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# Virgo upgrade plans



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for the Virgo Colaboration



# R&D for Virgo

- The discovery announcement triggered the discussion around the possible upgrades
- A White Paper is in the process of making

## Vision document on the future of Advanced Virgo

*The Virgo collaboration*

April 2016

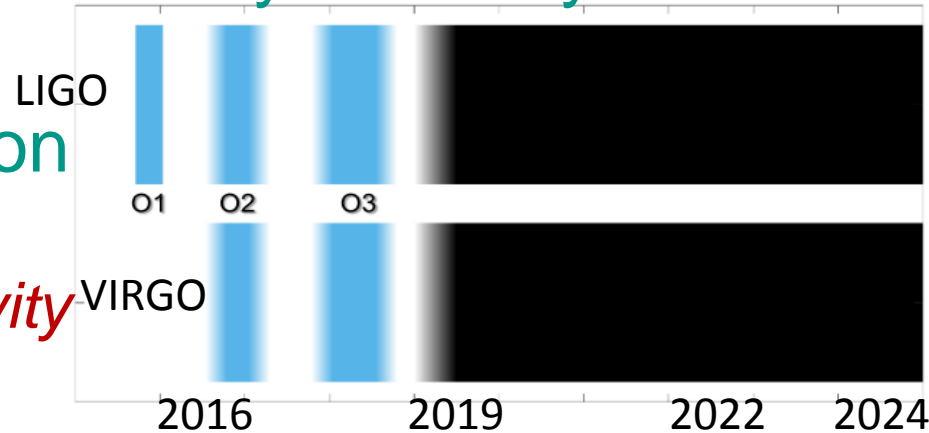
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- ◆ Not all the activities of the WP are presented here

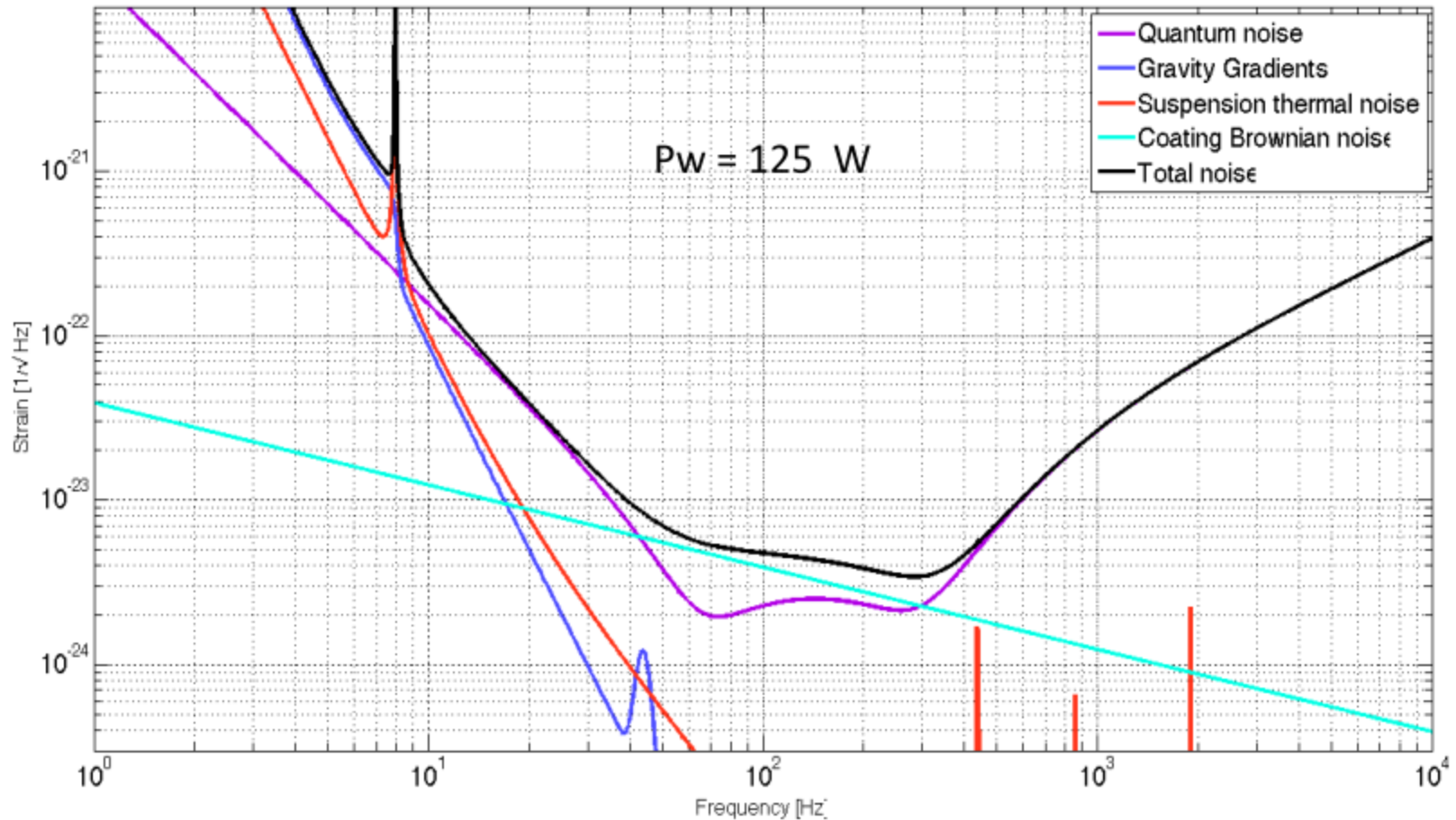
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# Preliminary considerations

- Securing the AdV target sensitivity and duty cycle
- 3 phases of implementation
  - ◆ PHASE 1 (2017-2021):  
*achieve the design sensitivity*
  - ◆ PHASE 2 (2021-2025):  
*the best we can do in the current infrastructure*
  - ◆ PHASE 3 (>2025)  
*possible implementation of 3G technology*
- Activities
  - ◆ Analysis (on going)
  - ◆ Selection of a suitable scenario (not started)
  - ◆ R&D



# AdV reference sensitivity curve



# 3 step to progress with AdV

Presented by Fulvio at the STAC meeting

Signal  
Recycling

R&D for Better  
Mirrors

Squeezing  
frequency  
independent

Newtonian  
Noise cancellation  
Test

Higher Power  
Laser

Parametric  
Instability  
Control

Squeezing  
frequency  
dependent

Implementation of  
Newtonian  
Noise cancellation

Reduction of the  
suspension  
thermal  
noise

Magnetic  
noise  
reduction

Alignment  
Control  
Noise

Heavier Mirrors

Larger Beams

Different beam  
profile

Suspension  
change

Better  
coatings

Long  
recycling  
Cavities

Improved  
TCS

Review of  
the  
squeezing  
strategy

# A synthetic view

	Milestones	Budget	Infrastructure	Implementation
Signal Recycling	- Demonstration - Coatings depos.	Available	No impact	After O2
HP Laser	- Choice (2016/06) - Long term test	Available	No impact	After O2
FI Squeezing	- Demonstration - 2 benches suspension	1.2 M€	No impact	After O2
R&D coatings	- Technology selection	0.6 M€ + 3 M€	No impact	Now (R&D) After O3 (Imple.)
NN site characterization	- Sensor development	0.1 M€	No impact	After O2
NN detection	- Deployment new sens.	0.3 M€	No impact	After O3
FD Squeezing	- Demonstration - Installation of vacuum	> 1.7 M€	Housing the filter cavities	After O3

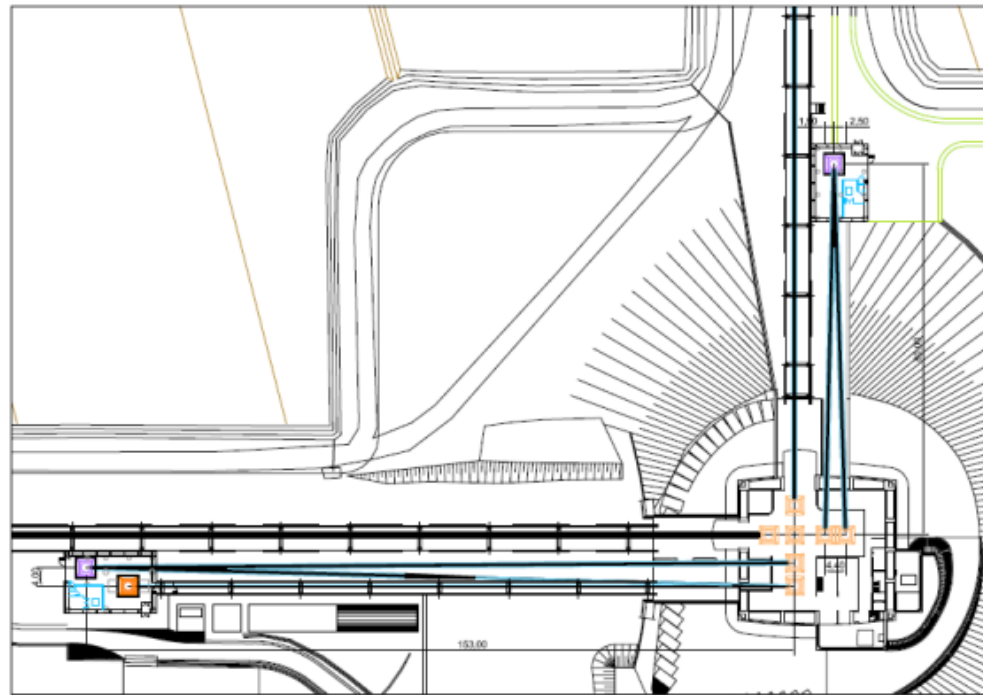
# Long recycling cavities

- The PR and SR cavities are too short

- ◆ Marginally stable cavities in AdV
- ◆ Higher power and larger beams could be impossible
- ◆ Long stable cavities proposed in AdV in 2010 and excluded for financial reasons

- Not enough room in the main building

- ◆ Civil works are needed
- ◆ 180 m PR, 80 m SR

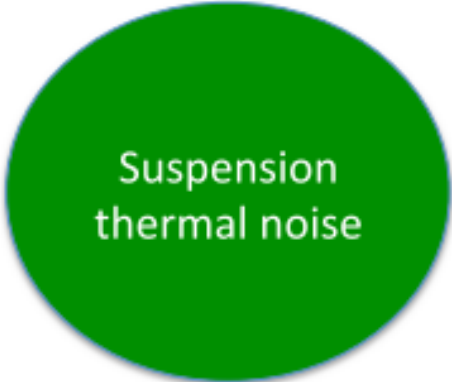


# Once the Newtonian noise limit is crossed

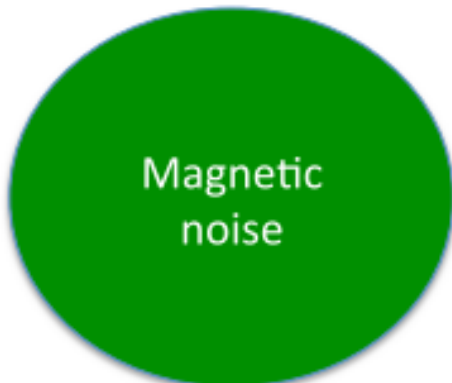
The other enemies to defeat



Alignment  
Control Noise



Suspension  
thermal noise



Magnetic  
noise

No Impact on the Infrastructure!

R&D cost  $\sim 600$  kE



Anthropogenic  
noise

Impact on the Infrastructure

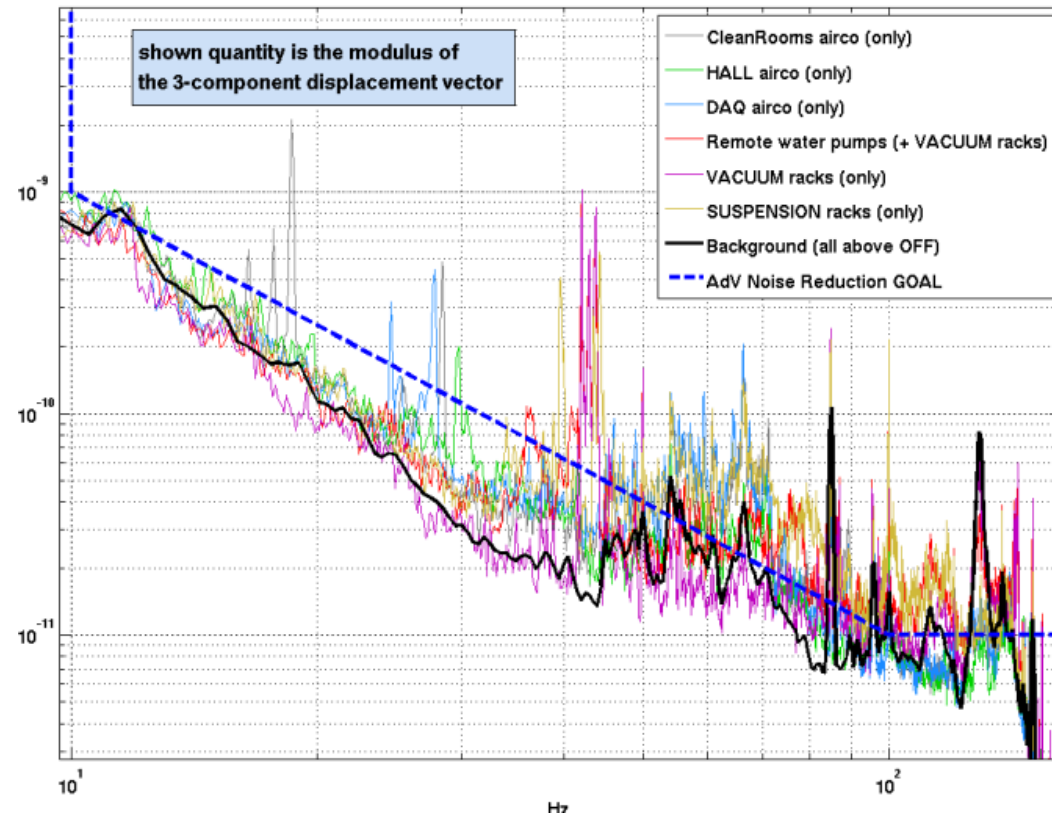
Cost  $\sim 500$  kE

Presented by Fulvio at the STAC meeting



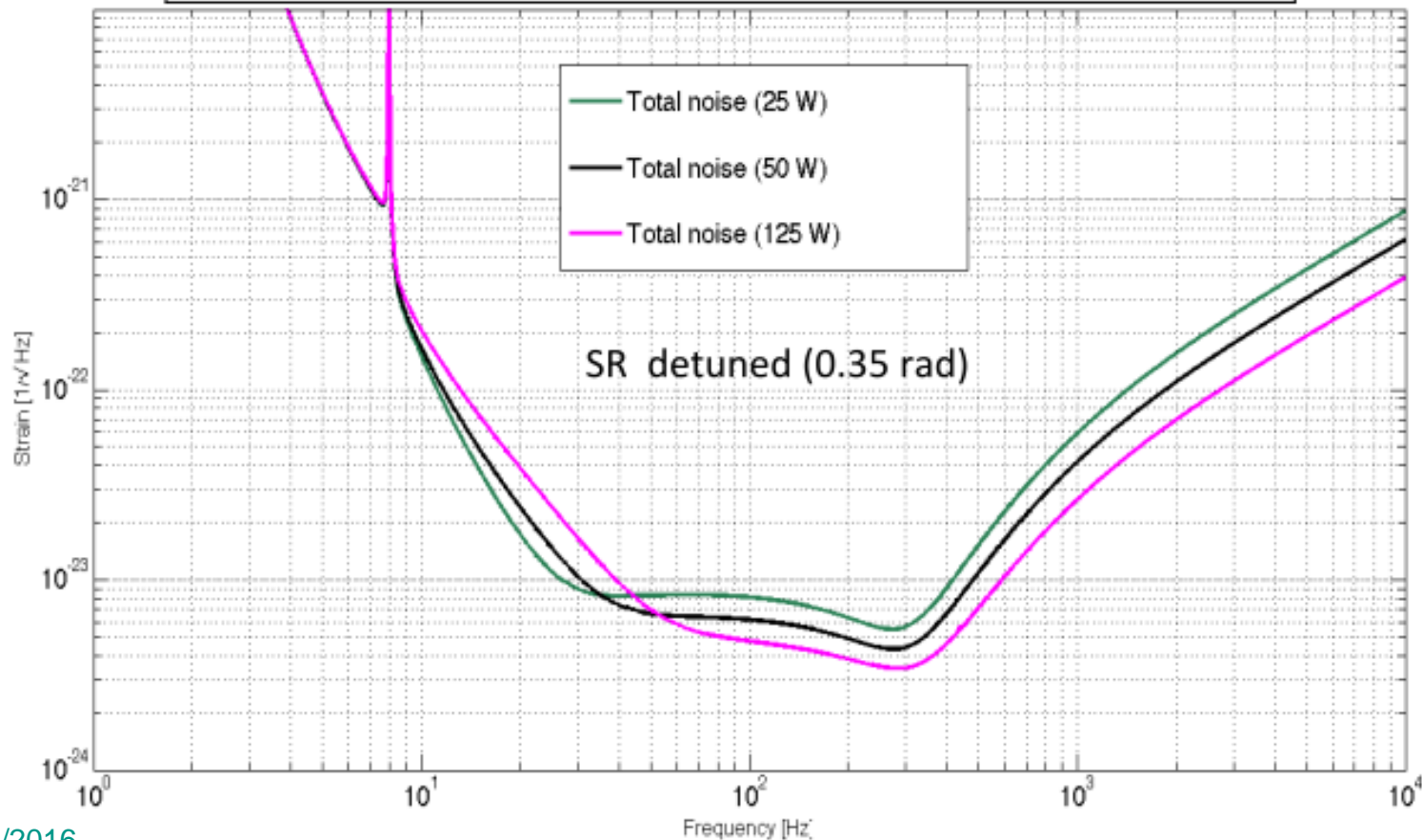
# Anthropogenic noise reduction

- The environmental noise is too high
  - ◆ Not a new discovery
- Construction of a technical building

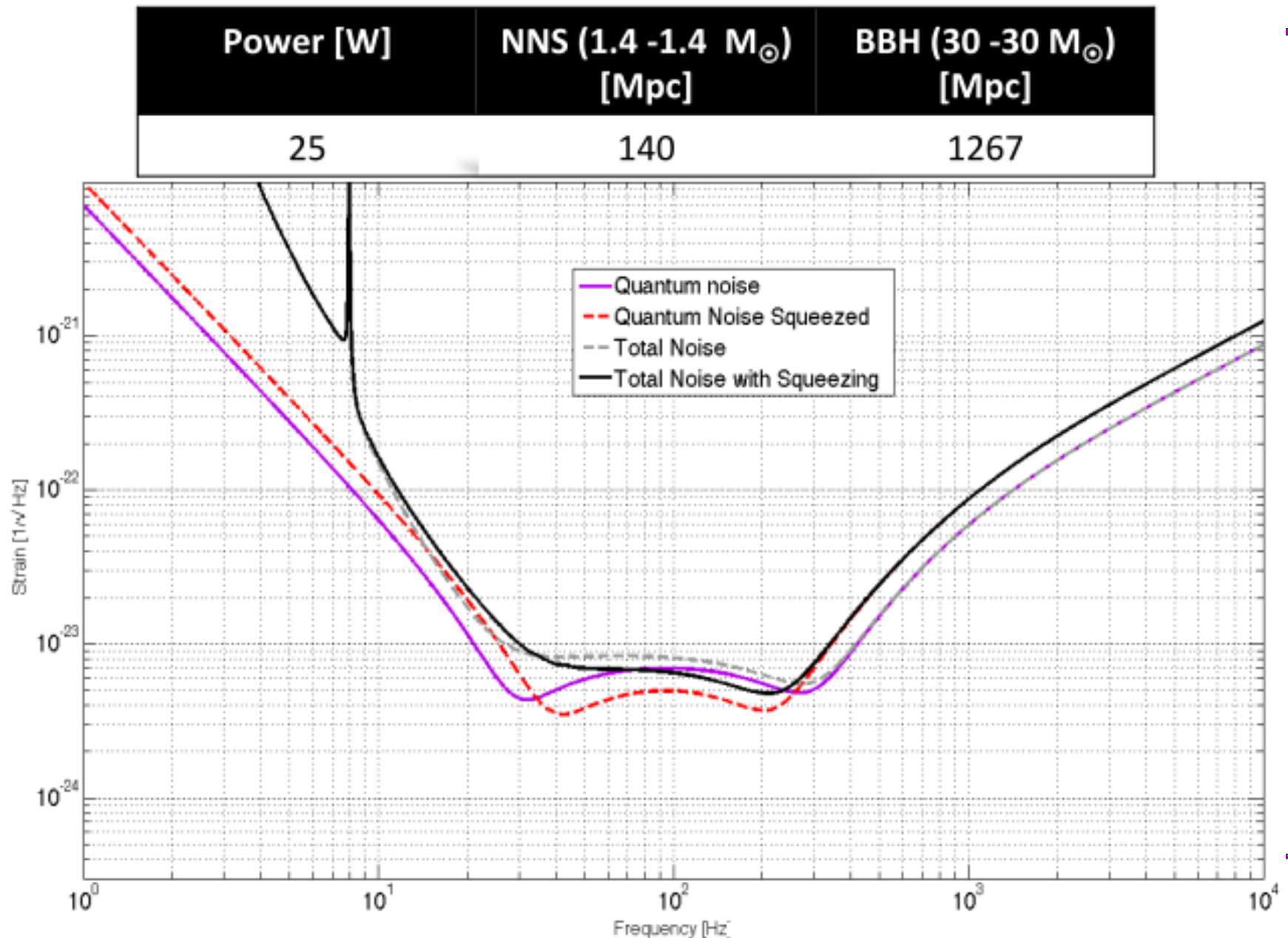


# Laser power increments

Power [W]	NNS (1.4 -1.4 $M_{\odot}$ ) [Mpc]	BBH (30 -30 $M_{\odot}$ ) [Mpc]
25	135	1503
50	145	1474
125	147	1192



# Squeezing freq. indep. 5dB - 20°



# Squeezing freq. dep. optimized

Power [W]	NNS (1.4 -1.4 $M_{\odot}$ ) [Mpc]	BBH (30 -30 $M_{\odot}$ ) [Mpc]
125	180	1595

