


- General introduction to instrumentation
- New instruments and opportunities
 - La Silla – Paranal Observatory (VLT)
 - E-ELT
 - Instrumentation R & D

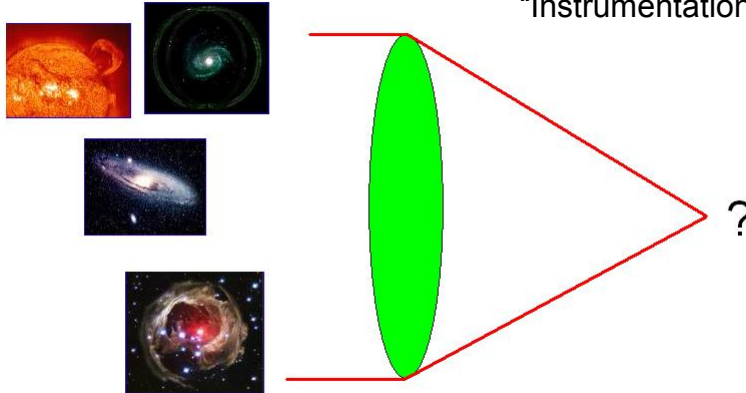
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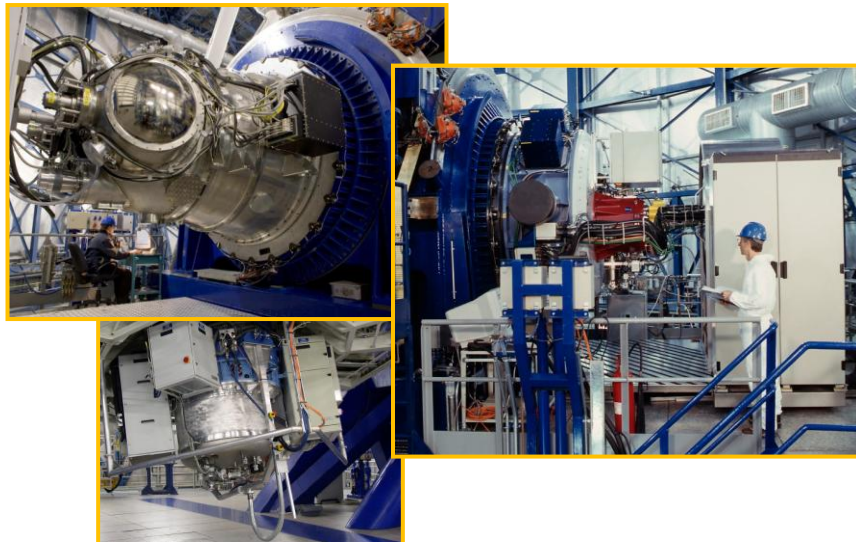


1. Introduction

What do we mean by
“Instrumentation” ?



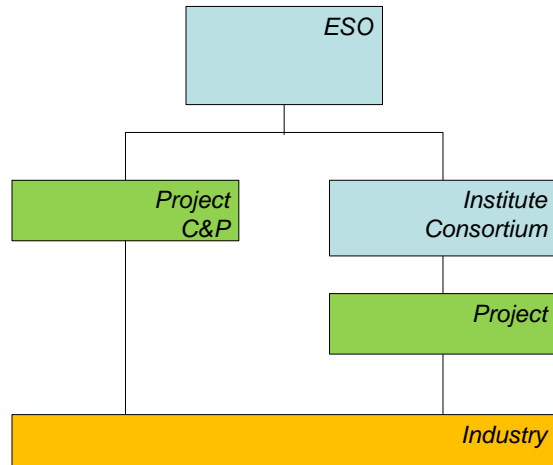
Instrumentation



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Instrumentation construction

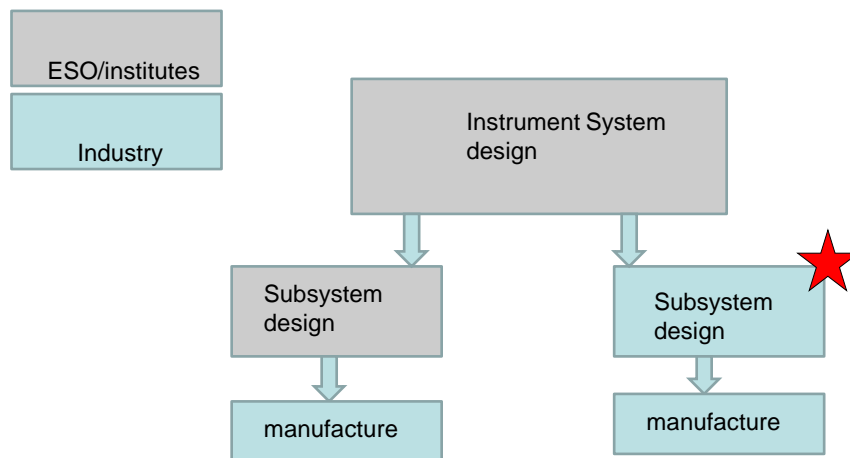


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Level of industrial procurements





10 years of change

- Non-astronomical technology developments
 - Adapted for astronomy
 - Computing, optics
- Targeted R&D in institutes and industry
 - Detector developments, deformable mirrors
- Large increase in funds for instruments, matching telescope investments



Instruments under development

- KMOS **IR 24-IFU IR spectrograph**
- MUSE **1 arcmin square optical IFU**
- SPHERE **high-order AO imager/spectrometer**
- AOF **4-laser, deformable M2, AO facility**
- MATISSE **LMN band 4-UT VLTI instrument**
- GRAVITY **K-band precision microarcsec VLTI**
- ESPRESSO **10 cm/sec precision optical spectrometer**



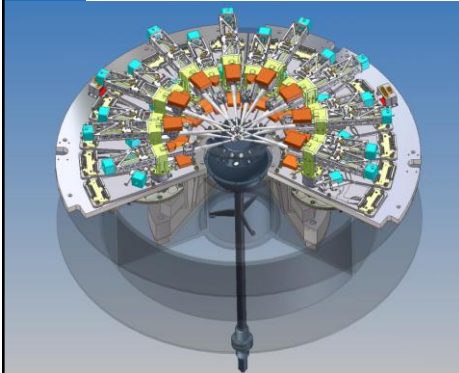


Key technologies

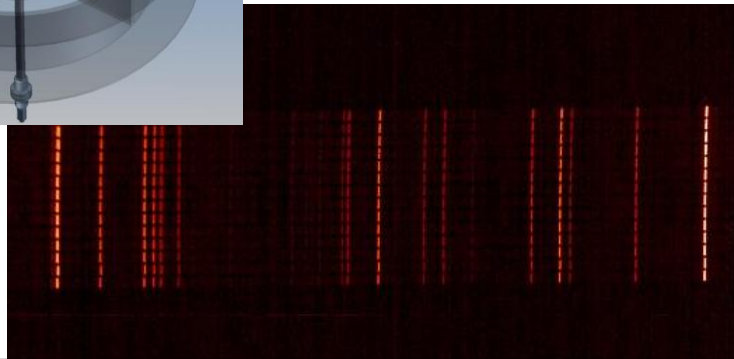
- Cryogenics
- Optics
- Vacuum
- Precision mechanics (also cryogenics)
- Deformable mirrors
- Stiff, light structures
- Imaging detectors
- Low-noise electronics
- Real-time computing
- Control systems and software

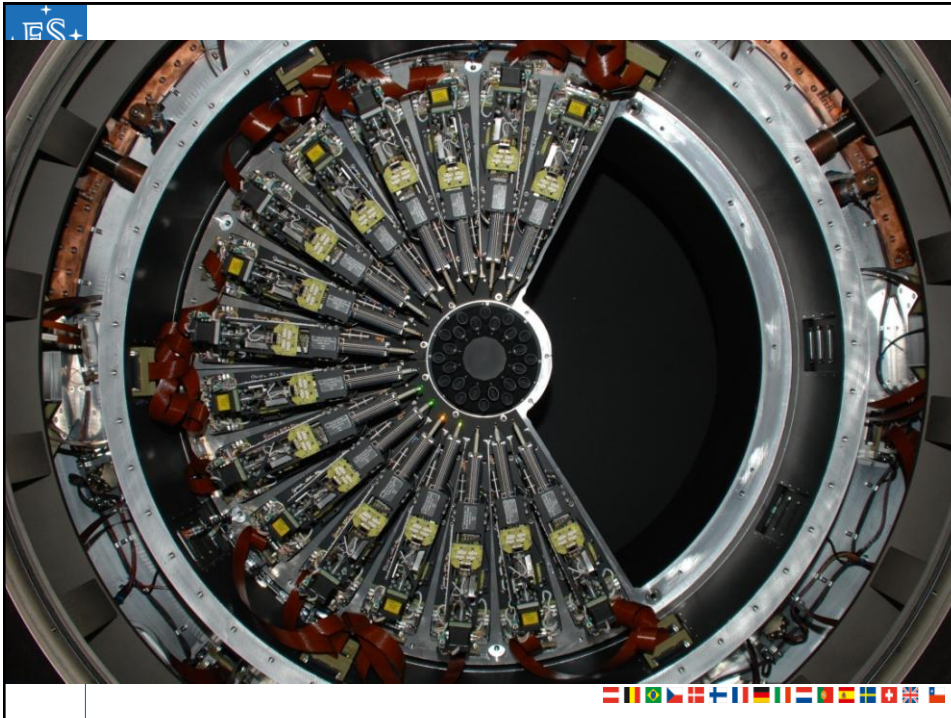



KMOS (2012)



PI – R. Sharples, Durham
24 2.8x2.8" IFUs. 0.2" sampling.
3 spectrographs (H2RG)
24 cryogenic pick-off arms,
operating on 7.2' field
1 to 2.5 micron operation

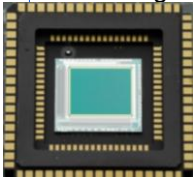




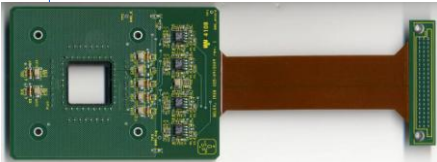


$\lambda_c=2.5 \mu\text{m}$ HgCdTe eAPD


- unlike silicon HgCdTe offers noiseless avalanche gain of up to 33
 - 3 successful predevelopment studies with 4-channel 320x256 prototype
 - new 32-channel multiplexer in development at SELEX tailored to needs of GRAVITY fringe tracker and AO wavefront sensing




320x256 eAPD array



cryogenic preamplifier





CCD Mosaic for OmegaCAM

- 8 x 4 science mosaic of 2K x 4K e2v CCD44-82 devices
- 268×10^6 $15\mu \times 15\mu$ pixels (0.21 arcsec x 0.21 arcsec)
- + two 2K x 4K CCDs for autoguiding
- + two 2K x 4K CCDs for image analysis (AO and focus)
- To be commissioned in 2011 on 2.6-m VST

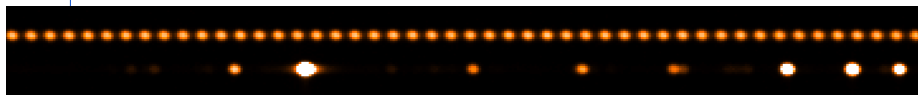
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Laser Frequency Comb


- Laser Frequency Combs as calibrators
 - Provides a series of perfectly equidistant lines
 - Covers a large wavelength domain
 - Stabilized at the 10^{-11} to 10^{-15} level
 - The absolute reference linked to an atomic clock
- ESO in collaboration with the MPQ have been developing a LFC calibration system for use in astronomical spectrographs since 2008
- Tested on HARPS

comb




Thorium-argon







52 actuator piezo DM
COME-ON-PLUS



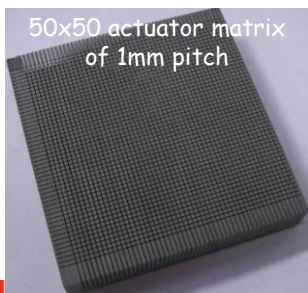
60 actuator bimorph
piezo DM: MACAO




189 act. Piezo DM for
NAOS




1377 act. Piezo DM for SPHERE
with its drive electronics



50x50 actuator matrix
of 1mm pitch



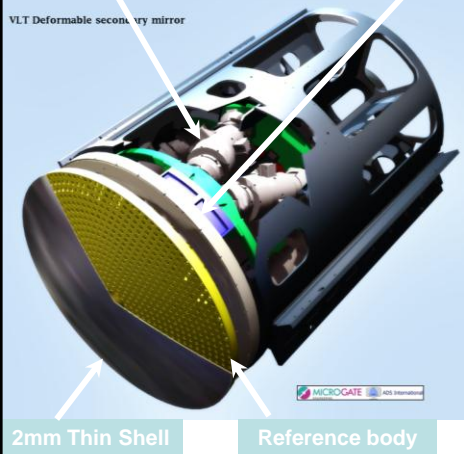
Hexapod for
centring & fine
focusing



Cold Plate; heat
evacuation & act.
attachment

AOF

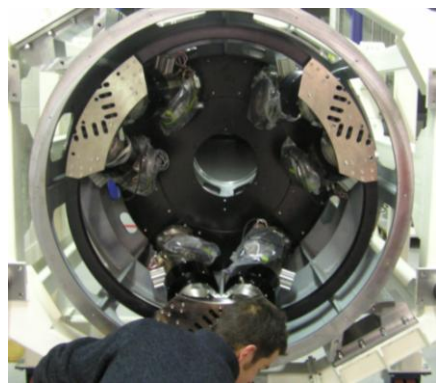
- Ø 1.1m convex
- 1170 actuators
- 29 mm actuator pitch
- 1 ms response
- Stroke 50 / 1.5 μ m



VLT Deformable secondary mirror

2mm Thin Shell

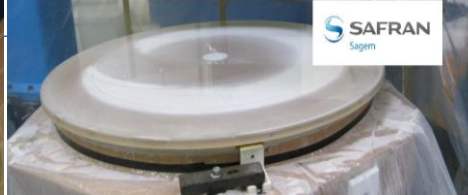
Reference body





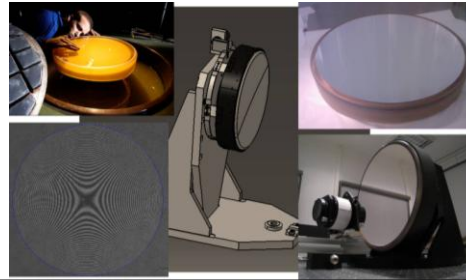
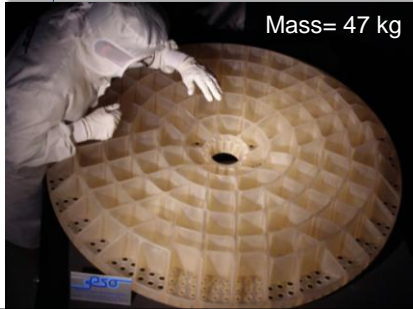
Special optics for AO

1.1 m light-weighted reference body
for the VLT Deformable Secondary Mirror



1.1m Zerodur shell, in manufacturing

400 mm toric mirror for SPHERE using
stress polishing; <1nm rms WFE



2. New Instruments and opportunities

- VLT
- E-ELT
- R&D

If you are interested in specific opportunities please
contact: eso_ins@eso.org





Scale of instrumentation programme

Spend in industry M€

Year	2011	2012	2013	2014	2015	2016	2017	2018
VLT	5.1	4.0	3.1	3.2	6.6	3.0	3.3	5.0
ELT		0.2	3.2	3.1	6.9	12.2	12.6	15.4
total	5.1	4.2	6.3	6.3	13.5	15.2	15.9	20.4

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VLT



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VLT

- ERIS : AO high-resolution imager/spectrometer
 - Precision mechanical assemblies
 - Stiff mechanical structures
 - Cryogenic Infrared imager
 - Low vibration 40K cooling system
- ESO project
 - Outsourcing to industry and institutes

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VLT

- Multi-Object Spectrograph conceptual design studies
 - Two studies for optical and IR instruments
 - Optical and IR fibres
 - Fibre robotic positioners
 - Optics
 - IR and Optical detectors

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Industrial opportunities: detectors

- Visible light science detectors
 - approx. 10-15 4k x 4k low noise CCD detectors
 - 4-6 9k x 9k format sought by optical spectrograph
- Infrared light science detectors
 - approx 40 4k x 4k low noise NIR (HgCdTe) detectors
 - 2 1024 x 1024 MIR (5-14um) detectors
- Near infrared and visible wavefront sensor detectors: fast read-out, low noise
 - 20 CCD detectors, format 1000-2000k-squared
 - ~5 HgCdTe detectors, format 1000k-squared



Industrial opportunities: optics

- The instrument programme will require significant procurement of large optics
 - (up to ~400mm, lenses and mirrors)
- Other areas of possible interest
 - Deformable mirrors of ~80x80 sub-apertures
 - Lenslet arrays for wavefront sensors
 - Micro-optics (mm scale) for integral field units (glass and Al)
 - Optical fibres – high transmission, broadband
 - Large dichroic mirrors
- Estimated spend on optics ~30MEuros over 2012-2020





Instrumentation ELT R&D

- Short time, low risk development & prototyping will be made within the instrument projects
 - Under the responsibility of the project consortium
 - Funded within the cost of the instrument
 - Related milestones will be defined with Consortium
- Longer time, key enabling technologies with higher risk for the project will start before the instrument selection (upon ELT approval)
 - ESO is preparing a long term development plan for instrumentation which will be updated on a two-year basis



Two First light ELT instruments



E-ELT Instrumentation Roadmap

- 7 instruments currently identified for construction
- Final definition of each requires further work
- Scheduled decision and starting dates

Year	ELT-IFU	ELT-CAM	ELT-MIR	ELT-4 (MOS or HIRES)	ELT-5 (MOS or HIRES)	ELT-6	ELT-PC8
2012	Decide science requirements, AO architecture		VISIR start on-sky	Develop science requirements for MOS/HIRES			Call for proposals for ETD
2013			TRL Review	Call for proposals for MOS/HIRES			
2014							
2015				Selection ELT-MOS/HIRES		Call for proposals	
2016							
2017							TRL check
2018							TRL check
2019						Selection	TRL check
2020							TRL check
2021							TRL check
2022 Tel technical first light							
	Pre-studies taking the form of phase A or delta-phase A work and/or ESO-funded Enabling Technology Development (ETD)						
	Decision point						
	Development of Technical Specifications, Statement of Work, A agreement, Instrument Start.						

END & Questions