JouFLU: an upgraded FLUOR beam combiner at the CHARA array

0pto-mechanical design overview

Atlanta - February 29th 2012

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FLUOR = Fiber Linked Unit for Optical Recombination

- interferometric beam combiner for 2 near-infrared telescopes
- high accuracy visibilities measurement (~ 1%) in large K band: [1.9 ; 2.4] µm

Main specifics:

- the use of single mode fibers for spatial filtering and optical recombination
- simultaneous interferometric & photometric outputs

FLUOR saga:

- 1992: Kitt Peak (Arizona)
- 1995: IOTA, Mount Hopkins (Arizona)
- 2002: CHARA, Mount Wilson (California)

  => no upgrade has been made since this date

JouFLU = Jouvence de FLUOR (FLUOR rejuvenation)

1 year - LESIA development

JouFLU motivations:

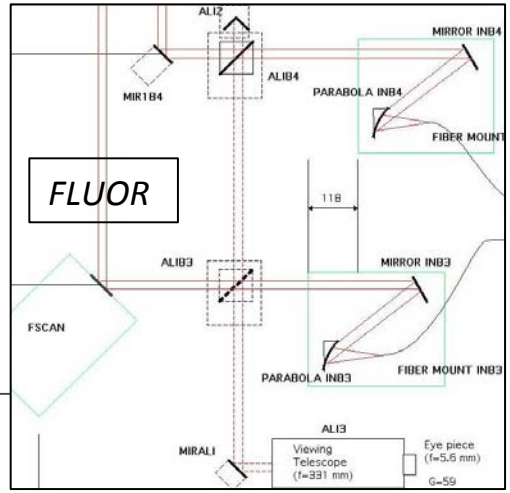
- integration into the CHARA environment
  - client/server under LINUX
  - fit CHARA upgrades
- CHAMP / VEGA coupling
- new observational modes: FTS, spectral dispersion, pupil control
- new scientific camera (PICNIC)
- remote control

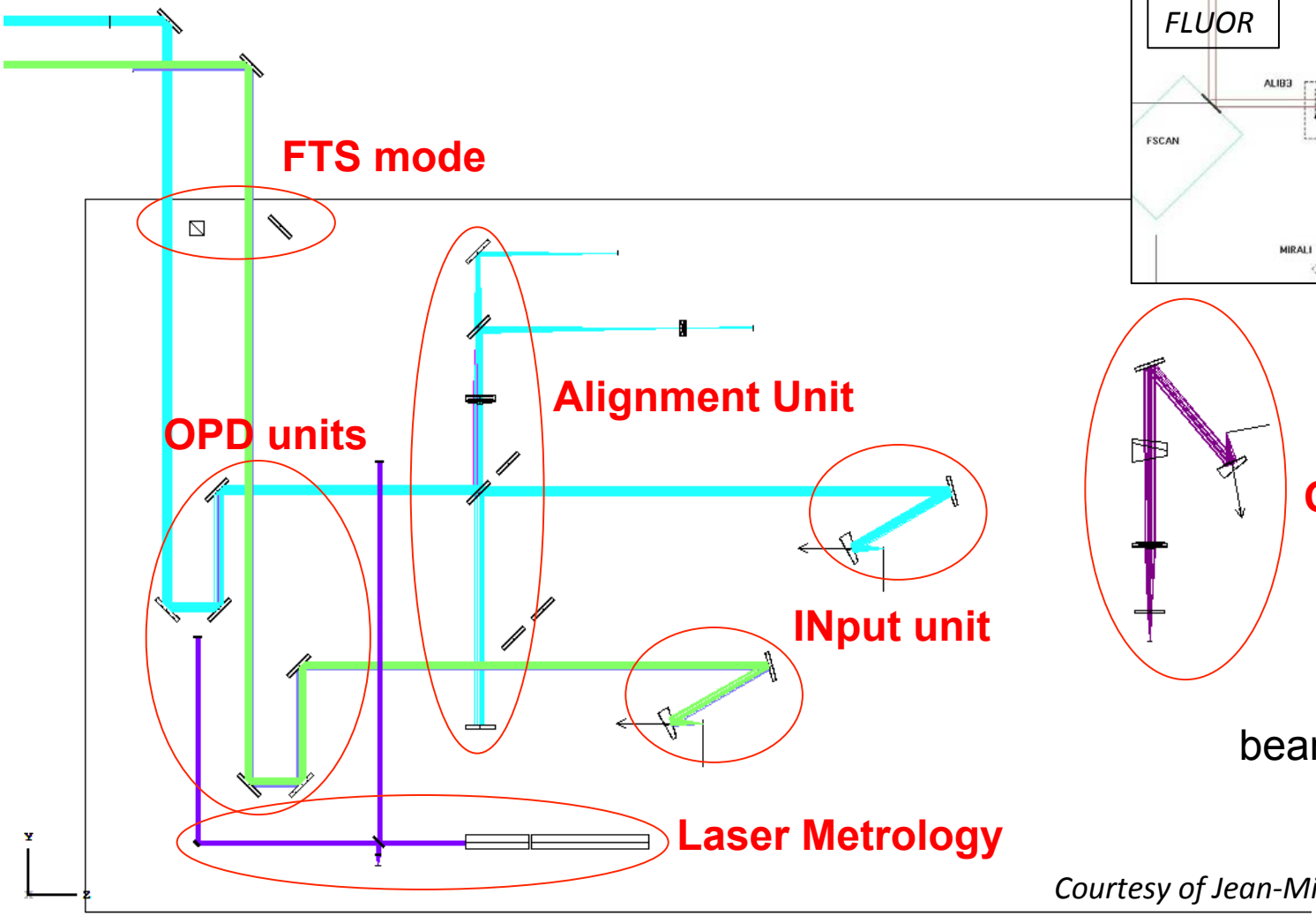
Expected performance:

- higher hardware robustness
- higher throughput

= gain of a factor 2 or 3 on visibilities measurements for 6-magnitude stars

Optical layout



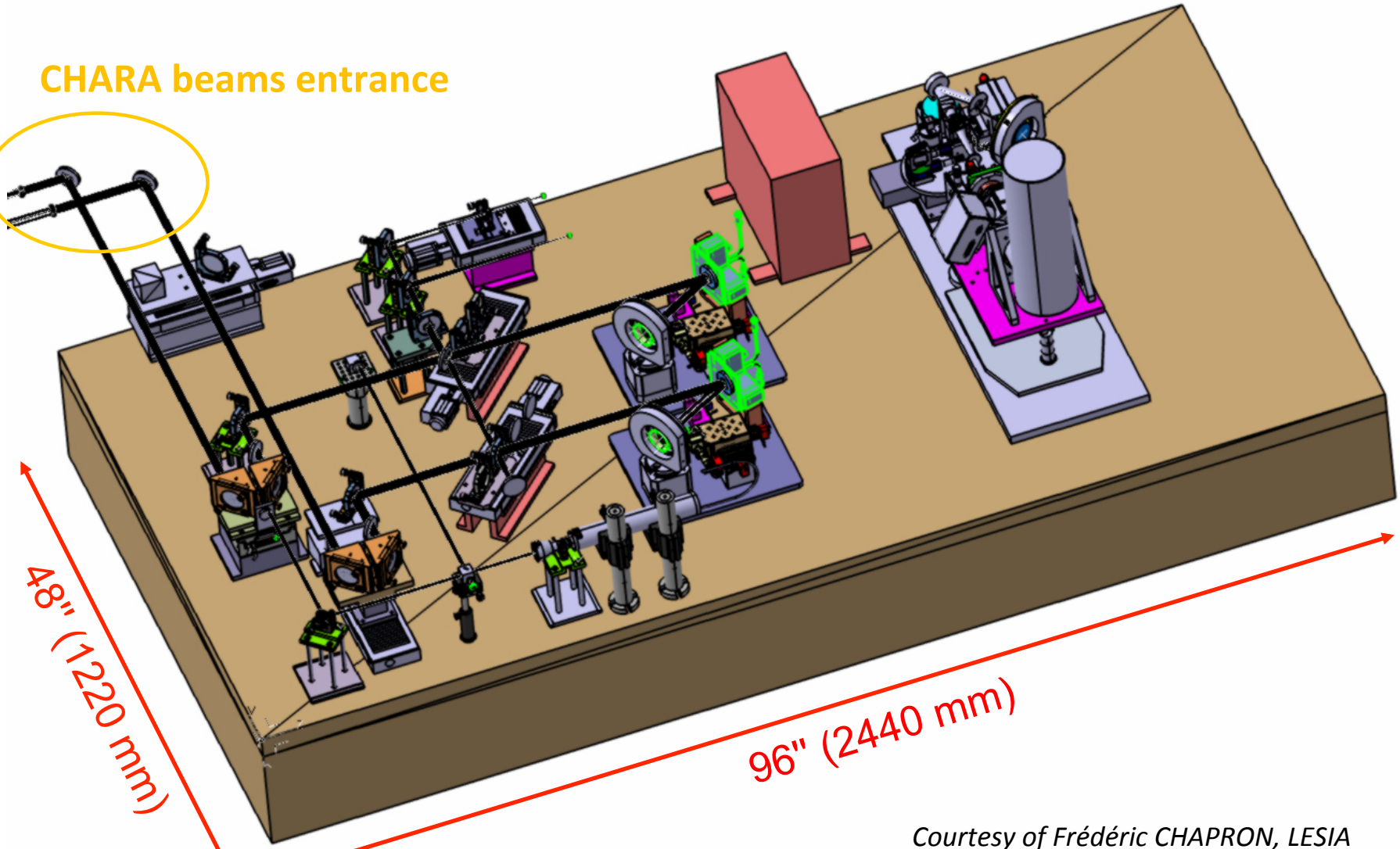


OUTput unit

beam diameter:
18mm

Courtesy of Jean-Michel REESS, LESIA

CAD overview



Courtesy of Frédéric CHAPRON, LESIA

OPD_Scan

JouFLU specifications:

- fringes tracking and modulation
- velocity linearity = ~ 1% on few mm travel range at low speed (100µm/s)
  → translation stage (linear DC motor)
  → optimization and qualification in lab (see Nic Scott's talk)

Travel range:

- small ~ 200µm (non-dispersive mode)
- large ~ 2mm (dispersive mode)

Optical payload:

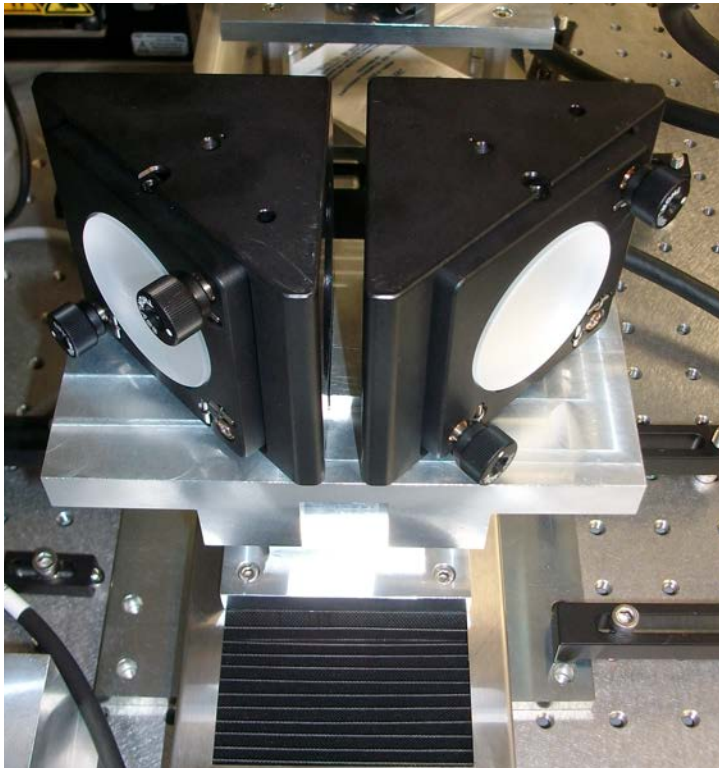
2'' retro-reflector

→ no axis tilt when yaw & roll

OPD_Stat – OPD correction

Residual OPD correction when:

- main mode
- FTS mode
- CHAMP / VEGA coupling



Technical solution:

100mm travel range translation stage

→ high repeatability for repositioning

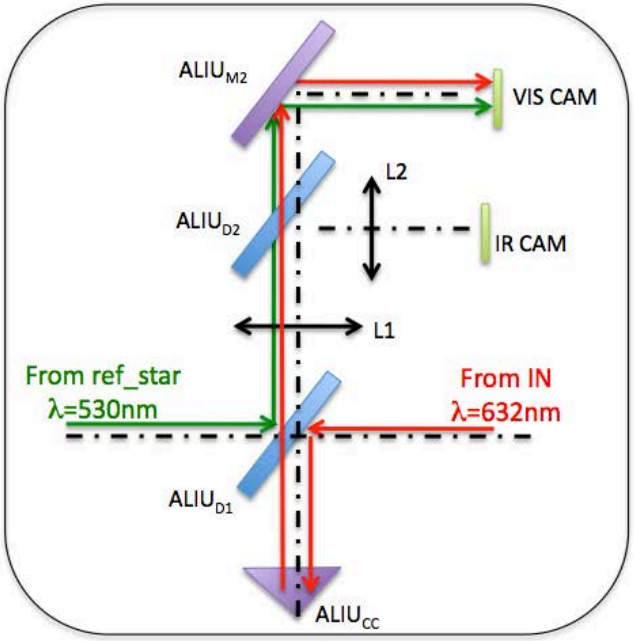
Optical payload:

2'' retro-reflector

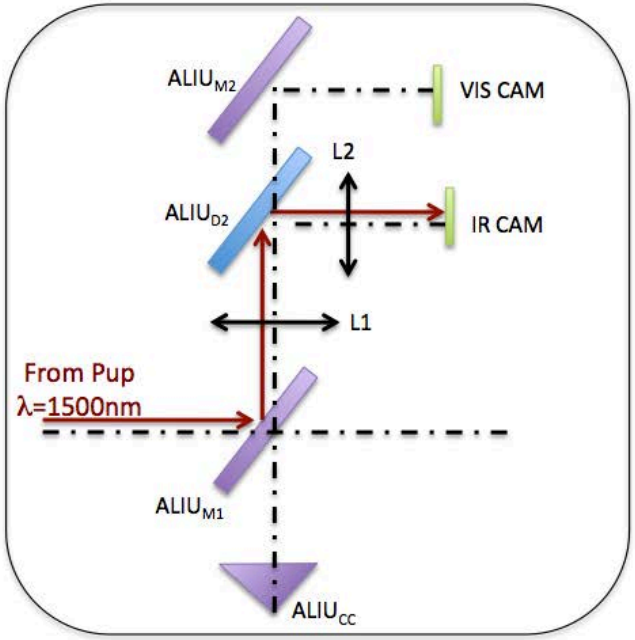
→ no axis tilt when yaw & roll

Alignment Unit

Routine alignment	CHARA pupil imaging
JouFLU (red LED) and CHARA (green laser) conjugation in the image plane → visible camera	• check for pupil shift • pupil position: [9.5 ; 22.5]m • H band → IR camera

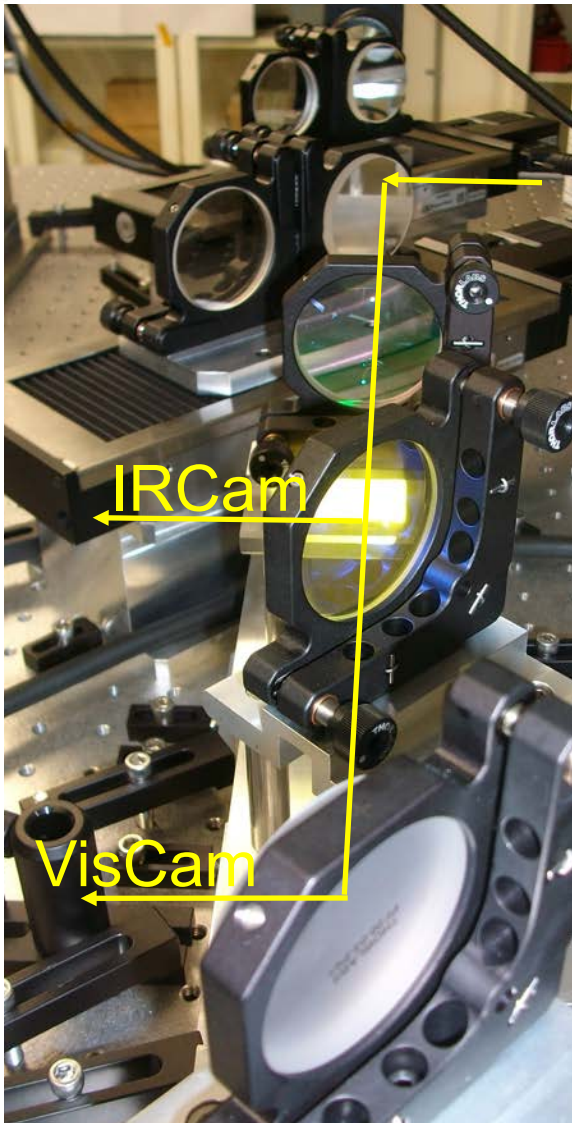


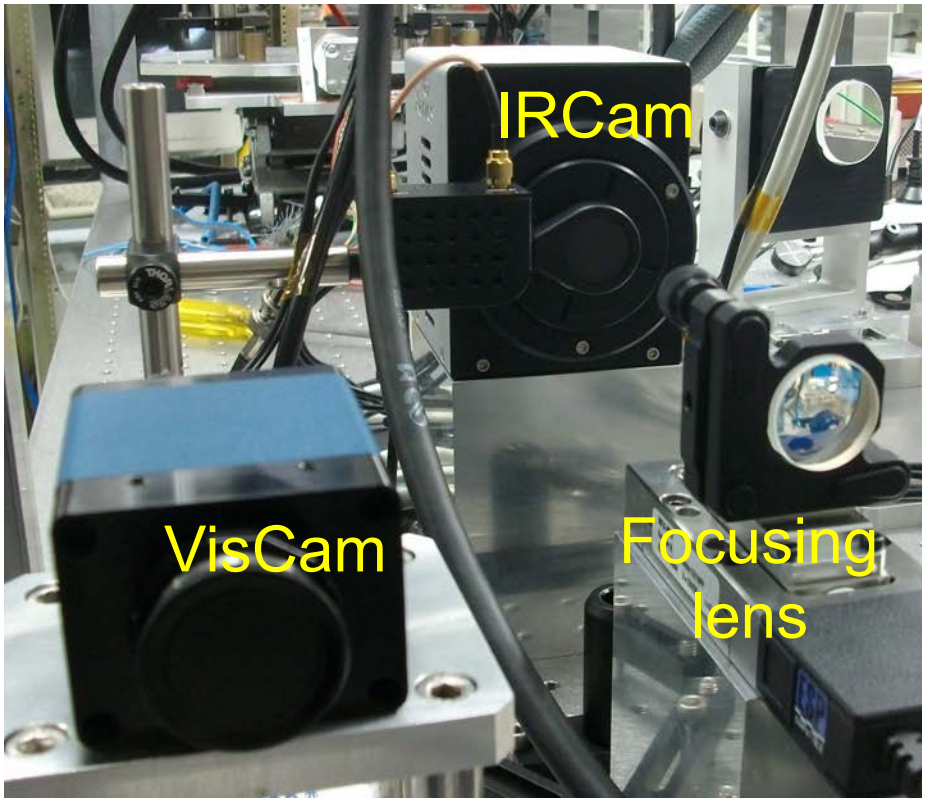
JouFLU and CHARA conjugation



CHARA pupil imaging

Alignment Unit





→ no more lab intrusion !

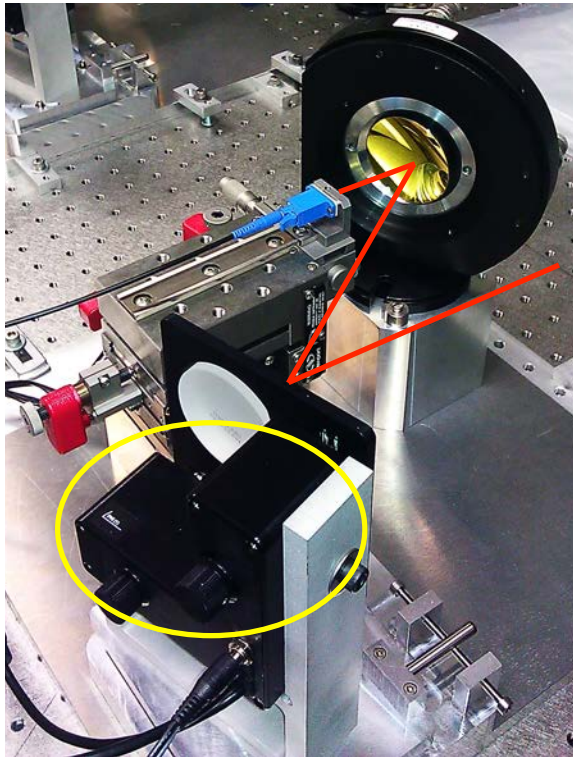
INput units

Functions:

- collect star light from each telescope into a single mode fiber (SMF)
- maximize injection during observations (raster)

Main improvements:

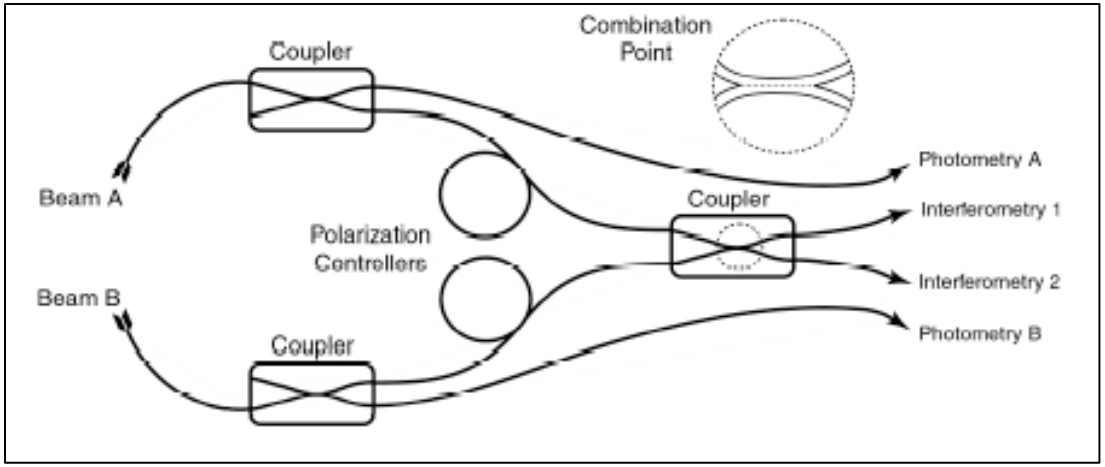
- new mirror mounts
  - → identical as CHARA ones
  - → actuators integrated
- new optics

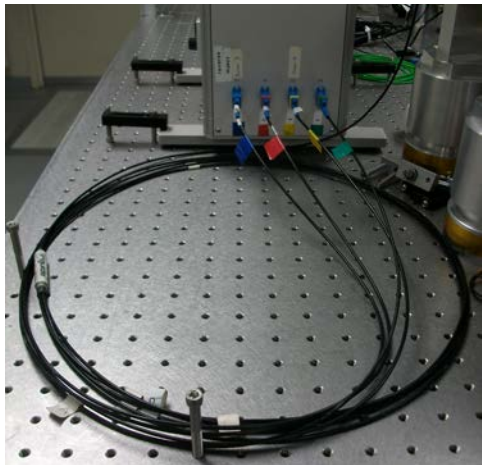


MONA beam combiner

Le Verre Fluoré fibered beam combiner

- Input: 1 SMF per telescope
- Output: 4 SMF sealed in a fiber bundle



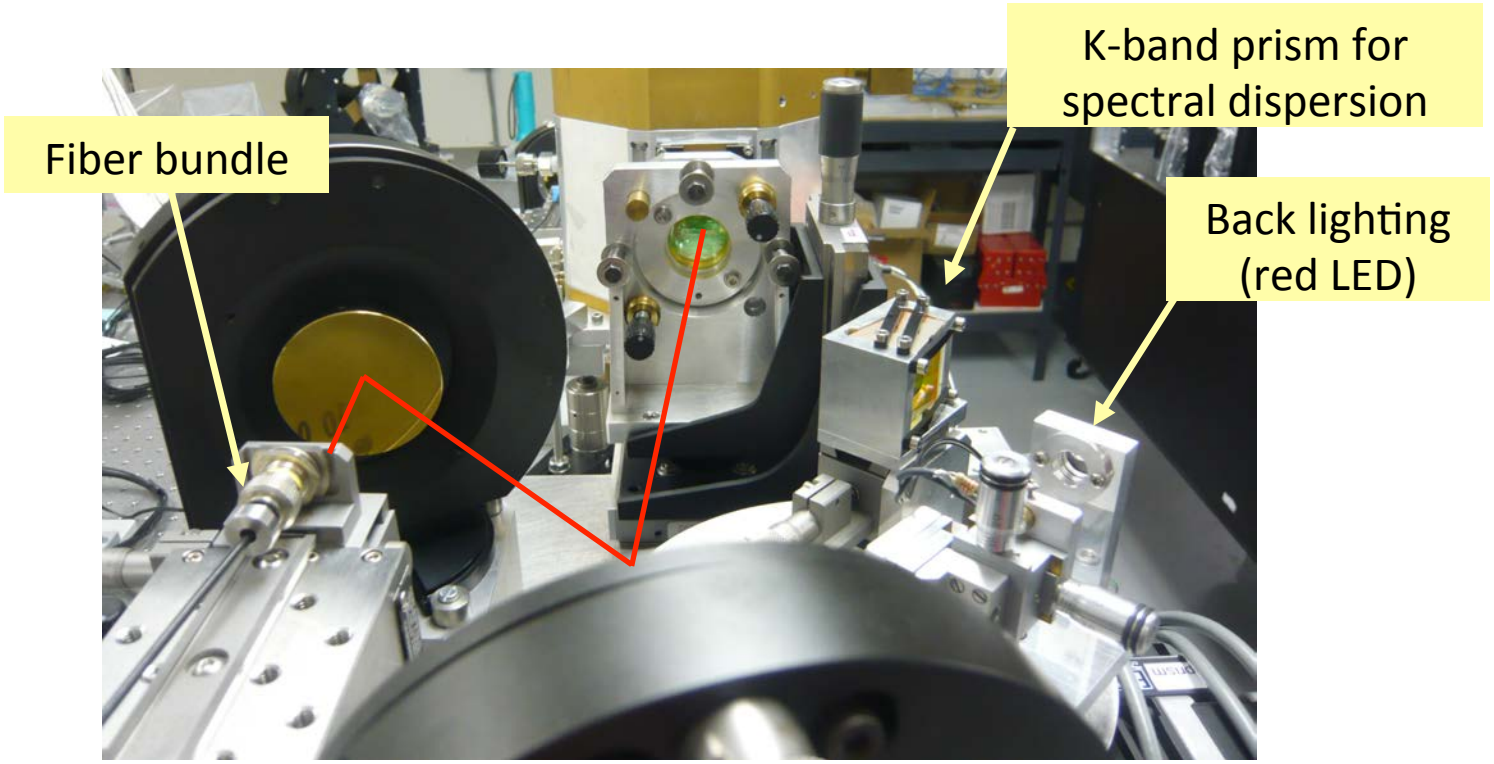


Check up: fiber heads cleaning and repositioning
→ gain in transmission

OUTput optical bench

Rotation stage:

- 4 spots
- 4 spectra
- back lighting for JouFLU alignment (red LED)

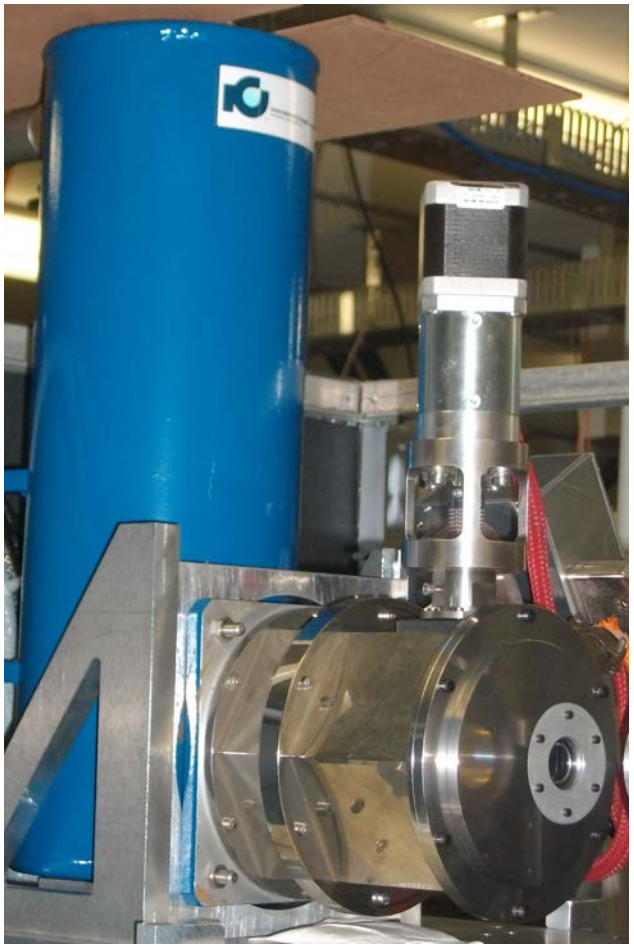


OUTput – scientific camera

CALI IR camera

- LN2 cooling (77K)
- frame rate max 500Hz (2ms)
- Ethernet communication

- PICNIC detector
- 4 quadrants of 128 x 128 pixels (40µm)
- 16 bits
- RON @ 250kHz: 18 e-



OUTput – scientific camera

Meudon optimization:

- destructive observations
- RON measurement (see Nic Scott's talk)

Packaging:

flying between JouFLU and OHANA

Integration into CHARA environment (thanks Theo ☺):

- software coded in C
- client/server under LINUX

  => in progress

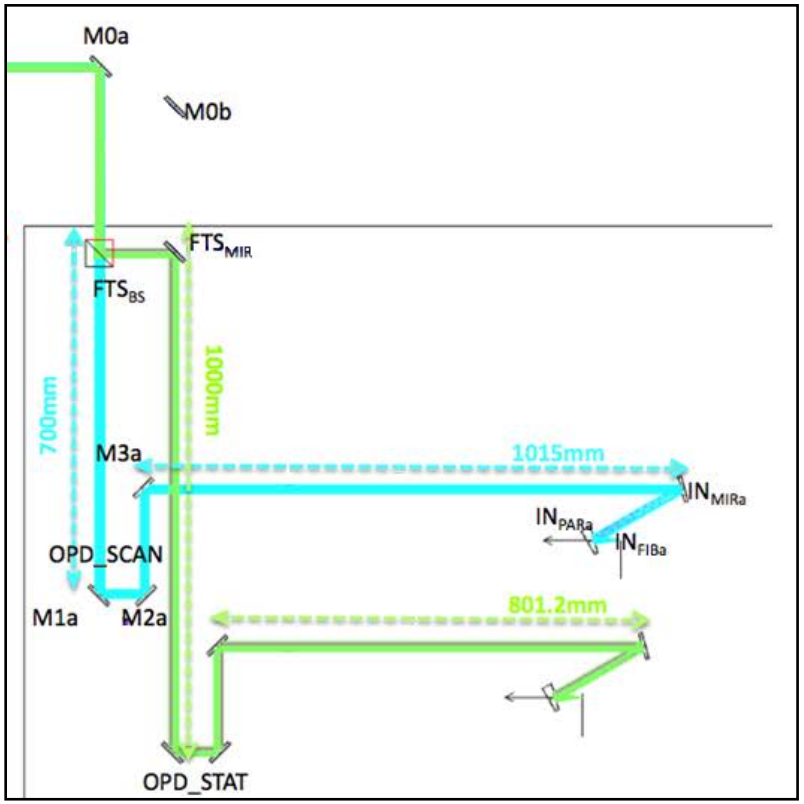
FTS mode

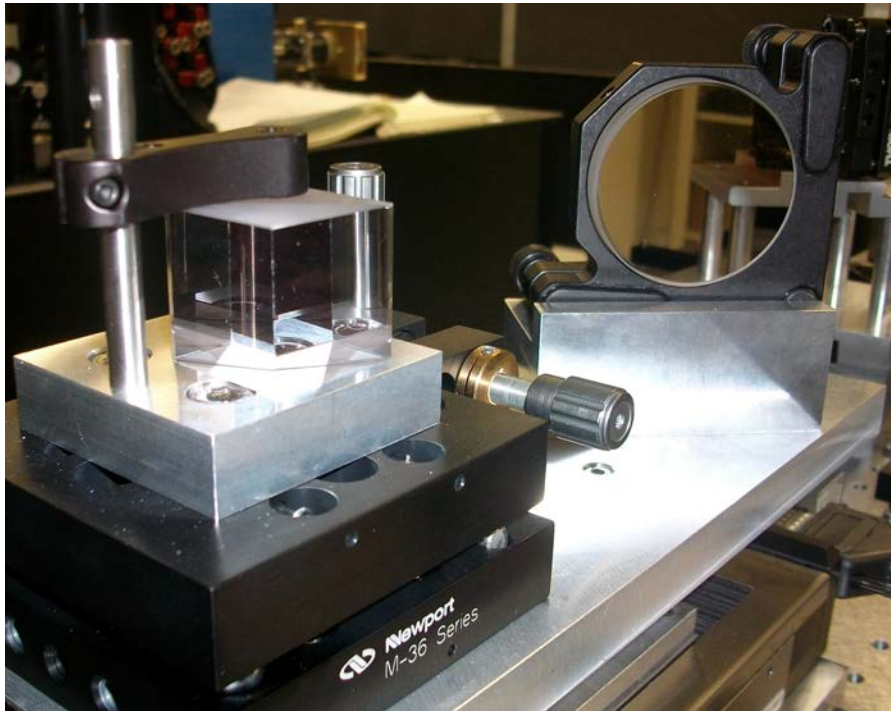
Spectral calibration:

- null base
- long scan

Optical payload:

- 1'' BS cube (50/50 in K-band)
- 2'' fold mirror





2012 schedule

February:

→ AIT / AIV (done)

→ software development (in progress)

Shipping : ~ 350kg

March:

→ lab fringes

→ scientific commissioning

→ first light

May to August:

→ scientific observations (on-site or remotely)

Conclusions

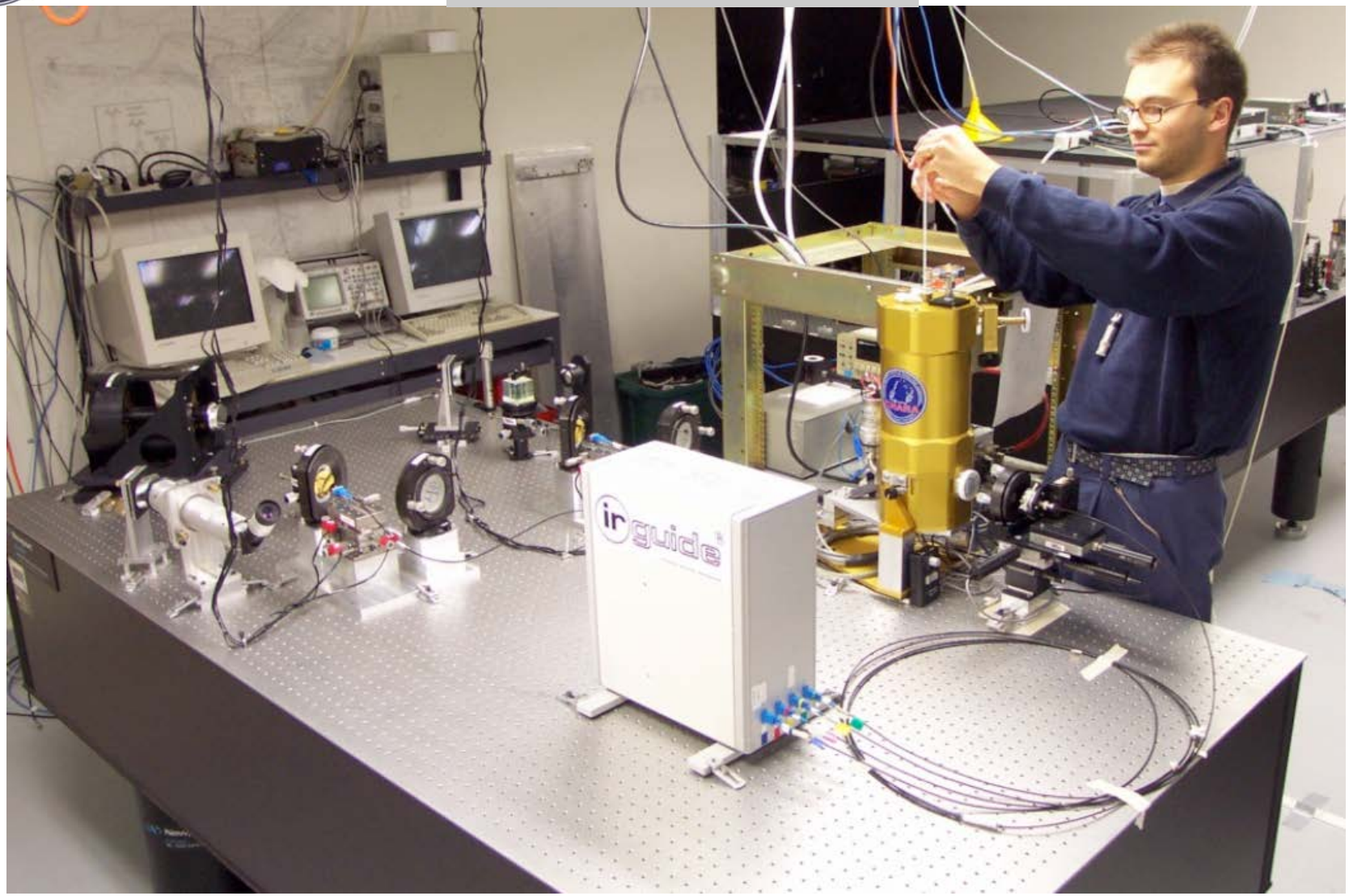
JouFLU is now integrated into the CHARA environment
→ easier maintenance

Remote control
→ no more lab intrusion
→ observations from Meudon

Hardware improvements
→ high robustness / throughput
→ more flux / no more lost of flux

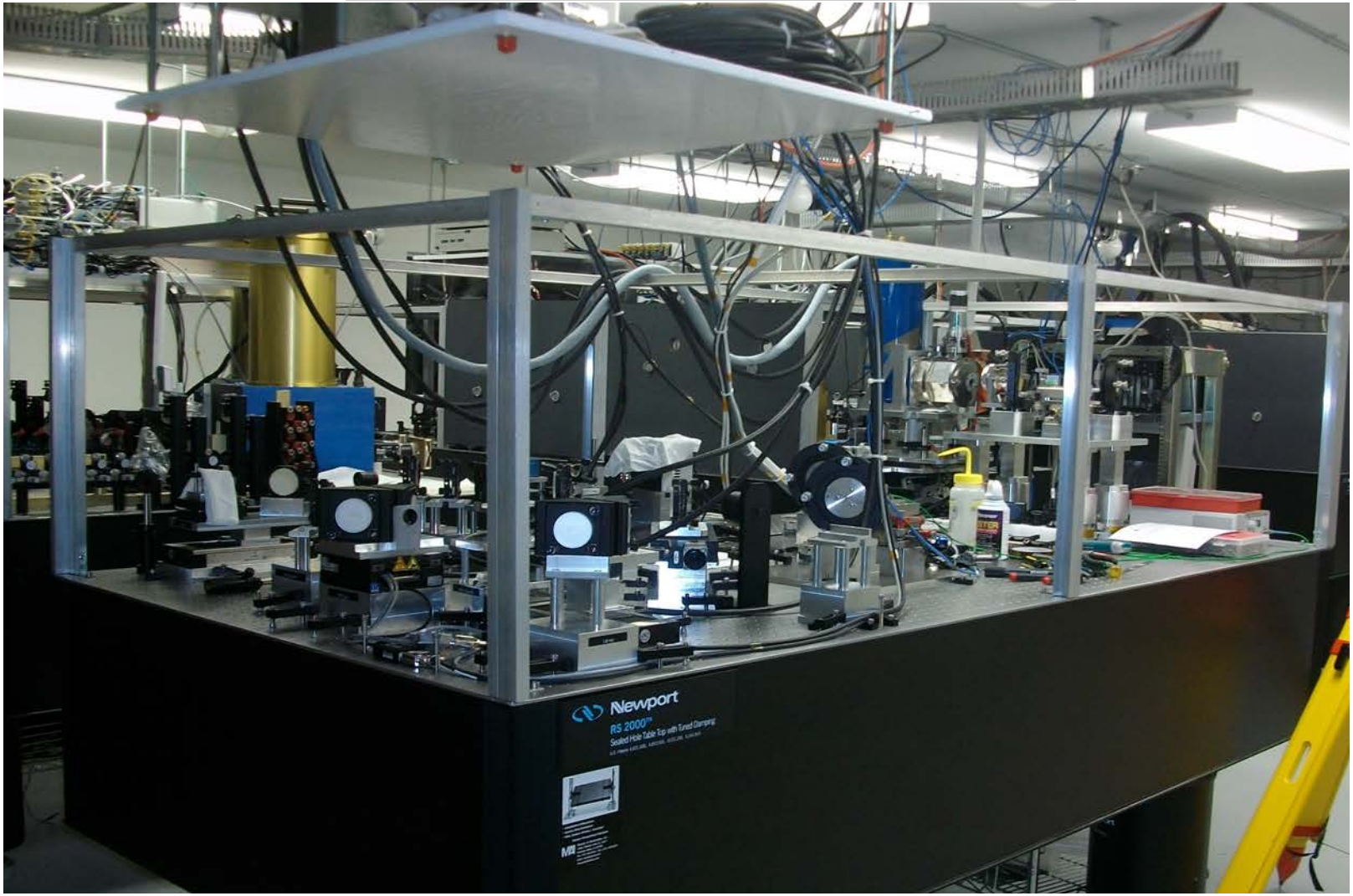
JouFLU rejuvenation: H band...

FLUOR table – 2002



FLUOR table – March 2011

JouFLU table – February 2012



JouFLU table – February 2012

Thank you for your attention.

Questions ?