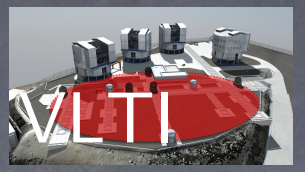
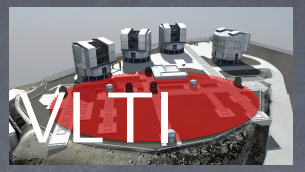
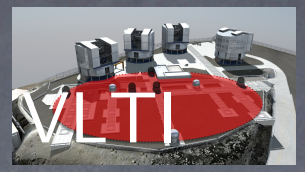


AMBER status report

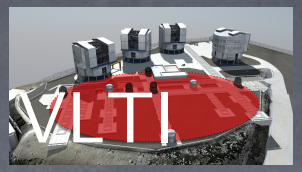
Grenoble - Amdlib 3.0

JP Berger on behalf of the AMBER IOT & TIOs
A. Merand (IS2), P. Bourget(IS), A. Ramirez (So), A. Gabasch (So), P. Mardones (So), F. Patru, I. Percheron (QC), A. Richichi, M. Schoeller, A. Segovia(So), M. Wittkowski (USD)



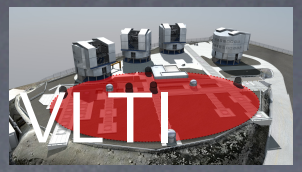


Current status



People

- Instrument scientists: J.-P. Berger, A. Merand
- USD support: M. Wittkowski, C. Hummel
- Quality control: I. Percheron, S. Moehler
- AMBER fellow: F. Patru
- Engineering support: P. Bourget, A. Ramirez, A. Segovia
- VLTI system engineering group: P. Haguenauer

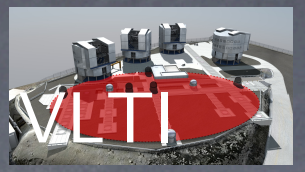


Official news

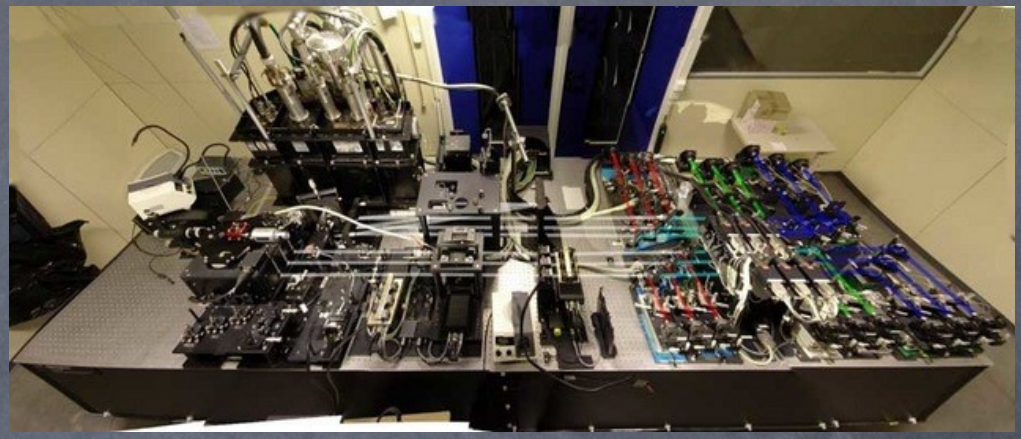
- The "Provisional Acceptance Chili" (PAC) of AMBER has been declared "closed" on May 20, 2010
- Change of Instrument Scientist 2011-Jan-01

  A. Merand -> JP Berger (A. Merand remains IS2)

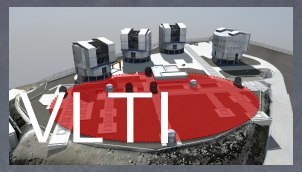
Instrument description



- AMBER offers three beam combination at the VLTI
- (J),H,K bands available
- Observables: visibilities, closure phase (CP), differential vis, phases, CP
- VLTI+AMBER offers 4x3 possible telescope triplets in single night



mode	FINITO	calibrated V	diff. ϕ	CP
low HK	not used	10%	NG	5^{o1}
	coherencing	5%	NG	3^{o1}
	cophasing	7%	NG	3^{o1}
medium K	coherencing	5%	2^o	4^o
	cophasing	5%	1^o	2^o
medium H	any mode[3]	5%	2^{o2}	4^{o2}
high K	cophasing	5%	1^o	2^o



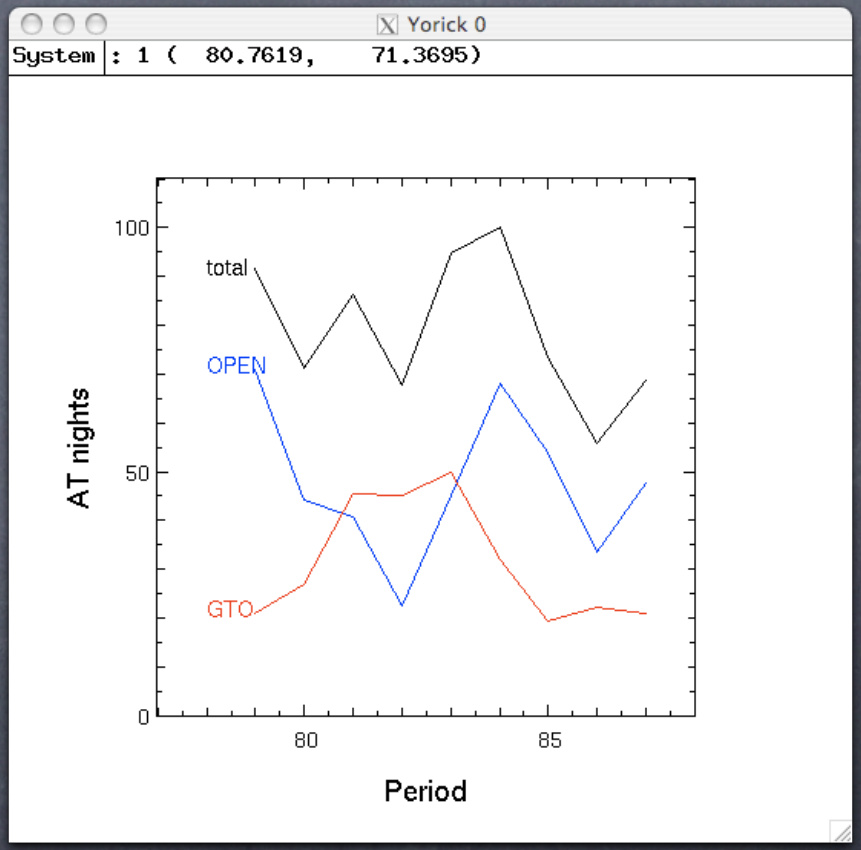
Instrument description

	AMBER	FINITO	Kcorr	Hcorr	H	VisK	VisH	AM	Vmag	Dist
UT	LR-HK	**no**	<7*	<7*	-	>10%	>10%	<2.0	1...17	<55"
	LR-HK	group tracking	<7.5*	<7.5*	> 1			<1.5	1...15	<13"
	LR-HK MR-K	fringe tracking	<7	<7						
	MR-H	fringe tracking	-	<5		-				
	HR-K	fringe tracking	<6	<6		>10%				
AT	LR-HK	**no**	<5.5 (4.1, 3.1)**	<5.5 (4.1, 3.1)**	-	>5%	>5%	<2.0	-1.7...13.5	<60"
	LR-HK	group tracking	<5.5 (4.5, 3.5)**	<5.5 (4.5, 3.5)**	> -2		>15%	<1.5	-1.7...11	<15"
	MR-H	fringe tracking	-	<4 (3, 2)		-				
	LR-HK MR-K HR-K	fringe tracking	<5 (4, 3)	<5 (4, 3)		>5%				

- H band medium resolution offered since 2009
- No radical evolution in offered limiting magnitude since P84

AMBER demand

- Increased pressure on UTs because of limiting magnitude but vibrations limit severely sensitivity (recent very significant improvements on system engineering side cf S. Poupar)
- AMBER+FINITO OK with ATs not so good on UTs. FINITO has hard time locking the fringes & AMBER instrumental contrast still outrageously low
- "Faint" object science observation



AMBER demand

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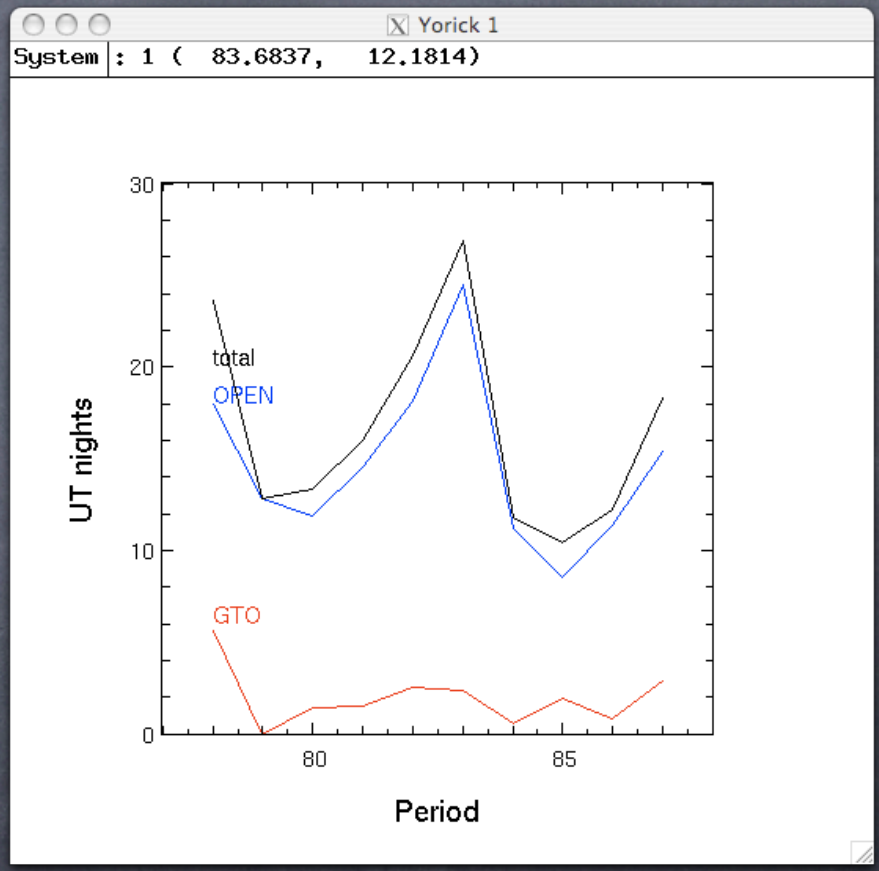

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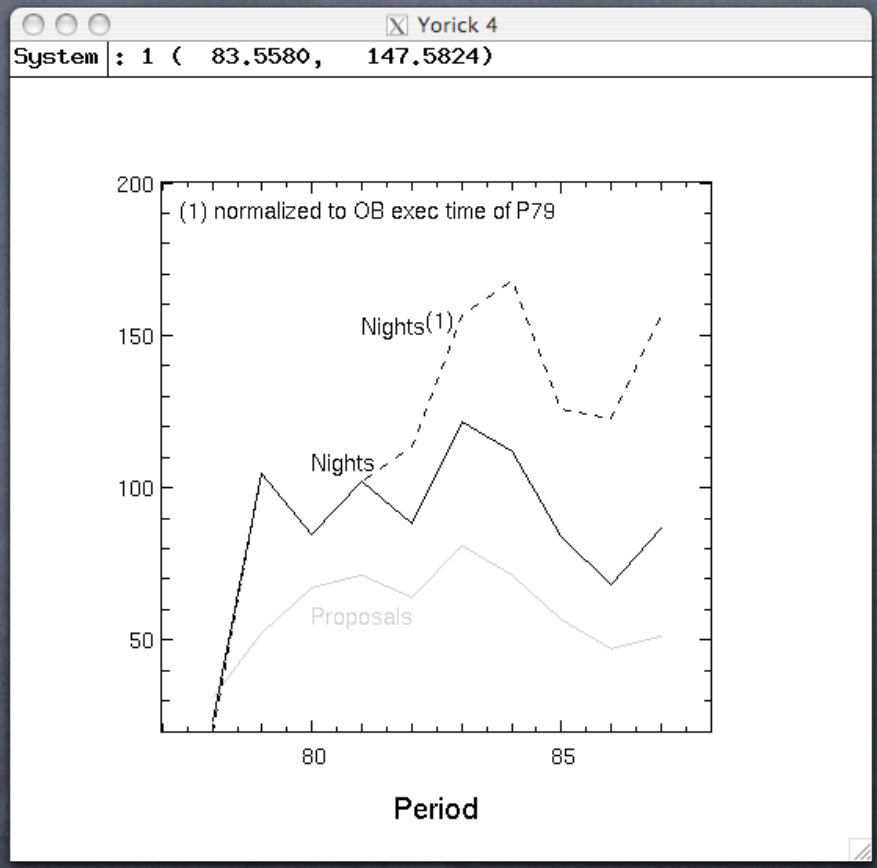
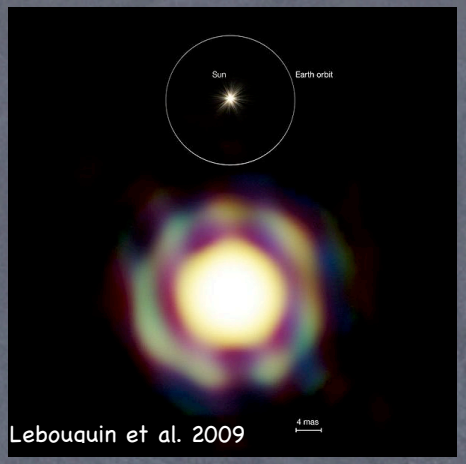
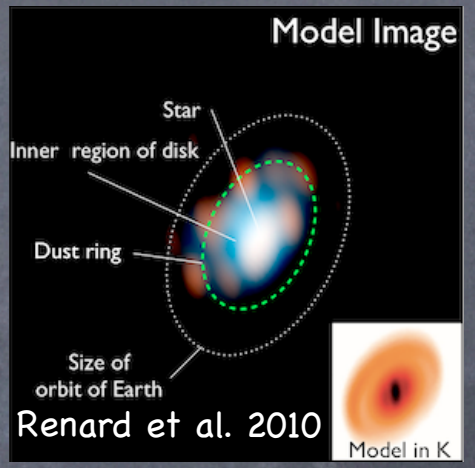
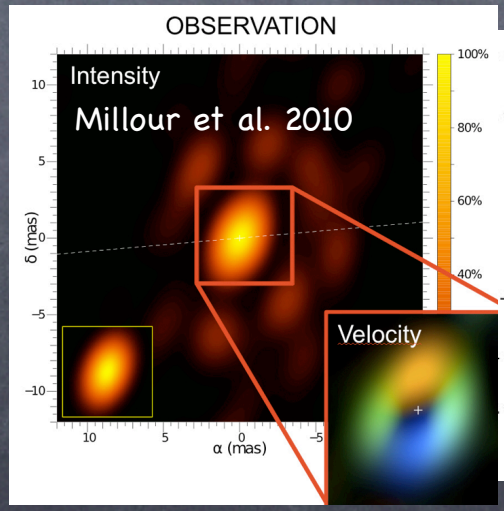


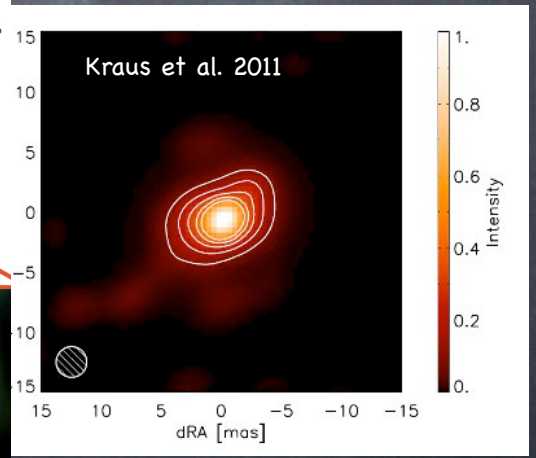
Scientific achievements

- Imaging with the VLTI has been the succesful focus of several teams (6 papers to date)
  - YSOs, MIRA, BeSG
- High spectral resolution unique feature
- Spectral resolution is AMBER strength but competition still active (KeckI K band ~2000) and frontal in some science cases (e.g YSOs)
- AGN/T Tauris very often out of reach
- Interest in J band expressed by visitors

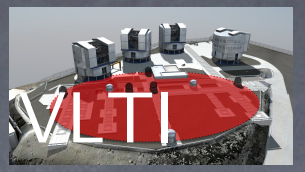








Publications



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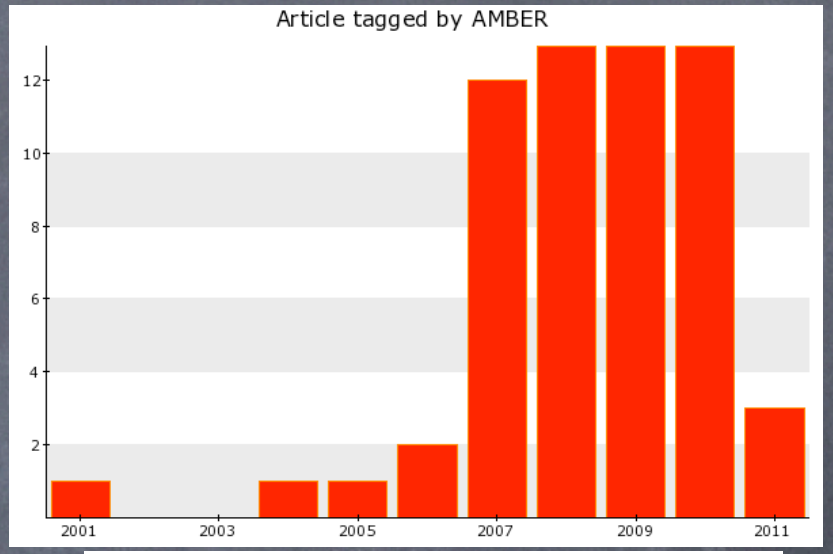
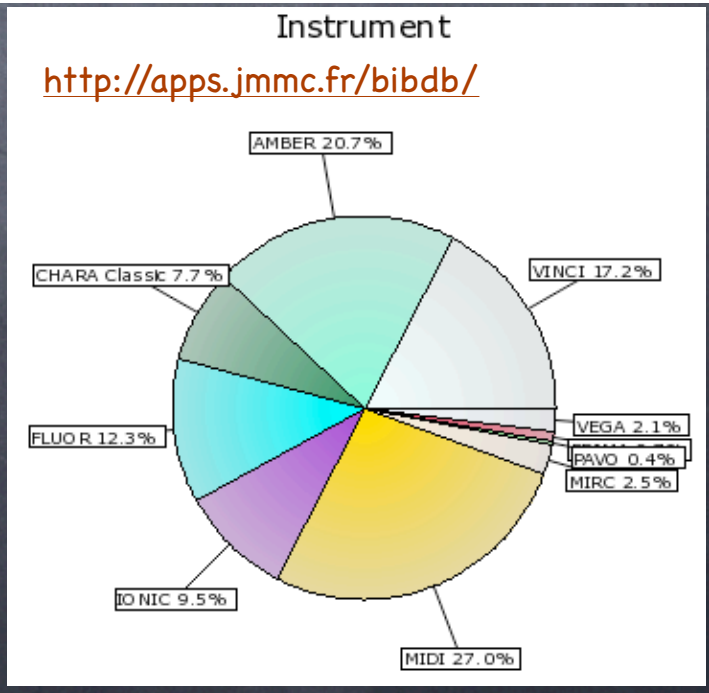
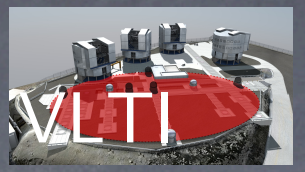
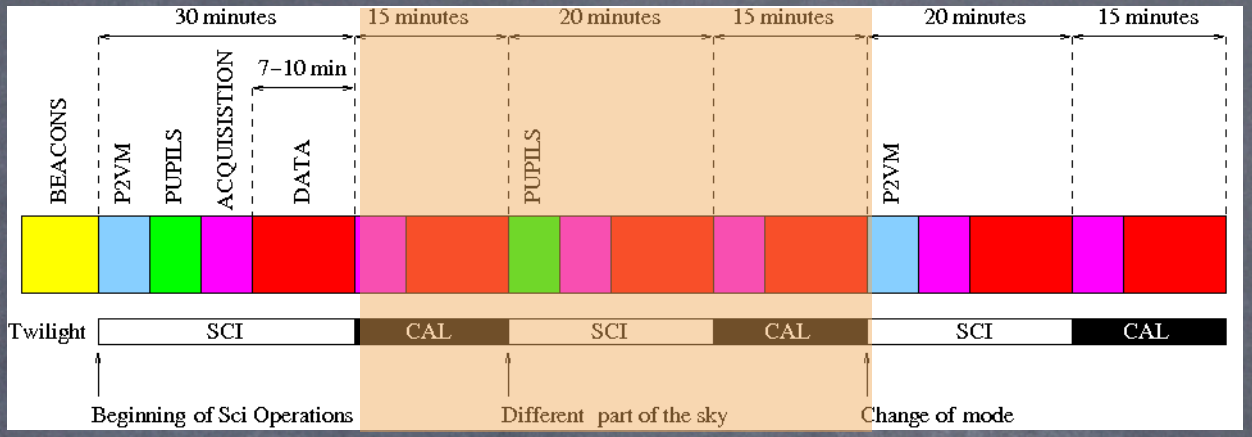




Standard operation



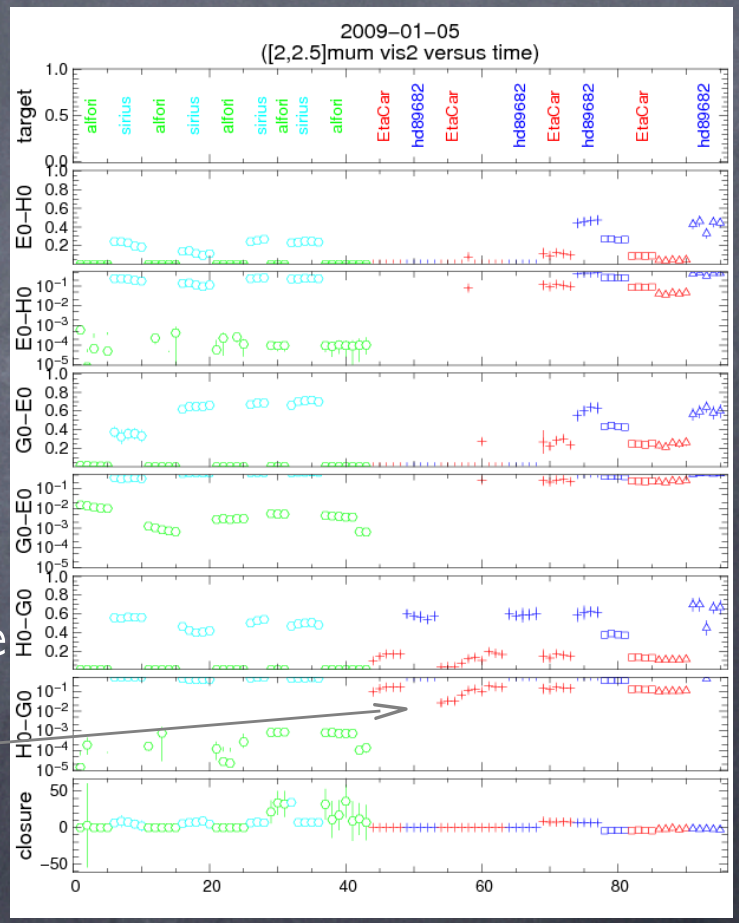
- Typical observation sequence: CAL-SCI-CAL now default



- Offered: LR: 75 minutes + MR/HR: 90 minutes: a little bit conservative can be shorten by a significant factor (e.g 60 inLR, tbc)
- AMBER+FINITO used "almost" smoothly
- 3T AT triplet can be choosen out of 4 positions (redundancy would avoid idle time)
- AT acquisition (when no failure) is quite fast: e.g. down to 5 minutes if same brightness as previous source. UT is dominated by MACAO acquisition (sometimes ~15 minutes)
- AMBER acquisition of faint sources cumbersome (PlayStation-like)

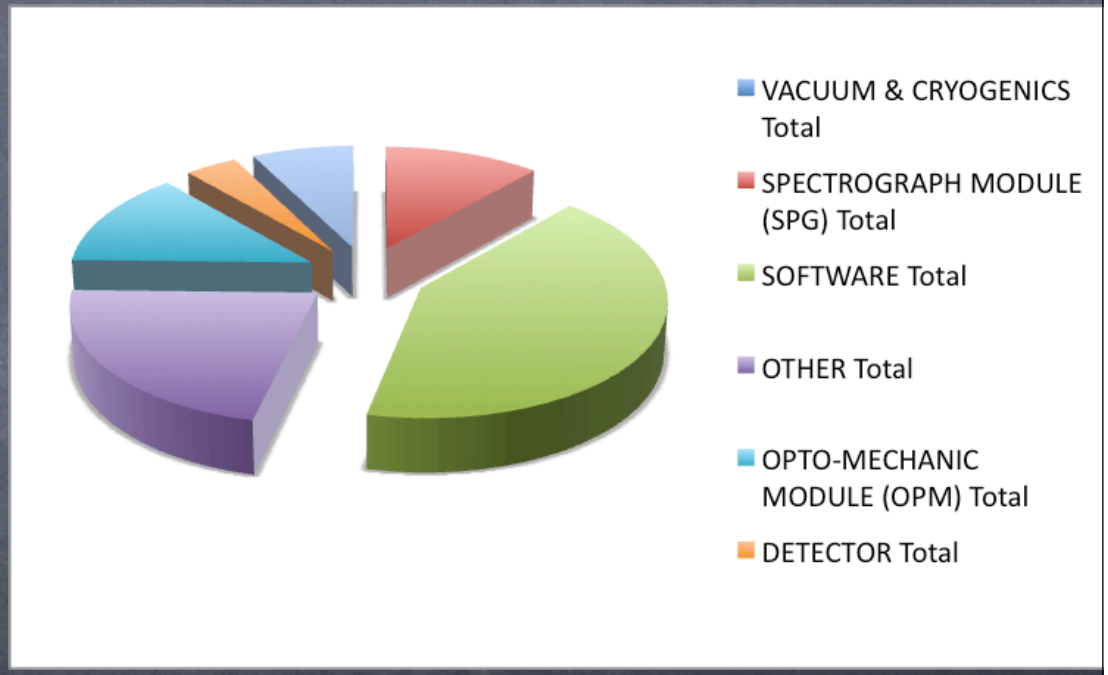
Data reduction and calibration

- AMBER precision is still disappointing:
  - slow integrations;
  - extreme sensitivity to piston/vibrations.
  - SM mode not adapted for proper transfer function (TF) estimation
- AMBER QC0 established by JB Lebouquin/A. Merand amdlib 2.0 (last contractual version),
- TF estimation from pipeline soon to be available (amdlib 2.0)
- BUT: JMMC now provides amdlib 3.0+ with notable differences (low snr) -> how do we implement it

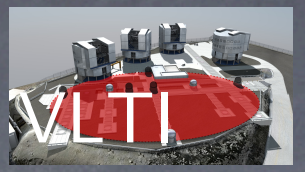


Time losses

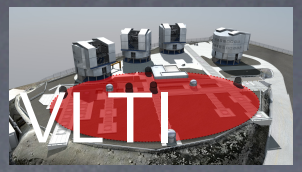
- 2009-2011
- Total losses 1408 mn
- Software dominates but
- ... still too much hardware losses



Technical operation



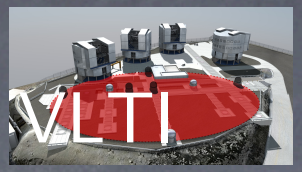
- AMBER is tricky: beam misalignment is frequent and requires often tweaking
- CAU unit not reliable (unstable + H/K discrepancy), P. Bourget has developed new robust low-cost concept but issues concerning K band coverage
- Full realignment AMBER hot optics (P. Bourget/P. Haguenauer) in 2010: no apparent improvement in througput but things are healthier and reference axis well defined
- DIU (prism/grism rotating support) is VERY flaky and the origin of technical losses due to AMBER. Workarounds but ideally would need cryostat opening and replacement
- Detector cutoff issue on the verge to be understood (A. Ramirez, A. Merand)
- Blank frames issues still pending (A. Ramirez)



Ongoing-projects

- Transfer function monitoring from the pipeline
- FINITO data recording included in AMBER data
- Coherencing

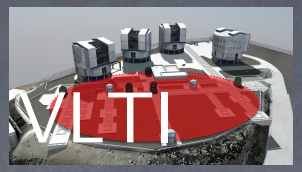
Finito+RMNREC



- Problem: part of AMBER lack of precision is due to its extreme sensitivity to optical path jitter
- Strong seeing dependance in the TF function estimation
- Idea: FINITO, when it works, estimates the jitter much faster than AMBER: provides information suitable for visibility post processing
- Implementation: A. Ramirez implemented RMNREC, A. Merand commissioned it. Now offered
- However: still expert feature (LR ok notMR)
  - -> collaboration with JMMC ?

$$\begin{aligned}\mu_k^2(\lambda,t) &= V^2_{\text{object}} \times T^2_{\text{instrumental}} \times T^2_{\text{atmo.}} \\ &= V^2_{\text{object}} \times T^2_{\text{instrumental}} e^{-\left(\frac{2\pi \text{OPD}_{\text{rms:}t,t+\texttt{DIT}}}{\lambda}\right)^2}\end{aligned}$$

Finito+RMNREC



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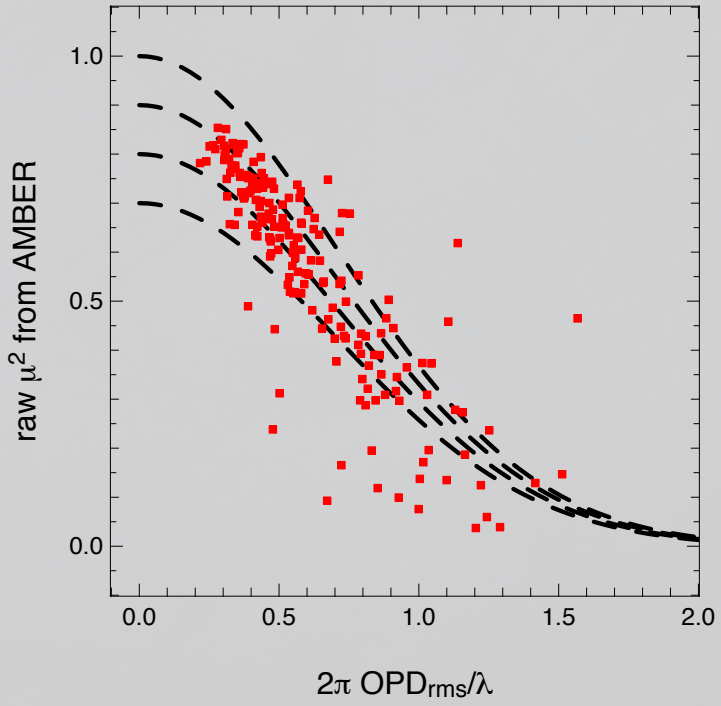

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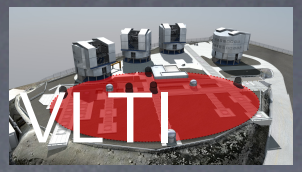

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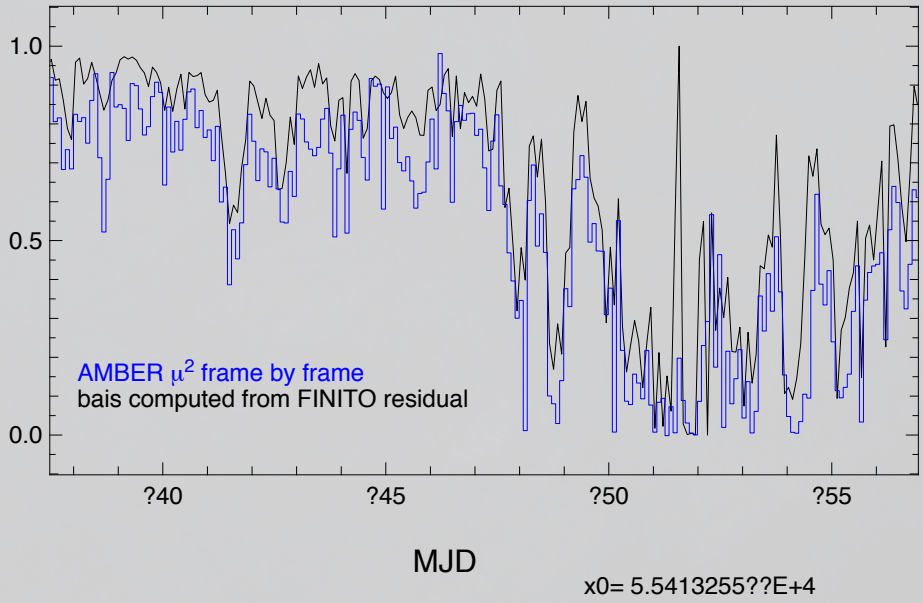
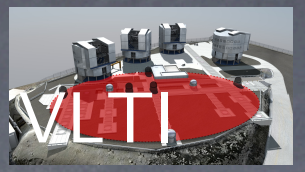


Figure 2: *Correlation in time between the visibility in one AMBER channel (in blue, step like plot) and the bias computed using the FINITO residual.*

Finito+RMNREC



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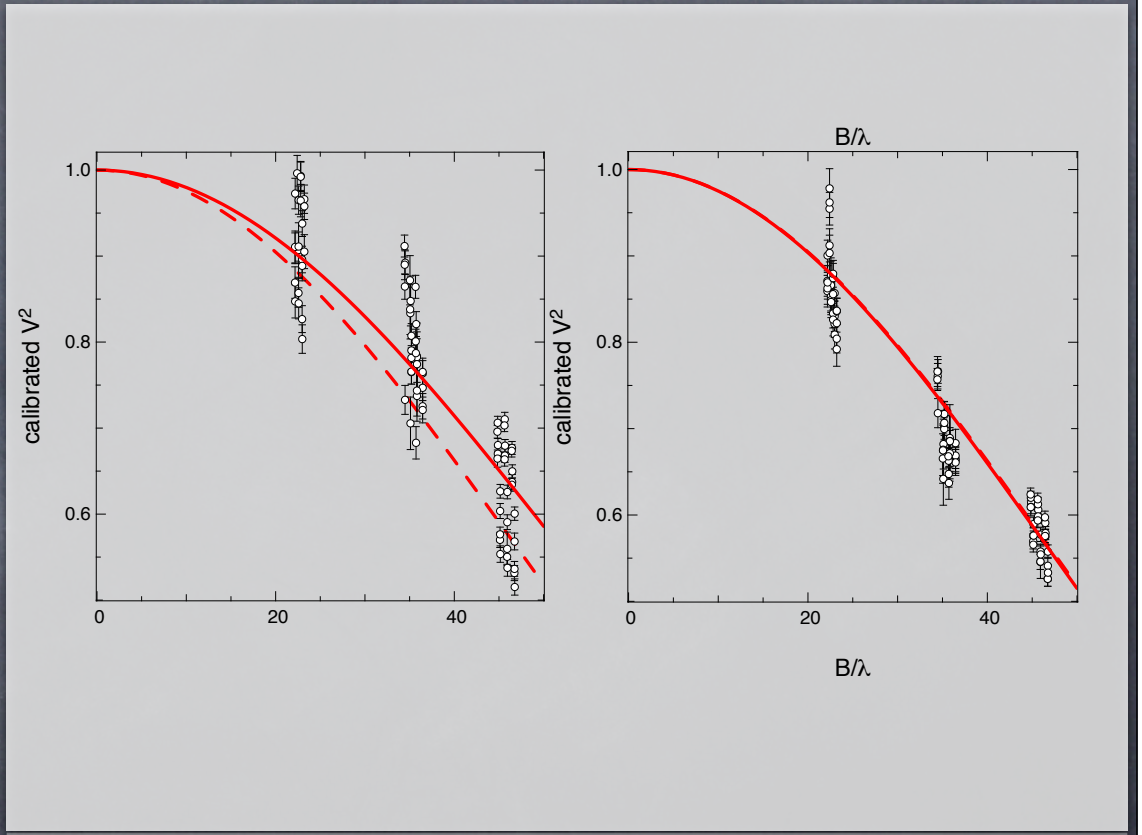

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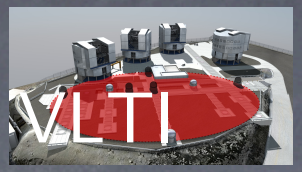

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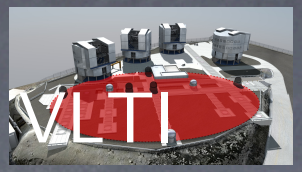
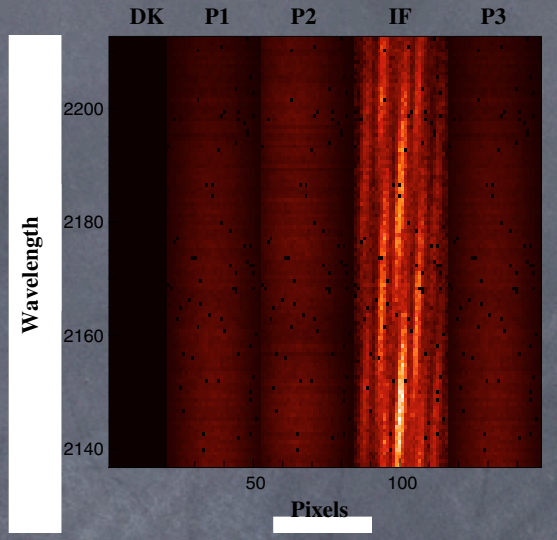
	K (2.07 ± 0.02mas)	H (2.06 ± 0.02mas)
using RMNREC data	2.02 ± 0.01mas	2.08 ± 0.03mas
(χ^2)	4.5	7
no post-processing	1.81 ± 0.07mas	1.88 ± 0.15mas
(χ^2)	26	33

Table 1: *angular diameter of HD 219784 (expected uniform disk diameter of* 2.07 ± 0.02*mas in K band, calibrator from Bordé et al, 2002) as measured using HD 216761 and HD 218619, calibrators from Mérand et al (2005) catalog. The transfer function was assumed linear with time.*

Coherencing

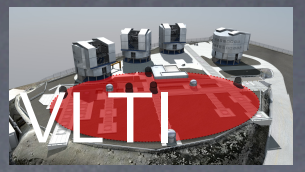


- Motivation: Increase AMBER sensitivity, decrease operator intervention (click ! & bias)
- Idea: Use AMBER to maintain fringes within coherence length
- Implementation: prototype script by JB Lebouquin
- Demonstration: technical time
  - Sequences of coherencing (on/off)
- Calibration proposal by Millour et al. based on different estimator

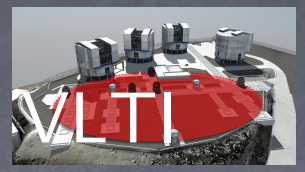


	Filter	V^2	σV^2	σCP
Coherencing OFF	J	0.025	75%	4.5
	H	0.063	42%	4.2
	K	0.15	30%	7.7
Coherencing ON	J	0.04	35%	2.0
	H	0.09	27%	2.2
	K	0.19	22%	0.8

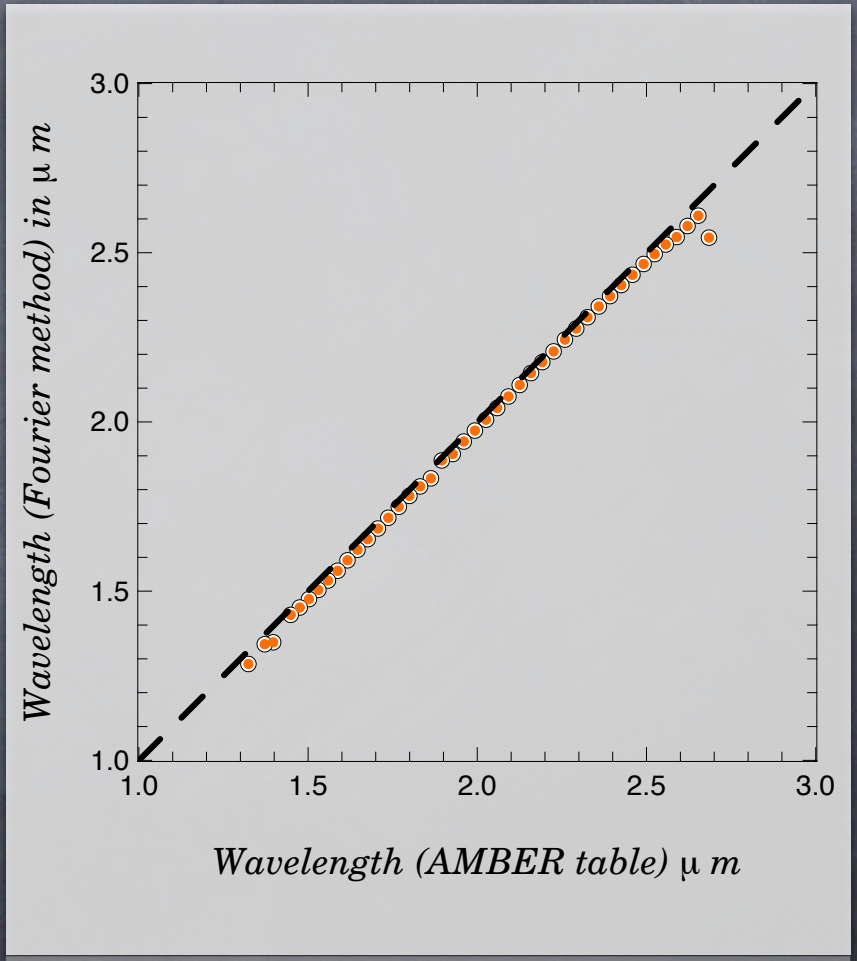
Assessments/future orientations



Spectral calibration



- There is a recurrent complaint that AMBER wavelength calibration tables are not valid. User have their own recipes to deal with
- Low Resolution: autocollimation test (FTS) shows not that bad (few %)
- Medium/High Resolution:
  - ➡ Demonstration by A. Merand and M. Wittkowski that using standard templates one can calibrate & remove telluric AMBER data
- Question: how is this implemented back for the benefit of users ?



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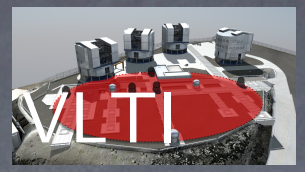

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  - ➡ Demonstration by A. Merand and M. Wittkowski that using standard templates one can calibrate (remove telluric) AMBER data
- Question: how is this implemented back for the benefit of users ?

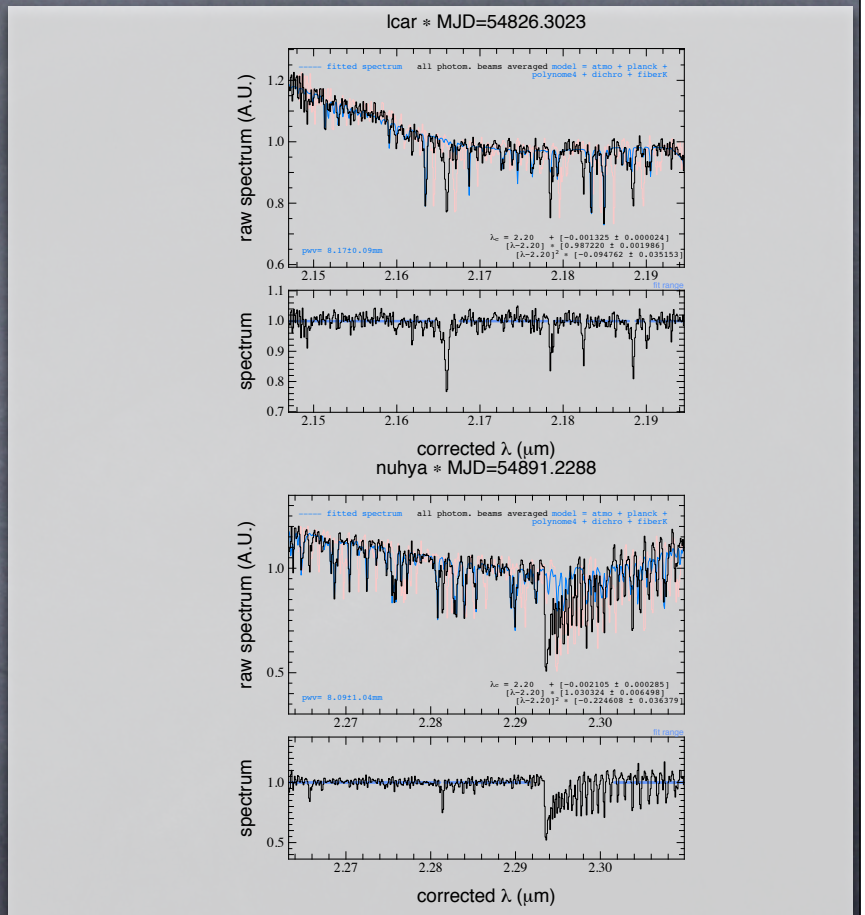
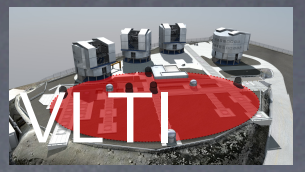


Figure 7: *HR-K spectra, for the 2 most popular AMBER setup: around the brackett gamma line (up) and around the CO lines (down). For these fit we used the hight resolution absorbtion atmosphere spectra from Alain Smette.*

AMBER sensitivity



- AMBER has an "intrinsic" poor transmission
- Uses polarizer to improve instrumental contrast (50 % flux lost)
- Little is known on detector readout scheme, is it optimum ?
- Evidence for important losses in H/wr to K band (Wittkowski, Merand)
- No such evidence from internal measurements (Berger)
- Anomaly in the injection process ? (role of ADC, fiber coupling ?)

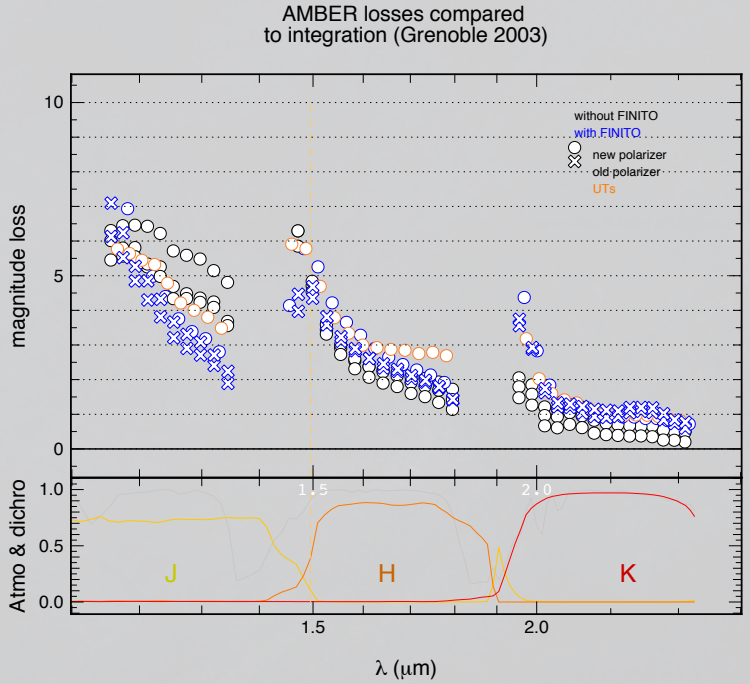
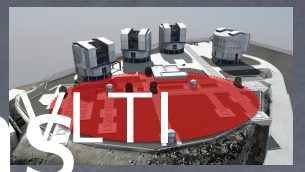
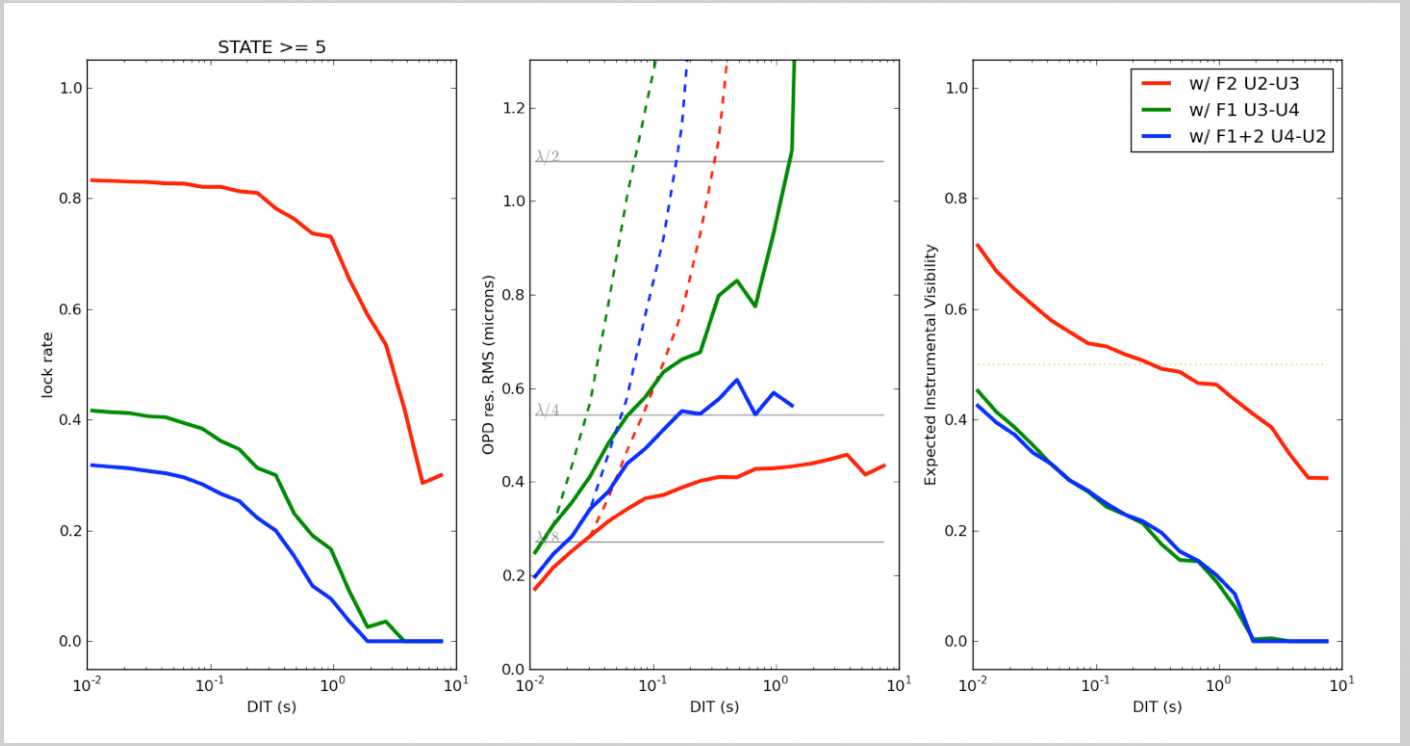


Figure 1: *Transmission loss as a function of wavelength, plotted for different observation files in low resolution mode. The data set is very heterogenous: UTs, ATs, with and without FINITO, different atmospheric conditions etc. The comparison it the transmission measured in Grenoble in 2003. The lower panel shows the atmospheric transmission (gray) as well as the combined transmissions of the dichroics of AMBER: $T_K^2 T_H^2$ for J band, $T_K^2 R_H^2$ for H and R_K^2 for K band. Note the misplaced cutoff wavelength for the shortest wavelength of H band and it visible effect on the transmission of H.*

AMBER & UT vibrations

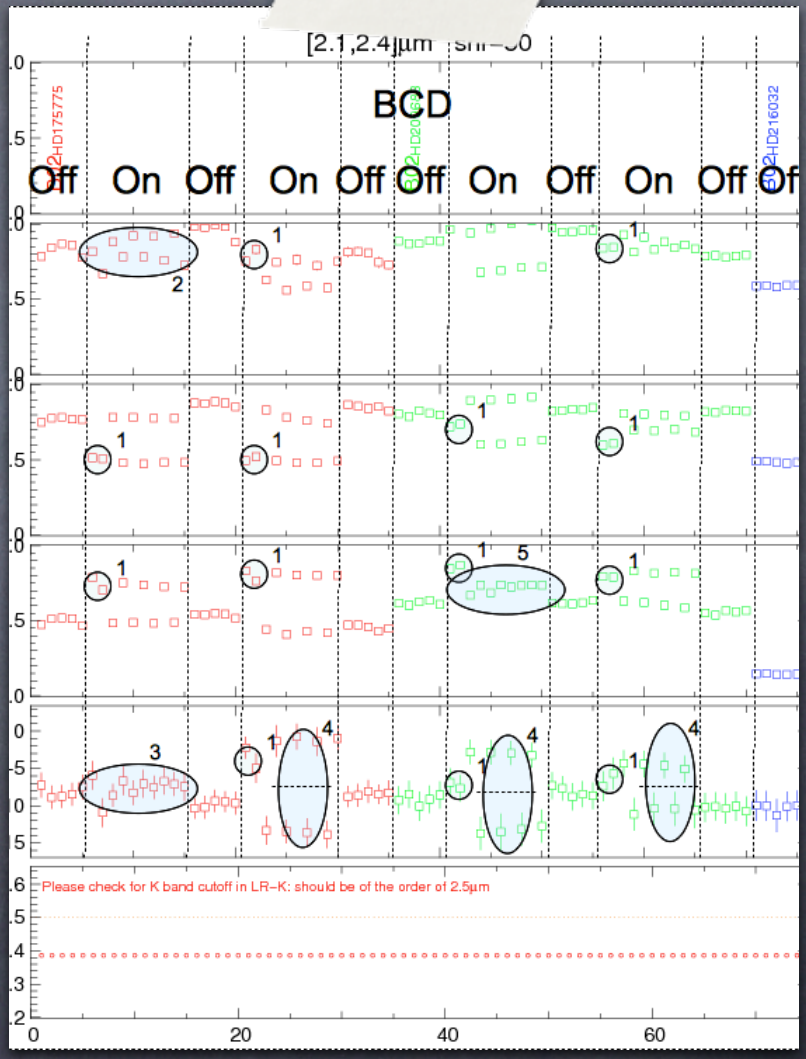




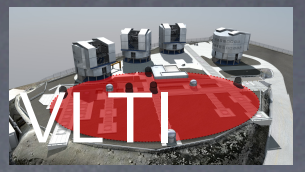
- FINITO+AMBER+RMNREC provide unique tools to sense the effect of vibrations (A. Merand)
- Strong SNR attenuation because of vibration => optimum DITs recommended

BCD

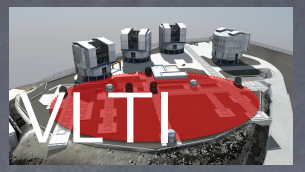
- Motivation: BCD subsystem provides means to calibrate instrumental closure phase
- Idea: BCD swaps two beams which supposedly cancels
- Commissioning: commissioning report sent by R. Petrov et al. in 2010 concludes to an improvement in LR CP accuracy
- Technical time: BCD not ready for routine operation need additional testing (coll. Petrov+Vannier) + software work
- Collaboration with Nice on OPC selected program (april, may 2011)



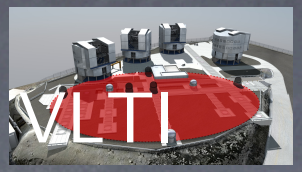
Possible hardware related improvements



- CAU source replacement;
- Internal calibration lamp (low resolution)
- Polarizer removal + polarization control (succesfully tested in PIONIER)
- Fiber throughput assessment -> replacement
- ADC assessment



CONCLUSION



- Knowledge of AMBER has considerably improved
- Several ongoing projects should result in
  - improved sensitivity (not fully dependent on AMBER)
  - improved precision
- Ideas to gain 1-2 (LR) magnitudes are credible
- Opening new modes (J, BCD) requires additional work: strongly dependent on available manpower
- Keeping a good connection with JMMC (amdlib) is essential
- Software and hardware manpower will be key to progresses
- Don't hesitate to contact the team for further information