



Squeezed Light in Virgo: O3 and future plans

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Reporting for the many people of the Squeezing Commissioning Team/ Working Group/ Researchers

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Quantum Noise and Squeezed Light



Quantum Noise in Interferometric GW Detectors



Squeezing in Interferometric GW Detectors

GW ITF squeezing enhancement replaces the vacuum state at the dark port with squeezed vacuum



Squeezing in Advanced Virgo for O3

- December 2016, AEI offered Virgo an in-air frequencyindependent squeezer, under preparation since early 2015
- Goal: Up to 4dB increase in sensitivity at higher frequencies without decreasing low-frequency sensitivity too much



O3 AdV Squeezing – Simple Block Diagram



Preparations at AEI

- Squeezed Light Source
- Advanced Virgo electronics integration and testing







Squeezer Box Installation







External Squeezing Bench (ESQB)









External Squeezing Bench (ESQB)



Squeezing Commissioning – Some examples



Squeezing Injection

• Squeezing/Anti-squeezing measured on 14 November



AdV O3 Squeezing Performance



AdV O3 Squeezing Activities

- Reduction of quantum noise at high frequencies
 - Up to 3 dB in the 2 kHz region
- High duty cycle overlapping with Science measurement time
 - Greater than 95 %

- Remainder of the O3 time frame
 - Maintain current performance during Science time
 - If possible, increase performance during short commissioning sessions
 - Depending on priorities/scheduling, undertake further tests to prepare for the next upgrade phase.

Frequency-dependent Squeezing



Frequency-dependent Squeezing using cavities



Plans for Frequency-Dependent Squeezing

- Frequency-dependent squeezing is part of the design for the next AdV upgrade phase (currently under review)
- Preliminary infrastructure design



Plans for Frequency-dependent Squeezing

• Preliminary overview layout – optics and sensors



Plans for Frequency-dependent Squeezing



(One of a number of) R&D on FD Squeezing



ExSqueez – Installation / Commissioning

ANR ExSqueez









- Frequency-independent squeezed light is being injected into Advanced Virgo for the O3 Science Run
 - Up to 3 dB in the 2 kHz region
 - Greater than 95 % overlap with Science Time
- Frequency-dependent squeezed light is being proposed for the next upgrade phase
 - Extensive planning and design work undertaken
- Research and development happening in parallel on quantum noise techniques for future interferometric GW Detectors
 - Frequency-dependent squeezing test platforms is one example, to test implementation processes and new ideas.