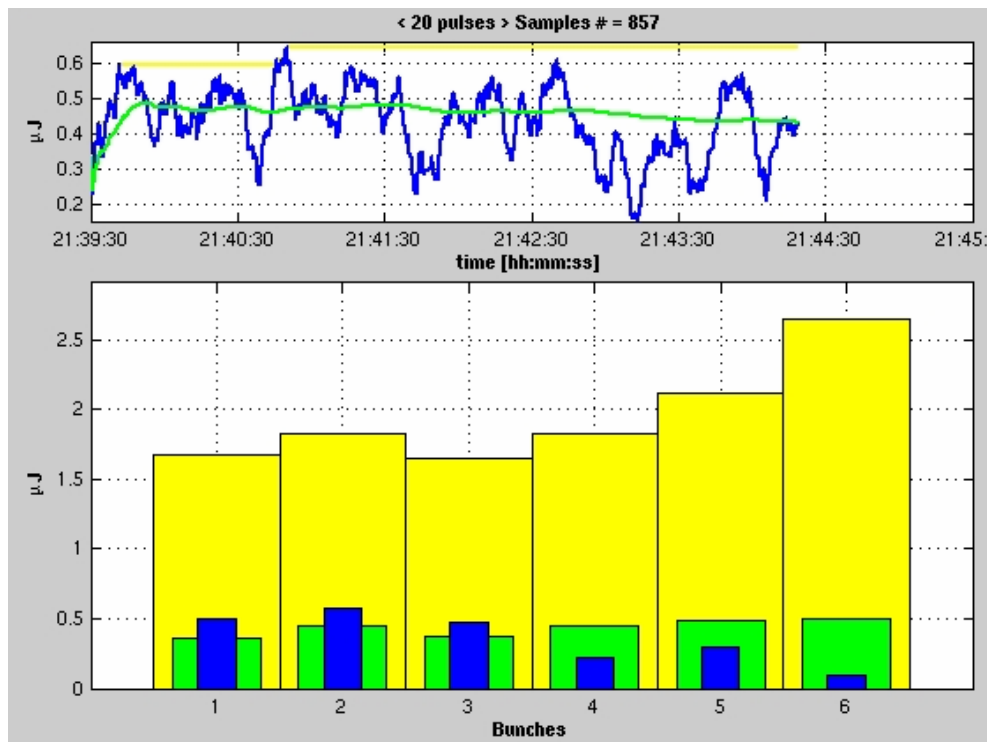


Slice emittance and bunch profile measurements with LOLA (09.10.07)

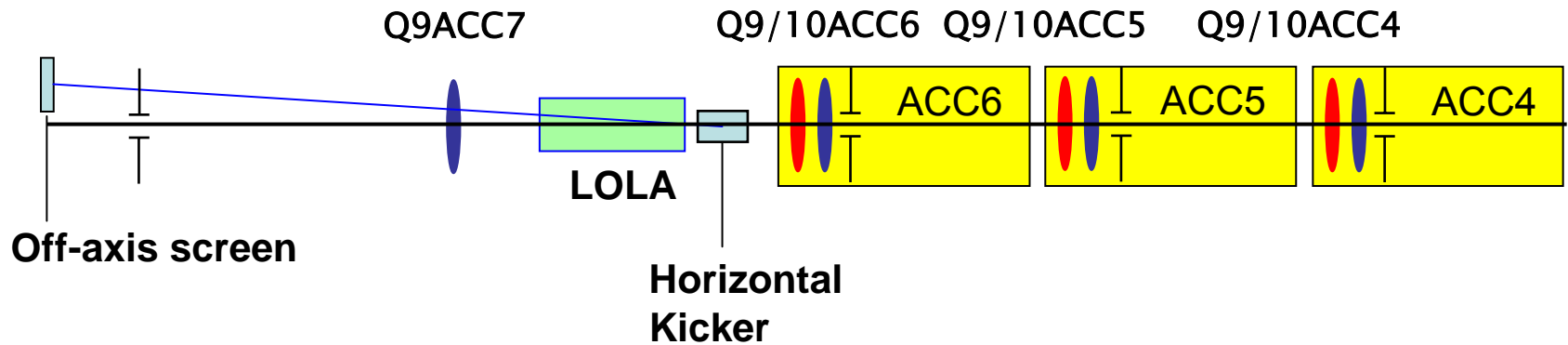
Michael Röhrs

Conditions (09.10.07)

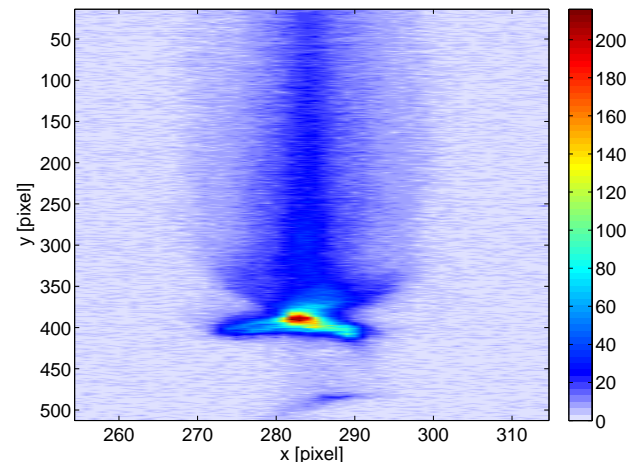
- Energy: 964 MeV
- SASE operation at 6.8 nm
- 0.5 μJ / pulse
- Charge: 0.67 nC
- ACC1-phase: -8.4°
- ACC23: on-crest



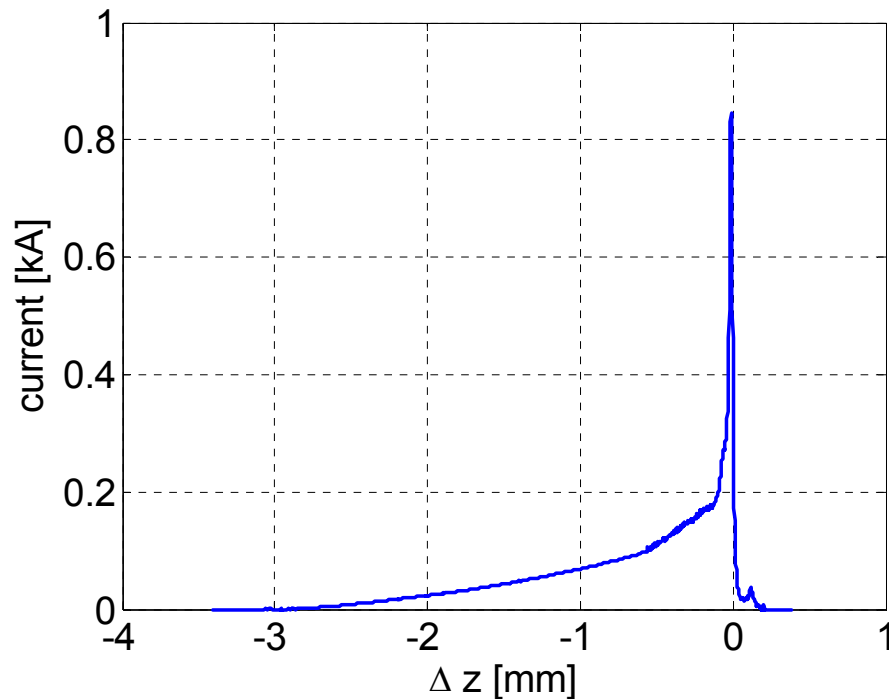
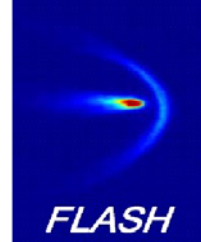
Problems



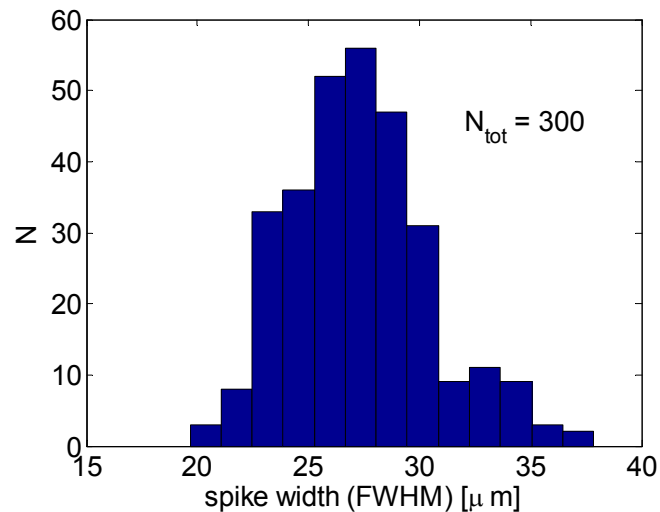
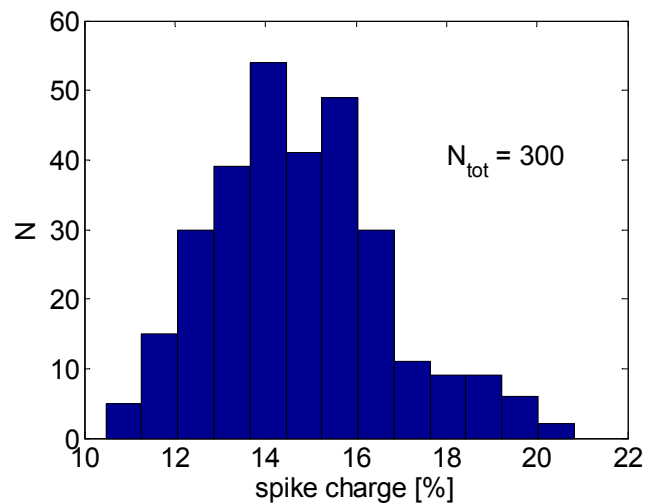
- Standard optics for multi-quadrupole-scan not applicable -> single quadrupole scan Q10ACC6
- Beam halo



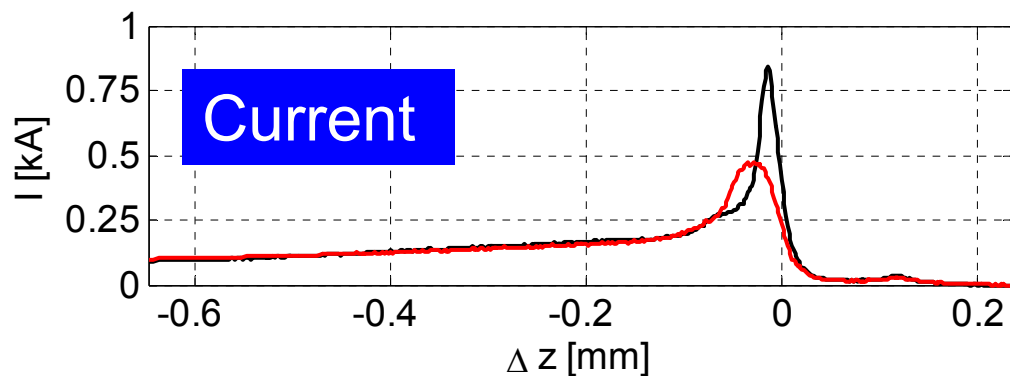
Current profile



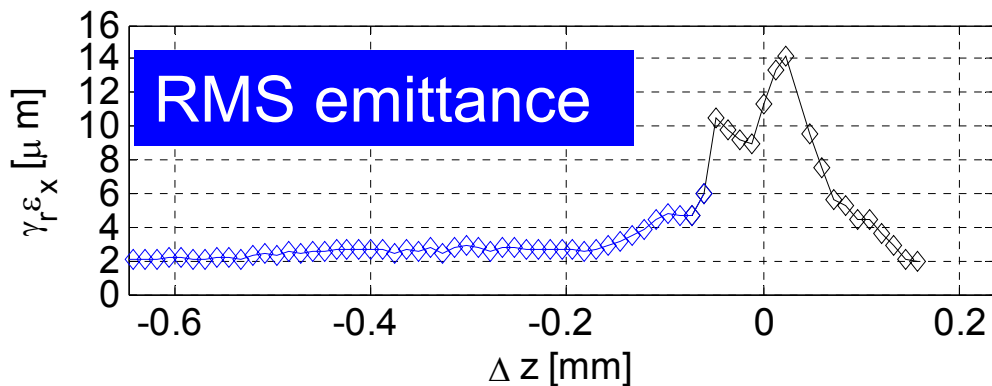
- Mean charge fraction in the spike: ~15 %
- Mean spike width (FWHM): 27.5 μm (82.5 fs)



Normalized RMS slice emittance



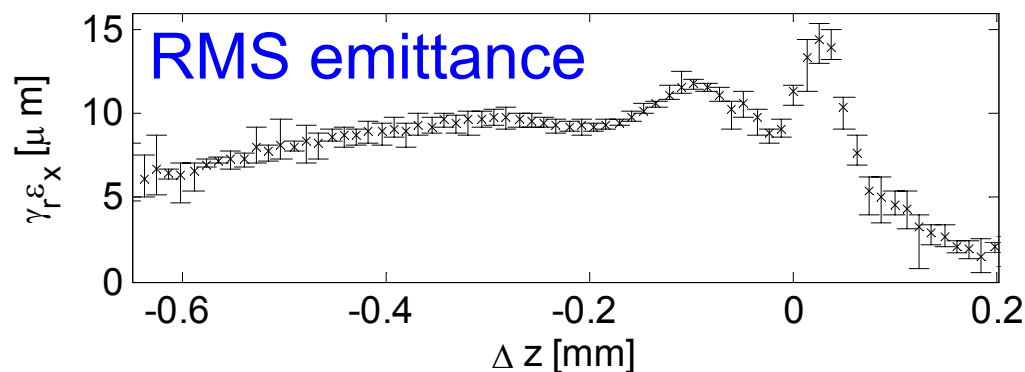
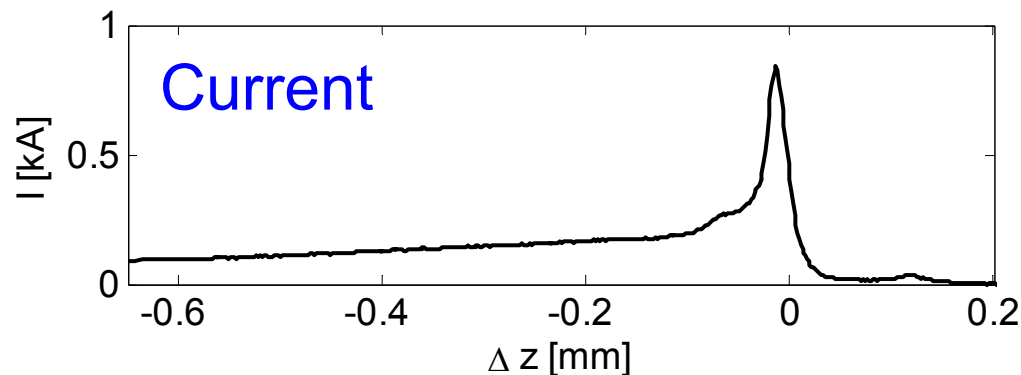
Best resolution
Worst resolution



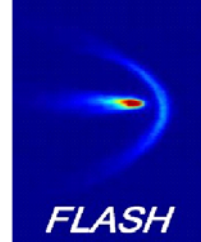
RMS method
Gauss-fit

Reproducibility of slice emittance results

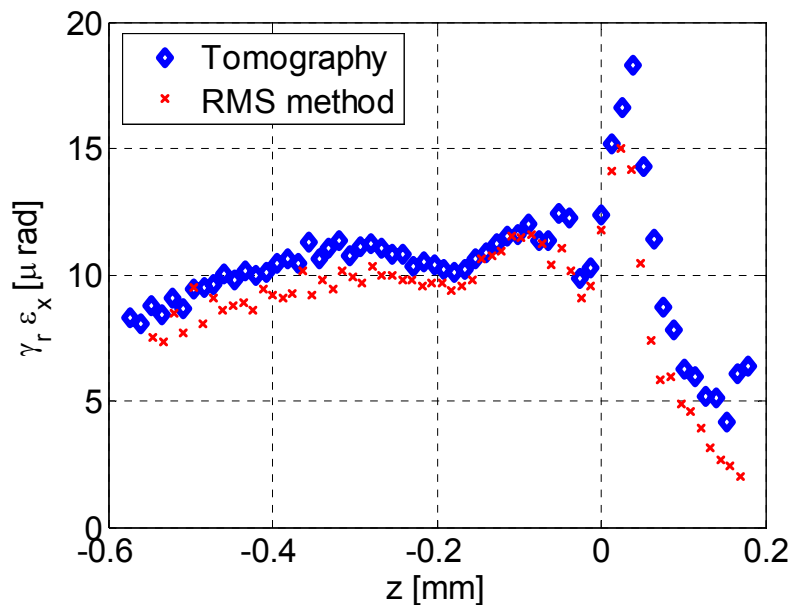
- 7 measurements in a row
- Error bars: mean, **maximum** and **minium** value for each slice
- Mean deviation (max-min)/min $\sim 12\%$



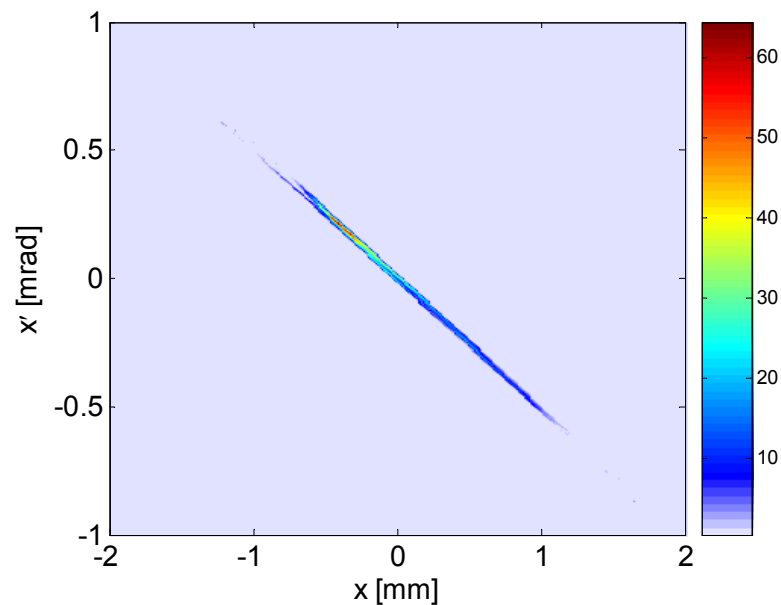
Phase space tomography



Comparison: Tomography and RMS-method



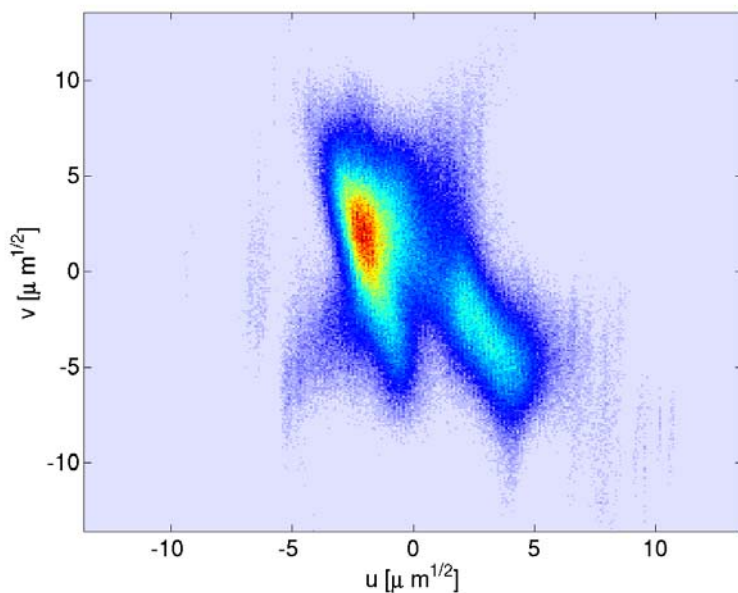
Horizontal Trace space of a single slice within the head



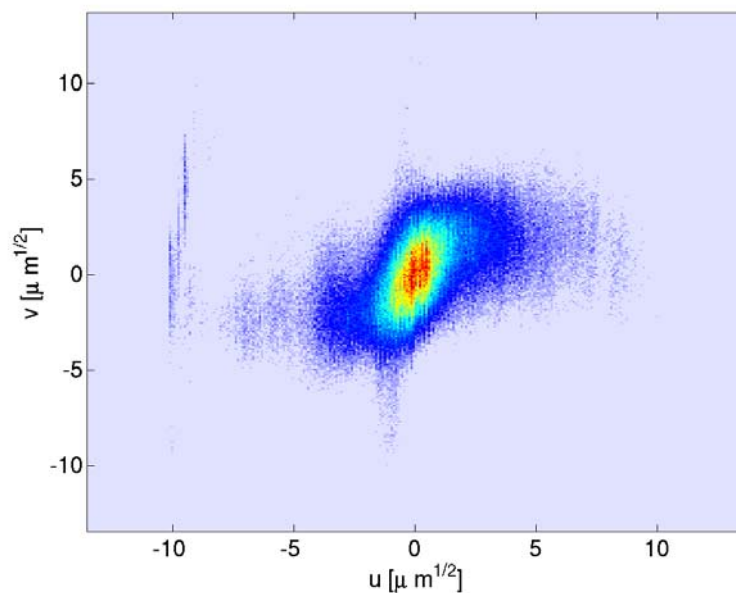
Maximum Entropy Algorithm, Implementation by J. Scheins

Transformation to normalized coordinates

Slice within the head

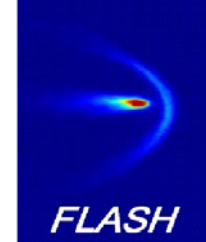


Slice within the tail

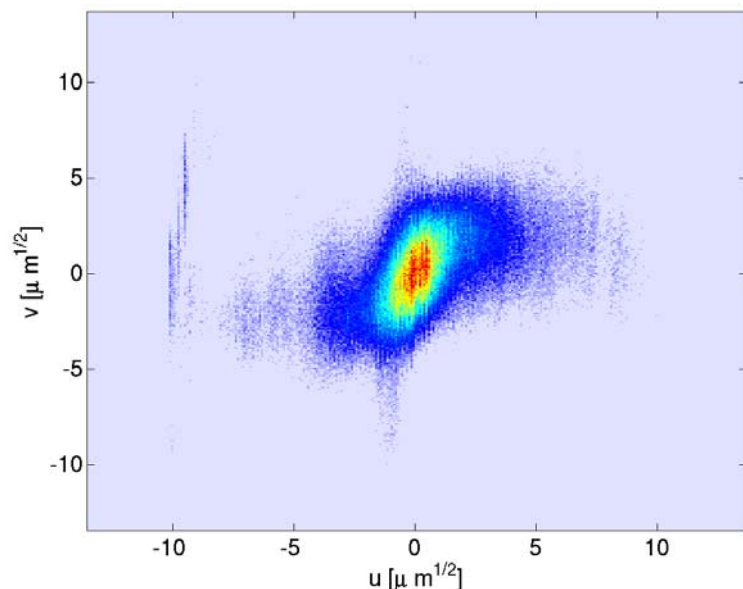


Circle with radius $1 \mu m^{1/2}$: area $\pi \mu m$, norm. emittance $1 \mu m$
 Reference: RMS ellipse parameters β, α, γ of the entire bunch

Core-emittance in the tail



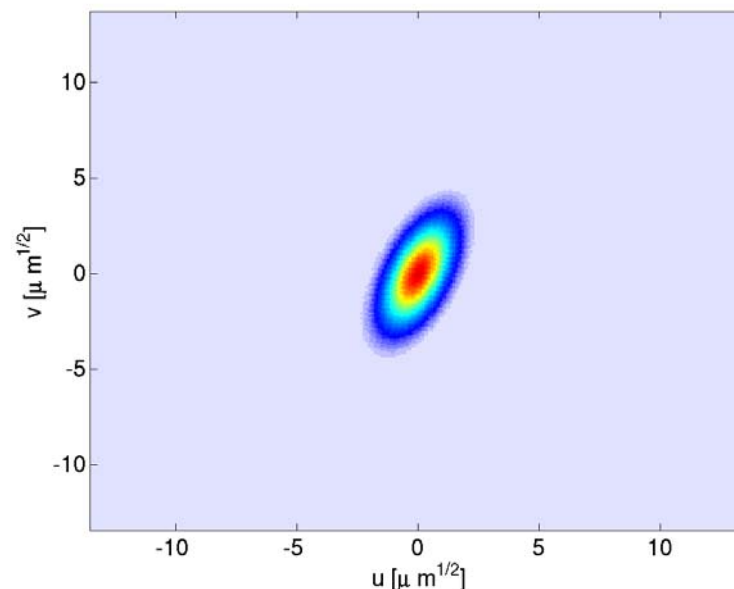
Horizontal phase space of
a single slice in the tail:



Norm. rms emittance: 10 μm

Gauss-fit to profiles: 2 μm

2d-gauss-fit to the intensity
peak:

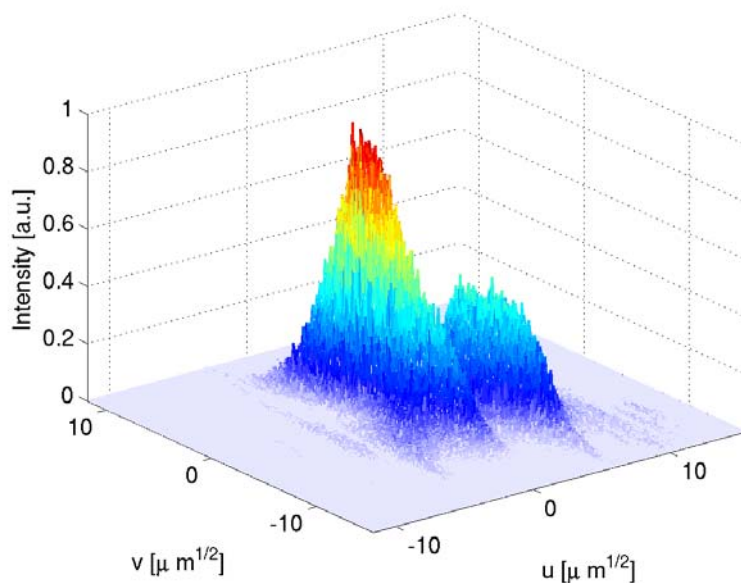


Norm. rms emittance: 1.3 μm

43 % of slice charge

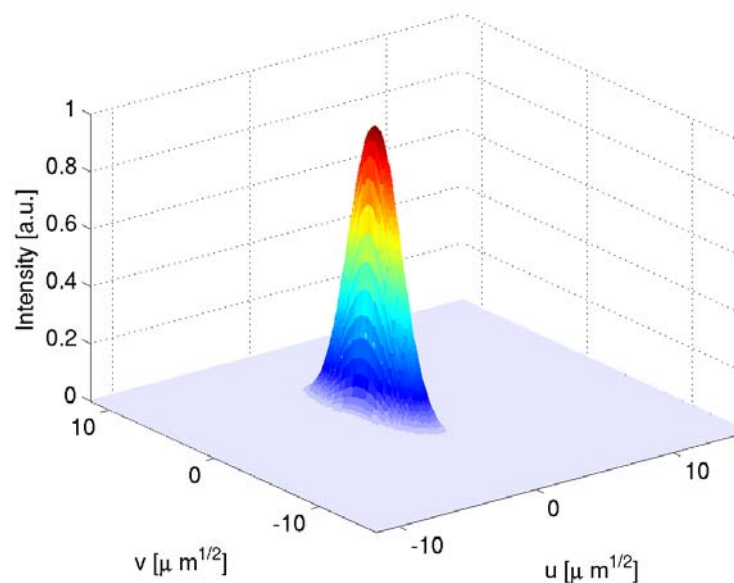
Density peak in phase space

Horizontal phase space of
a single slice in the head:



Norm. rms emittance: $10 \mu\text{m}$

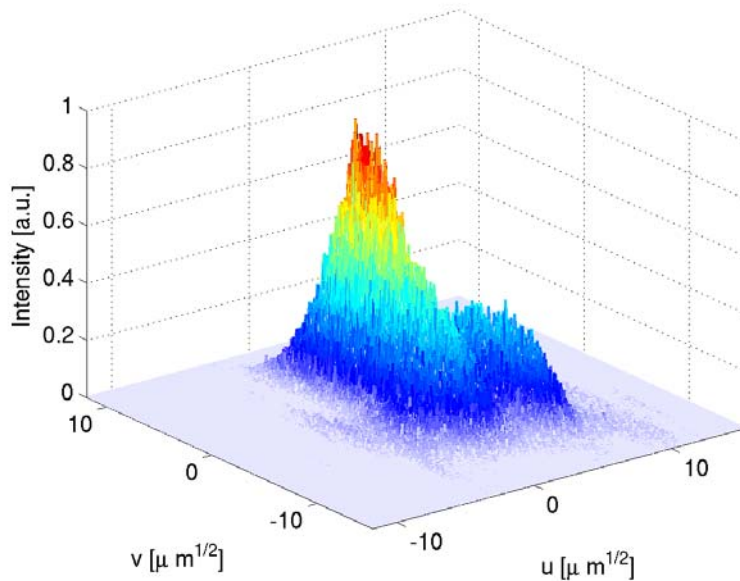
2d-gauss-fit to the intensity
peak:



Norm. rms emittance: $1.1 \mu\text{m}$
26 % of slice charge

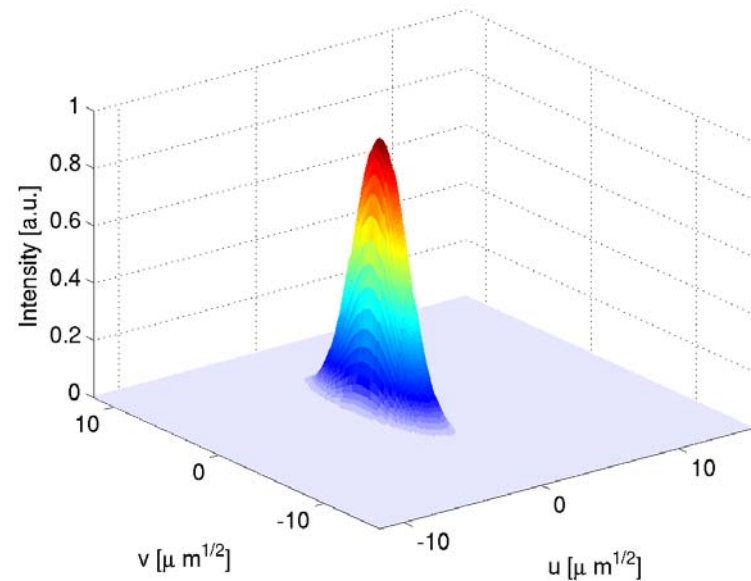
Density peak in phase space

Horizontal phase space of entire head (FWHM) :



Norm. rms emittance: 11 μm

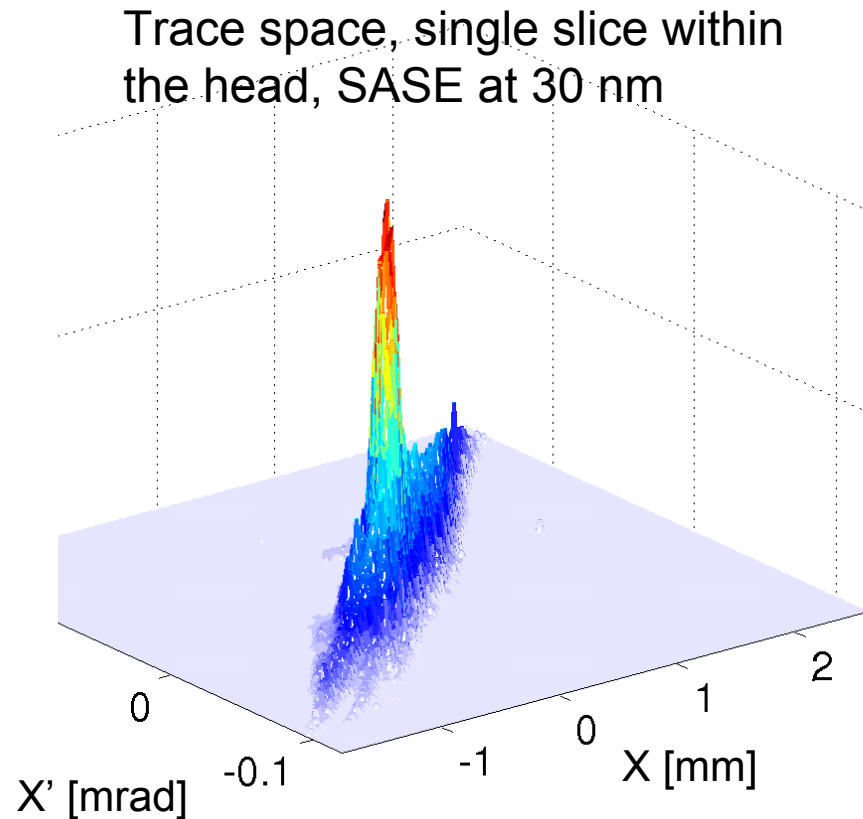
2d-gauss-fit to the intensity peak:



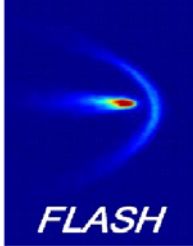
Norm. rms emittance: 1.4 μm
28 % of head charge

Current of the small-emittance fraction

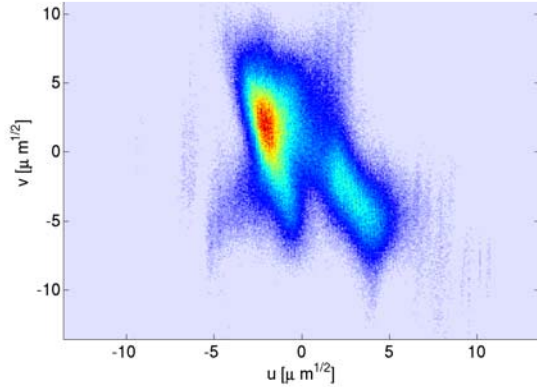
- Expectation at high radiation energy per bunch: 2-3 kA
- Here: only $\sim 0.5 \mu\text{J}$
- Compression in the dogleg-section?
- Peak current may be clearly larger than measured due to resolution limits
- Measurements with better resolution and at higher radiation energy : $\sim 40 \%$ of slice charge, $1.3 \mu\text{m}$ norm. emittance



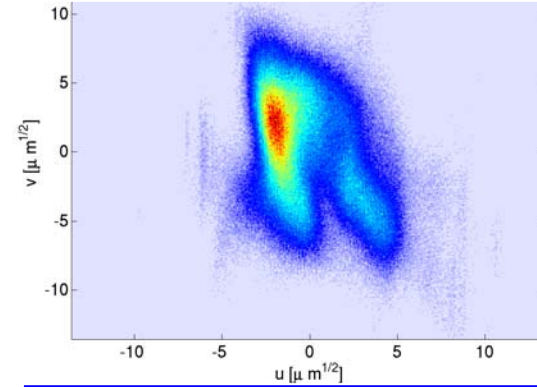
Horizontal phase space structure



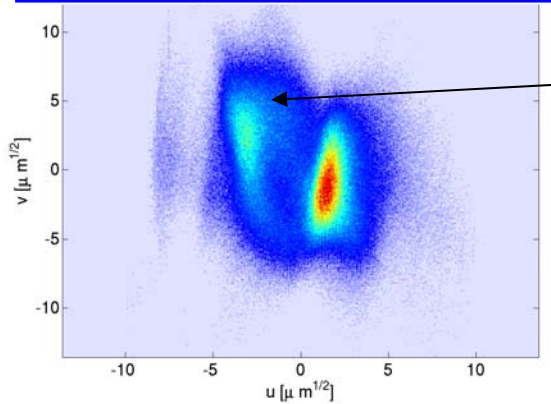
Slice within the head



Entire head (FWHM)

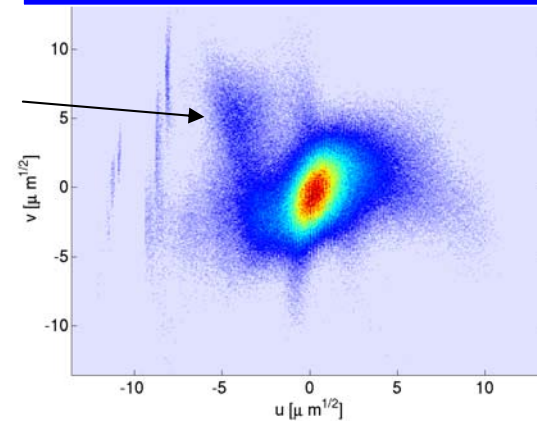


Head and Surroundings

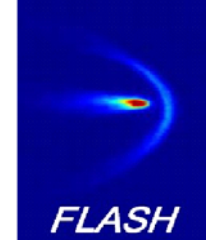


Head

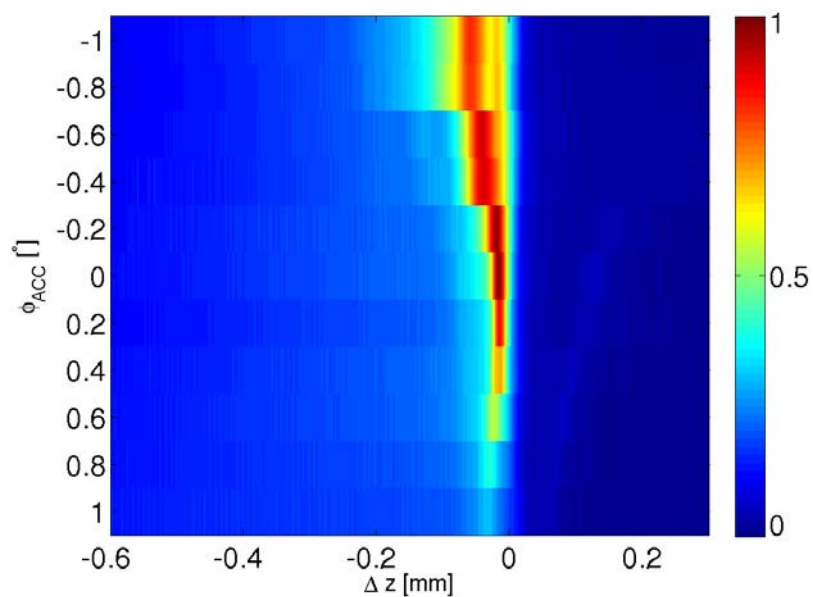
Entire bunch



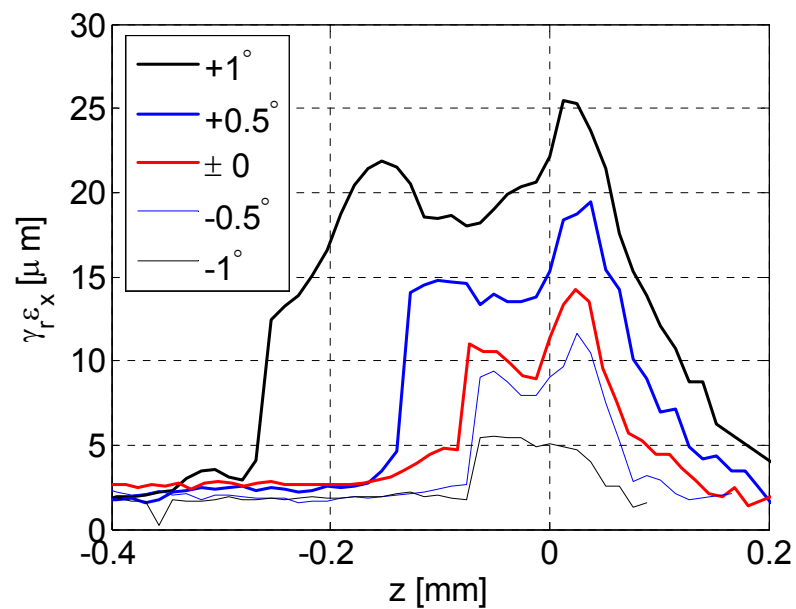
Phase scan ACC1



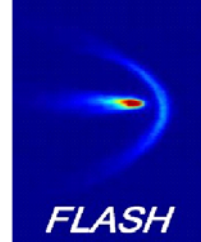
Current profile:



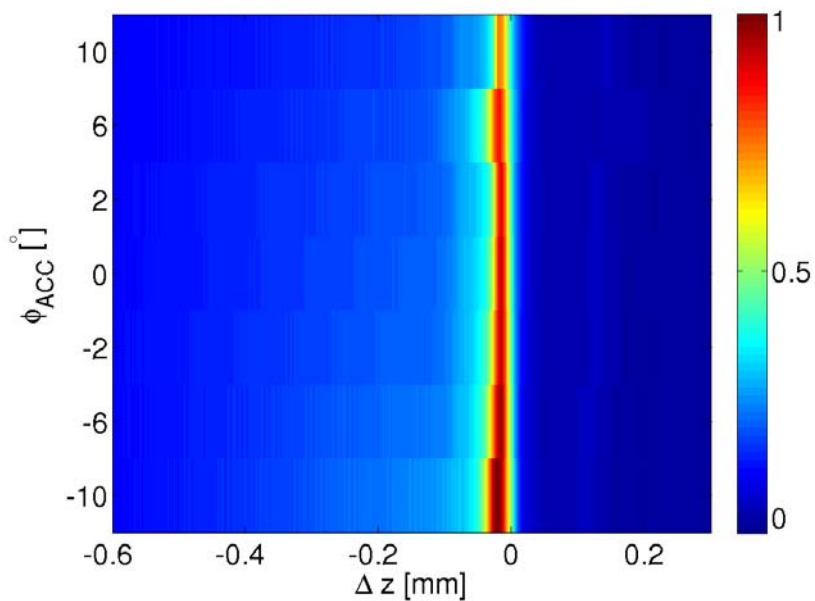
Normalized emittance:



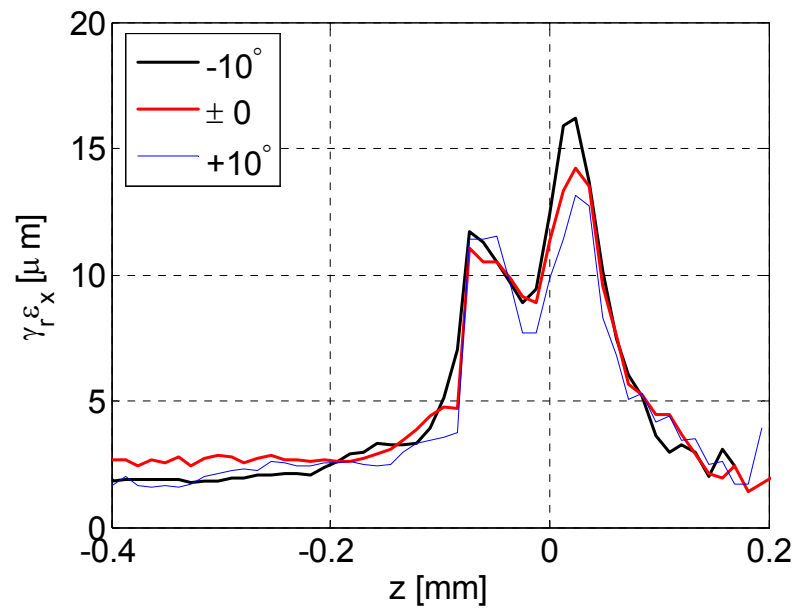
Phase scan ACC2,3



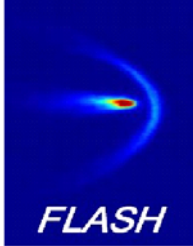
Current profile:



Normalized emittance:



Outlook



- Alternative optics including less quadrupoles with a reasonable resolution
- Comparison with simulations

Thanks to:

C. Gerth, H. Schlarb, V. Kocharyan,
E. Schneidmiller, F. Löhler