Optimization of high order harmonic generation and application to holography

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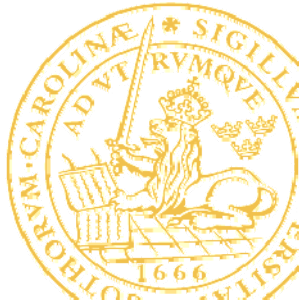
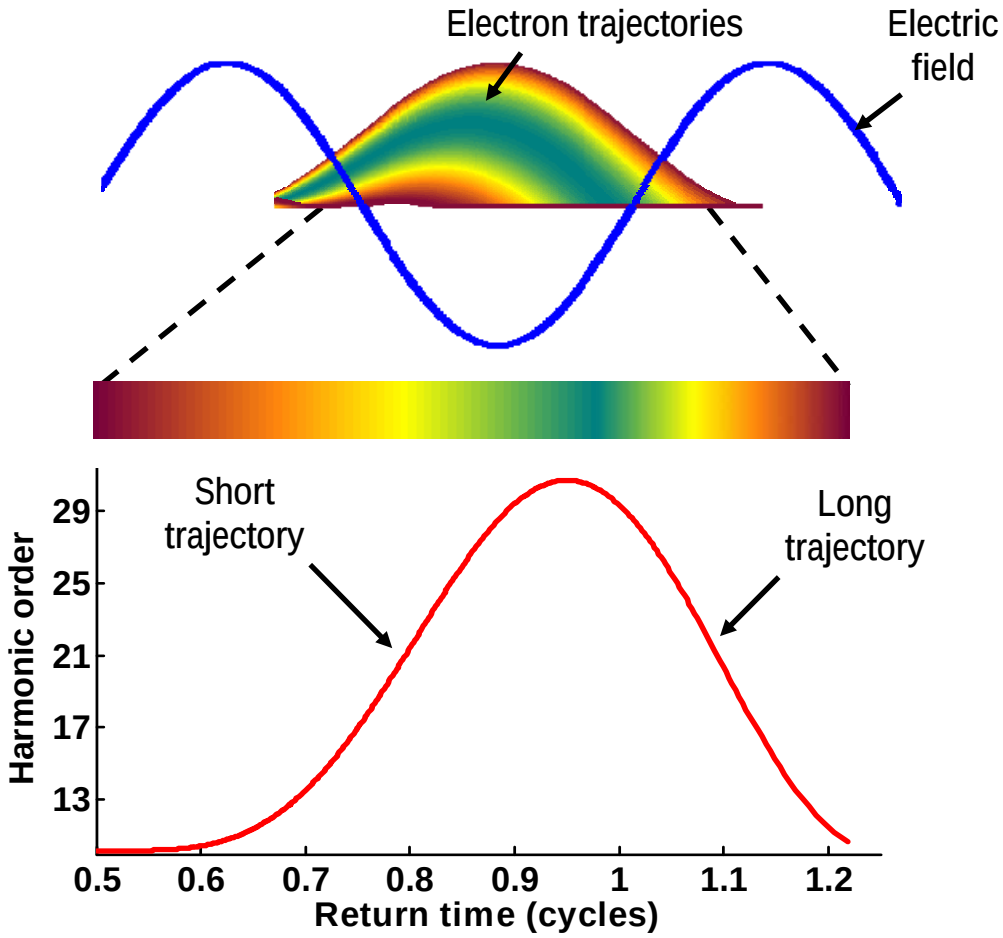
Lund Laser Centre

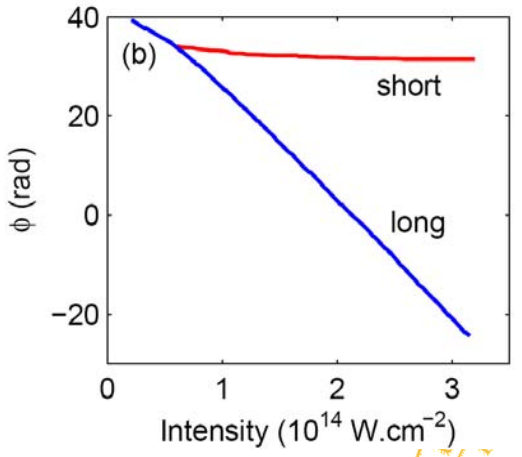


Physics of HHG — two trajectories

A Semi-Classical Picture



$$\Phi_j(\mathbf{r},t) = \alpha_j I(\mathbf{r},t),$$

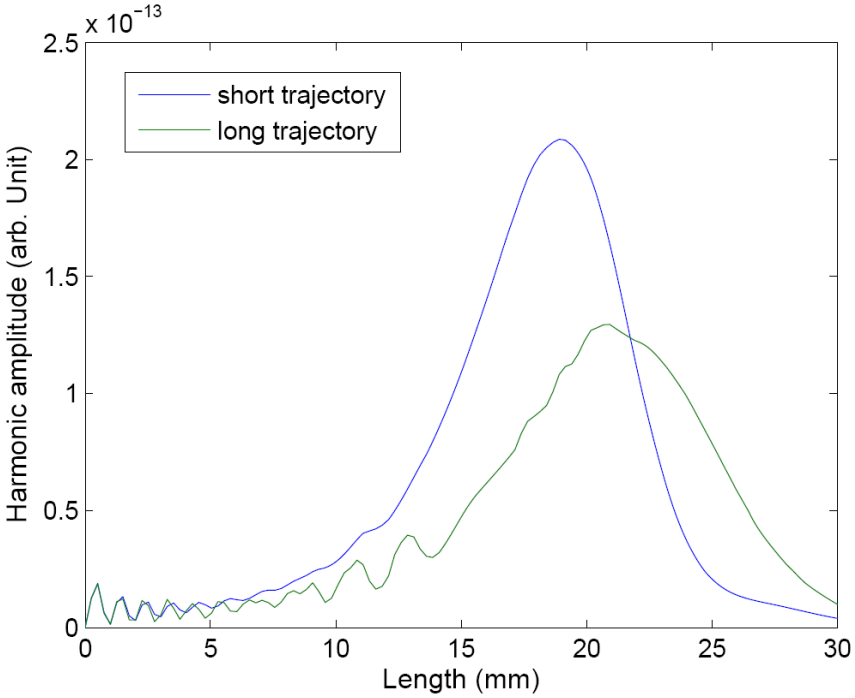


Phase-matching —1D simulation

$$\delta\Phi_q(z) = \Delta k_q z - q\arctan(z/z_R) + \alpha_j I(z),$$

$$\Delta k_q^f = 2\pi(q^2-1)e^2\mathcal{N}_f j/mcq\omega \geq 0$$

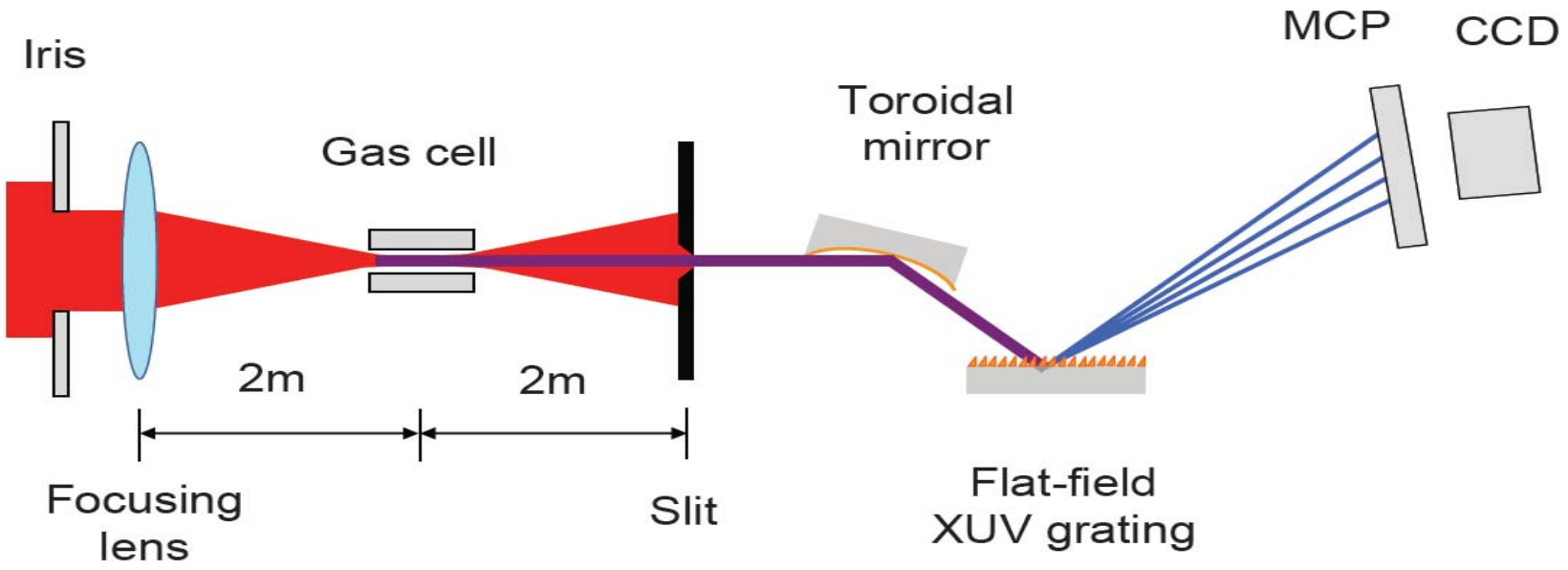
$$\Delta k_q^n = (n_q - n_1)q\omega/c \leq 0$$



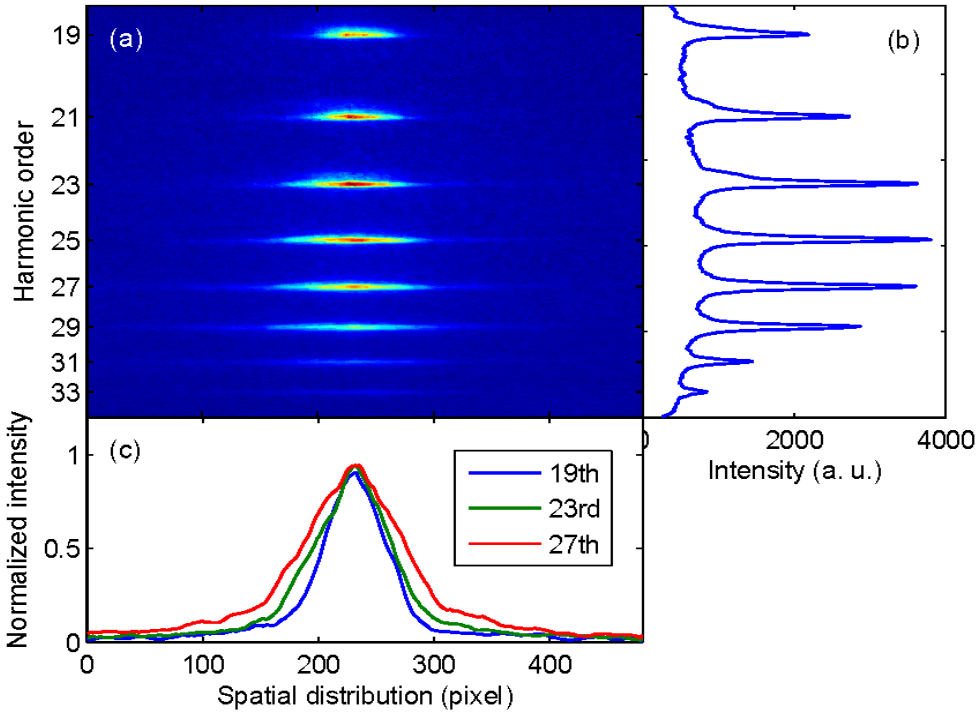
1D result for 21st harmonic from Ar

Harmonic generation setup

Laser : 100mJ 35~40fs

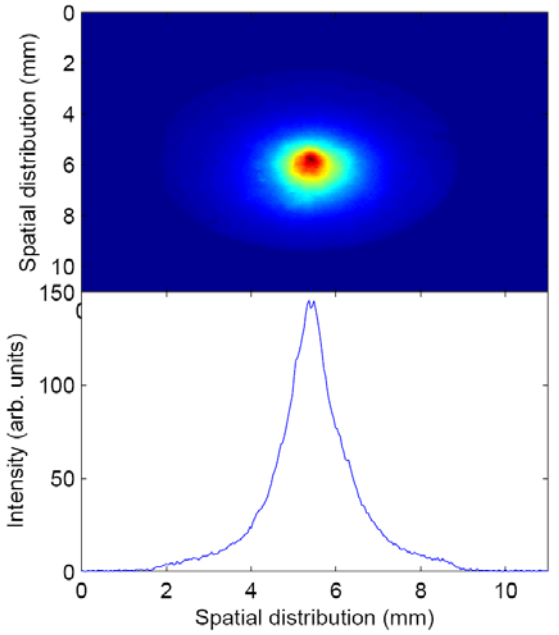


Divergence of the harmonic beam



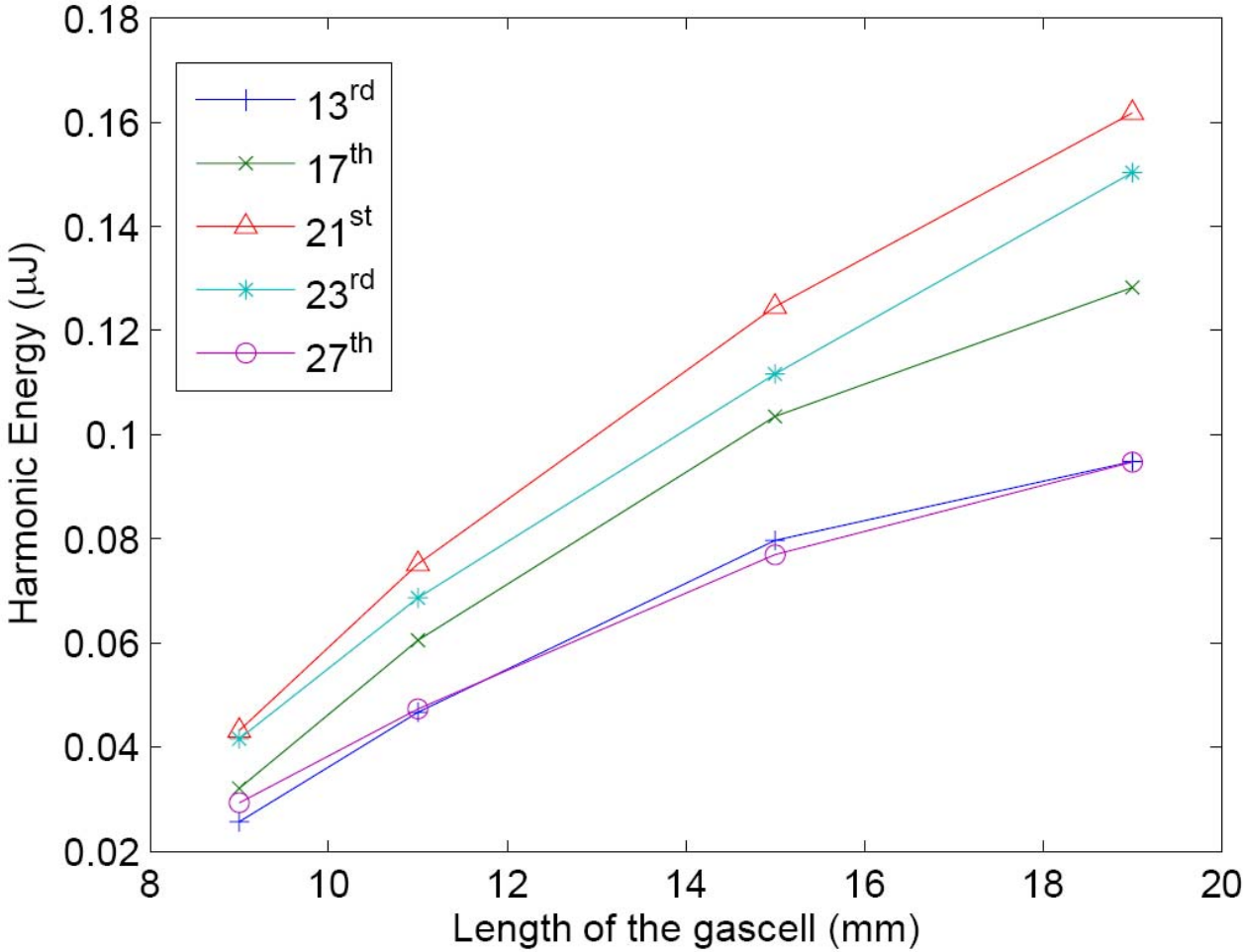
Typical experiment spectrum.

Beam profile: 0.7 mrad



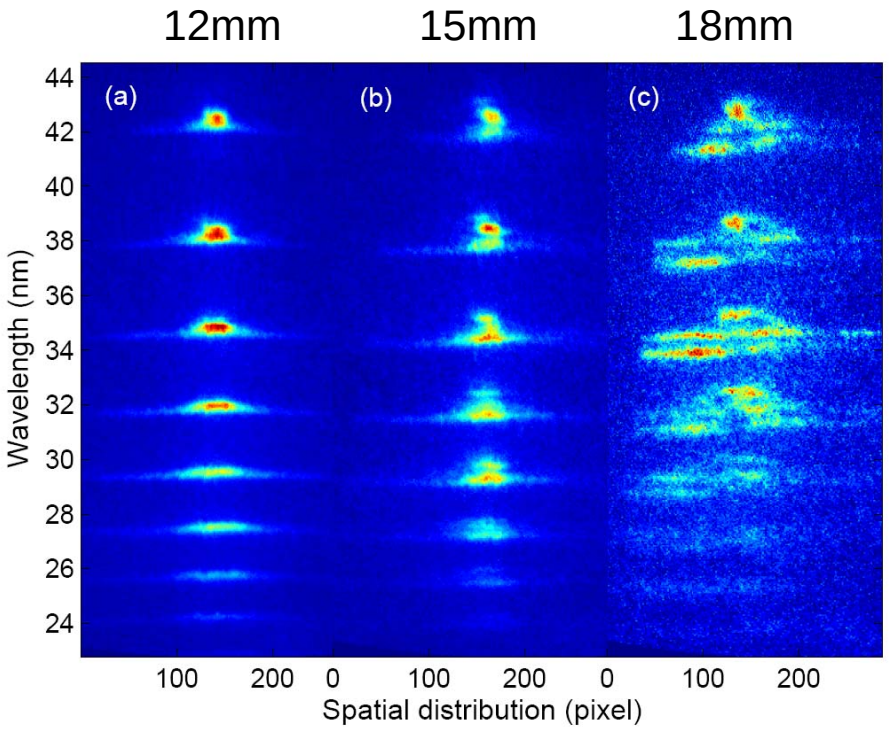
Measure the absolute harmonic energy

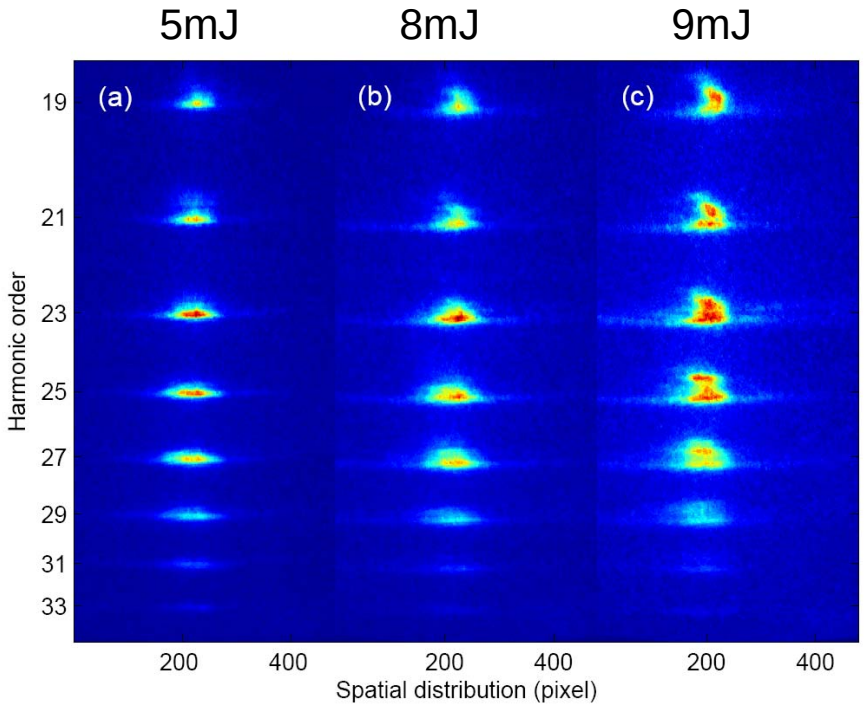
A calibrated XUV photodiode is used to measure the absolute energy of harmonic generation. Two 200 nm Al filters were needed to block the fundamental beam.



Possibility to broaden the wavelength

Spectrum with different iris





Spectrum with different energy

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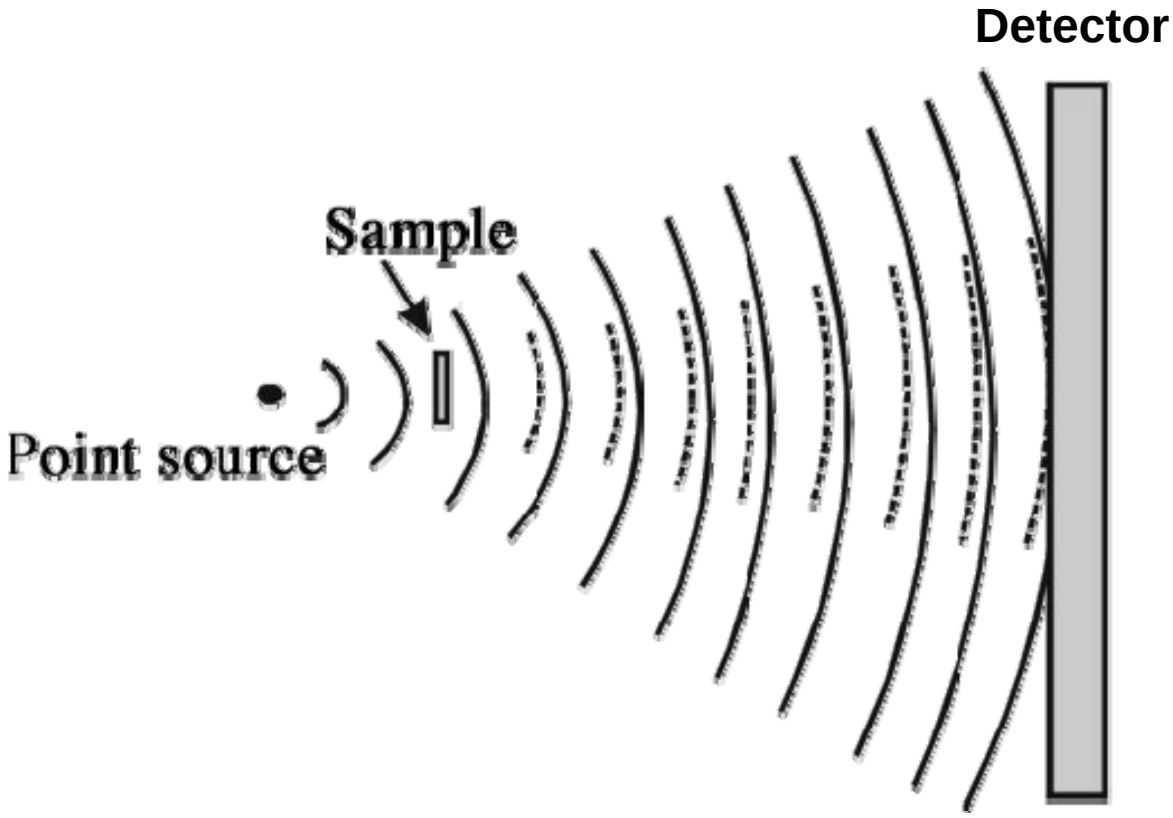
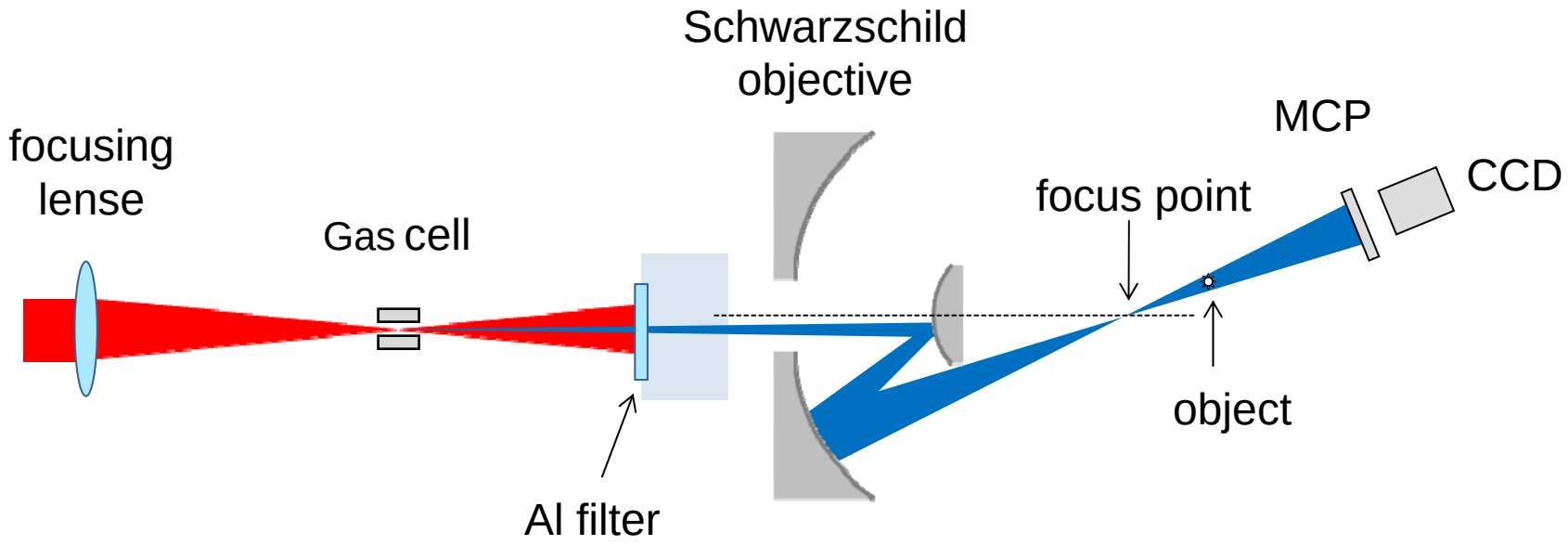
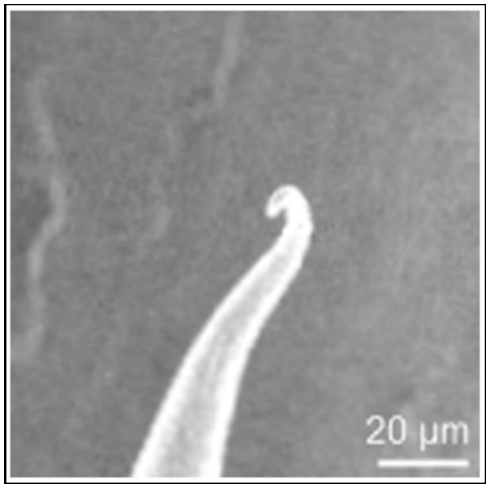
Digital in-line holography



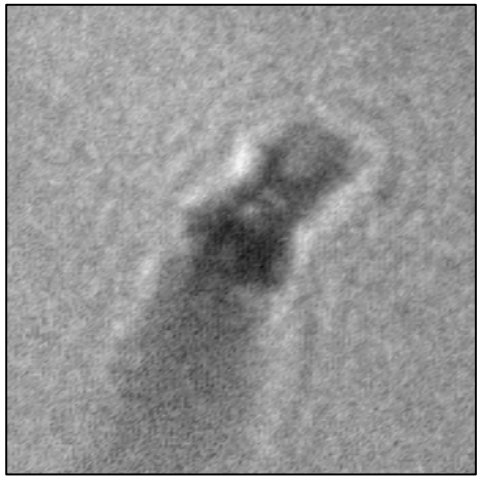
Holography setup

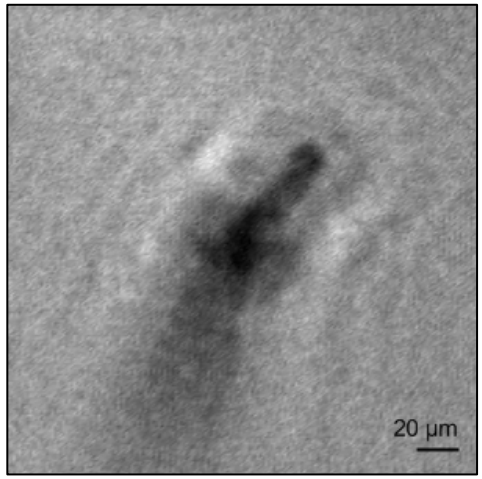


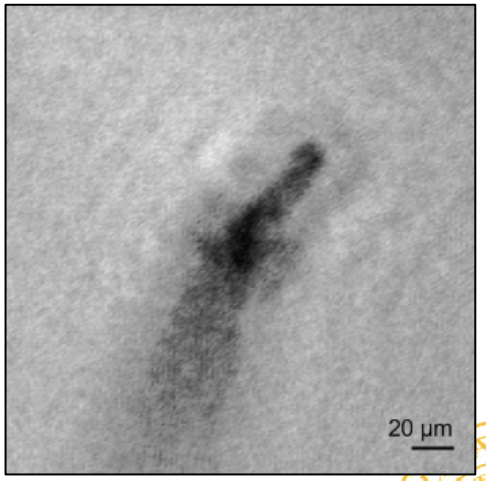
Tungsten microscope tips



Tip 2







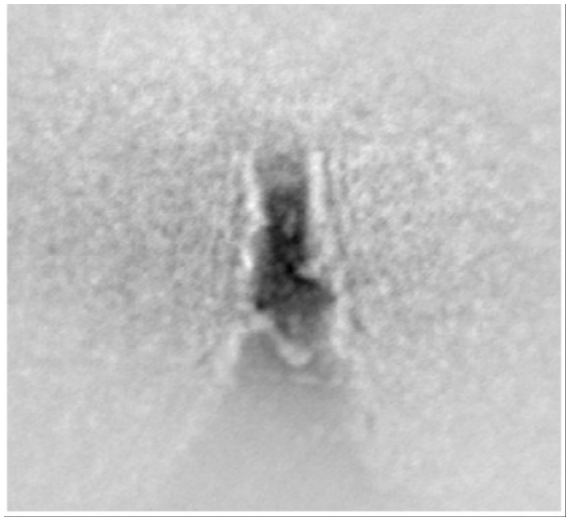
Hologram

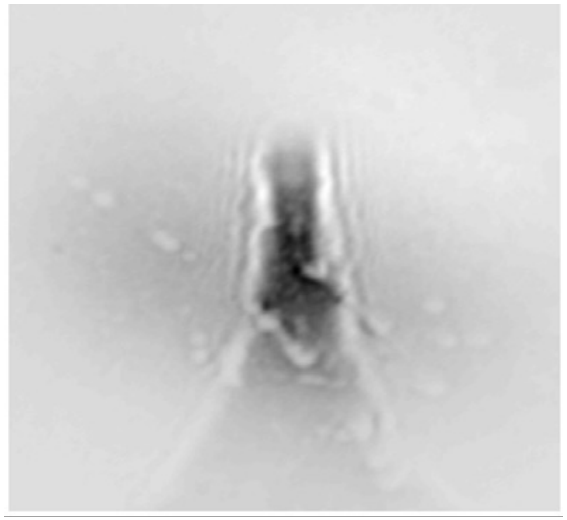
Reconstructed Object

After iteration

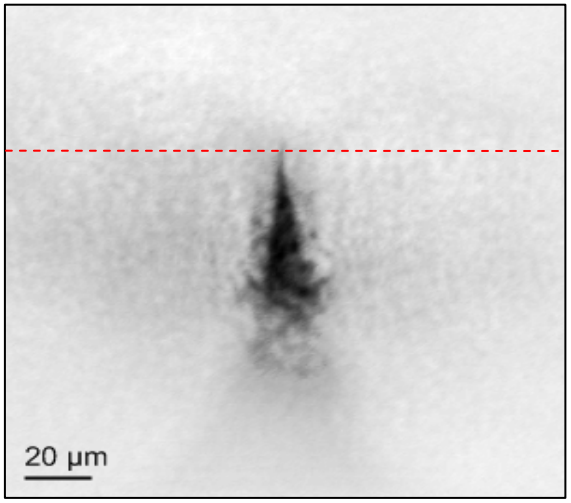
Single shot / multiple shots comparison

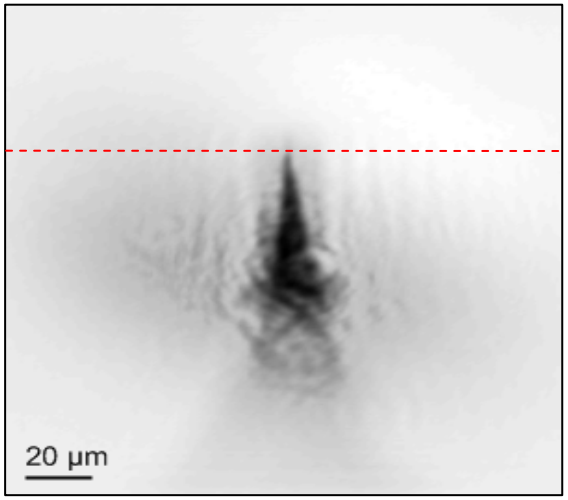
Hologram





Reconstructed objects





single shot

Tip width: 4.3 µm

multiple shots

Tip width: 4.7µm

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Summary

- *30~40nm, 170nJ,*
- *phase-matching is achieved,*
- *Single shot holography.*

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Thanks