



Update³

An Update on the Update on the Update of
FLUOR



Nicholas J Scott

March 2013



LESIA



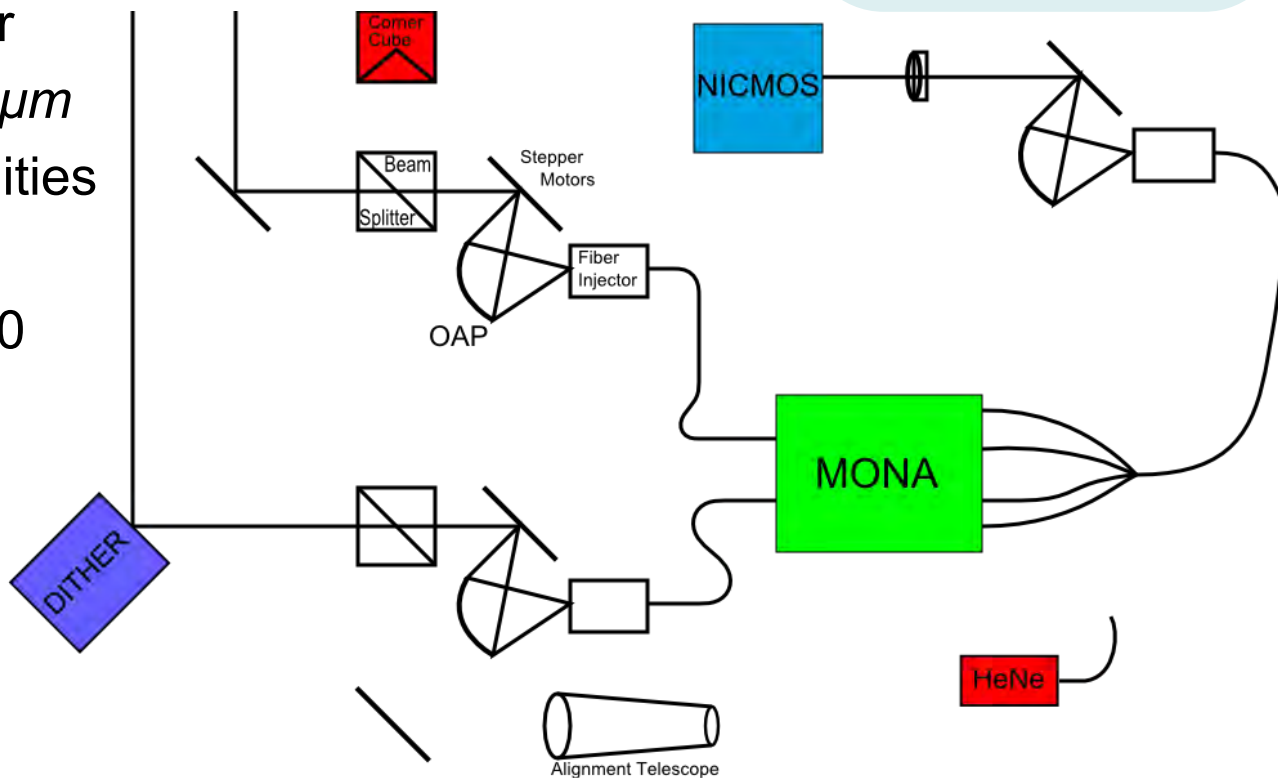
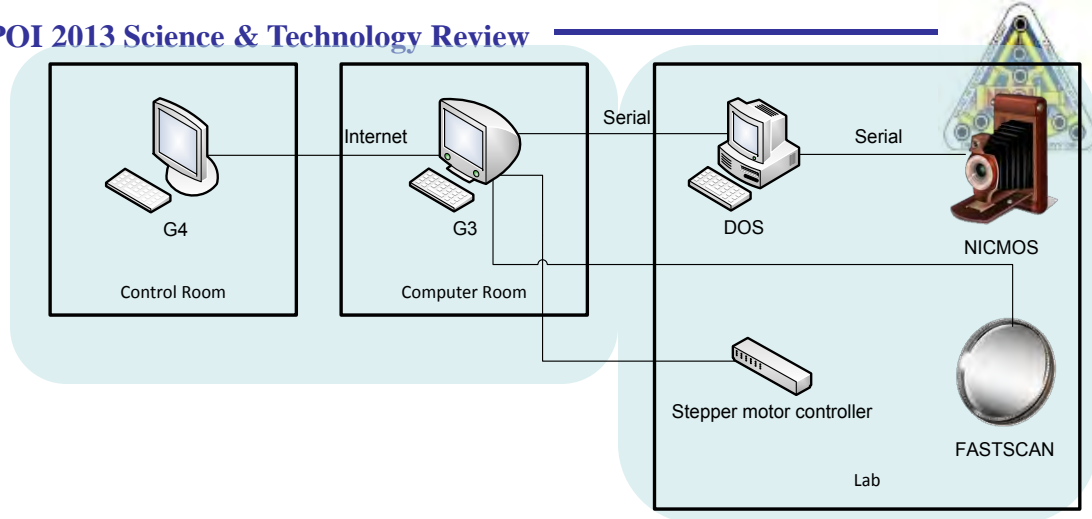
Observatoire
de la COTE d'AZUR

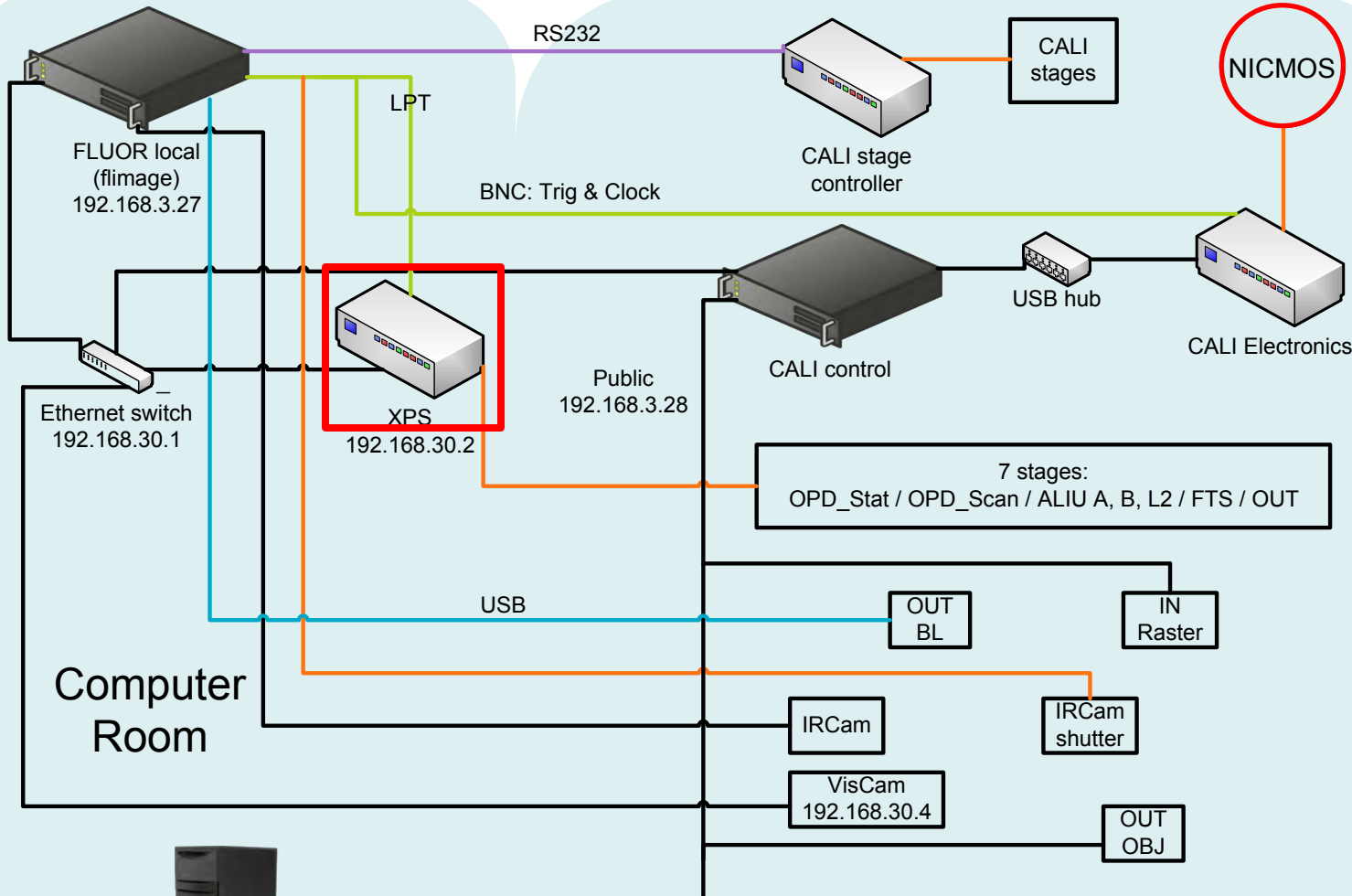


FLUOR?

Fiber Linked Unit for Optical Recombination

- 1992 IOTA
- 2002 moved to CHARA
- 2-way fiber combiner
- K band, $\lambda = 2.0-2.4 \mu\text{m}$
- High precision visibilities
- K mag limit ≈ 5
- Dynamic range ≈ 300
- Limited by
 - Piston
 - Chromatic bias
 - Number of scans





Computer Room

Lab



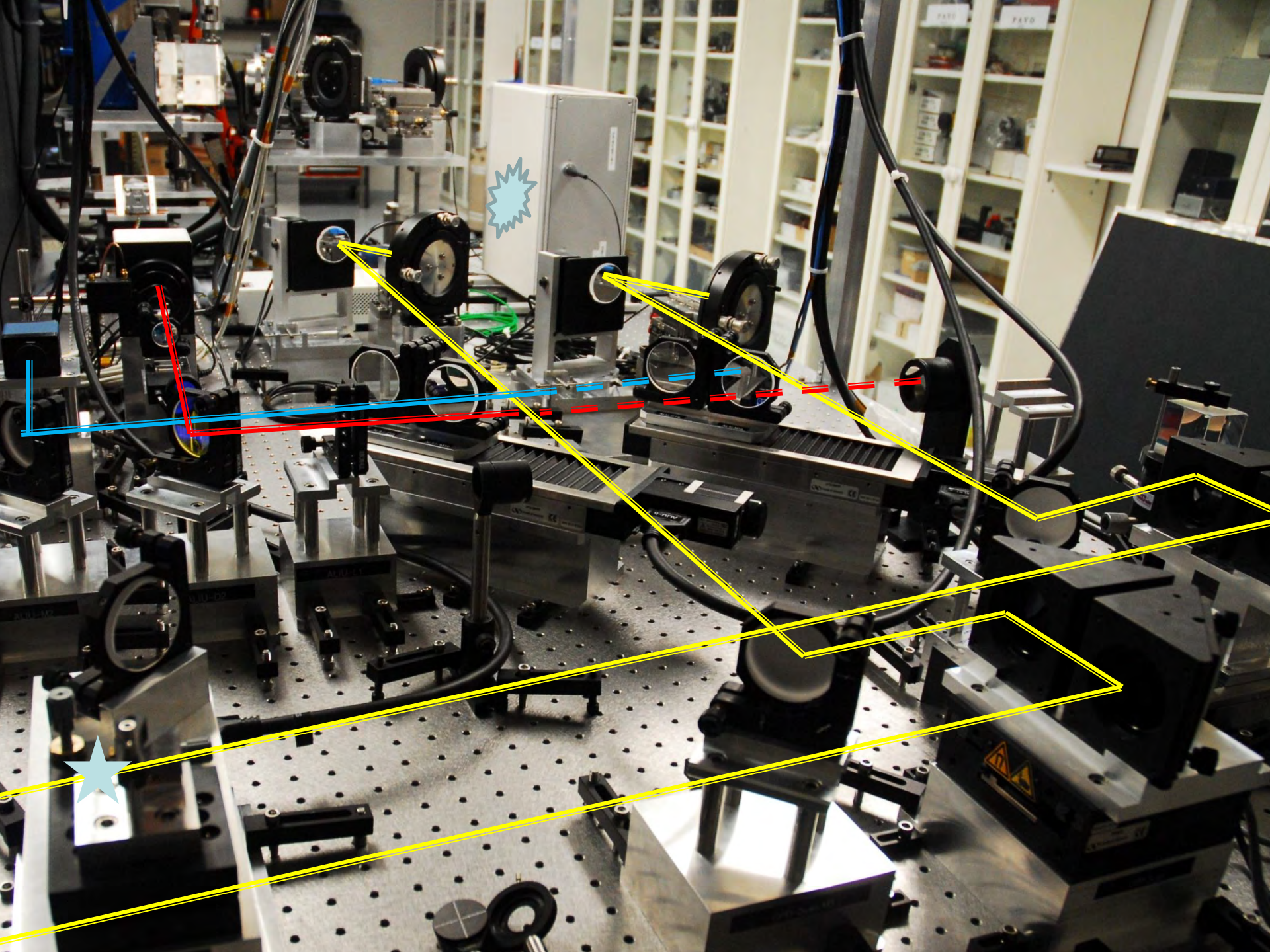
FLUOR remote (Meudon)

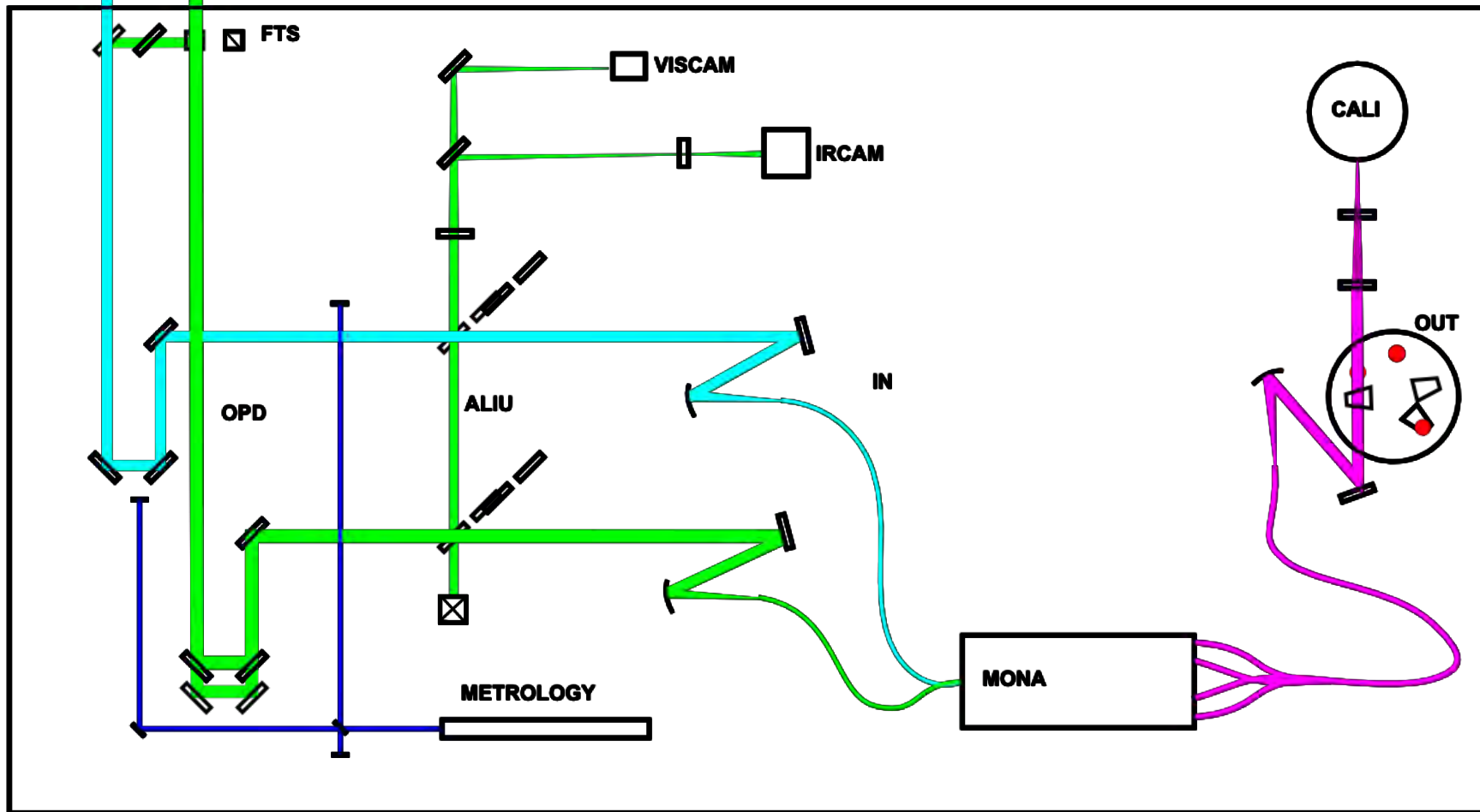


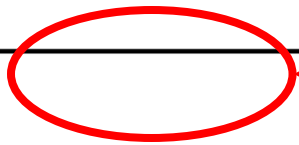
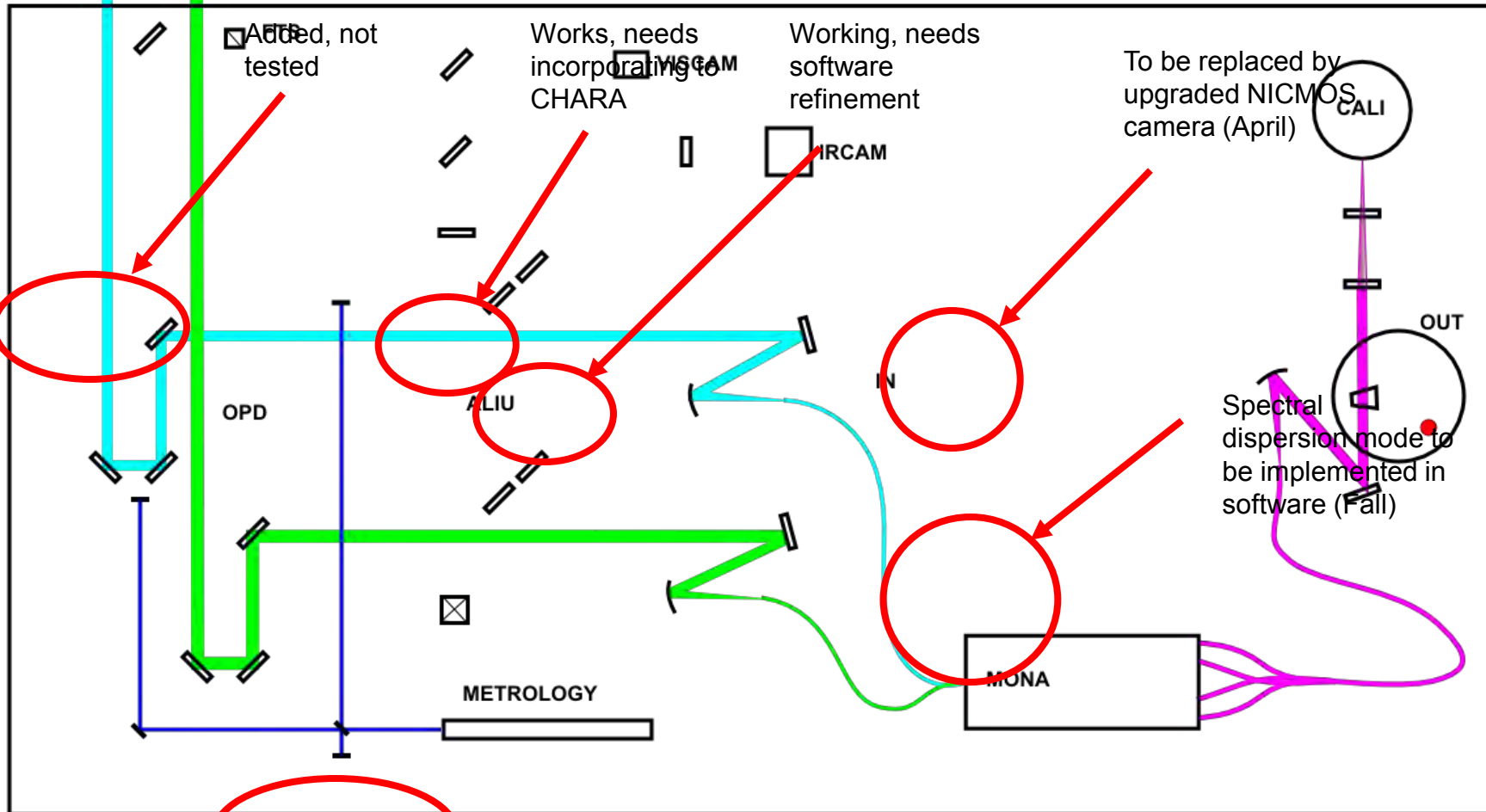
LESIA



Observatoire de la COTE d'AZUR







To be added



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Observatoire de la COTE d'AZUR



Differences

- Improved camera
- Remote operations
- Software & hardware integrated with CHARA environment
- Spectral dispersion mode
- Pupil imaging
- Improved fiber injection
- Improved alignment procedure

Timeline



FLUOR
software
upgrade



Summer
2013

Component
commissioning

First
Science



Winter
Spring
2013

Camera
replacement
(Apr)

Chateaubriand
Fellowship -1

**First Fringes!!!
(May)**

CB
2-1

CB
2-2



Current status report

- All optical-mechanical components installed
- Alignments completed and new alignment procedures being documented
- Alignment cameras tested
 - IRcam functional, viscam needs software integration
- On-sky fringes obtained
- Remote ops tested and working
- Most software functionality complete
 - GUI
- Data reduction pipeline in the works
- Expect first science in May





Camera changes

Decision made to replace intended camera (CALI) with upgraded NICMOS

Disadvantages of CALI

- Lack of engineering support
- Inadequate sensitivity
- High readout noise
- Poor dynamic range
- Complex interface
- Very small Dewar

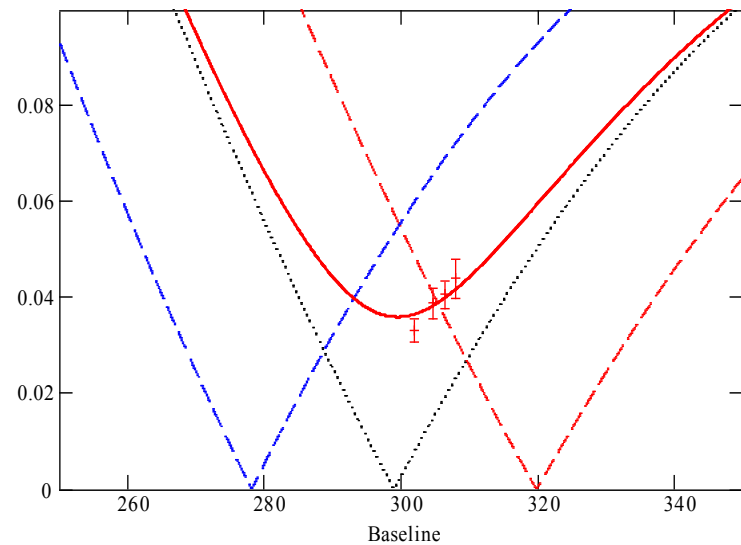
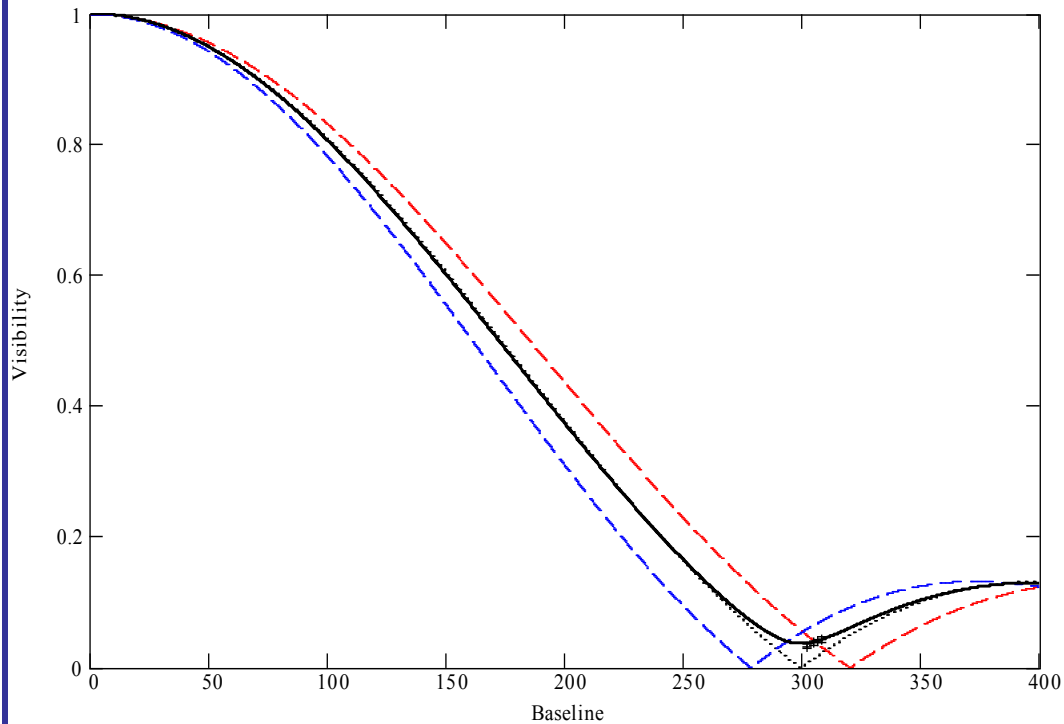
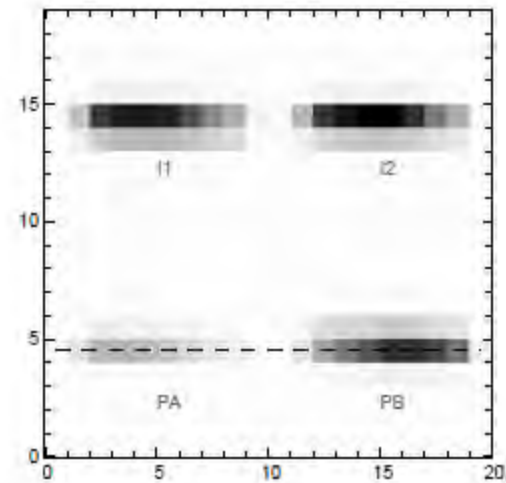
Advantage of NICMOS

- Known behavior (previous use & NIRO)
- Upgrade to increase readout speed
- Easier integration with CHARA



Spectral dispersion

- K band
- 10 spectral channels
- Remove chromatic biases / bandwidth smearing
- Expect factor of 100 improvement when science star and calibrator are of different types



Remote operations

Meudon (ROCMe)
Atlanta (AROC)
Sydney (ROCS)
Michigan (ROCMi)
Nice (GROC)

Image © 2012 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image

39°44'28.24" N 103°05'00.31" W elev 4555 ft

©2010 Google

Eye alt 6155



Remote observing procedure and requirements

- VPN connection
- CHARA control tree install
 - CentOS 5 or 6
- Skype
- On-site operator does star acquisition sequences or controls needed systems
 - saves bandwidth and time
 - Insures safety of telescopes
- Operator may be running other (1-2) combiners
- Screen real estate



ROCMe

Applications Places System Wed Nov 7, 4:26 PM CHARA Observer

COSMIC DEBRIS - SECONDARY

LOCAL TIME: 16:26 CHARA TIME: 15:26 SIDEREAL TIME: 10:43

JOB QUEUE: 0 START JOB QUEUE STOP JOB QUEUE CLEAR JOB QUEUE

CONTROL STARS CALIBRATORS CONFIGURE

Tiptilt (mS) XXXX Center (m) 0.000 Range (m) 0.010 REF AUTO 0.0

CLASSIC SKIP LOW SNR TARGET MEM Samp/Frg: 5 Acq: None Init Tpoint

K BAND 2&3/566 LONG SCAN 750Hz DESTRUCT

SYNC ME SYNC ALL TO S2 STAR ACQUIRED TRACK SOCKET SET DISPLAY

COMMENT ALIGN ACQ ON S1 TIPTILT COMM NIRO 8000 3 STOW

SCAN FOR FRINGE RECORD SCAN RECORD TWO BEAMS RECORD THREE BEAMS QUICK LOOK

Failed to send TIPTILT_OPEN_LOG to tiptilt.
Failed to send OPLE_OPEN_LOG to ople.
LOG OPEN: /ctrscrut/chara/data/status_secondary_001.txt
UT YEAR 2012 MONTH 11 DAY 7
Beam combiner CLASSIC server socket NOT OPEN.
OPLE server socket NOT OPEN.
TIPTILT server socket NOT OPEN.

AUTO MODE OBSEQUE VERBOSE REOPEN PING END NIGHT QUIT

S1

MAIN CONTROL ADJUST

TELEVISION:

ACIN ACOUT FIND

SPY1 SPY2 M10AL

DUST BIAS ZBIAS

ON OFF ADJ

ZOOM CLEAR

TV TRACKING:

ON OFF

SET CEN ADJ

GET GRAB

CCW STOP INIT CW

POINTING SERVO:

ACQ TIP/TILT

ACQ & T/T FINDER

NO SERVO ZERO T/T

GENERAL:

STATUS CONTROL

PING REOPEN

HD_62044 Acq: Out
10 44 15.3 +34 14 59.7
AzEl +172.0 90.0

QUIT

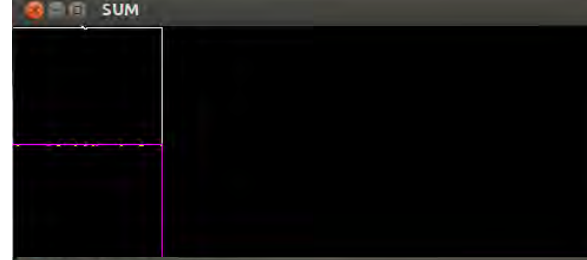
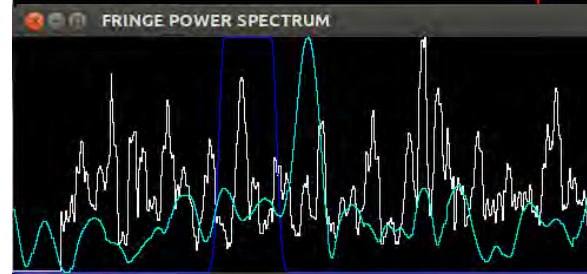
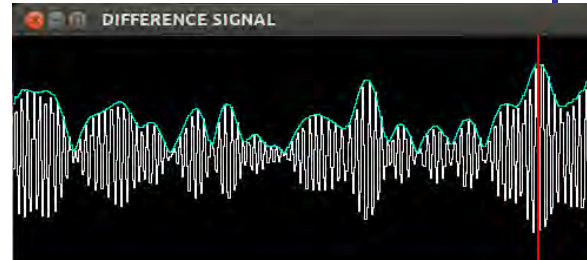
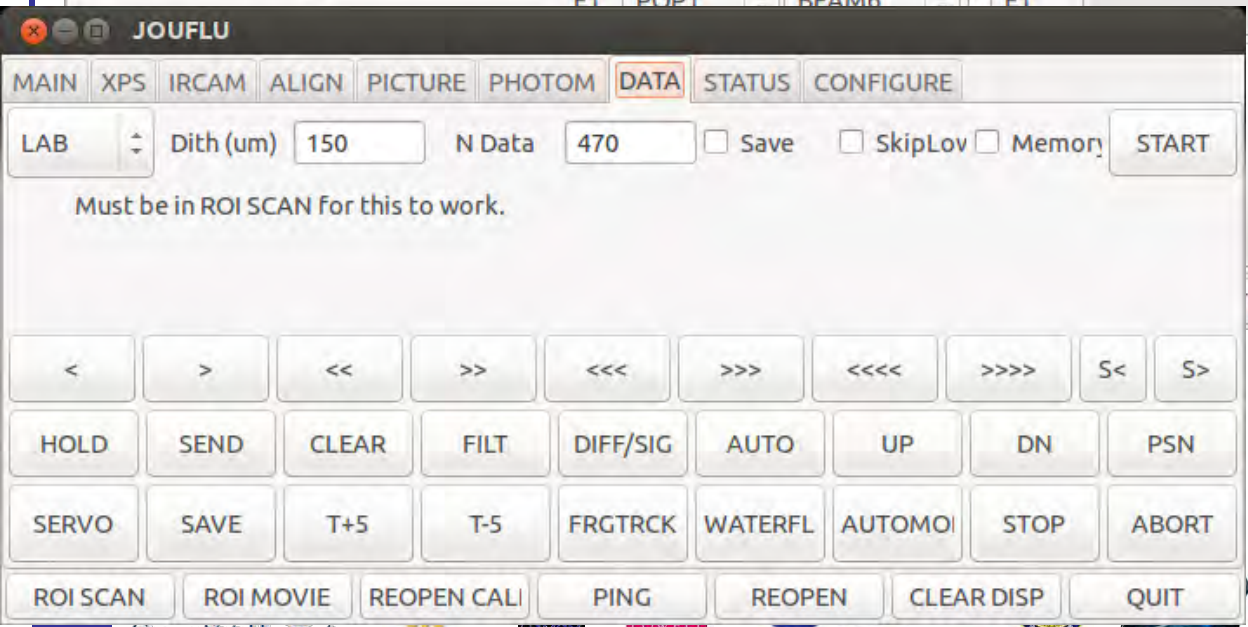
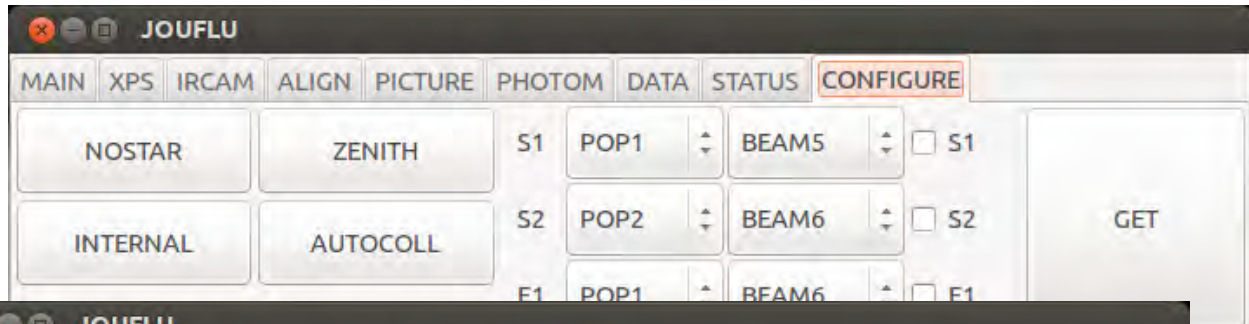
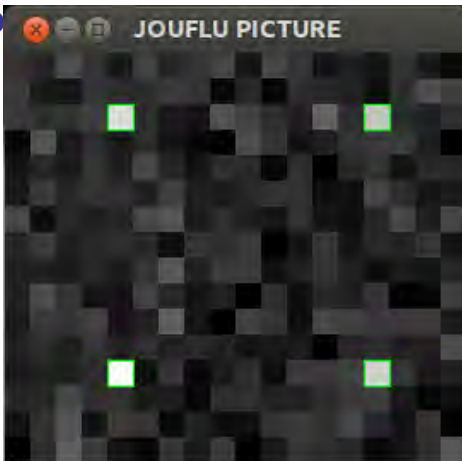
S1 SPY1

SCOPE	UT	WIND	DIR	GUST	DIR	MEAN	Tout	Tbunk	RH	DP/P	Ttel	RHtel
<input checked="" type="checkbox"/> S1	15:26	0.0	109.7 E	0.0	0.0	0.0	16.2	19.2	20.2	-6.7	16.6	21.3
<input checked="" type="checkbox"/> S2	15:26	0.0	12.7 N	0.0	0.0	0.0	14.8	18.6	32.0	-1.8	15.9	23.7
<input checked="" type="checkbox"/> E1	15:26	0.0	236.2 SW	0.0	0.0	0.0	17.8	20.2	25.1	-2.5	16.8	20.8
<input checked="" type="checkbox"/> E2	15:26	0.0	88.6 E	0.0	0.0	0.0	14.8	18.1	29.2	-3.1	16.6	21.4
<input checked="" type="checkbox"/> W1	15:26	0.0	234.8 SW	0.0	0.0	0.0	14.9	16.6	18.5	-8.8	15.8	23.3
<input checked="" type="checkbox"/> W2	15:26	0.0	63.3 NE	0.0	0.0	0.0	14.9	16.6	21.9	-6.7	16.2	22.1
<input checked="" type="checkbox"/> L1	15:26	0.0	180.0 S	0.0	0.0	0.0	21.9	23.8	20.3	827.6	----	----

NO PLOTS DUST PING REOPEN QUIT



JouFLU GUI





CHARA

CHARA messages

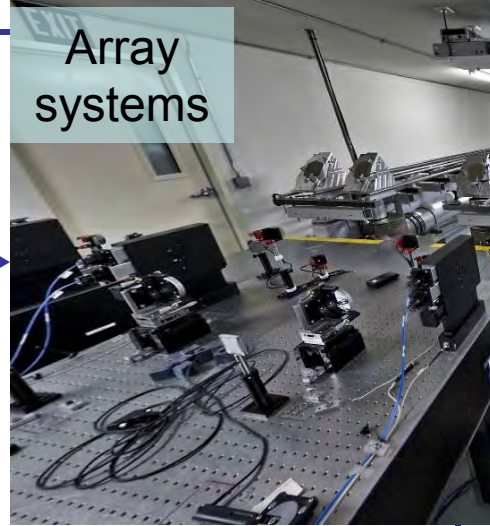
Array systems

CHARA systems interface

```

chara_messages.h (-/control/libs/include) - VIM
define JOUFLU_XPS_HOME (FIRST_JOUFLU_MESSAGE+31)
* Client->Server - Home XPS stage specified */
struct s_jouflu_stage_move {
    int group;
    double displacement;
};
define JOUFLU_XPS_REL_MOVE (FIRST_JOUFLU_MESSAGE+32)
* Client->Server - Make relative move of XPS stage */
define JOUFLU_XPS_ABS_MOVE (FIRST_JOUFLU_MESSAGE+33)
* Client->Server - Make absolute move of XPS stage */
struct s_jouflu_stage_spot {
    int group;
    int spot;
};
define JOUFLU_XPS_ABS_MOVE_SPOT (FIRST_JOUFLU_MESSAGE+34)
* Client->Server - Make absolute move of XPS stage to particular spot */
define JOUFLU_XPS_GET_SPOT (FIRST_JOUFLU_MESSAGE+35)
* Client->Server - Return the spot position of particular stage */
define JOUFLU_XPS_GET_POS (FIRST_JOUFLU_MESSAGE+36)
* Client->Server - Requests the position of a particular stage */
struct s_jouflu_event {
    int group;
    int trigger;
    int event;
};
define JOUFLU_XPS_INIT_EVENT (FIRST_JOUFLU_MESSAGE+37)
* Client->Server - Intitlizes an event for a particular stage */
define JOUFLU_XPS_REMOVE_EVENT (FIRST_JOUFLU_MESSAGE+38)
* Client->Server - Removes a set event */
* IRCAM messages - messages sent to or from ir pupil camera */
struct s_jouflu_ircam {
    int integrationTime;
};
define JOUFLU_IRCAM_VIEW (FIRST_JOUFLU_MESSAGE+39)

```



server

```

alic@serberus:~/control/client/jouflu/server
Local Tm : 00:51:24 Data Mode: REST Scan (um): 0.0/ 0.0
CHARA Tm : 08:51:24 Data Coll: NO OPD_SCAN : 0.000000
Lost T/S : 0/ 0 XPS Lin : NO OPD_STAT : 0.000000
OUT : Out Sample mS: 2 ROI : NONE
FTS : Out Num Frame: 0 BEAMS : 5&6
ALIU_L2 : 0.0000 Zabers : FTS OUT OUT Star : NOSTAR
ALIU_A : Out Shutter : CLOSED
ALIU_B : Out Loop/Read: 0/ 0
OPD_STAT : FTS Out Nfrm/Tim0: 0/ 0

JOUFLU 2.0
F1 Get help
F2 Background control menu
F3 Socket control menu
F4 Utilities Menu
F5 Astromod Display Functions
F6 Astromod Set Functions
F7 Clock menu
F8 Jouflu control menu
F9 Motor control menu
F10 Quit system

Current menu : MAIN
Previous menu : None
Menu Depth : 0

<?> Help
<BACKSPACE> Previous menu
<^> MAIN menu

Star data cleared.

```

vpn

hardware



Gtk client

MAIN XPS IRCAM ALIGN PICTURE PHOTOM DATA STATUS CONFIGURE

OPD_SCAN HOME Step (um) 100 rel < rel > abs

OUT: Out GO Pos:

FTS: Out GO Pos:

ALIU_L2: Focus Min GO Pos:

ALIU_A: Out GO Pos:

ALIU_B: Out GO Pos:

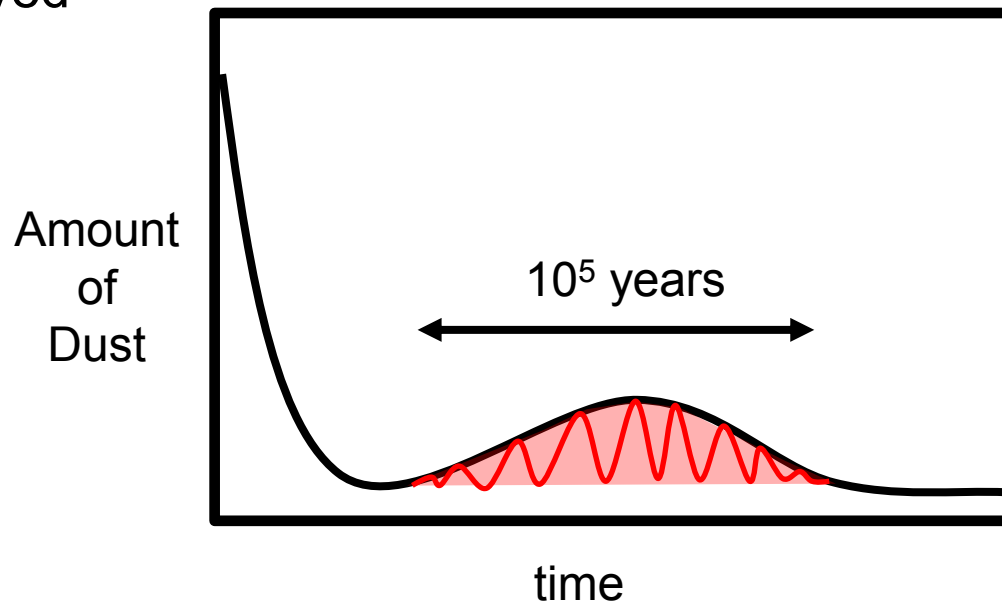
OPD_STAT: FTS Out GO Pos:

Trigger Motion Init event Event 0 remove event

ROI SCAN ROI MOVIE REOPEN CALI PING REOPEN CLEAR DISP QUIT

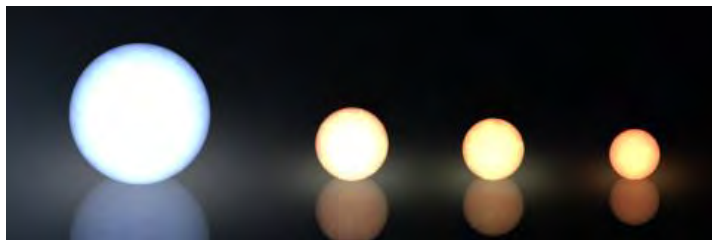
Evolution / dynamics

- Dust production mechanism poorly understood
- Close-in dust extremely short lived
 - ≈ few yrs
 - ≈ $10^{-8} M_{\oplus}/\text{yr}$ to replenish
 - (10 Hale-Bopps per day)
- Destruction factors:
 - Sublimation
 - Radiation Pressure
 - Poynting-Robertson (P-R) drag
- Models:
 - ~~– Steady state/continuous replenishment~~
 - Steady state/trapped nano-grains [Su et al. (2013), Lebreton et al. (2013)]
 - LHB & outgassing



Statistics, origin, and evolution

Absil et al. Disk Survey



42 stars A-K (mag limited)

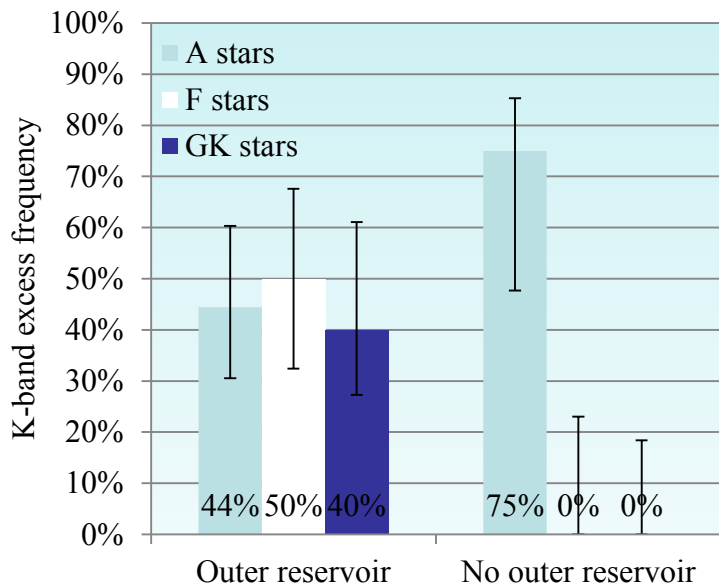
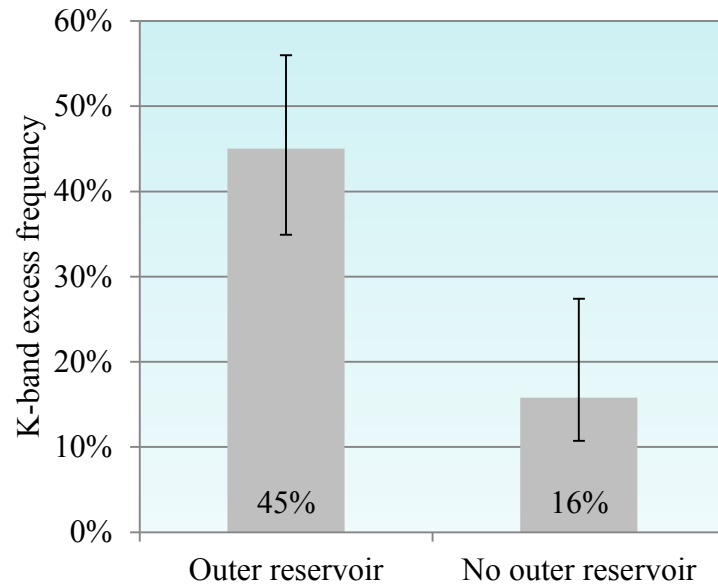
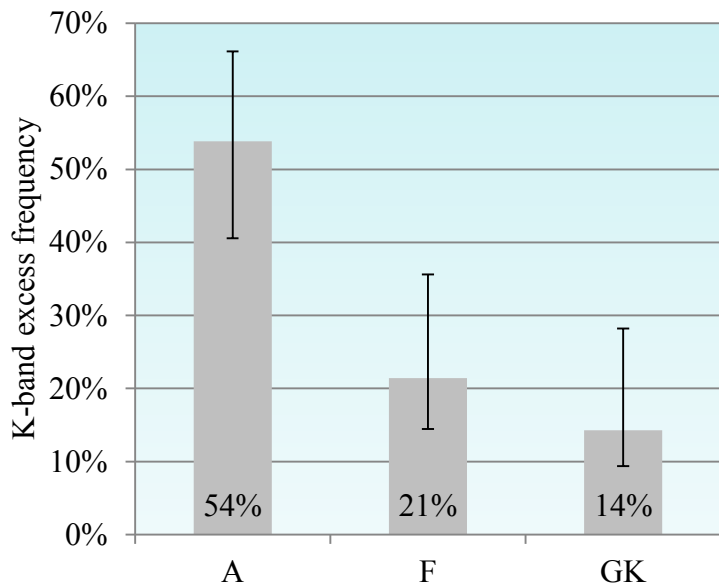
Spectral type, age, metallicity, presence of cold dust

	A	F	G-K	Total
Cold disk	8	6	6	20
No outer disk	4	7	9	19
Unknown	0	2	0	2
Total	12	15	15	42

Absil et al. 2013
(submitted)

- Most common around A stars

	# MS (K < 4)	# MS w. debris (K < 4)	# MS (K < 5)	# MS w. debris (K < 5)
All	303	45	1158	103
North	156	16	536	42
South	147	29	622	61
-10° < dec < +20°	73	8	256	21



Age or amount of available material?

- A stars: not clear if correlation with metallicity
- FGK stars lack warm dust due to ages > 1 Gyr

Absil et al. 2013 (submitted)



NASA Origins Program with Bertrand Mennesson

- 3 year program: exozodi disk survey
 - ≈ 100 nearby MS stars
 - 20% long/short, rest only short baselines
 - hot dust (1000-1500K), expected in 25-30% of MS systems
- Goal: excesses at 0.5% level (5σ) for $m_K=5$
 - Determine grain properties, disk morphology, correlations b/t stellar properties
- Visibility precision to $<0.1\%$



Future plans

- CHARA AO
 - Increased sensitivity
 - Fainter magnitude limit
 - More targets
 - On axis, small field of view AO systems for each telescope.
- CHAMP
 - Full fringe tracking and locking capability on all baselines.

for FLUOR

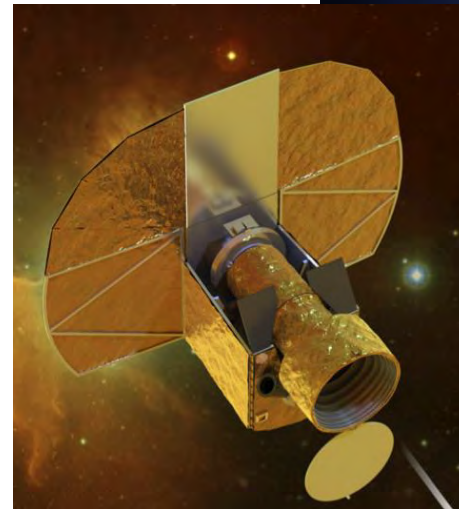
- Spectral Dispersion mode
- Integration with CHAMP
- H band
- Further camera and software improvements



Complementary studies

- Follow-up of gravitational microlensing survey
 - Faint, 7th mag
 - Targets of opportunity
 - Alert network?

(Cassan 2012)
- CHEOPS (CHaracterizing ExOPlanet Satellite)
 - Photometry of known exoplanet host stars
 - Bright, low activity stars
 - Determine radii, dynamics, and atmospheric properties
- Investigate potential targets of EChO transit space mission
 - 2022 launch
 - Feasibility study, **full program requires CHARA AO**
 - ≈ 100 planetary spectra





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