European Extremely Large Telescope Astronomical instrumentation

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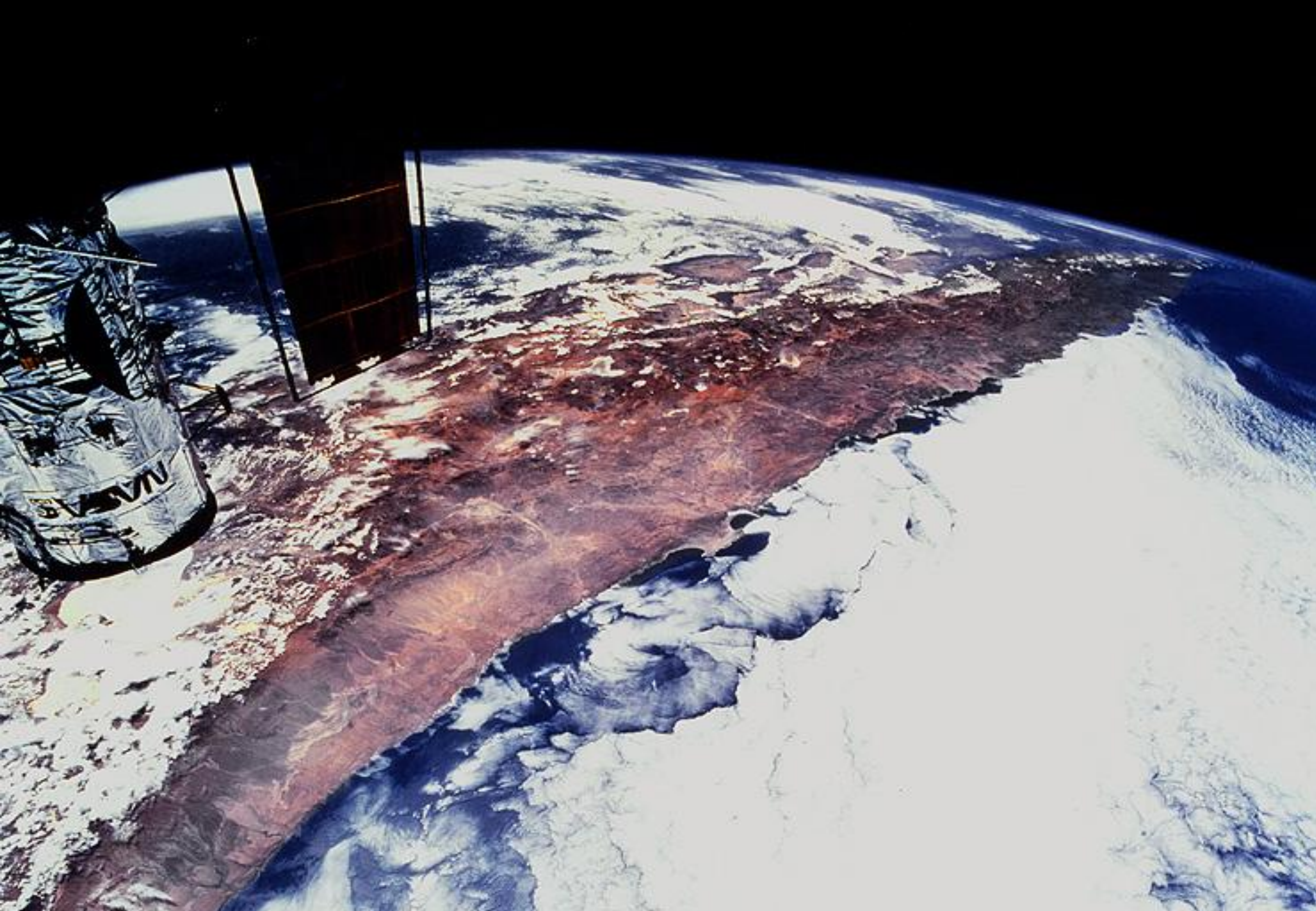
NOVA introduction

- Netherlands Research School for Astronomy
  - Top research school, evaluated exemplary in 2010
  - Federation of university astronomy institutes
  - 290 fte scientific staff (20% is directly funded by NOVA)
- Mission
  - Facilitating top astronomical research in the Netherlands
    - Hire researchers
    - Build instruments
  - Train young astronomers at highest international level

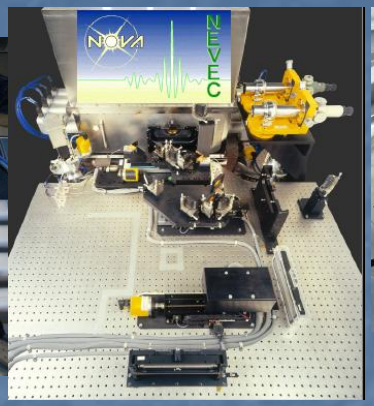
ESO Very Large Telescope

Atacama Large Millimeter Array
ALMA

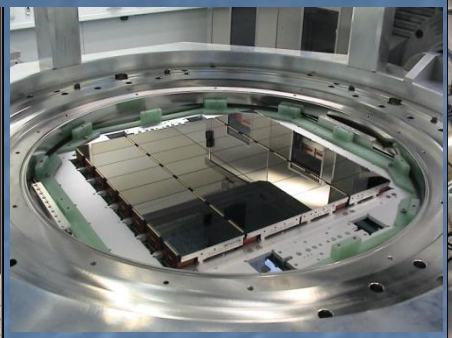


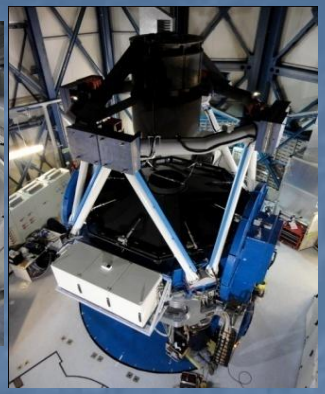
NOVA ESO projecten

MIDI

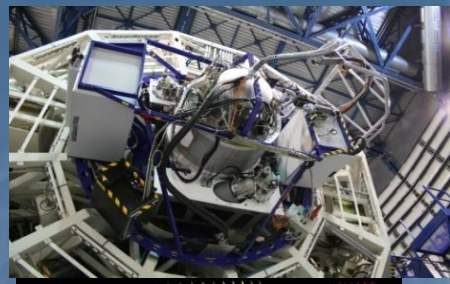


NEVEC

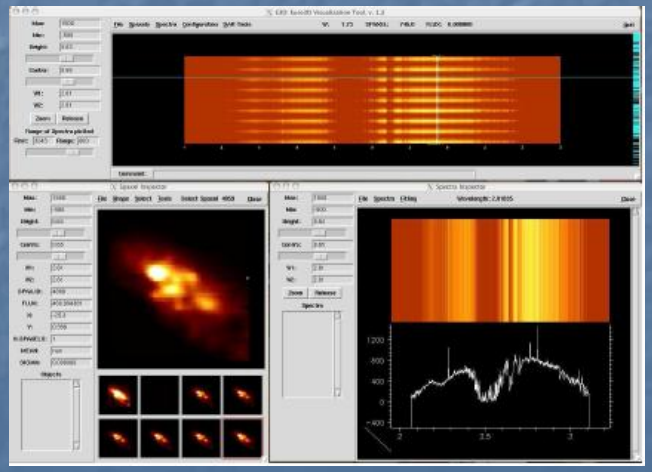




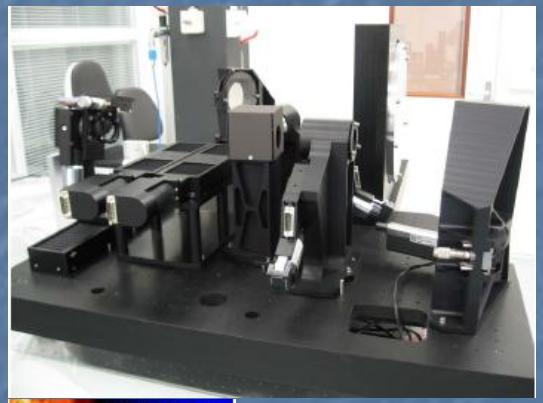
OmegaCAM voor VST → OmegaCEN



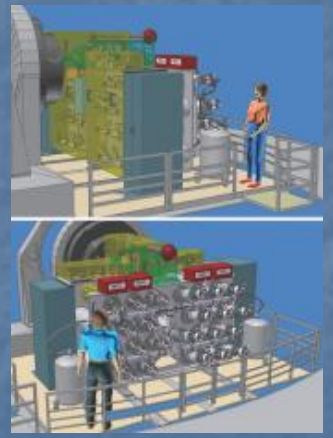
X-Shooter nabij-IR spectroscopische arm



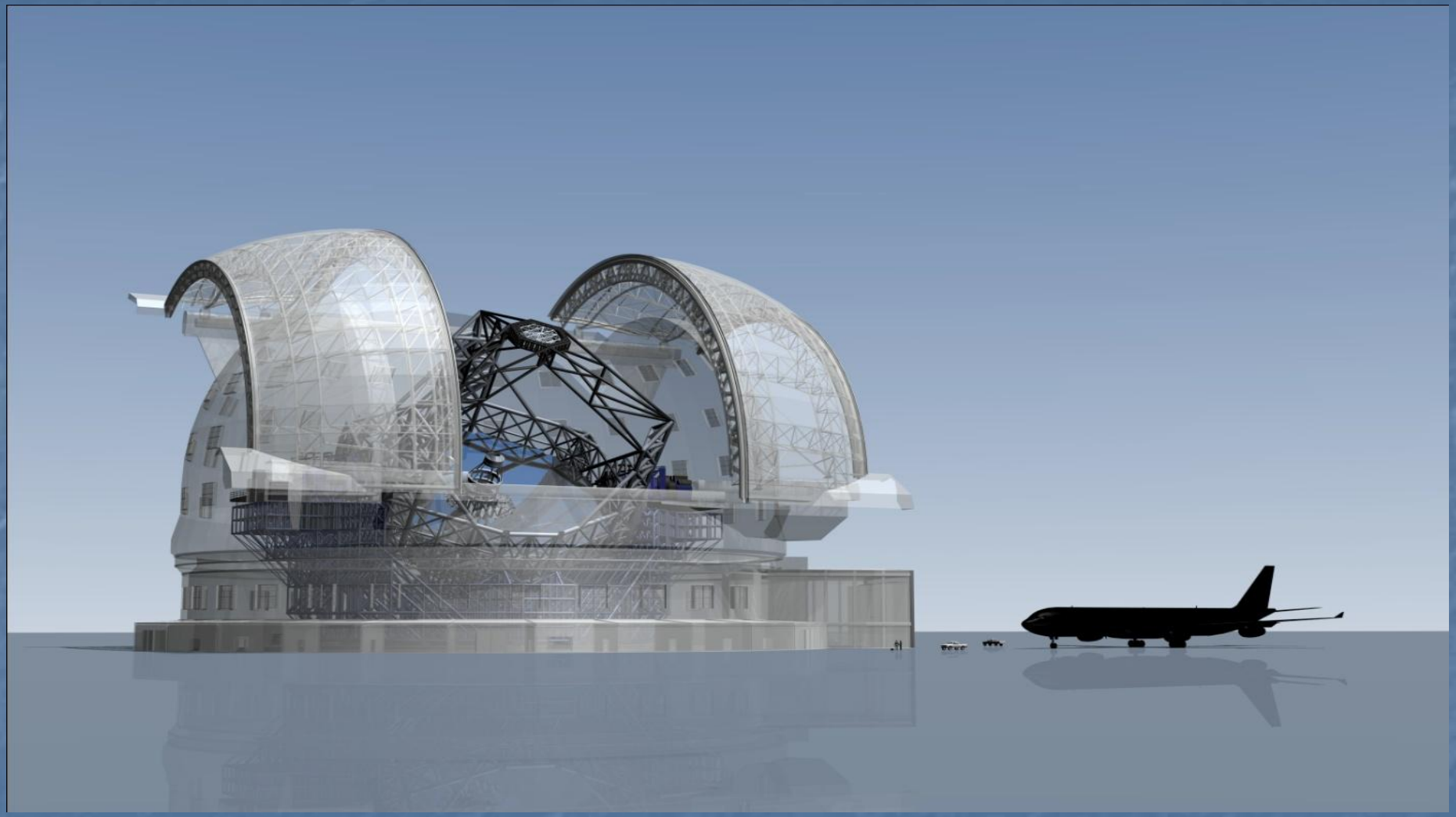
SINFONI: 2k camera voor SPIFFI: nabij-IR integral field spectrometer



Optical bench voor SPHERE Zimpol



MUSE-ASSIST: test set-up voor nieuwe VLT deformeerbare secundaire spiegel

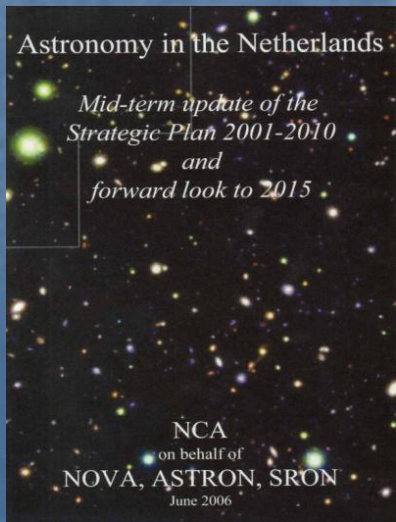


Nieuwe grote ESO project: ~40m optisch/IR telescoop

Fase B afgerond: klaar voor de bouw! (na goedkeuring Council)

NOVA instrumentation program

- Many discoveries are driven by new instrument capabilities
  - Involvement in instrument ⇨ decision about functionality
  - Involvement in instrument ⇨ understanding the instrument performance
  - Involvement in instrument ⇨ early access to data
  - Involvement in instrument ⇨ ideal position to make discoveries!
- NOVA strategy:
  - Design & construct instruments for international facilities
  - Focus on ESO
  - NOVA Optical-Infrared instrumentation group located at ASTRON in Dwingeloo

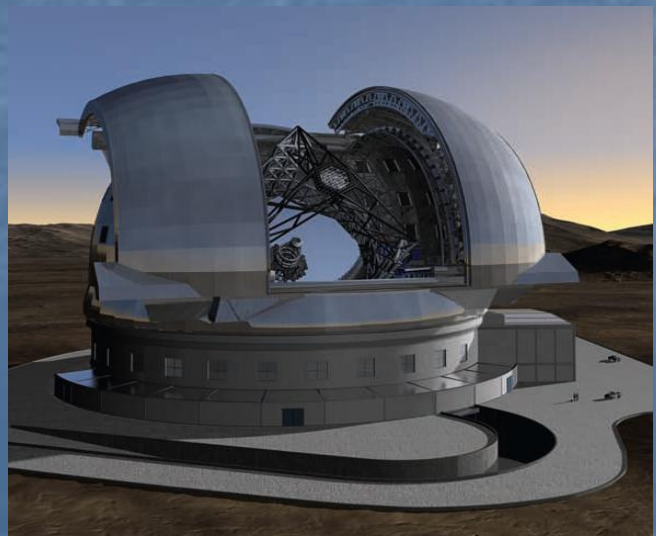


Instrument Project Characteristics

- Collaborations with international partners (for ESO projects ~4-6 partners)
- NOVA astronomer NL-leader and connection to the international consortium
- Common Project management procedures under ESO protocol (PDR, FDR, progress meetings etc.)
- Hardware design and manufacturing by NOVA Optical-IR instrumentation group
- Dutch astronomers in (inter)national science team to ensure interesting capabilities

NOVA and the E-ELT

- Objective:
  - Participate in design & construction of instrumentation for E-ELT
    - In one as a leading partner (40% share)
    - In another one as minor partner (20% share)
- Funding:
  - General NOVA budget
  - ESFRI grant of 18.78 M€
    - 8.78M€ for design and development
    - 10M€ to build one instrument (requires PI role)
  - Other grants

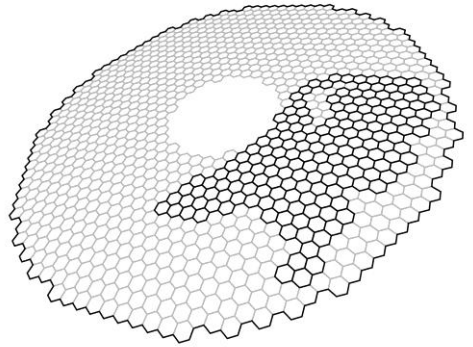


E-ELT: 8 SCIENCE INSTRUMENTS +2 Post Focal AO MODULE STUDIES

INSTRUMENT	MAIN OBSERVING MODES
OPTIMOS	Multi-slit and fiber MOS options are being studied
CODEX	High Resolution, High Stability Visual Spectrograph
METIS	Mid IR camera /spectrograph
EAGLE	WF, Multi IFU NIR Spectrograph. +AO
HARMONI	Single IFU , Wide Spectral Band Spectrograph
SIMPLE	High-Resolution IR spectrograph
MICADO	NIR Camera sampling to the DF
EPICS + XAO	Planet Imager and Spectrograph
MAORY	(MCAO) with 2 additional DM
LTAO	Module Provides DL images over a field <30”

E-ELT Instrumentation in NL

- Consortium:
  - Universities: NOVA, TU Delft, UTwente
  - Technological institutes: ASTRON, SRON & TNO
  - Companies: Airborne Composite BV, Dutch Space, JPE
- Applied for in 2008, awarded in 2009, end 2020+
- Phase I (8.78M€):
  - Preliminary design (4 instruments)
  - Technology developments
- Phase II (10M€):
  - Construction of one instrument



Industrial participation

- Large research facilities means big business
- Industry can become project supplier to ESO and/or NOVA
  - Construction of the telescope
  - Delivery of subsystems to the telescope
  - Supplier of parts of instrumentation, or partner in (optical, mechanical or thermal) design; partner is R&D to demonstrate technical readiness

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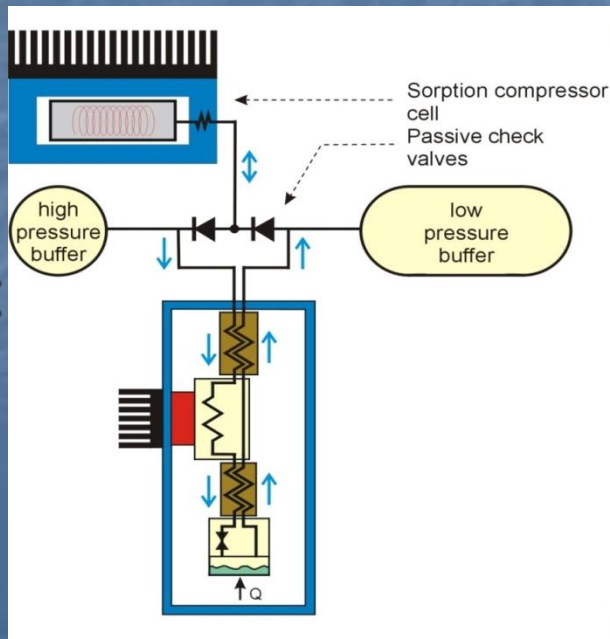
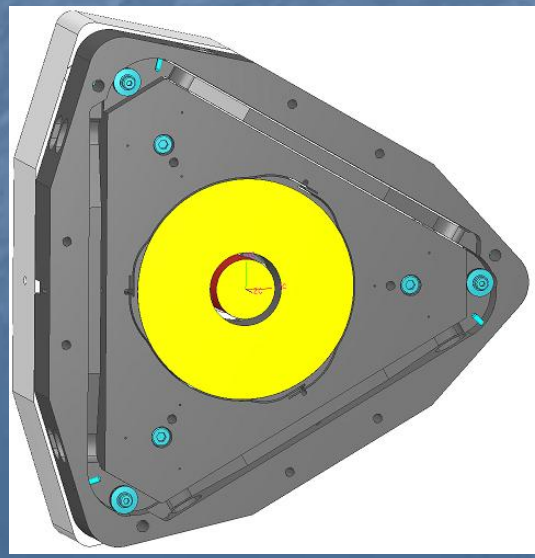
Technology developments I

- Vibration-free and precise cryo-coolers
  - Present partners: UTwente, Dutch Space
  - Motivation: High precision instruments, no vibrations
  - Potential solution: sorption coolers
  - Remaining problems:
    - Cooling power too low (10mW ⇨1W)
    - University product ⇨ commercial product



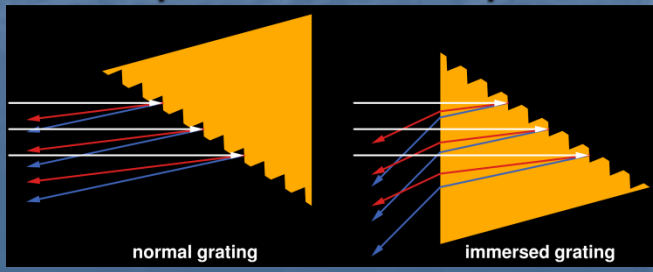
Technology developments II

- Movable cryogenic systems
  - Present partners: NOVA Op-IR, JPE, SRON, TNO
  - Motivation: High precision positioning and stability of movable elements in a cryogenic environment (80K)
  - Problems:
    - Opto-mechanical engineering
    - Very accurate positioning (nm), metrology and control



Technology developments III

- New optical components and materials
  - Present partners: Airborne, NOVA Op-IR, SRON, TNO
  - Motivation: Standard techniques will make the instrument rather big and heavy, or do not provide the required stability
  - Potential solutions: composite materials, immersed gratings, integrated optics, smart optics, free form mirrors
  - Remaining problems:
    - Behavior of composite materials in a cryo-vacuum environment (stiffness, air tightness, out-gassing)
    - Immersed gratings have not yet been made with the required accuracy
    - Manufacture products with the required accuracy (required micro-roughness RMS for free-form 30cm large Al mirrors = 15nm)



Technology developments IV

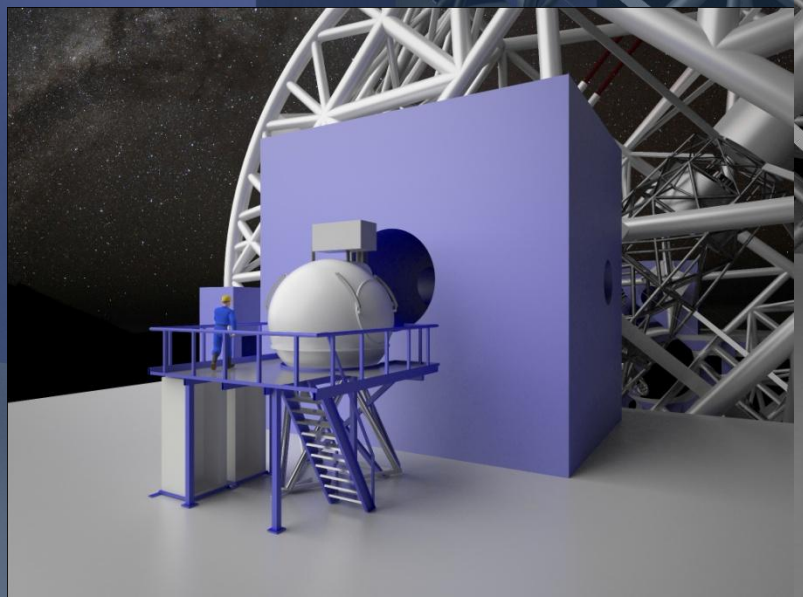
- Other areas where NOVA will look for partners:
  - Polarimetric elements and engineering
  - Precision engineering
    - Better performance prediction,
    - improved overall system engineering control,
    - modeling alignment tolerances,
  - Advanced data flow system
  - AO Control (hardware and software)
  - Industrial production process

There are many opportunities for industrial participation and products!

One example: METIS

Mid-infrared E-ELT Imager and Spectrograph

- Operating from 3 to 14 micron
  - Imager (L,M, N-band)
  - Low resolution long slit spectrometer (L, M, N-band)
  - High resolution IFU spectrometer (L, M band)
  - Coronography (L, M, N band)
  - Polarimetry (N-band)
- NOVA has PI role
  - Overall project management
  - High resolution IFU spectrograph
  - Fore optics
  - Cold central structure



Conclusion and Contact

There are many opportunities for industrial participation and products!

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- Frank Molster (molster@strw.leidenuniv.nl)