Enrico Pinna on behalf of the SHARK team
(P.I. Jacopo Farinato)

A CALL FOR AO SCIENTIFIC TOPICS FOR SHARK

Arcetri Astrobigné – 28 January 2014

Call for new LBT Instrumentation

Call official web page
http://lbto2014um.weebly.com/2014_call.html

- **February 28, 2014, 23:59 UTC -** Deadline for proposal submission

- **March 2014 - Your proposal will be reviewed** by a committee set up by LBTO to assess its technical aspects, especially as they rely to the integration in the observatory environment, and the LBTO Scientific Advisory Committee (SAC)

- **March 23-25, 2014** - You will be welcome to present your proposal to the LBTO users' community at a dedicated session of the **LBTO Users' Meeting** to be held in Tucson.

- **March 26-27, 2014** - **The SAC will review the proposals** at its Tucson meeting following the Users' Meeting and send a recommendation to the LBTC Board of Directors.

- **April 28-29, 2014**. **The selection** of the successful proposal(s) will be made at the LBTC Board meeting.

Italian proposals

webpage
http://lbt.inaf.it/Call_per_nuova_strumentazione_LBT.htm

Polarimeteria con LUCI
LBC Blue: Upgrade UV
LBC Red: Upgrade near IR

SHARK

Camera diretta AO-assisted per imaging con modulo coronografico.
La proposta prevede due strumenti paralleli, uno ottimizzato nell'IR (bande Y-K) e uno del visibile (Bande V-Z). Per lo strumento nel visibile è anche allo studio un modulo IFU abbinato al coronografo.

Contatti:
Per la parte hardware: **Jacopo Farinato , Fernando Pedichini** e **Enrico Pinna**
Per i casi scientifici e' stato chiesto a **Enrico Cappellaro , Emanuele Giallongo, Isabella Pagano** di raccogliere proposal relativi all'uso dello strumento.

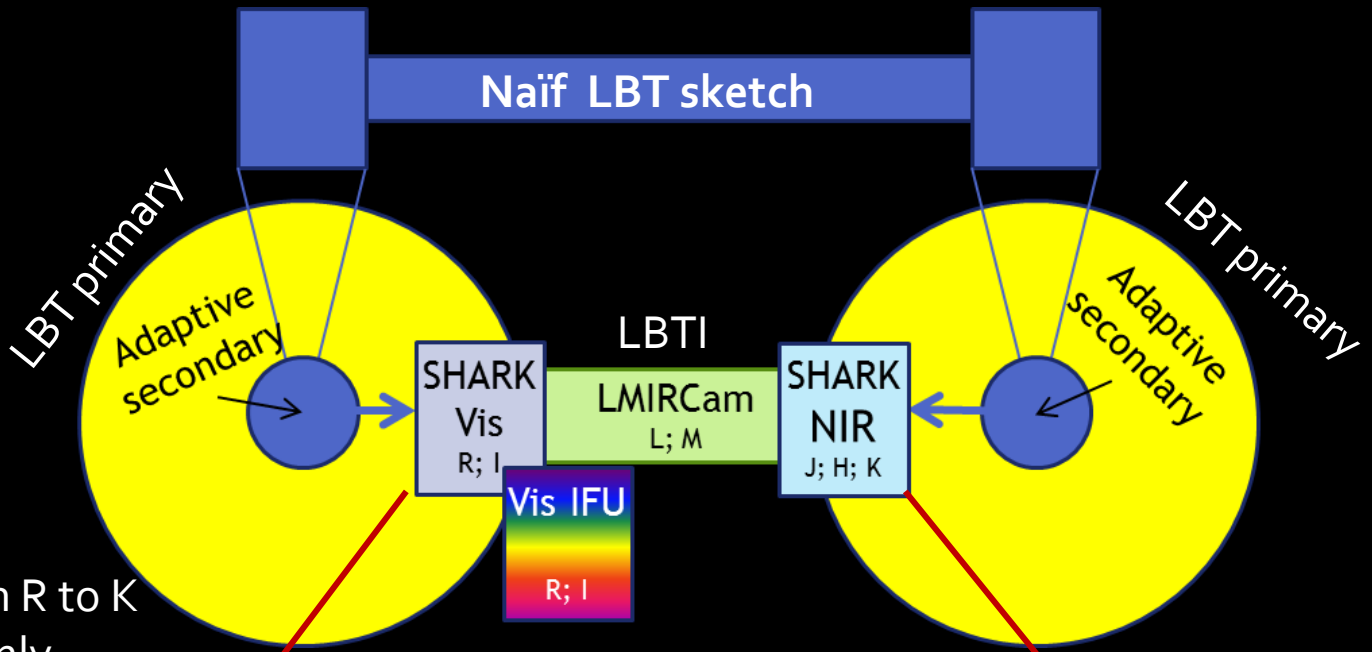
Documenti collegati:
SHARK "White Paper" (2012)

Involved in the science case:
F. Bacciotti, E. Sani

Progetto Tecnico Aggiornato (23 gennaio 2013)

Casi Scientifici Aggiornati (23 gennaio 2013)

SHARK: DL imager/coro. from R to K band



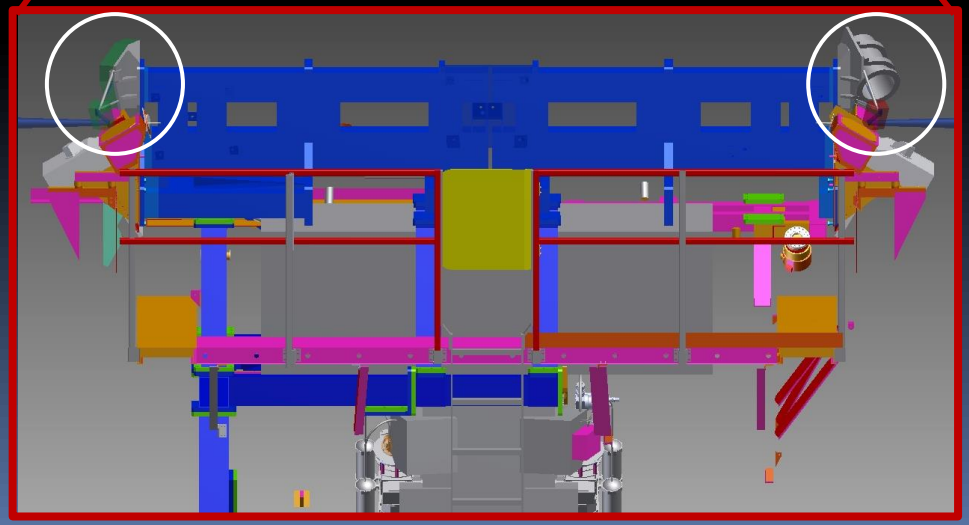
SHARK

drivers:

- Coro. / imaging from R to K
- diffraction limited only (small optics)
- very high optical quality (few surfaces, low NCPA)
- fast track instruments

2 independent instruments:

- NIR coro/imager
- VIS coro/imager (+IFU?)

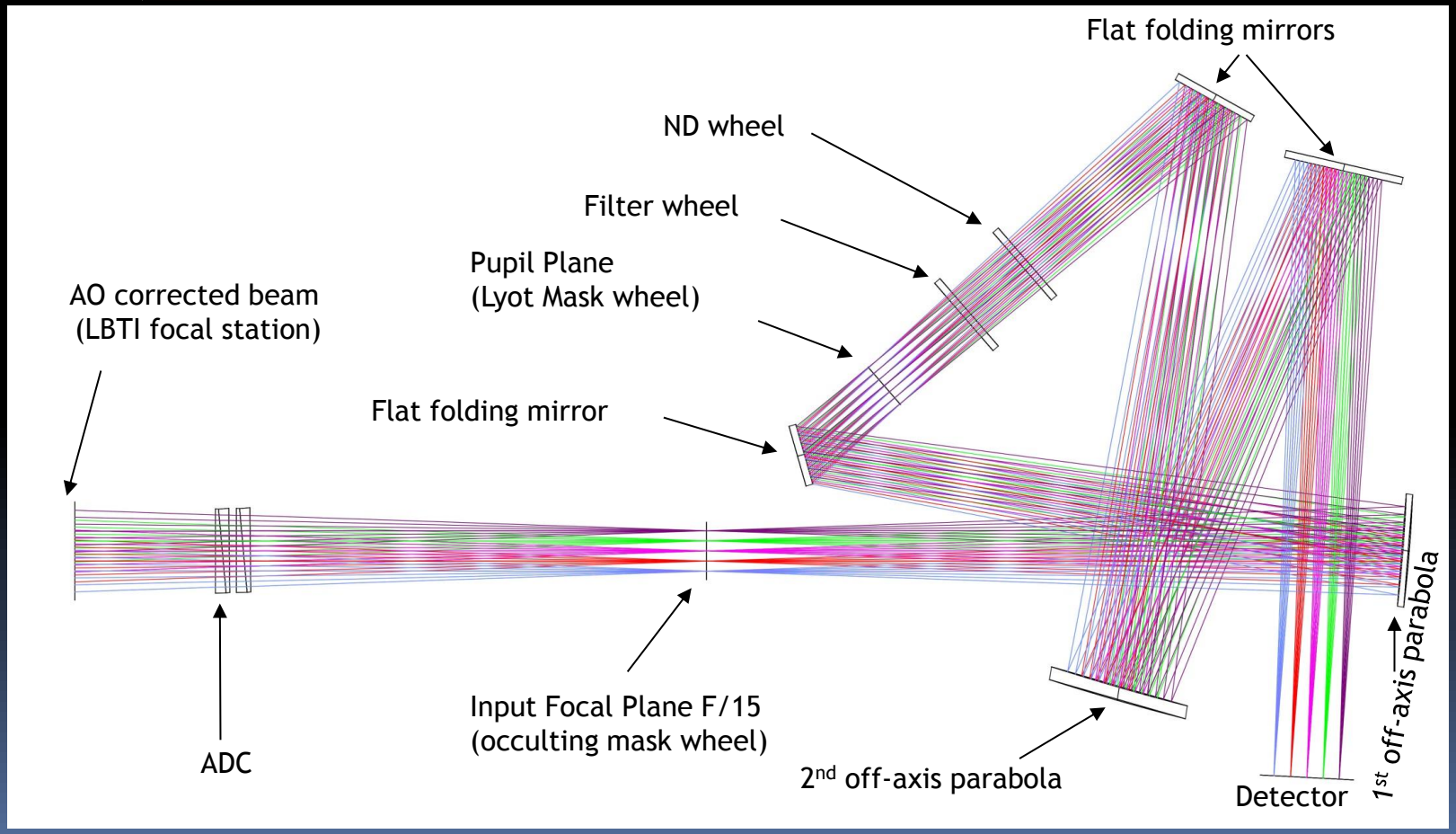


The technical doc: NIR channel

J, H and K diffraction limited imager and coronograph

OA Padova (J. Farinato, D. Magrin, D. Greggio, M. Dima)
[optical design, integration]

OA Arcetri (F. Lisi, C. Baffa, L. Carbonaro)
[cryostat, detector]



The technical doc: NIR channel

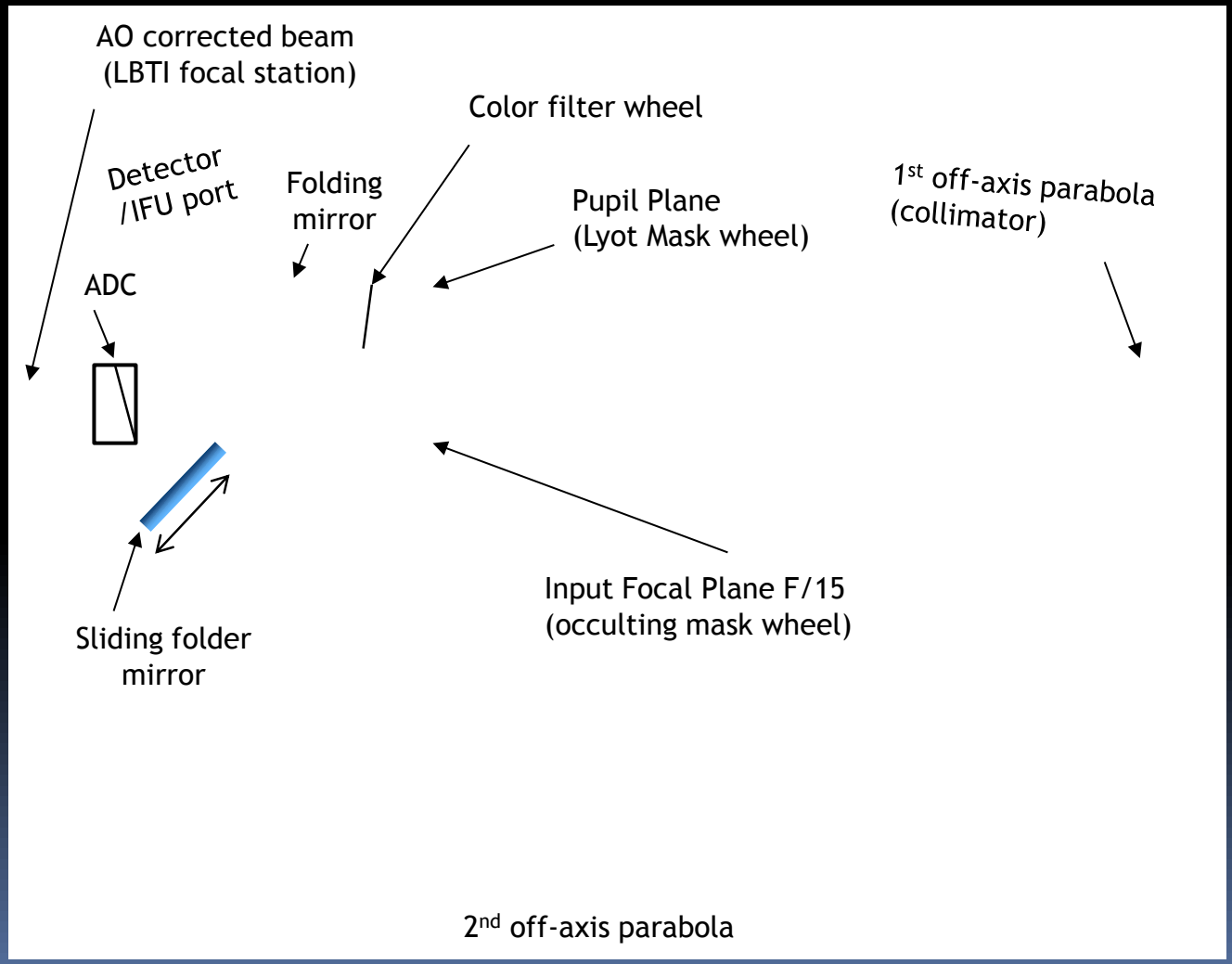
J, H and K diffraction limited imager and coronograph

Main characteristics	
Field of View	19.2 x 19.2 [arcsec x arcsec]
Wavelength Range	1.1-2.4[mm]
Sampling	19 [marsec/pix]
Intrinsic Optical Quality (0°-25° Zenithal Distance - NO ADC)	SR > 99.8%
Intrinsic Optical Quality (30° Zenithal Distance with ADC)	SR > 97.8%
Intrinsic Optical Quality (45° Zenithal Distance with ADC)	SR > 97.7%
E.E. @ 37 mas (J Band Diffraction Limit PSF)	> 83%
Coronagraph type	Lyot (+ TBD?)
Filters	TBD (J, H, K + Narrow Bands?)
Polarimetric filters	TBD

The technical doc: VIS channel

diffraction limited imager and coronograph

OA Roma (F. Pedichini, M. Centrone, M. Stangalini)



The technical doc: VIS channel

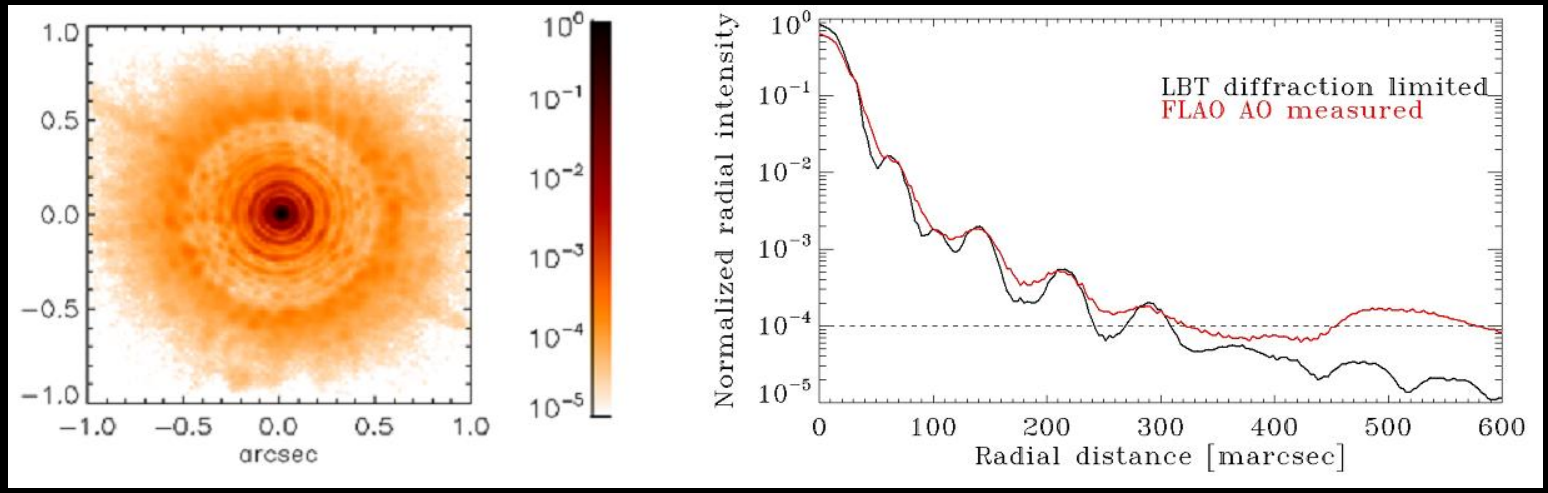
diffraction limited imager and coronograph

Main characteristics / mode	Imager	Corono graph	IFU
Field of View [arcsec]	20 x 20	5 x 5	1x1 ÷ 2x2
Sampling [marcsec/pix]	10	5	50 ÷ 100
Band-width [nm]	10 ÷ 150	10 ÷ 100	350
E.E. @ 13 mas [%]	> 80	> 80	> 80
Coronagraph type	Lyot (+ TBD?)		
Filters	TBD (J, H, K + Narrow Bands?)		
Polarimetric filters	TBD		

The technical doc: AO NIR performance

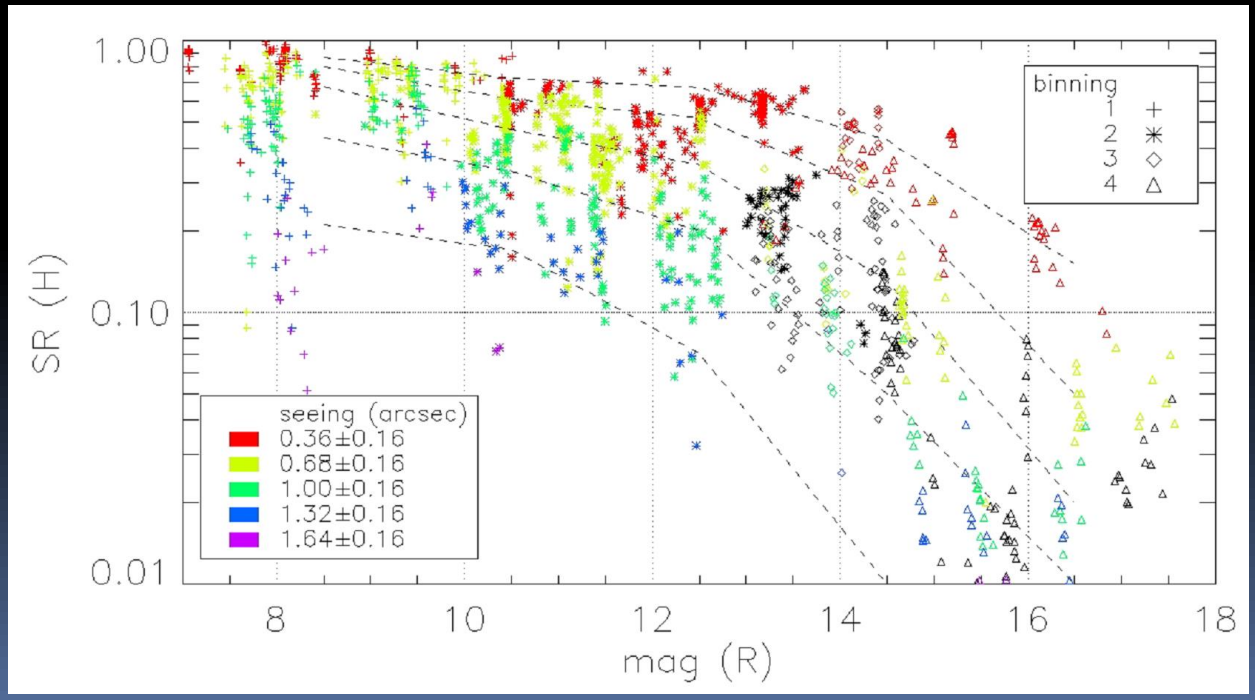
(the same old LBT –FLAO results!)

Top performance in H band

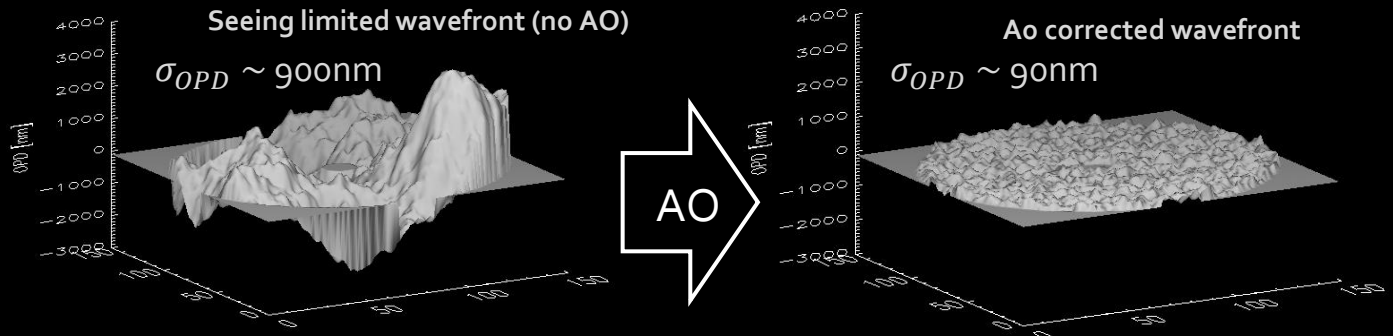


Perfomance Summary *SR Vs. Rmag and seeing* (on-axis)

Esposito+, SPIE 2012



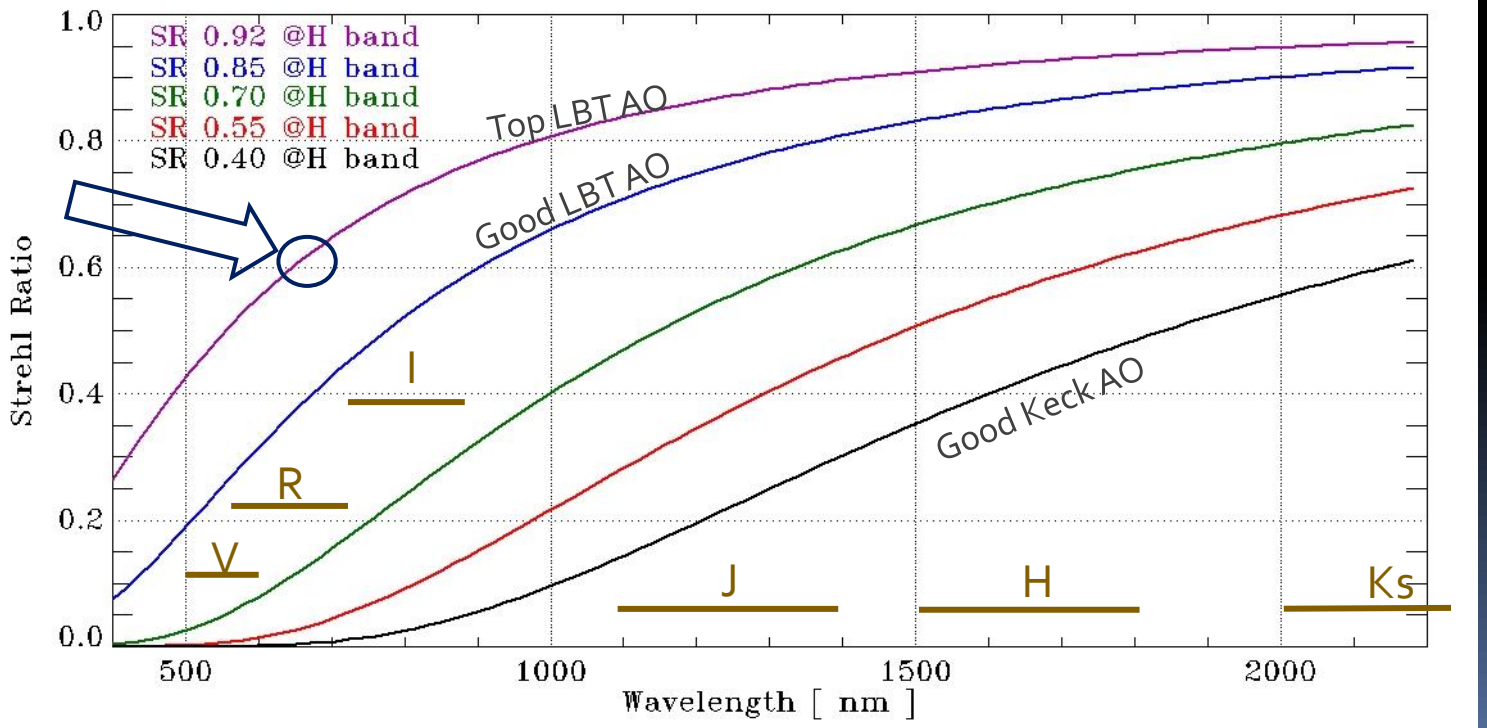
The technical doc: AO @shorter λ



The AO correction provides a residual OPD in the telescope pupil

wafefront phase variance = $\sigma^2 = \left(\frac{2\pi\,\sigma_{OPD}}{\lambda}\right)^2$ ← scintific wavelength

$$SR = e^{-\sigma^2}$$



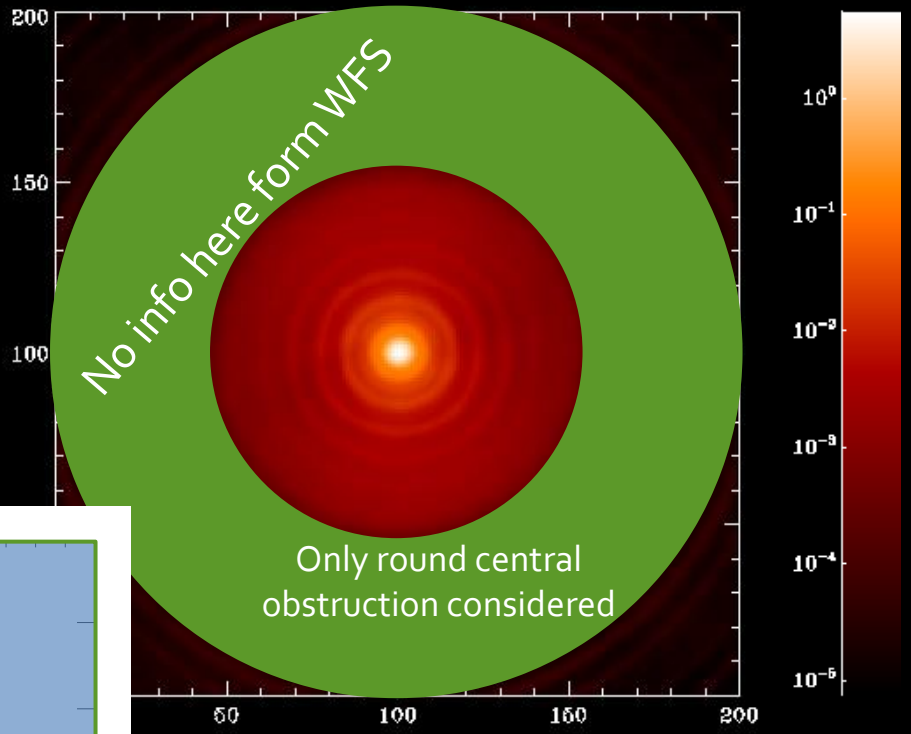
SR>60% @675nm, really?!?!

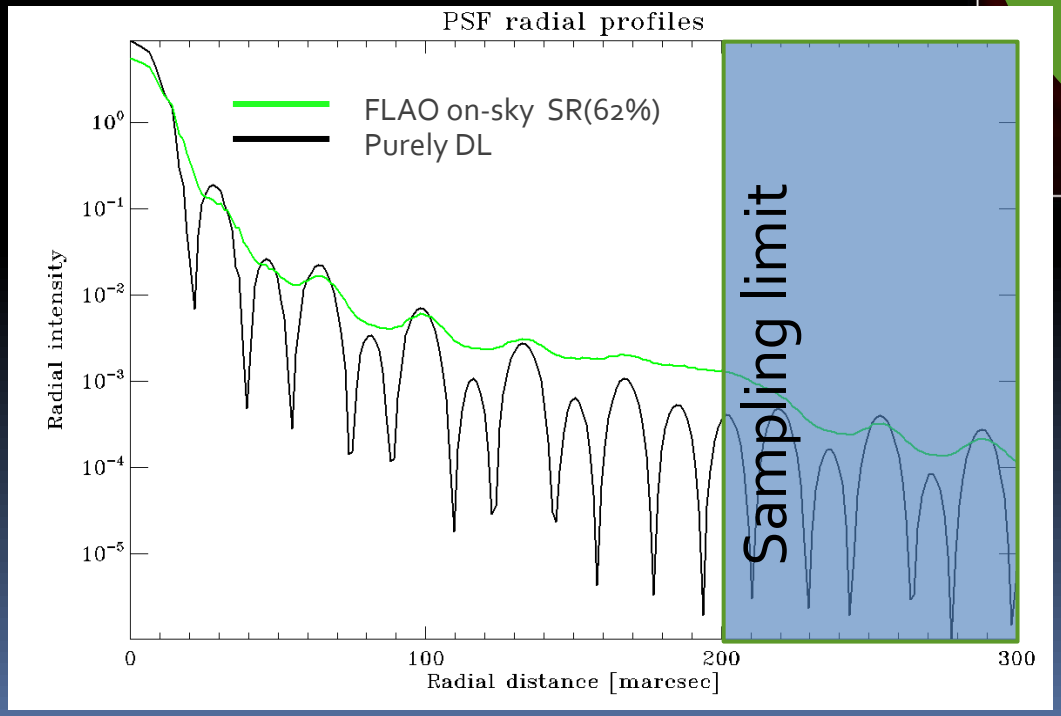
we have wavefront **on-sky data recorded** by the FLAO wavefront sensor.

From a «top performance» AO loop real 2D OPD series -> FFT -> PSF

$$SR \simeq e^{-\sigma^2}$$

PSF @675nm (4s exp.)



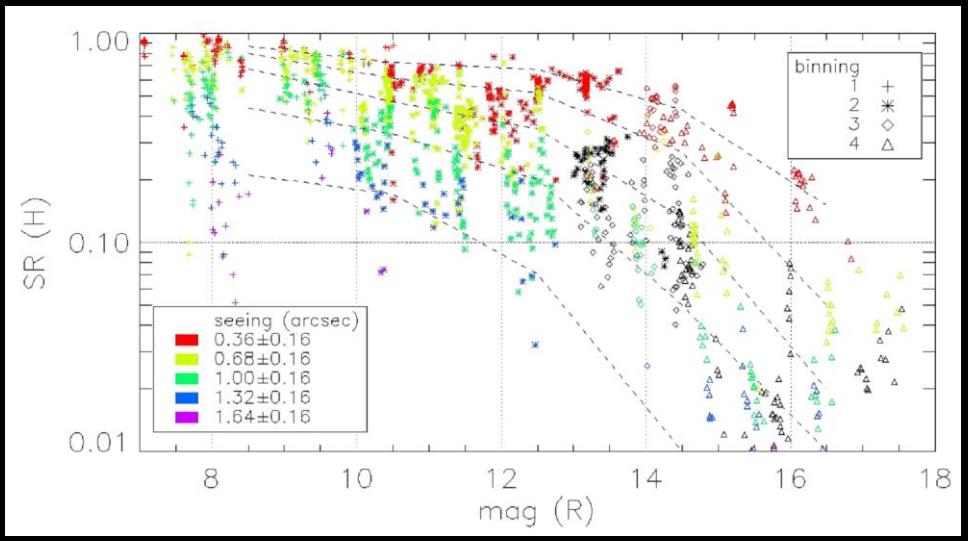


A pathfinder is in progress to measure on-sky the VIS AO-PSF

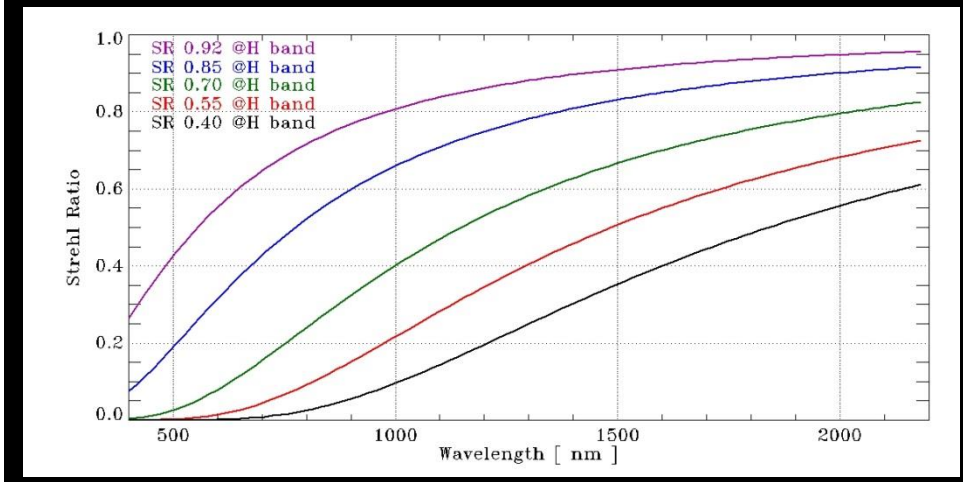
How to compute «your» SR in 3 steps

1. Rmag of the AO reference star
2. Scientific band
3. Distance of your science object from the reference star (if any)

1: Guide star *R = 10.5* + Seeing= 0.8"-> SR(H)=55%



2: Science obs. in *Ks band* -> SR = 70%



	J		Ks	
Exposure time	10s	2s	15s	2s
θ_0 *[arcsec] Isoplanatic angle*	7.8	10.3	**28**	30
$\sigma(\theta_0)$ *[arcsec]*	0.43	1.1	1.2	7.7

3: $SR = SR_{on\text{-}axis} \exp(-d / \theta_0)^{(5/3)}$

Target distance from NGS *d = 10"*

«YOUR» SR = 60%

Credits: F. Zolesi (Tesi di laurea)

The science doc: AO VIS performance

From I. Pagano, E. Giallongo, E. Cappellaro

«Con riferimento alla "2014 Call for Proposals for Instrument Upgrades and New Instruments", scriviamo per chiedere la vostra collaborazione alla formulazione della proposta scientifica per SHARK. ...
... Se siete interessati alla scienza possibile con SHARK, vi preghiamo di contribuire alla formulazione del documento di cui al punto C, integrando, commentando, ed eventualmente sottoponendo anche nuovi casi di interesse.»

1) **31 gennaio 2014**: è il termine per confermare il vostro **interesse** a firmare la proposta mandando una mail a *isabella.pagano@oact.inaf.it, enrico.cappellaro@oapd.inaf.it, emanuele.giallongo@oa-roma.inaf.it.*

2) **10 febbraio 2014**: termine per ricevere **contributi**.

3) **17 febbraio 2014**: circolazione primo **draft**

4) **25 febbraio 2014**: documento finale.

5) **28 febbraio 2014: deadline per la sottomissione**

A call for AO scientific topics for SHARK

E. Cappellaro, E. Giallongo, I. Pagano

The proposed instrument aims to obtain diffraction limited images with coronagraphic capabilities both in the NIR (with a typical resolution of 50 mas at 2 micron and extreme strehl ratios >90%) and in the visible bands with a resolution ~20 mas at 650 nm and still very good SR values >45%). The diffraction limited FoV is limited to a distance of 2-3 arcsec from the reference star where the AO correction is more effective. Partial AO correction can be obtained at larger radii (<10 arcsec). In the visible an IFU facility is planned in a 2 arcsec^2 region, with spaxel in the range 40-80 mas and spectral resolution in the range 100-5000. The instrument will exploit the LBT binocular configuration providing observations in the visible and NIR channels.
Compared with other coronagraphs in commissioning phase like GPI at Gemini and SPHERE at VLT, the proposed instrument represents a simpler but very efficient alternative which relies on the superb performances of the FLAO system at LBT.

In what follows we list a few scientific topics which would benefit of such proposed instrumental setup. The science cases are not exhaustive or complete, include some of the topics proposed in the previous white paper and need to be developed in detail. More topics could also be added. The aim of the present document is to motivate the researchers potentially interested in this instrument to investigate in detail specific scientific programs of their interest, included or not in the present list of broad topics. *People interested in participating to the science team and contributing to the new white paper of the instrument should send an email to us.*

Examples of scientific topics

Exoplanets The detection of extra solar planets is one of the most exciting goal of the modern Astronomy. Due to the very demanding resolution and contrast required on the scientific images, it is also a very challenging task to be achieved.

Most of the known planets have been discovered by the radial velocities and transit methods. The combination of radial velocities, from spectroscopy, and transits, from photometry, constrain the exoplanets's internal structure and characterizes their orbits. These informations are now available for about 200 planets. However, the two techniques are biased towards exoplanets close to their hosting star, and even though RV measurements are able to detect giovian planets up to a few AU from their stars, these measurements alone are not sufficient to fully constrain the planetary properties

Direct imaging gives the possibility both to analyze the outer regions of planetary systems for stars in a wide range of masses and to characterize photometrically and spectroscopically the detected planets. The database of known planets at distance larger than 1AU includes about two tens of young planets of mass larger than that of Jupiter, detected by direct imaging. This number will increase in the near future thanks to the contributions of the ESO SPHERE and Gemini GPI instruments, now ready to start their operational life.

In the next few years GAIA will provide the astrometric detection of giant planets with mass between 0.1 and some tens of Jupiter masses, at distance between 0.1 and few tens

Available on-line