T. Eberle, M. Mehmet, S. Steinlechner, H. Vahlbruch, A. Khalaidovski, K. Danzmann and R. Schnabel

Generation of Squeezed Light at 1064nm and 1550nm

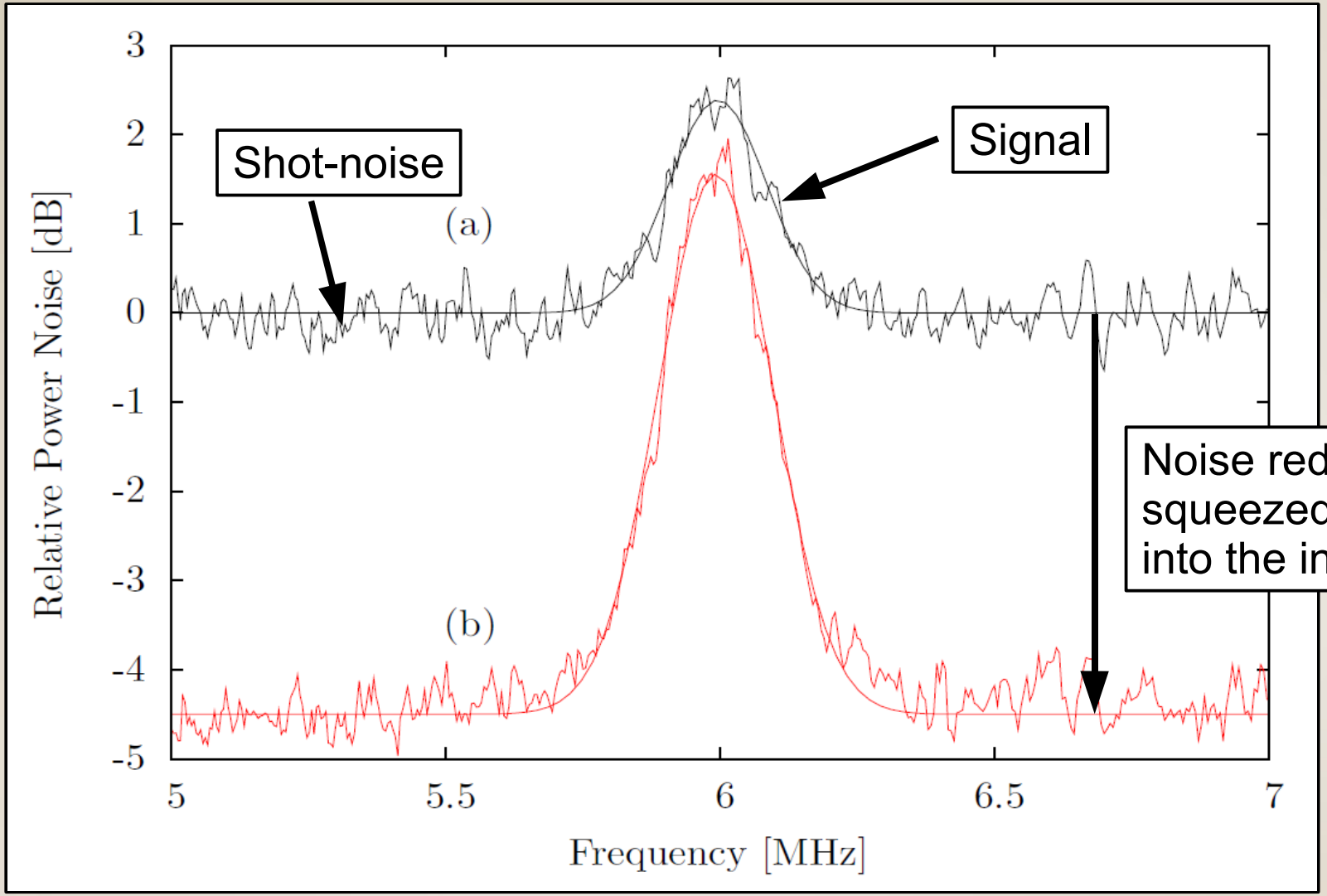
Institute for Gravitational Physics, Leibniz Universität Hannover and
Max Planck Institute for Gravitational Physics (Albert Einstein Institute)
Callinstr. 38, 30167 Hannover, Germany

Max Planck Institut
for Gravitational Physics
AG Quantum Interferometry

Centre for Quantum Engineering
and Space Time Research

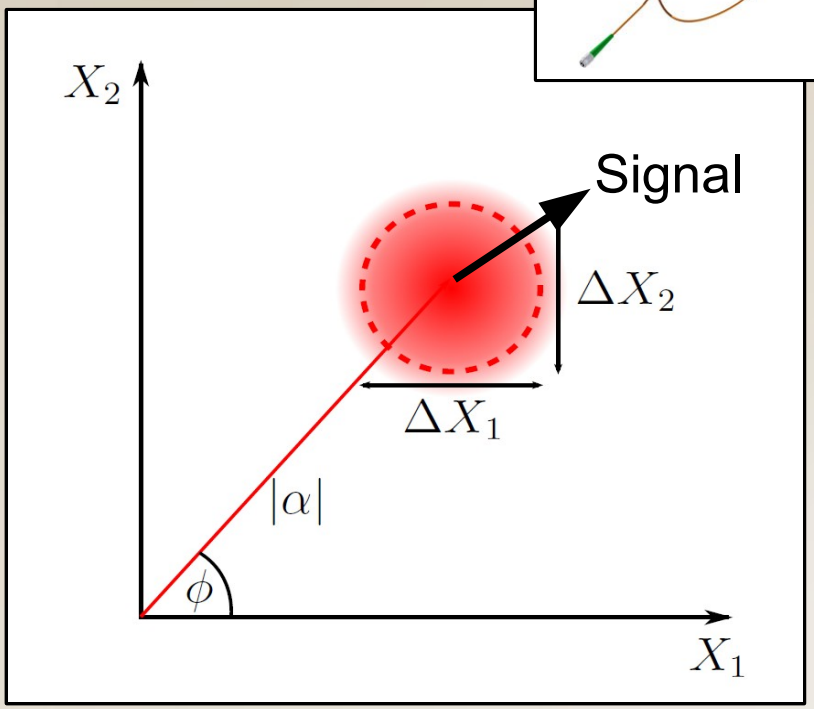
Leibniz Universität Hannover

Why Squeezed Light?

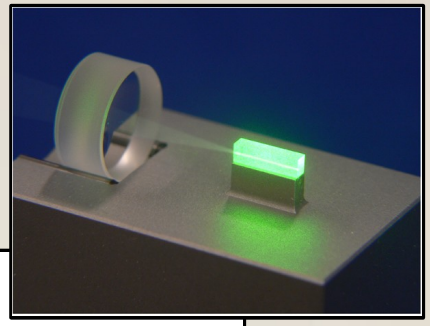


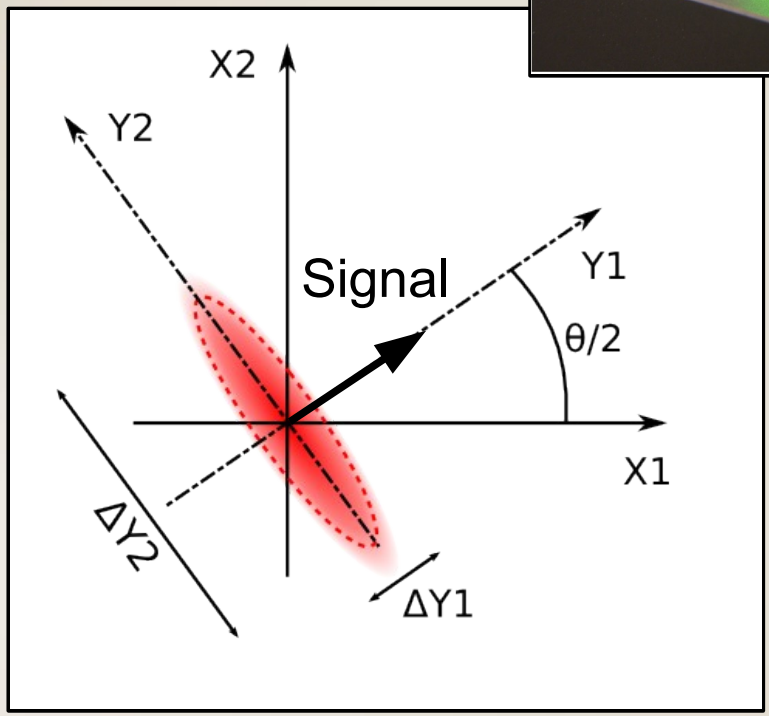
What is Squeezed Light?

Coherent State



Squeezed State

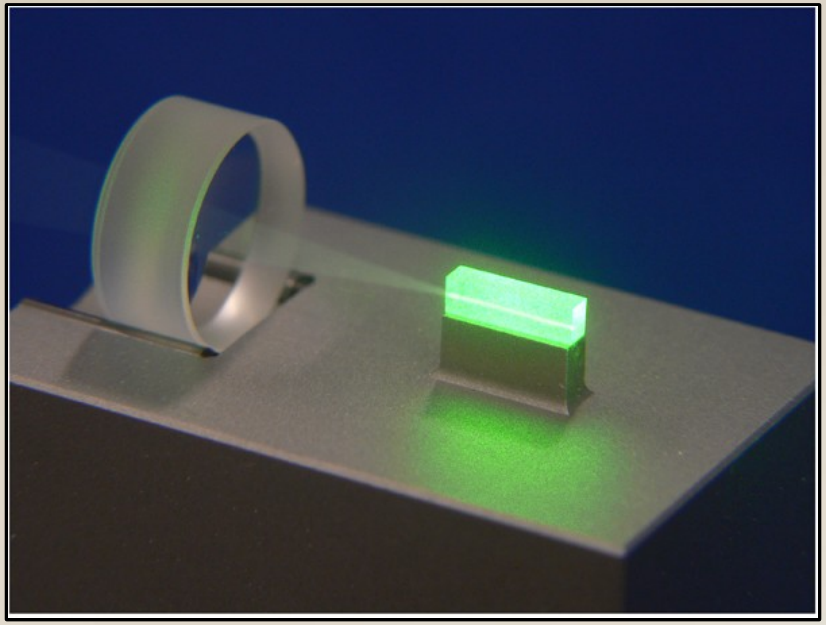




Uncertainty Principal: $\langle(\Delta\hat{X}_1)^2\rangle\langle(\Delta\hat{X}_2)^2\rangle \geq \frac{1}{16}$

www.squeezed-light.de

Generation of Squeezed Light



What do we need?

- A nonlinear crystal like
  - Lithium Niobate ($MgO:LiNbO_3$)
  - Periodically Poled Potassium Titanyl Phosphate (PPKTP)
- A pump beam at half the wavelength
- A resonator
  - To have a well defined mode

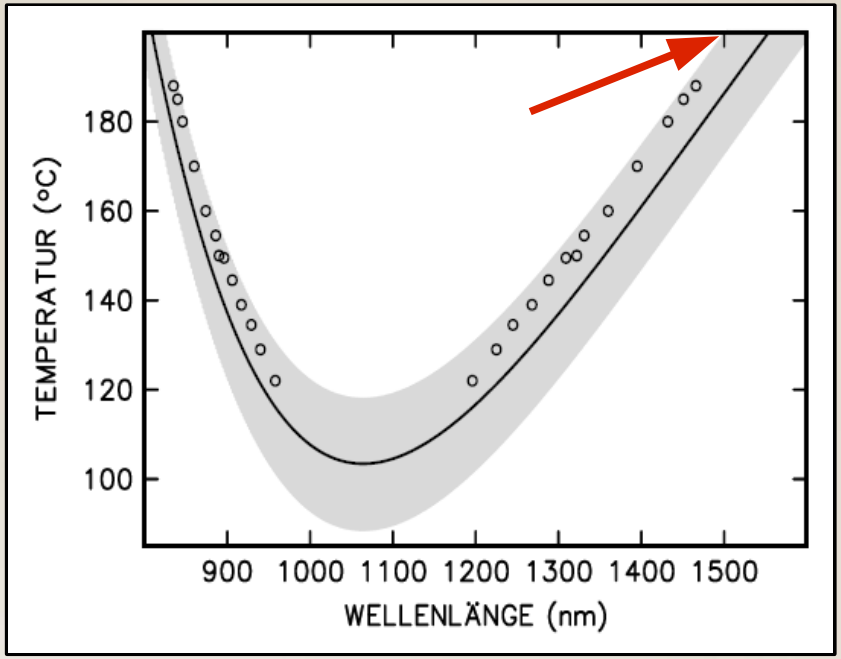
Nonlinear Crystals

Lithium Niobate ($MgO:LiNbO_3$):

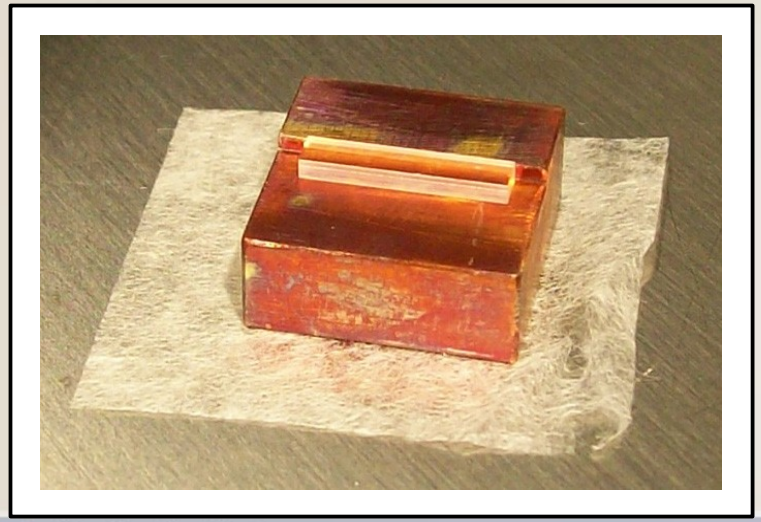
type I phasematching

\+ well-proven material with excellent results (10dB squeezing; audio band squeezing)

– very high phase matching temperature @ 1550nm (problems with stabilization, gradients, ...)



K. Betzler, Osnabrück



Periodically Poled Potassium Titanyl Phosphate (PPKTP):

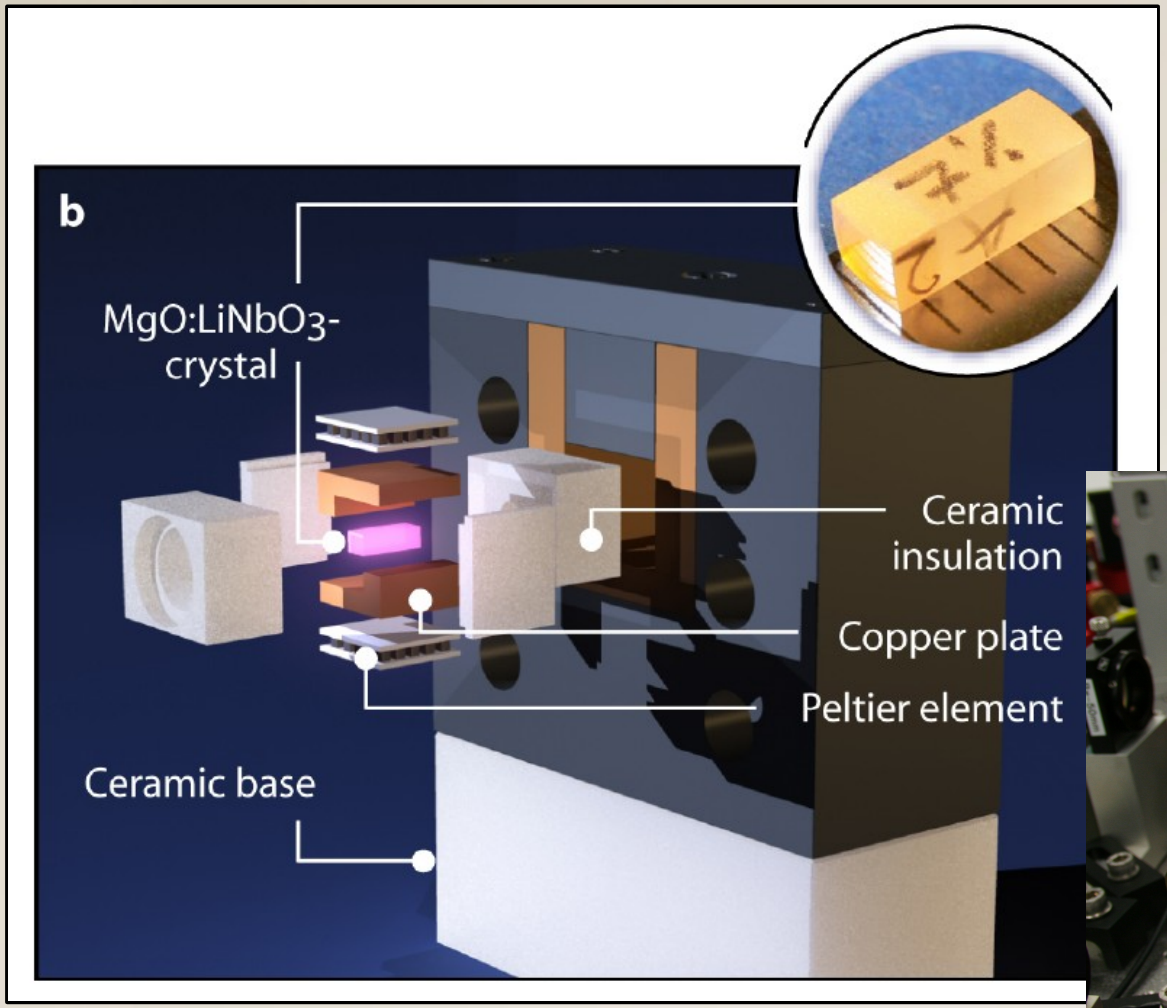
quasi phasematching

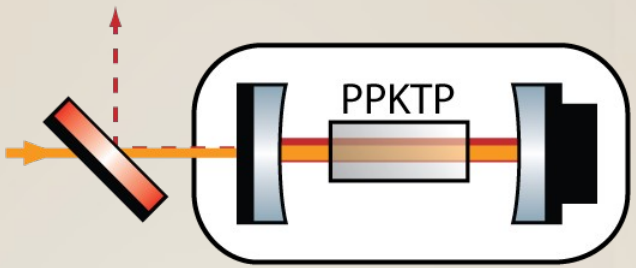
\+ higher nonlinearity

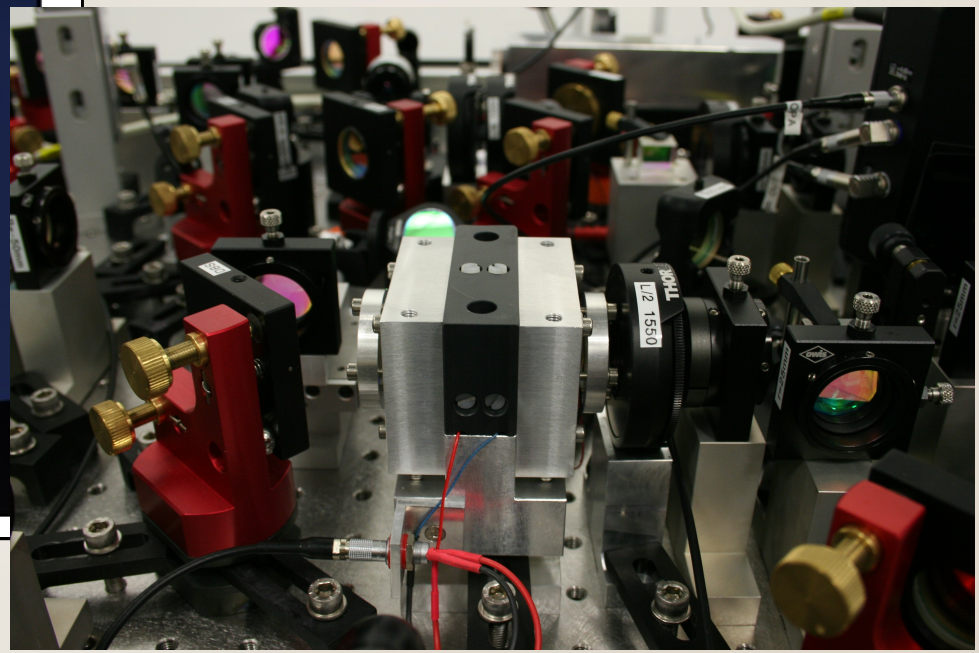
\+ adjustable phase matching temperature

– grey-tracking issues (though maybe not at 775nm/1550nm)

Squeezed Light Source

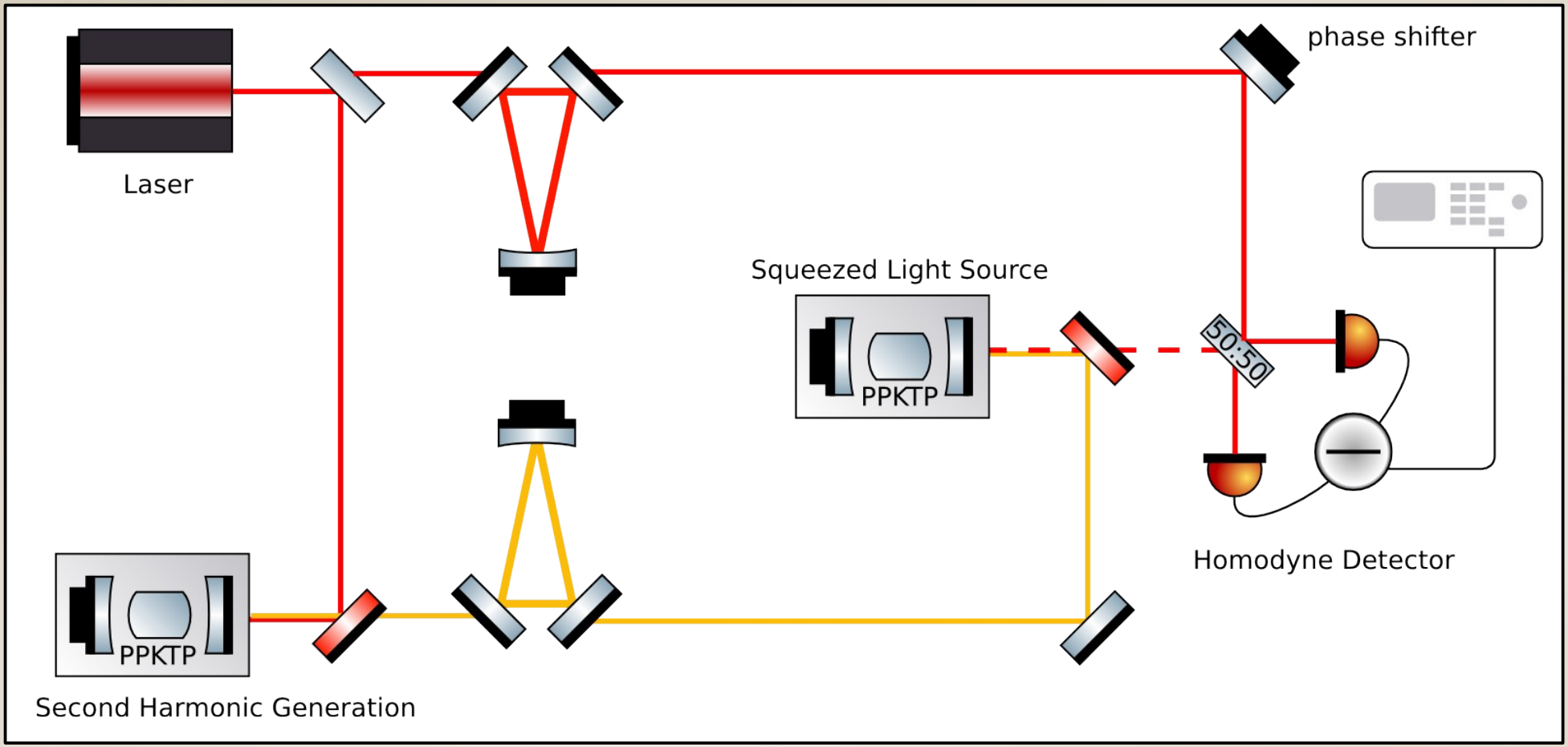






www.squeezed-light.de

Generation of Squeezed Light: Experimental Setup



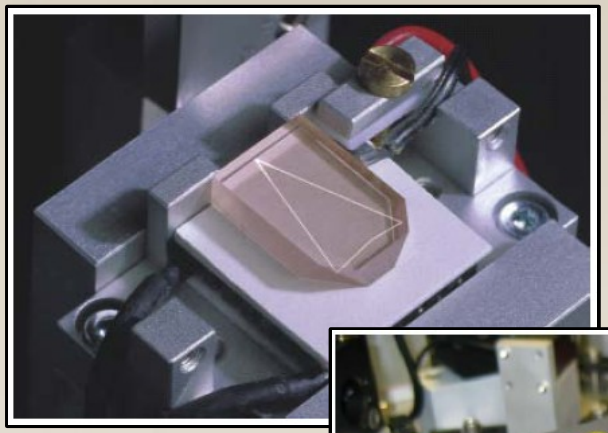
www.squeezed-light.de

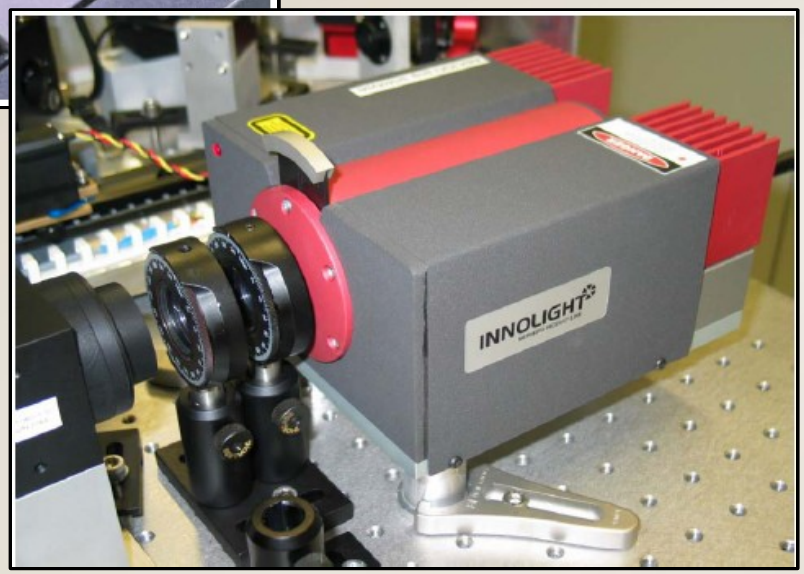
Lasers at 1064nm and 1550nm

1064nm

Well known technology:

- Non planar ring oscillator (NPRO)
- Nd:YAG



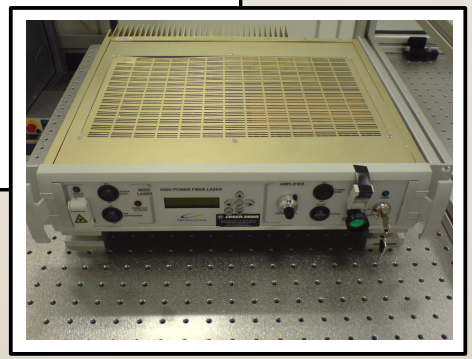


1550nm

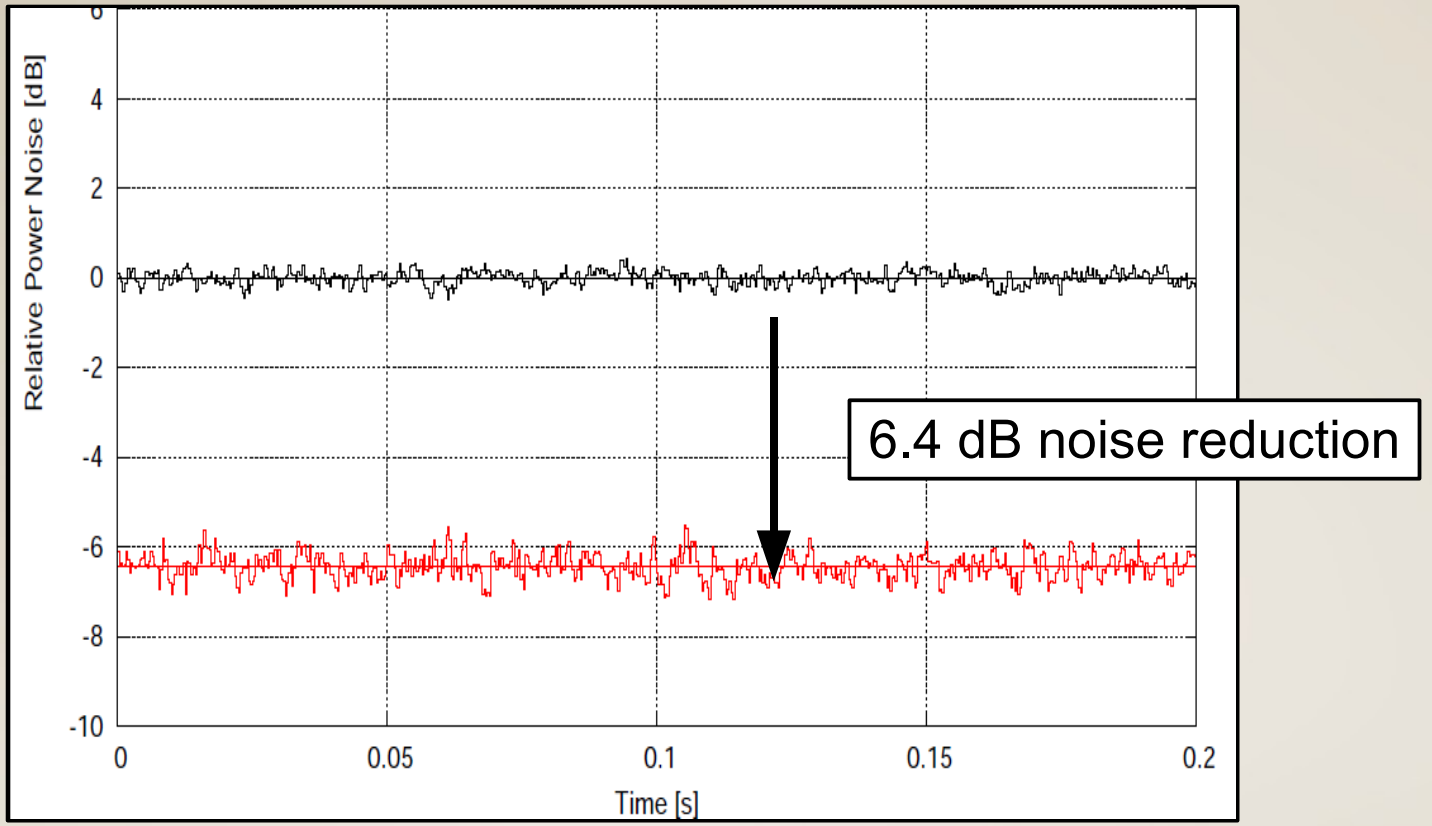
Technology: Erbium doped fiber

Commercially available:

- Reliable high power lasers for telecommunication purposes
- 1-2W polarization maintaining

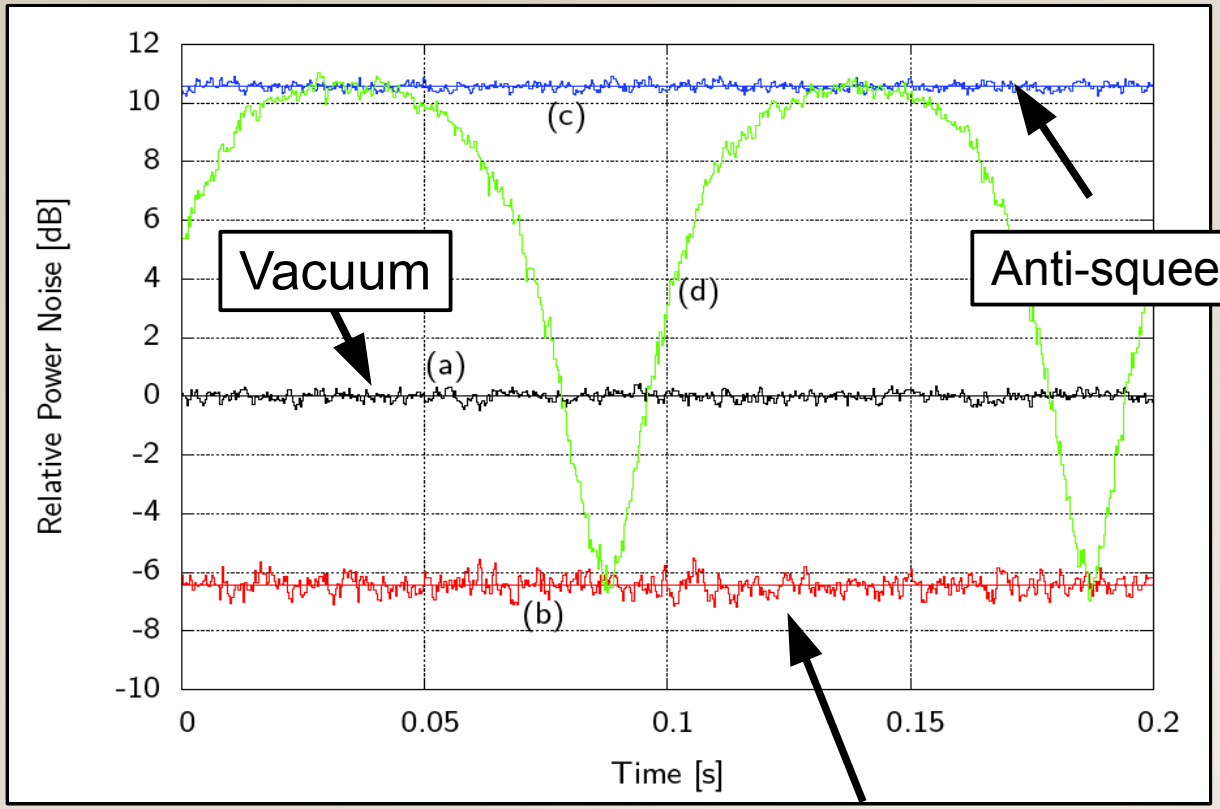


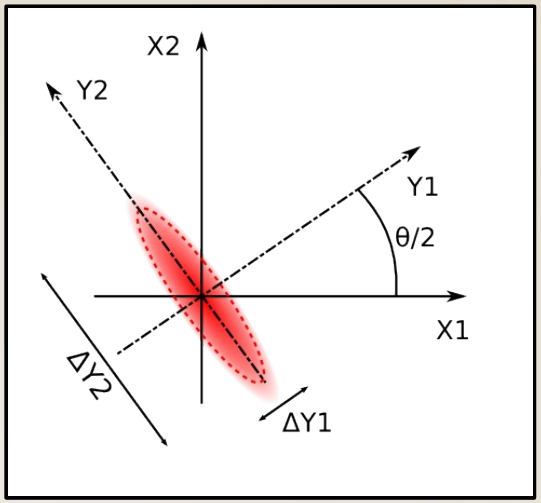
Results: Squeezing



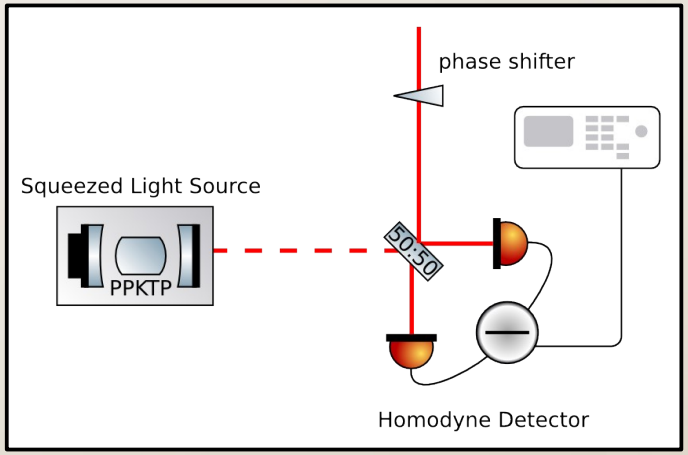
Sideband frequency: 5 MHz

Results: Squeezing / Antisqueezing





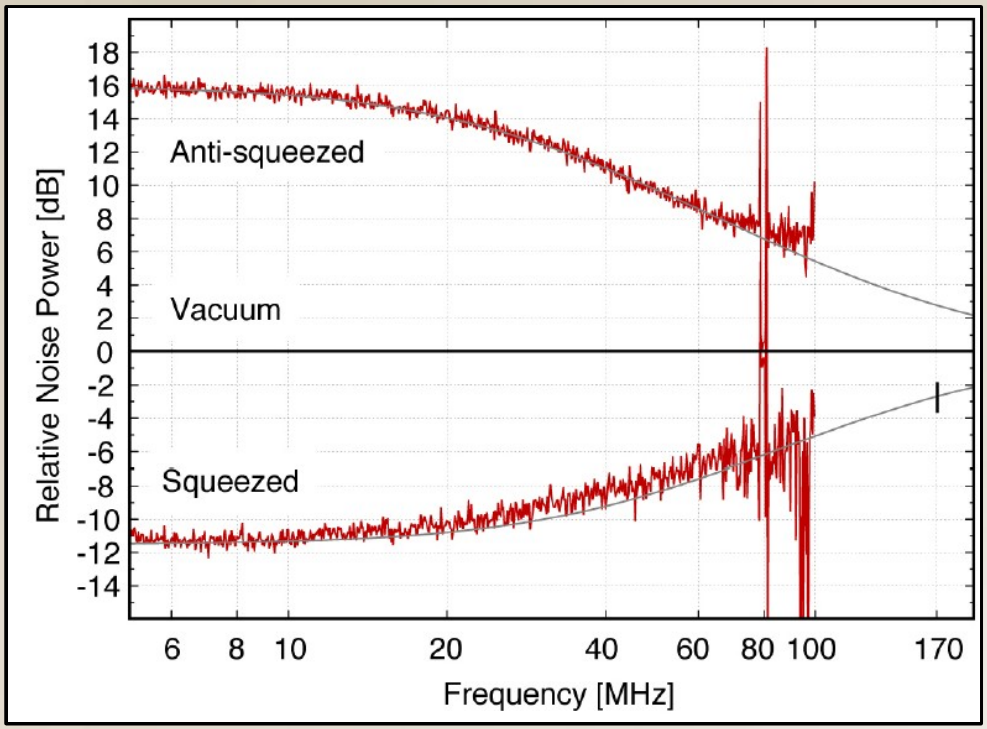
Sideband frequency: 5 MHz



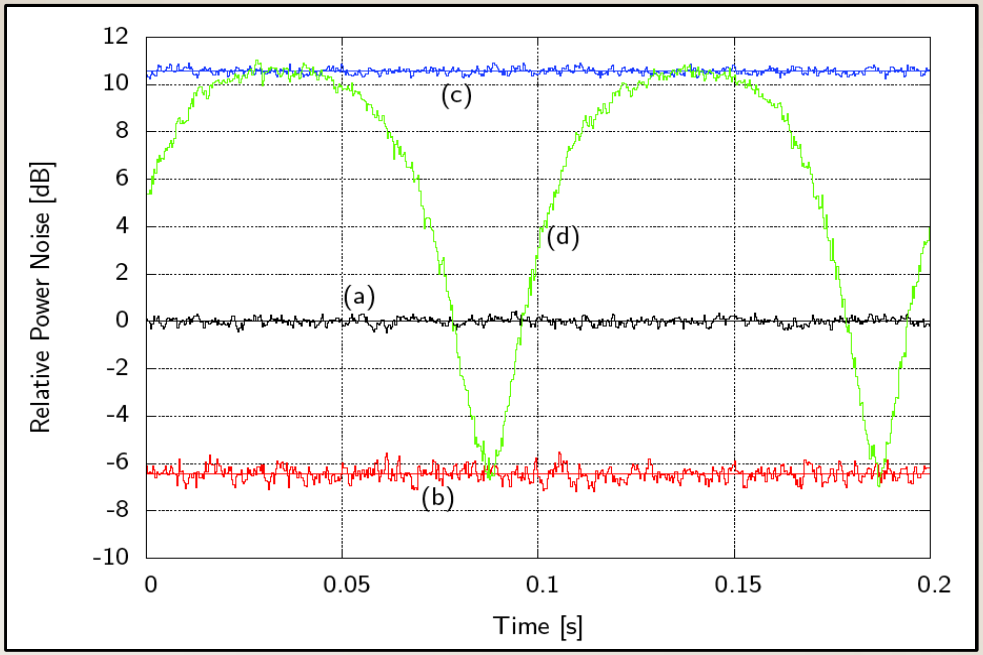
www.squeezed-light.de

Squeezed Light at 1064nm and 1550nm

1064nm



1550nm



Sideband frequency: 5 MHz

1550nm

- More squeezing possible with further investigation (e.g. lower losses)
- Audio frequencies feasible by applying same techniques as at 1064nm

www.squeezed-light.de

Conclusion

- Squeezed light can reduce shot-noise in interferometers
- Squeezed light is generated in nonlinear crystals: MgO:$LiNbO_3$ or PPKTP
- Squeezing is not only available at 1064nm but also at 1550nm:
  - 11.5dB @ 1064nm
  - 6.4dB @ 1550nm