The Brazilian Tunable Filter Imager (BTFI for SOAR)

Claudia Mendes de Oliveira, PI
Keith Taylor, Project Manager

BTFI is pioneering several new technologies and concepts

iBTF (Blais-Ouellette – Caltech)

Crossed VPHGs to give novel tunable filter

SESO Fabry-Perot (LAM - Marseille)

Piezo amplification to give large range in resolutions

EMCCDs (e2v - Montreal)

Photon counting CCDs for rapid-scanned data-cubes

Dual channel

Simultaneous on- and off-band tunable filter imaging

BTFI to be used on SAM

GLAO at optical wavelengths over a 3 arcmin FoV

Collaborating Institutions (technical side)

Brazilian

- University of São Paulo, Brazil (IAG, Poli-Technica)
- Instituto National de Pesquisas Espacias, Brazil (INPE)
- Laboratório Nacional de Astrofísica, Brazil (LNA)
- Unipampa (Bajé, RGS)

International collaborations

- Laboratoire d'Astrophysique de Marseille, France (LAM)
  - SESO Etalon controller
- University of Montréal, Canada (LAE)
  - EMCCD controller

BTFI project

Instrument Team

- Claudia Mendes de Oliveira (USP) - PI
- Keith Taylor (USP) – Instrument Scientist and Manager
- Rene Laporte* (INPE) – Mechanical and Optical Engineer
- Luiz Reitano (INPE) – Mechanical technician
- Fernando Lourenço (INPE/LNA) – Mechanical technician
- Luiz Cavalcanti* and Denis Andrade* (USP) – EE
- Giseli Ramos* and Fernando Fontes (USP) – Software Engineers
- Bruno Correa Quint* (USP) – Instrument Physicist
- Fabricio Ferrari (UniPampa) – High-level software
- Javier Ramirez Fernandez and students (Poli/USP) - EE

* Working full-time for the project

Science Team

- Claudia Mendes de Oliveira (USP)
- Henri Plana, Jaqueline Vasconcelos and Adriano Cerqueira (UESC)
- Francisco Jablonski (INPE)
- Laerte Sodré Jr. and João Steiner (IAG/USP)
- François Cuisinier and Denise (Obs. Valongo) + others

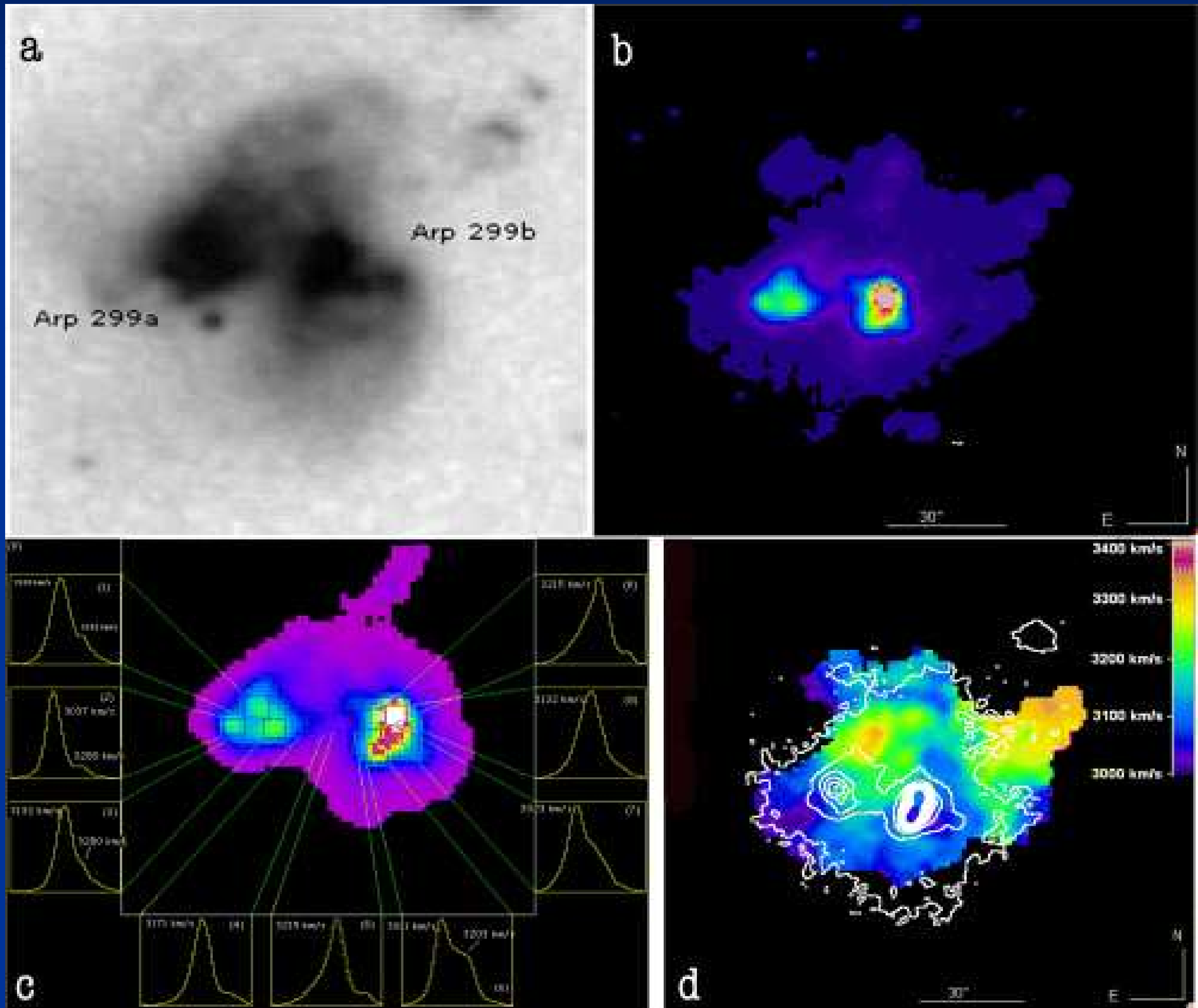
Consultants

- Dani Guzman (AstroInventions) – Electronics/Detectors
  - Systems Engineer
- Damien Jones (Prime Optics, Qld) – Optical Design
- Olivier Daigle (U. Montreal) - Detectors
- Alvaro de Calasans (São Paulo) – Electronics Engineer
- Sebastien Blais-Ouellette (PhotonEtc) – iBTF physicist
- Jean-Luc Gach (LAM) – Optics/Electronics

BTFI will allow a variety of scientific projects to be developed

(just a few examples in the following.....)

Velocity fields and metallicity maps of interacting galaxies



The centers of active galaxies

Study the nuclear activity of nearby galaxies to understand how mass is transferred from galactic scales down to nuclear scales to feed the supermassive blackhole. Small scale disks in the centers of AGNs have been found . We need to map the streaming motions of gas towards the nucleus, along dusty spiral arms, for a sizeable sample of galaxies.

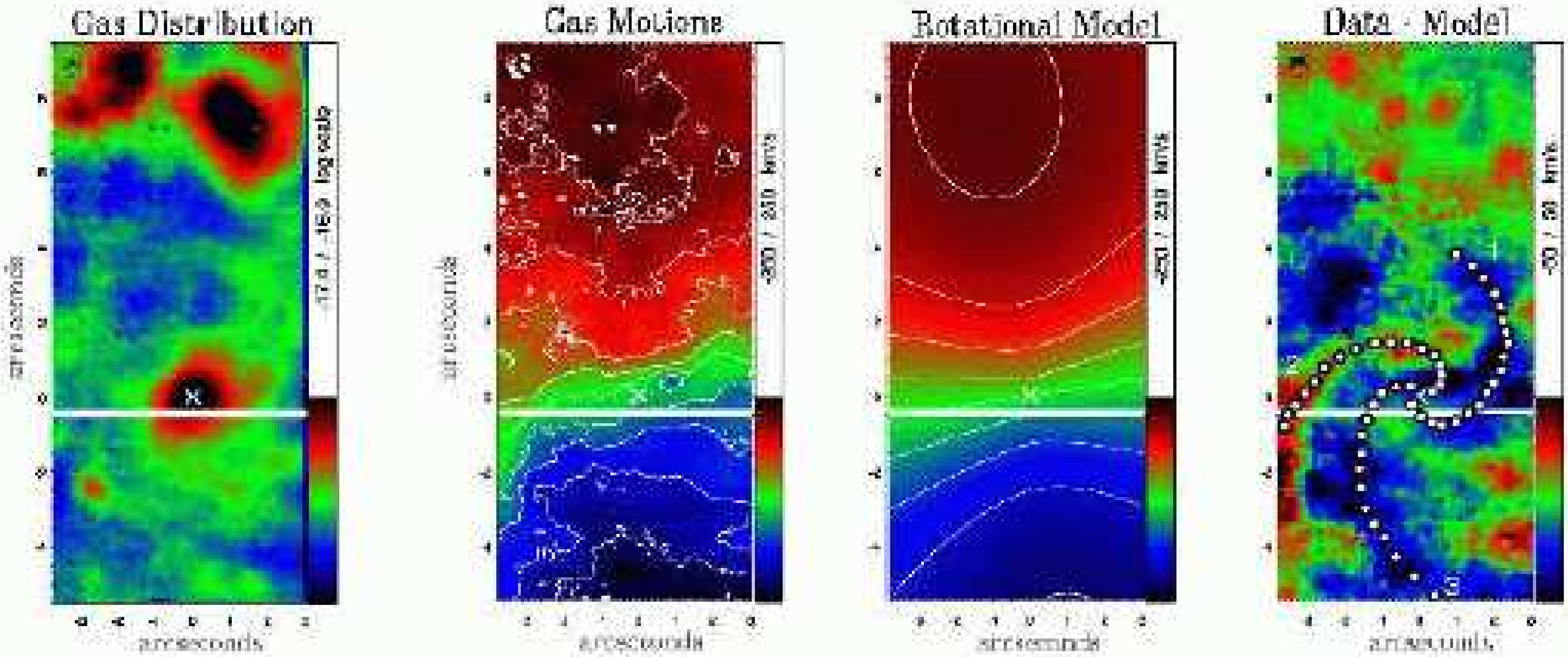
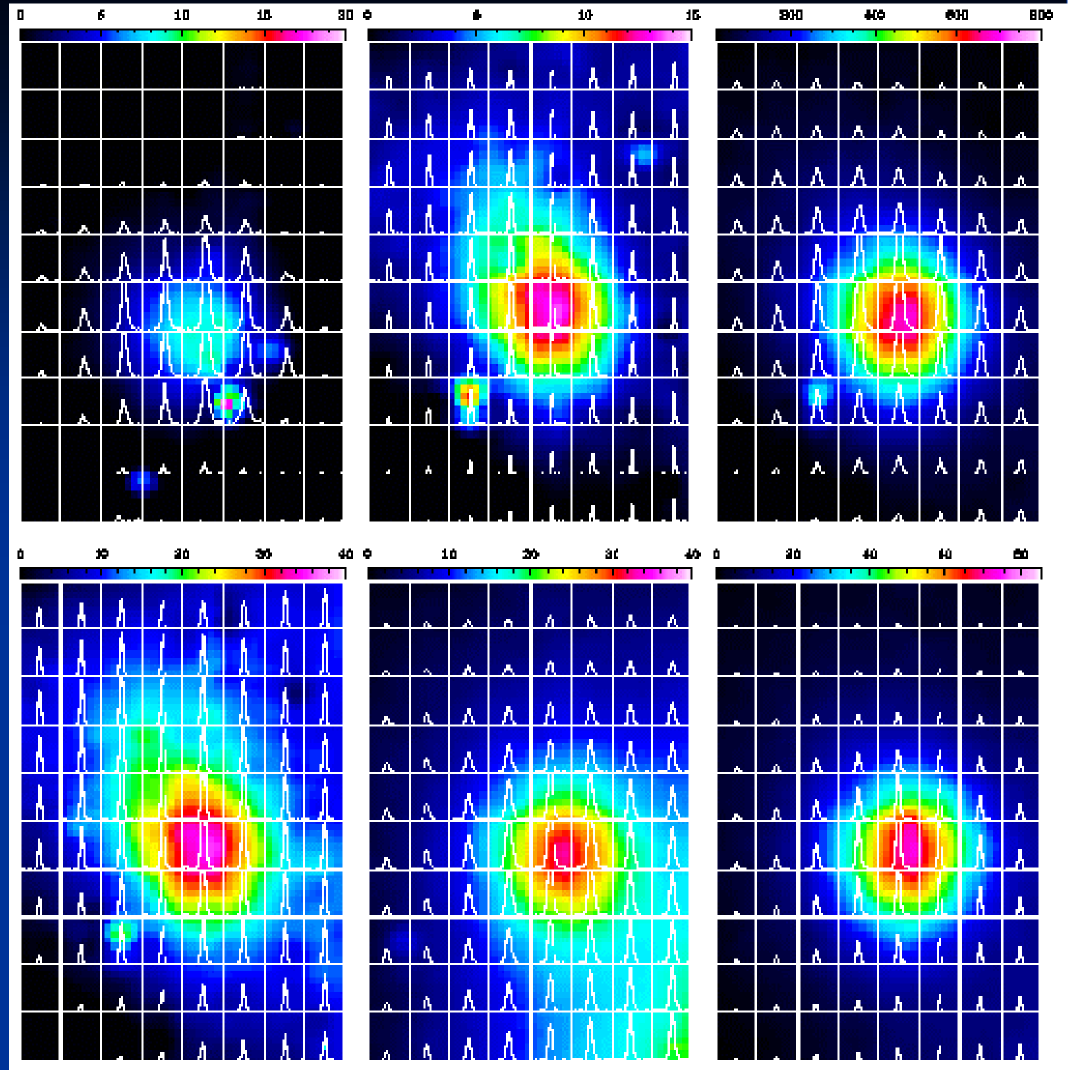
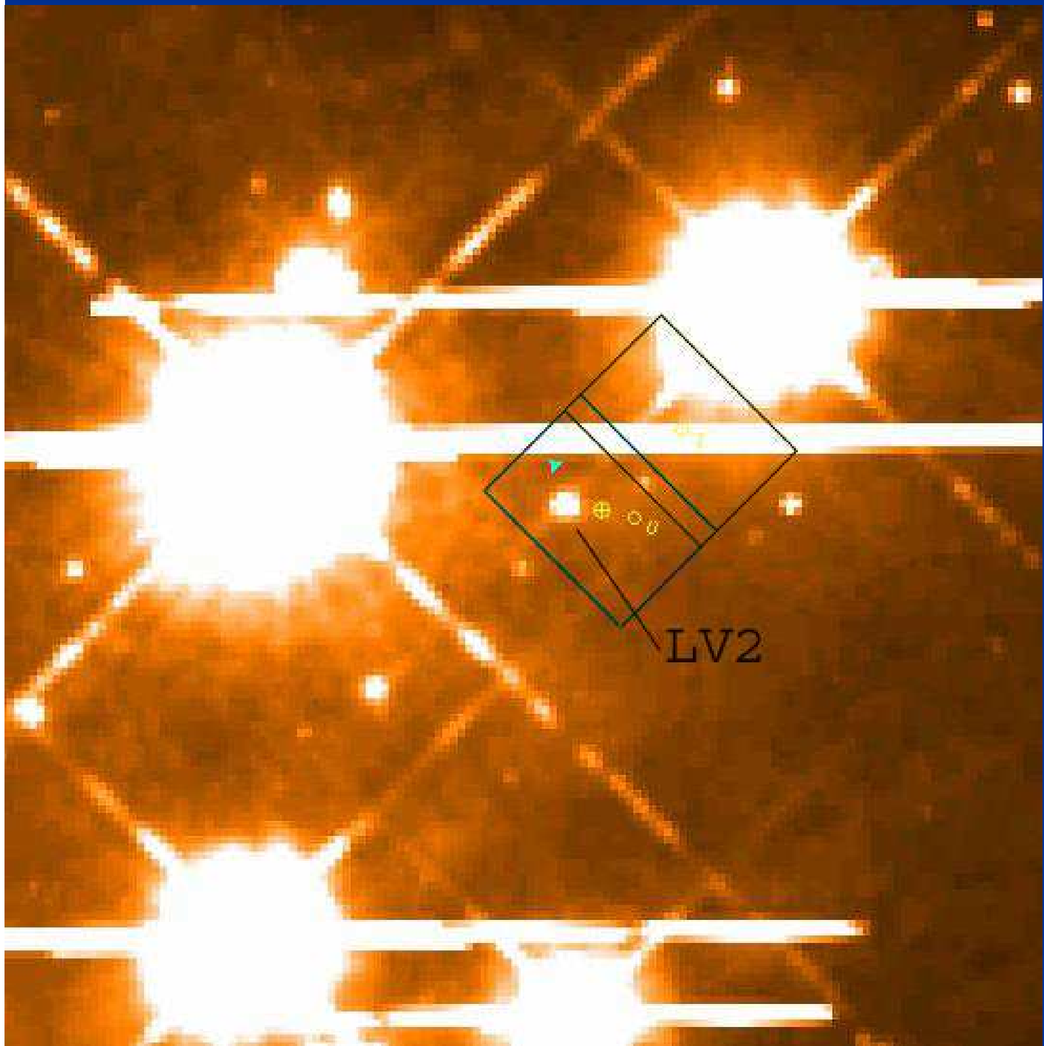


Fig. 2.— GMOS-IFU data results for NGC 1097. From left to right: [NII] flux distribution; radial velocity map derived from the [NII] emission-line; exponential disk velocity field model; and residuals. The spiral features seen in the residual map are delineated by white dots as in Fig. 1(red color indicates redshift and blue color, blueshift). Adapted from Fathi et al. 2006.

LV2 Proplyd GMOS – IFU

Vasconcelos et al. 2005





Generic System Requirements

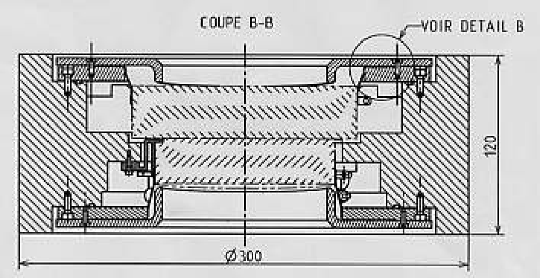
- 400nm < wavelength < 1000nm
- 5 < *R* < 30,000
- GLAO-fed 3D optical spectroscopy
- Spatial sampling ~0.1”
- FoV ~ 3.0’ ; $1{,}600^2$ (16 micm pixel) EMCCD
  - E2V @ US$25k each
  - Allows photon counting and rapid-scanned data cubes
  - f/7 camera

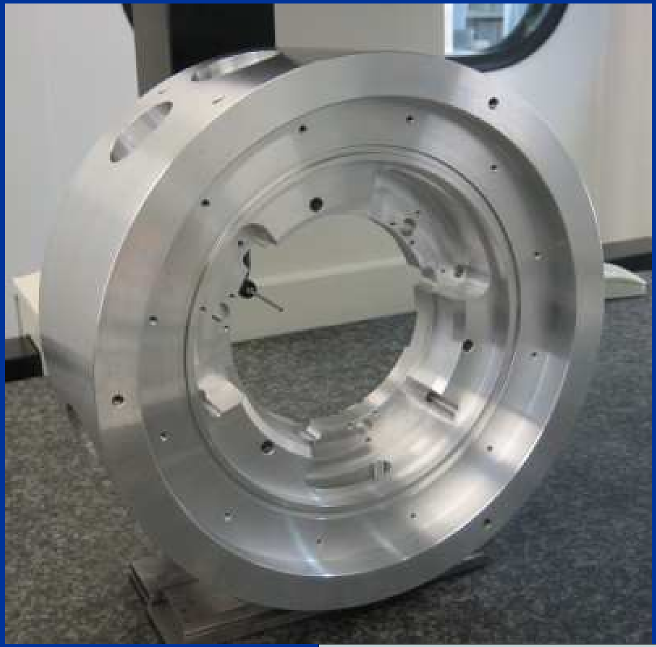
Advantages of BTFI on SOAR

- What is different in this instrument? (cf: TAURUS etc)
  - It combines a Tunable Filter (iBTF) with an FP
    - Large range of resolutions, $5 < R < 30000$
  - Capability for correcting for seeing (PSF) and transparency variations
    - Twin camera system (using iBTF's 0^{th} order channel)

- Use in SAM's GLAO-fed mode:
  - GLAO corrected field: BTFI will be the first of such instrument to work within a GLAO-corrected (3 x 3 arcmin) field.
  - Excellent spatial resolution, not achieved with any other such instrument.
  - Optimal use of SOAR's investment in high spatial resolution.

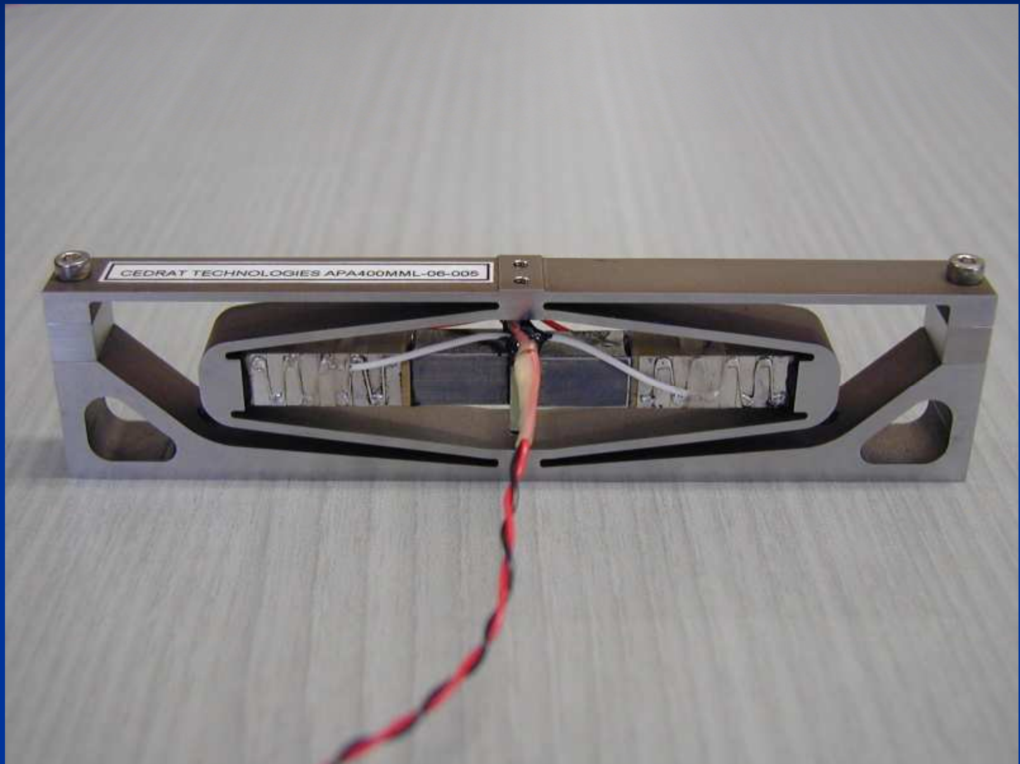
The new SESO etalons

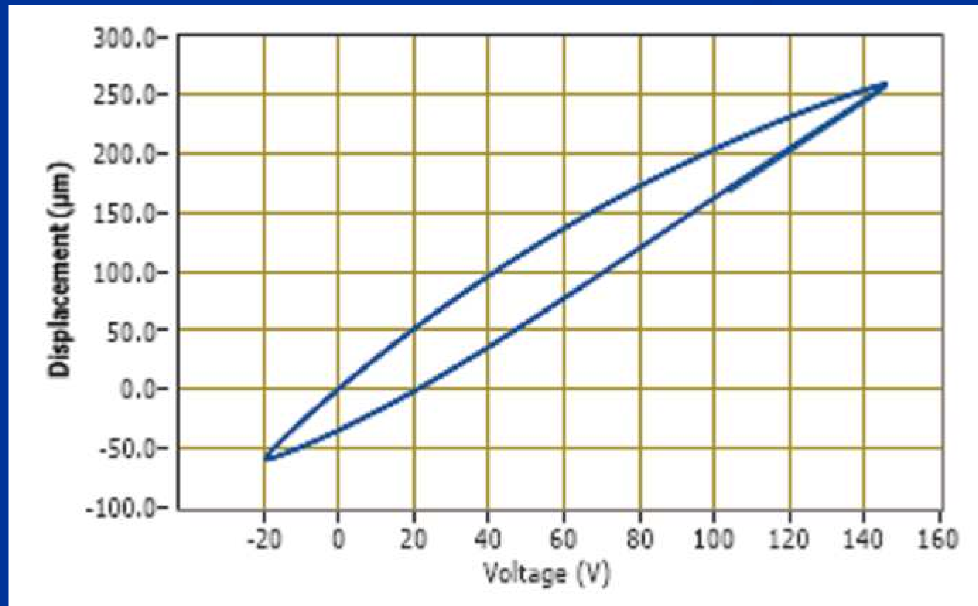




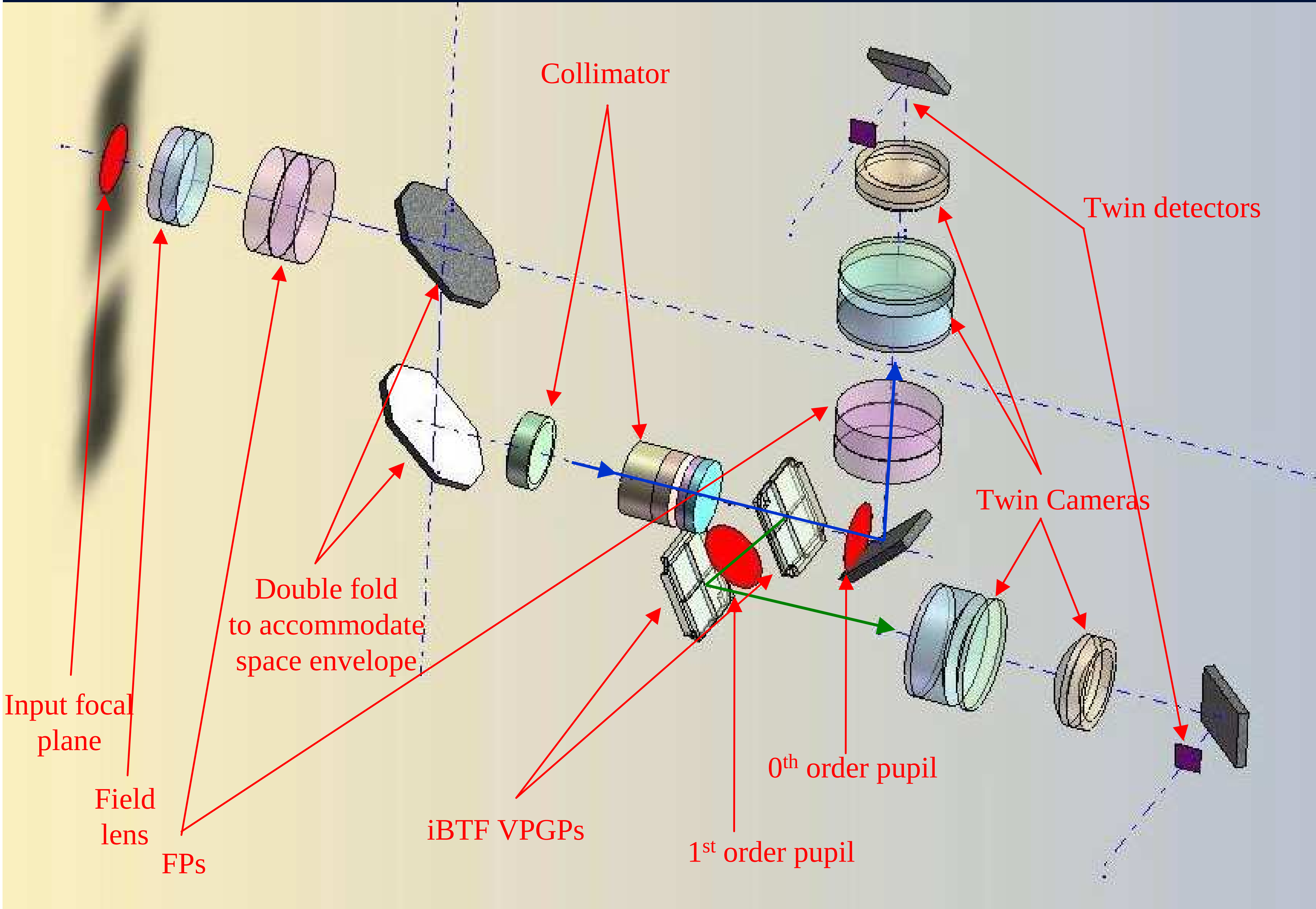
From Jean-Luc Gach (2007)

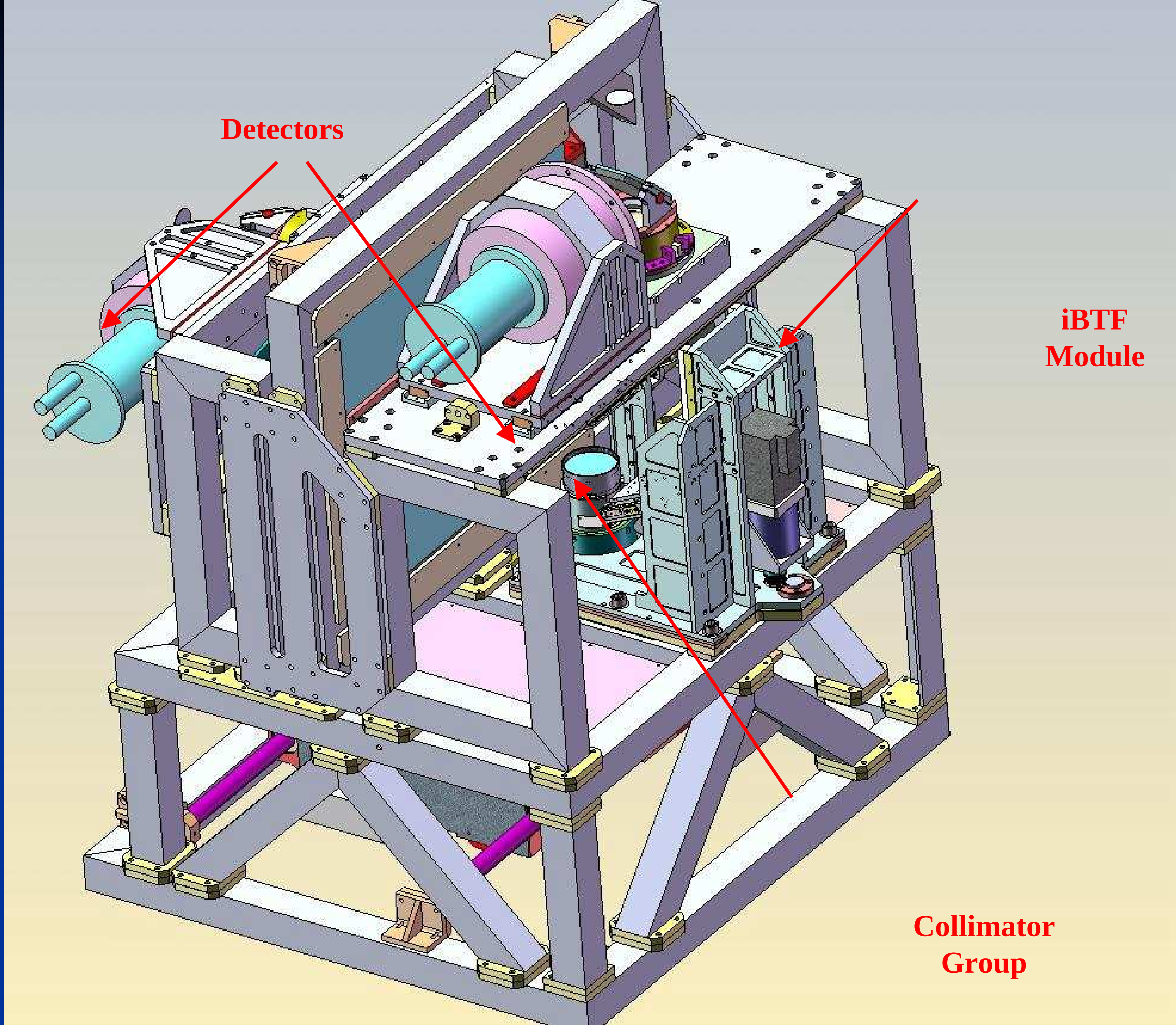
Piezo Actuator

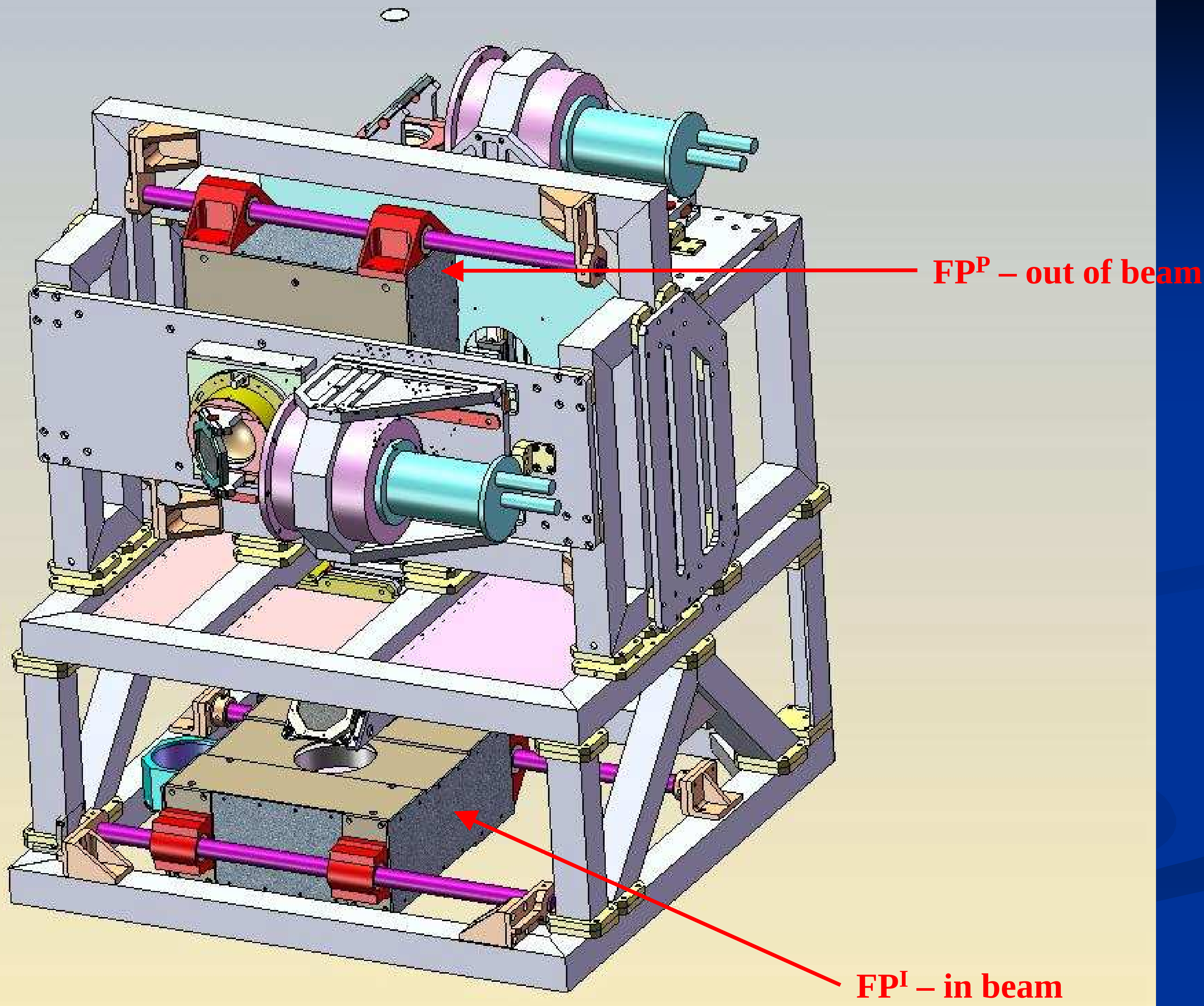




Références	APA 400MML	Unit
Excursion over [-20, +150]V	365	µm
blocked force	189	N
Stiffness in mouvement axis	0.59	N/µm
Mass	56.5	g

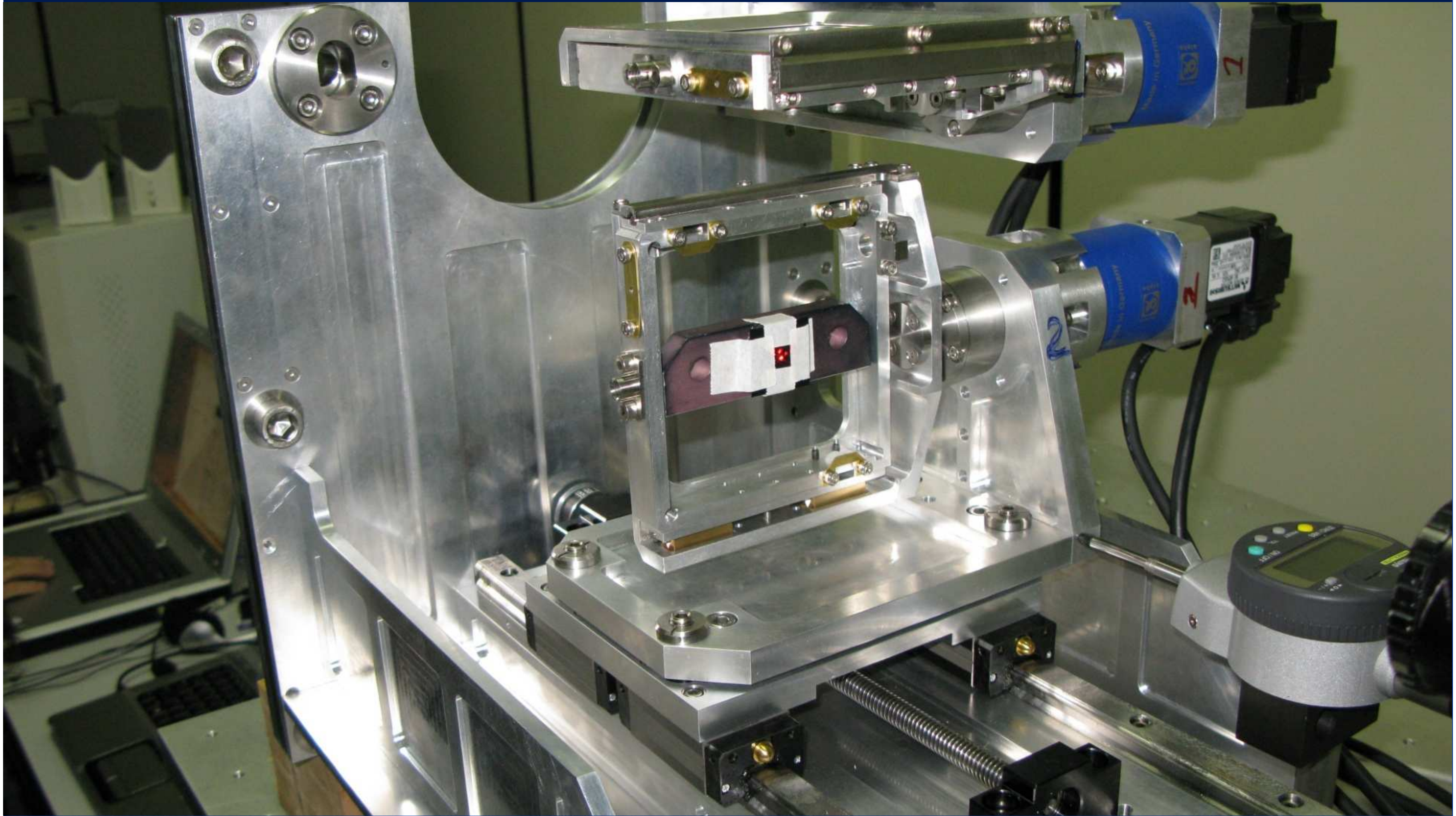

Collimator
Twin detectors
Twin Cameras
Double fold
to accommodate
space envelope
Input focal
plane
Field
lens
FPs
iBTF VPGPs
0th order pupil
1st order pupil


Detectors
iBTF Module
Collimator Group


FP^P – out of beam
FP^I – in beam

BTFI Milestones

- **Feb’07: Start of the project**
- **July'07: CoDR**
- **Sep’08: PDR**
- **Oct’09: Mechanical Integration**
- **Nov/Dec’09: Electronic Integration**
- **Dec’09-Feb’10:   Detector characterization**
  - Dani Guzman (Durham) at IAG mid-Dec’09
- **Mar/April’10: Optical Integration**
- **Apr'10:   Full Integration and test**
- **End of April’10: Freighting to SOAR**
- **End of May’10: Commissioning on SOAR (of the low resolution mode – the FP etalons will come only in October 2010).**



Módulo do iBTF – low resolution

BTFI is now at IAG
awaiting optics
integration and test