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Advanced Virgo Project Leader

for the Virgo Collaboration and EGO

ADVANCED VIRGO
at the
DAWN WORKSHOP

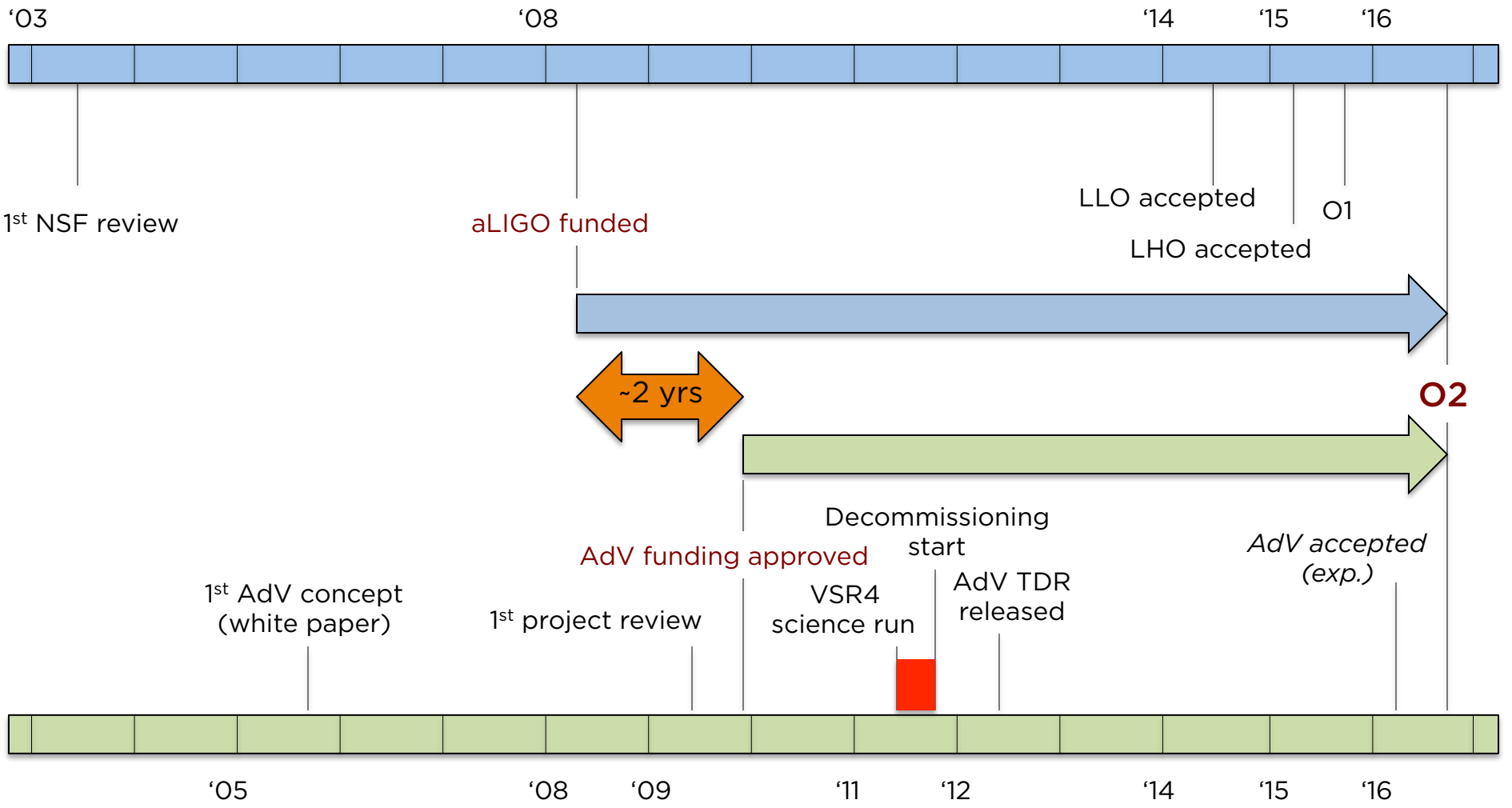
ADVANCED VIRGO

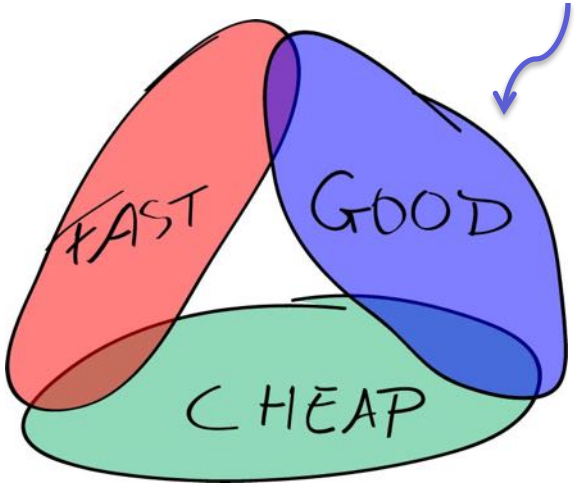
THE VIRGO COLLABORATION:
5 European countries
19 labs, ~200 authors

- Participated by scientists from Italy and France (former founders of Virgo), The Netherlands, Poland and Hungary
- Funding approved in Dec 2009 (21.8 ME + Nikhef in kind contribution)
- Construction in progress. End of integration: fall 2015
- First science data in 2016

APC Paris
ARTEMIS Nice
EGO Cascina
INFN Firenze-Urbino
INFN Genova
INFN Napoli
INFN Perugia
INFN Pisa
INFN Roma La Sapienza
INFN Roma Tor Vergata
INFN Trento-Padova
LAL Orsay – ESPCI Paris
LAPP Annecy
LKB Paris
LMA Lyon
NIKHEF Amsterdam
POLGRAW(Poland)
RADBOUD Uni. Nijmegen
RMKI Budapest

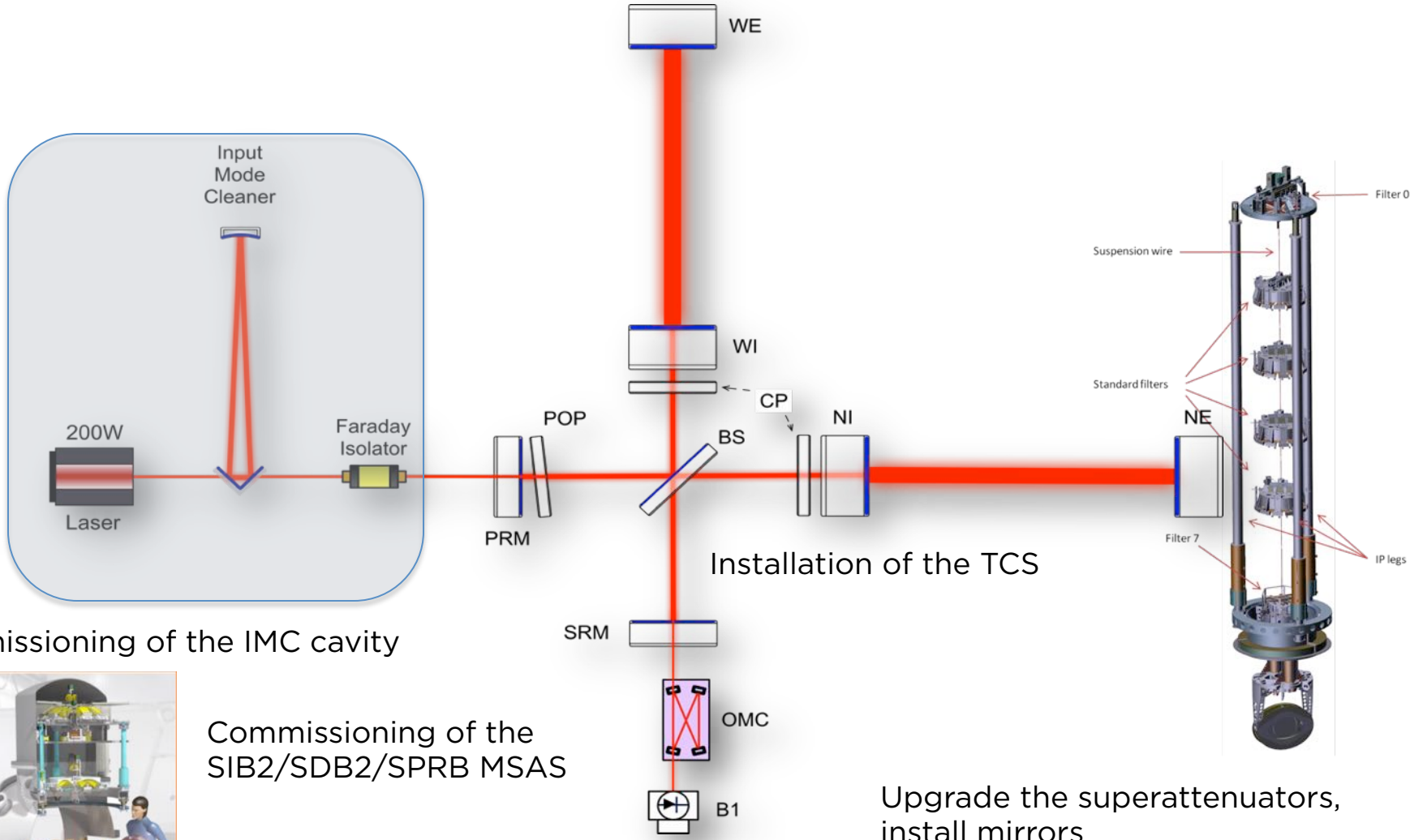
SOME HISTORY





CONSTRUCTION/ INSTALLATION/INTEGRATION HIGHLIGHTS

MAIN ON SITE ACTIVITIES



Commissioning of the IMC cavity

Installation of the TCS

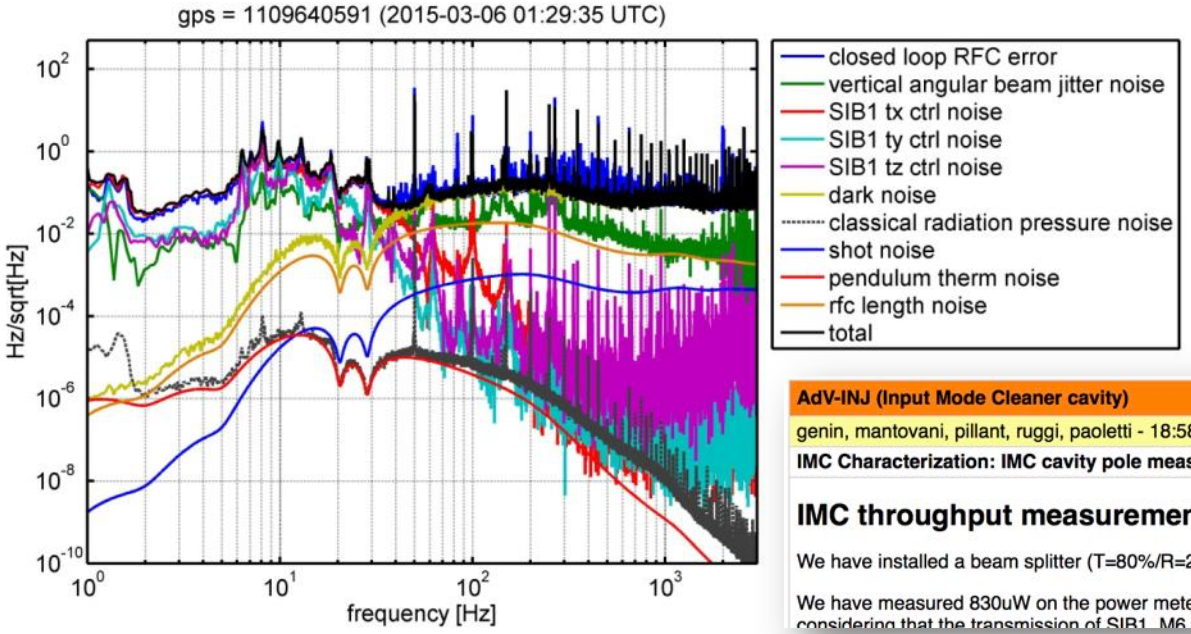
Commissioning of the SIB2/SDB2/SPRB MSAS

Preparation/installation of the suspended detection benches

Upgrade the superattenuators, install mirrors

IMC commissioning

- Commissioning of the IMC now in progress.
  - Tackling problems which will save time next year
  - Students and newcomers being trained with a suspended cavity
- IMC locked with all loops closed, can start DetChar work
- Noise hunting: RF injections, noise from electronics, air conditioning in low noise regime



AdV-INJ (Input Mode Cleaner cavity)

genin, mantovani, pillant, ruggi, paoletti - 18:58, Wednesday 27 August 2014 (31558)

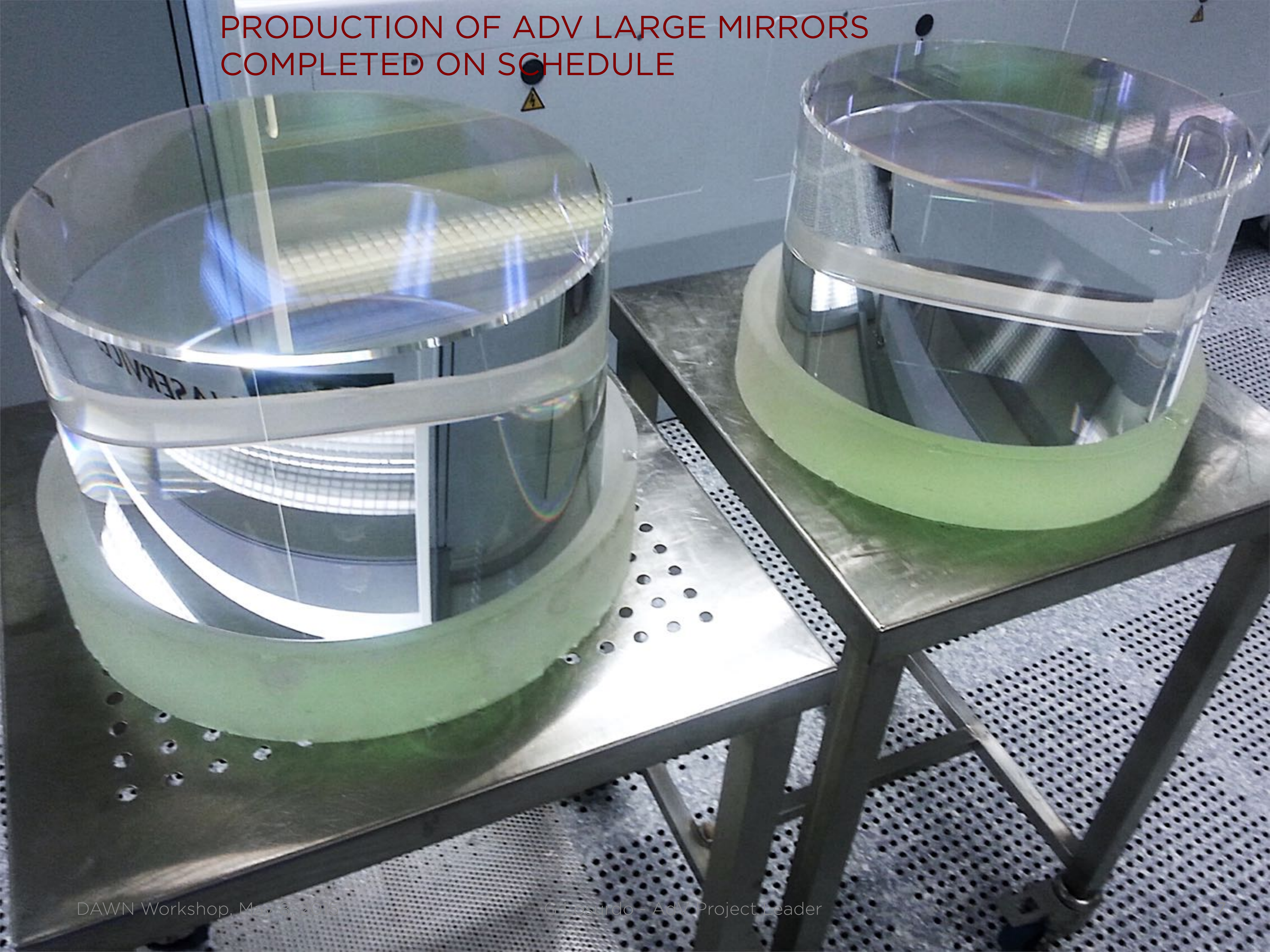
IMC Characterization: IMC cavity pole measurement and throughput measurement.

IMC throughput measurement

We have installed a beam splitter (T=80%/R=20%) in front of IMC_Tra photodiode in order to measure directly the po

We have measured 830uW on the power meter (which corresponds to 7.44V on IMC_Tra). Using the direct measure considering that the transmission of SIB1_M6 mirror has been measured by LMA to be 734ppm (T_M6)

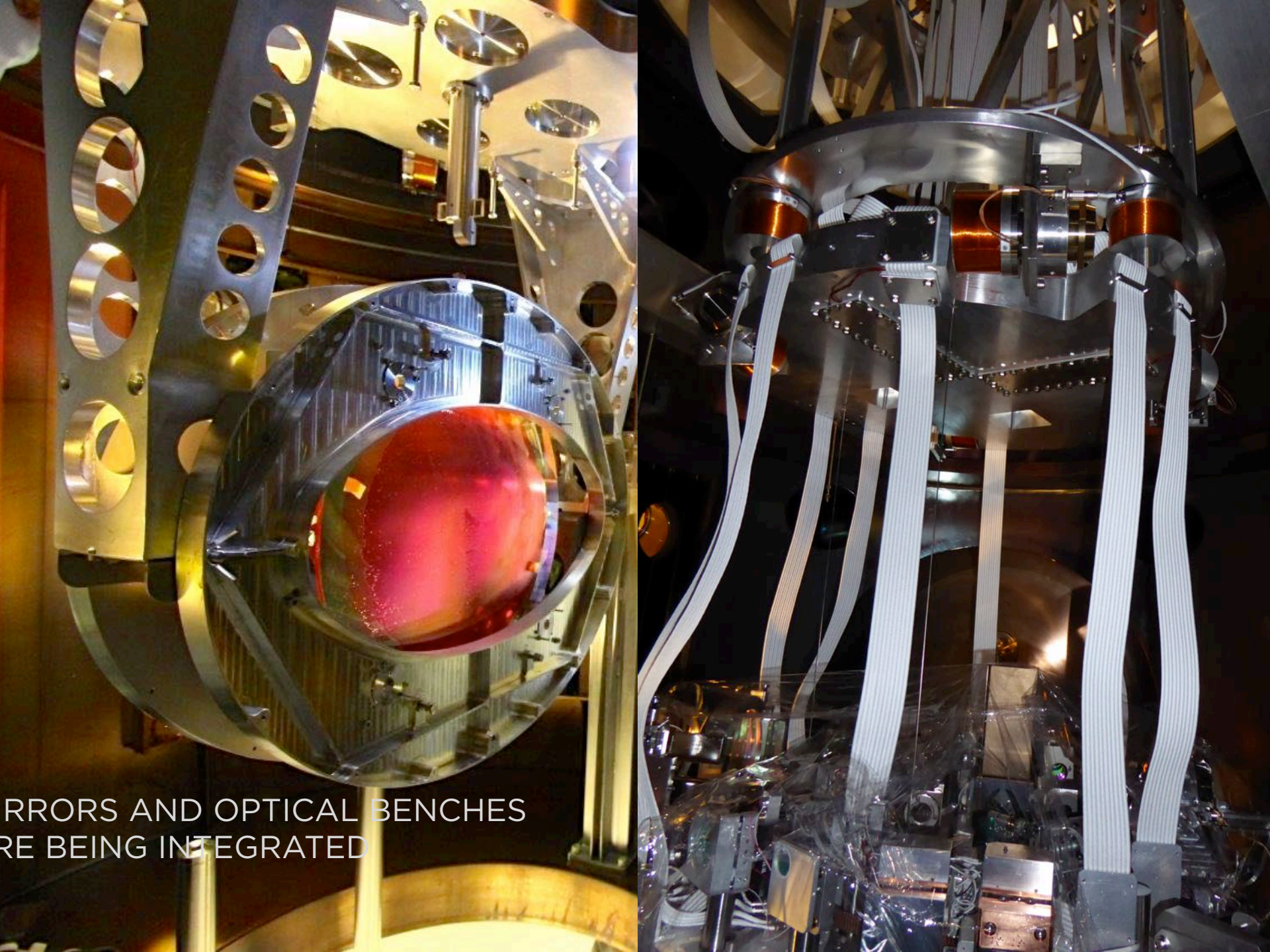
PRODUCTION OF ADV LARGE MIRRORS COMPLETED ON SCHEDULE



MIRRORS

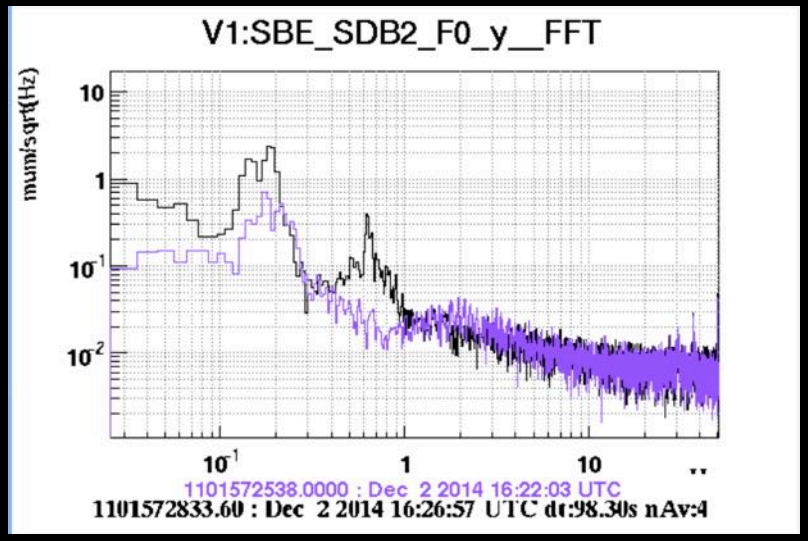
		IM02	IM04	EM01	EM03
Absorption Ø150mm @1064 nm	TDR Spec.	< 0.5 nm	< 0.5 nm	< 0.5 nm	< 0.5 nm
	Result	0.22 ppm	0.19 ppm	0.24 ppm	0.24 ppm
RMS Flatness Ø150mm	TDR Spec.	< 0.5 nm	< 0.5 nm	< 0.5 nm	< 0.5 nm
	Result	0.31 nm	0.27 nm	0.50 nm	0.35 nm
ROC	TDR Spec.	1420 m -5m, +15 m	1420 m -5m, +15 m	1683 m -3m, +17 m	1683 m -3m, +17 m
	After polishing	1425.2 m	1425.2 m	1690.6 m	1690 m
	After Coating	1424.5 m	1424.6 m	1695.2 m	1696.3 m
AR reflectivity Ø150mm 1064 nm	TDR Spec.	<100 ppm	<100 ppm	<300 ppm	<300 ppm
	Result	58 ppm	32 ppm	133 ppm	155 ppm
RTL	TDR Spec.	< 150 ppm			
	Result	25 ppm			

SUPERATTENUATORS BEING UPGRADED



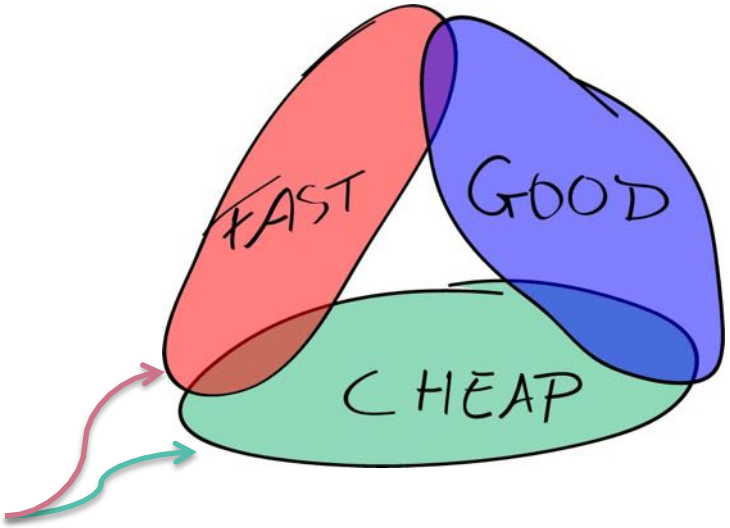
RRORS AND OPTICAL BENCHES
RE BEING INTEGRATED

3 MSAS installed (out of 5), pre-commissioning



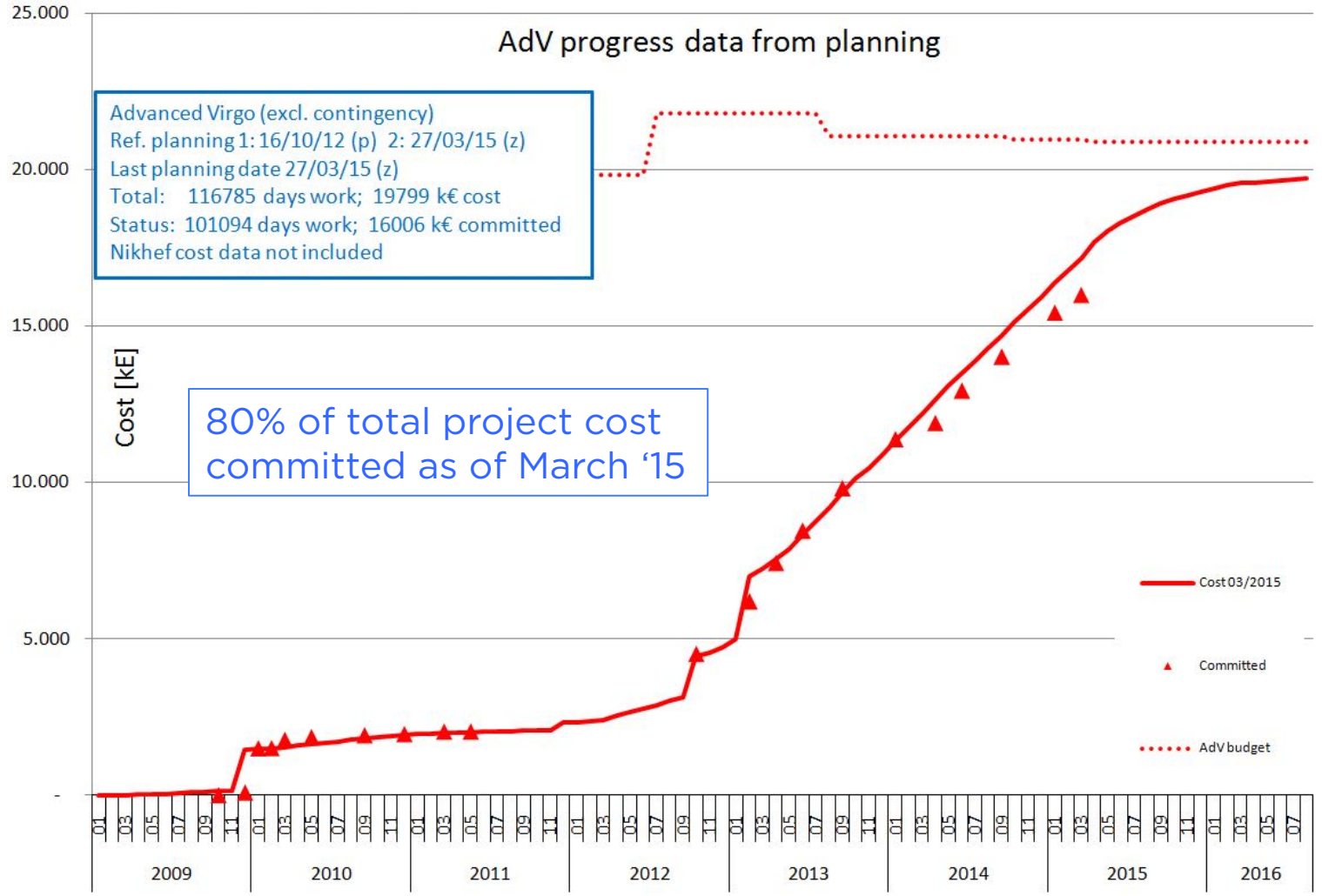
TCS BENCHES BEING ASSEMBLED
INTEGRATION SOON


THE INSTALLATION OF THE LARGE
VACUUM PARTS HAS BEEN COMPLETED



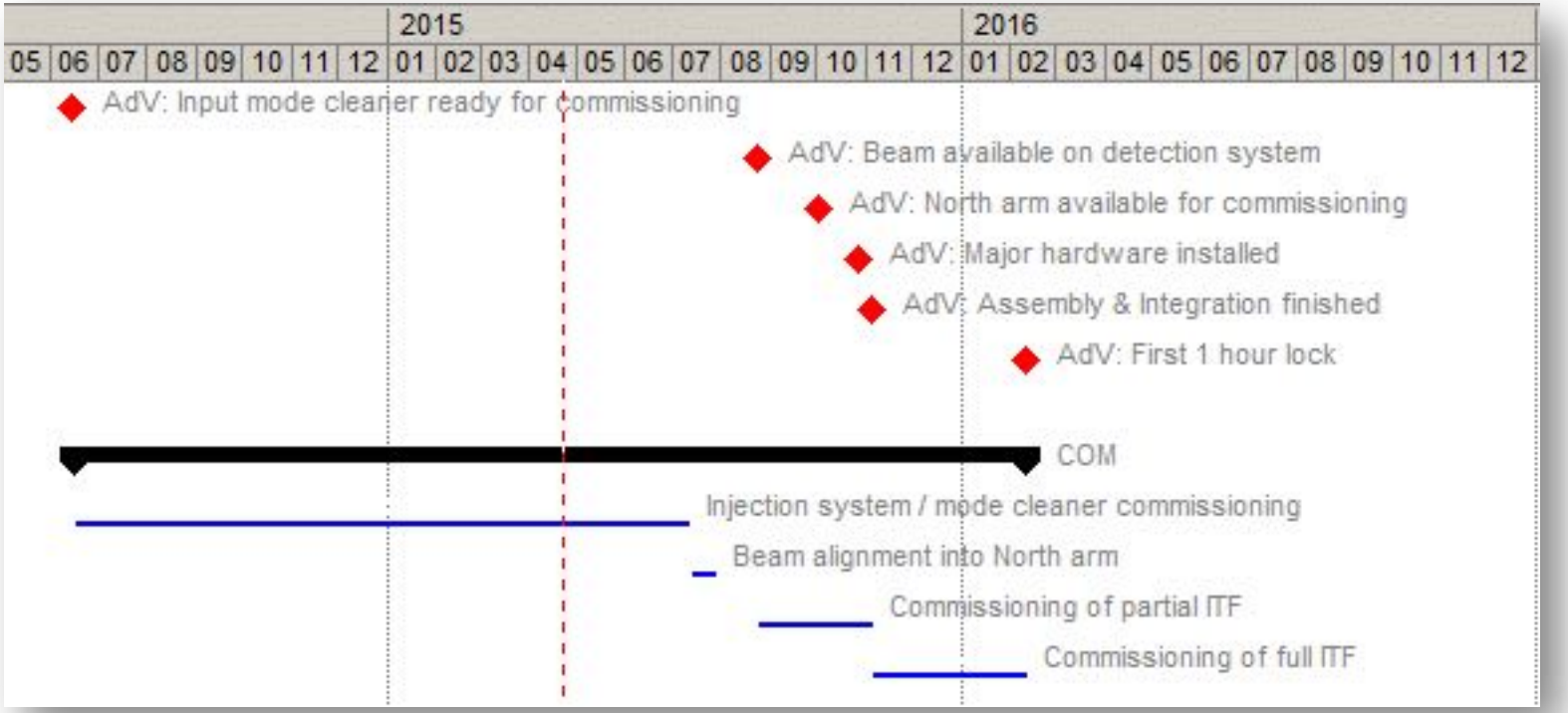
SCHEDULE, BUDGET

SPENDING


AdV progress data from planning
Advanced Virgo (excl. contingency)
Ref. planning 1: 16/10/12 (p) 2: 27/03/15 (z)
Last planning date 27/03/15 (z)
Total: 116785 days work; 19799 k€ cost
Status: 101094 days work; 16006 k€ committed
Nikhef cost data not included
80% of total project cost committed as of March '15
Cost [kE]
25.000
20.000
15.000
10.000
5.000
-
Cost 03/2015
Committed
AdV budget
2009
2010
2011
2012
2013
2014
2015
2016

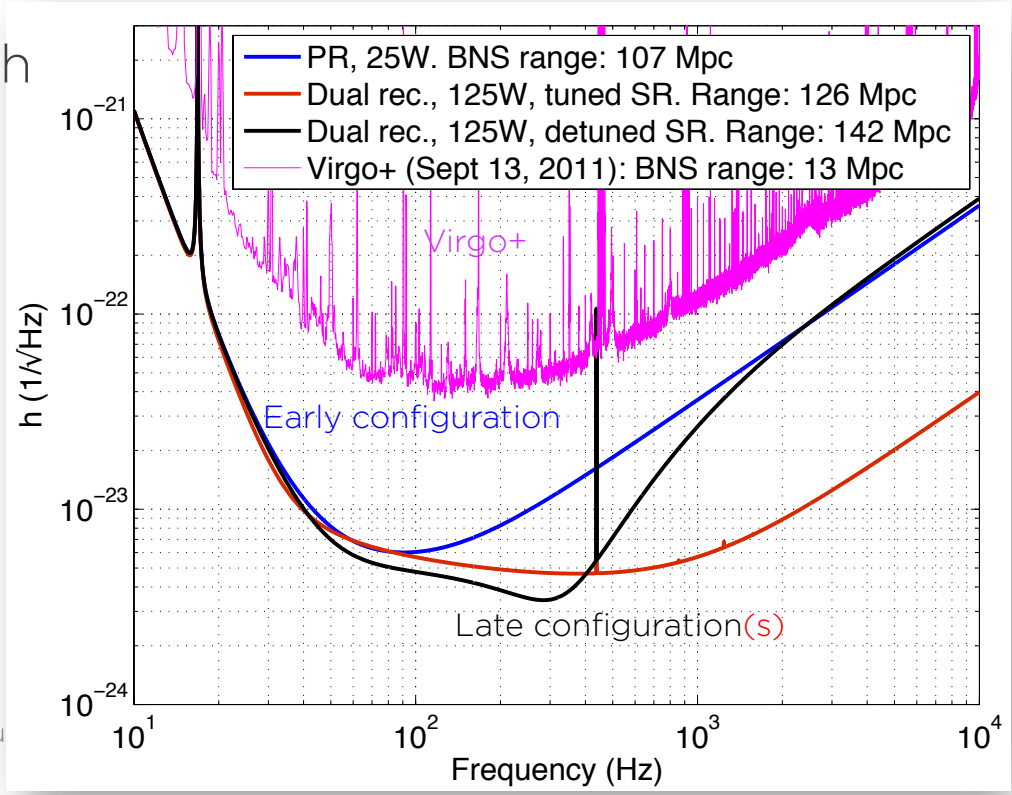
SCHEDULE

- Main top level milestones:
  - A&I completed: fall 2015
  - Interferometer accepted: Feb 2015



TOWARDS O2

- Short-term goal: join the network in the O2 run
- AdV will not start its operation in full-configuration
- O2 configuration: PR-mode, low power
- Later (2017-18, TBD): installation of SR, HP laser
- This approach will allow to reach a good sensitivity with a faster commissioning



FOCUS ON COMMISSIONING

- Advanced Virgo construction will be completed by the end of the year
- Time for pre-commissioning and acceptance of single subsystems will be limited (compared to aLIGO)
- High intensity effort needed to speed up the global commissioning and the sensitivity progress
- We have set up the commissioning organization and are anticipating as much as possible the commissioning-related activities

VISITORS PROGRAM

- We are defining a Visitors program to support the commissioning
- Addressed to LSC people who have done experience in commissioning the LIGO/GEO detectors
- Details for support being defined
- To be formally announced in weeks, start at the end of 2015

ADV IMPROVEMENTS AND UPGRADES

ADV IMPROVEMENTS AND UPGRADES

SOME CONSTRAINTS

- AdV shutdown to install the SR mirror and the HP laser
  - These will complete AdV as designed. Budget is allocated
- This opens a window of opportunity to implement other changes on the detector
- Schedule constraint: ~6 mts downtime in 2017-18 (TBD)
- Modifications fitting in this window will be referred to as "*phase 1*"

PHASE 1: DESIGN FIXES AND RISK MITIGATION

We can identify two main classes of phase 1 improvements:

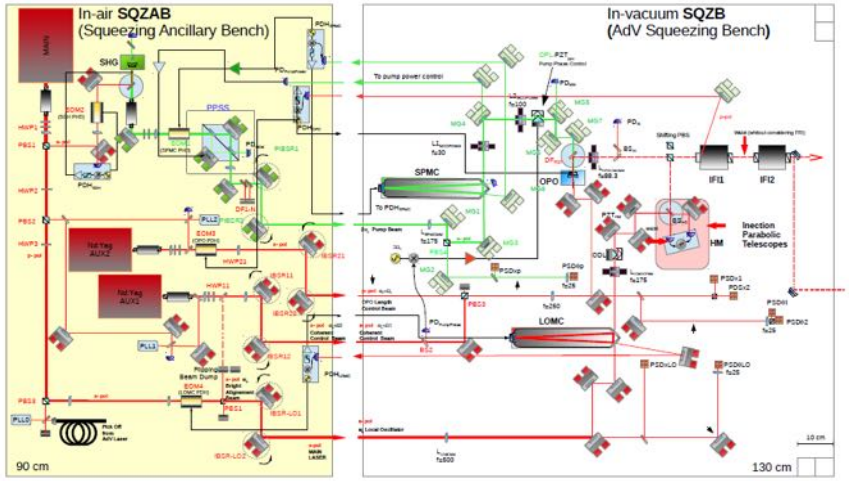
1. New hardware aimed to fix detector issues discovered during the commissioning
   - e.g.: replacement of noisy sensors/electronics, replacement of damaged optics, re-design of some parts, …).
   - These can hardly be dealt with in advance, since they strictly depend on the commissioning outcomes
   - However, SS and commissioning teams are starting the exercise of thinking what are the "riskiest" aspects of our detectors and which could be good backup options in case of unsatisfactory performance

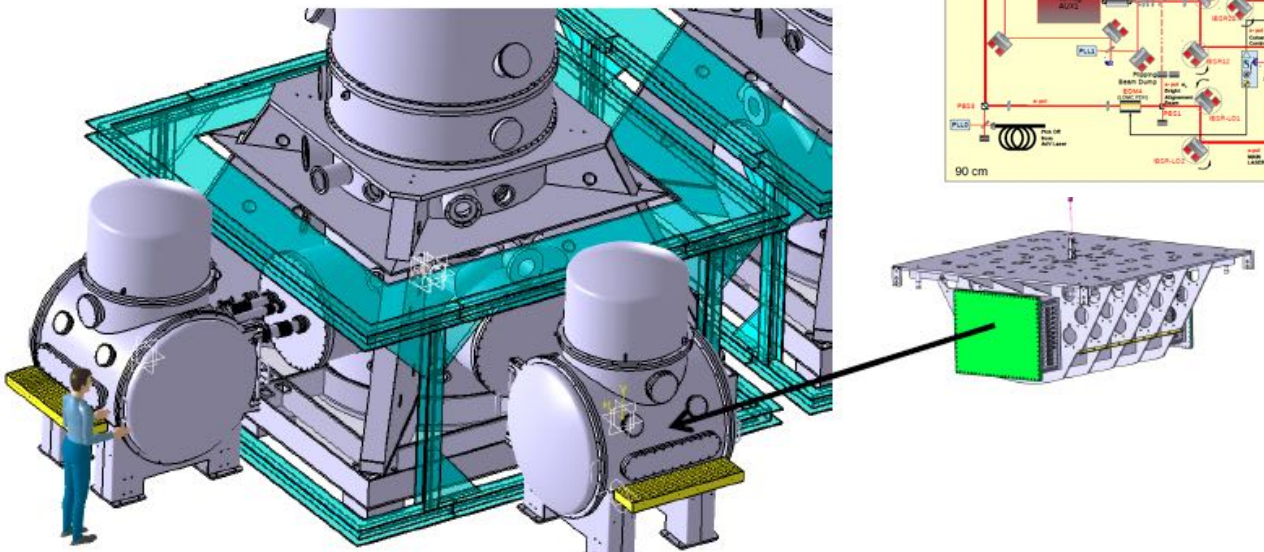
2. New hardware aimed to improve the robustness of the detector or to mitigate risks
   - Squeezing
   - Control of aberrations
     - All/some CITF mirrors with state-of-the-art polishing?
     - Further improvement of TCS?
   - Control of parametric instabilities
   - Suspension control improvement (tiltmeters)
   - …

- All the items in the list are of interest for both LIGO and Virgo and can open collaborative initiatives

SQUEEZING

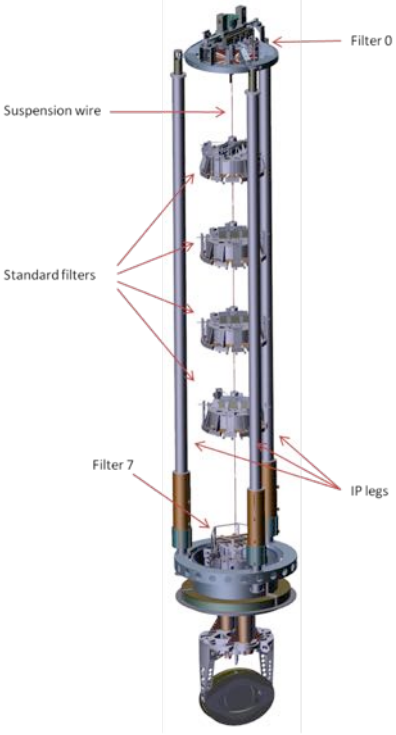
- The space to host a squeezer is already foreseen in the AdV detection lab
- The TDR for a squeezer is being completed

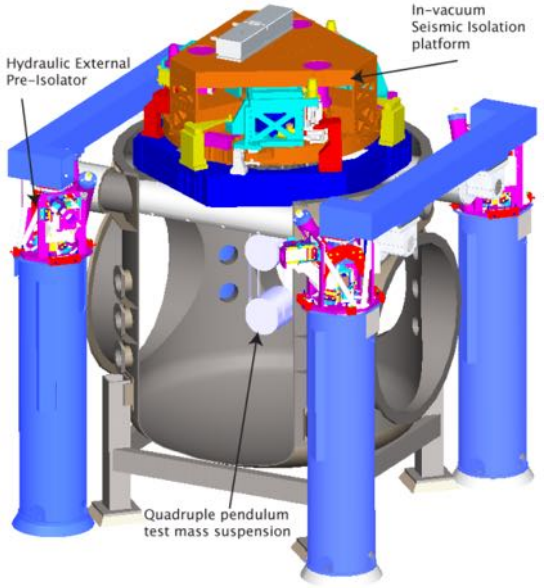




TILTMETERS

- Virgo and LIGO seismic isolation systems are based on different concepts, but both make use of “inertial platforms”
- The low-frequency performance is limited by the tilt-horizontal coupling of the accelerometers
- Improving LF performance means improving the lock robustness and the DUTY CYCLE
- The problem could be solved by realizing a tiltmeter with very good LF performance
- Collaborative R&D?





PHASE 2 UPGRADES

The baseline AdV design is not the ultimate limit of the Virgo infrastructure. Sensitivity improvements are still possible.

3. New hardware aimed to improve the sensitivity beyond the design target. Requires R&D investments. Longer term

   - Frequency dependent squeezing
   - Coatings with reduced losses
   - Newtonian noise subtraction (*possibly short-term?*)
   - Non-gaussian beams
   - Adaptive optics
   - …

CONCLUDING REMARKS

- AdV is advanced installation/integration phase
  - Expected completion: end of 2015
- Mid-term target: join aLIGO in the O2 science run
- Plans for detector mid-term improvements are being discussed: ground for collaborative effort

- The main message from this workshop: we are not working on single detectors. We are preparing a world-wide *single machine*: the GW network
- In this framework it is reasonable to think of a coordinated effort on the priorities for the improvement of the detectors
- Why not starting a joint WG focused on “network enhancement”?