10 years of Operations of the VLT interferometer

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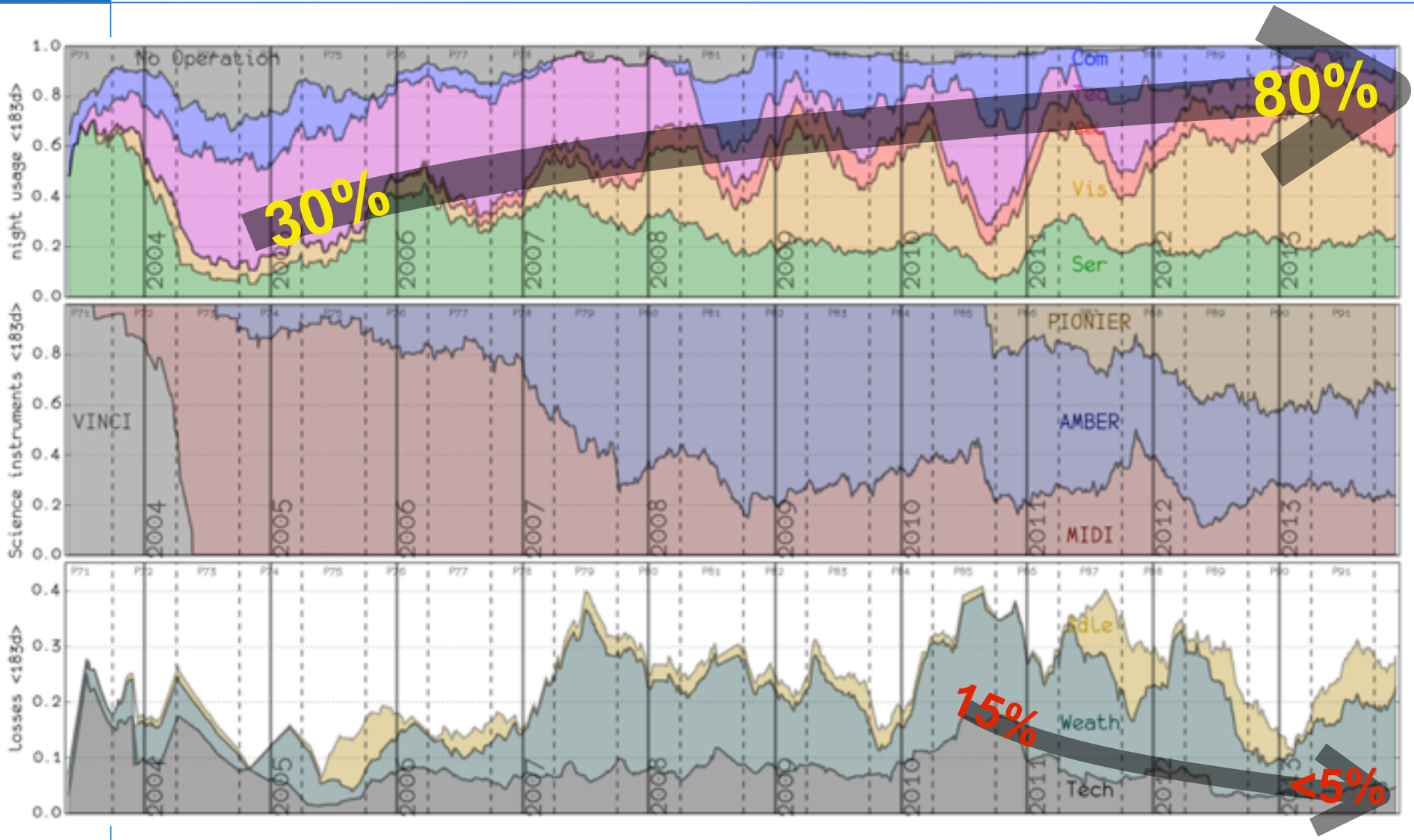
10 years or operations in one plot



Improvements

- Observation execution time (CAL-SCI):

2006	2010	2013
~120min	60min	40min

- we switch between instruments / config in 10 minutes
- **AMBER** guaranteed limiting magnitude:

2010	2013
K = 5/7	K = 6/8

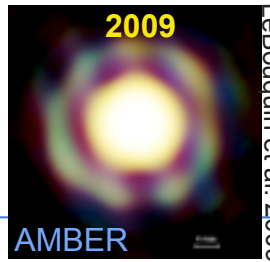
after spectrograph realignement and change of one optic by PAR-INS

soon: expected addition 1mag more with polarization control "à la PIONIER"

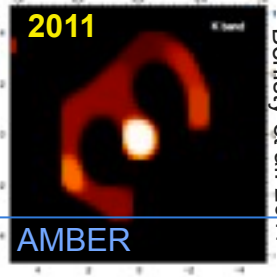
- **AMBER** blind mode (AMBER++): sensitive but low precision: dozen of AGNs K>10
- **MIDI+PRIMA/FSU**: gain of 2 mag lim, AGNs survey on the ATs (before on UTs)

Imaging

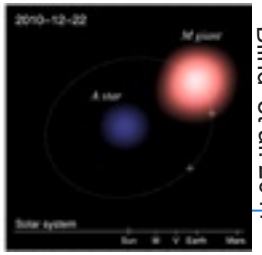
- **imaging == rich u,v coverage (and good data)**
- **Requirements / constraints**
  - use 4 ATs configurations instead of 3ATs
  - allow to change triplets during the night
  - ideally, 4ATs configurations do not have baselines in common -> at most 1 AT in common
  - on Paranal, *for regular operations*, only 2 ATs can be moved per day
- **Implications:**
  - validate 4AT operations: AT reliability and PIONIER
  - offer 3 x 4ATs configurations with one AT in common (2 days between configurations)

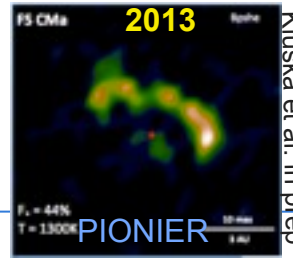


LeBouquin et al. 2009



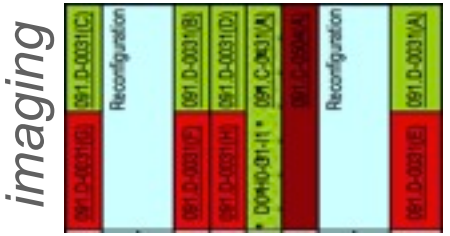
Benisty et al. 2011

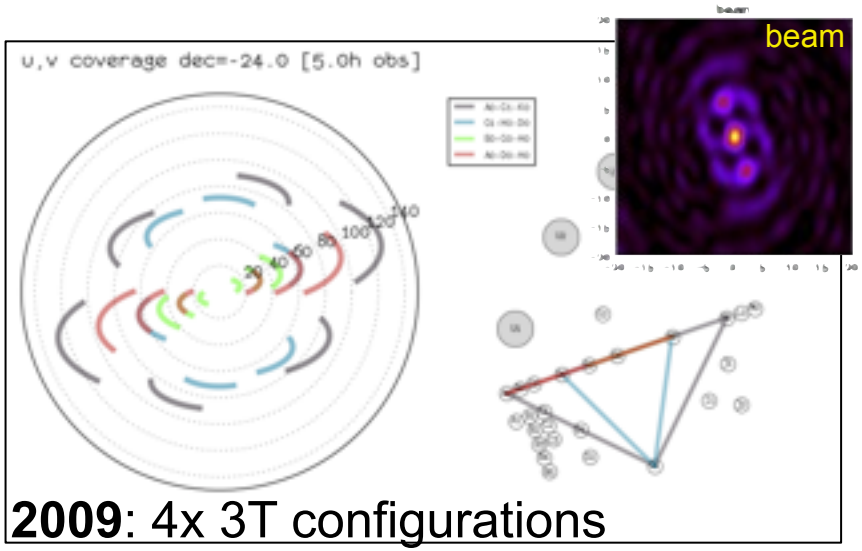

Blind et al. 2011



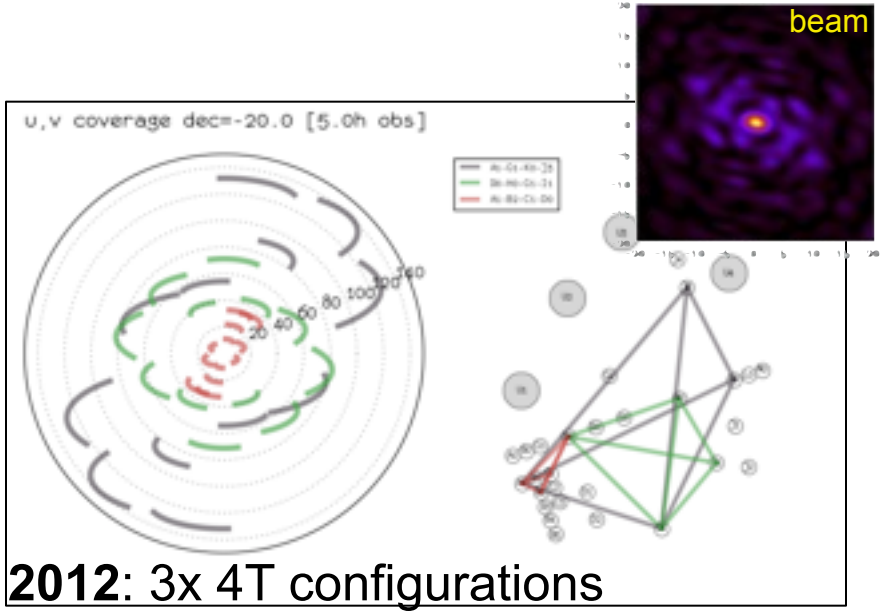
Kluska et al. in prep

- VLTI first images in 2009
- **2012**: Non-redundant 4T-configurations (ATs)
  - scheduling “program oriented”
  - increased number of relocation nights
  - scheduling nightmare...





2009: 4x 3T configurations



2012: 3x 4T configurations

Efficiency metrics

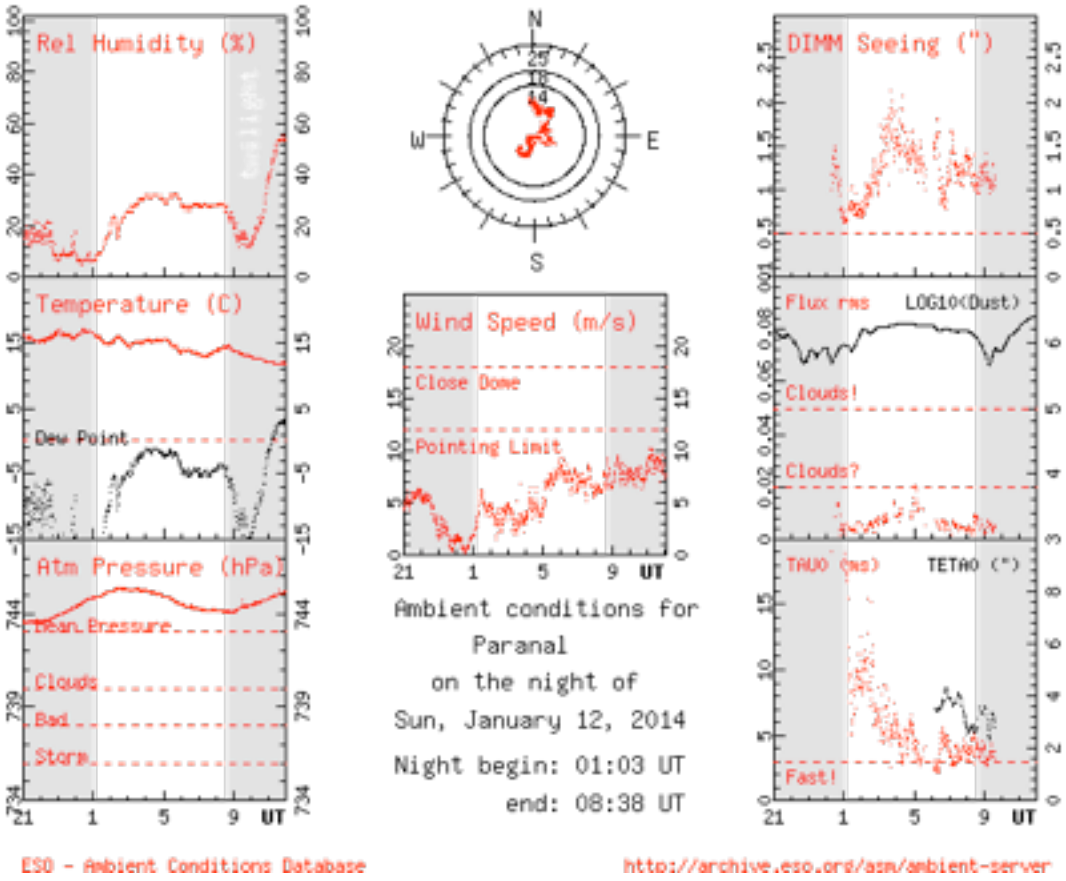
- How many observations per hour effectively?
- How many unique u,v points per hour?

	2006	2010	2013
operations	40%	60%	80%
obs / h	0.5	1	1.5
sci - reloc	80%	75%	70%
eff. obs / h	**0.15**	**0.45**	**0.85**
u,v / config	3	4	6
unique u,v points / h	**0.5**	**1.8**	**5**

enables qualitative improvement of science:
"YSO: size / Lum" → "image the inner rim of the disk"

What about the weather?

Paranal runs the ASM (Atmospheric Site Monitor)



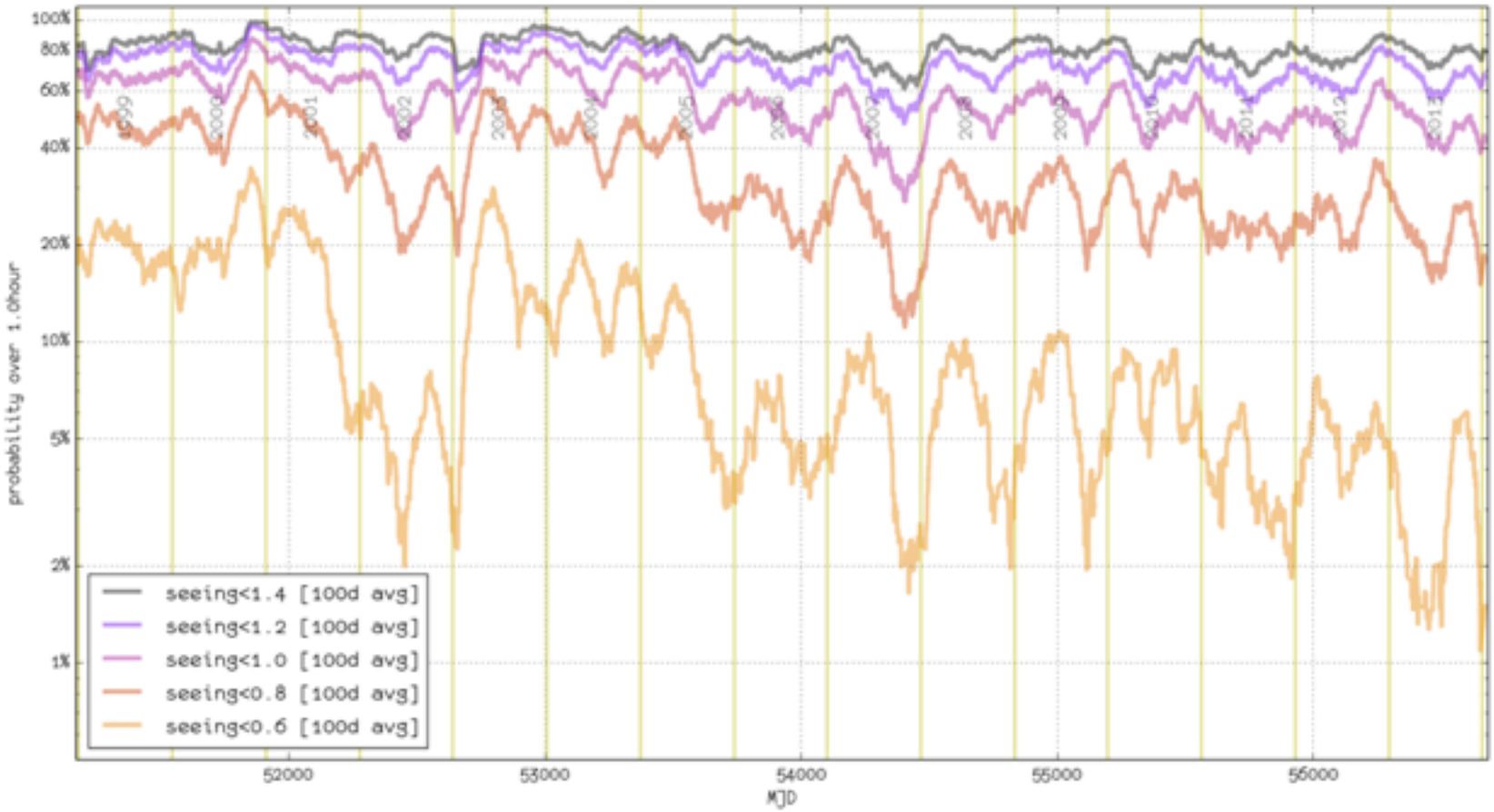
http://archive.eso.org/asm/ambient-server?night=+12+Jan+2014&site=paranal

Sensitivity to weather

- **Seeing**:
  - bad coupling in single mode fibers (low sensitivity)
  - measured by differential image motion monitor (DIMM)
  - only used by users to select the conditions (0.6, 0.8, 1.2)
- **Coherence time** (tau0):
  - speed of the turbulence
  - how fast fringes get blured (how fast we need to take frames)
  - not measured in practice: deduced from seeing and turbulent wind speed (from model)
- **Local wind**
  - low wind (<1m/s): dome seeing in the ATs
  - high wind (>10m/s): ATs shake and fringes are blurred

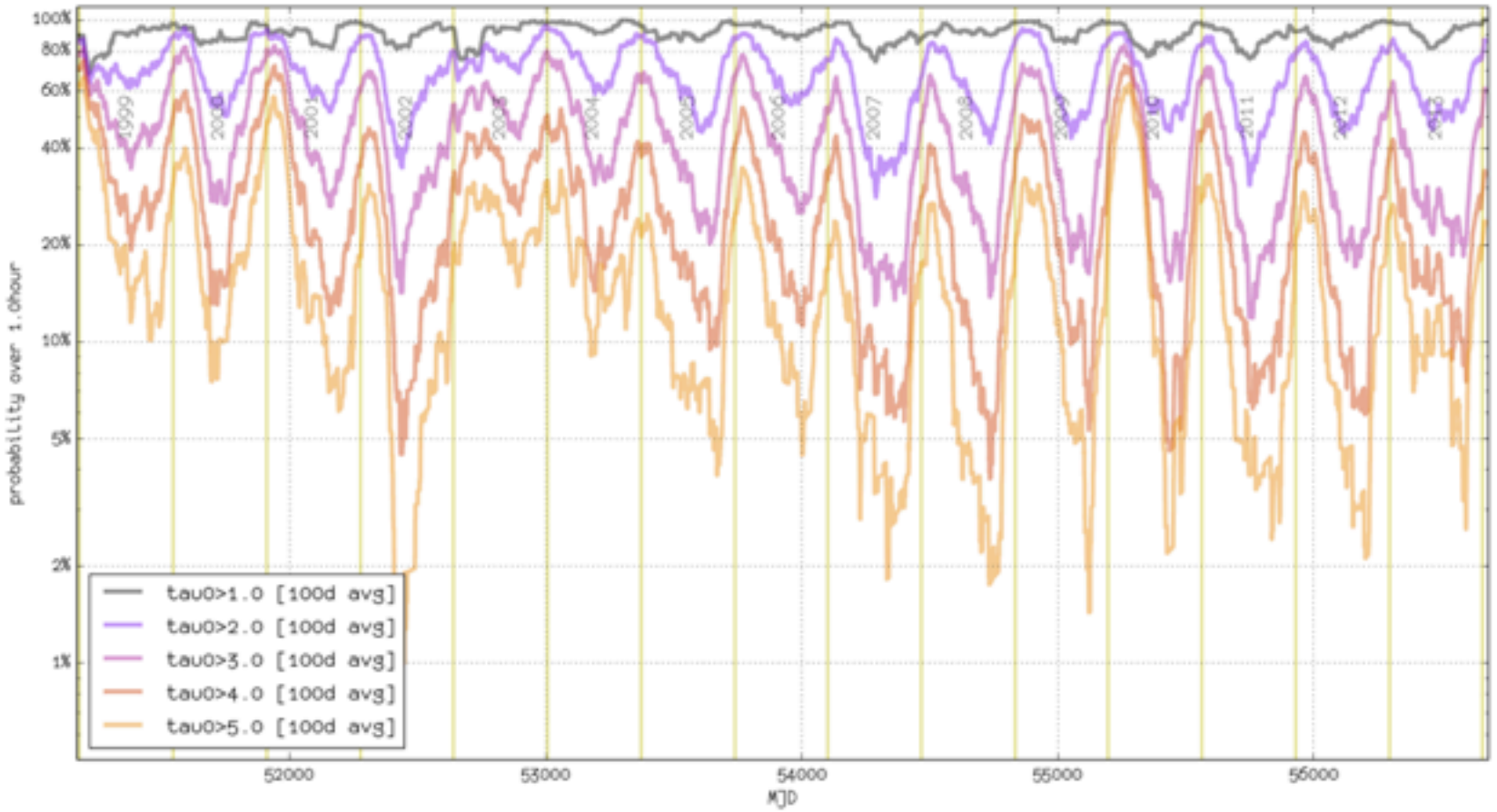
Seeing

- median DIMM seeing ~ 1.0”
- DIMM: what ATs see but pessimistic estimate for UTs



Coherence Time

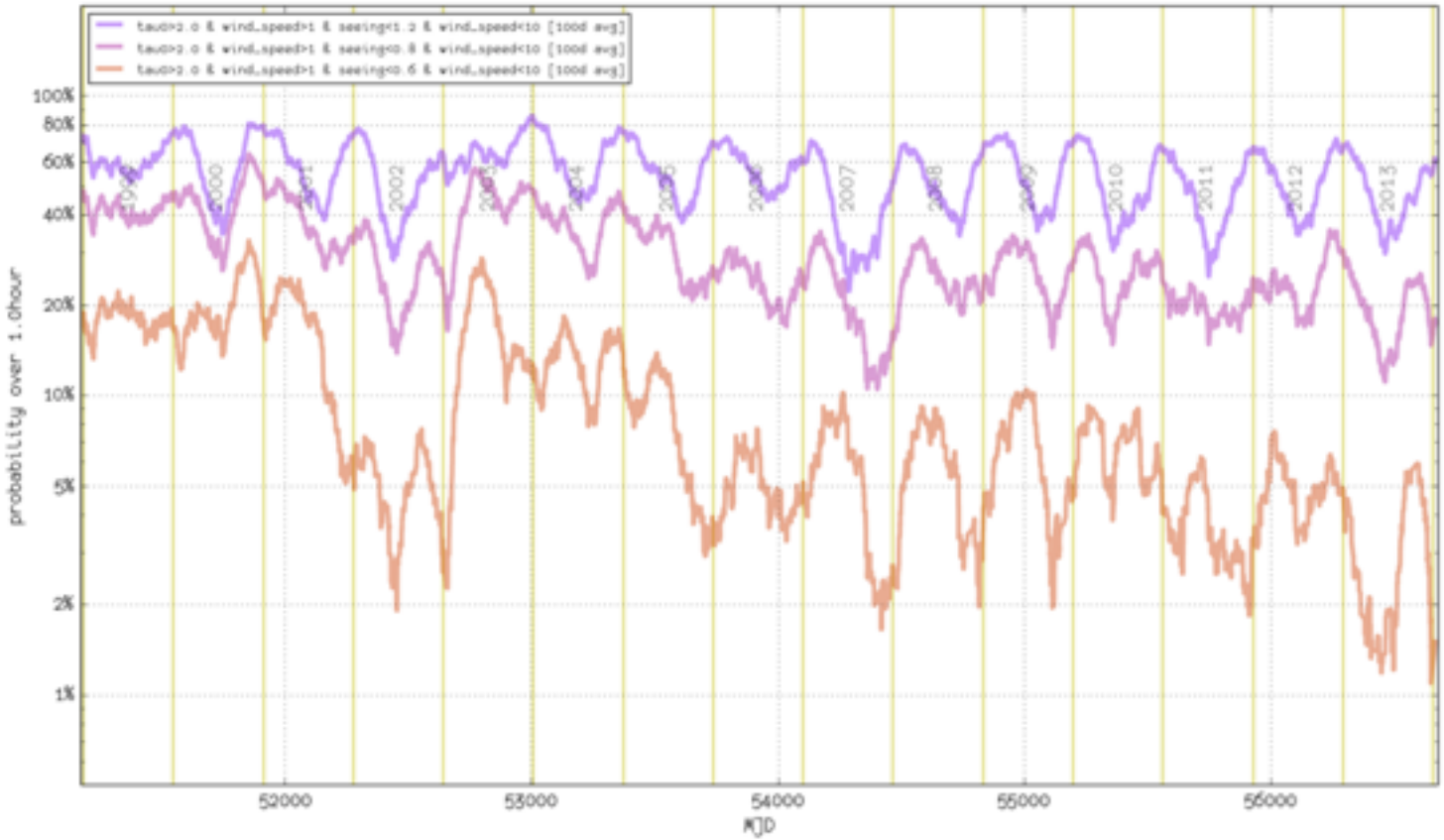
- large seasonal variations (jet stream)
  - median: from ~2ms to ~4ms



Interferometric conditions

- seeing <0.6” <0.8” <1.2”
- coherence time >2 ms
- wind speed 1 to 10 m/s

Mérand et al.
2012 SPIE paper on
FINITO data analysis



~40/70%

~15/30%

~2/7%

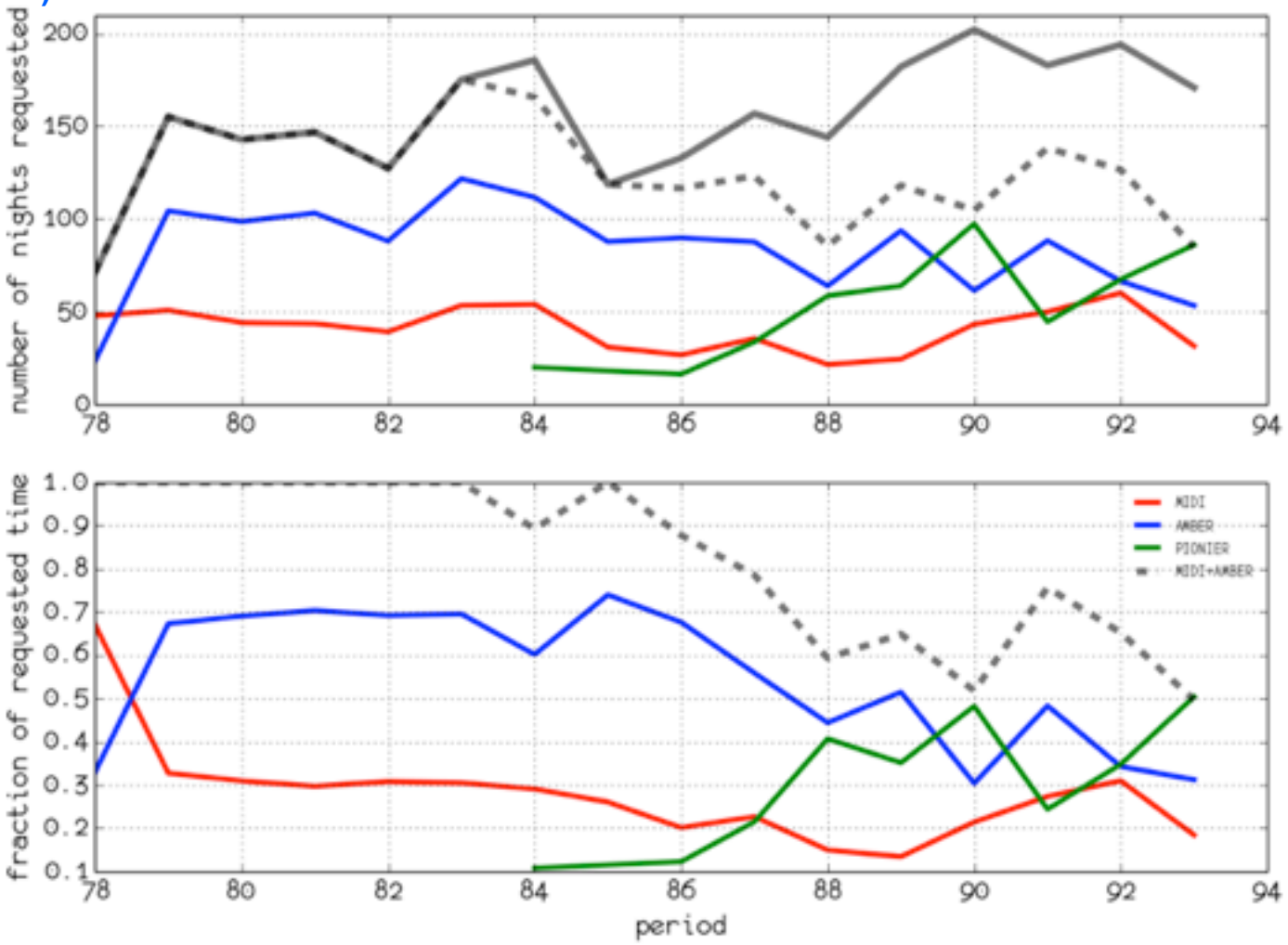
lessons learned on weather

- **strong seasonal effects**!
  - January/February is the **best** (low seeing but high coherence time)
  - July/August: very fast turbulence
  - explanation: **jet stream** located ~30ºS and moves south in the (austral) summer
- **weather loss is "built-in"**: at best ~70% of the time is suitable to (fast) interferometry
- Improvements?
  - **fringe tracking**? actually used to set conditions for this study...
  - **AO**? NAOMI for ATs would enable to use the least favorable conditions (wind<1m/s and seeing ~1 to 2")

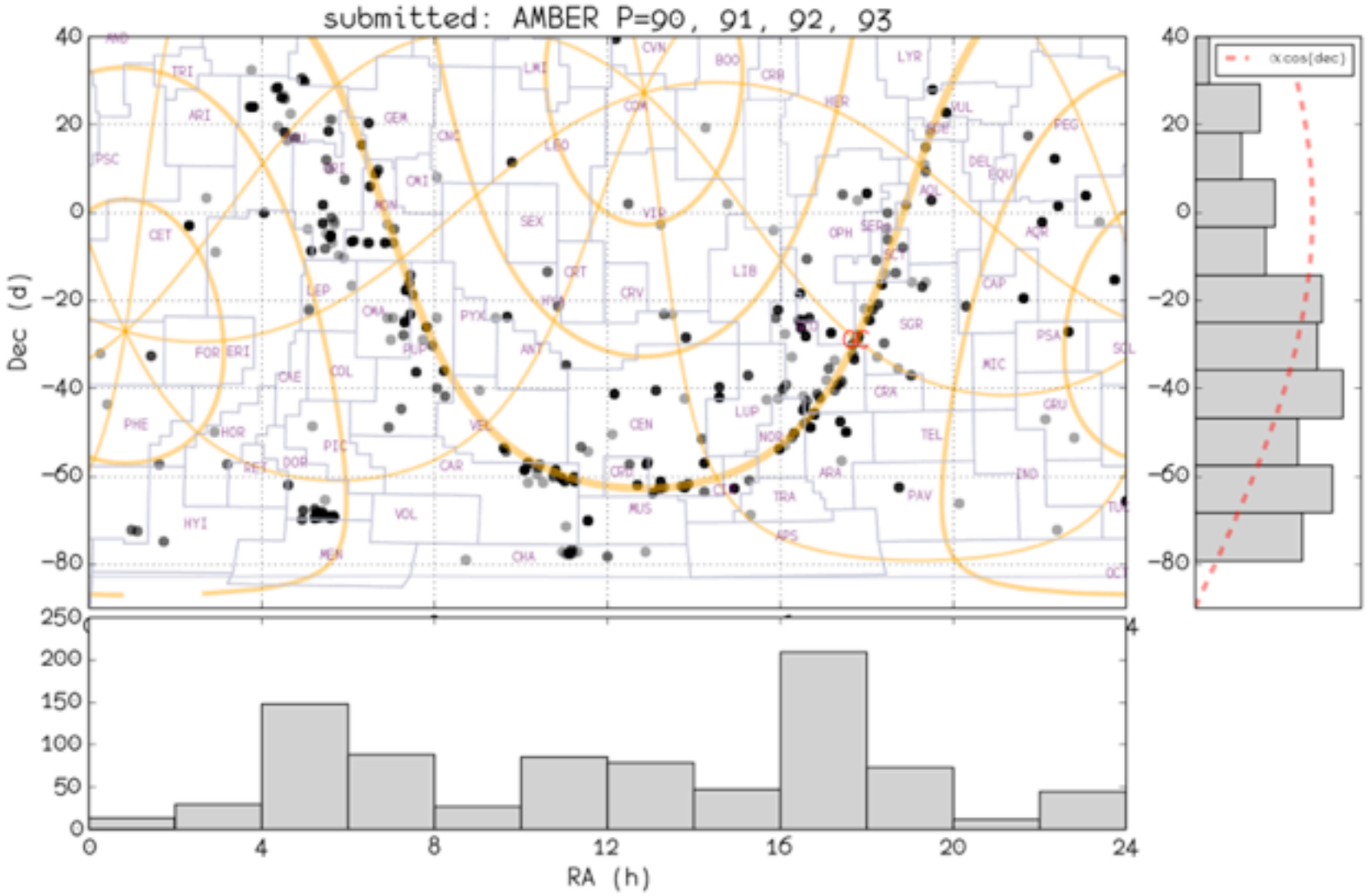
Amount of requested time

we barely request 180n per period (!)

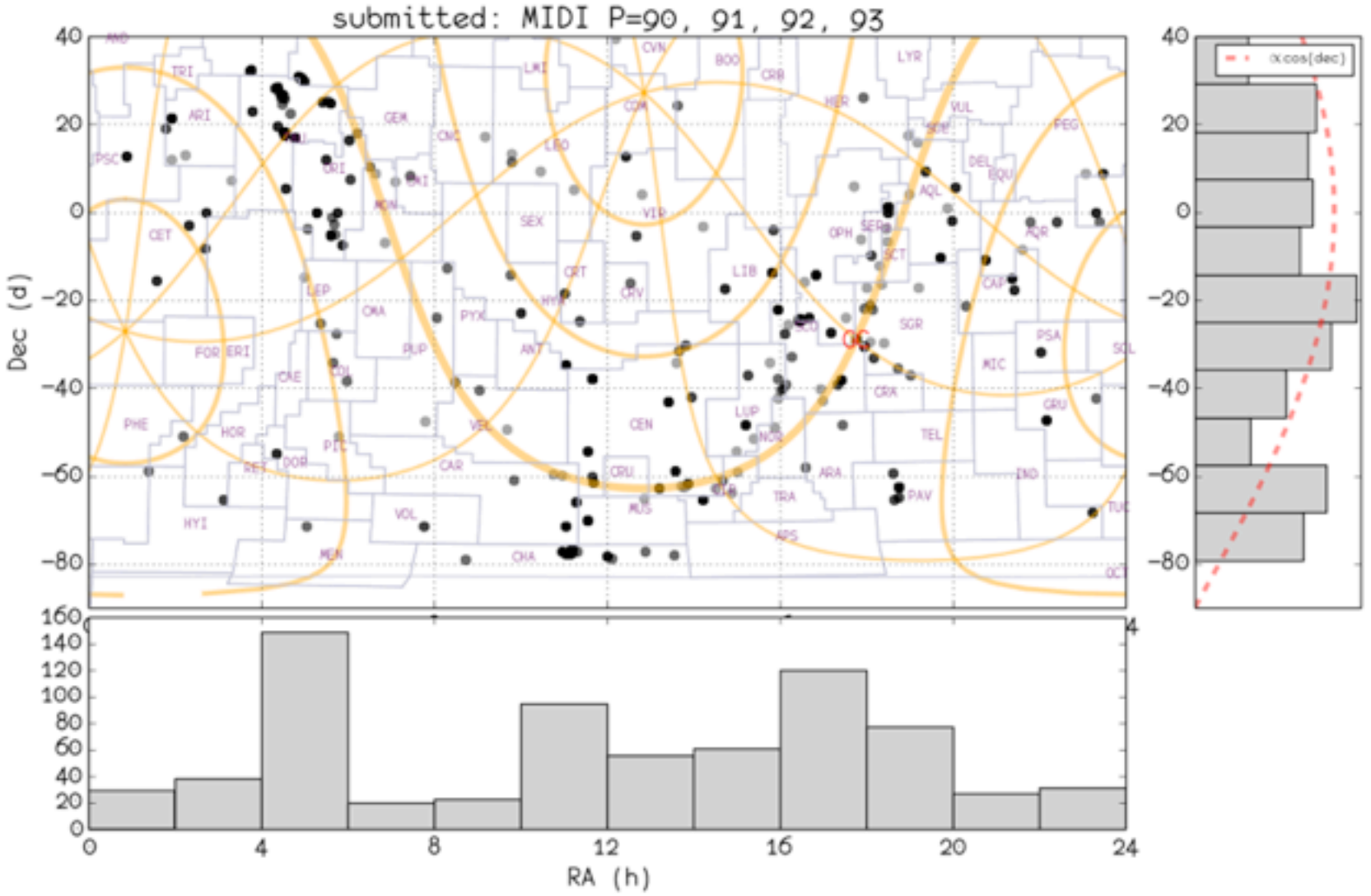
(sci-cal / h) 0.5 1 2



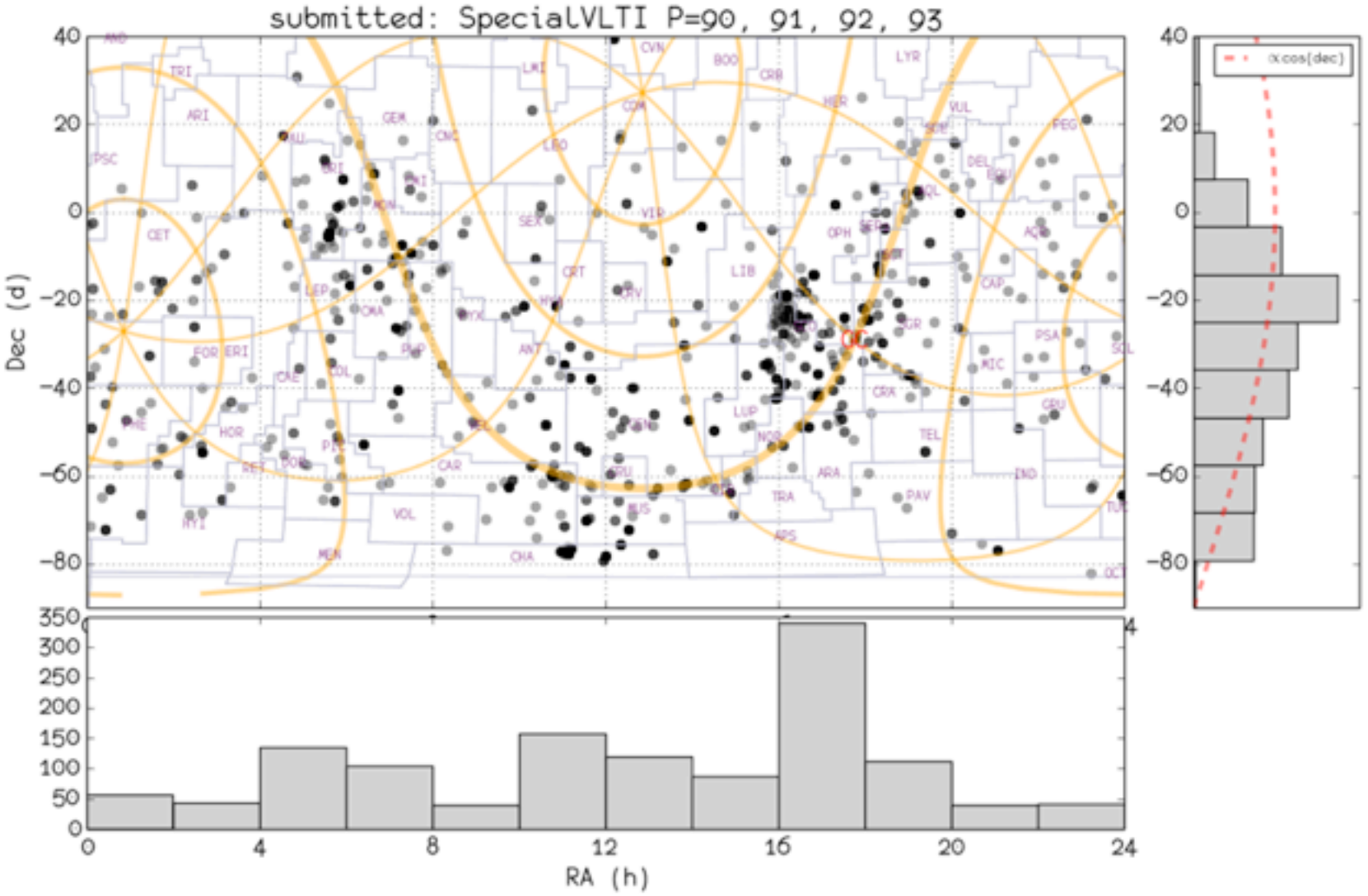
All targets: AMBER



All targets: MIDI



All target: PIONER



Targets in the sky

- Dominated by the **galactic plane**
  - AMBER > MIDI > PIONIER
  - because we look at stars
  - implies more trouble to schedule (esp. around April)
- Requested declinations:
  - actually, southern directions more requested
  - ... or observability of northern declination too limited?
  - important input for AT configurations (delay lines limits)

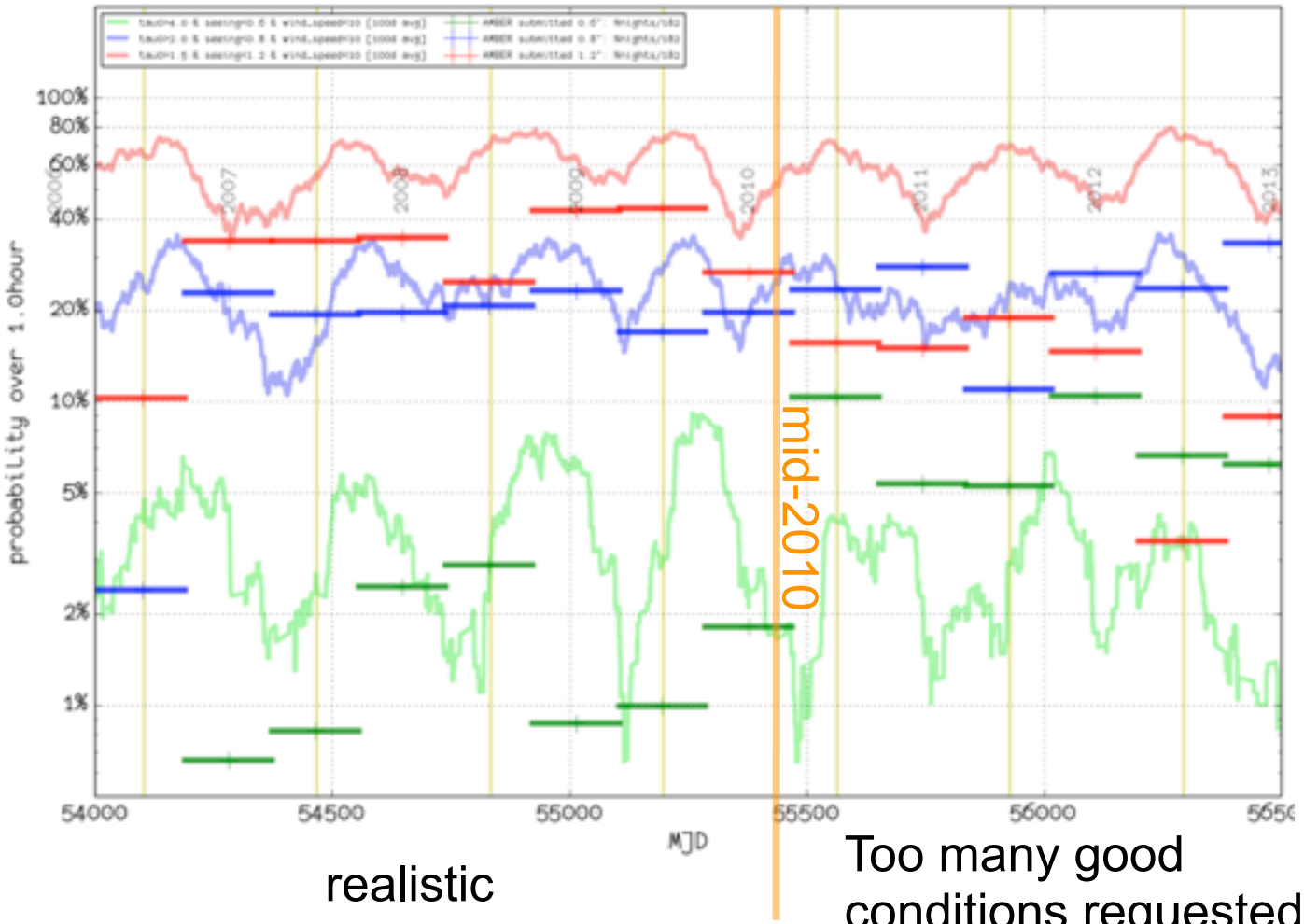
time requests (P93)

	AMBER	MIDI	PIONIER
AT / UT	66% / 33%	40% / **60%**	**90%** / 10%
small quadruplet **medium quadruplet** **large quadruplet**	26% 37% 37%	20% 40% 40%	15% 25% **60%**
service / visitor	**12% / 88%**	35% / 65%	0% / 100%

- AMBER PIs vastly prefer **visitor mode** (more efficient?)
- MIDI PIs need **sensitivity**
- PIONIER is **sensitive** enough to do a lot on ATs
- PIONIER PIs need **angular resolution**

AMBER weather requests

- what people want / what we get:



realistic

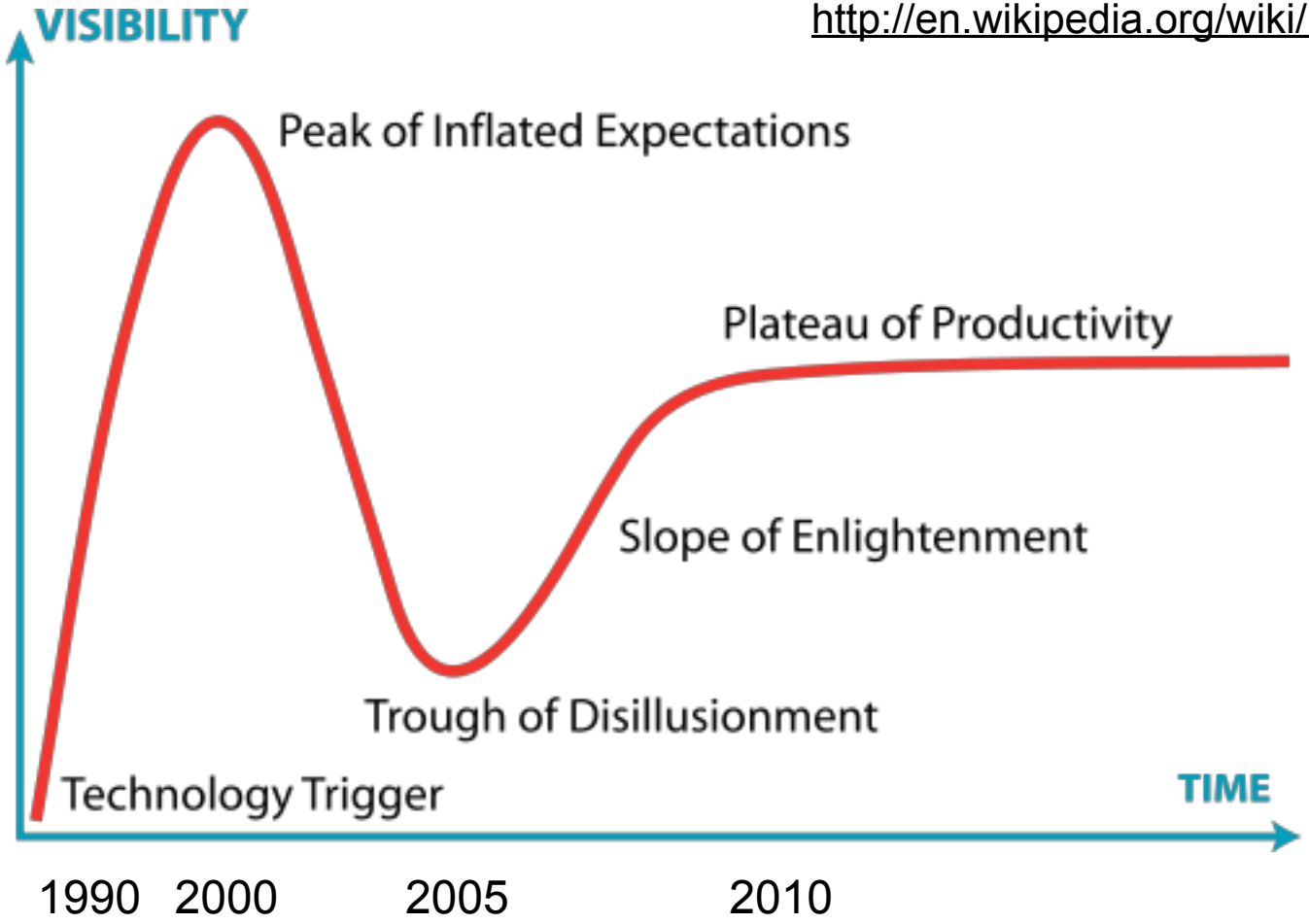
Too many good conditions requested!

some hard points

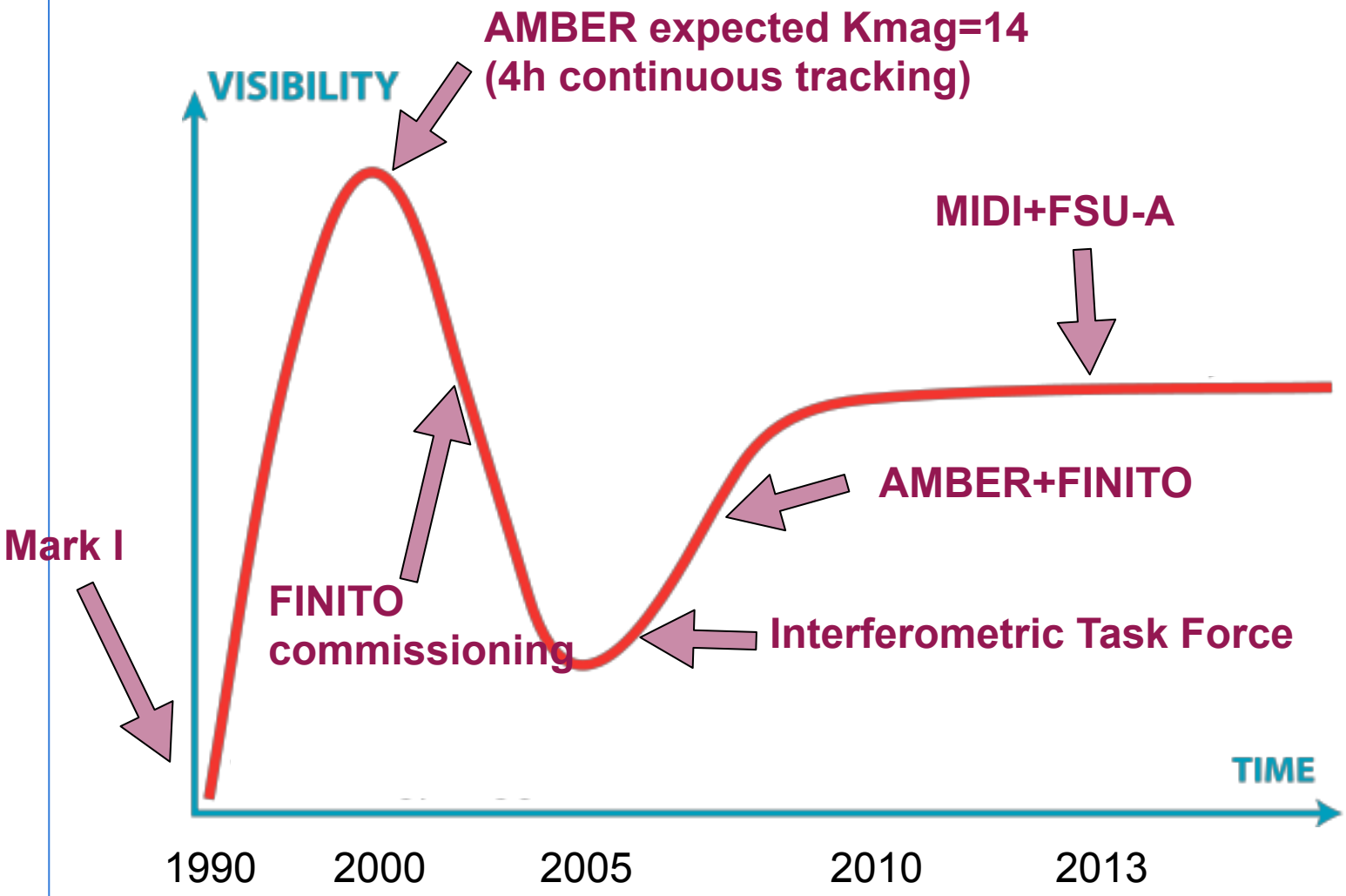
- Sensitivity
  - VLTI transmission is monitored: currently >40% in K
  - not the full story: single mode fiber injection -> AO
  - simple instruments are more sensitive
- Scheduling
  - VM ranked highest scheduled first -> sets the AT schedule
  - schedule of the rest until no time left
- Developments and improvements in an operational environement
  - strong inertia of ESO operations (4+6mo cycle)
- Lessons learned in fringe tracking
  - FINITO has disapointing sensitivity *(high RON, low transmission)*
  - ...but PRIMA has fringe-tracked on K>8 on the ATs

hype cycle

*"A **hype cycle** is a graphic representation of the maturity, adoption and social application of specific technologies."*
http://en.wikipedia.org/wiki/Hype_cycle



hype cycle: fringe tracking



one harder points: UT vibrations

- Vibrations mostly on UTs: underperformance compared to ATs
- Cause:
  - intrinsic vibrations of the telescope...
  - ...excited by every thing else (instruments, etc.)
- Solutions -> OPD residuals saturates around 300nm
  - fringe tracking -> overwhelmed
  - Manhattan: accelerometers M1,2,3 and open loop corrections
  - passive dumping of instruments
- Feb 2013: “no instruments” measurements campaingn
  - UT1 and UT3 with instruments turned OFF
  - at some frequencies: x0.75 on UT1 and x0.5 on UT3
  - OPD rms from 300nm to 240nm on UT1-UT3
- STC has tasked ESO to improve further the situation

Conclusions

- VLTI is continuously improving (x10 in 6 years)
- We are victim of our sucess
  - good u,v coverage / many relocations nights
  - operations scheduling favors few program
  - some highly ranked programs not scheduled
  - 1rstG instruments show their limitations
- Challenges
  - Operations optimized for 1G, can we maintain for 2G?
  - Operation limited: hard to do time coverage and snaphot imaging etc.
  - sensitivity improvement is not a simple issue
- Hard points remain...