NAHUAL-NIRINTS:

A Near-InfraRed High&INTermediate resolution Spectrometer for the 10.4-m GTC

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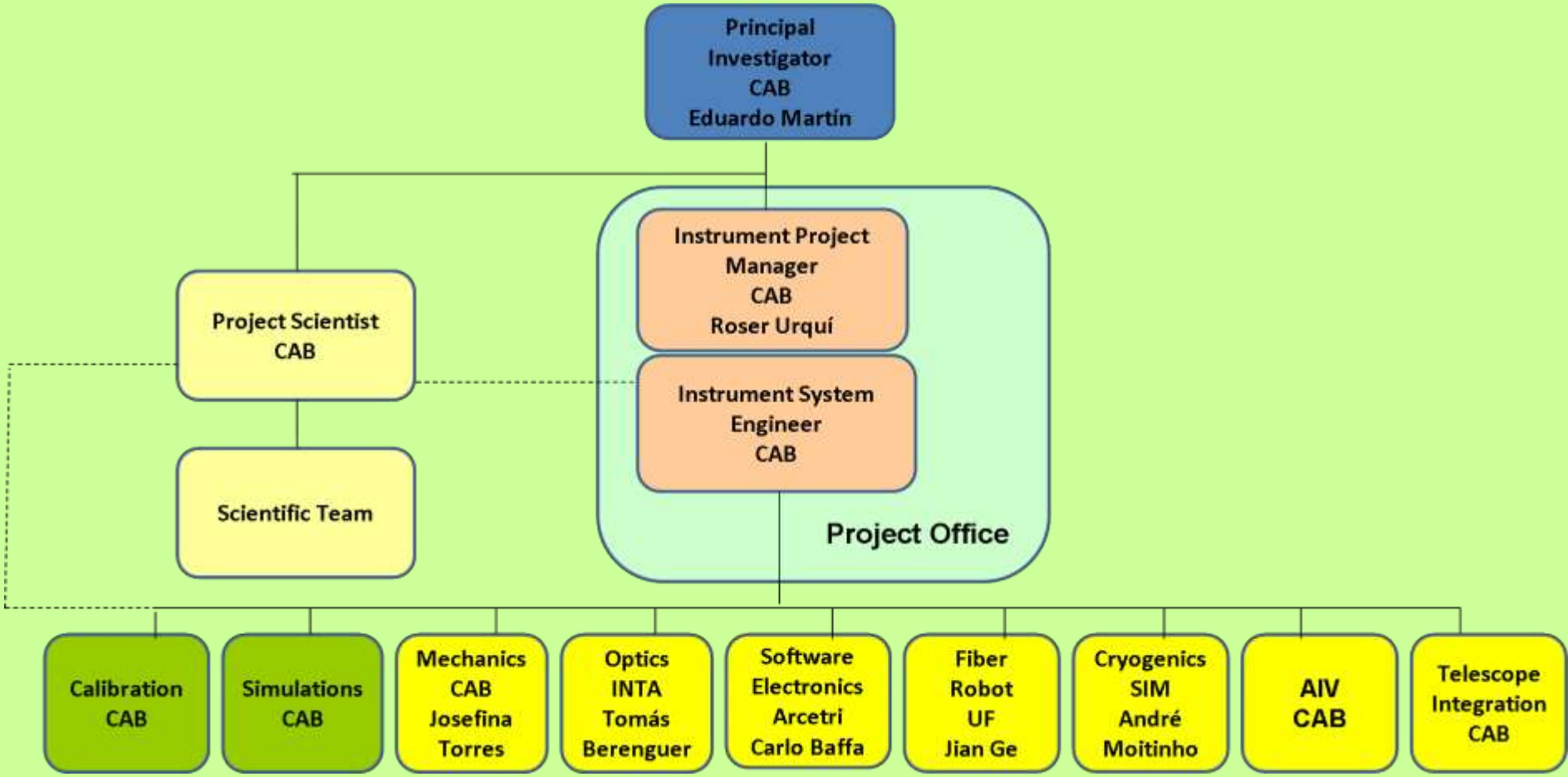
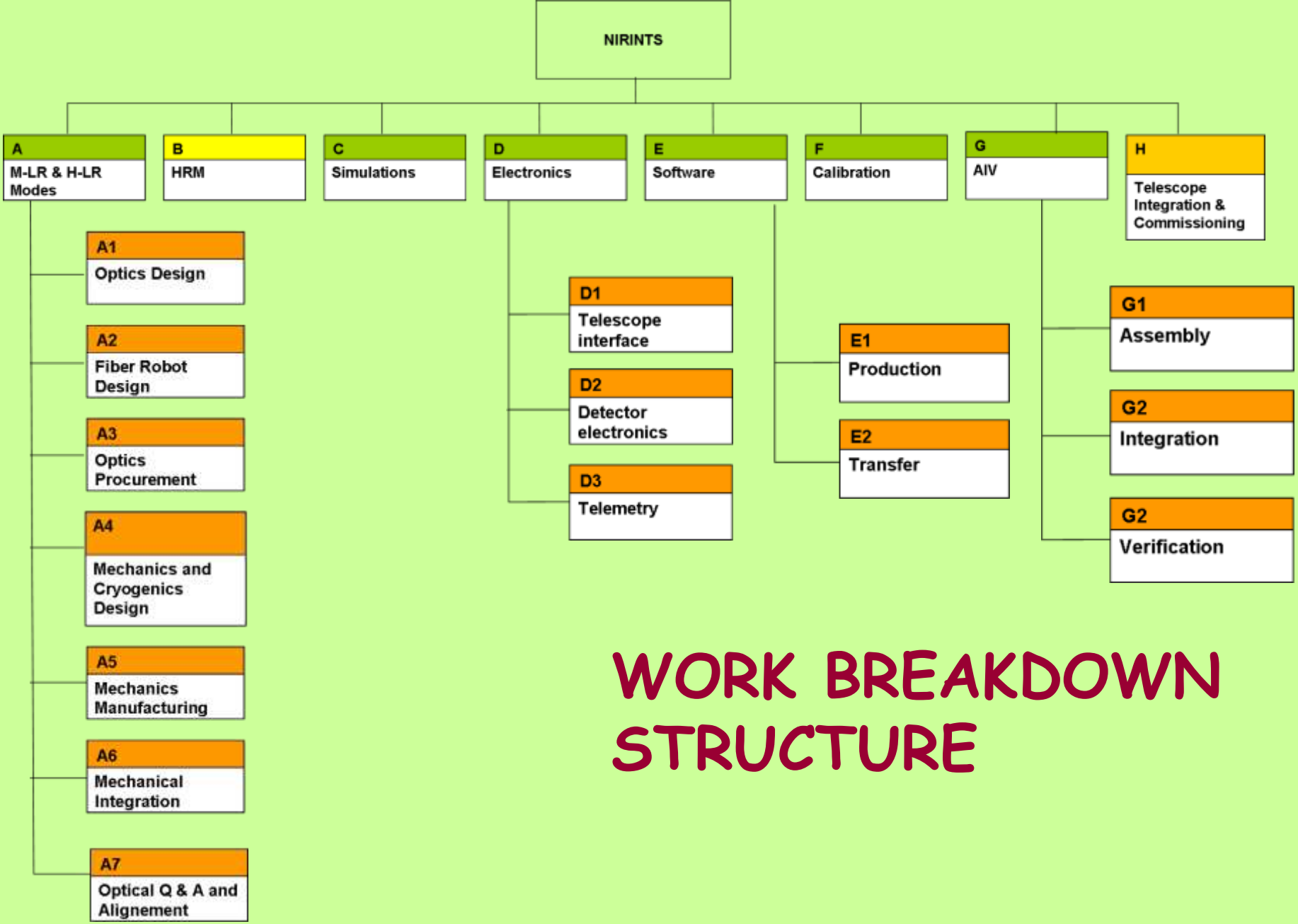
NIRINTS ORGANIZATIONAL CHART





WORK BREAKDOWN STRUCTURE

Key science topics

- Giant planets around cool stars (M-HR and HRM)
- The IMF in young open clusters (M-LR)
- Physics and evolution of high-z galaxies (M-LR)
- Detection of habitable rocky planets around the nearest stars (HRM)
- Characterization of transiting hot jupiters (HRM)
- Atmospheric characterization of transiting rocky planets (HRM)

Science requirements

- A variety of spectral resolutions from 7000 to 70000.
- Multi-object capabilities for 40 objects simultaneously.
- Near-infrared spectral range, possibility to tune to any wavelength in the range from 0.9 to 2.4 microns.
- RV precision between 100 m/s for multi-object spectroscopy and 1 m/s for single object.
- Total efficiency better than 10% .
- For single stars, high stability and broad wavelength coverage, resolving power around 70,000, accurate wavelength calibration and image scrambing.

Versatile observing modes

- Mid-Low Resolution (M-LR) spectroscopy, resolving power from 7000 to 13000 from 0.9 microns to 2.2 microns
- Mid-High Resolution (M-HR) spectroscopy, resolving power from 14000 at 0.9 microns to 26000 at 2.2 microns.
- Multi-object capability (around 40 objects) in 5 sq. arcmin FOV with M-LR or M-HR, exploiting superb natural seeing at ORM.
- Integral field capability with M-HR over 2 sq. arcmin.
- Possibility to tune to any wavelength in the range from 0.9 to 2.4 microns.
- High-resolution mode (HRM) for single stars, high stability and broad wavelength coverage, resolving power of 70,000, accurate wavelength calibration and image scrambing.

Optical Managerial Requirements M-LR & M-HR

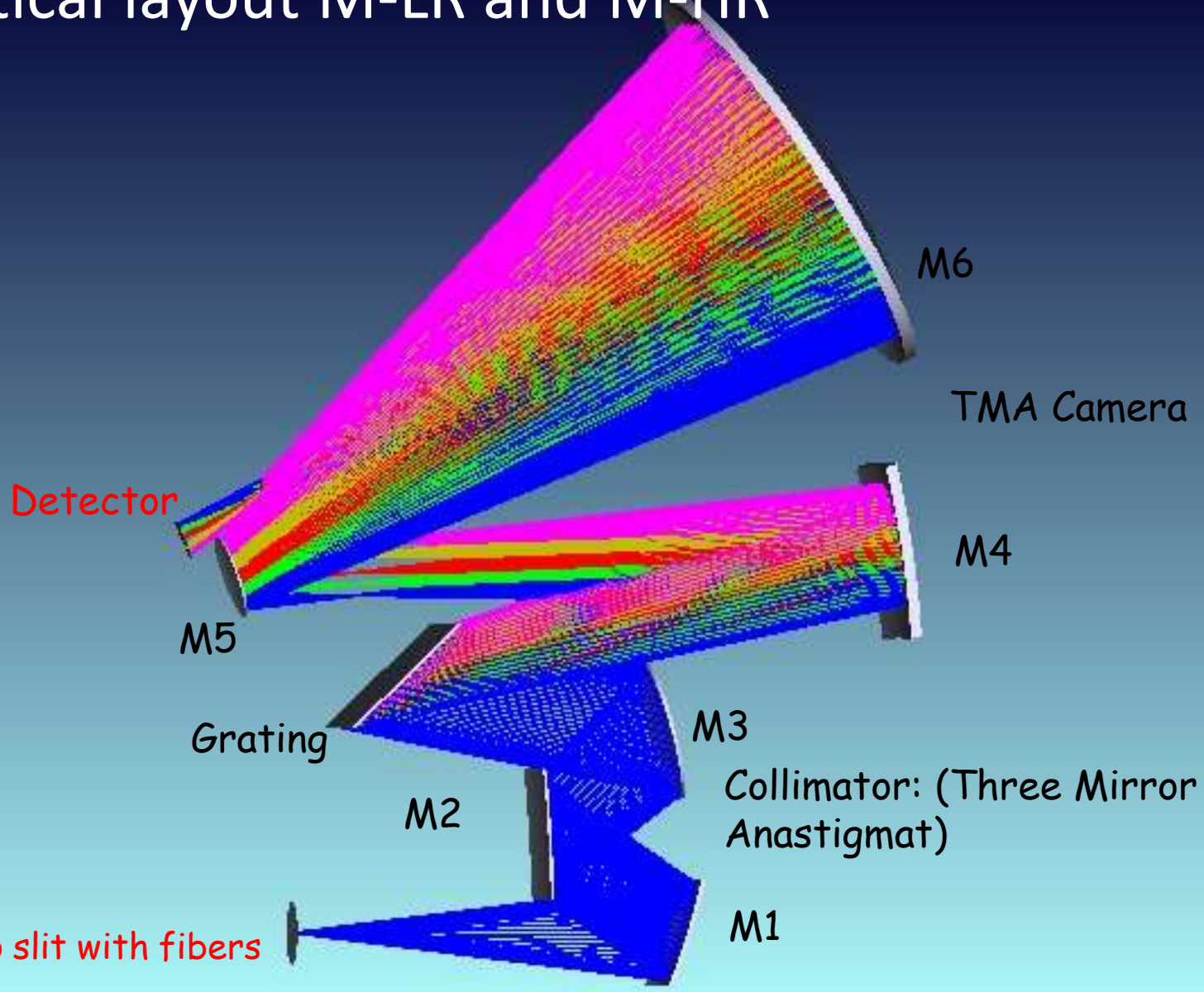
- Use of commercial catalogue gratings
- Use of Teledyne 2048x2048 pixels detector with 18 microns pix
- No active detector movements allowed
- Between 50 and 100 fibers in pseudo-slit
- 10 pixels between adjacent fiber projections on detector
- Fiber size 50 and 100 microns
- F number at fiber exit and spectrograph entrance: F4

Generador de estrellas

Main optics description for M-LR and M-HR modes

- Pseudo-slit size: 25.4 mm
- F4 collimator with effective focal length of 450 mm
- Pupil size: 112 mm
- F2.9 camera with effective focal length of 324 mm
- Detector use of 1K in spatial direction and 2K in spectral direction
- M-LR or M-HR is selected with fiber selection on pseudo-slit
- A 100 microns fiber is projected on 4 pixels (72 microns), while a 50 microns fiber is projected on 2 pixels (36 microns)

Optical layout M-LR and M-HR



Gratings Performance: H band.

R=17447 (50 micron fiber)

R=8723 (100 micron fiber)

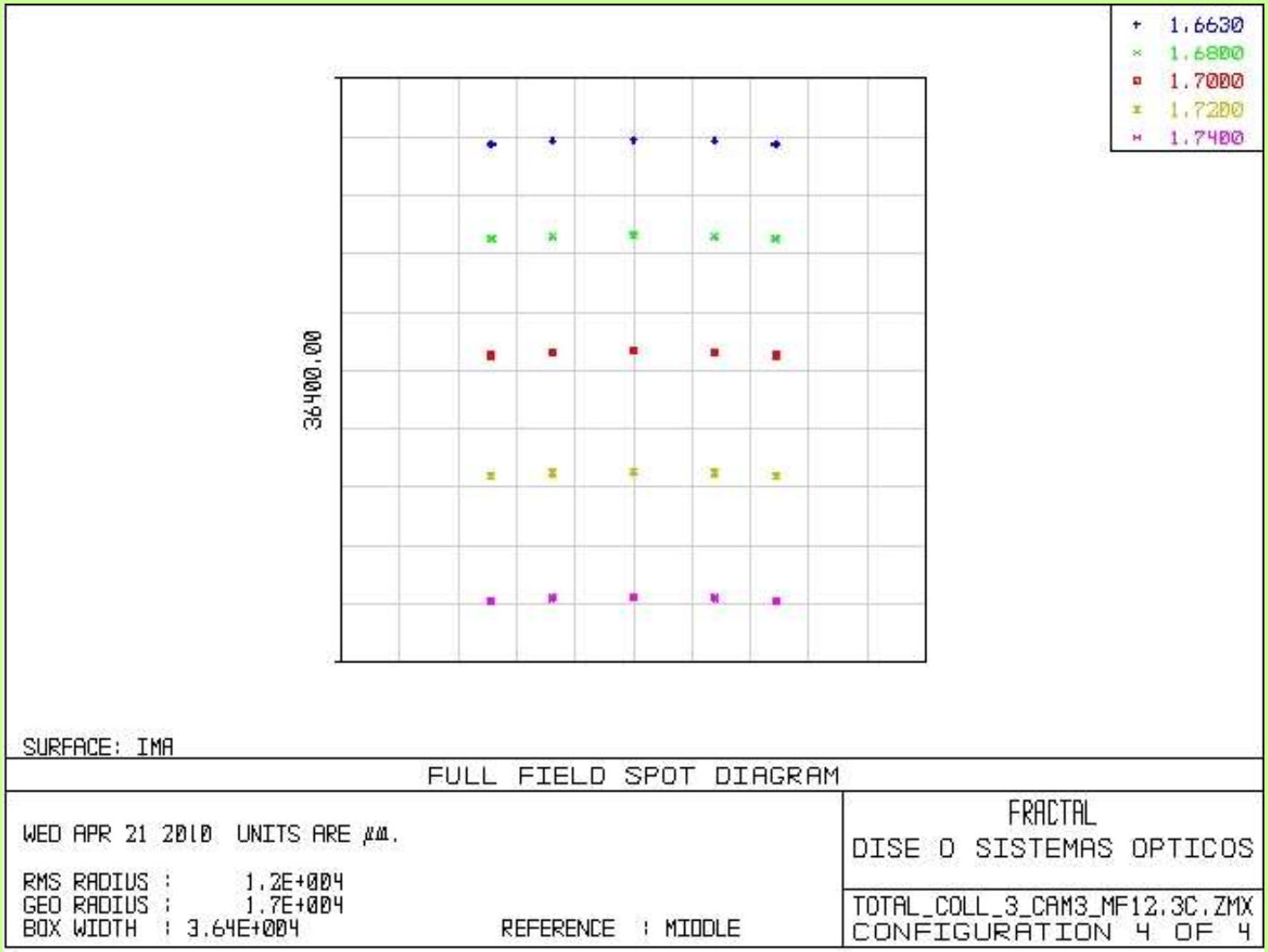


Image quality of M-LR and M-HR modes

Fiber image on the detector is within requirements.
100% of the encircled energy is within the required projection on the Detector.

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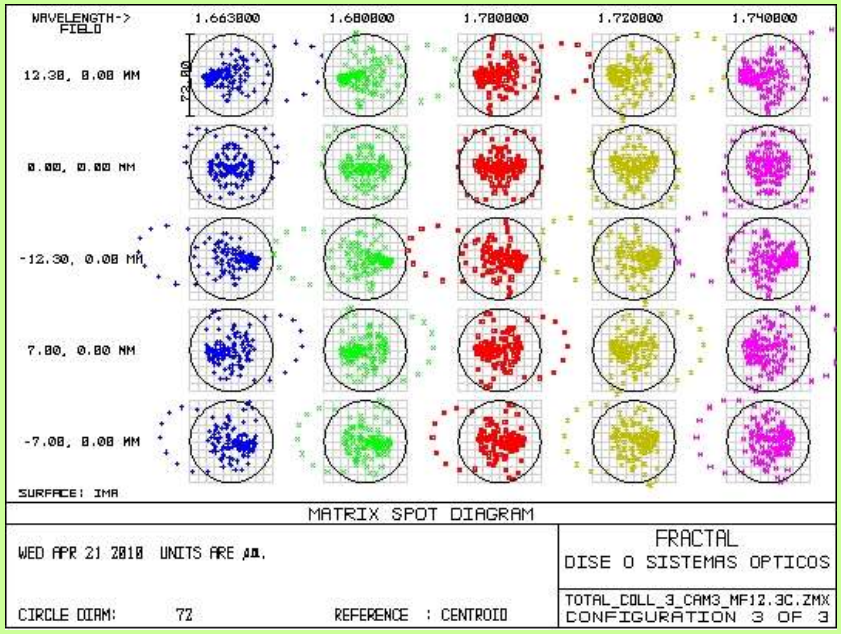
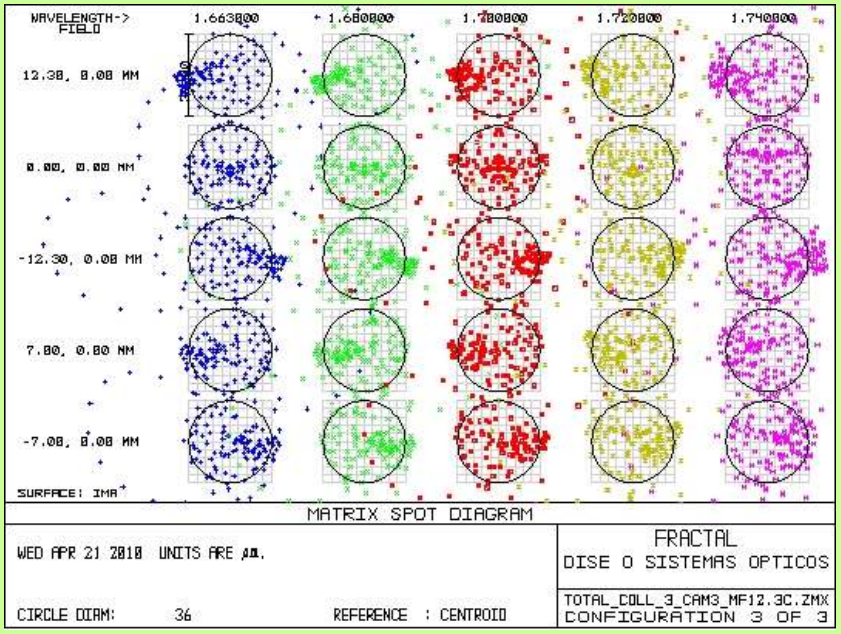
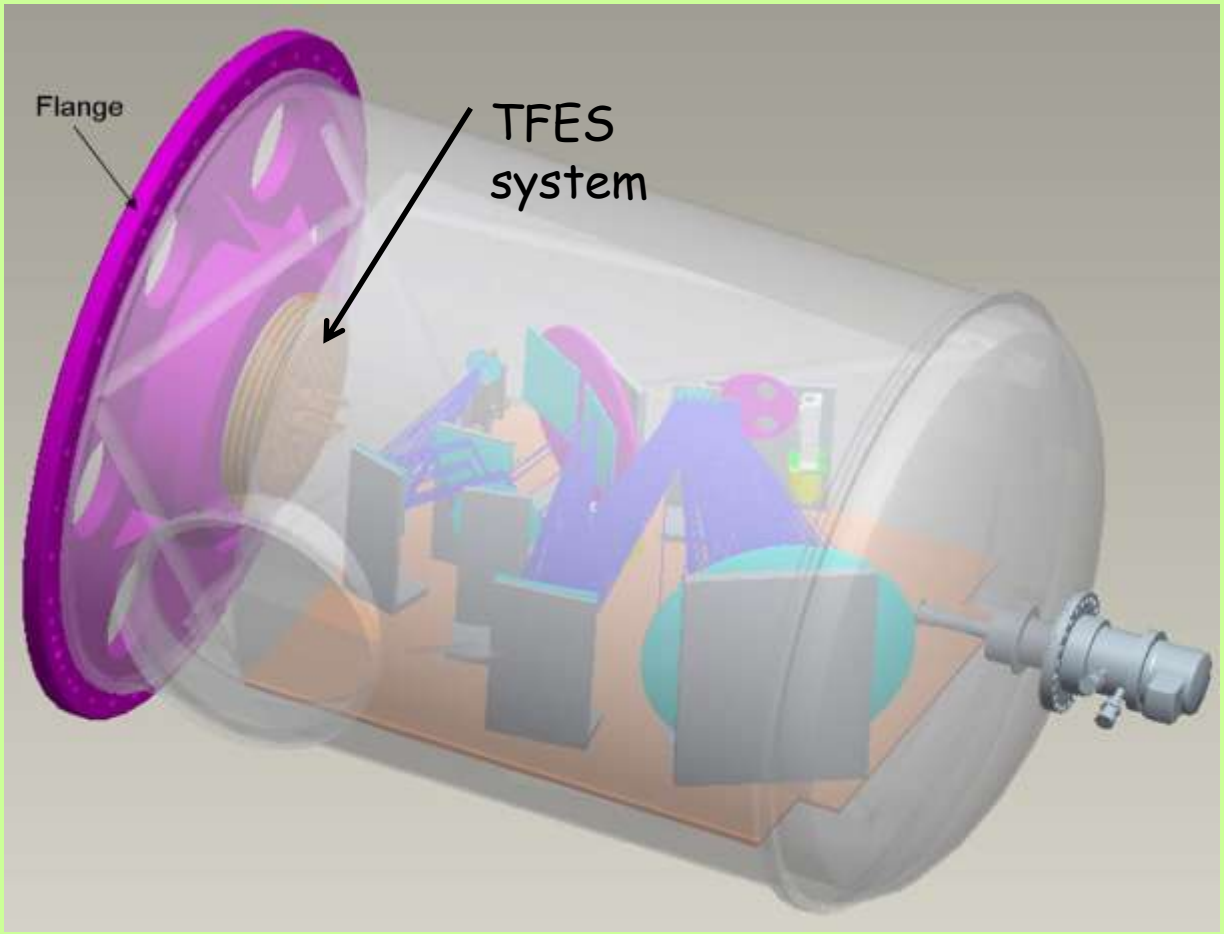
100 micron fiber on four pixel



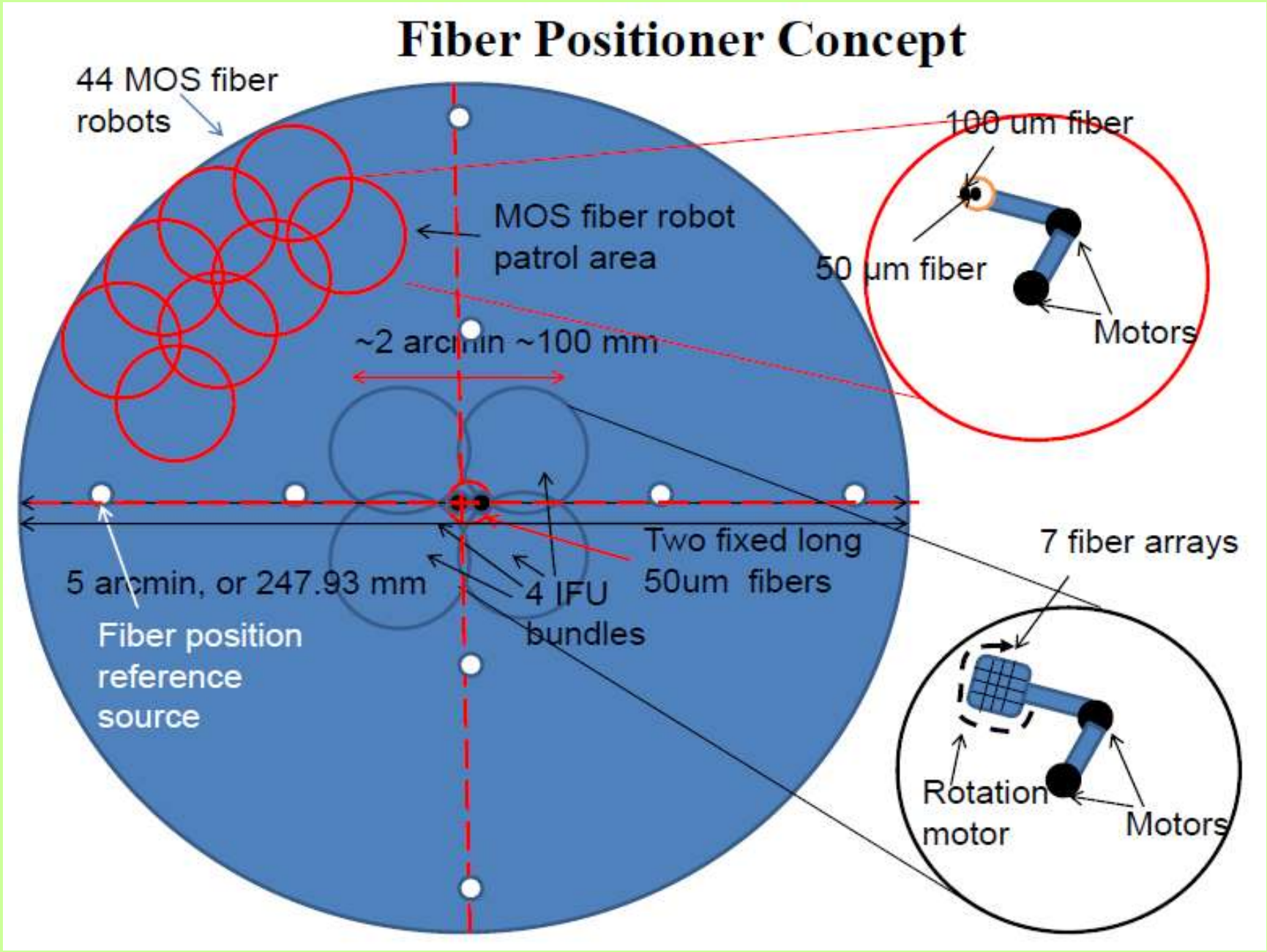
50 micron fiber on two pixel



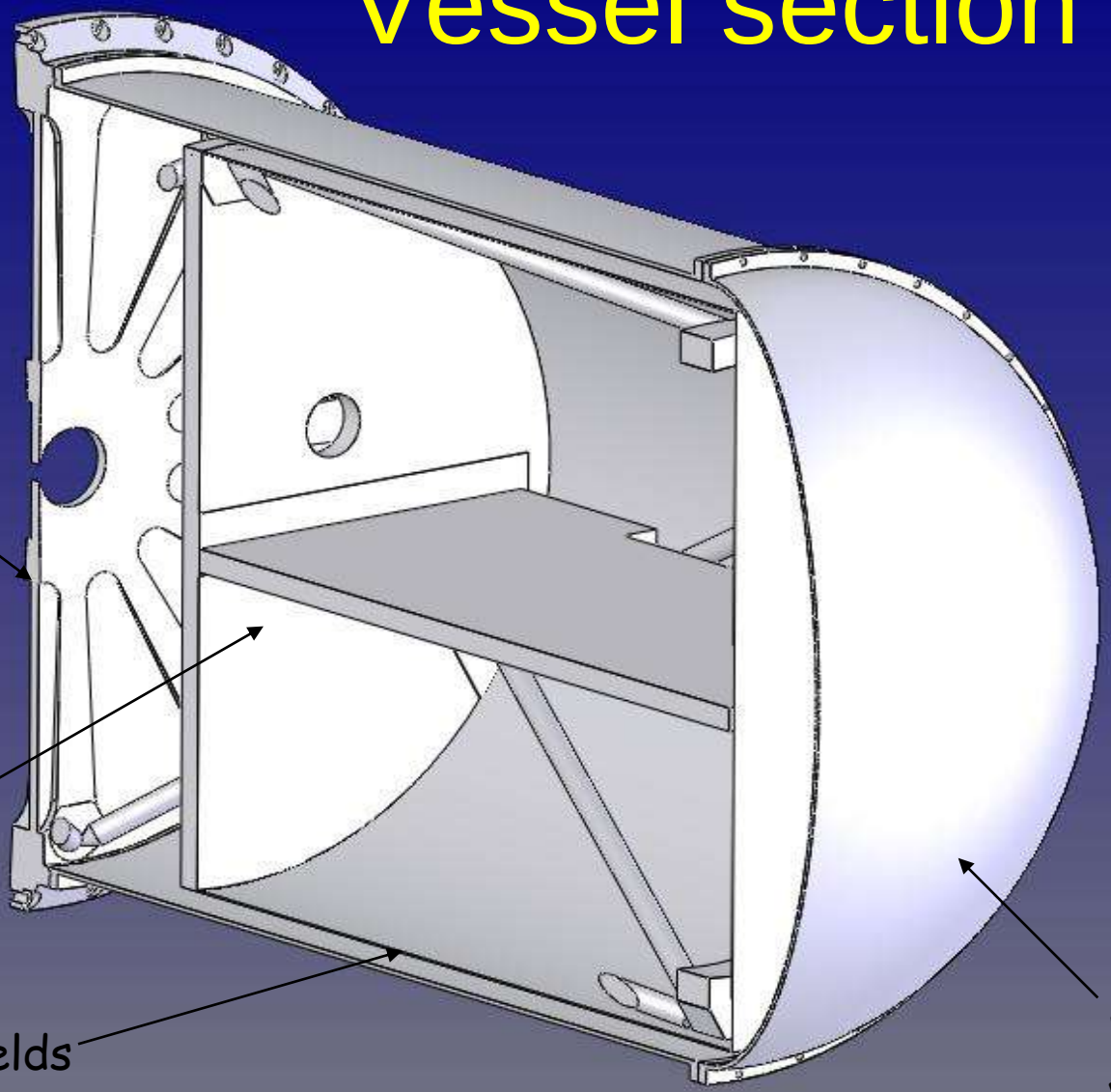
Telescope Front End System Overview



- TFES required to provide fiber feeding for multi-object spectroscopy (MOS) and Integral Field Unit (IFU) spectroscopy for NIRINTS Mid-Res Mode and single object spectroscopy for its High-Res mode.
- Mid-Red fibers required to have ~0.5 meter long in the warm environment to minimize its thermal radiation to near IR spectroscopy.


Fiber Positioner Concept
44 MOS fiber robots
MOS fiber robot patrol area
~2 arcmin ~100 mm
5 arcmin, or 247.93 mm
Fiber position reference source
4 IFU bundles
Two fixed long 50um fibers
100 um fiber
50 um fiber
Motors
7 fiber arrays
Rotation motor
Motors

Vessel section view



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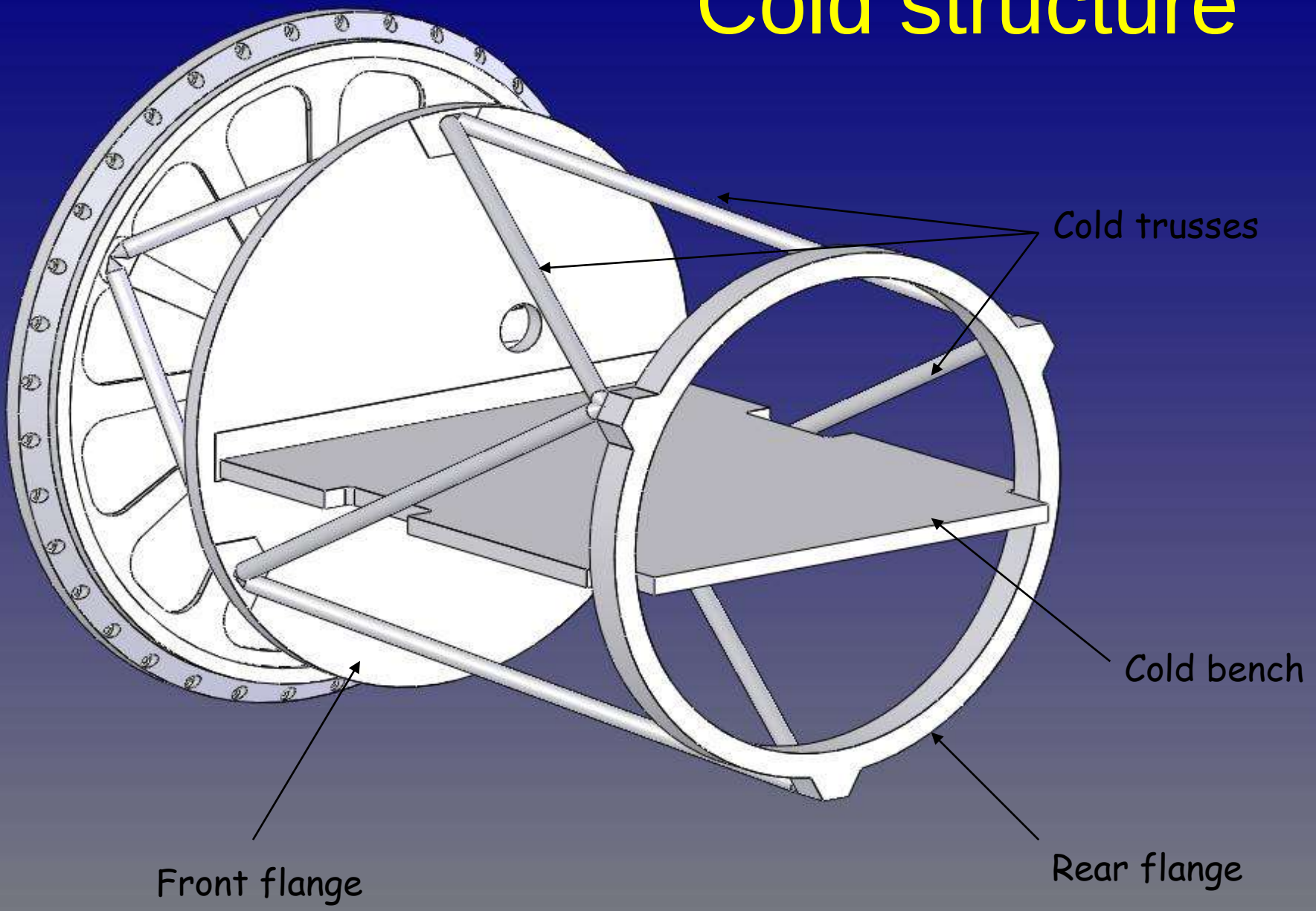
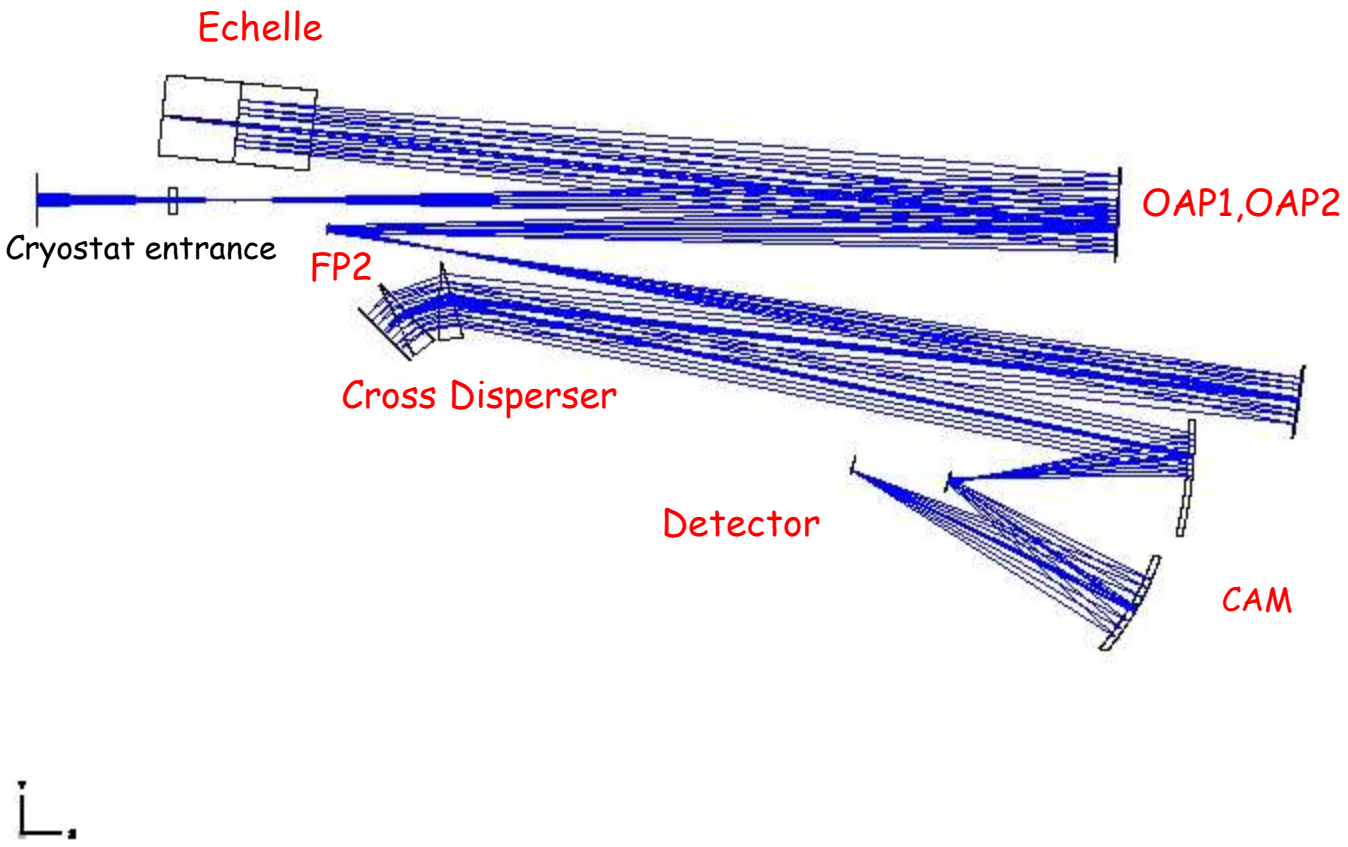
Cold structure



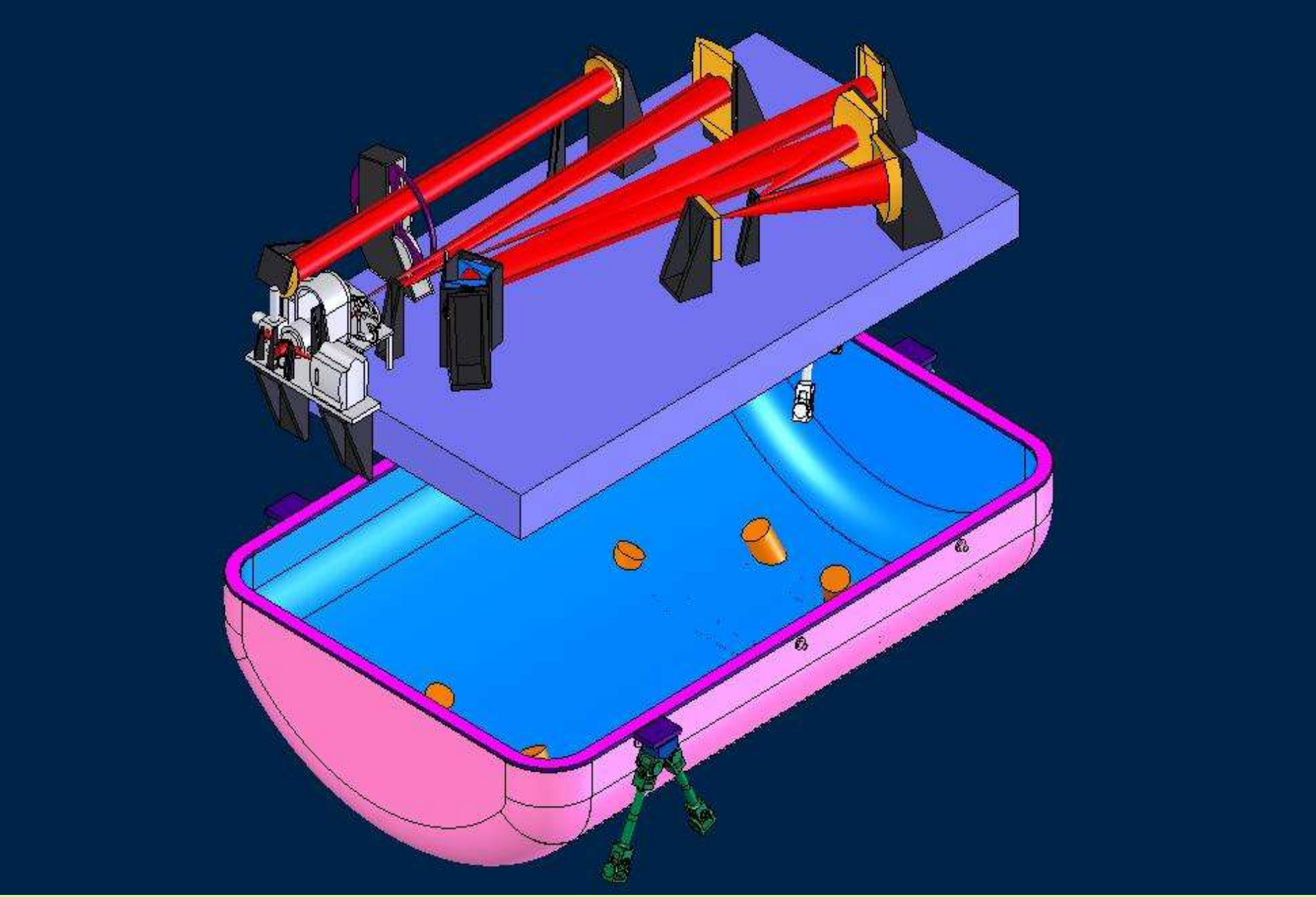
Main optics description for the HRM

- Pseudo-slit size: 0.144 mm x 2.163 mm (0.175 arcsec x 2.163 arcsec)
- The beam is collimated by an off axis parabola (OAP) of focal length 1700 mm
- Pupil size: 109 mm
- Fixed echelle grating is placed at the pupil image. The grating is a 31.6 lines per mm replica on an aluminium substrate, and has a size of 154x408x30 mm. It is tilted 0.9 degrees.
- Baffling to suppress scattered light is done at FP2.
- Another OAP collimates the beam onto the cross disperser, which is formed of two ZnSe prisms (140 mm clear aperture) and a returning mirror. The beam passes twice through the prisms.
- The camera is a 3 mirror system with effective focal length of 381 mm
- The detector is an HgCdTe Hawaii 2Kx2K with 18 micron pixel. Thus the focal plane size is 36.864mm x 36.864mm.

Optical layout for the HRM



High quality polished ZnSe prisms



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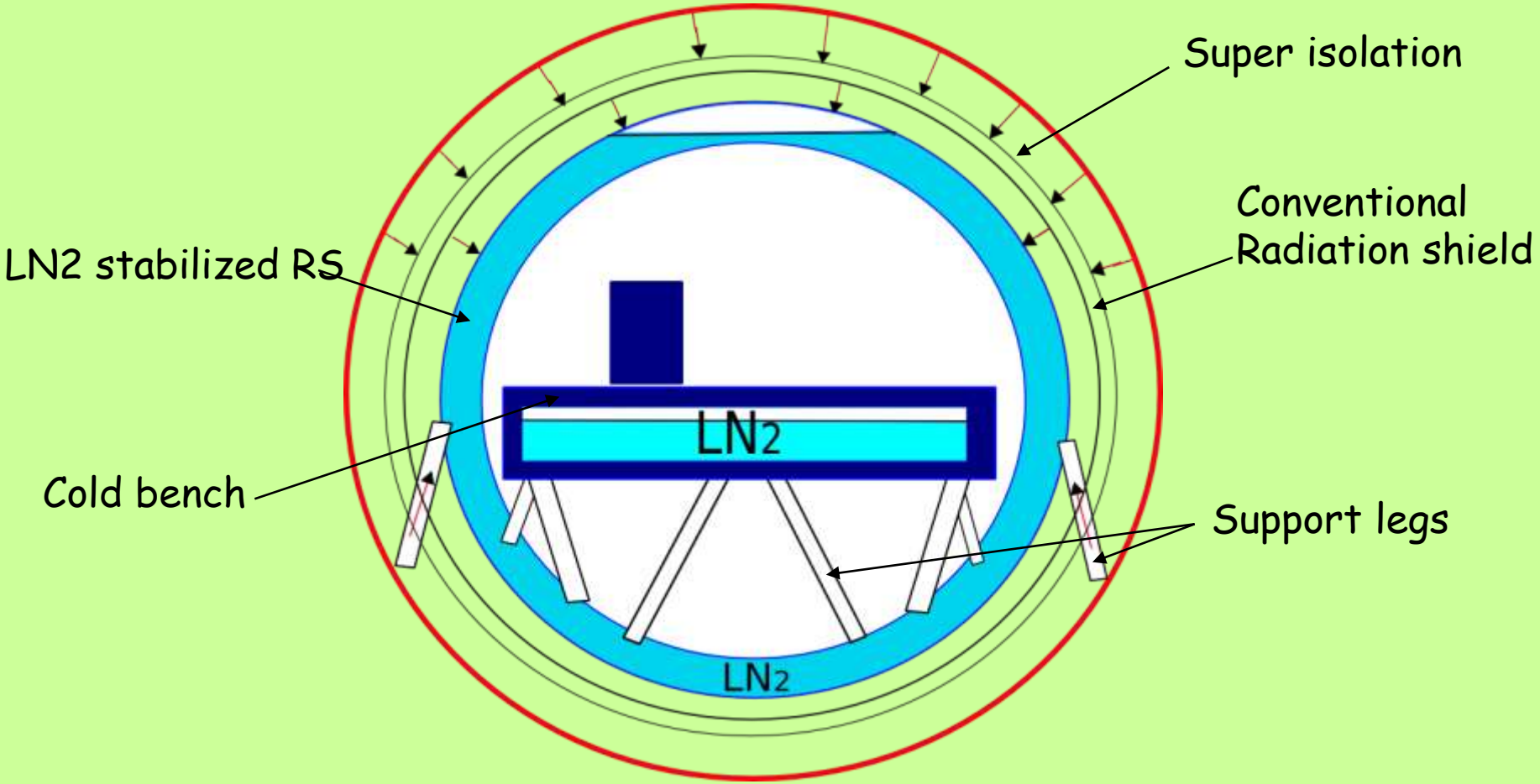
Final configuration



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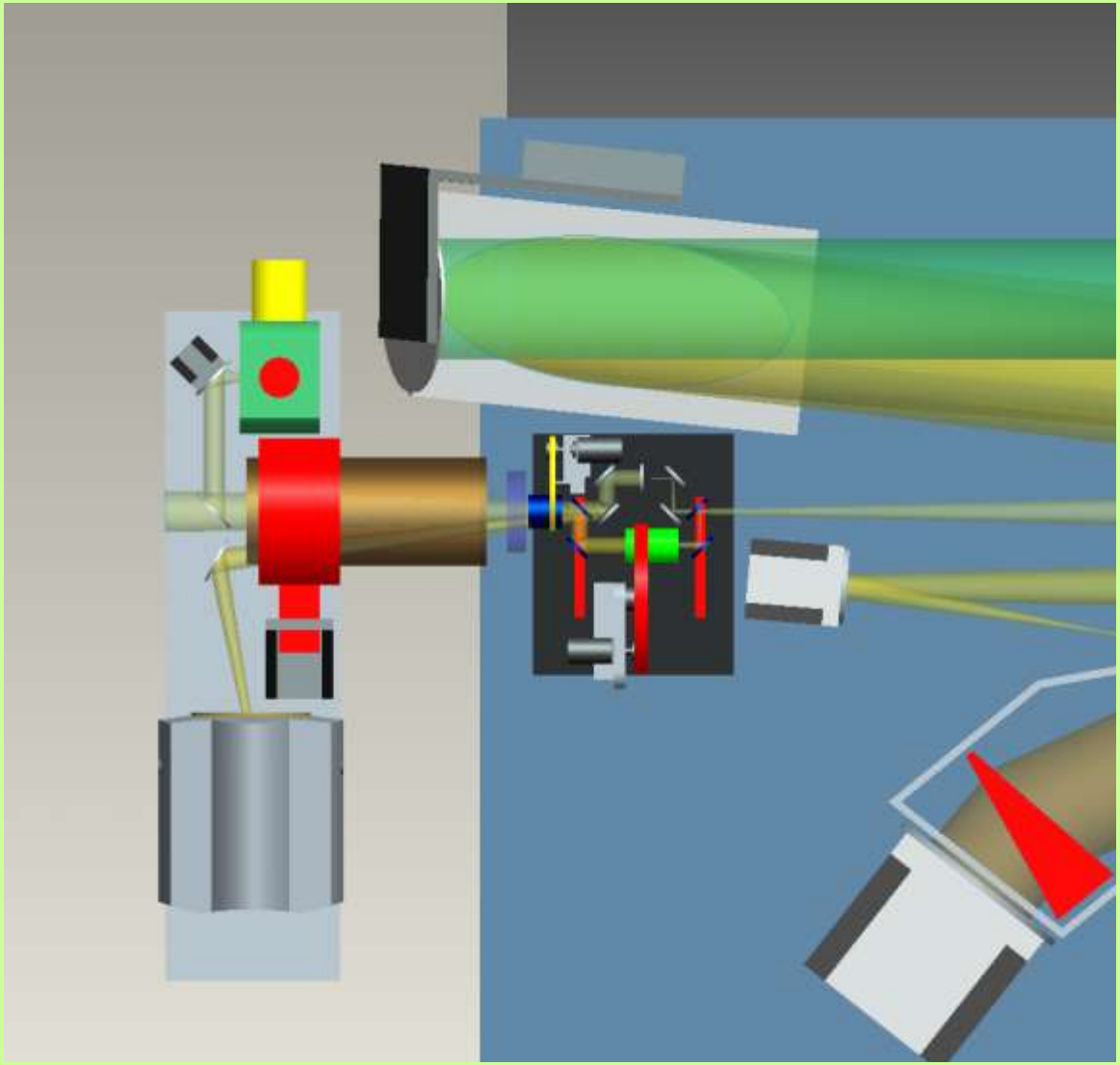
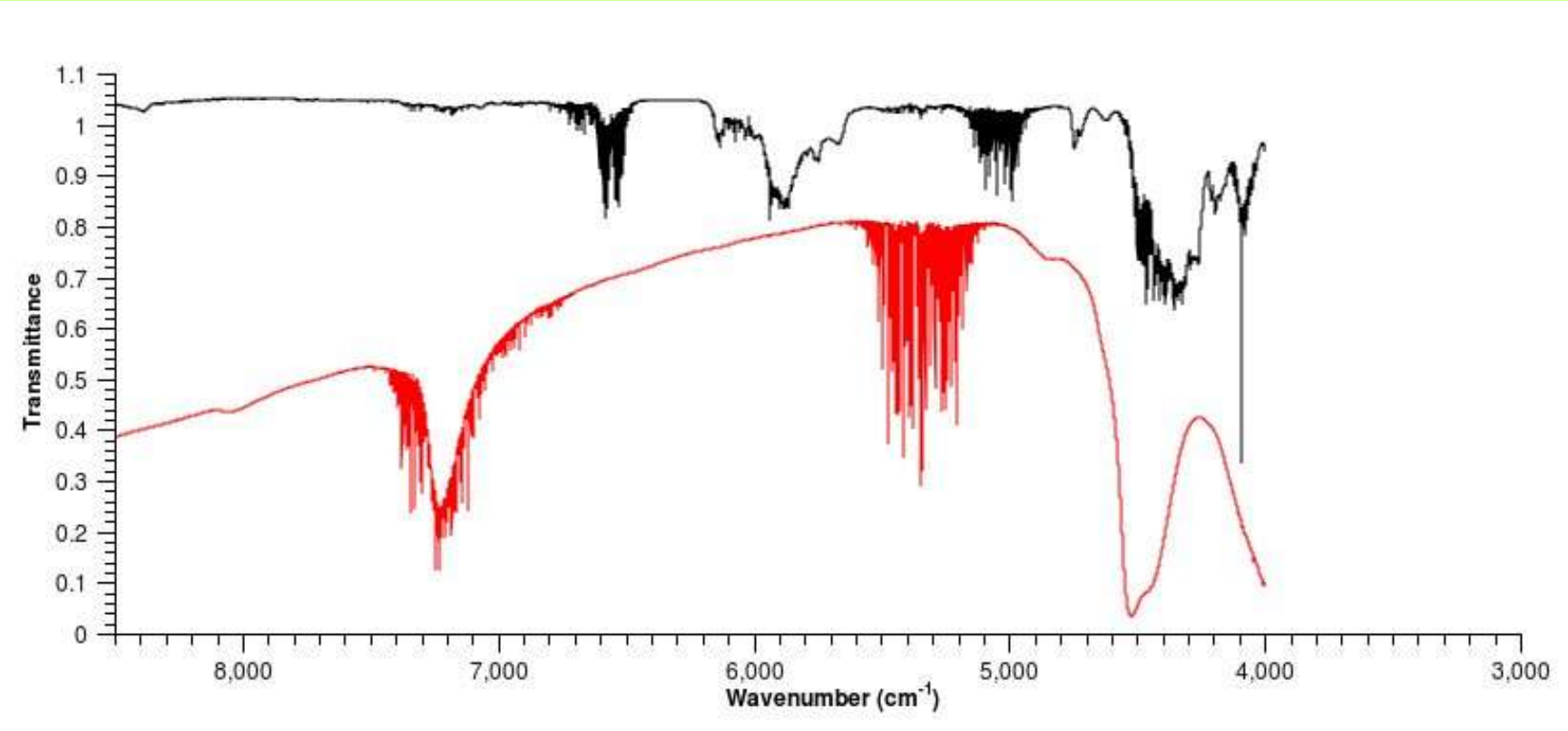
Calibration unit: Gas cells

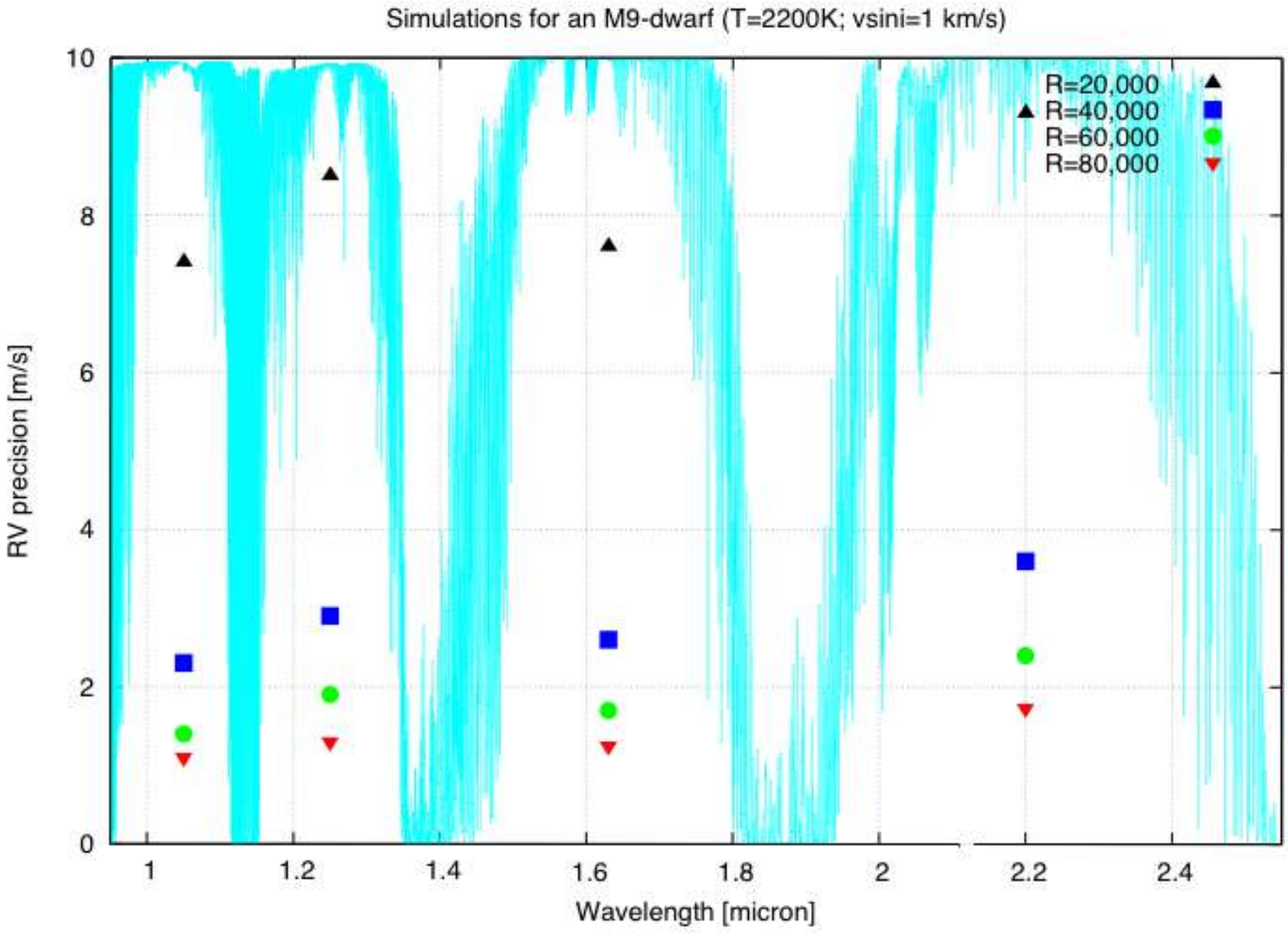


Gas cell development

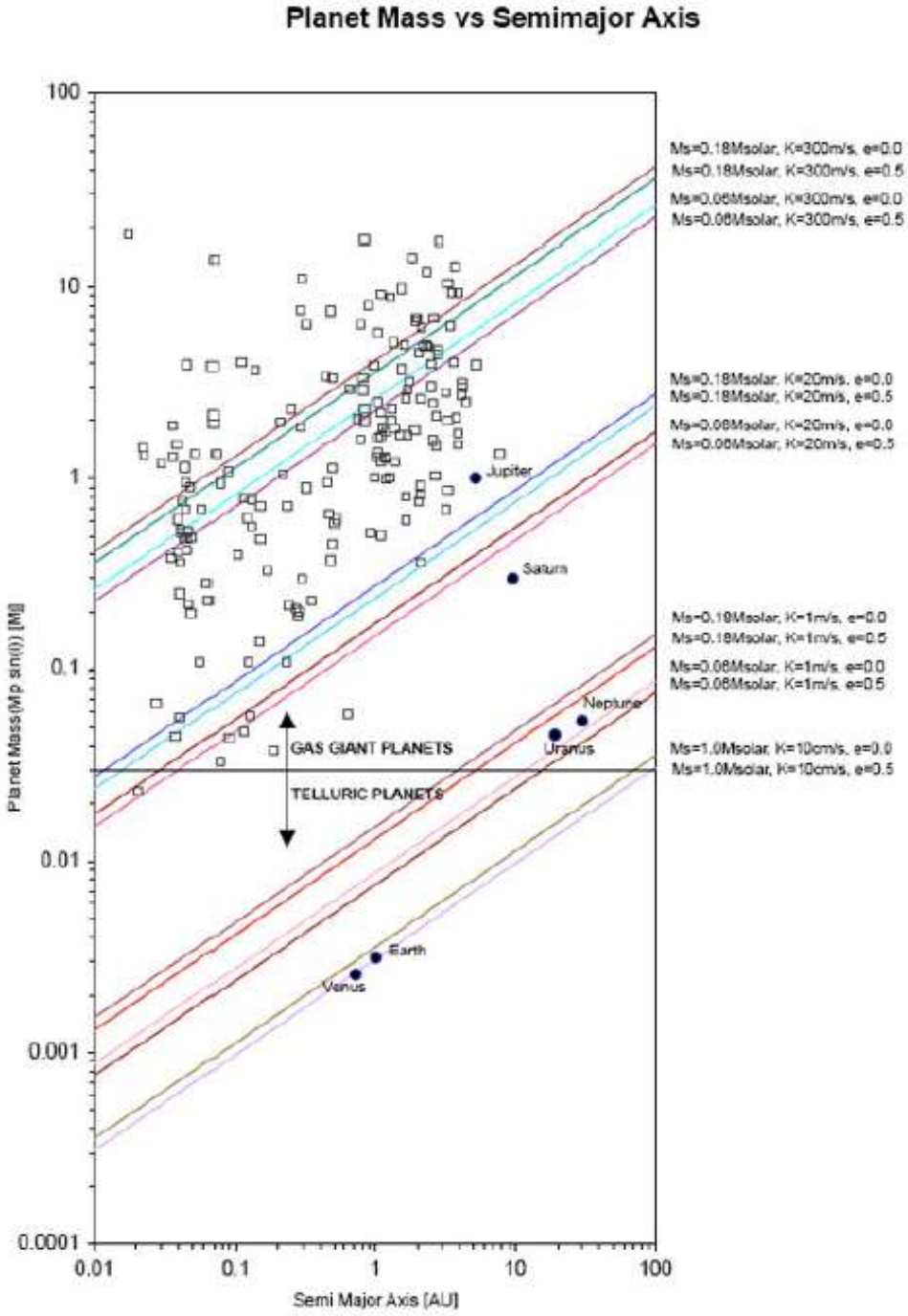
Mid-resolution gas cell spectra



L. Valdivielso et al. 2010, ApJ

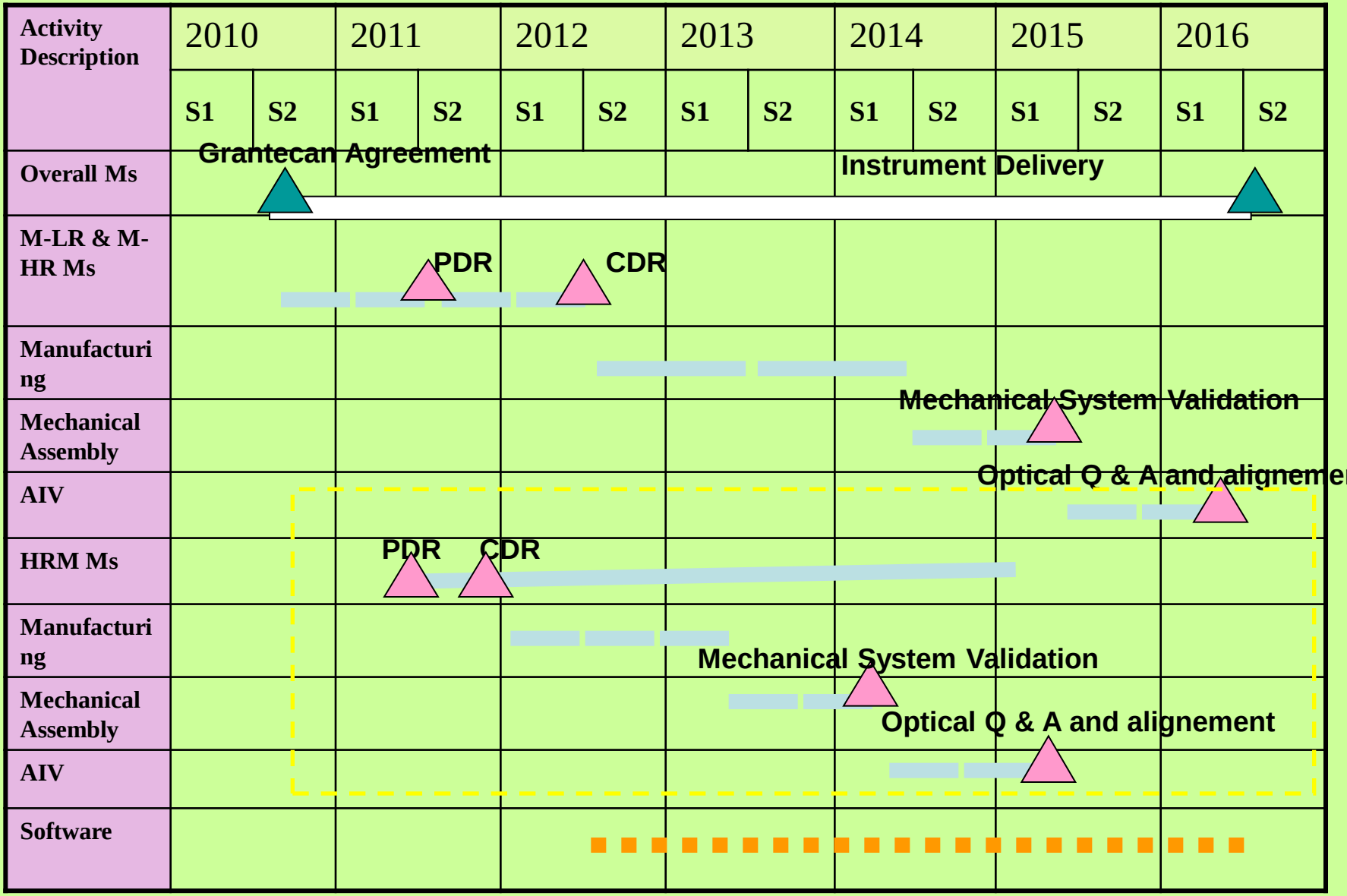


F. Rodler et al. 2010



0.06-0.1 Msun, 1 m/s

SCHEDULE


Activity Description
2010
2011
2012
2013
2014
2015
2016
S1
S2
Overall Ms
Grantecan Agreement
Instrument Delivery
M-LR & M-HR Ms
PDR
CDR
Manufacturing
Mechanical Assembly
Mechanical System Validation
AIV
Optical Q & A and alignement
HRM Ms
PDR
CDR
Manufacturing
Mechanical System Validation
Mechanical Assembly
Optical Q & A and alignement
AIV
Software

Summary

- Simplest alternatives to optical design has been chosen to maximize throughput and reduce risks.
- Optical design uses optical components available from well-known manufacturers.
- Critical components for HRM are already in hand, such as ZnSe prisms and gas cells.
- If we start in 2011, the instrument should be ready for science operation in 2016