VLTI 2nd generation and beyond

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Hi-5 Meeting - Liège 2,3 Oct 2017

Context

- "ESO in the 2020s" https://www.eso.org/sci/meetings/2015/eso-2020.html
- "Reaching New Heights in Astronomy — ESO Long Term Perspectives" https://www.eso.org/sci/publications/messenger/archive/no.166-dec16/messenger-no166-2-27.pdf
- VLTI Upgrade http://www.eso.org/sci/publications/messenger/archive/no.162-dec15/messenger-no162-16-18.pdf
- VLTI Community Days in March 2017 https://www.eso.org/sci/publications/messenger/.../no.../messenger-no168-49-49.pdf
- VLTI Roadmap to be presented on 23.10.2017 to ESO Science and Technical Committee (STC)
- ESO top priorities: building the ELT, finishing started projects

Paranal Instrument Program

Yr	Phase A	Design & Constr.	Delivered
2013		CRIRES+ MOONS	MUSE
2014	NTT Call for Ideas	4MOST	SPHERE PRIMA Astrometry (discontinued)
2015		NIRPS (New I)	LFC for HARPS VLTI PR1 GRAVITY BCI
2016		SOXS (New I)	GRAVITY CIAO VISIR Upgrade VLTI PR4 NACO ESPRESSO
2017	New II (for UT4)	CUBES(?)	MATISSE CRIRES+
2018	New III	New II (for UT4)	AOF VLTI PR3 & PR5 SOXS&NIRPS(?)
2019	New IV	New III	MOONS
2020	New V	New IV	ERIS CUBES(?) 4MOST
2021	New VI	New V	

Pasquini. L

http://adsabs.harvard.edu/abs/2016SPIE.9908E..02P

VLTI upgrade

- 2014: MIDI removal, preparation for MATISSE
- 2015: AT converted to STS, maintenance station
- 2015: PIONIER move
- 2015: GRAVITY installation
- 2016: UT converted to STS
- 2016: 4 CIAO IR-AO for GRAVITY
- 2017: Refurbishment of AT Coudé Trains
- 2018: MATISSE commissioning
- 2018: NAOMI commissioning
- 2018+ GRA4MAT commissioning

VLTI Transmission

UT -> Laboratory J=17% H=33%, K=35%

Performance Improvements

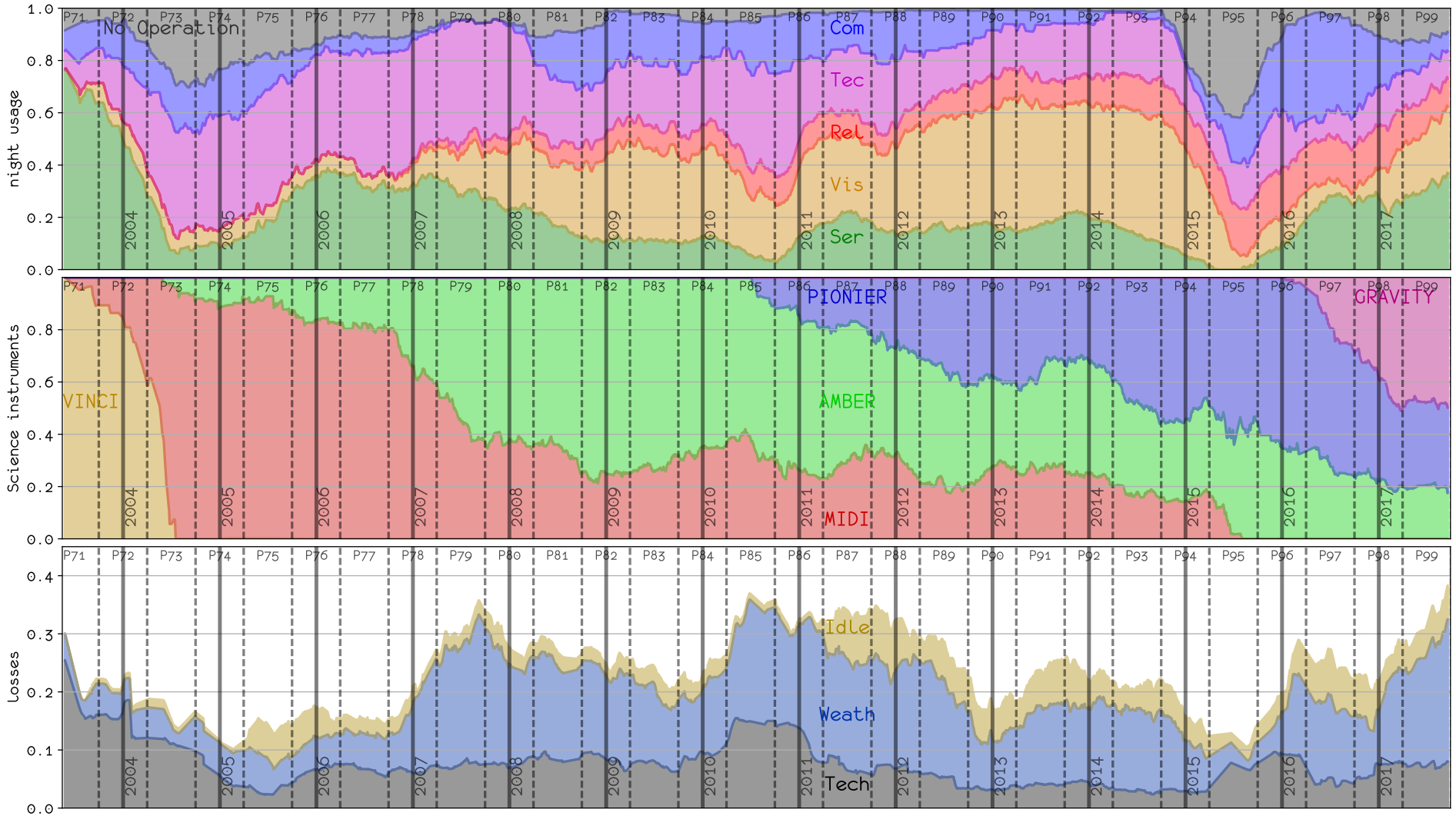
- Operational Improvements

	2006	2009	2013
Fraction science time	30%	45%	56%
Observations / hour	0.5	1.0	1.5
Yearly obs. / hour	0.15	0.45	0.85
Unique *uv*-/ config.	3	4	6
Unique *uv*-/ hour	0.5	1.5	5.0

All losses considered

- UT Vibrations
  - 2012: 300-500nm rms per UT
  - 2017: 140nm per UT by changing cooling pumps, vibration tracking in AO loops, …
- See also Woillez et al. 2016 https://arxiv.org/pdf/1608.06752.pdf

VLTI is healthy



Impact of upgrades

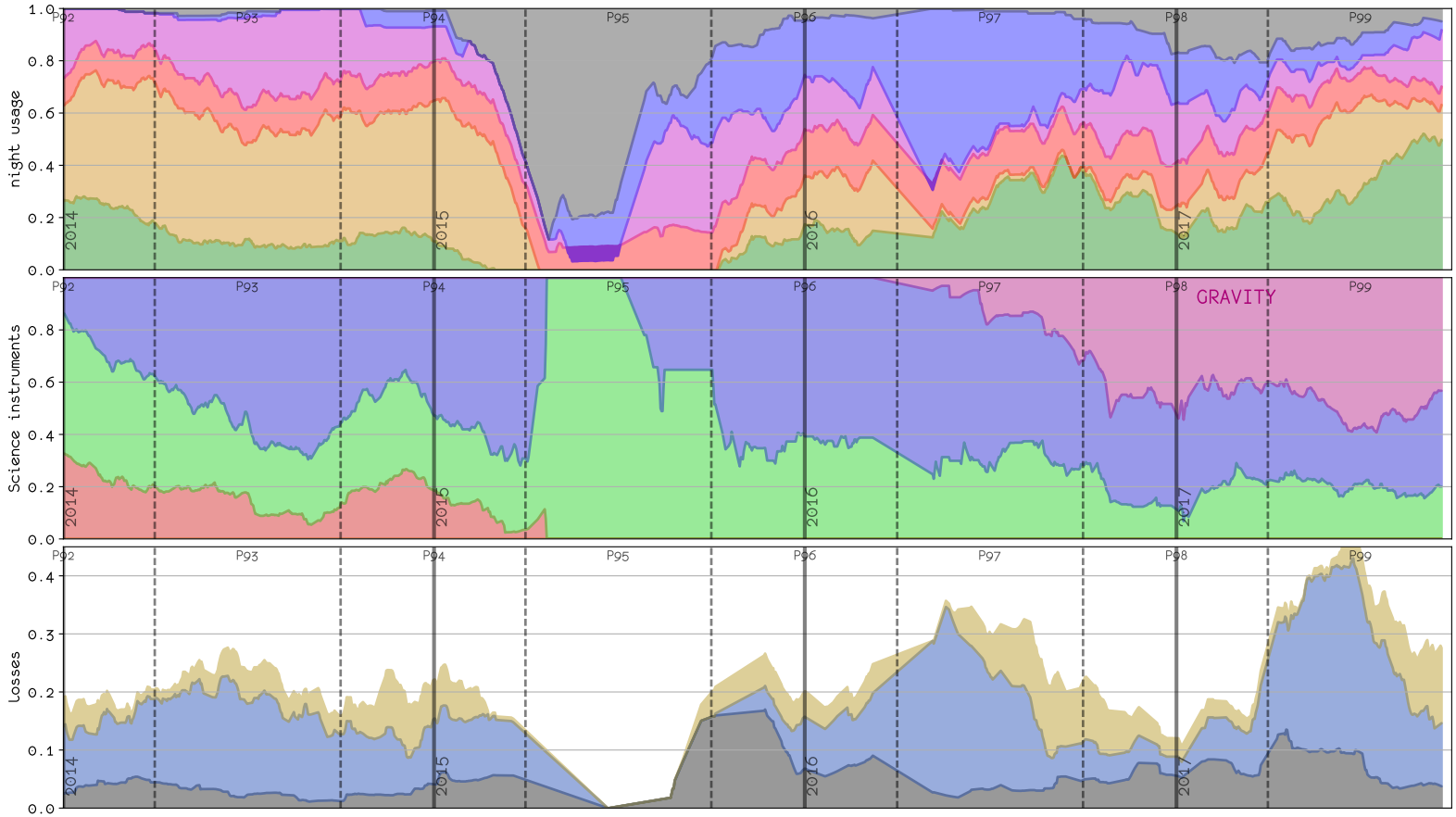
80% Science

Facility Upgrade

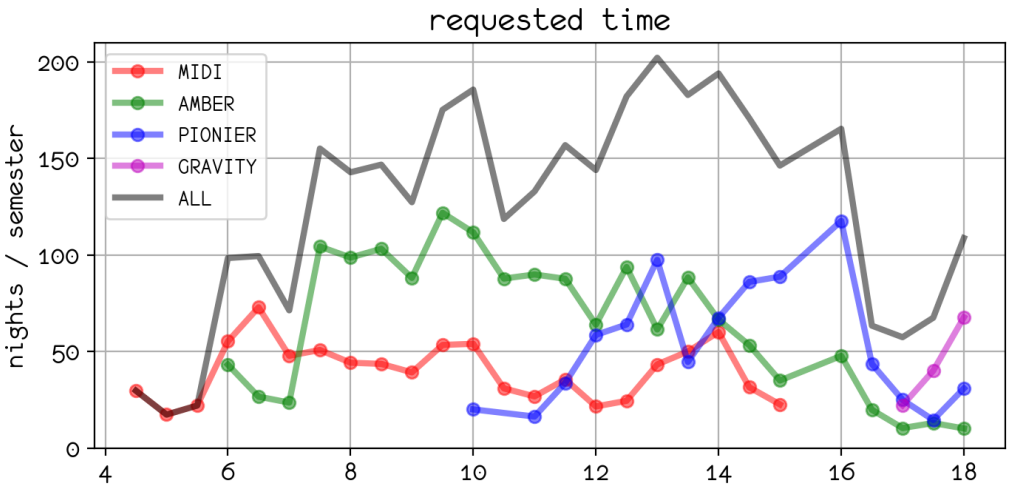
GRAVITY Comm.

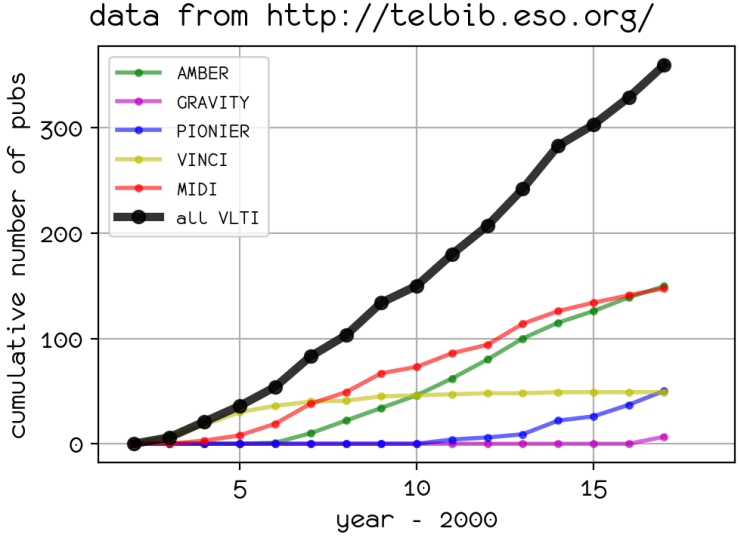
AT Coudé

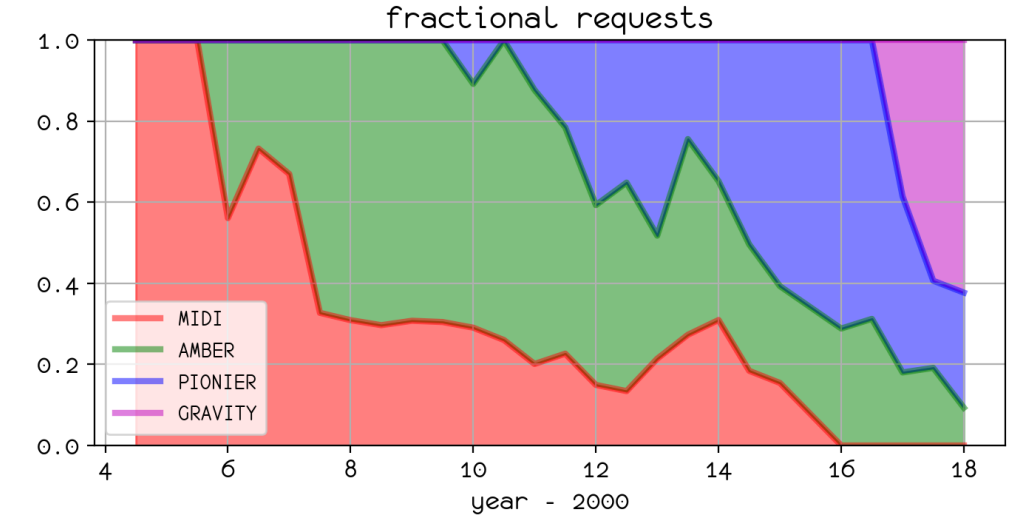
70% Science

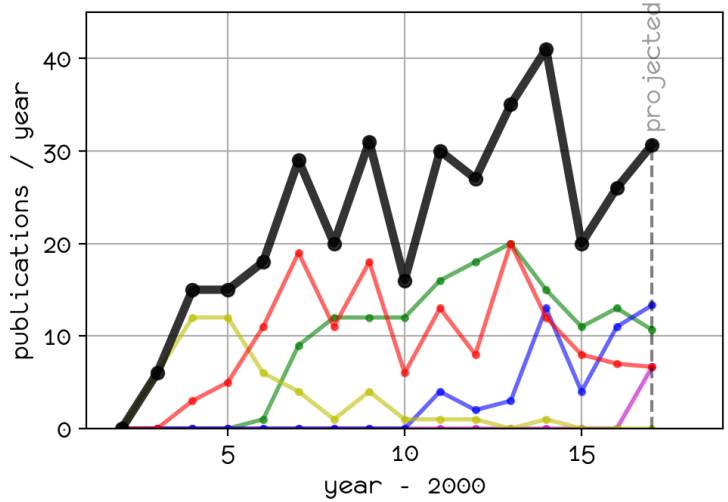


VLTI usage


requested time
nights / semester
MIDI
AMBER
PIONIER
GRAVITY
ALL

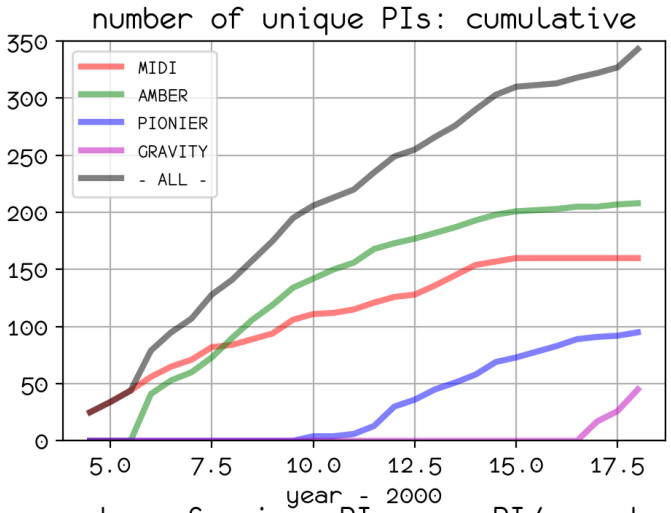

data from http://telbib.eso.org/
cumulative number of pubs
AMBER
GRAVITY
PIONIER
VINCI
MIDI
all VLTI
year - 2000

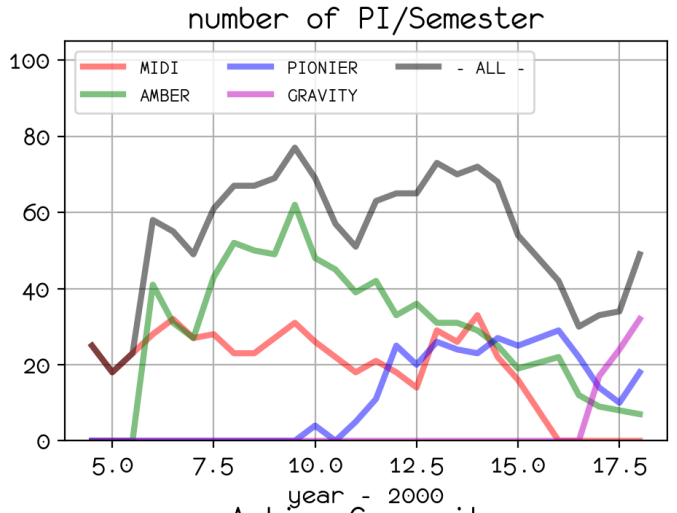

fractional requests
MIDI
AMBER
PIONIER
GRAVITY
year - 2000

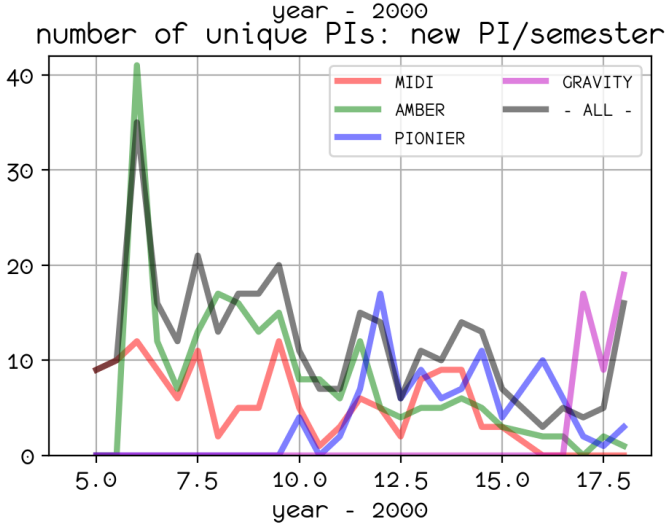

publications / year
projected
year - 2000

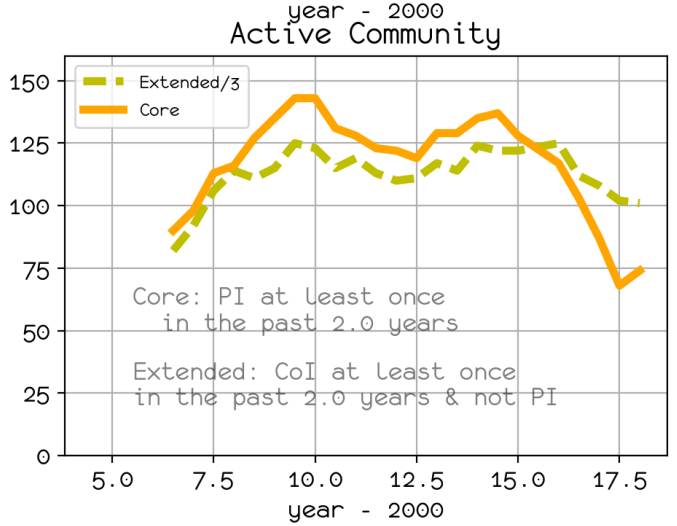
VLTI Community

- ~5-10% of ESO PIs apply for VLTI
- Less and less new PIs with time
- Community took a hit after upgrade
- Only new instruments bring new users









As of 2017

- Nearly 15yrs of operations
- Performances keep improving
- Still deploying 2G: MATISSE, NAOMI, GRA4MAT
- GRAVITY and MATISSE open new scientific opportunities
- **A terrific facility for years of scientific exploitation**
- … Scientific productivity and impact on the lower end of Paranal instruments (workhorse instruments publish 10x more than VLTI instruments)

Foreseen VLTI improvements

Room for improvements, but only resources for incremental ones (**VLTI Roadmap**):

- Doubling DL path for full sky access at B~200m
- Optimisation of operations model: imaging / time monitoring / snapshots
- iShooter Mode: PIONIER+GRAVITY+MATISSE
- Opening of a Visitor Focus

Beyond VLTI 2.0

- Recognised interests in the community:
  - ➢ High contrast combiner
  - ➢ Visible beam combiner
- Extension of the facility (e.g. more telescopes) to be financed by the community
- 2015 conference (“ESO in the 2020s”) led further explore 2 possible post-ELT:
  - ➢ 30m single dish for sub-mm
  - ➢ 16m spectroscopic telescope

Visitor Instrument?

- not only VLTI: https://www.eso.org/sci/facilities/paranal/instruments/visfocus.html
- PIONIER is widely regarded as a success at ESO:
  - ➢ Cost / resources effective
  - ➢ Fast development (design->science) thanks to proven technologies (IOBC, data reduction)
  - ➢ New tech: IR APD, polarisation control…
- AMBER not offered after P101 (Apr-Sept 2017)
  - ➢ Frees a 4T focus
- VLTI delivers 4T stabilised focus (image, OPD)
- GRA4MAT: first software “super-instrument”

Next steps

- Update ESO's *Science and Technical Committee* on Hi-5
- Formally re-open the VLTI visitor focus: https://www.eso.org/sci/facilities/paranal/instruments/vlti-visitor.html
- VLTI Community Days to be organised in 2019
  - ➢ Reflect on GRAVITY / MATISSE results
  - ➢ Build rationale for next instrumentation
- Most 2G Paranal instrumentation projects need to be delivered before new ones will be considered (2021+)