Organization and Management

of large Instrumentation projects in Astronomy

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Issues to be addressed today

- Start-up of the project
- Organization of astronomy in the Netherlands
- Management of a large community
- Management of the NOVA instrumentation program
- Multi-partner collaborations

Warming up

- What makes you a successful project leader?

Warming up

- What makes you a successful project leader?
  - Do you know yourself?
  - Have you already done the SWOT analysis for yourself?
    - Strengths
    - Weaknesses
    - Opportunities
    - Treats
  - Read/watch the news and you learn
    - a lot of examples what you should not do as leader?
    - that there are many styles of leadership

Warming up -2

- People are successful in one project and fail in another one. Why?

Warming up -2a

- For example, football trainers have success with one team, but fail somewhere else. Why?
  - It is the collaboration between coach and team
  - Is the team motivated to work together?
  - … to go for the championship?
  - The Board of the club is an important factor
  - The environment

Warming up -2

- People are successful in one project and fail in another one. Why?
  - Role of the team
  - Role of the team leader
  - Environment
  - Budget
  - Time schedule
- Lesson learnt: analyze the position offered before you accept it. Who are the team players, what are the resources available, what are the specifications, where are the challenges, what is your authority to take decisions?

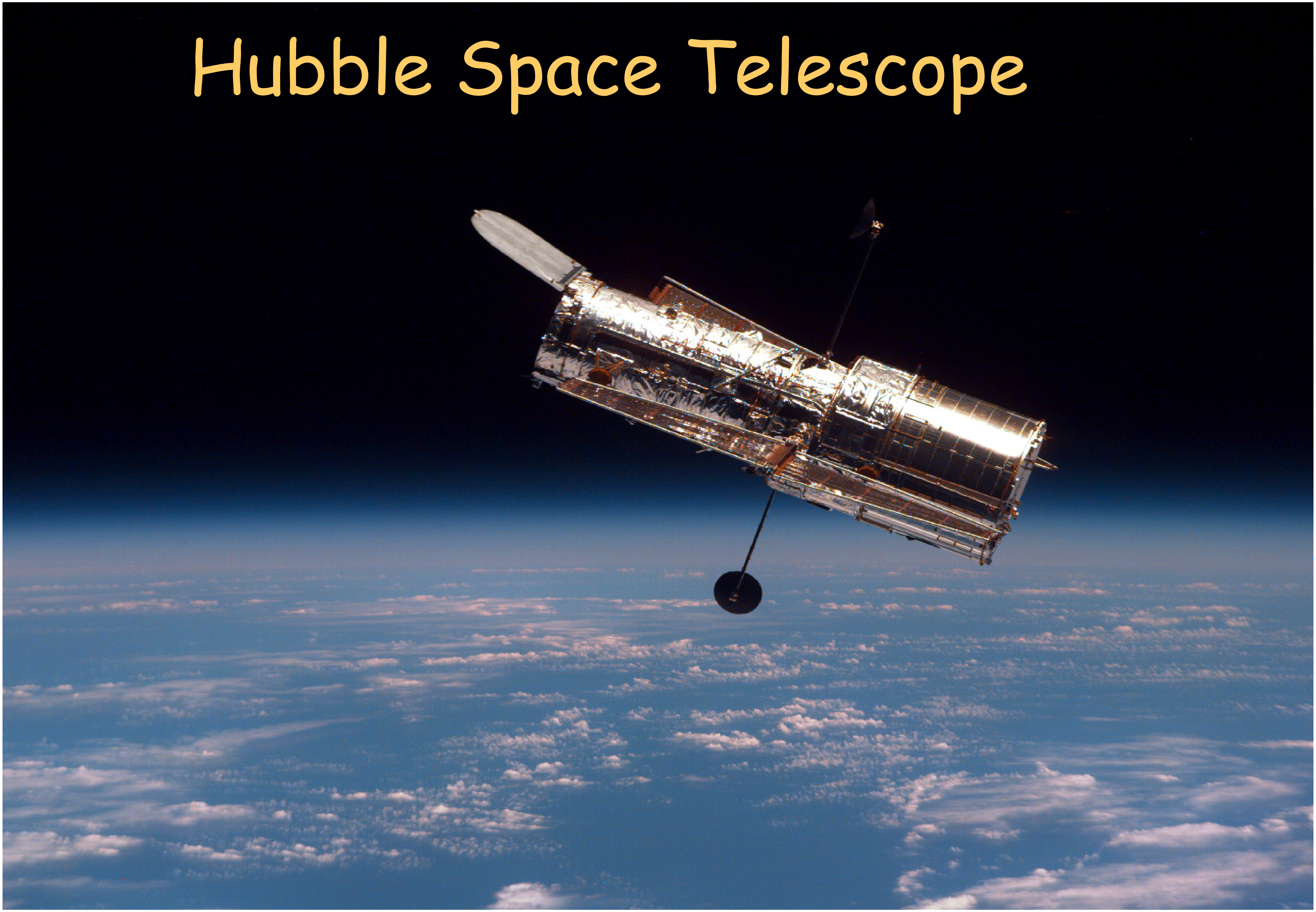
Warming-up 3

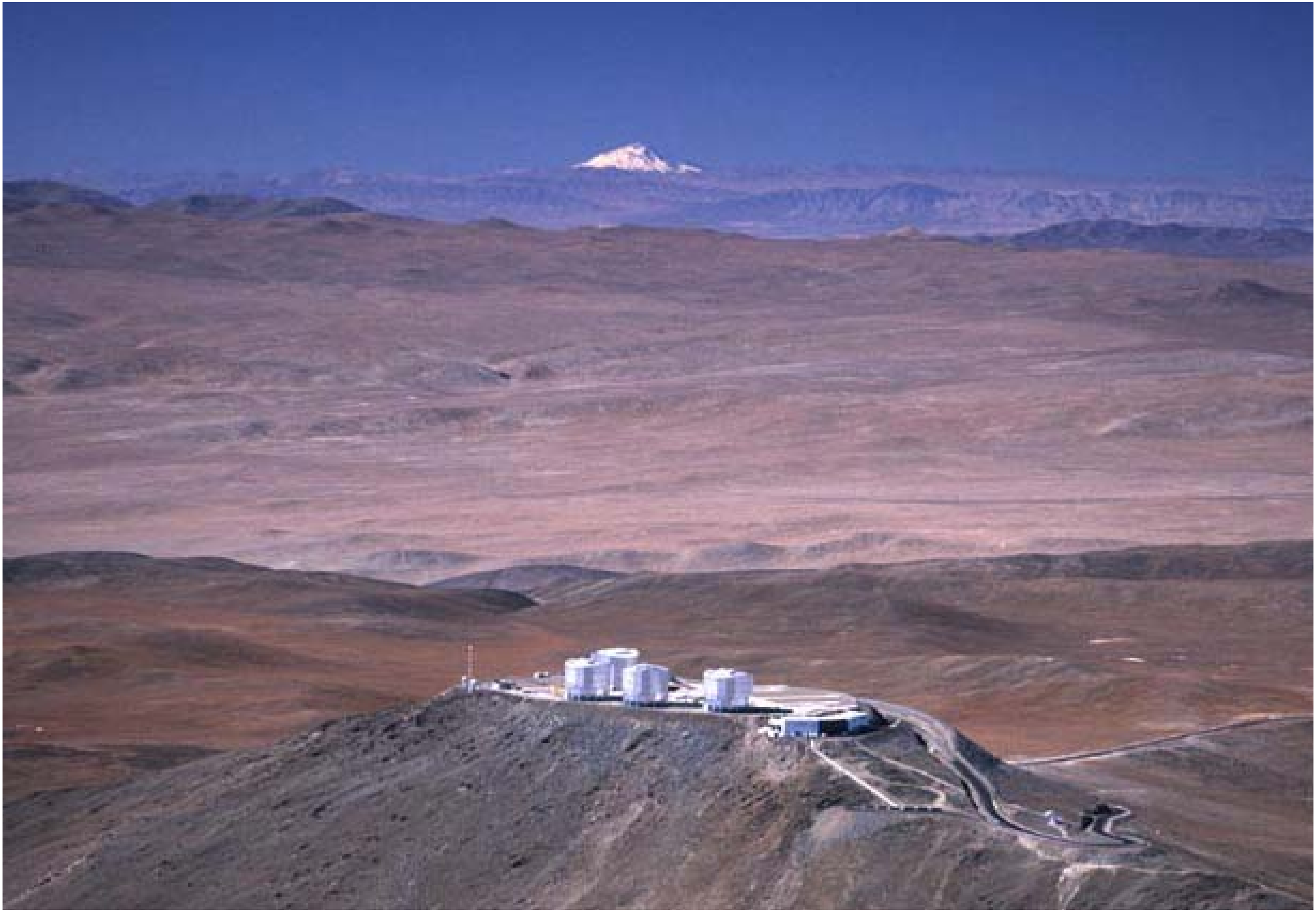
- Projects in astronomy are challenging, because
  - You are going to explore new territory
  - The aim is to make new discoveries
  - New instruments have to open a new regime in parameter space;
    - New wavelength band
    - Detection of weaker signals
    - Higher angular resolution
    - Higher spectral resolution
    - Polarimetry
    - Detection of non electromagnetic signals

Astronomy

- Observation-driven science
  - Measurements over entire electromagnetic spectrum
  - Gamma & X-rays, optical, infrared, mm and radio waves
- Technology now available to
  - Study galaxies over 95% of the age of the Universe
  - Detect and study planets around other stars

Hubble Space Telescope





Very Large Telescope and Interferometer

European Southern Observatory, Cerro Paranal


Atacama Large Millimeter Array
Llano Chajnantor (5000 m)

Start-up of the project

- What is needed before the work begins?
  - – Scientific vision about the science to do with the instrument
  - – Check whether existing instruments can be used to achieve the science goals
  - – Which (existing) telescope facilities can be used?
    - On the ground?
    - In Space?
  - – Who will to your potential partners in the project?
- About yourself
  - – How much time and energy do you want to invest in the project?
  - – Make the gain versus investment analyses for yourself

Start-up of the project -2

- Building of the partnership
  - Organize meetings-workshops to draft the science case
  - Organize the scientific community
  - Carry out feasibility studies
  - Estimate project costs
  - Guess the contributions of each of the partners
  - Guess what the competing projects are and judge were your project fits in the large-range plan of a broader community (in the Netherlands, in Europe, world-wide)

Start-up of the project -3

- Familiarize yourself with the company/organization

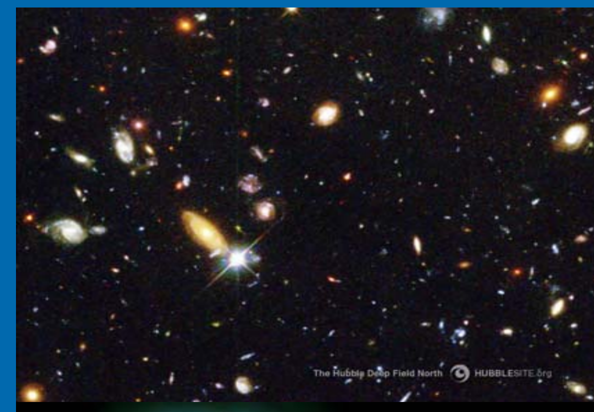
Organization of astronomy in the Netherlands
Who are the players?

- Universities
  - Federated in NOVA (270)
- National funding agency NWO
  - NWO institutes: ASTRON (160) en SRON (220)
- Membership of international organizations
  - European Southern Observatory (ESO)
  - European Space Agency (ESA)

- NOVA – Nederlandse Onderzoekschool Voor Astronomie
- NWO – Nederlandse organisatie voor Wetenschappelijk Onderzoek
- ASTRON – Netherlands Institute for Radio Astronomy
- SRON – Netherlands Institute for Space Research

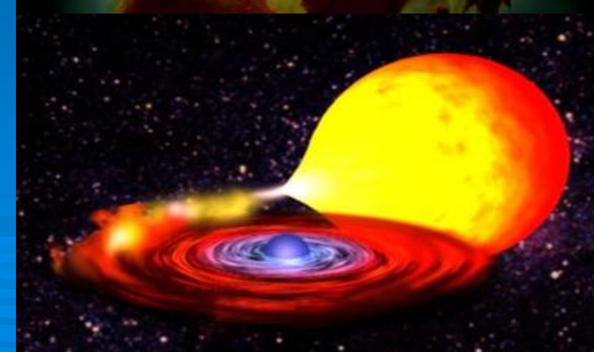
Main Themes Dutch Astronomy

- Formation and evolution of galaxies: from high redshift to the present
  - From first light to the Milky Way
  - Dark matter and dark energy
  - Black holes and the cosmic web



- Formation and evolution of stars and planetary systems
  - Is planet formation common?
  - Evolution of biogenic molecules

- Astrophysics of compact objects
  - Physics under extreme conditions
  - Black holes, neutron stars, white dwarfs



National priorities to participate in next generation large facilities

- Get involved in the European ELT through ESO; pro-active role in design and construction of an E-ELT instrument: NOVA, ASTRON, SRON and industry
- Assure LOFAR will be success for research in astronomy; pro-active role in preparations for SKA: ASTRON, with NOVA and industry
- Instrument contribution to a X-ray instrument on board of ESA's IXO mission or a instrument contribution to the Japanese/ESA SPICA mission: SRON, with industry

NOVA organization and mission

- Netherlands Research School for Astronomy
  - Federation of university astronomy institutes, rotating ‘penvoerder’
    Amsterdam, Groningen, Leiden, Nijmegen, Utrecht (penvoerder)
  - Research school for all PhD’s in the Netherlands
    Overview progress PhD projects; national approach advanced education
  - 270 fte scientific staff: ~60 fte permanent/tenure-track, ~40 fte postdocs, ~130 fte PhD students, ~40 fte staff working on instrumentation projects
- Mission
  - Carry out top astronomical research in the Netherlands
  - Train young astronomers at highest international level

One page overview

- Research, science support and instrumentation are interlinked elements of a national NOVA program.
- The integrated national program provides new discoveries, new insights and scientific leadership in an international astronomical community.
- The ambition is to maintain a forefront position in a world where several other countries show significant progress in astronomical research as well.
- Astronomy is currently in a golden age where many new discoveries occur every week; it attracts much attention from the general public and we are obliged to share our new findings with them.

NOVA program

- Program overview
  - Science
    - Three thematic research networks
    - Cross network/university projects; science support
    - Overlap positions
  - Instrumentation
    - Focus on ESO and some miscellaneous projects; towards E-ELT instruments, NOVA optical-IR instrumentation group hosted at ASTRON
  - Public outreach (http://www.astronomie.nl)

Organization of NOVA
viewed from organizational point of view

- National university astronomical community speaks with one voice to NWO, OCW and international organizations (ESO, ESA):
  - On a national scale needed to get funding for large projects
  - On an international scale to make impact is a setting where the Dutch are one of the many players
- Keeping the national community united is a challenge!
  - How to do so?

How to keep a community united?

- There are many ways to do it?
  - My personal experience
  - What are the ingredients?
  - Dutch "polder" model

How to keep a community united?

- Understand the main objectives of each of the players, and note how their objectives evolve with time
- Identify a common baseline; communicate the baseline to the team players and check for support/opposition
- In meetings were are “common rules” to follow in order to reach conclusions:
  - Have a well-defined agenda; draft decisions and their motivations should be distributed in advance;
  - People need to time express their own thoughts; later-on they might be prepared to search for a common basis and a joint decision
  - Identify support and opposition
  - Make sure everyone participates in the process
  - Check whether the proposal for the joint decision is well formulated and is interpreted in a unique way
  - Related issues that might not always under your control ….

General remarks on team management

- Team Building is the process of improving collective performance.
- A simple but effective methodology involves:
  - Establishing **ownership** of shared goals
  - **Removing inhibitors/blockages** to achievement of those goals
  - **Introducing enablers** (awareness, resources, information, processes, etc.) to help achieve those goals
  - Using team building processes (e.g.: health checks, performance management, feedback) in to gradually raise performance, akin to climbing a ladder one rung at a time

General remarks on team management

- Observe communication between team members
  - Convince yourself that people with different expertise needed to achieve the design/product are indeed talking sufficiently to each other
  - Are people able to resolve conflicting points of view?
  - Is the outcome indeed the best solution
- Observe communication with experts outside the team
  - Do people indeed contact leading experts?
  - How frequently is the exchange to relevant knowledge?
- Regular written progress reports are required to review project progress when the team becomes large or the project is carried by sub-teams at different locations
  - All team members have to contribute to the reporting process through writing about their own work
  - Use standard tables and figures in the report to allow the reader a quick scan

Overview of the NOVA instrumentation program

- The NOVA instrumentation program consists of 17 projects with a large spread of activities
- Each project has a Principal Investigator (PI): he/she
  - leads the (NOVA involvement in) the project,
  - provides the scientific and the managerial lead,
  - has responsibility for the way the project is carried out,
  - is accountable to NOVA for use of the funds and for the reporting
  - has responsibility for the human resource management of his/her team members
- In large projects the PI is supported by a project manager (PM) and a project controller.

NOVA instrumentation program

Phase-3 instrumentation program	Allocated budget in k€	
Optical-IR group, including		5,829
SPHERE-Zimpol (MAIT phase)	908	
METIS Phase-A study	414	
Micado Phase-A study	102	
OPTIMOS-EVE Phase-A study	171	
EPICS Phase-A study	88	
Matisse PDR study	196	
ALMA Band-9 production		10,238
ALMA ALLEGRO		547
ALMA technical R&D		517
MUSE		314
MUSE-ASSIST		986
MIRI		1,191
Gaia		424
LOFAR-DCLA		1,773
AMUSE		526
S^5T		339
$MATRI^2CES$		458
Seed funding, EC, contingency, new initiatives		2,288
TOTAL INSTRUMENTATION PROGRAM		**25,430**

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Overview of the NOVA instrumentation program -2

- The Instrument Steering Committee (ISC)
  - reviews progress on each of the projects twice per year (in March and October)
  - reports its findings to the NOVA Board and Directorate
  - makes recommendations to the NOVA Board and Directorate on required actions, modifications of projects, release of contingency funds, etc
- The Board takes the final decisions

Overview of the NOVA instrumentation program -3

- Each project has to provide a written report every half year. The report has to address the following topics:
  - Overall objective and status of (NOVA's involvement in) the project
  - Project management (key persons and collaborating institutes; overall resource contribution from NOVA; reporting methods; status of agreements and major contracts, etc)
  - Progress since previous report
  - Major meetings, past and future (science/technical committees, reviews)
  - Milestones, past and future (key deliverables, acceptance tests, etc)
  - Training aspects and publications
  - Critical areas (hardware, personnel, resources, external suppliers, collaborators, etc)
  - Items for specific consideration by the ISC (e.g request for release of contingency funds)

Overview of the NOVA instrumentation program -4

- Some PI's are requested to give an oral presentation at the ISC meeting, and to answer questions of the ISC
- A first discussion of the project status and of the recommendations to NOVA are discussed by the ISC with the PI present and invited to comment; final conclusions are reached at a closed session of the ISC.
- In exceptional cases a project requires a more elaborate evaluation; NOVA sets up an ad-hoc review panel of (inter)national experts that gets access to much more project information and meets with the project PI and his/her team to carry out a detailed fact finding. The review panel reports its findings in writing to the NOVA Board and Directorate and makes recommendations where needed. The NOVA Board makes the final decisions.

Role overall program manager

- Make sure that the procedures from written progress reports, review by the ISC, recommendations of the ISC to the Board/Directorate, and decisions by the Board is transparent, fair and effective.
- Carry out additional fact finding through talking to the project PI's and PM's, project team members, and to foreign partners in international collaborations.
- Take appropriate actions where required.

Role overall program manager -2

- Some principals
  - How to assure that PI's and PM's are providing all and accurate information?
  - How to check whether PI's and PM's themselves have up-to-date information?
  - Discuss eventual fall back options with 'PI's
  - Call in experts when you feel that the PI and the PM can not resolve all problems within the time available

Role overall program manager -3

- Some principals
  - How to assure that PI's and PM's are providing all and accurate information?
    - Create transparency; open communication, supportive attitude
    - Frequently talking to people on progress, milestones, critical path and risk register is essential
    - Is the attitude really on 'delivery on time, on budget and according technical specifications'? Which one has priority? Discuss eventual short cuts before they are really needed!

Role overall program manager -4

- Some principals
  - How to check whether PI’s and PM’s themselves have up-to-date information?
    - Do team members pass all information to their PI and PM? How open is the internal communication within the project?
    - Often official figures on ‘hours worked on projects’ and actual financial expenditures are 3-5 weeks old. Project administration takes time and often some people are not cooperative.
    - Experts prefer to resolve issues themselves: often a bit more dialog would remarkably speed up the process. Be aware of that!
    - Experience is that many large projects has a “unknown unknown” that might hit the project soon or later. Discuss this with the PI.

Role overall program manager -5

- Some principals
  - Discuss eventual fall back options with ‘PI’s
    - The project risk register lists all eventual risks, their impacts, and options or measures taken to mitigate the risk
    - In large projects the risk register has to be updated every months starting mid-way the FDR phase; before this register is under development, and hence has regular attention as well
    - Fall back options include cancellation of the project when the ambition is a bridge to far, searching for an additional partner, relax the technical specifications (and hence reduce the scientific ambition), call for more staff resources and hence additional funding

Role overall program manager -6

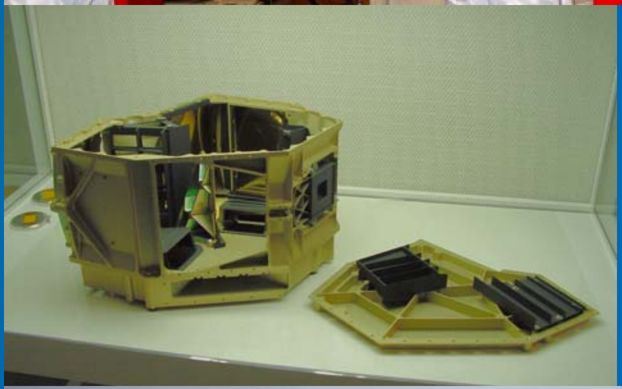
- Some principals
  - Call in experts when you feel that the PI and the PM can not resolve all problems within the time available
    - It is difficult to judge when to do so
    - When you have decided to call in experts and they met with the project team you are glad you called them in
    - Often more problems were discovered

Management of dispersed teams

- Large projects are often collaborations of a number of institutes
- Some examples with NOVA involvement:

Multi-partners collaborations

- The X-Shooter spectrometer for ESO's Very Large Telescope; the Netherlands designed, fabricated and tested its near-IR arm
- The Mid-IR Instrument (MIRI) for use on the James Webb Space Telescope; the Netherlands delivered the cold optical bench for its mid-IR spectrometer
- The Atacama Large Millimeter Array (ALMA): the Netherlands designed and fabricated the Band-9 receiver cartridge covered the 600-720 GHz part of the sub-mm spectrum



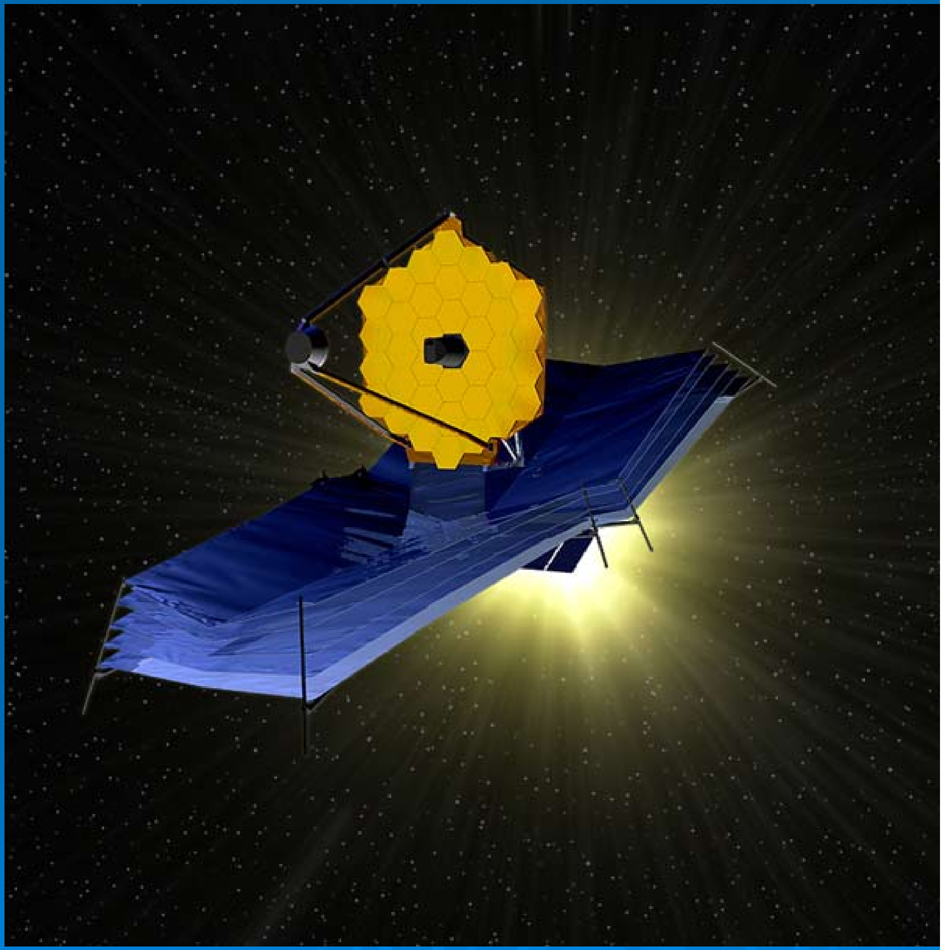
Motivation for these collaborations

- Joint scientific motivation
- Each partner has limited
  - staff and cash resources
  - coverage of all required expertise
- The collaboration offers complimentary in knowledge, experience and putting together available resources

A significant benefit in scientific return for a limited cost

MIRI as an example

- James Webb Space Telescope (JWST); successor of HST
- Launch in 2013
- NASA (85%) – ESA (15%) collaboration; total costs ~4.5 B$
- NASA provides the spacecraft, 1.5 instruments, and satellite operations
- ESA provides the launcher and 1.5 instruments: NIRspec and half of MIRI
- Mid-InfraRed Instrument (MIRI): total costs are ~150 M€
- The European part of MIRI is a consortium of UK (lead), Fr, Ger, Sp, Swe, Bel, NL, Swi, Dk and Ire (10 countries)
- The NL contribution is the cold optics for the mid-IR spectrometer and a set of gratings (~10 M€)



James Webb Space Telescope

James Webb Space Telescope (JWST)

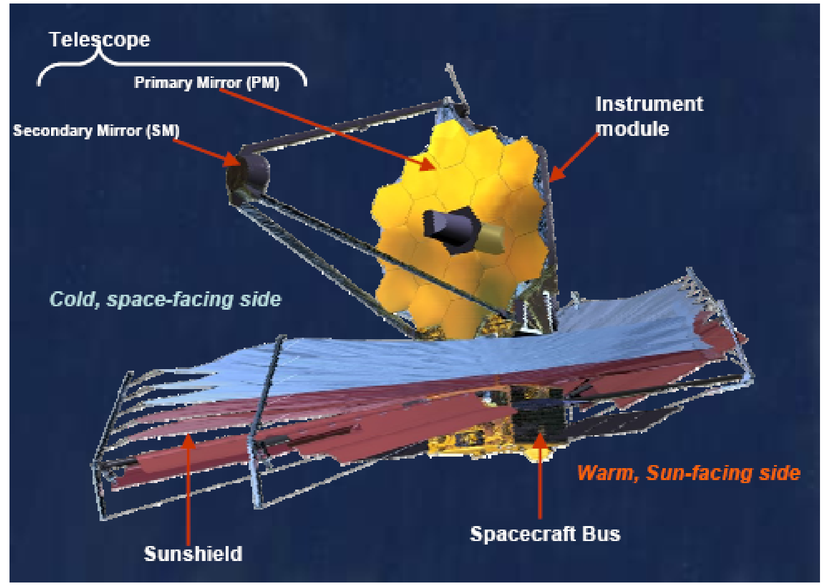
Mission Objective

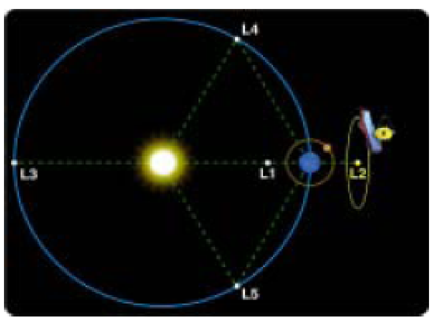
- Study the origin and evolution of galaxies, stars and planetary systems

  Optimized for infrared observations (0.6 – 28 μm)

Organization

- Mission Lead: Goddard Space Flight Center
- International collaboration with ESA & CSA
- Prime Contractor: Northrop Grumman Space Technology
- Instruments:
  - Near Infrared Camera (NIRCam) – Univ. of Arizona
  - Near Infrared Spectrograph (NIRSpec) – ESA
  - Mid-Infrared Instrument (MIRI) – JPL/ESA
  - Fine Guidance Sensor (FGS) – CSA





Description

- Deployable telescope w/ 6.5m diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch NET June 2013 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2
- 5-year science mission (10-year goal)

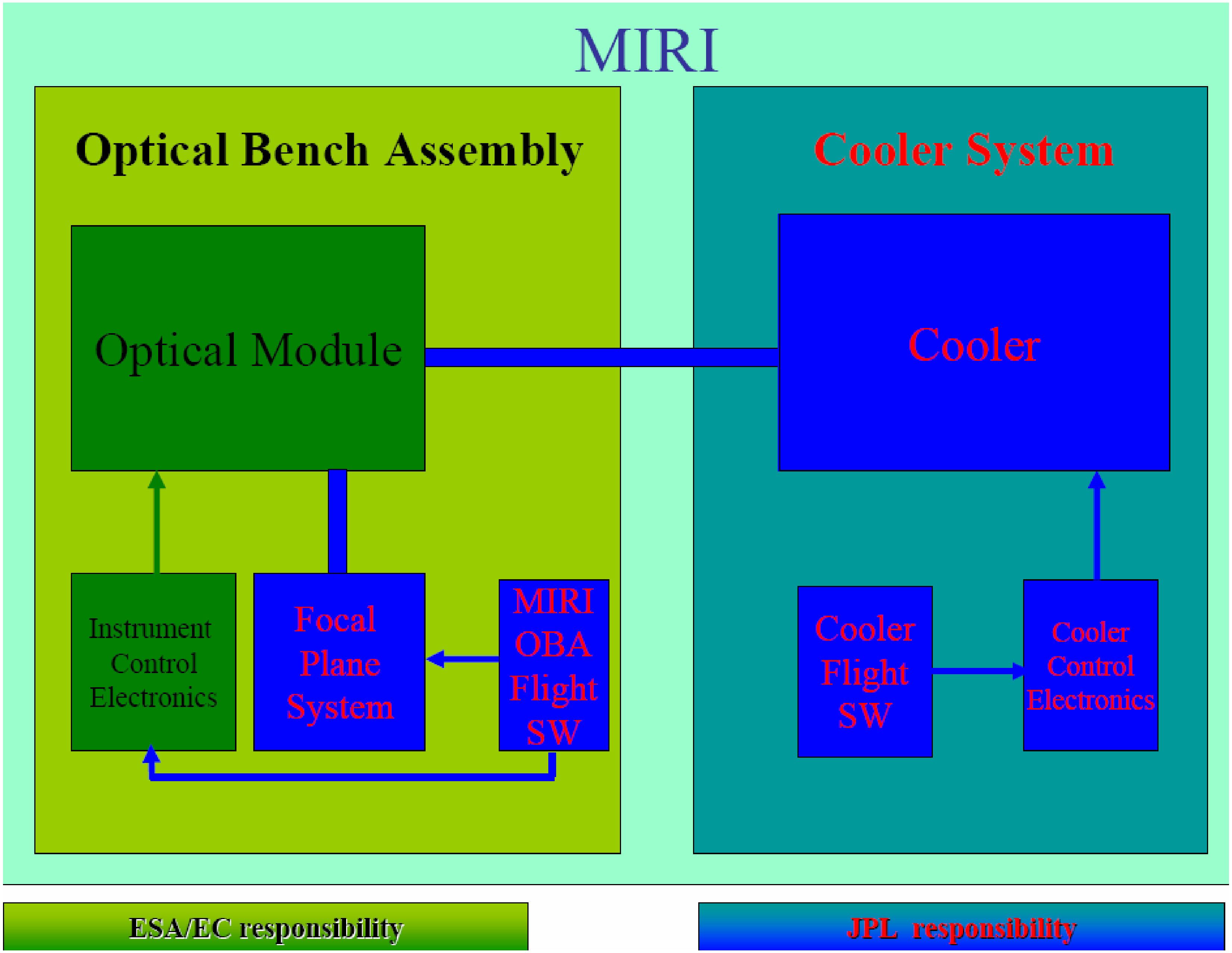
www.JWST.nasa.gov

99	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019

Concept Development | Design, Fabrication, Assembly and Test | science operations ...

Phase A | Phase B | Phase C/D | Phase E

ormulation uthorization | ICR (PNAR) | NAR | Launch


MIRI
Optical Bench Assembly
Optical Module
Instrument Control Electronics
Focal Plane System
MIRI OBA Flight SW
Cooler System
Cooler
Cooler Flight SW
Cooler Control Electronics
ESA/EC responsibility
JPL responsibility

MIRI as an example

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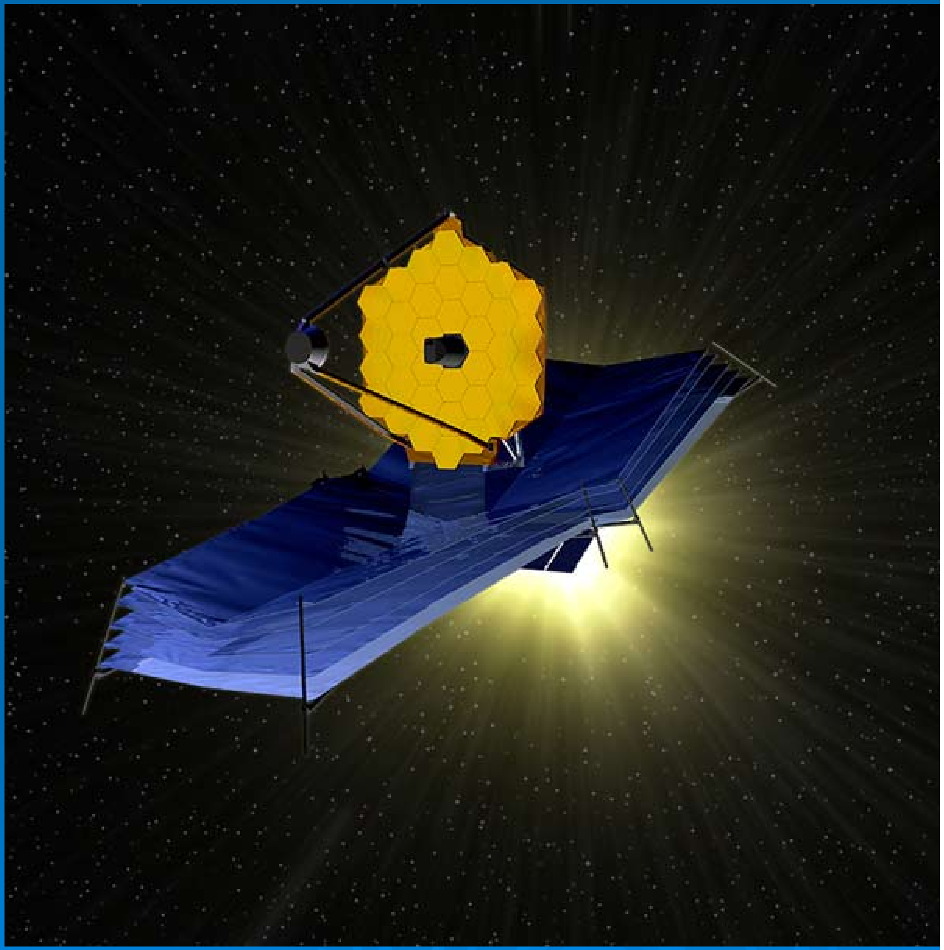
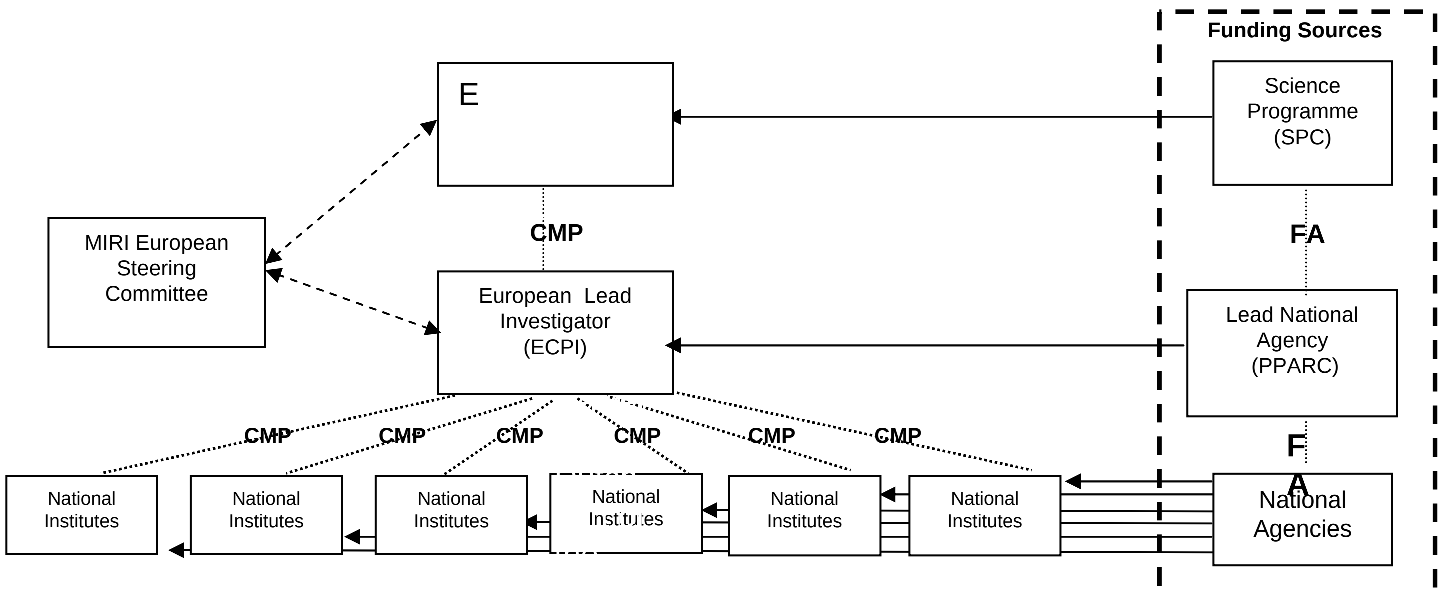


The aims of the NOVA project

- design, build and deliver the Dutch part of the spectrometer to the European consortium according to specifications;
- ensure strong Dutch participation in the scientific exploitation of MIRI;
- maintain and develop mid-infrared scientific and technical expertise in the Netherlands, important for securing a Dutch role in future infrared missions.

The European MIRI Consortium



NL MIRI project

- Funding (~ 9.5 M€) secured in 2002
  - 5.765 M€ NWO-Groot
  - 1.5 M€ NOVA Phase-2
  - 2.5 M€ matching Universities + ASTRON
  - SRON consultancy
- NL contribution is led by NOVA; has signed the European consortium agreement on behalf of NL
- NL responsible for spectrometer module; integral field units ('fore-optics') by UK; mechanisms by Germany
- NL work packages were carried out by the Optical-IR instrumentation group at ASTRON; TNO contributed to the optical design; Industry contributed hardware components, for instance the gratings; for quality control an external experts was hired; hardware delivered to UK in early 2009
- Lessons learnt

European consortium

- Ten countries involved; formal arrangements were concluded in a consortium agreement
  - Each country had responsibility to design, fabricate, verify and deliver well-defined parts of the instrument
  - Interface control document
  - Consortium PI (Gillian Wright) leads the European part; she is supported by managers from Astrium Aerospace
  - Oversight by
    - European science team
    - European MIRI Steering Committee
    - Special arrangements between ESA and the European Consortium

European Consortium -2

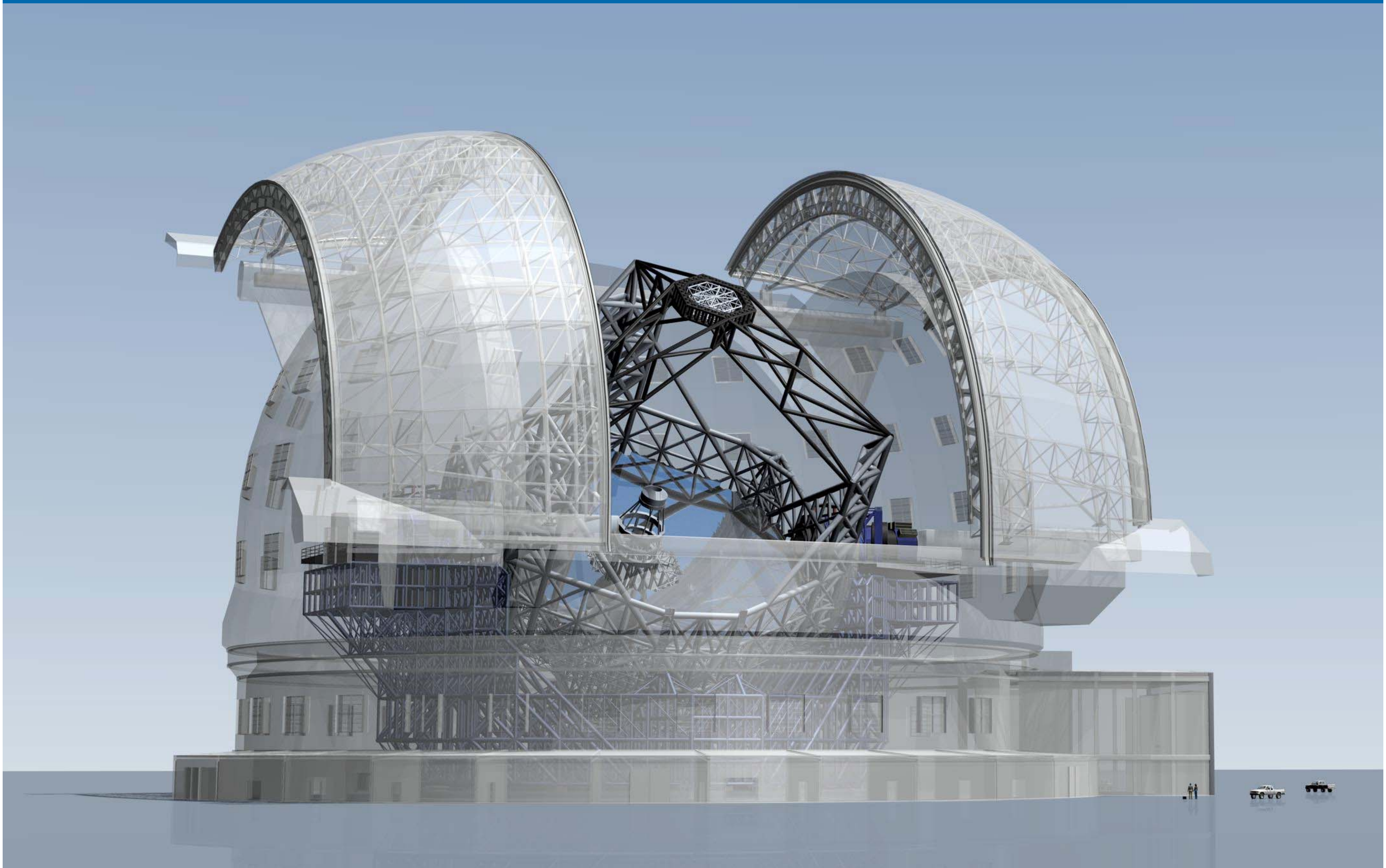
- Realize that each partner has to meet its commitments up to full specifications otherwise the instrument will not perform
- Detailed interface documentation is essential; invest in it
- How to handle tension between the priorities of individual partners versus vital interest of the consortium? Difficult when a partner is the national space agency

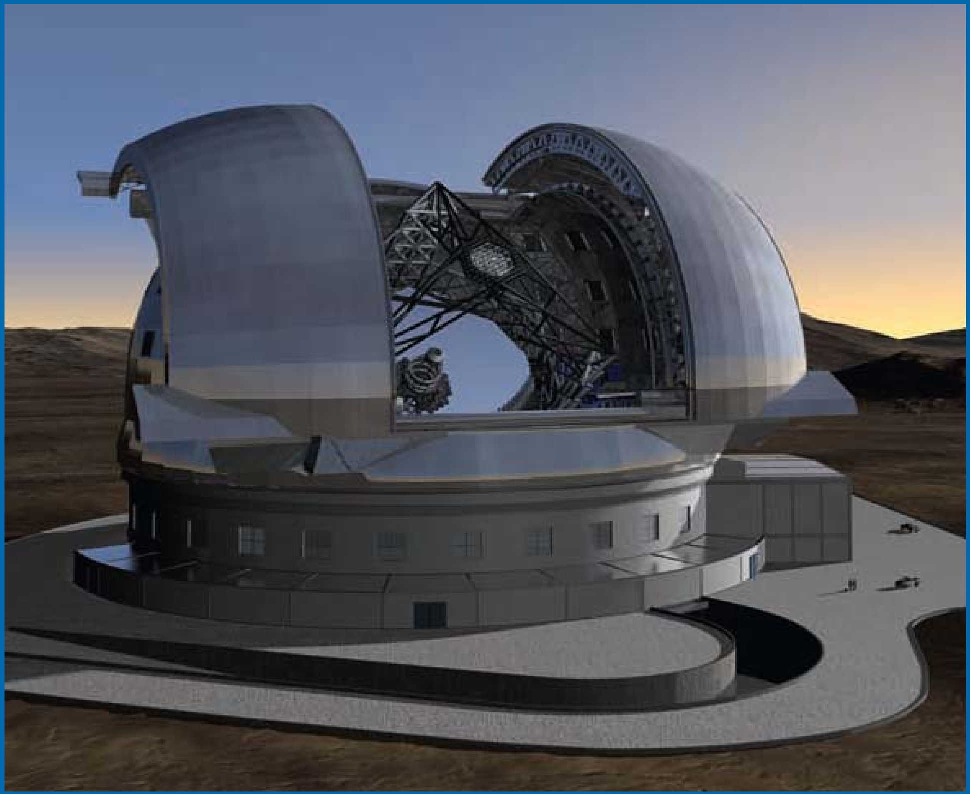
Some lessons learned

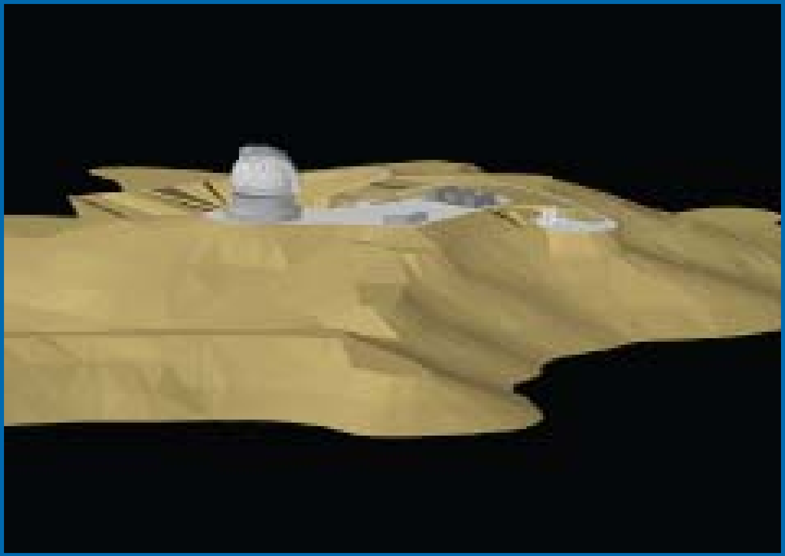
- Know your team members, your partners and the organizations involved
- Coach people on their strengths; keep them highly motivated, and assure they have sufficient time to work on your project
- Be aware of threats from within the host organizations of the partners; get your project sufficient priority
- During the Phase-B study review the work packages, commitments and available resources (staff and cash) of each partner, and take actions where necessary
- Is the entire consortium organization robust enough to handle unforeseen problems?

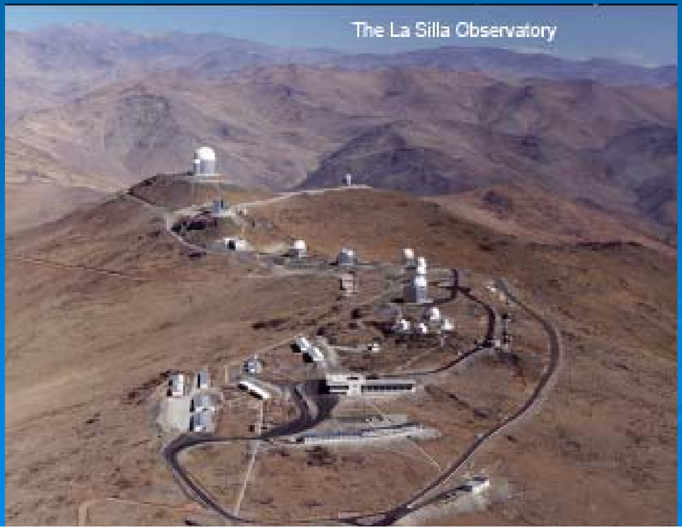
Some lessons learned -2

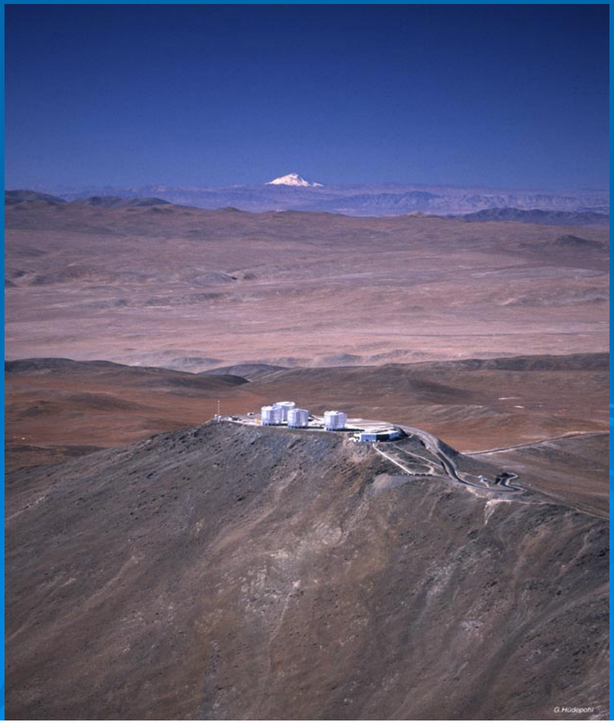
- At the start of the project negotiate with ESO/ESA on the technical specifications and statement-of-work and find solutions that are acceptable for all parties involved
- Invest time is good interface specifications, and in assuring that partners understand and accept them
- Be aware of changes in the technical specifications during the project: a proper analysis is absolutely needed








The La Silla Observatory



The E-ELT project

- A project led by ESO on behalf of 14 member states and in collaboration with the European astronomical community
- 42m adaptive telescope, segmented primary mirror
  - Will enable transformational science
  - 25x increase in collecting area compared to present generation
  - 5x improvement in angular resolution
- Schedule:
  - Detailed design phase: Jan 2007 – Jun 2010
  - Decision ESO Council expected in Dec 2010
  - Start of construction: 2011
  - First light: 2018
- Cost:
  - Telescope, including 1st hardware generation instruments: ~1000 M€
  - Operations: 50 M€/year

Motivation to design/build instruments

- Ensure future scientific capabilities to enable scientific breakthroughs by astronomers in the Netherlands
  – Ensure instruments are ideally suited for NL science strenghts;
  – Get early access; exploit the instrument to its limits because knowing it well
- Involve young talent, draw more of the younger generation into science
- Generate technological breakthroughts in the Netherlands, many potential spin-offs
- Build on existing heritage

  - ISO-SWS, VISIR, Herschel, MIRI → METIS

  - X-Shooter → OPTIMOS

  - SPHERE → EPICS

  - OmegaCAM → MICADO

Our national partners

- Netherlands Research School for Astronomy (NOVA)
  - Federation of university astronomy institutes, rotating 'penvoerder', Amsterdam, Groningen, Leiden, Nijmegen, Utrecht (penvoerder)
  - 270 fte scientific staff: ~60 fte permanent/tenure-track, ~40 fte postdocs, ~130 fte PhD students, ~40 fte staff working on instrumentation
- Academic partners
  - ASTRON, SRON, TNO, TU Delft, TU Eindhoven, Univ Twente
- Industrial partners
  - Airborne Composites, Cosine Research, Dutch Space, Janssen Precision Engineering, Thales Cryogenics

Netherlands strategy towards E-ELT

- Current involvement in 4 Phase-A instrument studies: 2008 - 2009
- Technology development / demonstration together with partners: 2009 – 2011
- On a minor level follow-up work on the 2-4 Phase-A studies: 2010
- From Phase-B (>2011) onwards our objective is to participate in two E-ELT instruments
  - In one as a major or leading partner (40% share; funded)
  - In another one as minor partner (20% share; not funded)

Budget

- 2009 – 2011: M€ 8.8 ESFRI grant + M€ 1.8 matching
  - WP1: management: k€ 150
  - WP2: Phase-A studies: k€ 1000
  - WP3: Phase-B studies: k€ 3000
  - WP5: Technology development: k€ 6130
  - WP6: Knowledge dissemination: k€ 300
- 2012-2018: M€ 10 granted on conditions
  - WP4: instrument final design and construction
- 2008: start Phase-A studies: k€ 700 from NOVA, ASTRON, SRON, TNO

Project management challenges

- Funding of NL participation: OK for short term; need further attention before the E-ELT instrumentation projects enter into Phase-B
- Price tag of an E-ELT instrument: 30-70 M€ each
- Need for international collaborations: consortia of 4-6 partners in preferred; good coverage of all required disciplines/expertise
- National structuring through NOVA as national body for collaborations with ESO

Requirements

- Important aspects:
  - Good interactions between the project PI, the PM and the project team (which might be spread over different locations)
  - Work in-house versus partnership with industry and TU's
  - Identify key-technology, like
    - Mid-IR spectrometers
    - Cryogenic operating conditions
    - Polarimetry
    - Software
    - Project control (staff, finance, reporting)

Requirements -2

- Identify key expertise
  - Translation of astronomical wishes to technical specifications
  - Optical, Mechanical and Thermal design
  - System engineering
  - Interface control
  - Quality assurance
  - Documentation
  - Production
  - Interactions with industry: outsourcing, control
  - Integration
  - Testing

Management challenges -2

- E-ELT instrumentation project: ambition is to become international PI of one project
  a. Organization and management of International consortium
  b. Interface with ESO
  c. The national contribution
- Effort on a + b = effort on c
- Project path:
  - Feasibility study / Conceptual design / Phase-A
  - Preliminary design / Phase B
  - Final design / Phase C
  - Fabrication, integration and testing / Phase D
  - Acceptance, integration in full instrument, testing, commissioning

Management challenges -3

- Is all technology mature?
  - If yes, your approach might be too conservative
  - If no, resolve the unknowns in an early stage of the project
- Use parallel approaches where major potential risks might occur
  - In technology: set-up two independent teams to work on solutions following different approaches
  - In production preparations: follow a open tendering procedure, select the two best proposals, and give two companies a contract to carry out the work package independently from each other

Conclusions

- There are different styles of project management
- Each person has his/her own style; it is an advantage when you have the capacity to switch style if the project needs it to do so
- Project management is also people management: recognize the strengths of individuals, let them work in those areas, and secure that the entire team covers all disciplines and skills needed.