

Estallidos con Elmer

2 de Diciembre de 2004

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- Which is the Connection Estallidos-Elmer ?
- DEA project (Juanma Martín) in the Estallidos Framework

  Co-directors:

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  - Estallidos in the laboratory

    Laboratory Observing Modes Characterization
    - Impact of the instrumental parameters on science data
    - Calibration and Data reduction Plan
    - Optimization of observational and calibrations strategies
  - Estallidos at the Telescope

    Demonstration program on sky for scientific performance commissioning of each observing mode.

    (with Casiana Muñoz)
  - Estallidos at the Computer

    Evolutionary Synthesis code update Estallidos-Elmer

    (with Mercedes Mollá)

Elmer Scientific Capabilities

Spectral Range	**0.365 μm – 1.000 μm**
FOV	**4.2arcmin ∅**
Plate Scale	**0.195 arcsec/pix**
Detector	**Marconi CCD44-82, 2K x 4K, 15 μm/pix** **Charge Shuffling and Frame Transfer capabilities**
Image quality	**EED_{80} < 2 pixels (@Imaging Mode)** **< 3 pixels (@Spectroscopy) for a 0.6 arcsec slit**

Observing Modes

- **Imaging** — **Broad and narrow band filters**
- **Long-slit Spectroscopy** — **Slits: length = 3', width: 0.6", 1.2", 2" and 5"**
  R = 80-300 (prisms), 1000(grisms), 2500 (VPHs) (for 0.6" slit)
- **Fast photometry** — **Slits: length = 3', width: 12.48",**
- **Time resolved photometry** — **>98% duty cycle at 1Hz short burst up to 1kHz**
- **Slit-less multi-object Spectroscopy**
- **Charge Shuffling Spectroscopy**
- **Fast slit Spectroscopy**
- **Mask Multi-object Spectroscopy**






Available Filters

Filter-ID	Central λ	Cut-on (1%)	Cut-off (1%)	Peak Transmission @λ
SDSS-g´	4830 ± 10 Å	4070 ± 10 Å	5570 ± 10 Å	89.07 % @ 5190 Å
SDSS-r´	6170 ± 10 Å	5350 ± 10 Å	6980 ± 10 Å	92.69 % @ 6060 Å
SDSS-I´	7720 ± 10 Å	6800 ± 10 Å	8630 ± 10 Å	98.54 % @ 8020 Å
SDSS-z´	8990 ± 10 Å	8130 ± 10 Å	9850 ± 10 Å	94.35 % @ 9480 Å

Filter-ID	Central λ	FWHM	Peak Transmission	Comments:
[OII]	We have one with less transmission than specified			It includes [OII] 3727 Å
Hβ	4858 ± 1 Å	27 Å	73.0 %	It includes Hβ 4861 Å
[OIII]	4976 ± 1 Å	57 Å	86.9 %	It includes [OIII] 4959+5007 Å
[OI]	6289 ± 1 Å	44 Å	87.5 %	It includes [OI] 6300 Å
Hα broad	6558 ± 1 Å	70 Å	81.1 %	It includes Hα 6563 Å + [NII]6548, 65
Hα narrow	6562 ± 1 Å	16 Å	77.3 %	It includes Hα 6563 Å (no [NII] lines)
[SII] narrow	6718 ± 1 Å	17 Å	87.0 %	Filter includes [SII] 6717 Å
[SII] broad	6711 ± 1 Å	70 Å	90.1 %	Filter includes [SII] 6717+6731 Å

Limiting Magnitudes @ Imaging

Limiting Magnitudes
5 sigma 1 hour (1” seeing)

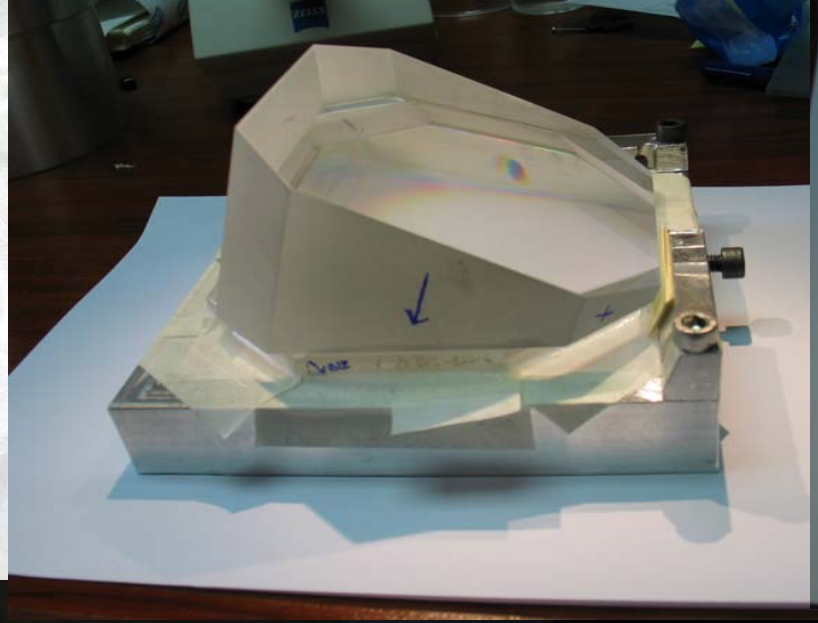
Broad band SDSS
g **28.1** r 27.5 i 26.6

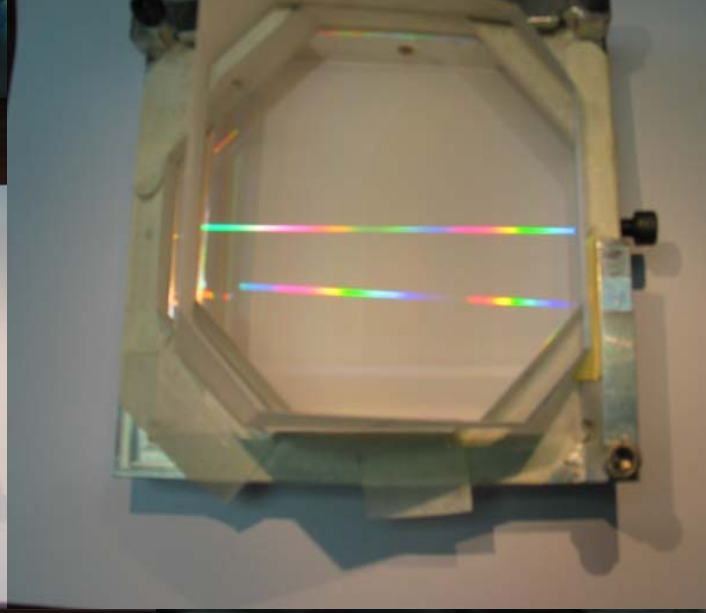
Narrow band
[OIII] 26.5 **Hα broad 25.7**

Filter	t=1s	t =60s	t=3600s	Filter	t=1s	t =60s	t=360
g´	23.08	25.87	28.11	**Hβ**	18.75	22.94	25.67
r´	22.81	25.28	27.50	**[OI]**	19.56	22.77	25.05
I´	22.05	24.39	26.61	**[OII]**	16.57	20.99	24.63
z´	21.08	23.42	25.65	**[OIII]**	20.13	24.06	26.53
H α broad	19.85	23.41	25.74	**[SII] broad**	20.10	23.73	26.08
H α narrow	18.12	22.19	24.77	**[SII] narrow**	18.47	22.61	25.21

Elmer Limiting Magnitudes at the GTC in the Imaging Mode for the available filters. The numbers have got assuming 5σ. Different columns give the calculations for 1 second, 1 minute and 1 hour respectively. When background limited, the difference in magnitude for a factor 60 increase in time should be 2.22 mag whereas when limited by the detector it will be about 4.44 mag.









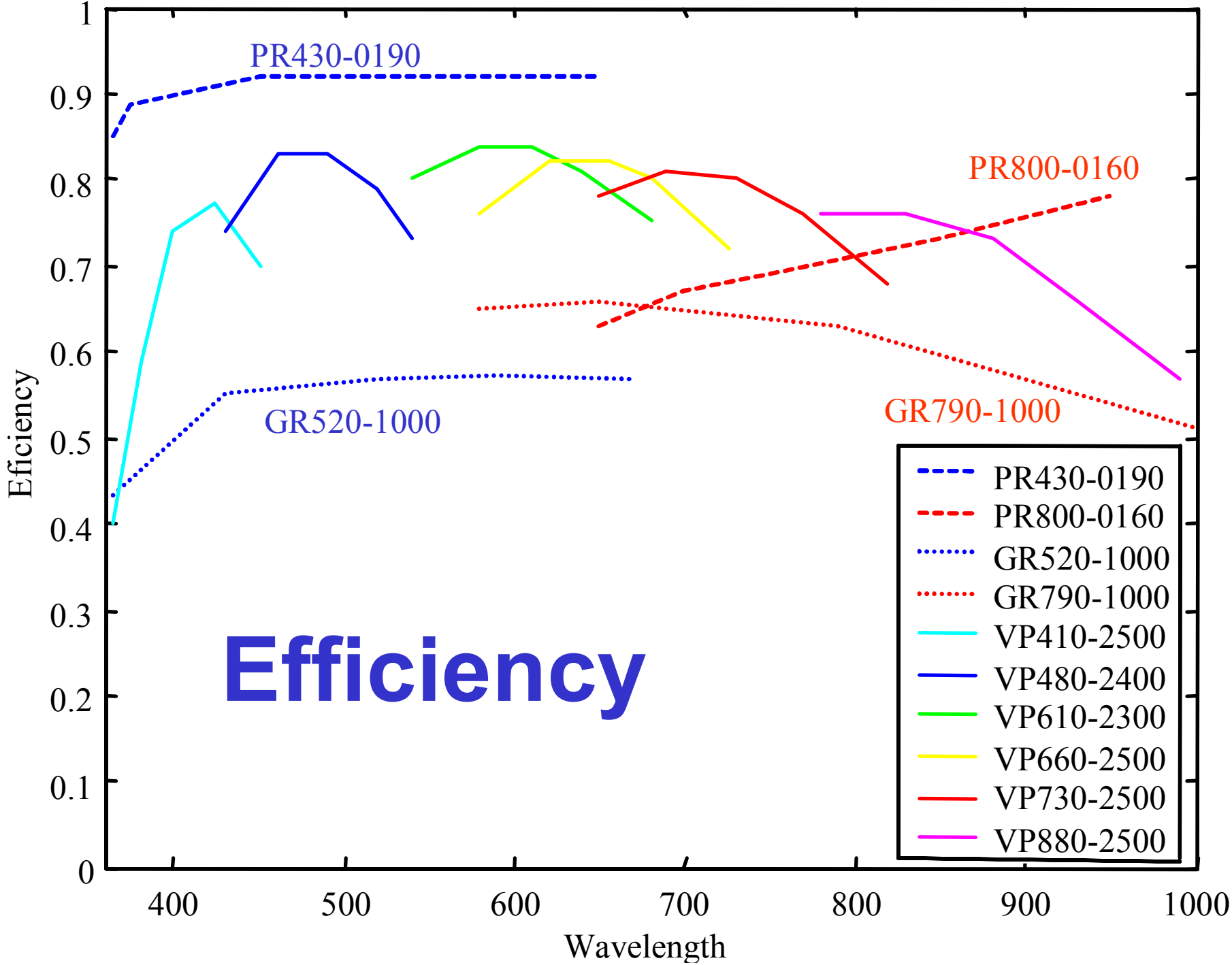




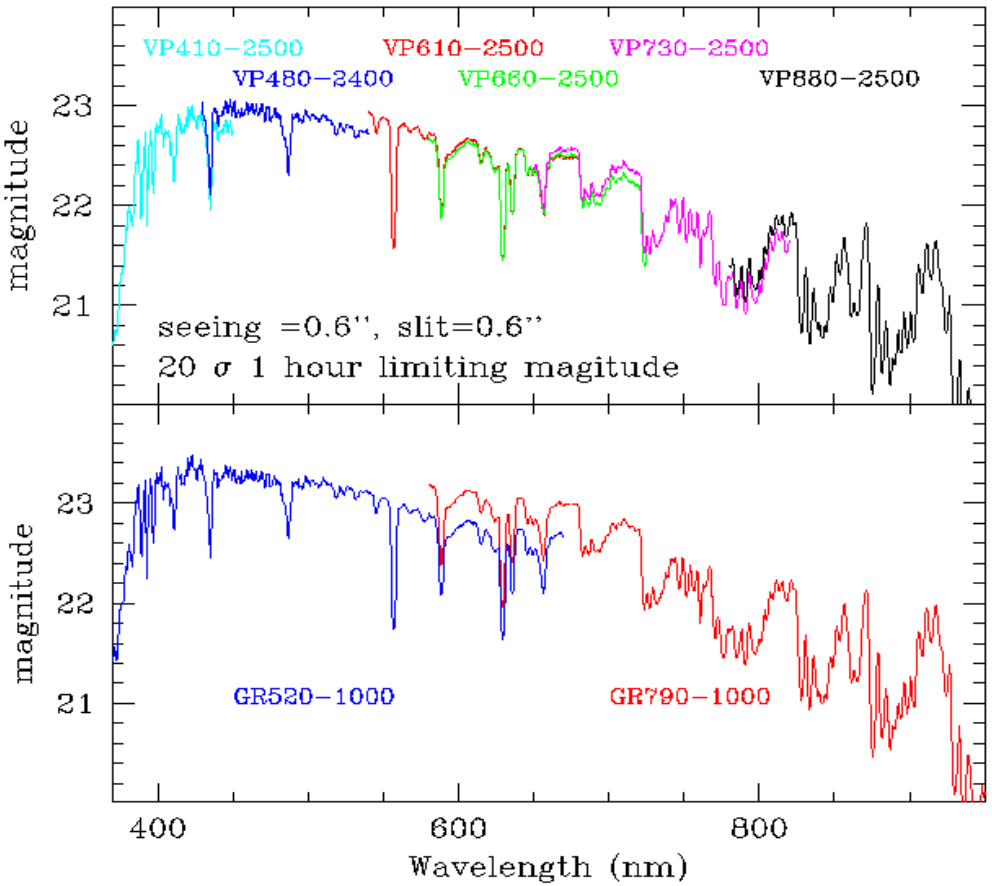
Available dispersion elements

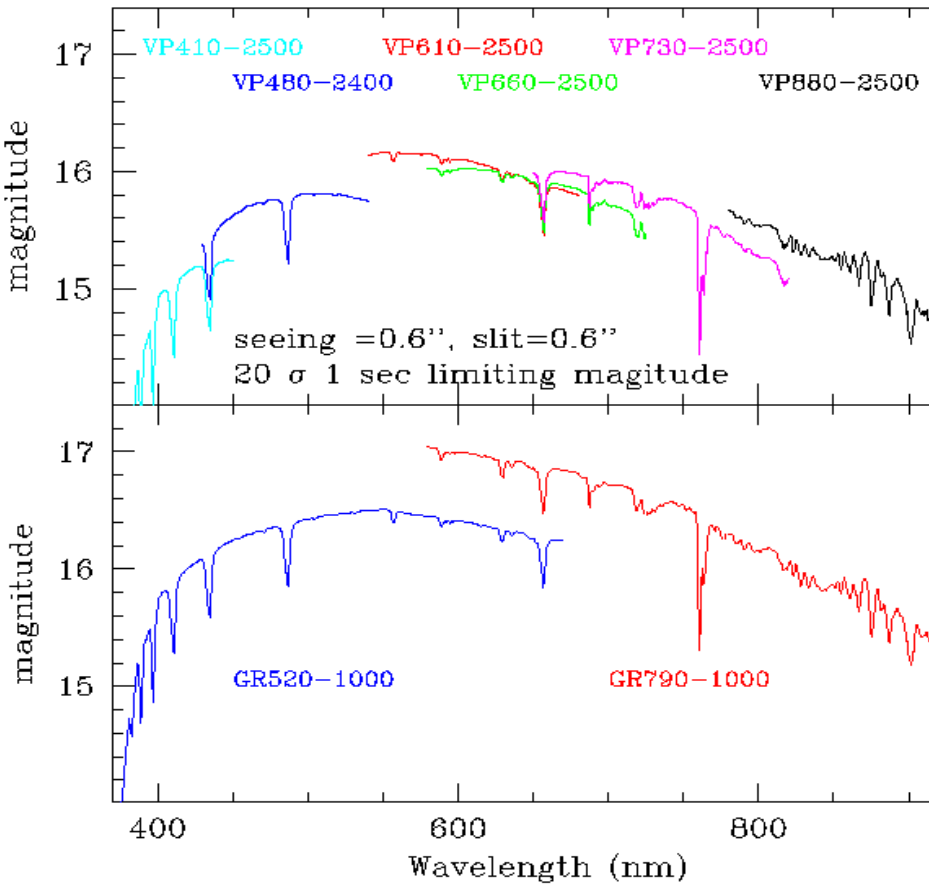
	λ coverage (Å)	λ_c (Å)	R (@ λ_c)	Type
PR430-0190	3650 - 6950	4350	145	Prism
PR800-0160	6509 - 9500	8000	127	Prism
GR520-1000	3650 - 6700	5175	962	Grism
GR790-1000	5800 – 10000	7900	957	Grism
VP410-2500	3650 – 4500	4100	2463	VPH
VP480-2400	4250 – 5450	4850	2350	VPH
VP610-2300	5350 – 6850	6100	2255	VPH
VP660-2500	5800 – 7300	6550	2510	VPH
VP730-2500	6500 – 8200	7350	2481	VPH
VP880-2500	7800 – 9900	8850	2448	VPH

(*): This prism covers 3650-10000 Å


Efficiency
Wavelength
Eficiency
PR430-0190
PR800-0160
GR520-1000
GR790-1000
PR430-0190
PR800-0160
GR520-1000
GR790-1000
VP410-2500
VP480-2400
VP610-2300
VP660-2500
VP730-2500
VP880-2500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
400
500
600
700
800
900
1000

Limiting Magnitudes @ Spectroscopy

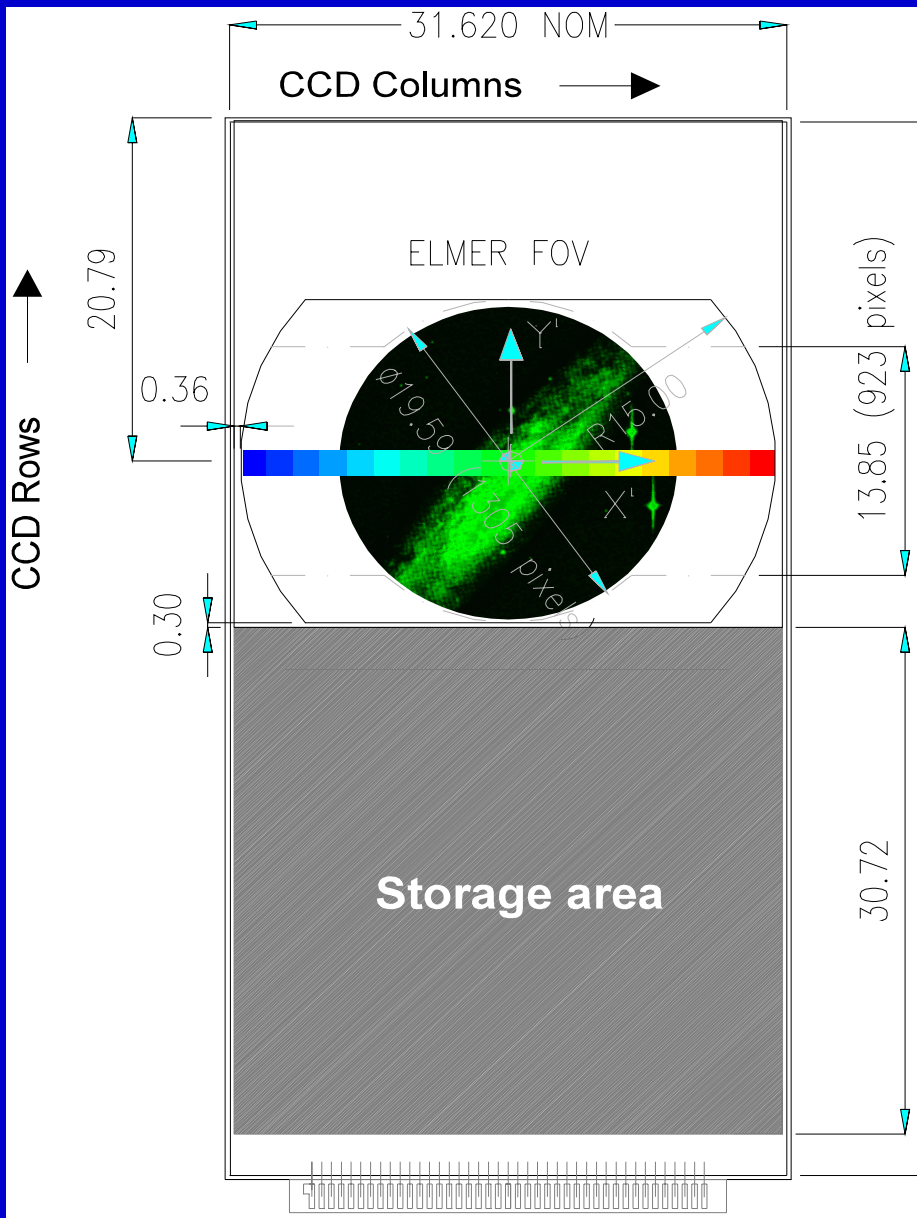




Predicted limiting magnitudes using ELMER in spectroscopic mode for the available dispersive elements. Numbers have been calculated for S/N = 20 and assuming seeing and slit of 0.6". Exposure time of these simulations are t=1 hour (left), representative of long slit or multi-objec mode, and t=1second, for fast spectroscopy modes

The Data on the detector

- CCD is looking into Z' direction
  Y' axis is aligned with CCD columns
  X' axis with CCD rows
- ELMER circular FOV of 4.2 arcmin (1305 pixels across the detector) is completely placed in CCD upper half
- Spectral direction is within CCD rows (2000 pixels across the detector at largest extent)
- CCD has frame-transfer structure which allows moving the complete FOV into the storage area (CCD lower half)

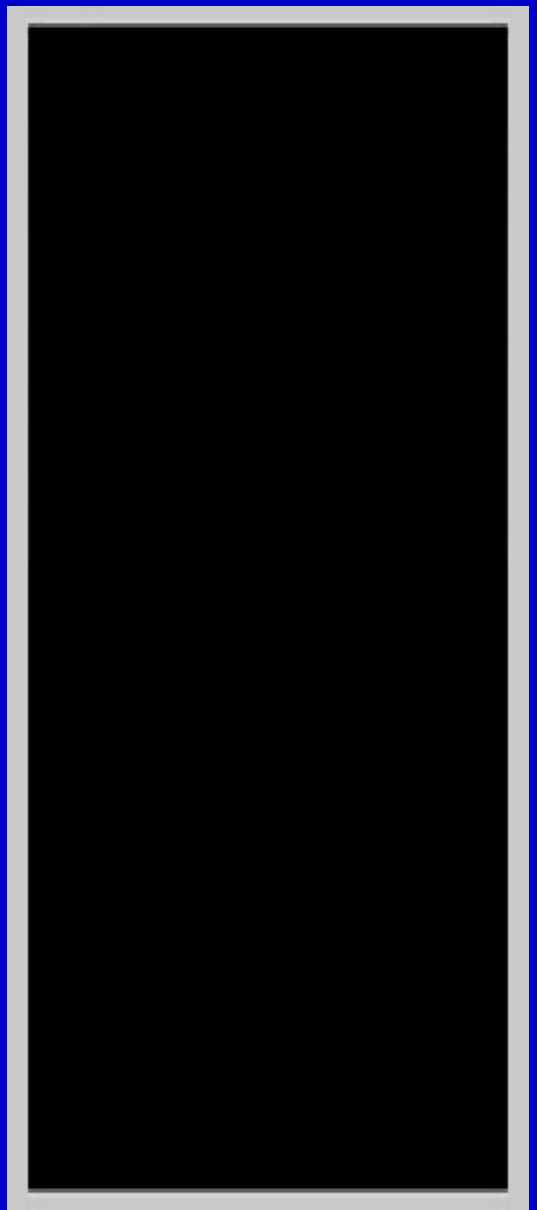


Frame Transfer capability

- Elmer Field of View cannot fill the detector, but we can get advantages from this “drawback”

- The detector allows the reading of the bottom half while the upper part is being exposed.

- This Frame Transfer capability shall be used as the standard read-out mode in Imaging and Long Slit Spectroscopy



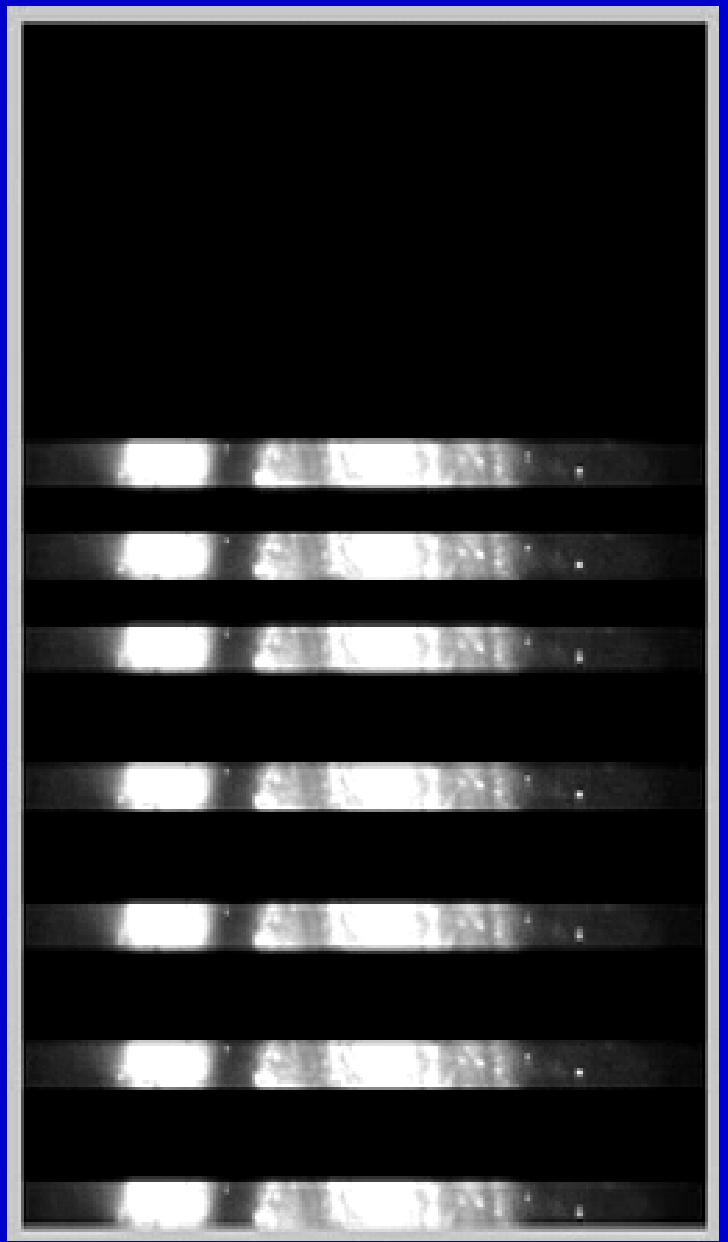
Charge shuffling capability

- Some exotic modes very useful for very Fast Photometry and time resolved spectroscopy shall be possible.

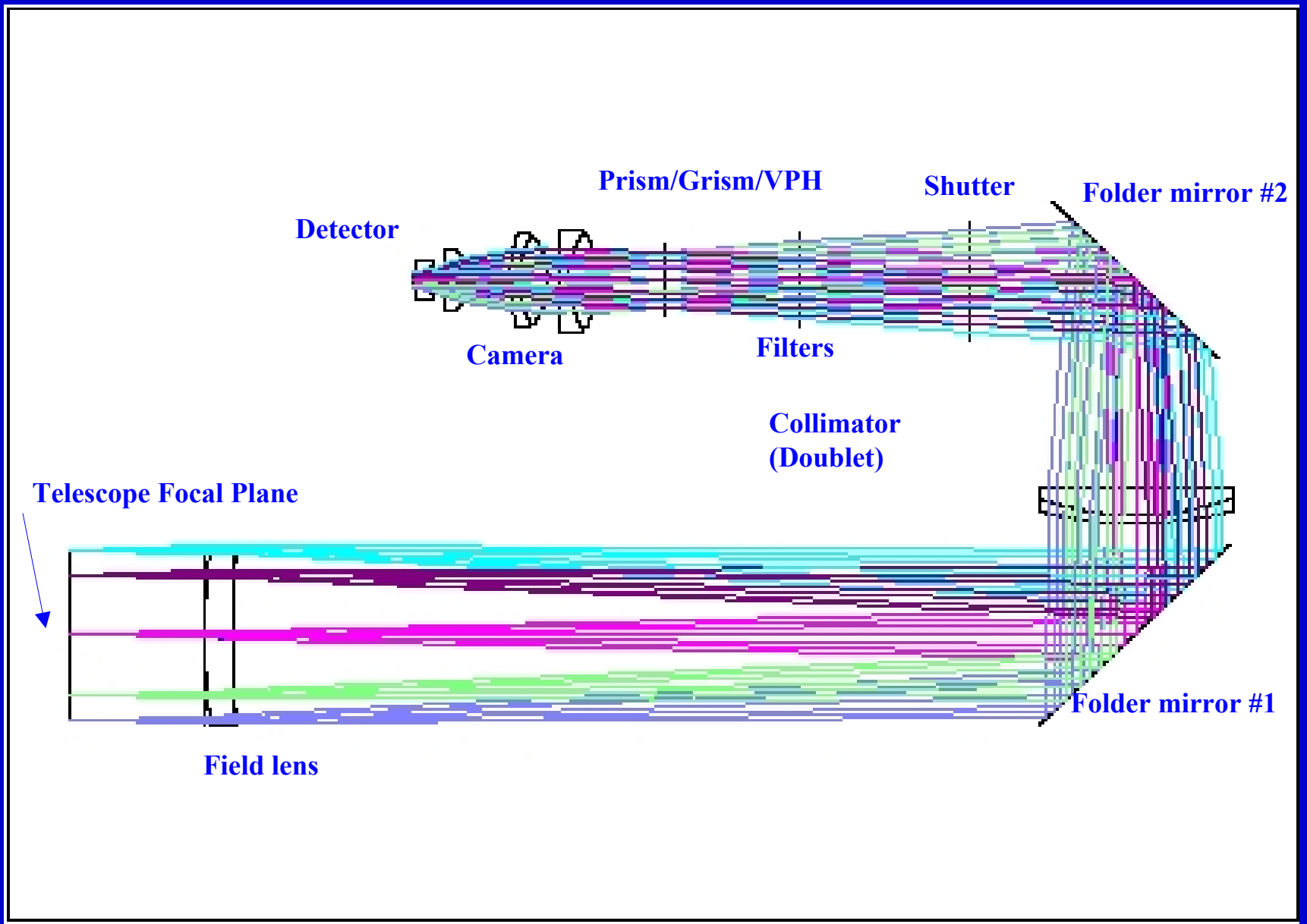
- The detector allows the movement of the charge in the two separate halves.

- This Charge shuffling capability shall be used for Fast Photometry and Fast slit spectroscopy

- Minimum exposure times
  - With shutter
    - Single exposure 10ms (±1ms)
    - Two consecutive > 400ms
  - Shutter-less
    - Limited by line shift (50 μs)
    - One pix = 0.2 arcsec



Elmer: Optical Layout



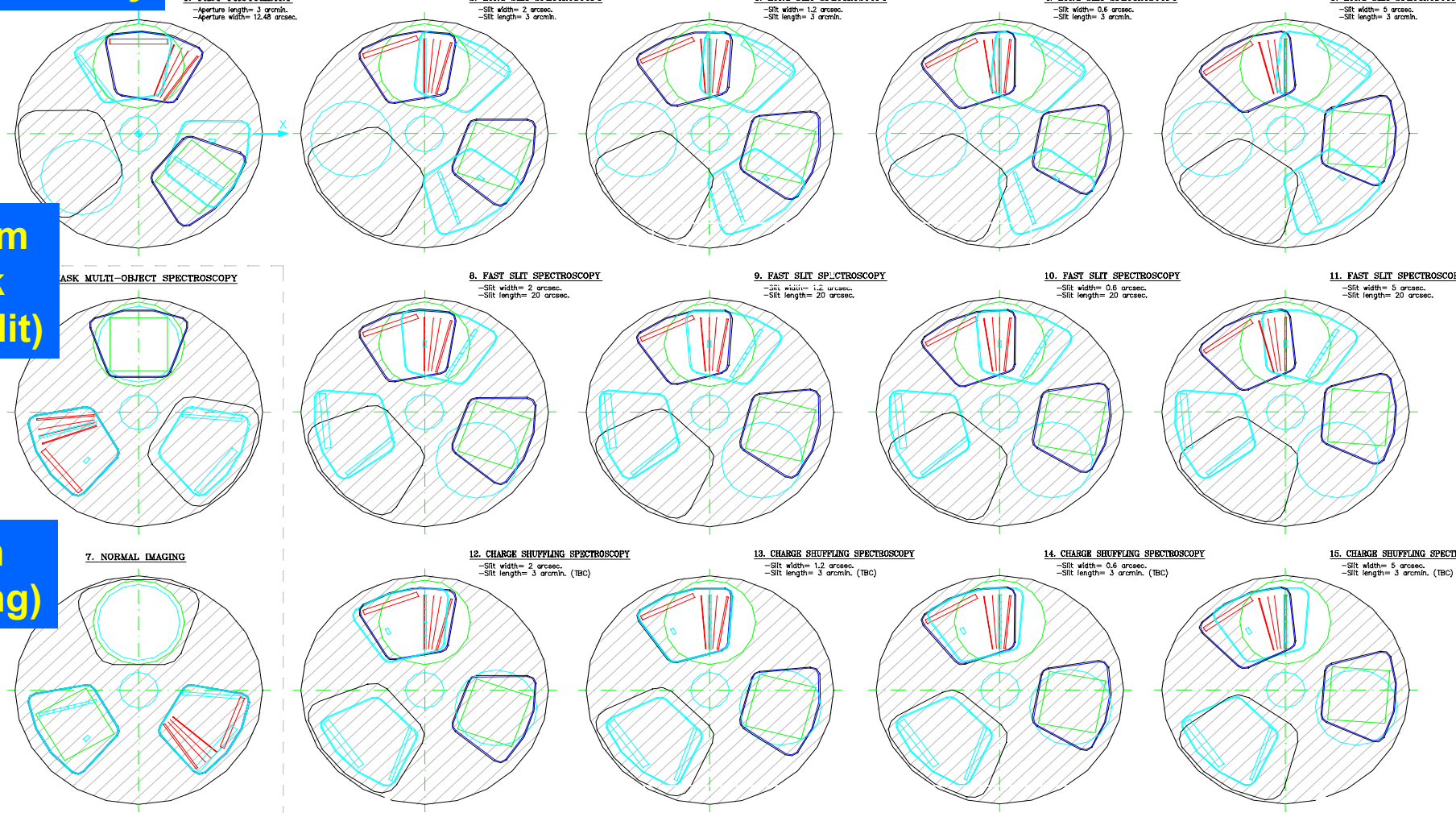
Slit Subsystem
Observing modes configuration

Long Slit Spectroscopy

Fast Photometry

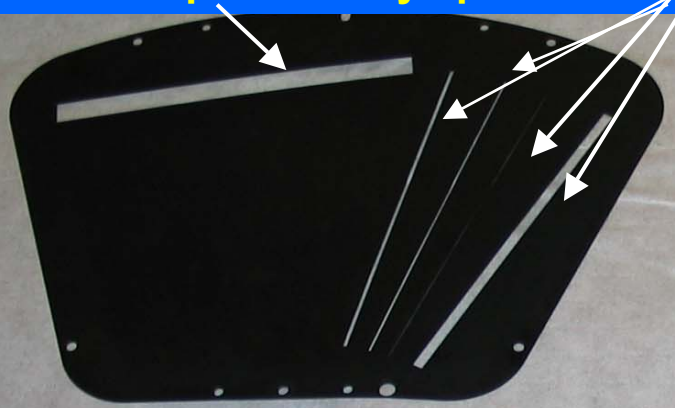
Custom Mask (multislit)

Open (Imaging)



FOCAL PLANE MASKS

Slit Mask with fast photometry aperture and 4 long slits

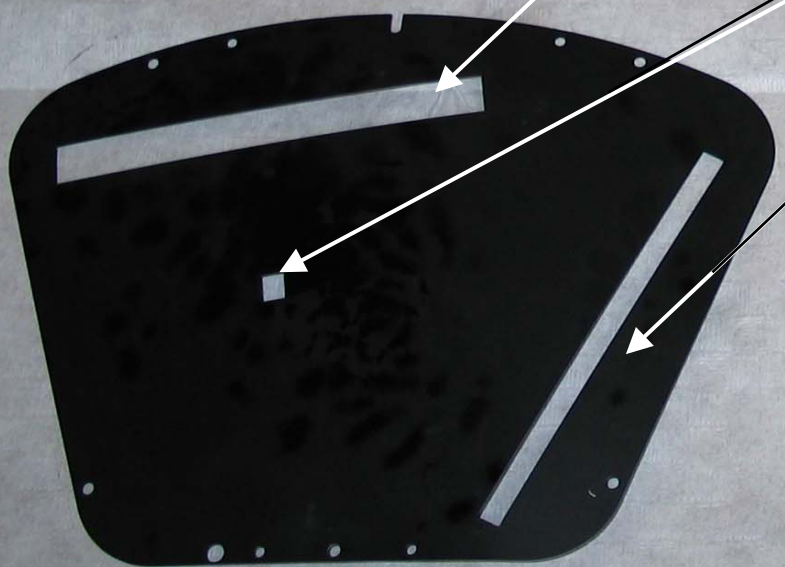


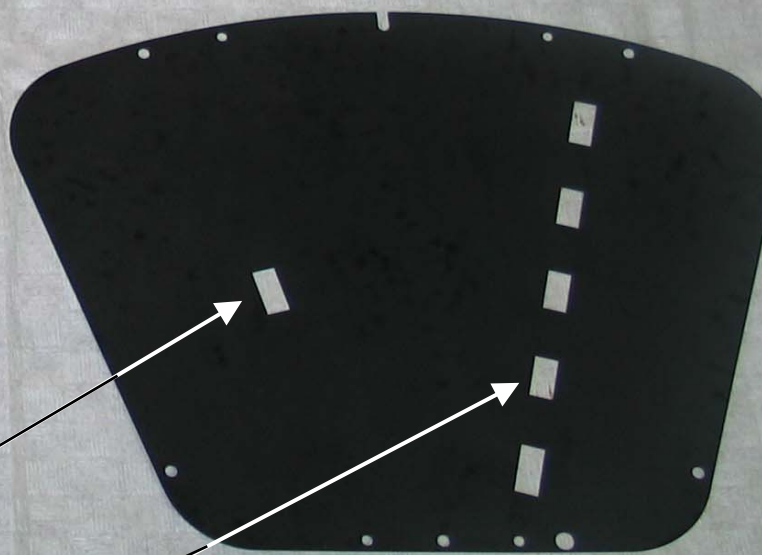
Calibration mask



COVER PLANE MASKS

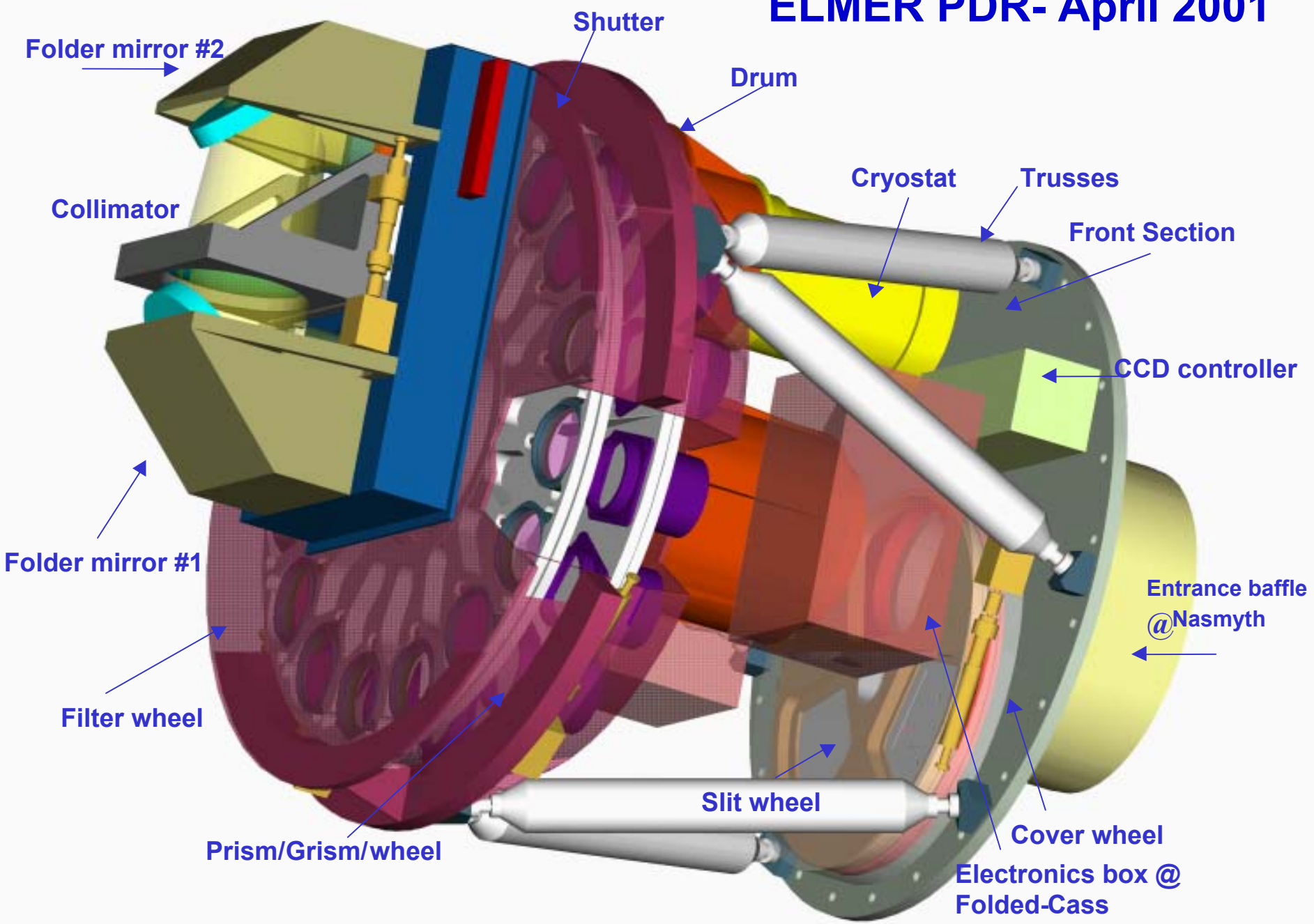
Cover Mask with fast photometry, acquisition and long slit covers



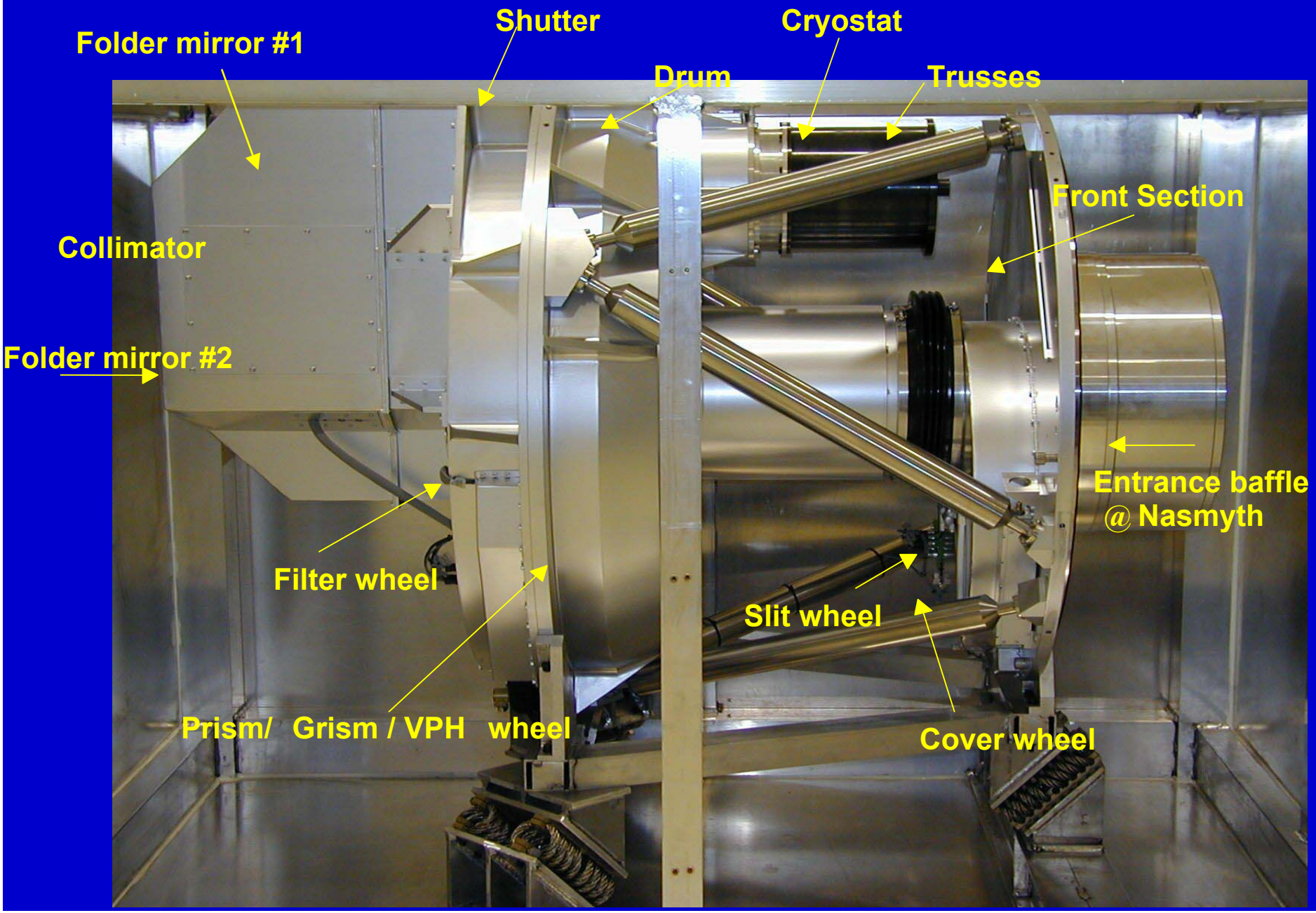


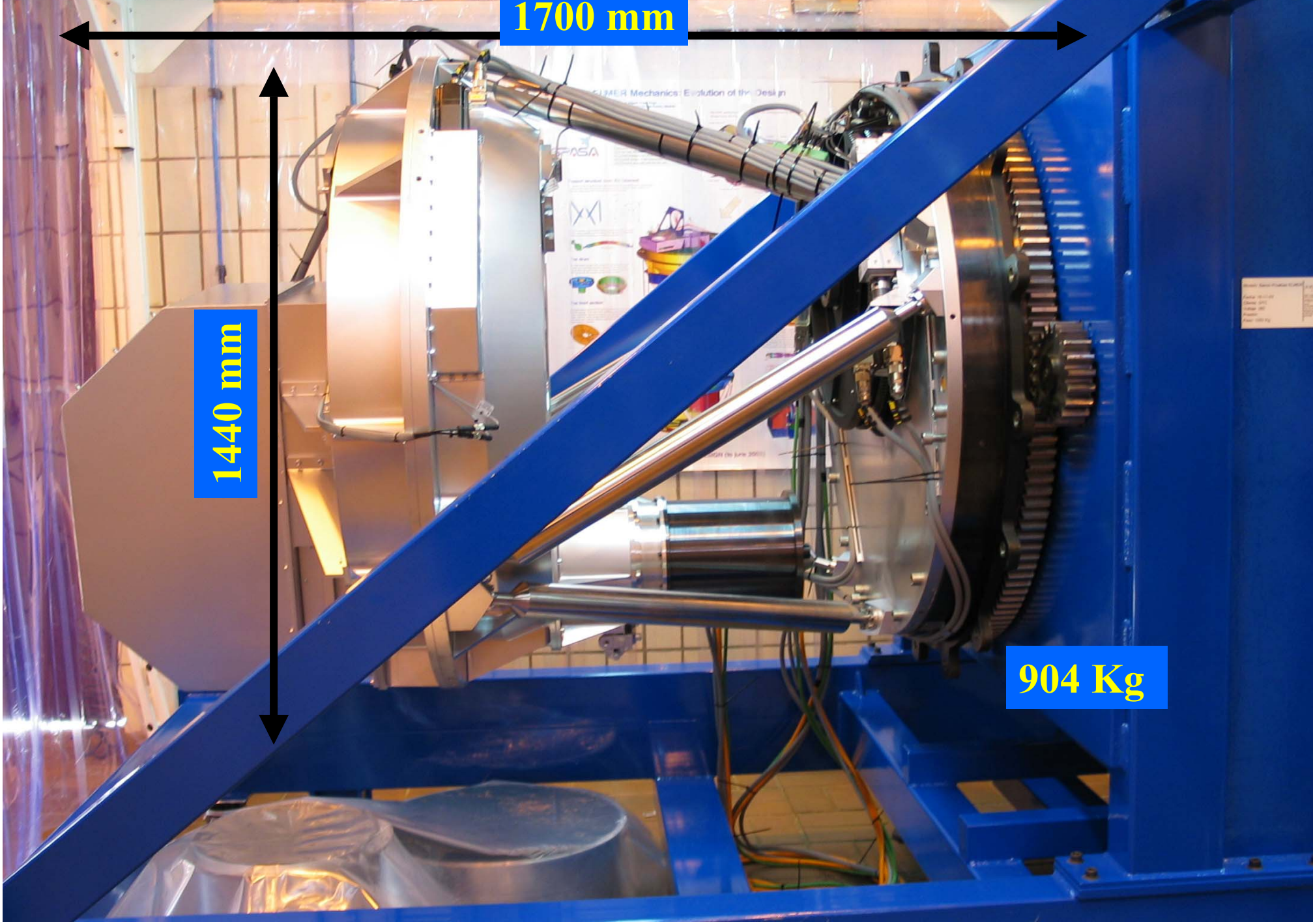
Cover Mask with fast slit charge shuffling spectroscopy covers

ELMER PDR- April 2001

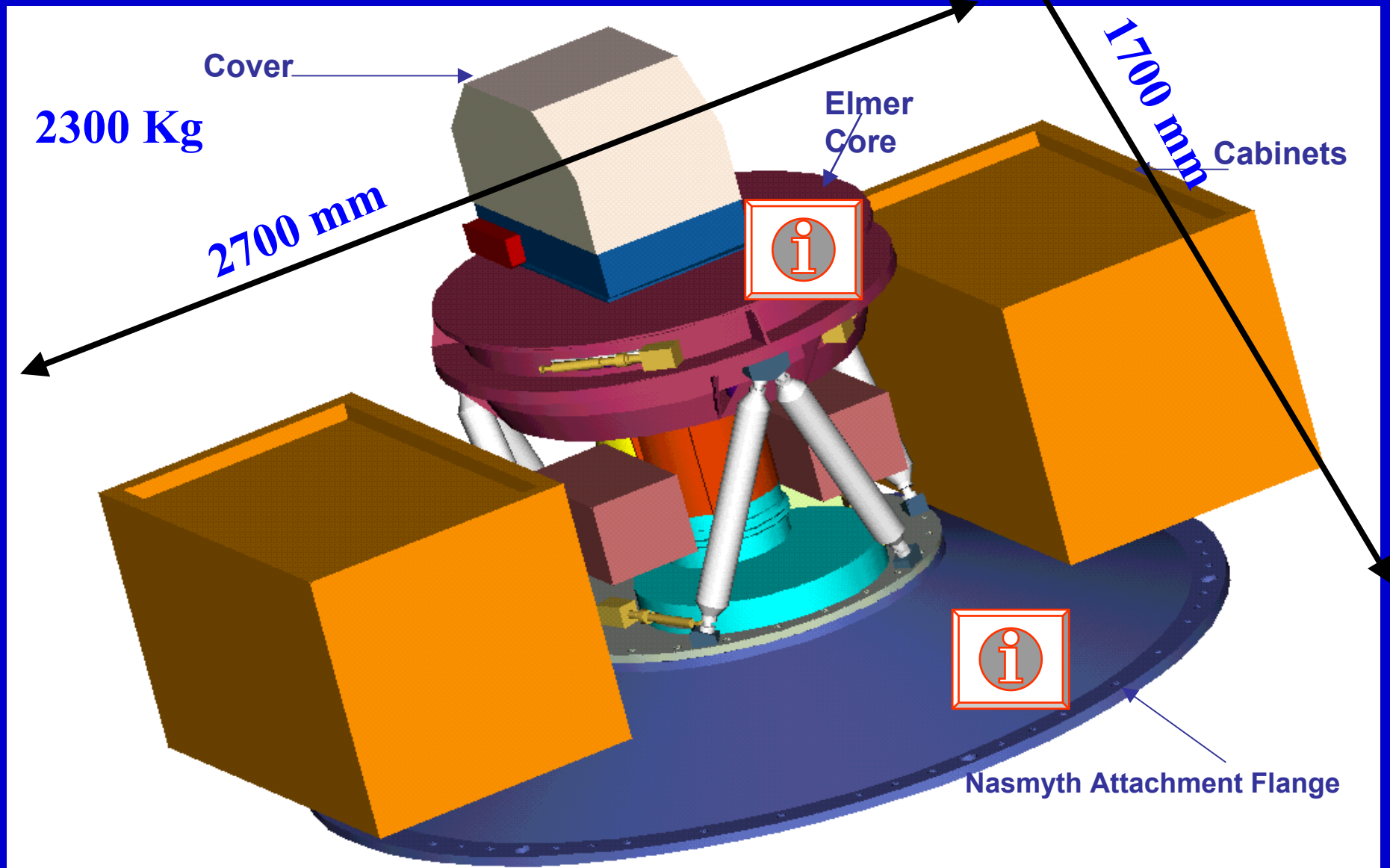


ELMER at La Laguna (November 2003)

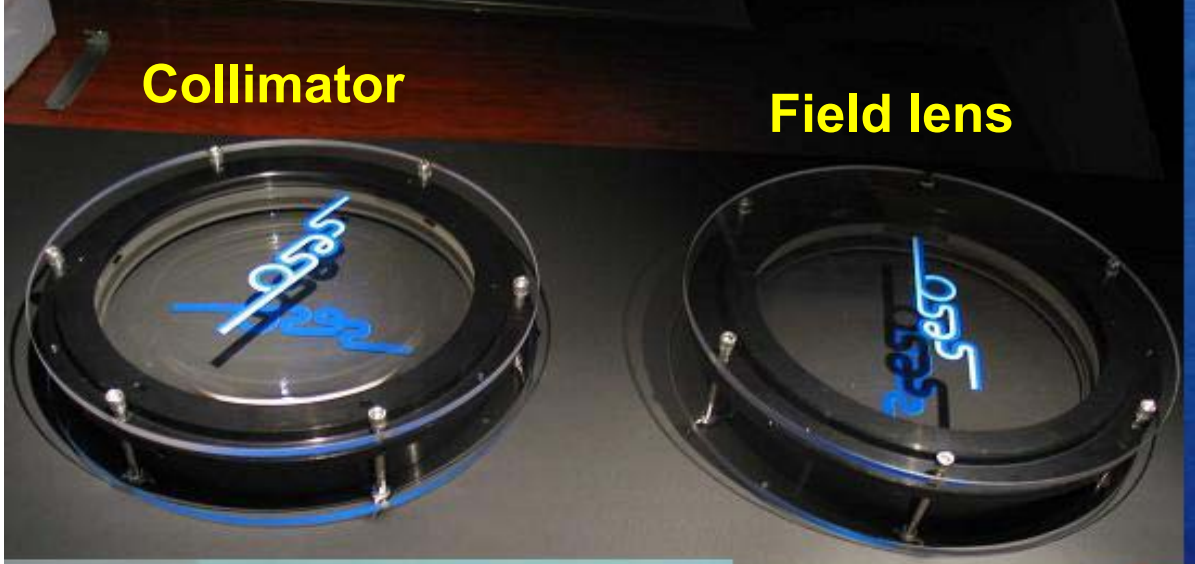


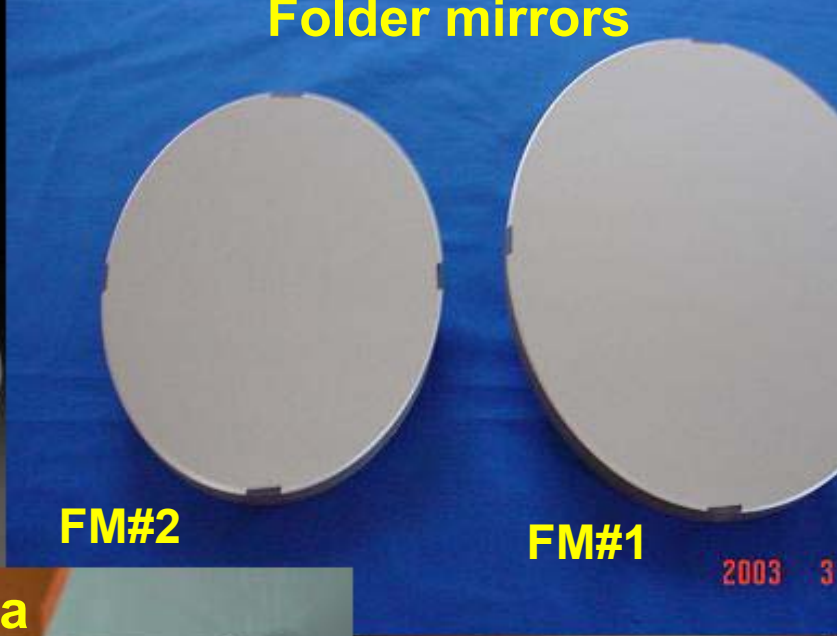

1700 mm
1440 mm
904 Kg

Elmer prepared to be installed at Nasmyth

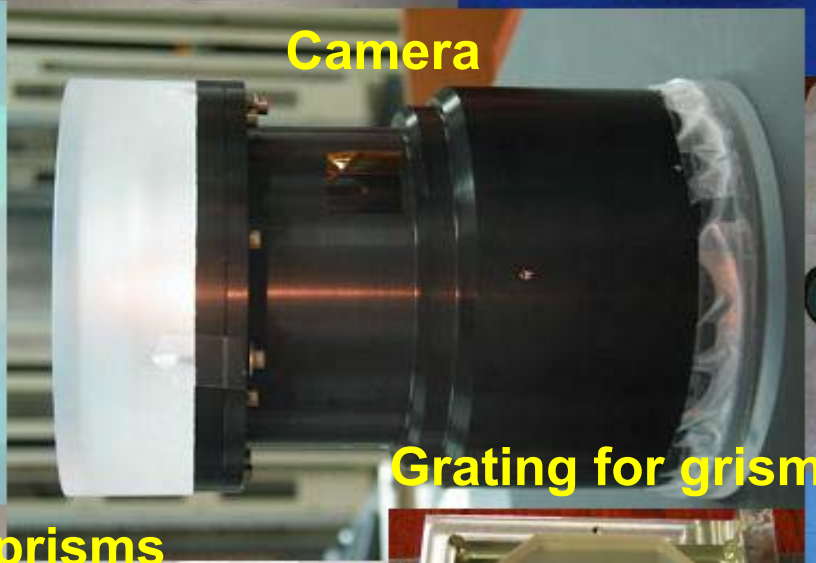




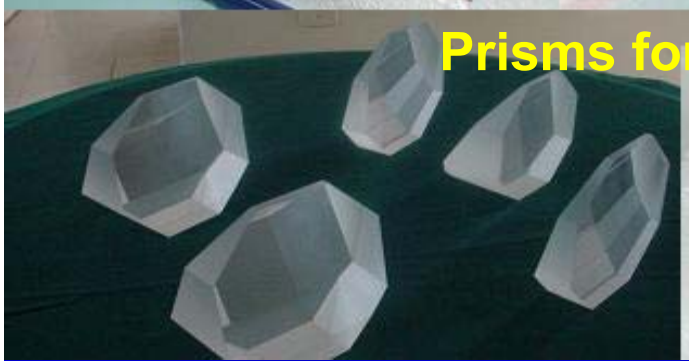

Collimator
Field lens


Folder mirrors
FM#2
FM#1
2003

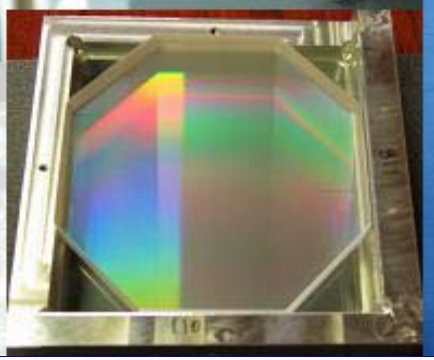

SDSS broad band set


Camera


Filter set


Prisms for prisms




Grating for grism


Prisms for grism

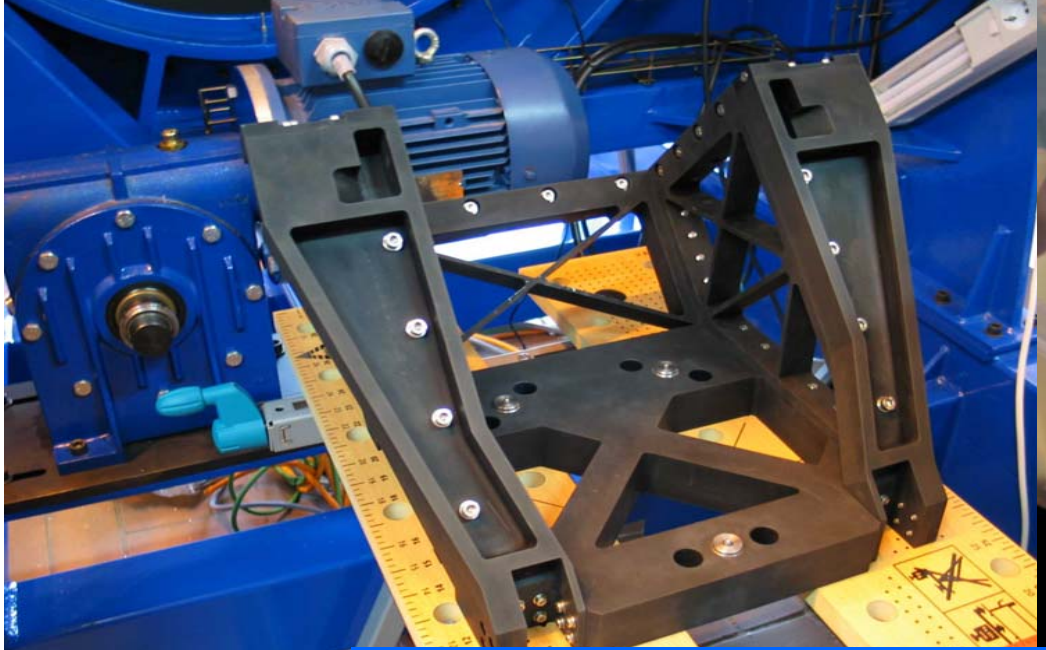




Arrival at GTC -IAC Headquarters (November 2003)



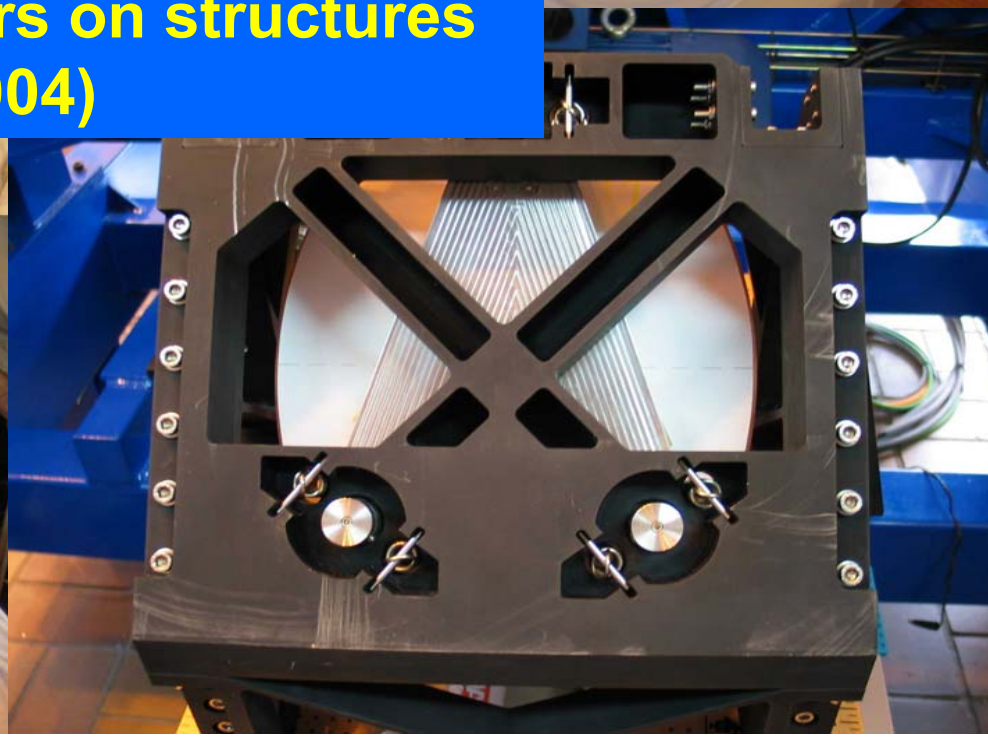


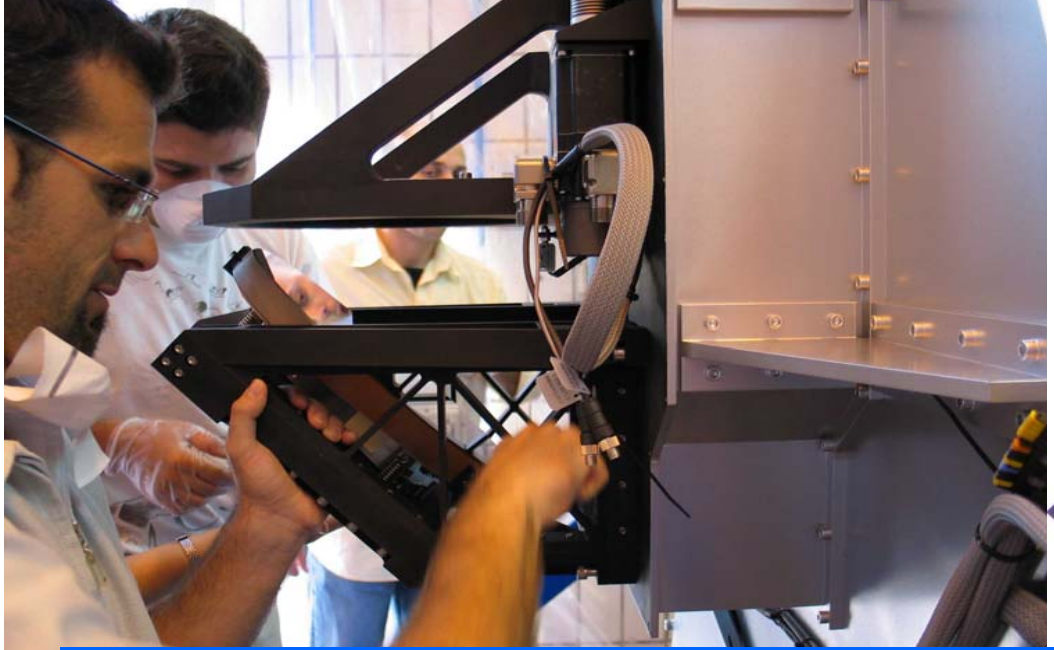


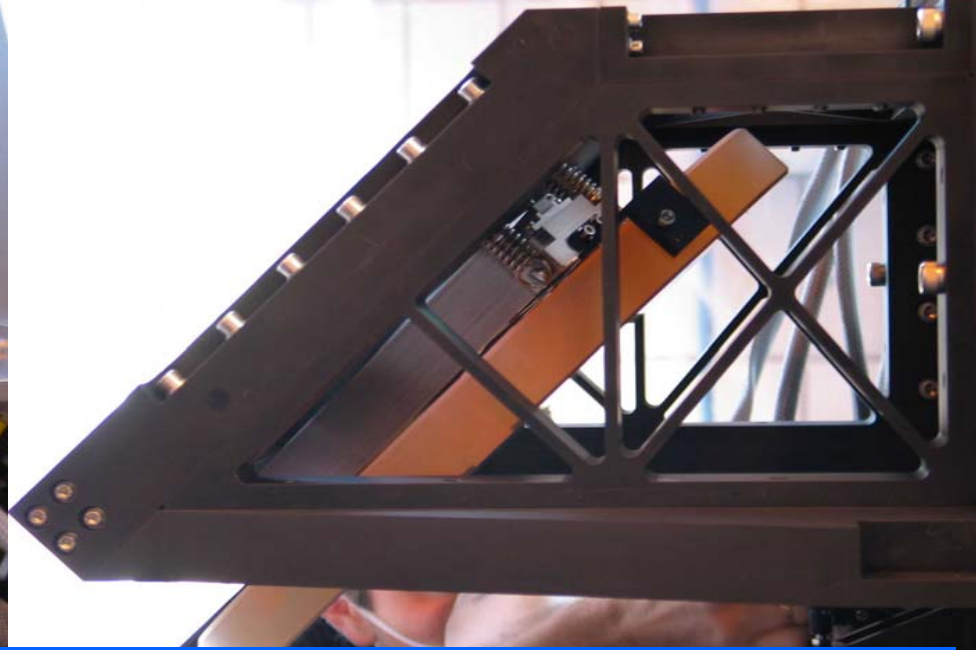


Mounting real mirrors on structures (May 2004)

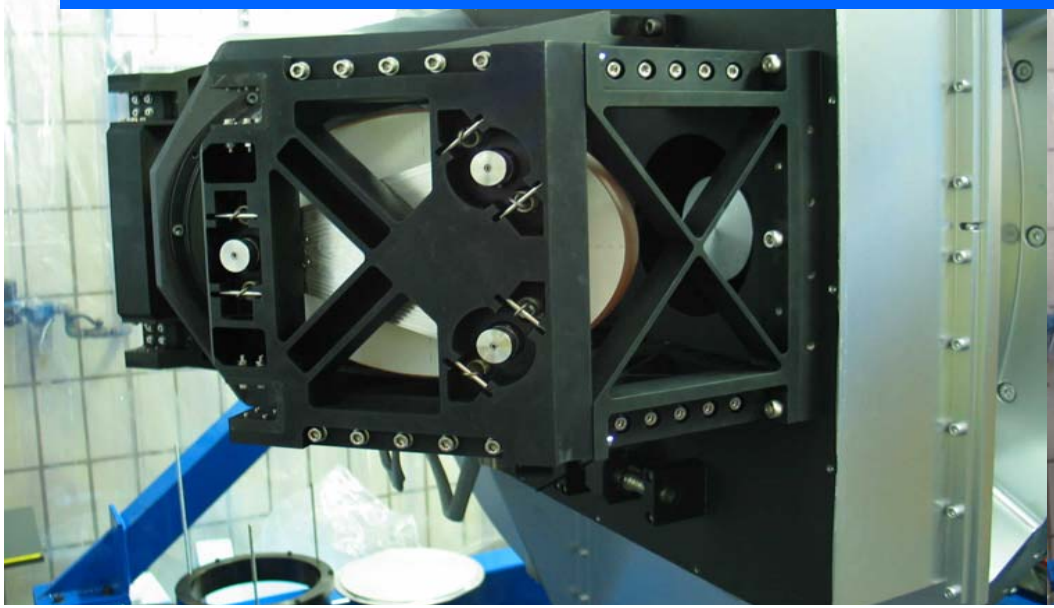


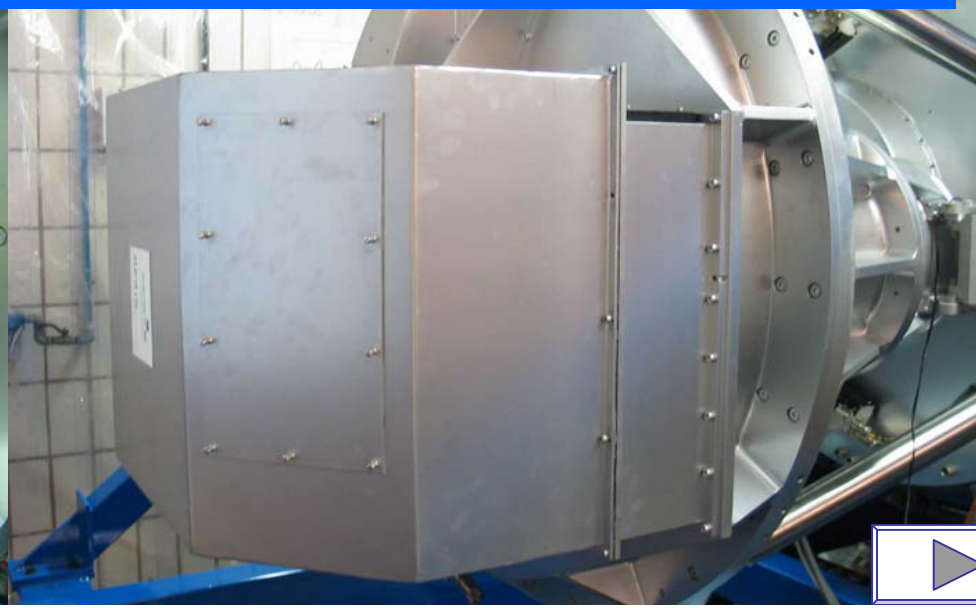






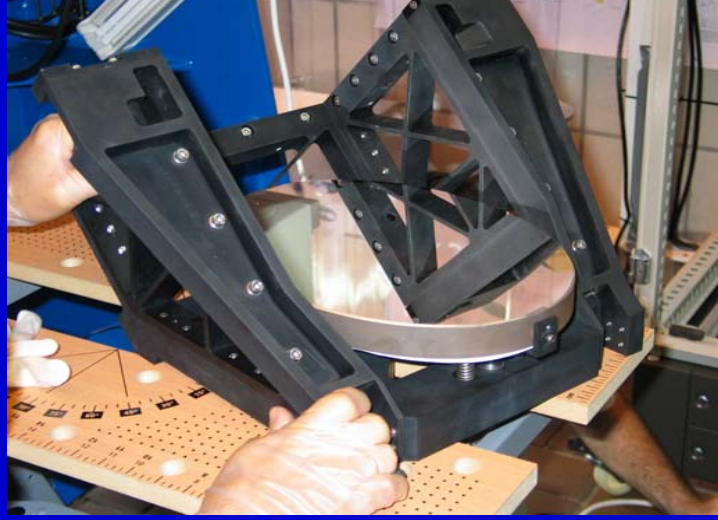
Mounting whole units on the main structure box-interface
May (2004)







MIRRORS
INTEGRATION

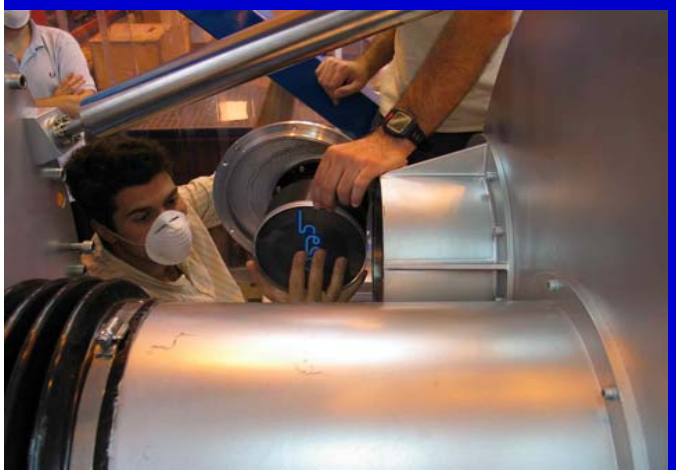


First integration images

CAMERA ASSEMBLY

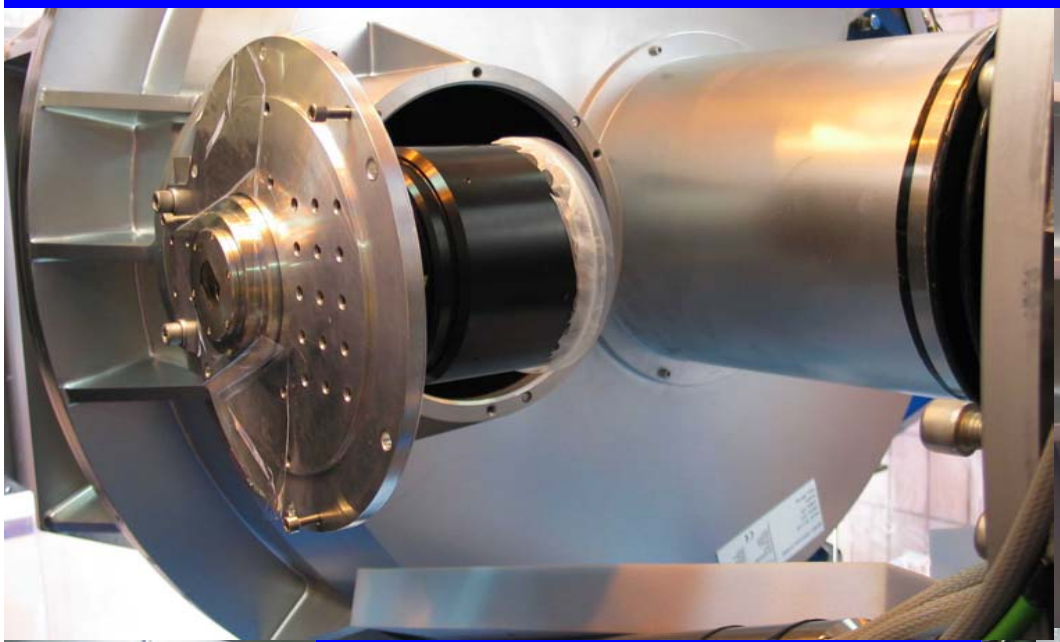


FILTER LOAD





Camera was mounted for pre-CCD integration testing

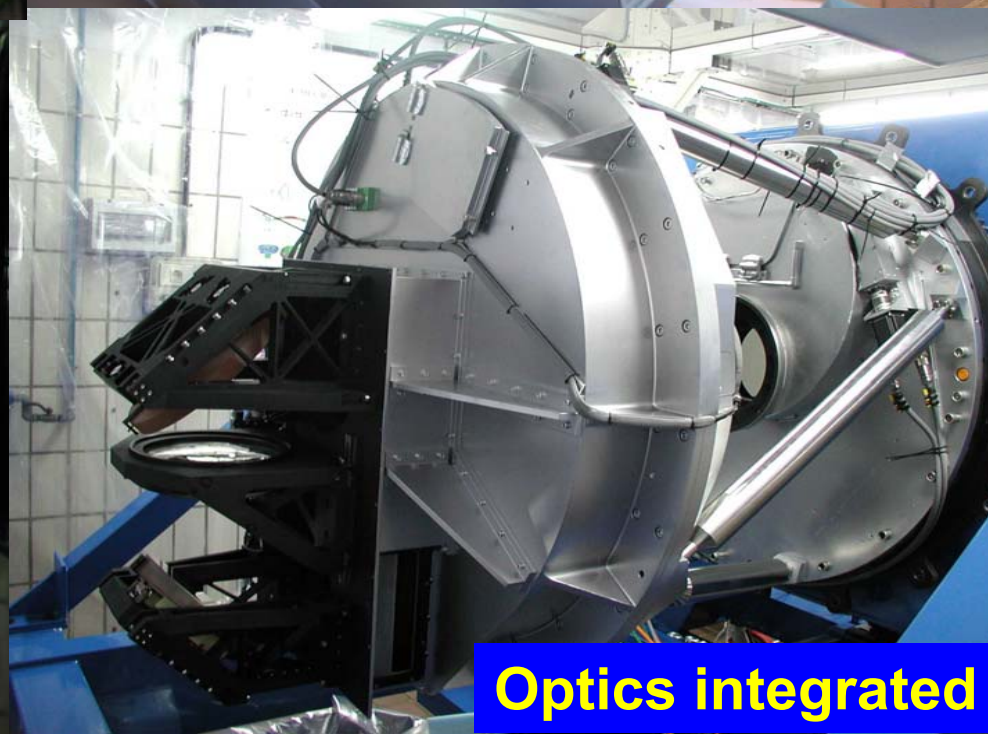




Back focal length measurement

Optics Image quality



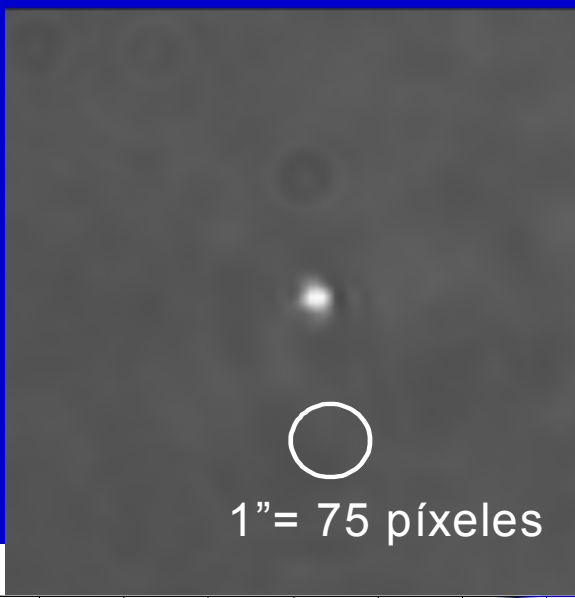


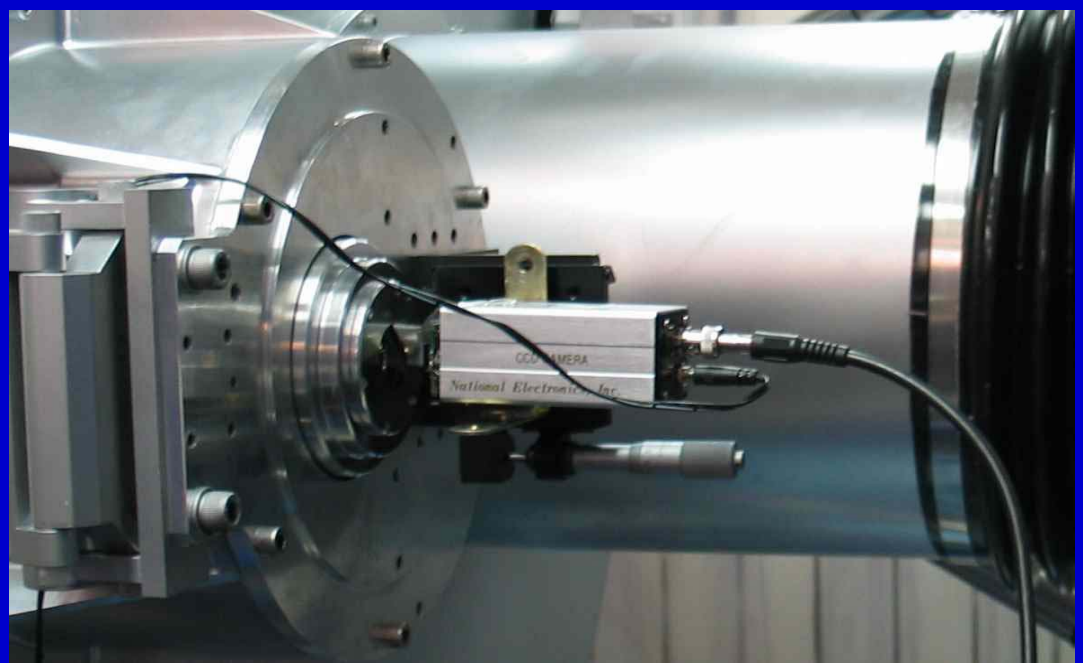
Optics integrated

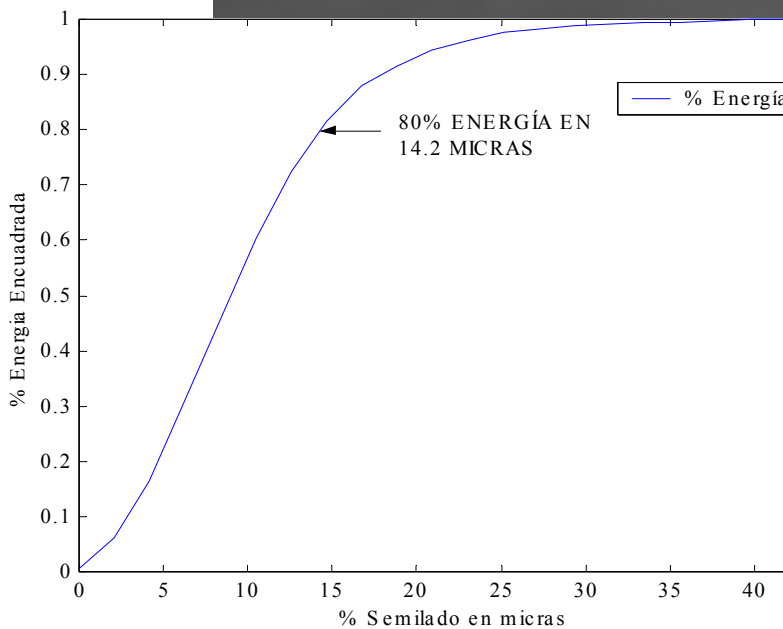
Preliminary Results: PSF and EER_{80}

Meaured EER_{80}% 14.2 Πμm (req. **EER_{80}%<15 μm**).
Symmetric PSF as expected

- AUXILIARY CCD FOR DIRECT IMAGING
- Polychromatic g' and r' imaging on the central field
- Input image in the focal plane:
  130μm became 10.9μm in the camera.
  The PSF is about **8.8 μm**.



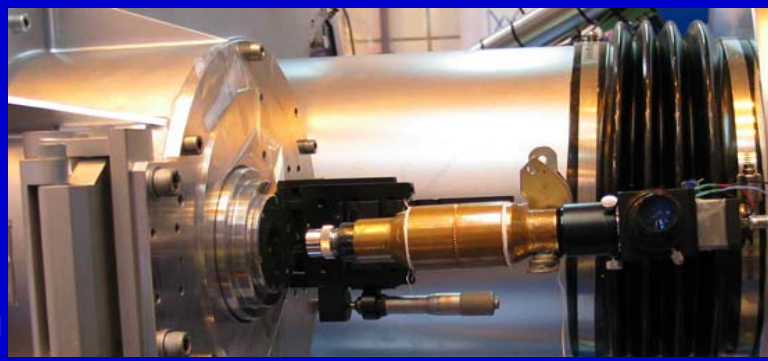




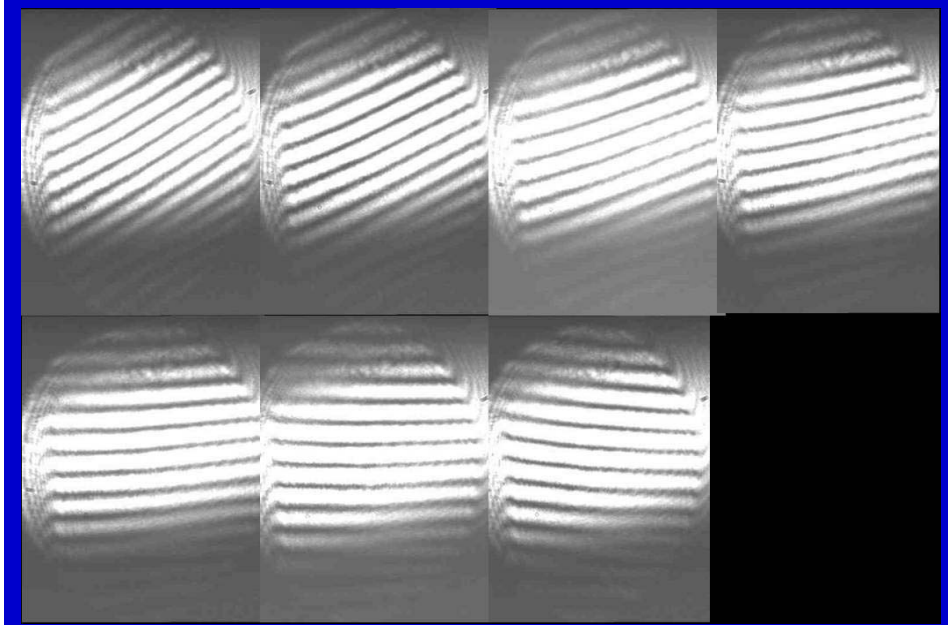
Preliminary Results: Instrument Back focal length and Collimator Position

- **BFL** was measured with an autocollimator

- Values are **the same as the measured for the camera alone at factory** and 0.13mm less than expected. The distance from the interface has to be measured to confirm the position of the detector



The autocollimator mounted in the camera interf



- The nominal position for the collimator was measured by using a lateral shearing interferometer.

- On the left, the un-tilted fringes indicate a **perfec flat wavefront**, which is in the collimator moveme range. These values are compared to those expected in the model.

May 2004

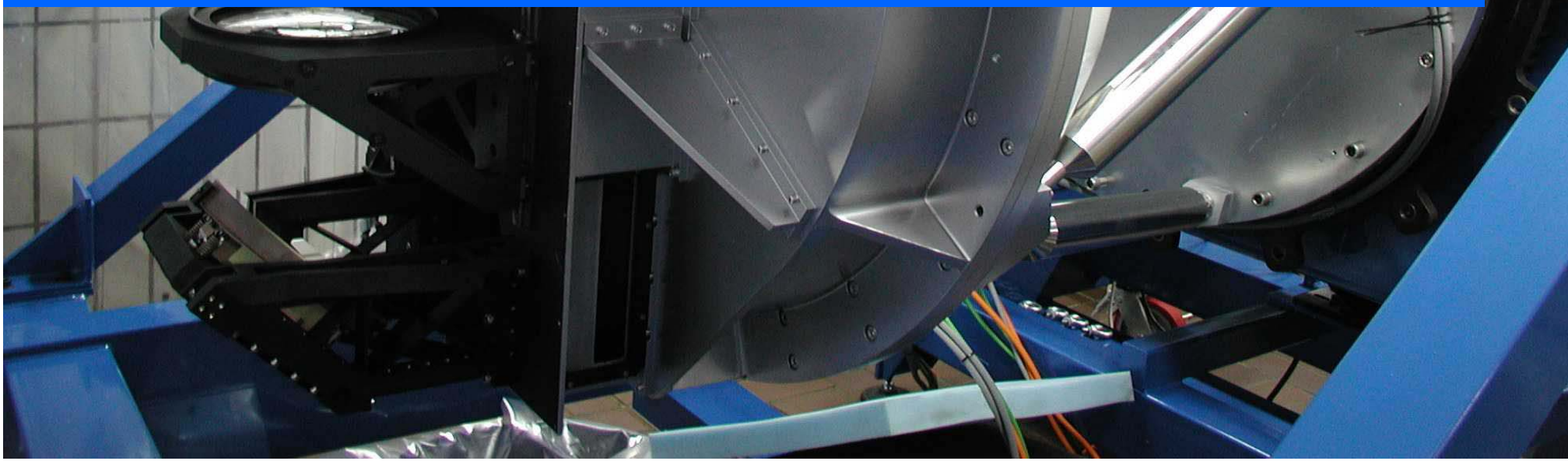
Elmer Optics ALIGNED!

Main optics parameters tested

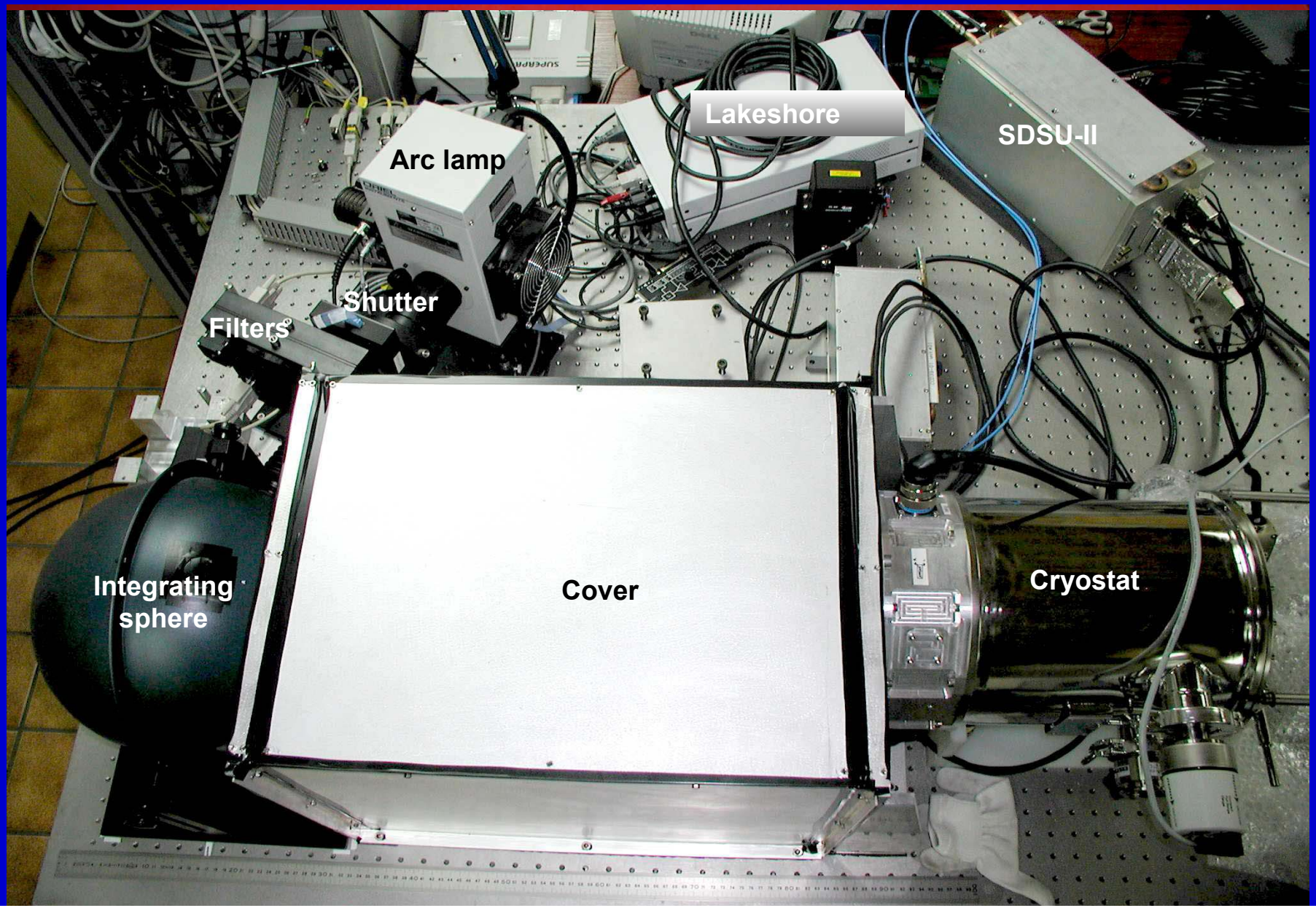
Superb performance!

Now, Optics is in the box again

System test starts in January05

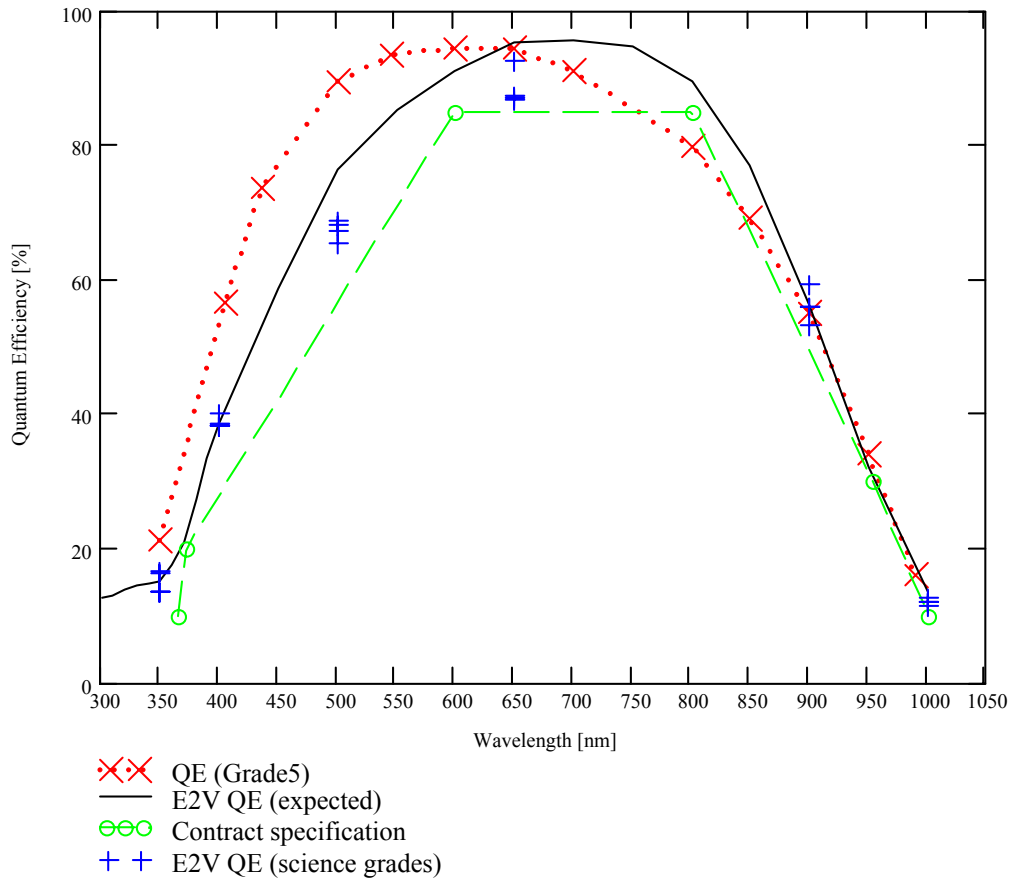


Elmer: Detector system pre-assembled



Tests on CCD44-82

QE_{peak} = 94.2% @ 600nm & -90ºC
RON_{min} = 2.3e- @ 50kpixels/s
Dark current = 5e-/pixel/h @ -100ºC
Cryostat hold-time > 2 days



Testing

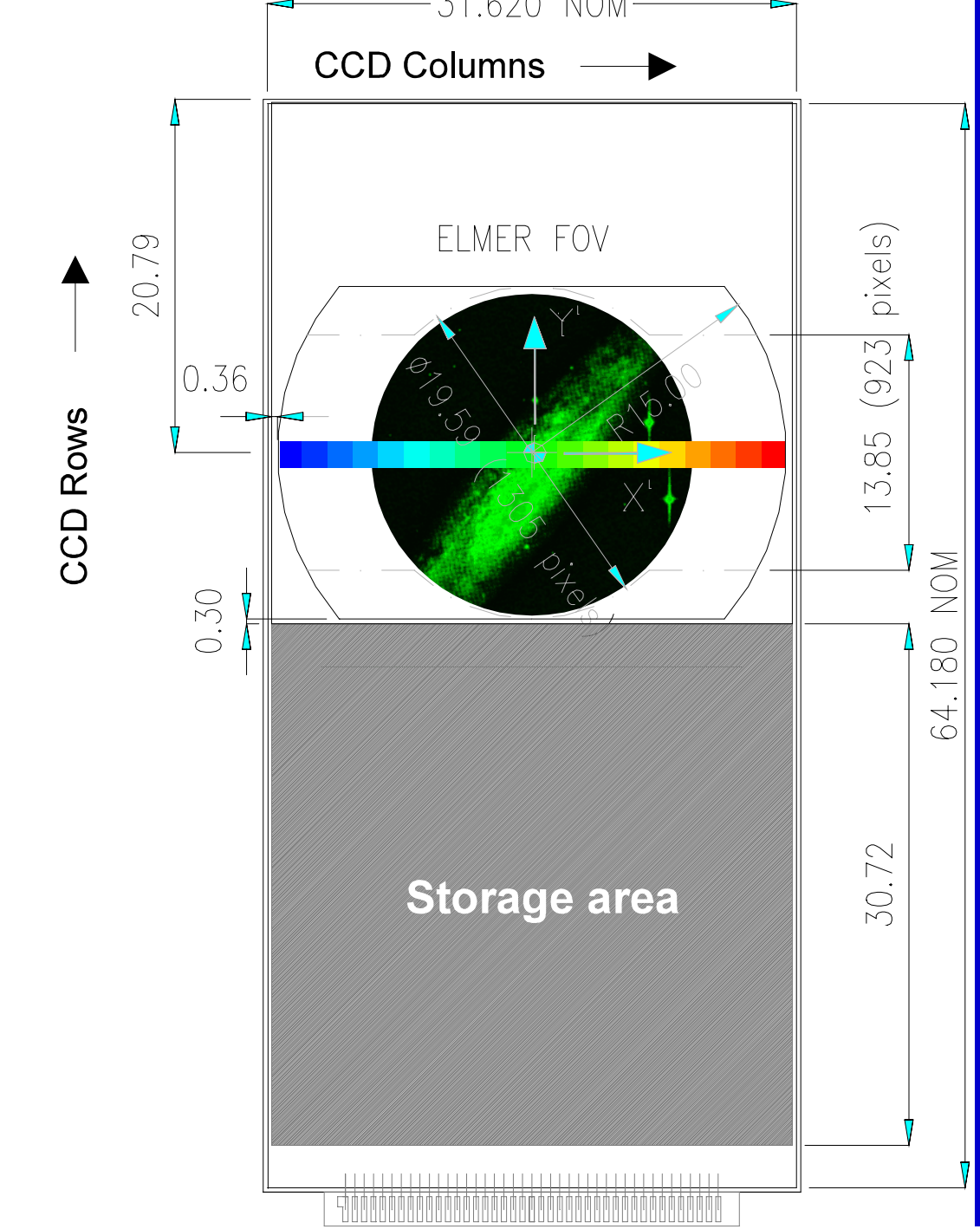
System fully tested and replicated

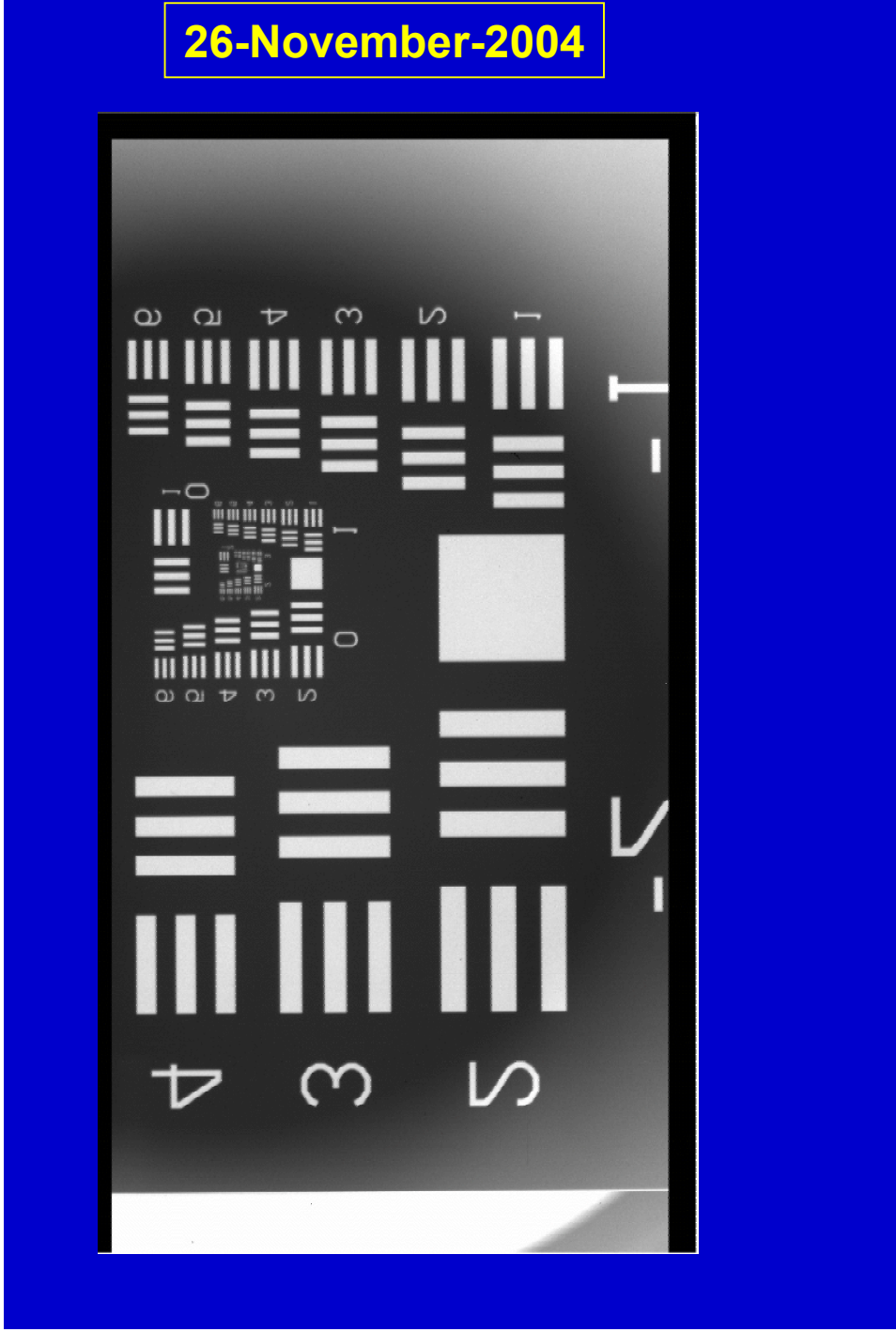
- Engineering detector characterized
- Science detector characterized

Software

Test-system running complete

Developed within the Inst. Group


31.620 NOM
CCD Columns
CCD Rows
20.79
0.36
0.30
ELMER FOV
ø19.50
R15.00
1305 pixels
13.85 (923 pixels)
64.180 NOM
30.72
Storage area

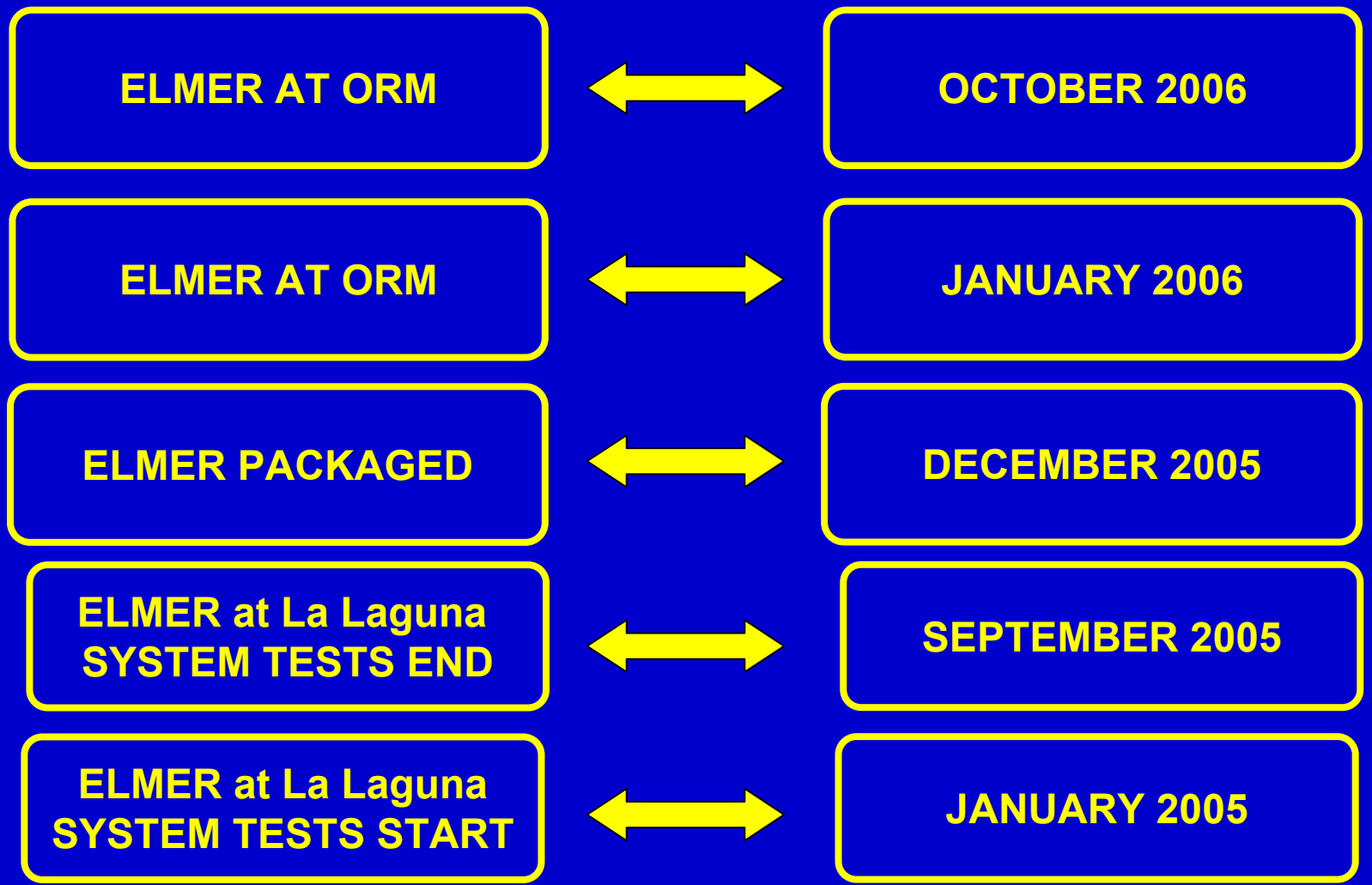

26-November-2004

On going activities

- Finishing Design & manufacture the prism, grism, VPHs mounts
- Finishing the pupil element tests
- Final Cabling and Electronic Cabinets
- Electrical Panels to physically disconnect the core instrument from the cabinets
- Final cabling inside the cabinets

- CONTROL SYSTEM
- SYSTEM TEST
  - A large amount of work is necessary to guarantee the success of the instrume
  - Testing implies reliability, and shortness of the commissioning at GTC
  - We estimate we need one year (2005) of Elmer team for system testing

CURRENT ELMER-GTC SCHEDULE



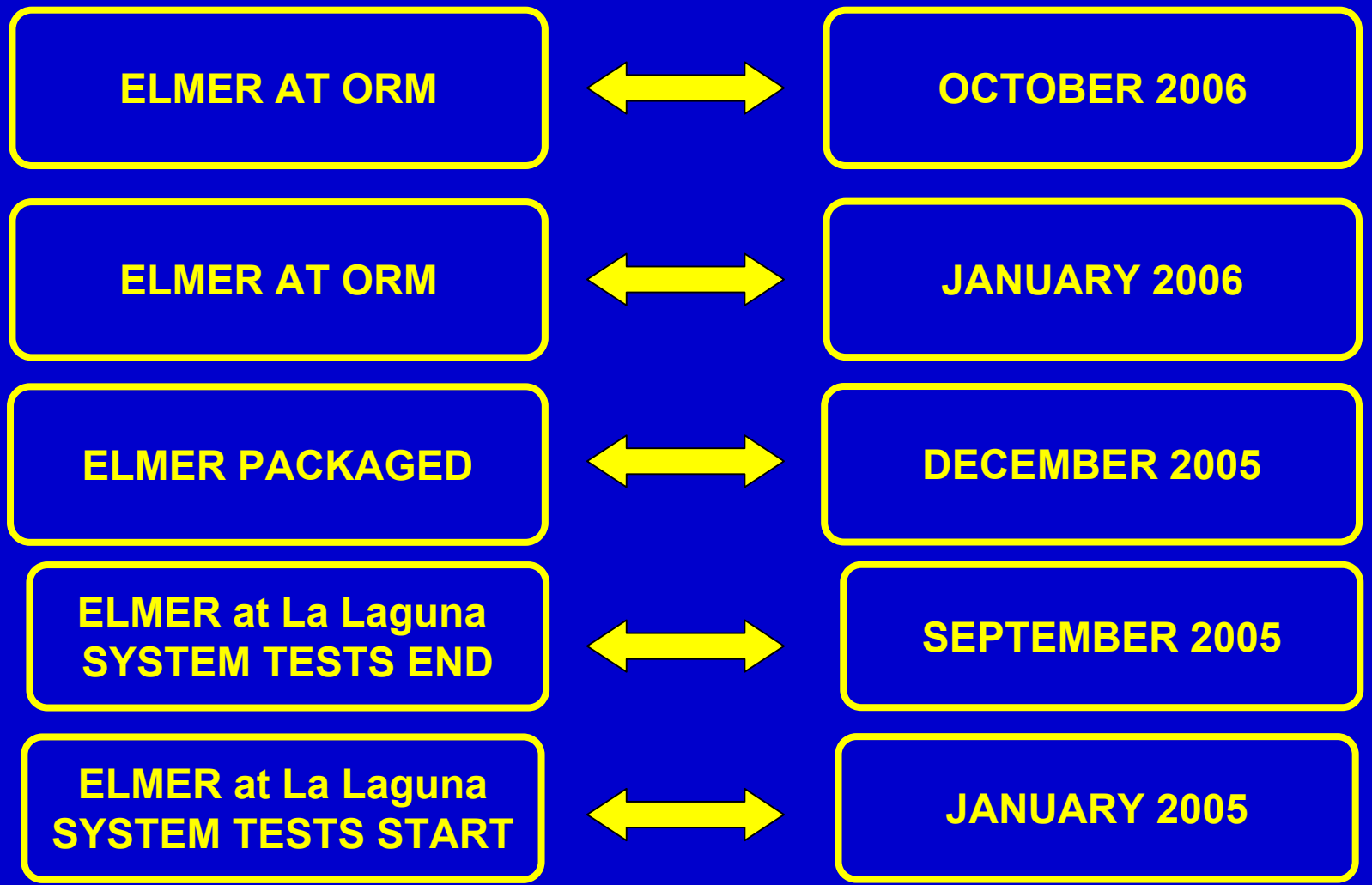
First alignment May 2004
PDR passed: April 2001
Approved: October 2000

ELMER in figures: global budget

- **Human resources (at the PO)**
  - Total (until the end): 19,0 man-years
- **Budget**
  - Everything except detector: **1.25 M€**
  - **TOTAL INSTRUMENT at ORM** **1.36 M€**

  (including detector, transportation, integration and commissioning)
  - GRAND TOTAL = 1.36 M€ + 19,0 man-years = A**prox 2.50 M€**

CURRENT ELMER-GTC SCHEDULE



First alignment May 2004
PDR passed: April 2001
Approved: October 2000

1.- Elmer: Estallidos in the laboratory

Juanma M., Marisa G., José Miguel R.E, Peter H., Luis Corral, Casiana M.

- **Observing Modes characterization**
- **Goals**
  - Take and analyze the data (fully access to the instrument for testing beyond of a basic test plan)
  - Discussion of the impact of the instrumental parameters and performance on scientific data
  - Proposal of an optimized calibration plan at the telescope
  - Proposal of an optimized Data Reduction Process
  - Development of a pipeline IRAF-based to support the characterization tests
  - Optimization of the observational strategies

ELMER TESTING AT LABORATORY

- Every Observing Mode of the instrument will be fully characterized and documented for the users. This information will allow a fine tuning of the observing sequence, the calibration and the data reduction procedures.

- The goal is to test at laboratory as much as possible to shorten and to optimize the commissioning time at the GTC.

- Tests
  - Engineering Tests
  - Scientific Performance Tests
    - Imaging
    - Spectroscopy
    - Special modes on detector (Frame Transfer and charge shuffling)
- Outputs
  - Instrument fully characterized
  - User manual
  - Maintenance manual
  - Calibration procedures
  - Sequences
  - Data reduction procedures

SCIENTIFIC TESTS: IMAGING MODE

- Every observing mode of the instrument will be fully characterized and documented for the users. This information will allow a very fine tuning of the observing sequence and the data reduction procedures.
  - IMAGING OF FOCAL PLANE APERTURES ON DETECTOR
  - FOCUS: OPTIMUM POSITION FOR EACH FILTER AND FIELD
  - EE_{80} REQUIREMENT: for 1' (Central Field) and for 4.2' (Whole Field).
  - IMAGE STABILITY REQUIREMENT : FLEXURE TEST
  - GHOST LEVEL REQUIREMENT: GHOST ANALYSIS TEST
  - PSF ALONG THE FIELD
  - SCATTERING LEVEL IN THE CENTRAL FIELD
  - FIELD DISTORTION
- Filters have been fully characterized and are ready to be used.
- Auxiliary equipment: Focusing and pupil masks and Data reduction software.

SCIENTIFIC TESTS: SPECTROSCOPY MODE

- FOCUS: OPTIMUM POSITION FOR EACH DISPERSOR.
- SPECTRAL COVERAGE FOR:
  - CENTRAL LONG SLIT and SLIT at the corners
  - SLIT-LESS SPECTROSCOPY
- EER_{80} in the Whole Field FOR
  - CENTRAL LONG SLIT
  - MULTIOBJECT SPECTROSCOPY (PRISMs, GRISMs and VPHs)
- SPECTRAL RESOLUTION FOR
  - CENTRAL LONG SLIT
  - MULTIOBJECT SPECTROSCOPY (PRISMs, GRISMs and VPHs)
- IMAGE STABILITY REQUIREMENT : FLEXURE TEST
- GHOST LEVEL REQUIREMENT: GHOST ANALYSIS TEST
- PSF (SPATIAL, SPECTRAL), DISTORTION
- SCATTERING LEVEL IN THE CENTRAL FIELD (SPATIAL DIRECTION)

2.- Elmer: Estallidos at the telescope

José Miguel R.E, Marisa G., Peter H., Juanma M., Casiana M., Luis Corral

- **Demonstration Program on-sky**
- **Goals**
  - To select targets and observations to be proposed for the commissioning phase fully oriented to the verification of the instrument performance on sk (observations not science-oriented)
  - To select specific deep observations to demonstrate detection limits, instrument throughput etc.. (science-oriented)
  - To select specific demonstration programs to validate each of the observir modes in each possible configuration to commission the observing mode from the scientific point of view (from instrument proposal to data reductio and quality control)
- Additional notes: If Elmer is selected (end of 2005) as Day One instrument then it will be at least 9 months at the GTC, with different commissioning periods

3.- Elmer: Estallidos in the computer

Juanma M., Marisa G., Mercedes M.

❑ Evolutionary synthesis models

Estallidos (Starburst) + Elmer + GTC

❑ Goals

- ❑ To update our existing synthesis code with the most recent isochrones, atmosphere models and stellar atlas (focused for young stellar populations and different hypothesis about IMF
- ❑ Include in the model the real Elmer filters, prisms, grisms and VPHs
- ❑ Include in the model simulated spectra through Elmer and the GTC
- ❑ Produce Synthetic spectra in the Elmer range (3.650-10.000 Å) with real Elmer pupil elements and spectral resolutions, with specific tools for aging the observed starburst with Elmer
  - ❑ Include Synthetic Stellar spectra
  - ❑ Predicted Nebular spectra under photoionization conditions
  - ❑ Calcium Triplet Synthesis
  - ❑ WR features Synthesis
- ❑ Develop an on-line Estallidos with Elmer as a working tool