Advanced Virgo Status

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On behalf of the Virgo Collabration

Advanced Virgo

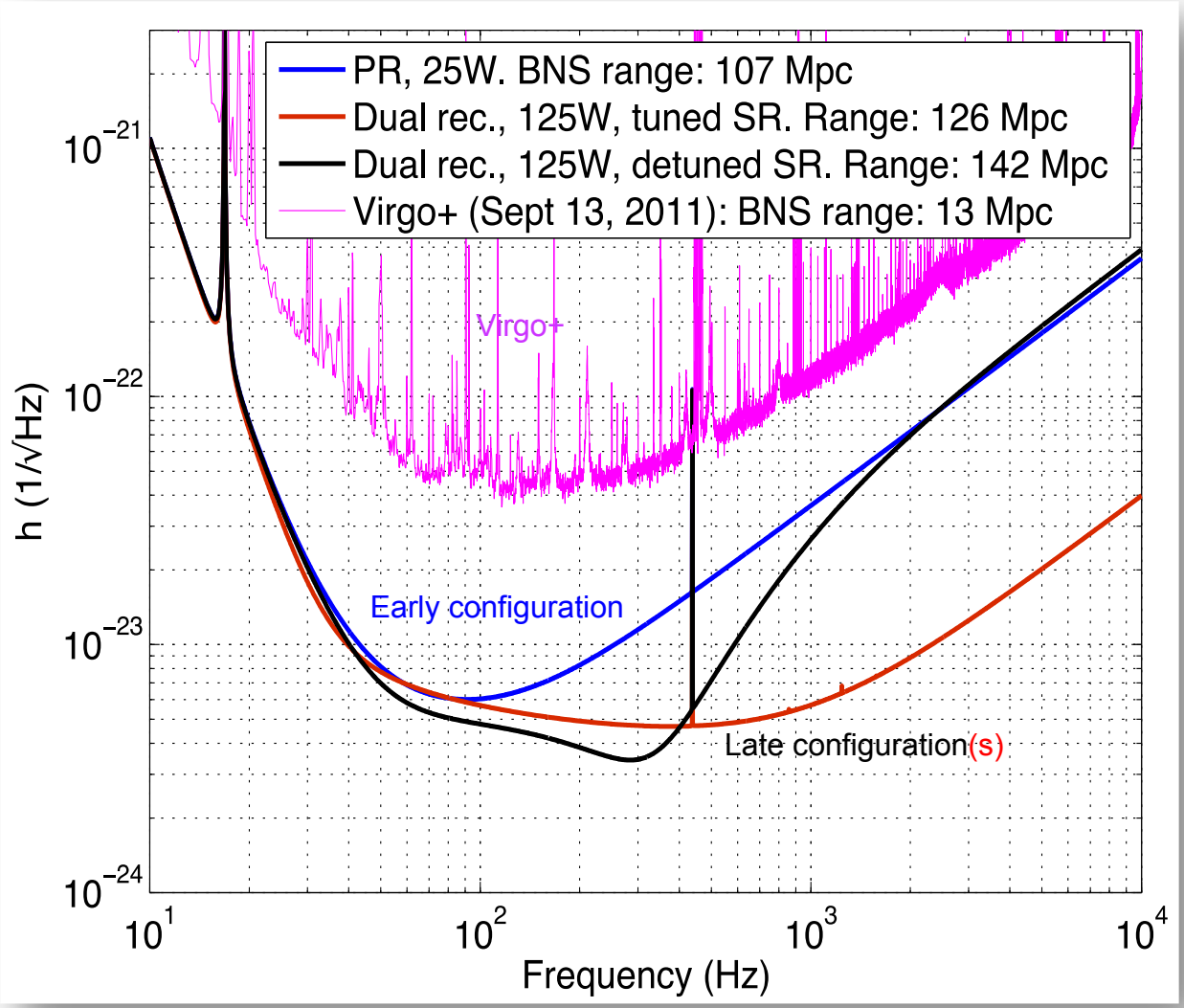
- Advanced Virgo (AdV): upgrade of the Virgo interferometric detector of gravitational waves
- Participated by scientists from Italy and France (former founders of Virgo), The Netherlands, Poland and Hungary
- Funding approved in Dec 2009 (23.8 ME)
- Construction in progress. End of installation: fall 2015
- First science data in 2016

5 European countries
19 labs, ~200 authors

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

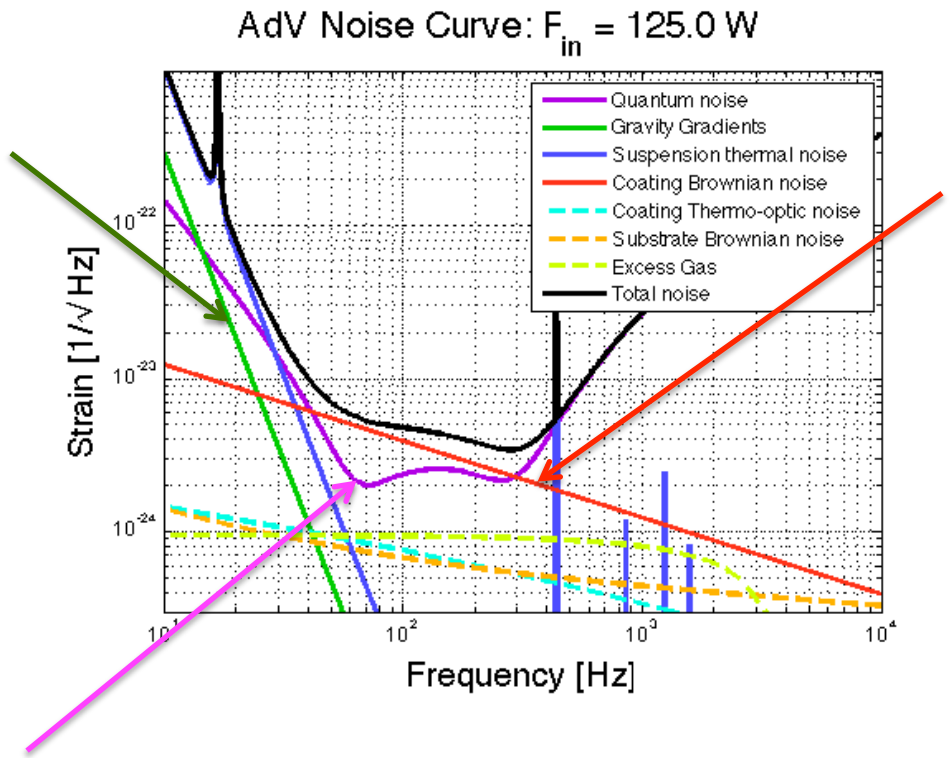
Advanced Virgo

Sensitivities



Noise budget

gravity gradient noise



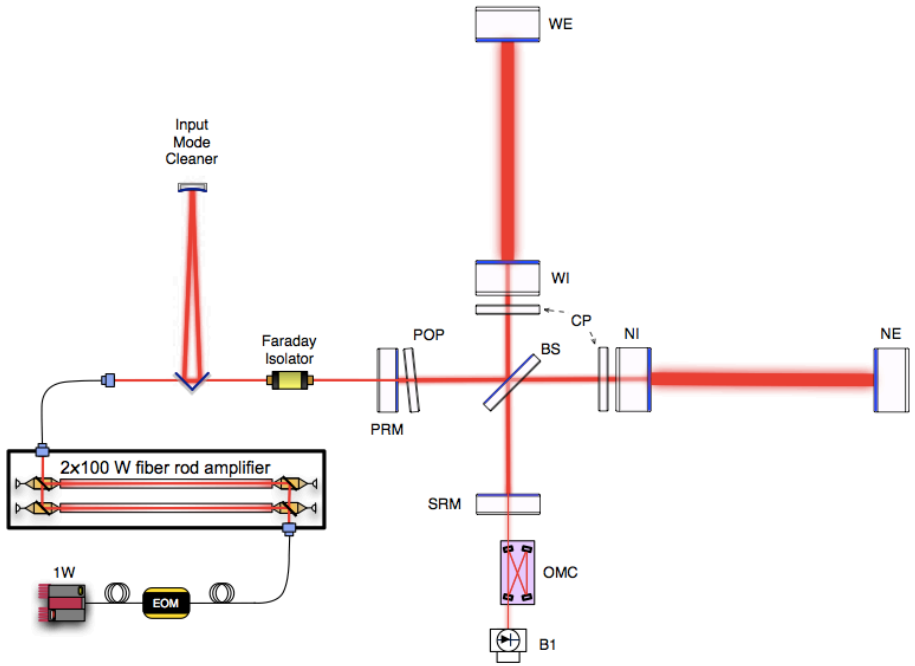
Coating thermal noise

Quantum noise

Optical scheme

- Dual recycled Fabry-Perot Michelson
- Bi-concave arm-cavities
- Marginally stable recycling cavities
- Compensation plates
- Pick-off plate for ITF control

Advanced Virgo main Optical parameters			
Light Power			
arm cavity power	650 kW	power on BS	4.9 kW
Arm cavity geometry			
cavity length L	2999.8 m		
IM R_C	1420 m	EM R_C	1683 m
Beam size on IM w	48.7 mm	Beam size on EM w	58.0 mm
waist size w_0	9.69 mm	waist position z	1363 m
Arm cavity finesse			
finesse	443	round-trip losses	75 ppm
transmission IM T	1.4%	transmission EM T	1 ppm
Power recycling			
transmission PRM T	5%	recycling gain	37.5
PRC length	11.952 m	Beam size on PRM	49.1 (TBC) mm
Signal recycling			
transmission SRM T	20%	finesse	26
SRC length	11.952 m	SRM tuning	0.35 rad
Mirrors			
IM diameter	35 cm	EM diameter	35 cm
IM thickness	20 cm	EM thickness	20 cm



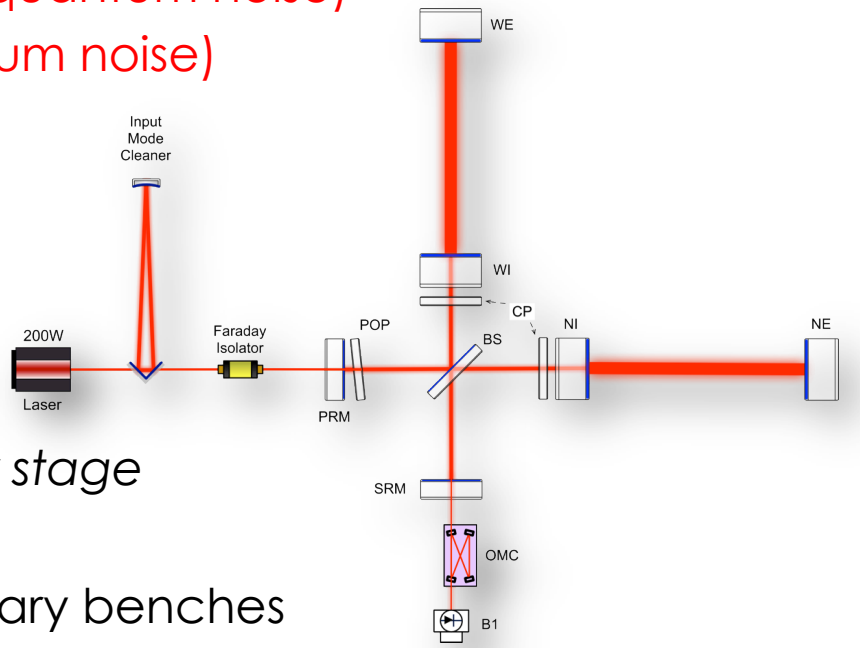
Some of the changes with respect to Virgo

- Larger beam (thermal noise)
- Higher quality optics (thermal noise, quantum noise)
- Heavier mirrors (thermal noise, quantum noise)

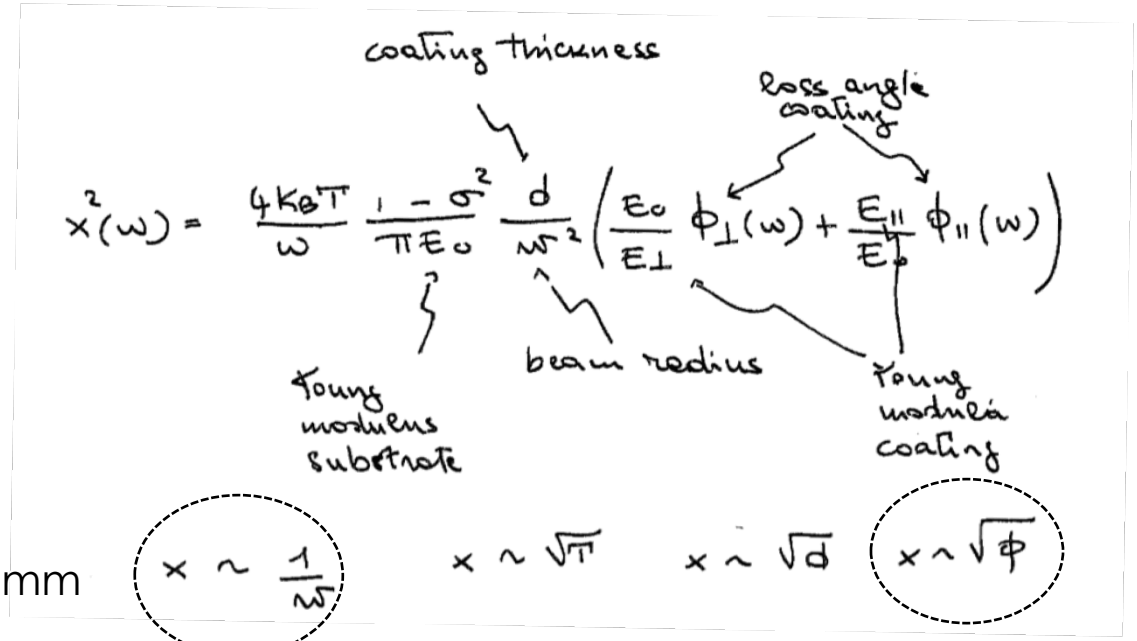
- *200W fiber laser*
- thermal control of aberrations
- *signal recycling*

- *Improvement in the suspension lower stage*

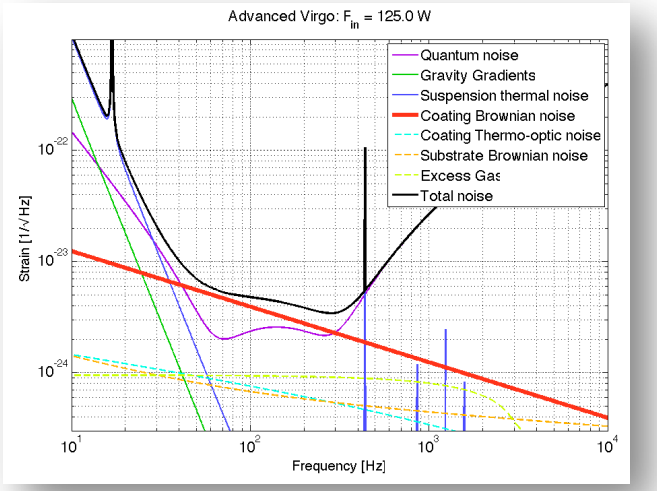
- Suspended and under vacuum auxiliary benches
- Baffles

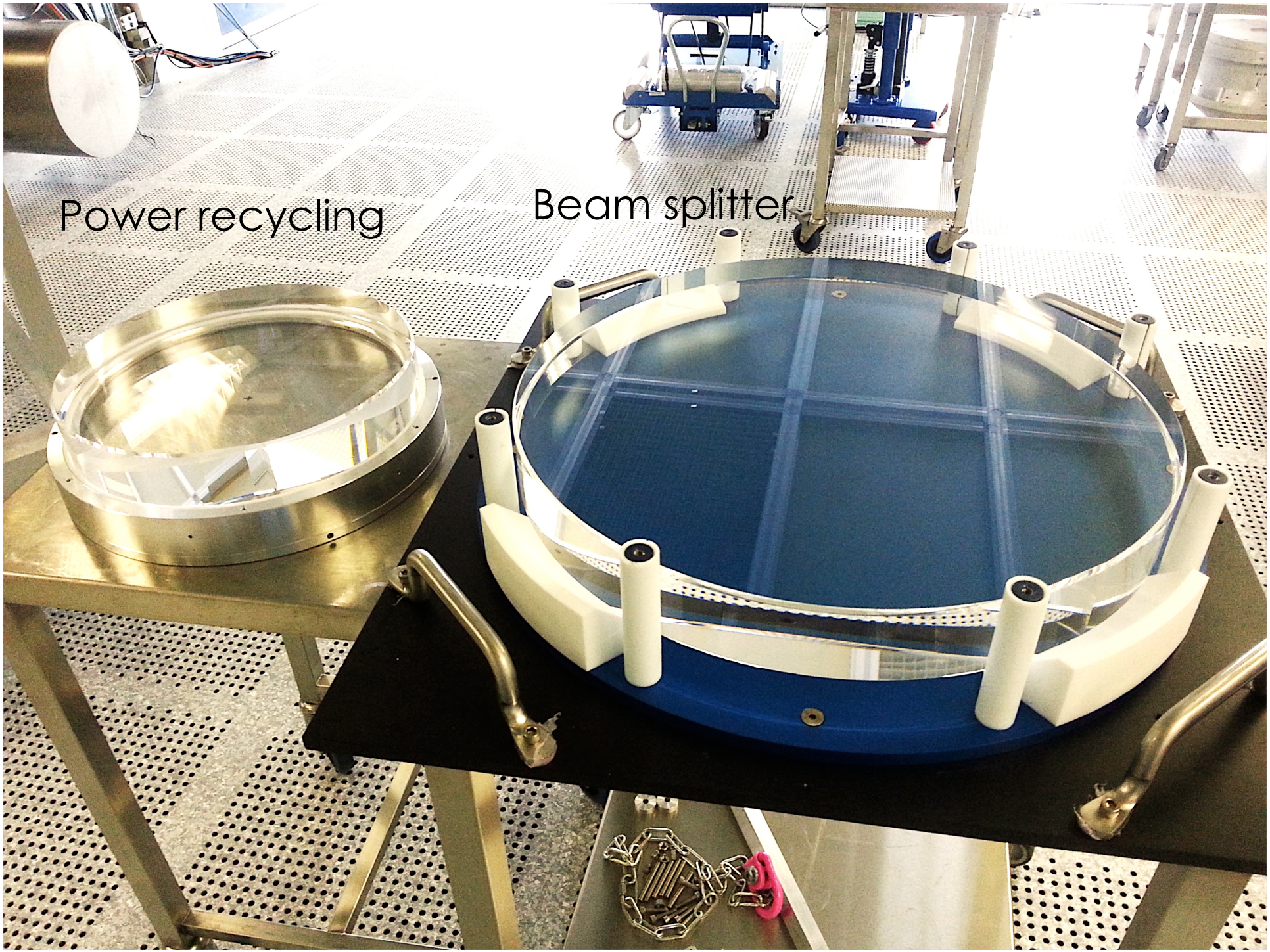


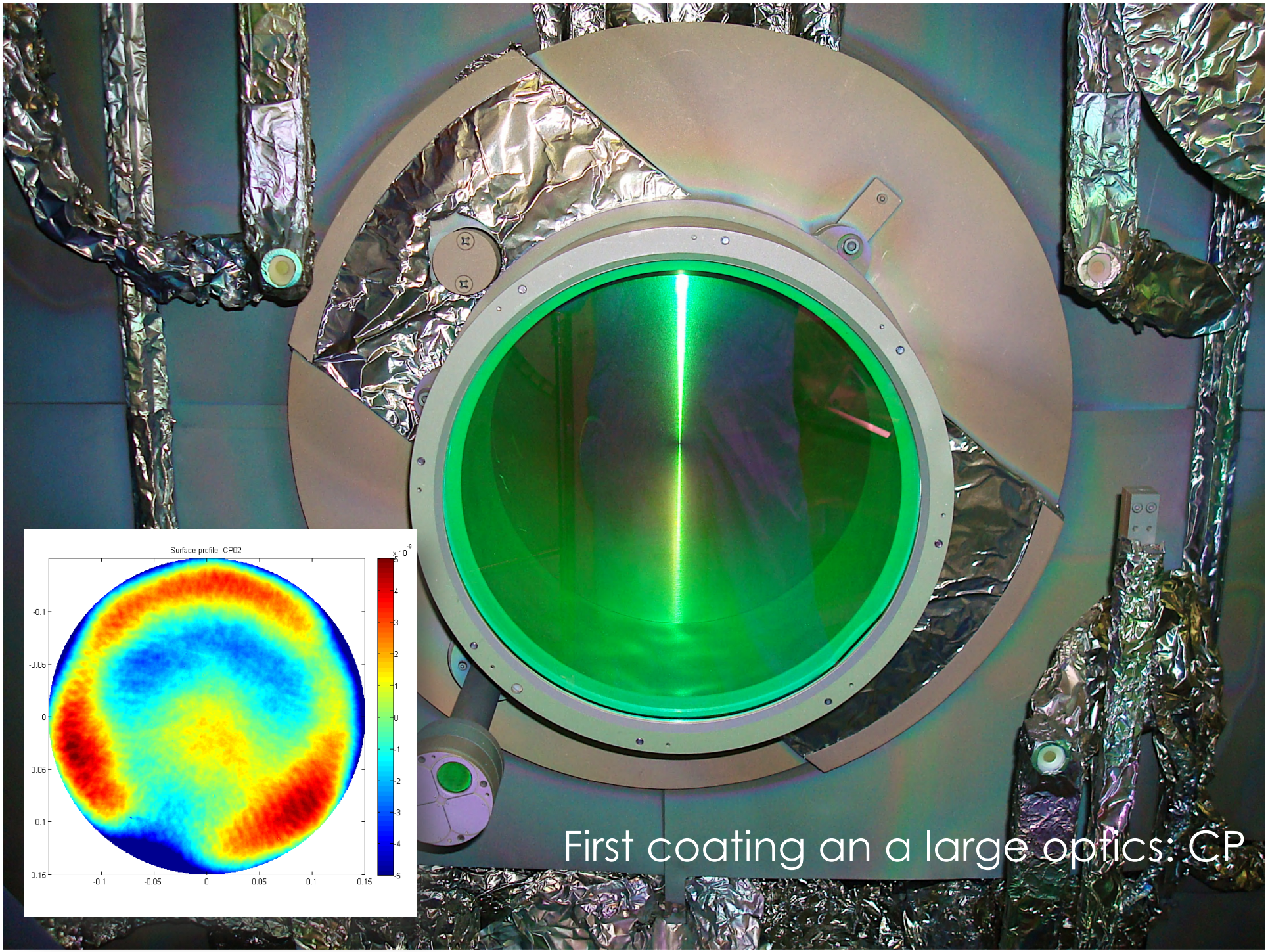
Coating thermal noise



21 mm → 49 mm

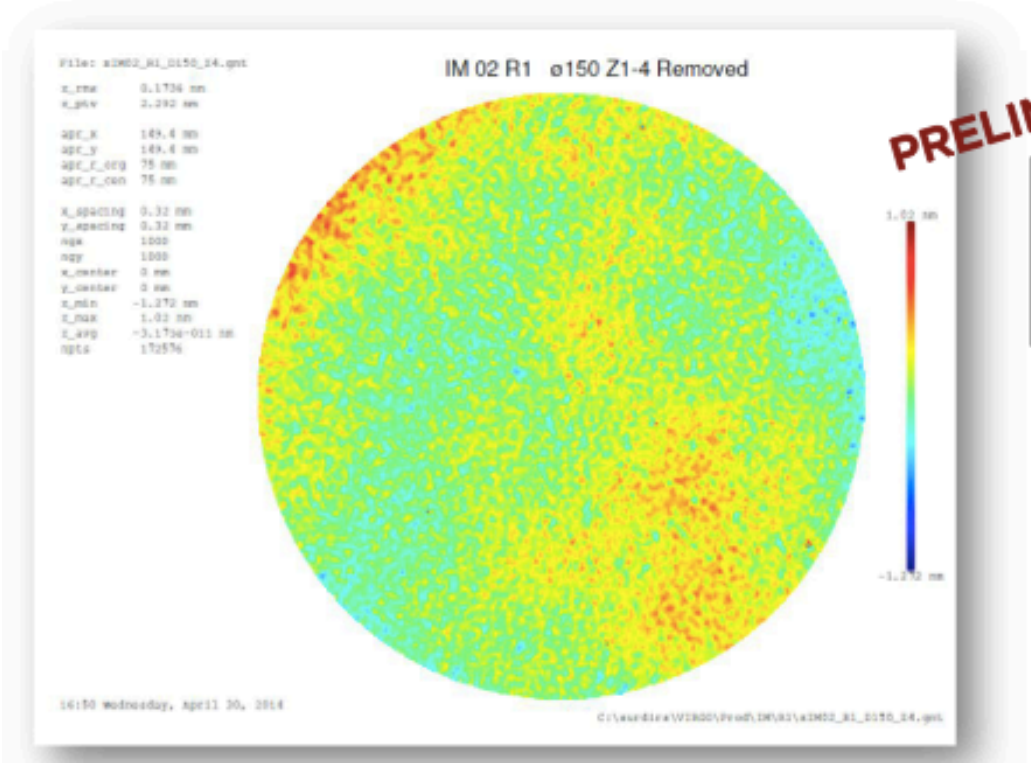



Power recycling
Beam splitter



First coating an a large optics: CP

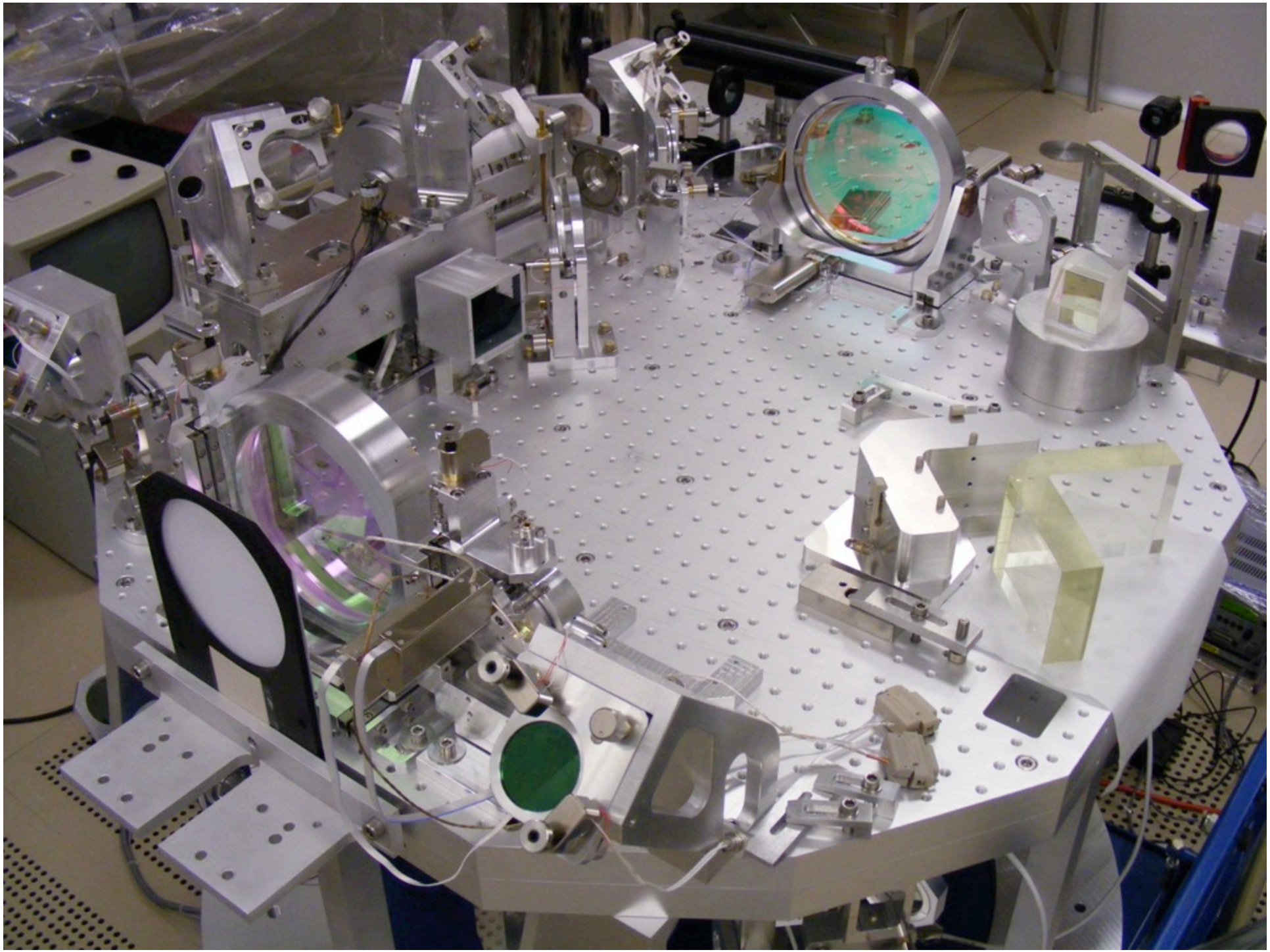
First map of test masses



PRELIMINARY

Flatness: 0.17 nm rms on 150mm Ø
(spec.: 0.5 nm rms)

RoC: 1425 m (spec.: 1420 [-5,+15] m)



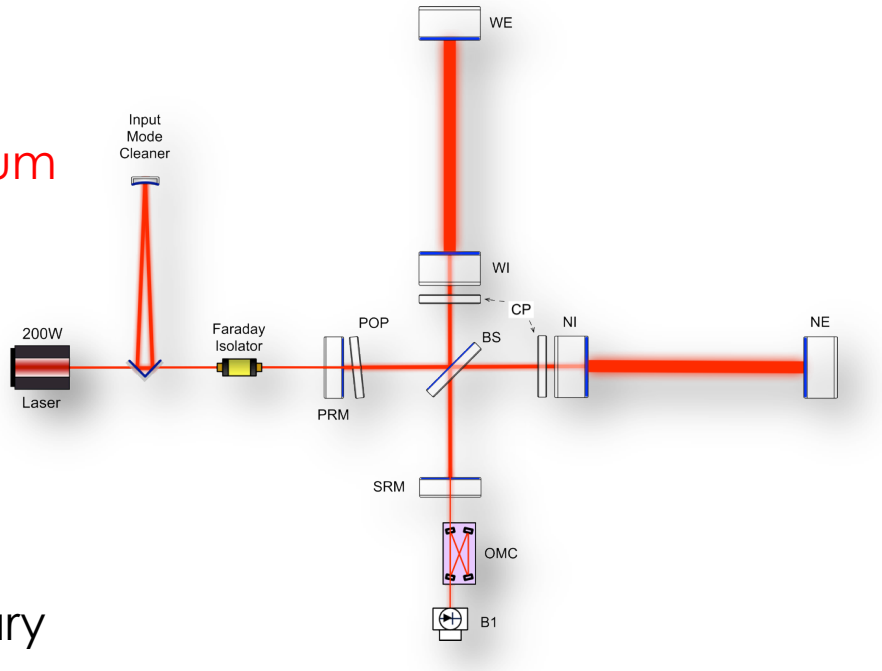
Some of the changes with respect to Virgo

- Larger beams
- Higher quality optics
- Heavier mirrors

- 200W fiber laser (quantum noise)
- thermal control of aberrations (quantum noise)
- signal recycling (quantum noise)

- Improvement in the suspension lower stage

- Suspended and under vacuum auxiliary benches
- Baffles



2015 configuration

- Start in 2015 with a simplified configuration: likely to reduce commissioning time
  - No signal recycling (reduce locking complexity)
  - Virgo+ laser (up to 60W)
  - Low power (reduce risks with thermal effects and high power laser)
- Target BNS inspiral range: >100 Mpc

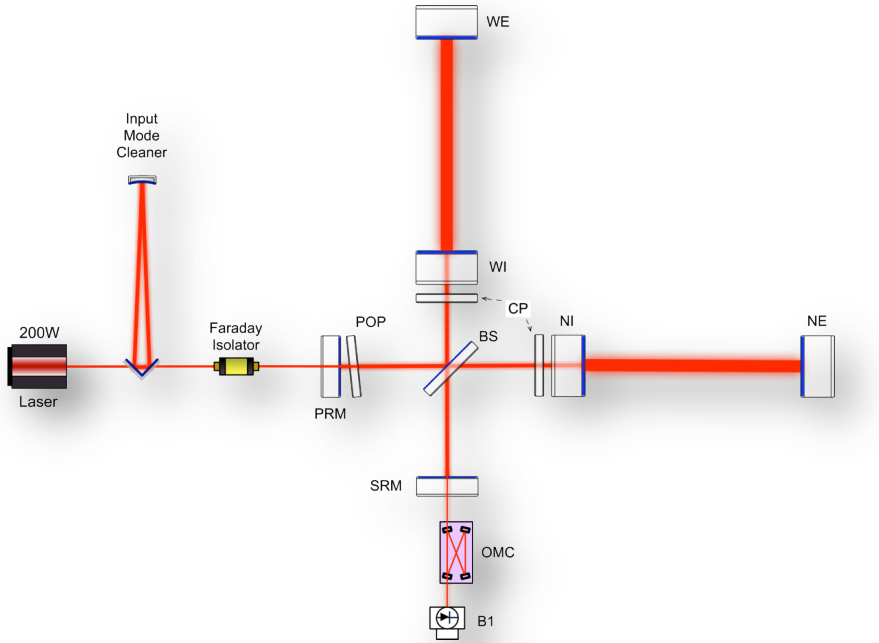
Some of the changes with respect to Virgo

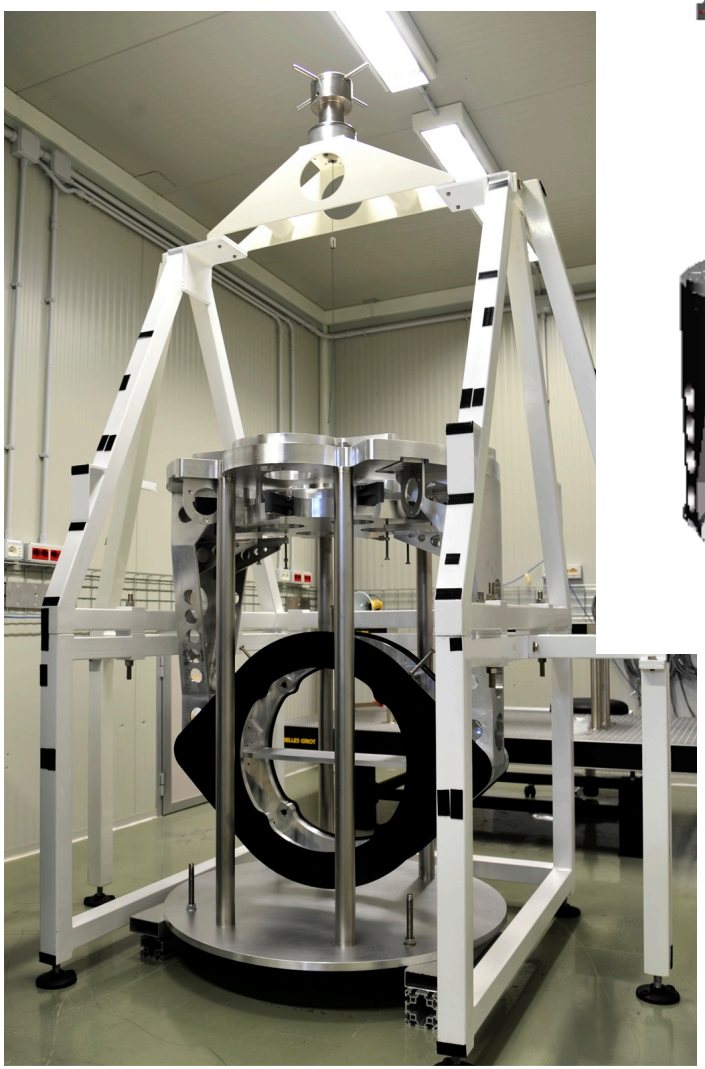
- Larger beam
- Higher quality optics
- Heavier mirrors

- thermal control of aberrations
- *200W fiber laser*
- *signal recycling*

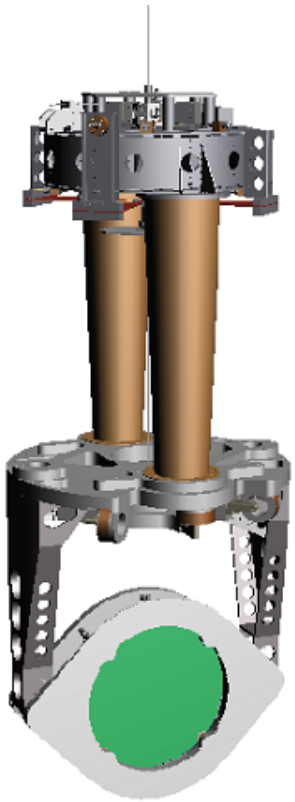
- *Improvement in the suspension lower stage (thermal noise, suspend CP/ baffles)*

- Suspended and under vacuum auxiliary benches
- Baffles

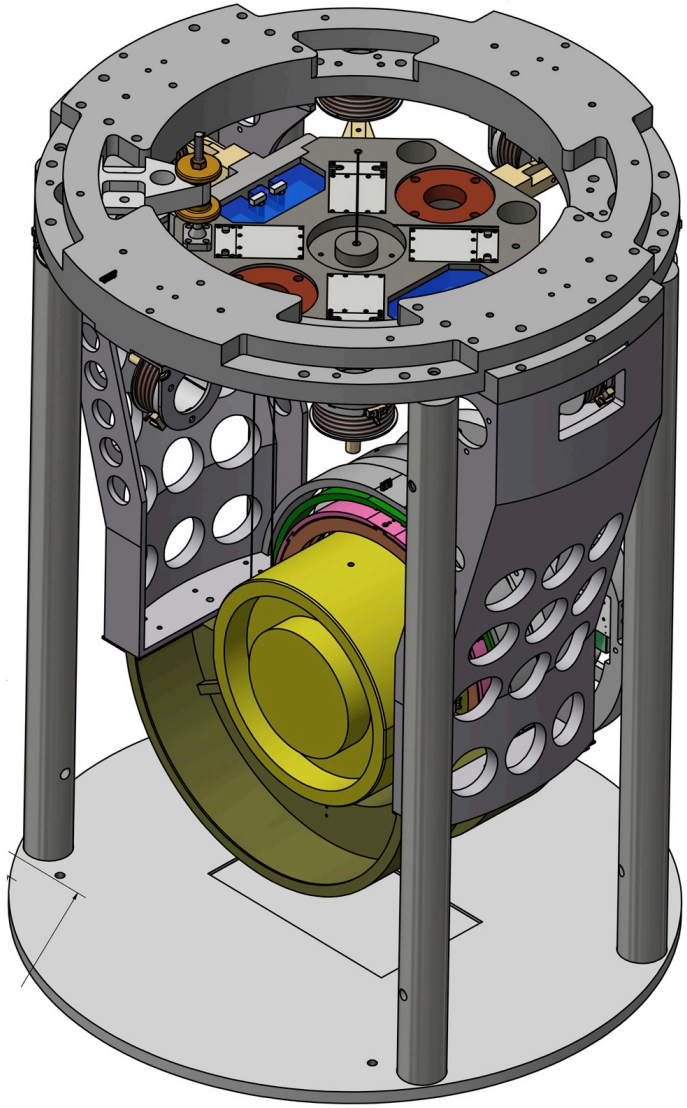


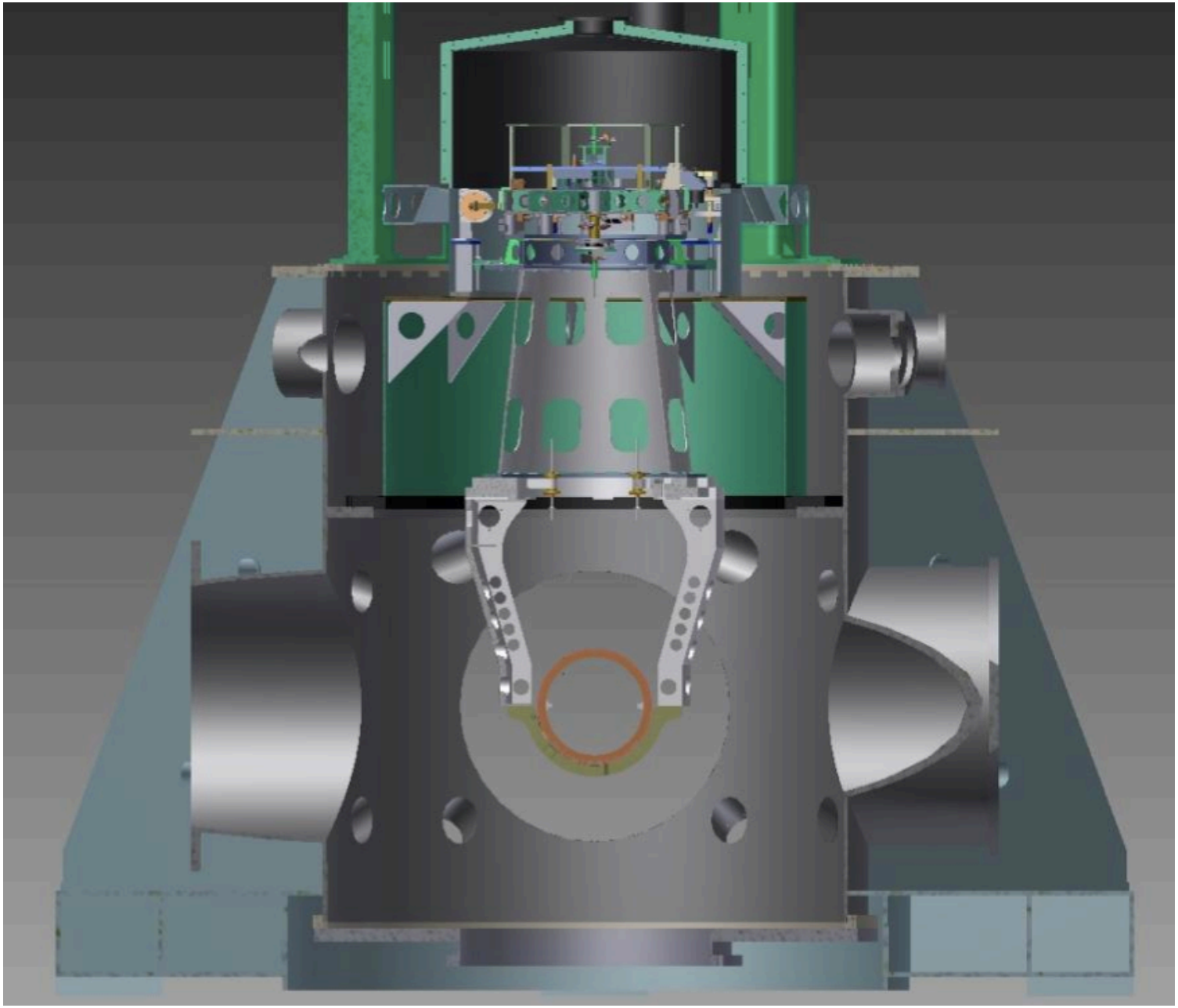


BS payload installation in July 2014



First test mass Dec 2014





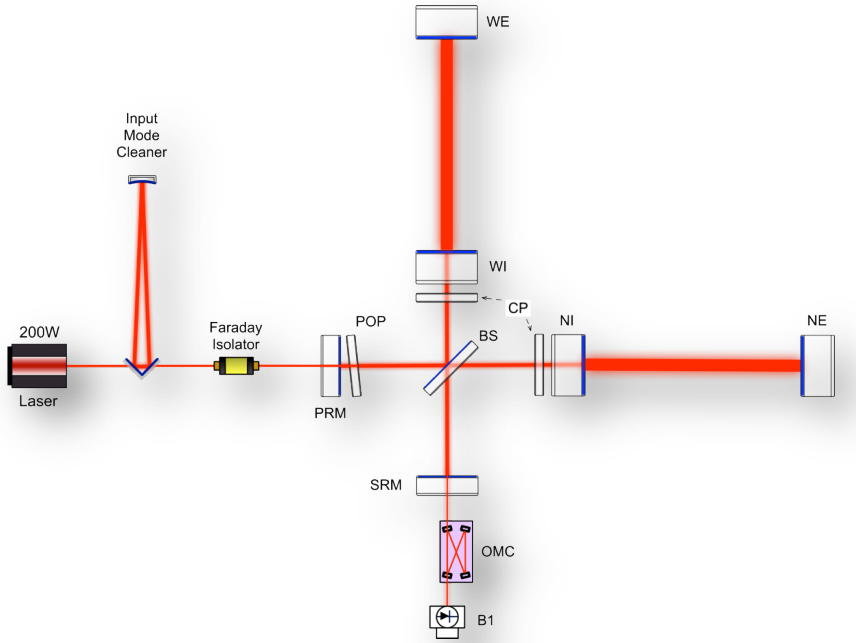
Some of the changes with respect to Virgo

- Larger beam
- Higher quality optics
- Heavier mirrors

- thermal control of aberrations
- *200W fiber laser*
- *signal recycling*

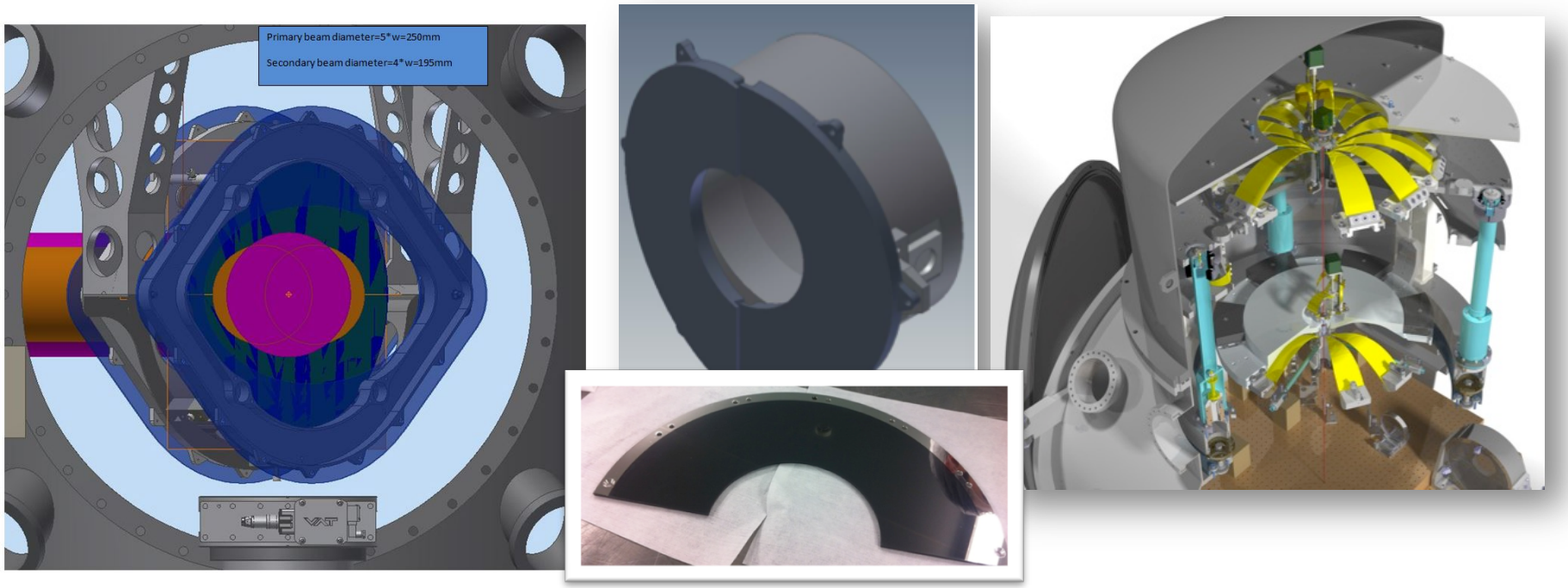
- *Improvement in the suspension lower stage*

- Suspended and under vacuum auxiliary benches (backscattering)
- Baffles (backscattering)

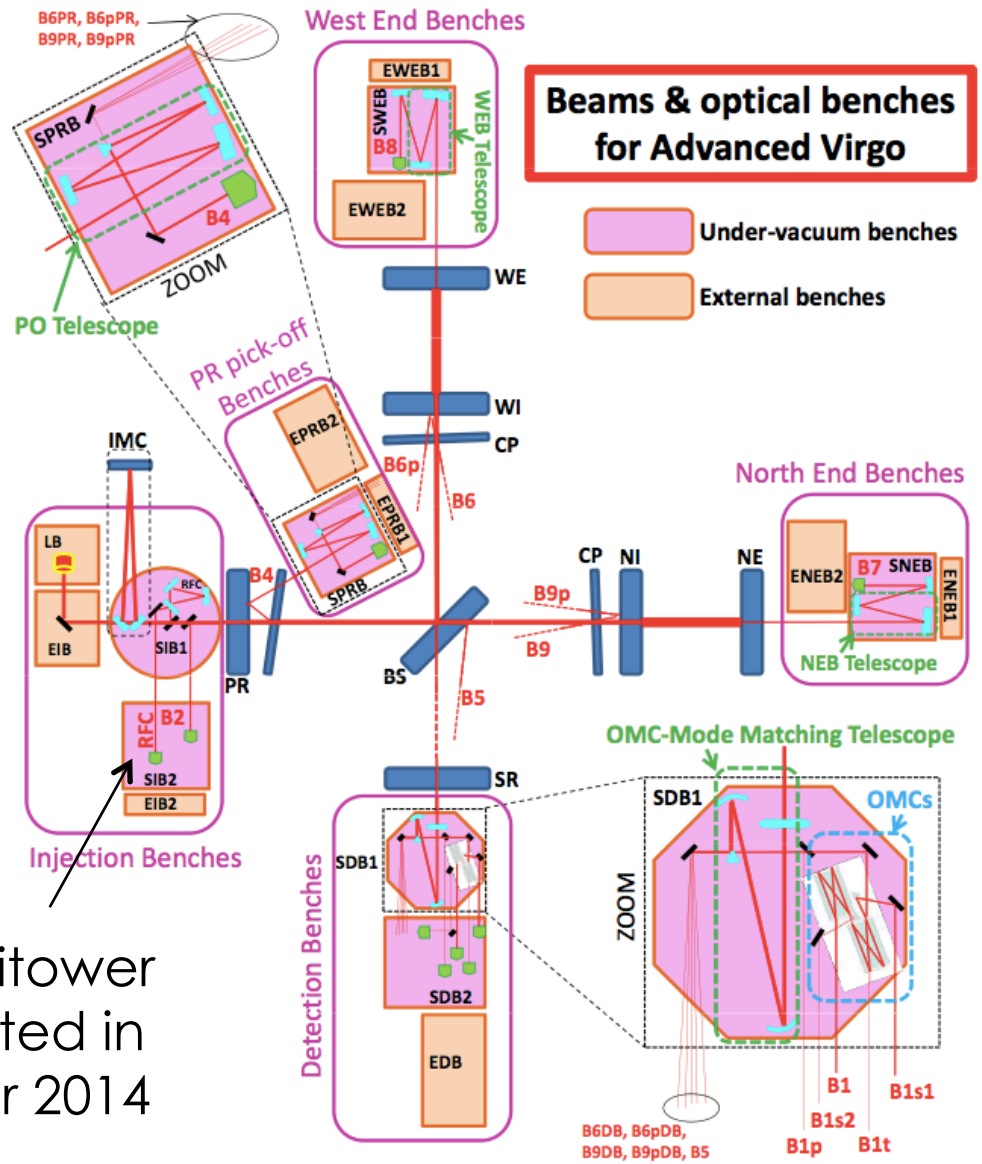


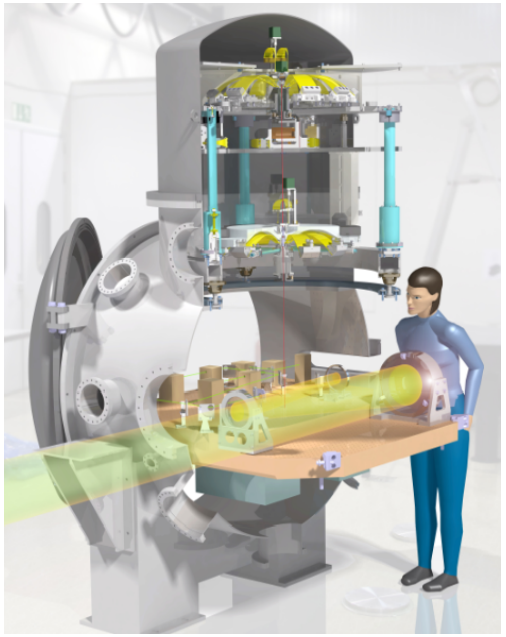
Backscattering

- Better optics quality
- Baffles to shield mirrors, pipes, vacuum chambers exposed to scattered light
- Photodiodes suspended in vacuum to isolate them from acoustic/ seismic noise
- If required, control the position of the benches wrt the interferometer



Benches under vacuum



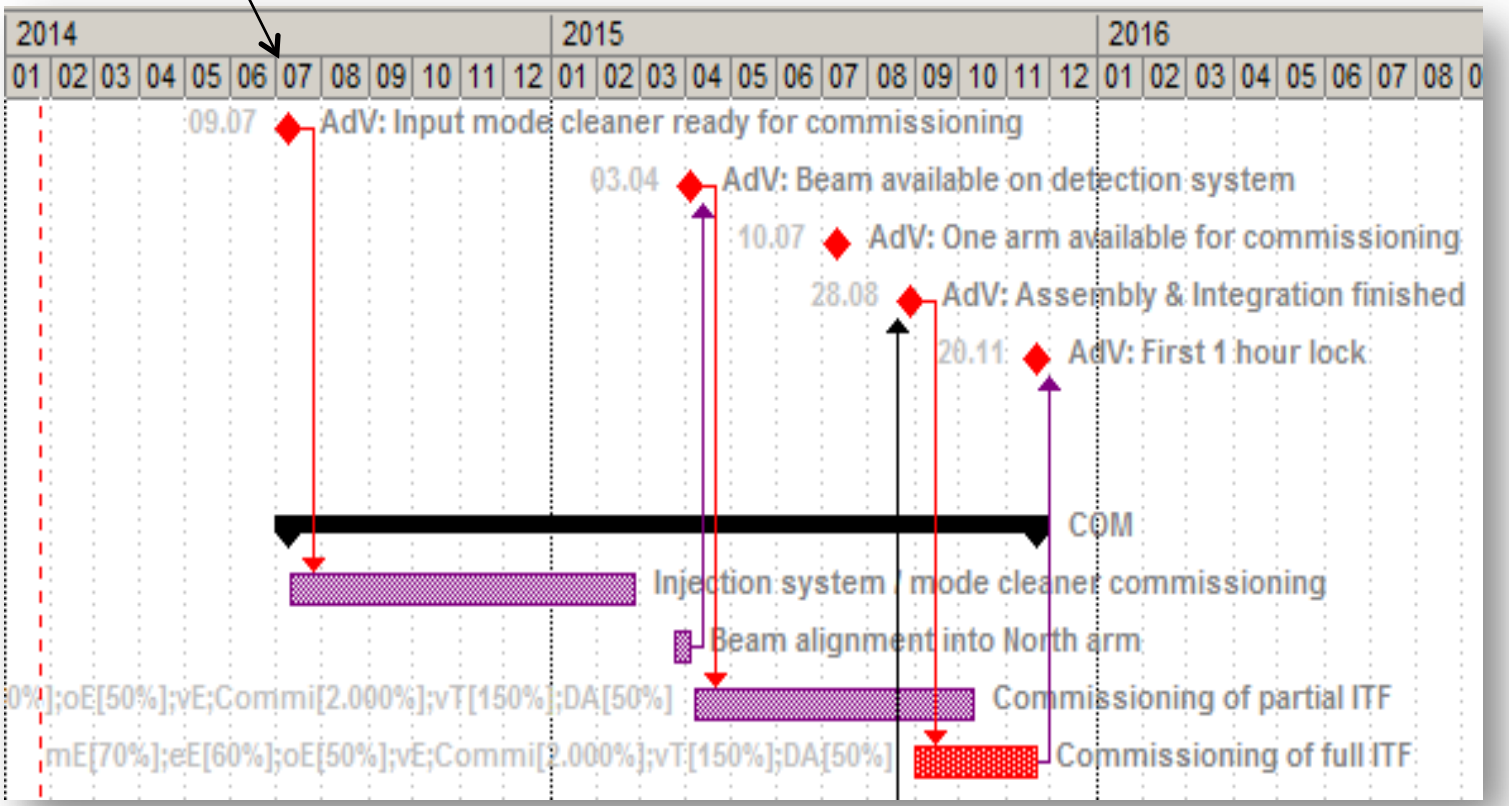


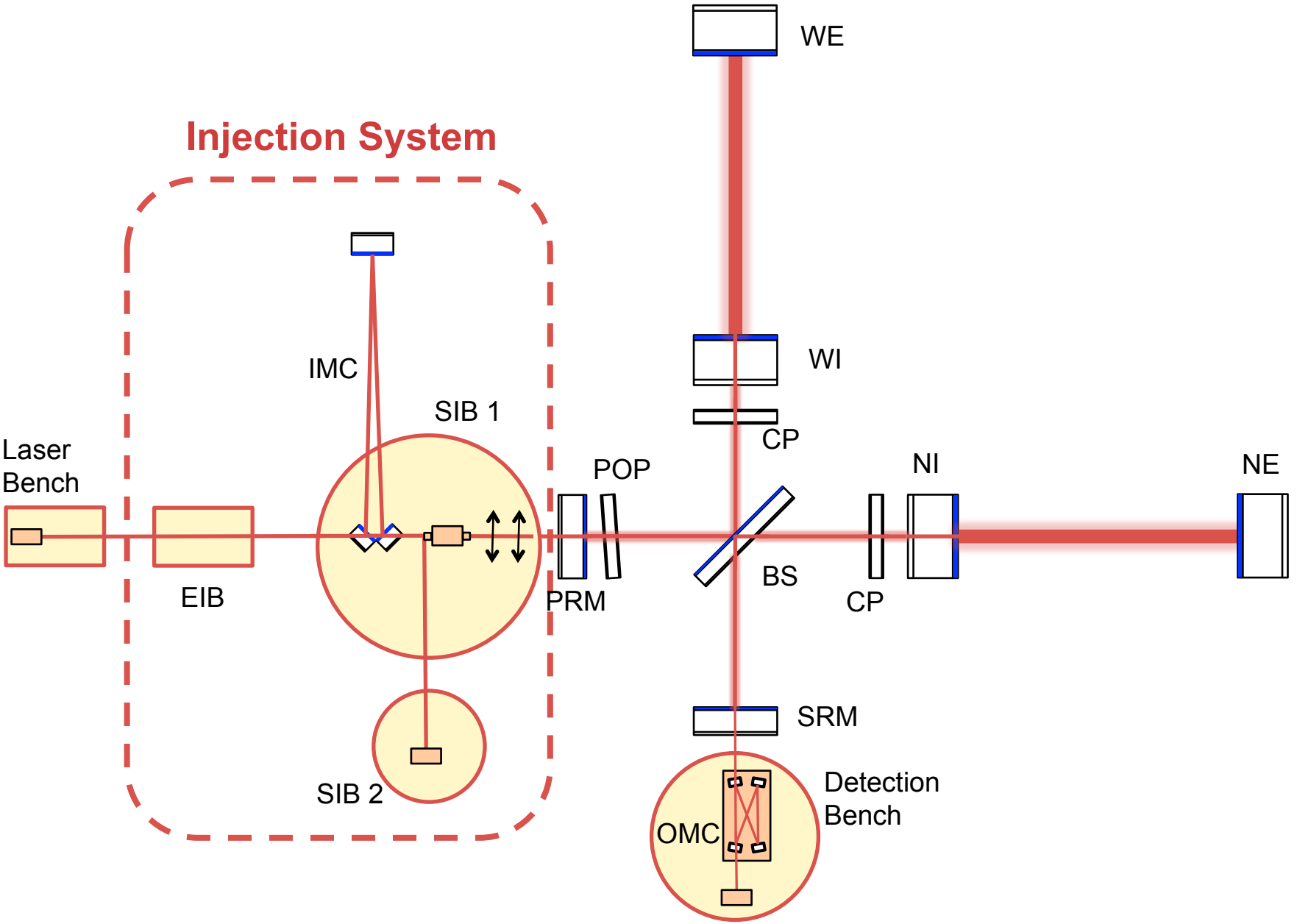
First minitower completed in October 2014

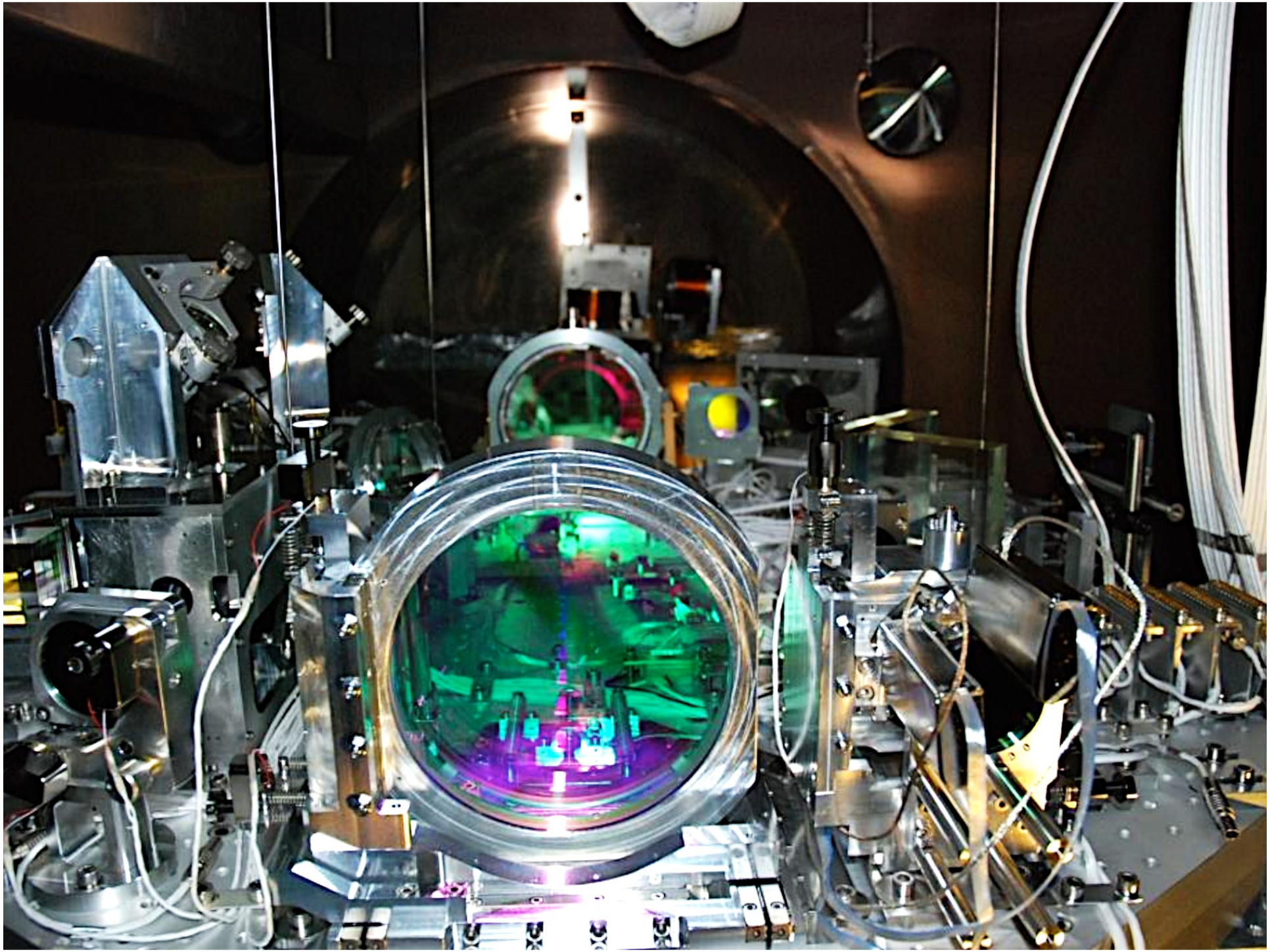

Seismic Attenuation System
VIRGO

Mode cleaner lock planned Now

Crucial dates




Injection System
WE
WI
CP
NI
NE
IMC
SIB 1
Laser
Bench
POP
EIB
PRM
BS
CP
SRM
SIB 2
Detection
Bench
OMC




Mode cleaner lock yesterday

Commissioning in detail

- July 2014: early commissioning of IMC
- Oct 2014: first minitower complete, finish commissioning INJ
- Early 2015: all mirrors installed in central building, lock PRMI
- Summer 2015: first end-mirror installed, 1-arm tests
- Fall 2015: full interferometer available, start locking in power-recycled configuration
- Early commissioning of complete interferometer, first science runs
- ??: Install signal-recycling mirror, auxiliary laser system, increase power
- Late commission towards full sensitivity

Summary

- Advanced Virgo goal: x10 sensitivity wrt Virgo
- Major change in all the Virgo hardware
- Progress in construction – start pre-commissioning
- Now: mode-cleaner locked
- End of construction: fall 2015
- First lock in a power recycled 25 W configuration: end of 2015
- First scientific run with LIGO: 2016
- Increase of sensitivity post-2016, and data takings