross dispersers
- High QE detectors
- No ghosts!

GHOST in Gemini Pier Lab



Gemini IR Multi-Object Spectrograph (GIRMOS)

Parameter	*Requirement*	*Parameter*	*Requirement*
Telescope Feed	Gemini-South 8.1-meter MCAO f/33 beam	**Individual IFU Field-of-view (arcsecs)**	0.75x0.75 1.5x1.5 3.0x3.0 6.0x6.0 (Combined)
MOAO Performance	~50% Encircled Energy within 0.1" (H and K-bands)	**Spatial Pixel Size (milli-arcsecs)**	25x25 50x50 100x100 100x100 (Combined)
Field-of-regard	2 arcminute diameter patrol field	**Spectral Resolution R**	3000 or 6000
Wavelength Range	1.1-2.4 µm (J, H, or K-bands)	**Spectrograph Throughput**	>45%
Number of IFUs	4 with possibility for more	**Detector**	2Kx2K HAWAII-2RG for every two spectral channels



Builds upon Subaru RAVEN

Leverages the unique Gemini MCAO System (GeMS)

GIRMOS Team (PI: Suresh Sivanandam – Dunlap)

GIRMOS Technology

Project Engineer: Darren Erickson
AO Lead: Scott Chapman

Adaptive Optics
Andersen, Lardiere, Veran, Bradley, Hickson, Lamb, Sivanandam, Correia, Akiyama

MEMS Deformable Mirrors
Chapman, El-Sankary, Shafai

NIR Spectrographs
Lead: Sivanandam
Moon, Andersen, Simard, Thibault, Akiyama

Calibration
Lead: Hickson

Optical Design and Fabrication
Lead: Thibault
Chen, Sivanandam, Moon

Data Management and Pipeline
Lead: Sawicki

GIRMOS Science

Project Scientist: Adam Muzzin

Distant Galaxy Formation and Evolution
Chapman, Sawicki, Abraham, Murray, Ellison, Simard

High-z Clusters of Galaxies
Yee, Muzzin

Observational Cosmology
Carlberg

Low Redshift Galaxies and AGN
Sivanandam, Yee, Andersen, Davidge, Akiyama

Stellar Populations
Sivanandam, Davidge

Metal Poor Stars
Venn

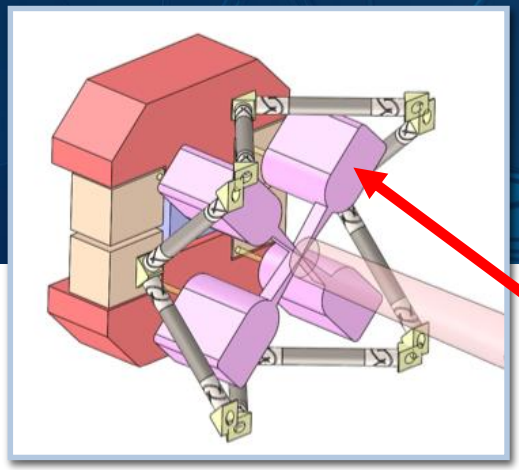
Star Formation
Murray

Gemini Scientific User Community

Partners: University of Toronto, Dalhousie, UBC, UVic, Laval, Saint Mary's, NRC-Herzberg, UManitoba, York U. Gemini Obs.. International Institutions.

$15M (CAD) Project - Funded

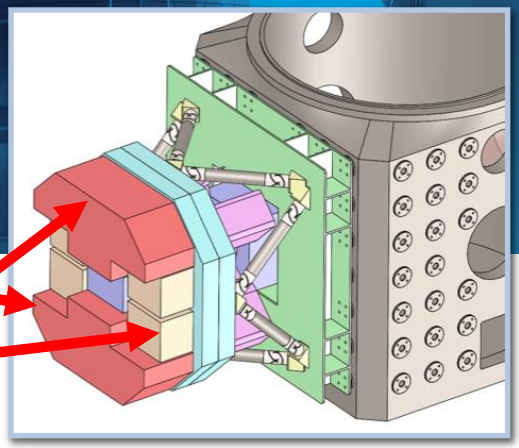
GIRMOS System Architecture



Object Selector

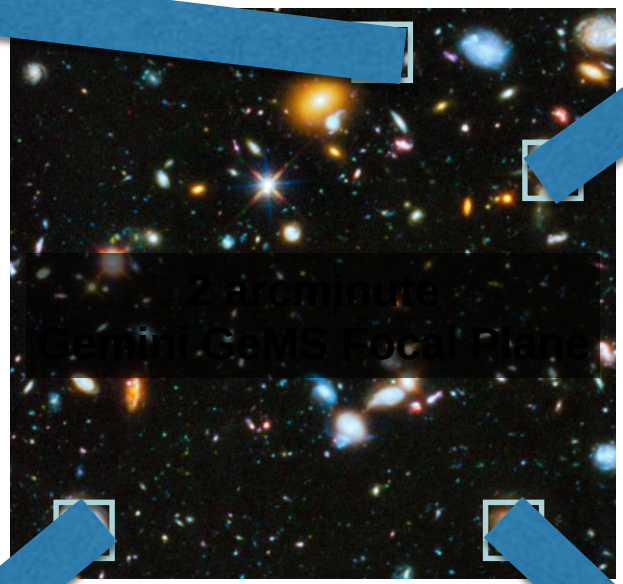
Spectrographs

AO Systems



Object Selector

Deformable Mirror



2x IFS

2x IFS

Open-loop AO

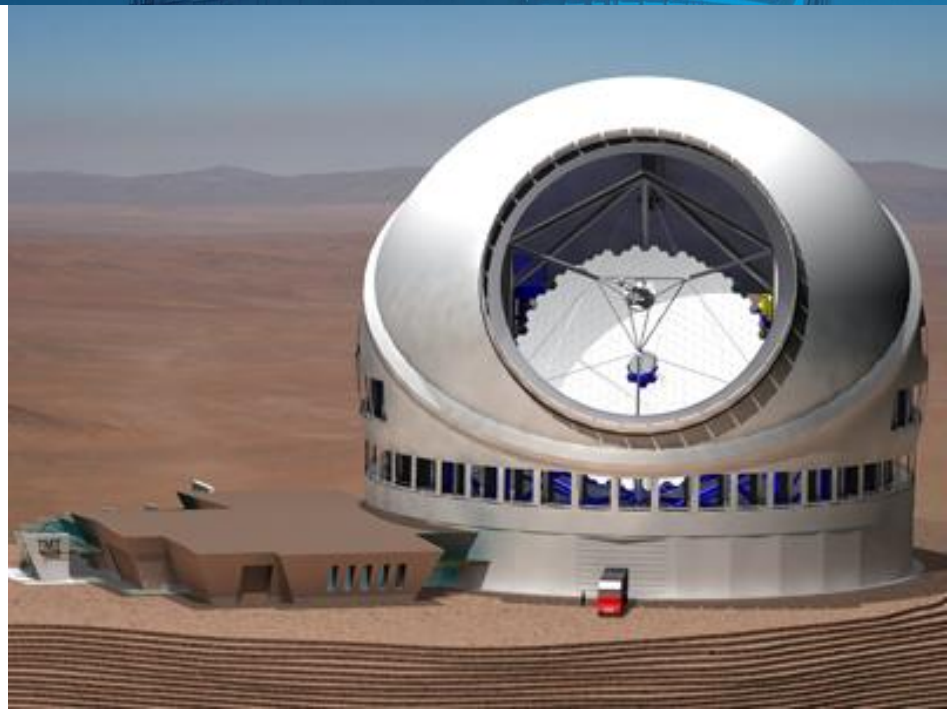
4x multiplexing advantage over similar instruments.

Thirty Meter Telescope (TMT)

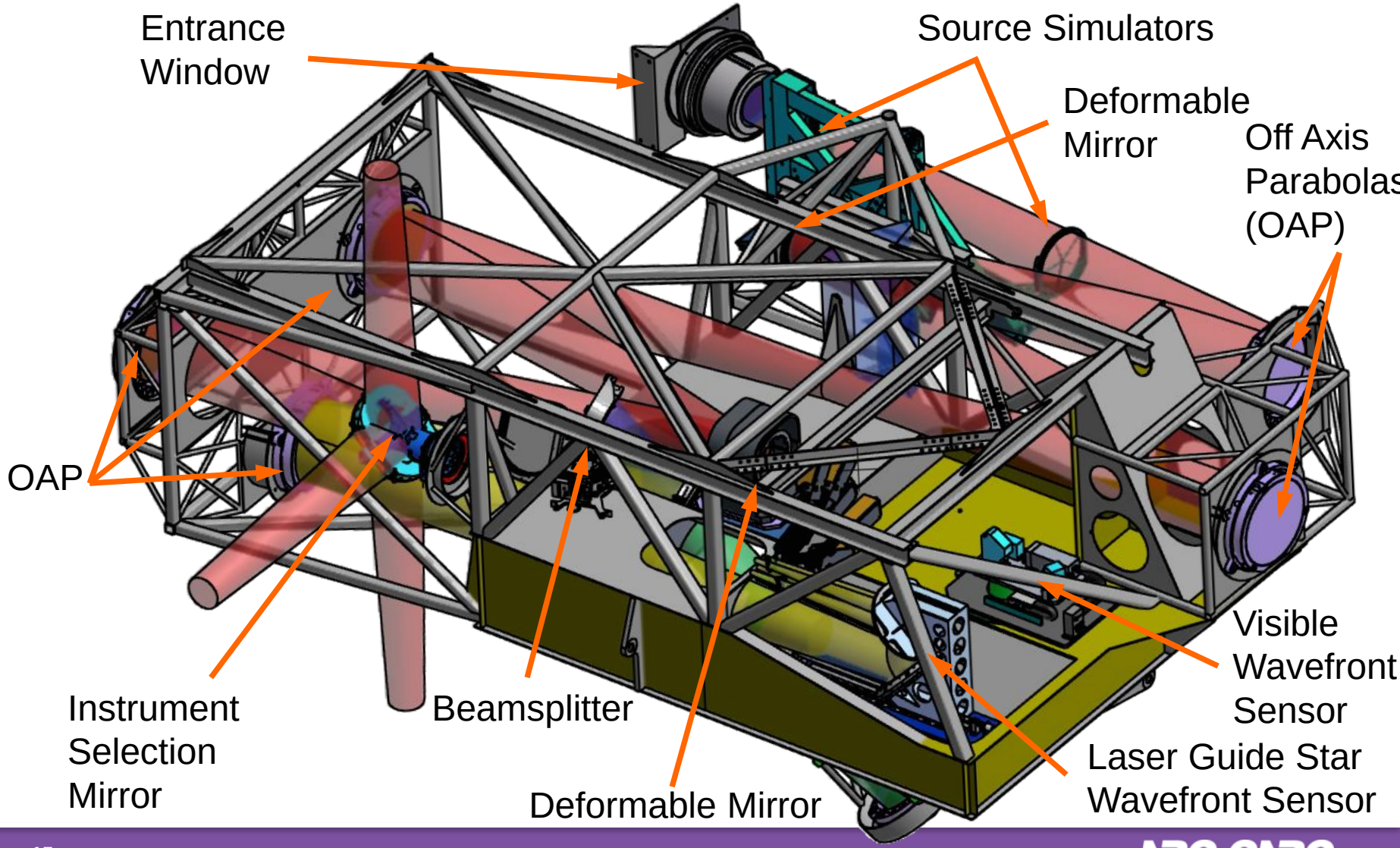
- 30 meter optical/IR telescope
- UC, Caltech, Canada, Japan, China, India
- 492 primary mirror segments

Current projects

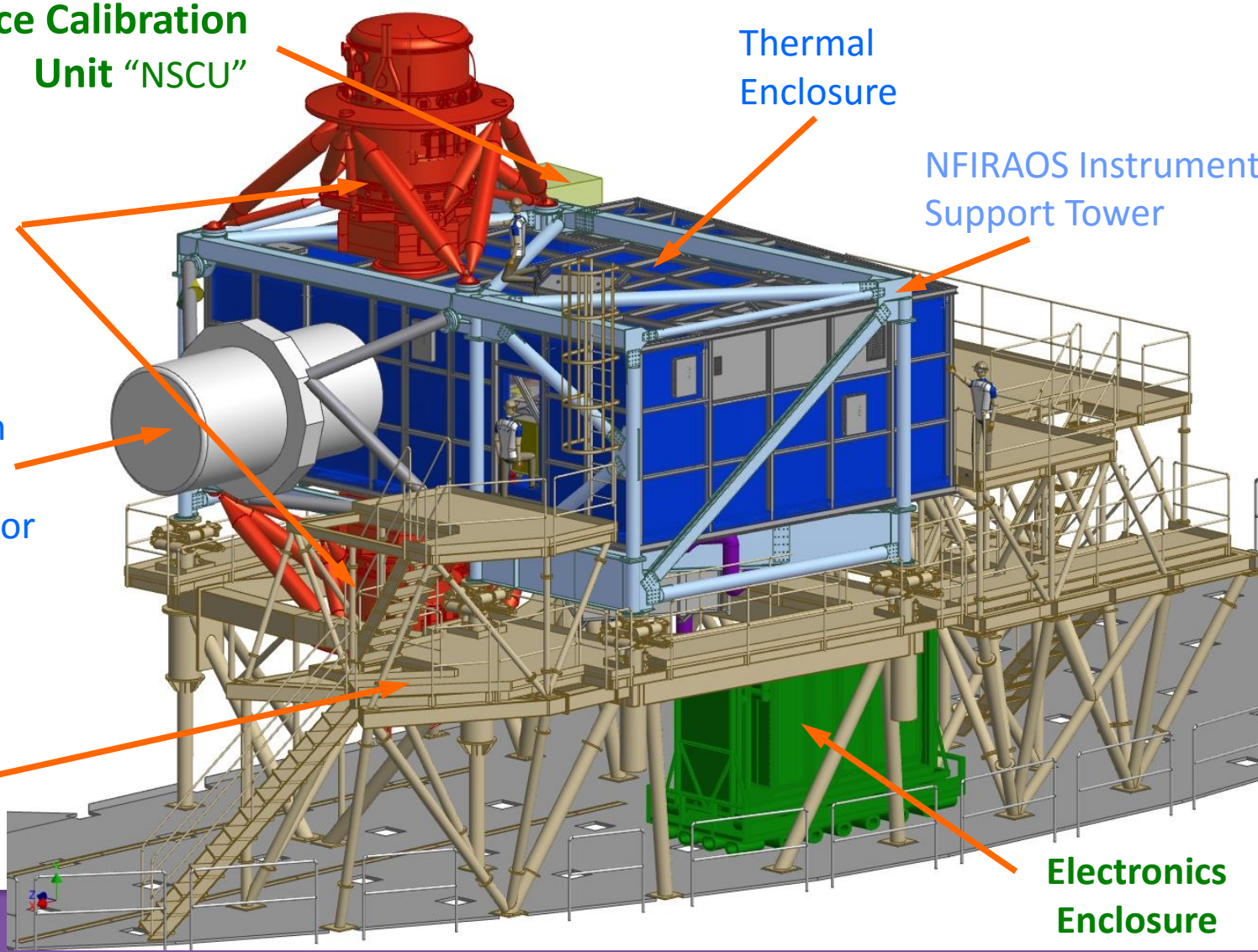
- NFIRAOS AO system
- IRIS science instrument
- AO components
- Enclosure



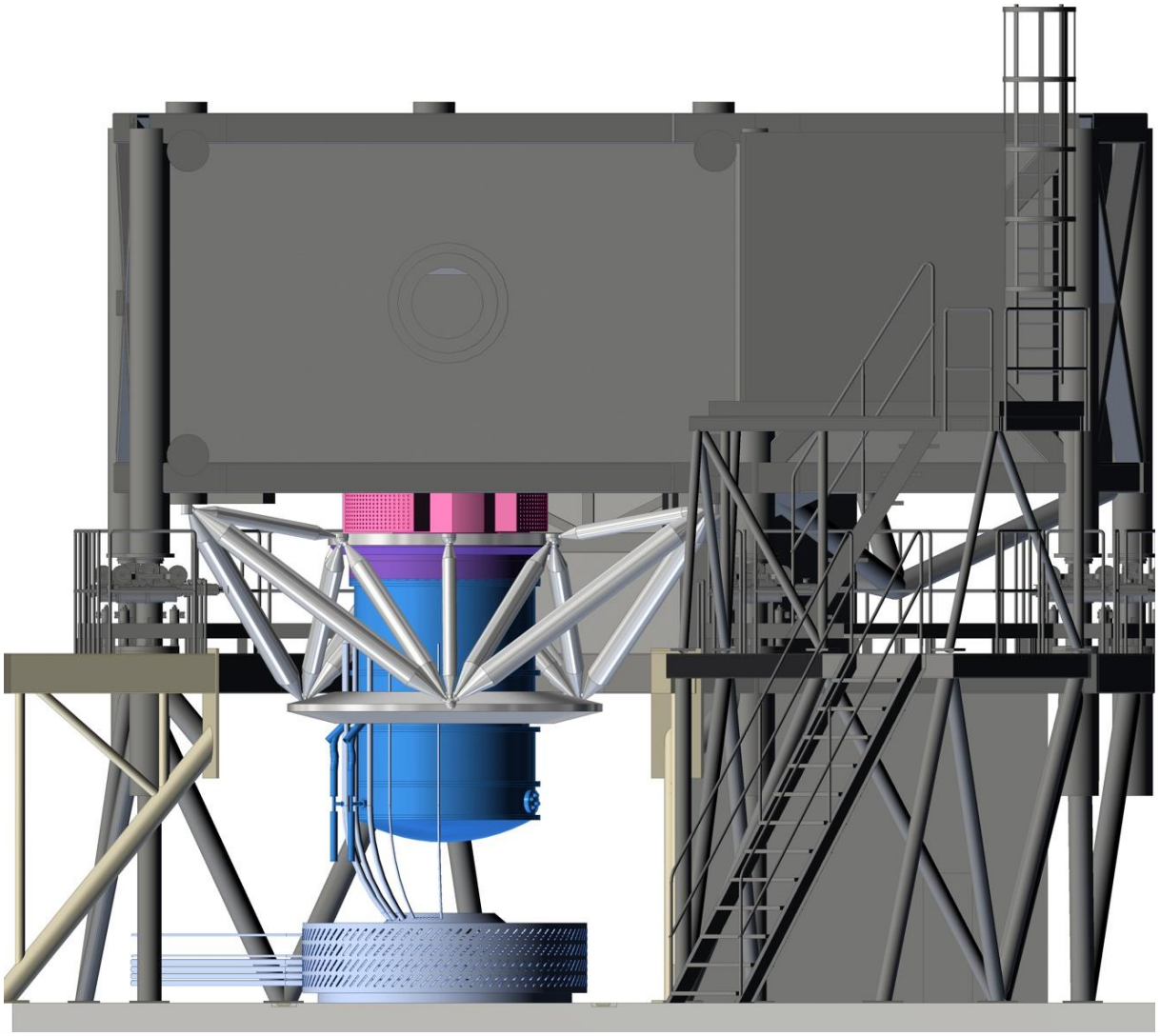
TMT NFIRAOS Facility AO System Layout



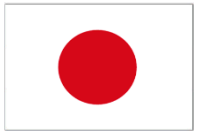
NFIRAOS on the TMT Nasmyth Platform



InfraRed Imaging Spectrograph (IRIS)



UC/ CIT



NAOJ

NIAOT

NRC

Canadian Technical Interest in ULTIMATE: Science Instrument

1. Wide-field imager (Pazder 2013) based on:
   - Adaptive Secondary Mirror + Concentric corrector providing a universal 22′.8 diameter field of view with residual aberrations less than 66 mas
   - 4-barrel imaging system feed :
     - Each barrel has 4K×4K H4RG detector covering 6′.8×6′.8 FoV w/ 0′′.1/pixel
   - Total imager FoV of 185 square arcminutes

2. Higher resolution (R~30,000), fiber-fed, multi-object spectrograph
   - Could leverage GHOST and SPIROU/NIRPS designs
   - GLAO IQ would positively impact spectrograph design

3. AO-assisted, deployable multi-IFU spectrograph
   - Could leverage GIRMOS design work
   - GLAO would provide AO “woofer” + MOAO “tweeter”

Canadian Technical Interest in ULTIMATE: Some Remarks

- Given current instrument work in Canada, interest has shifted from option 1 to options 2 and 3

- All optical/IR instrumentation groups are fully committed until (at least) late 2018 / early 2019:
  - Low-level design work is possible
  - Availability to depend on choice of ULTIMATE instrument

- Major funding now comes from the Canadian Foundation for Innovation (CFI):
  - Next call for proposals is expected in 2019

Thank you!

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