Introduction to the longitudinal phase space tomography at PITZ

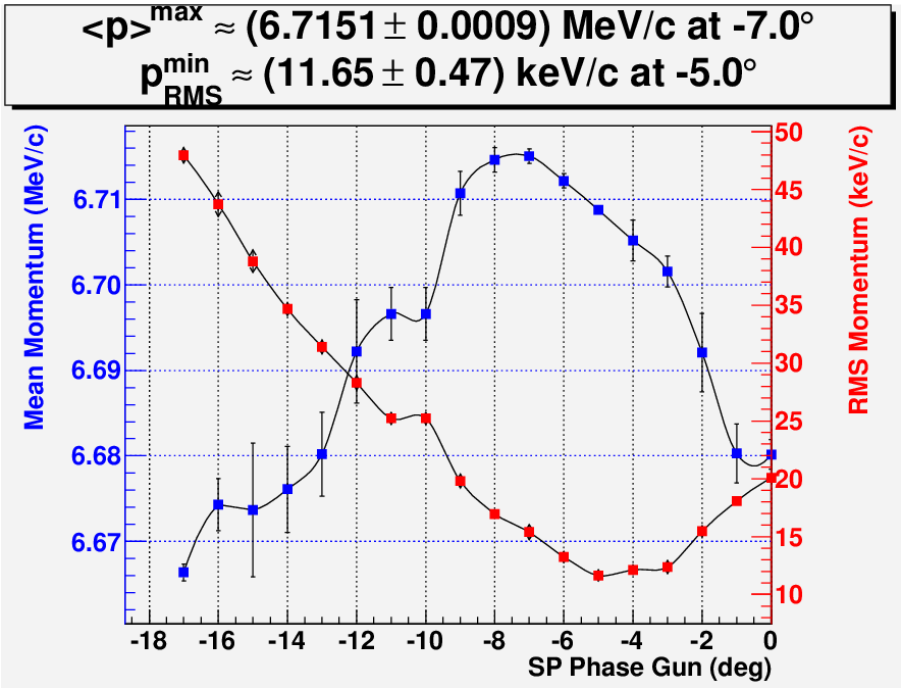
1. **Example of the momentum phase scan 2011.05.07N, momentum resolution.**
2. **Longitudinal phase space rotation.**
3. **Conclusion**

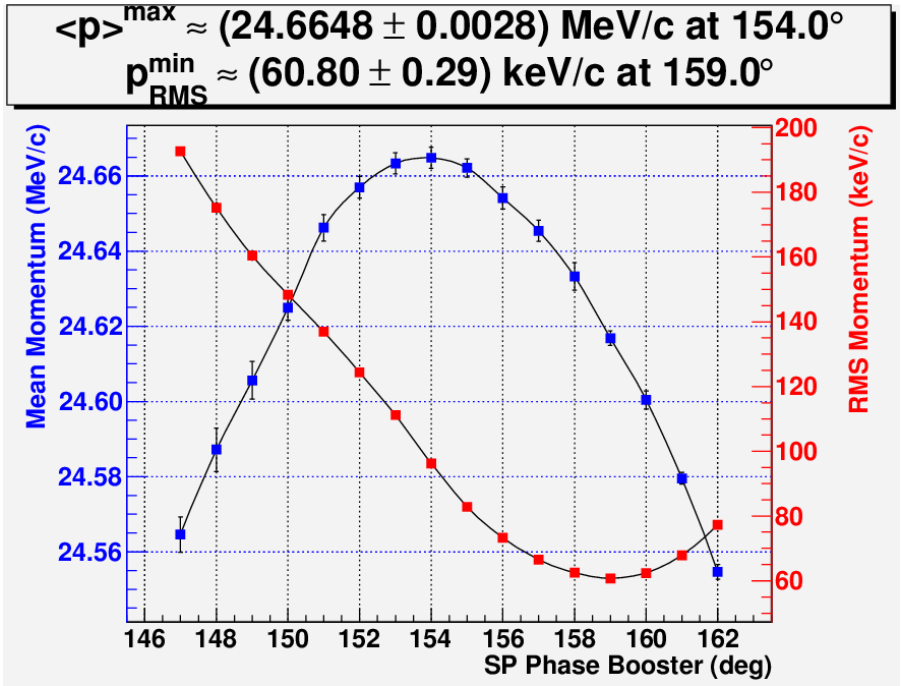
Dmitriy Malyutin
PPS January 2013

HELMHOLTZ GEMEINSCHAFT

DESY

LEDA and HEDA1 momentum phase scans, 2011.05.06N

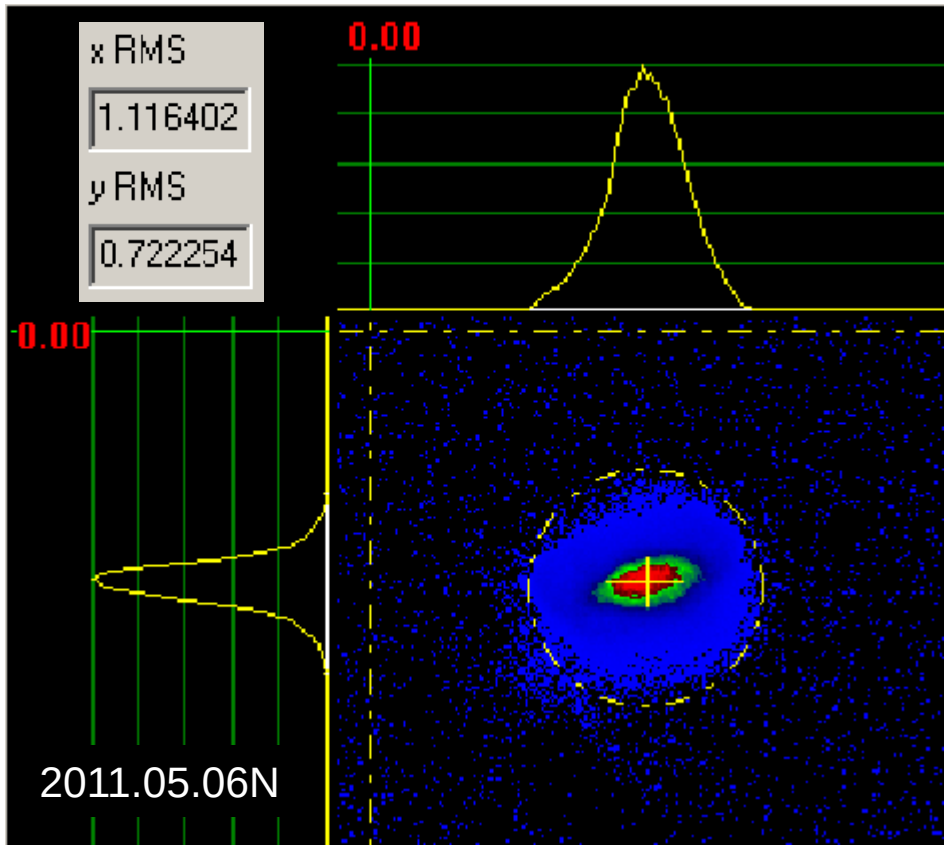




First guess: $p(\varphi) = 6.7Mev/c + 18Mev/c \cdot \cos(\varphi)$

HEDA1 momentum resolution, standard measurements

High1.Scr5 Yrms = 0.72 mm



$$\sigma_\delta = \frac{\sigma_y}{D_y}$$

$$D_y = \rho(1 - \cos(\theta)) + Lsin(\theta) = 2\rho$$

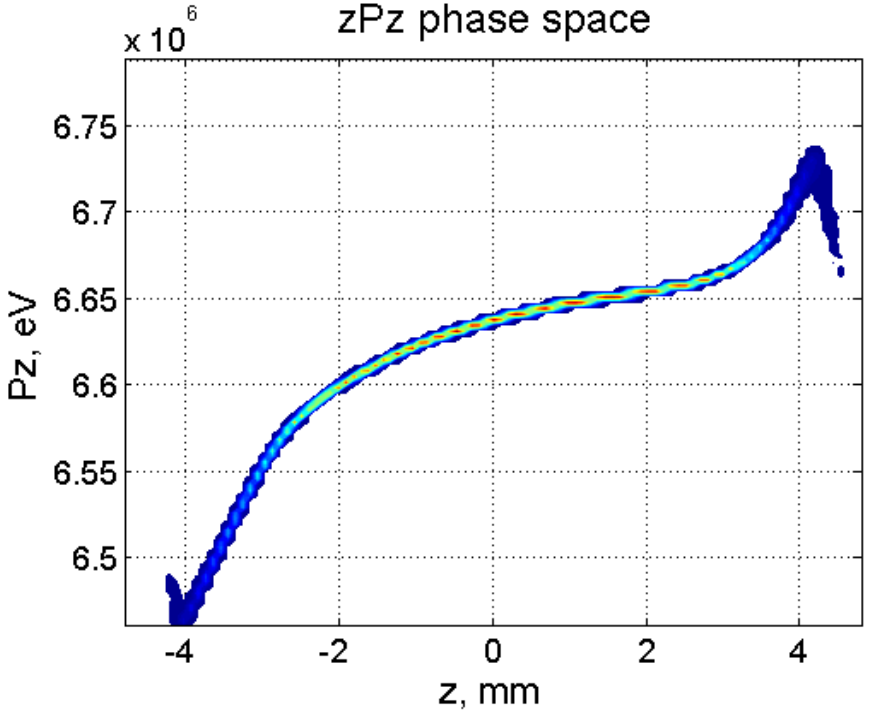
$\rho = 0.3\ m$ – bending radius

$$\sigma_\delta = \frac{0.72 \cdot 10^{-3}}{0.6} = 1.2 \cdot 10^{-3}$$

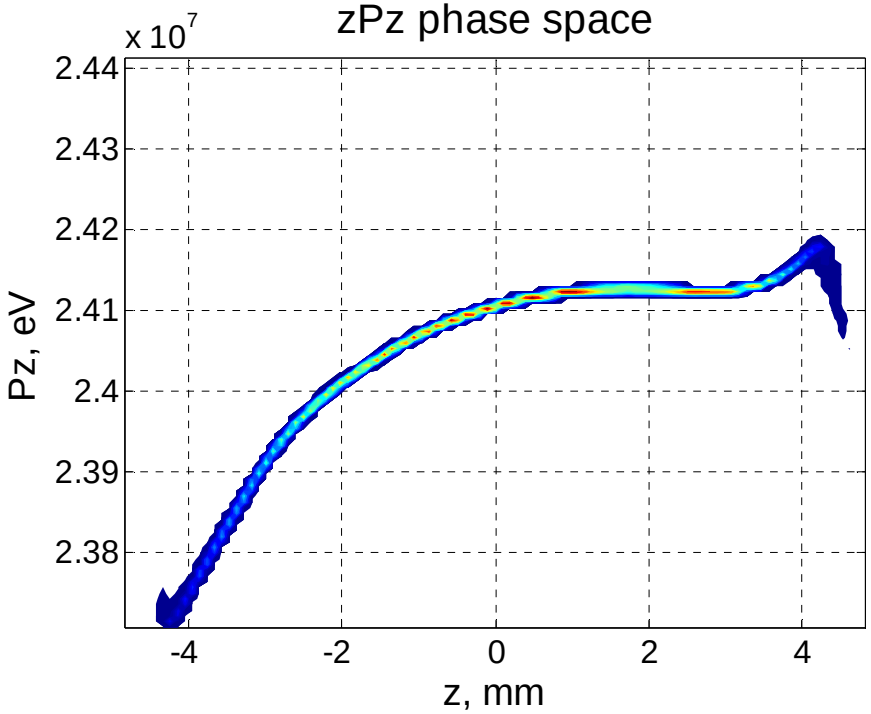
For 25 MeV/c beam → 30 keV/c

Longitudinal phase space, 1 nC simulation

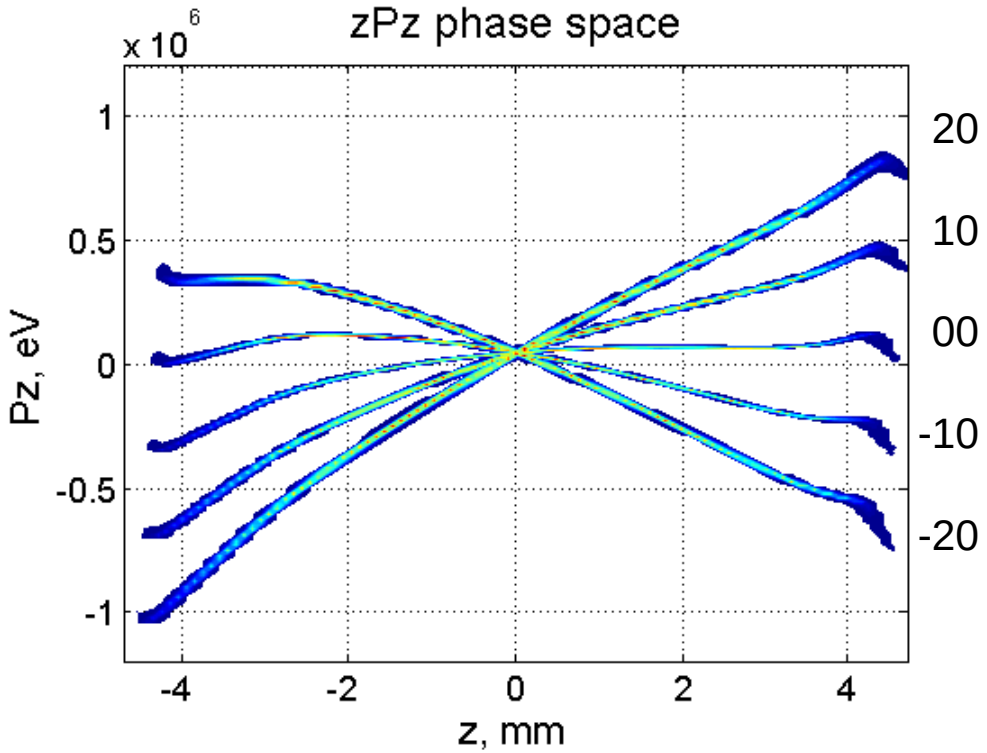
After gun (phase 0)



After booster (phase 0)



Longitudinal phase space, 1 nC simulation



Longitudinal phase space for different booster RF phases.

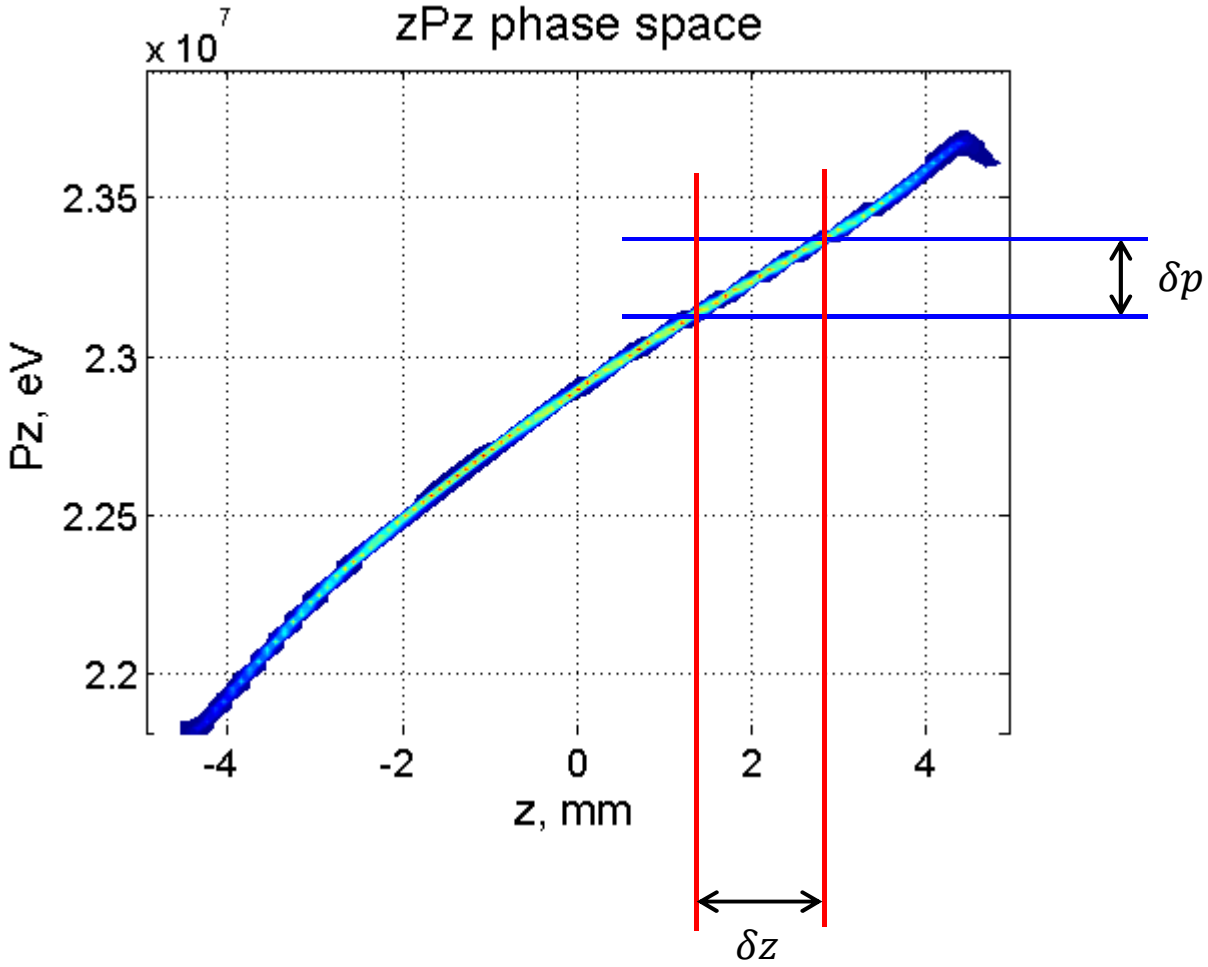
Phase space rotation:

$$p_z(z) = p_z(z) + k \cdot z$$

$$p_{mean} = 6.7Mev/c + 18Mev/c \cdot \cos(\varphi)$$

$$p \approx 6.7Mev/c + 18Mev/c \cdot \cos(\varphi_0) - 147\frac{keV/c}{ps} \cdot \sin(\varphi_0) \cdot \frac{dz}{c}$$

Longitudinal resolution



$$\delta z = \frac{\delta p}{k}$$

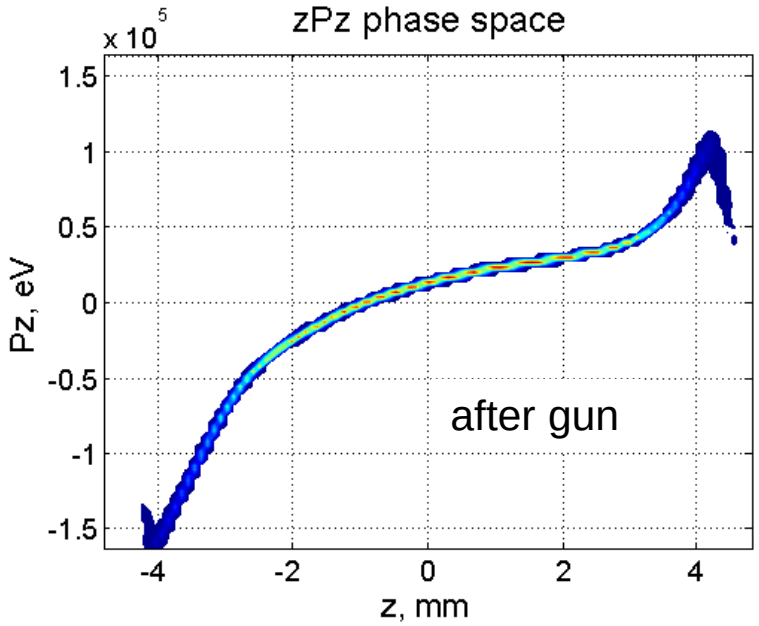
Longitudinal resolution

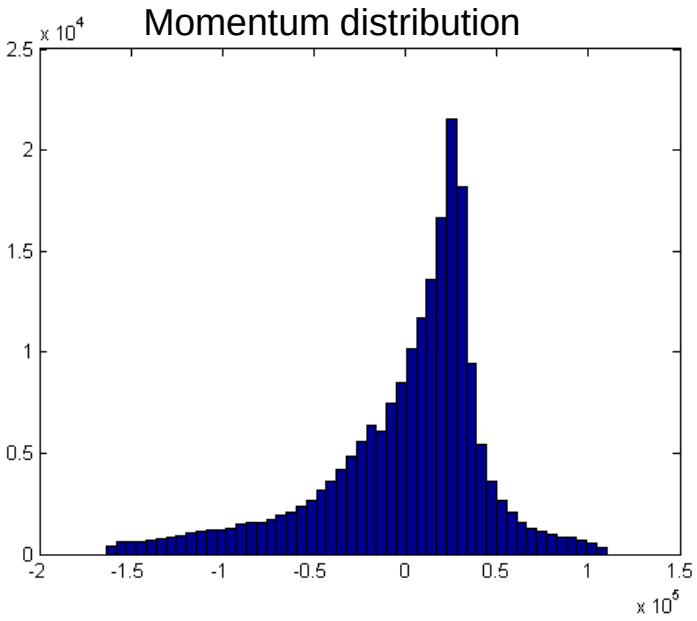
$$\frac{dp}{dt} = -18 \cdot 2\pi f \cdot \sin(\varphi) = -147 \frac{keV/c}{ps} \cdot \sin(\varphi)$$

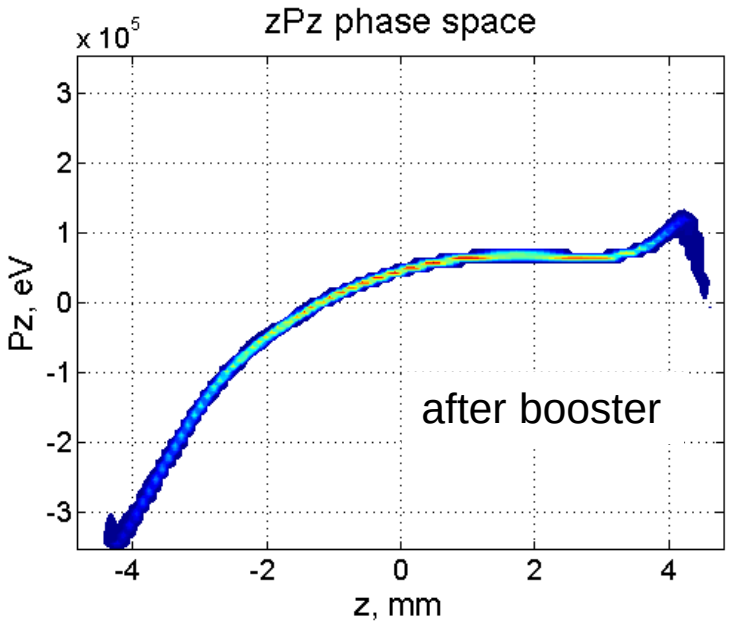
$20 \frac{keV/c}{ps}$ (for 8° phase offset) → 0.05 ps resolution??? (1 keV energy spread)

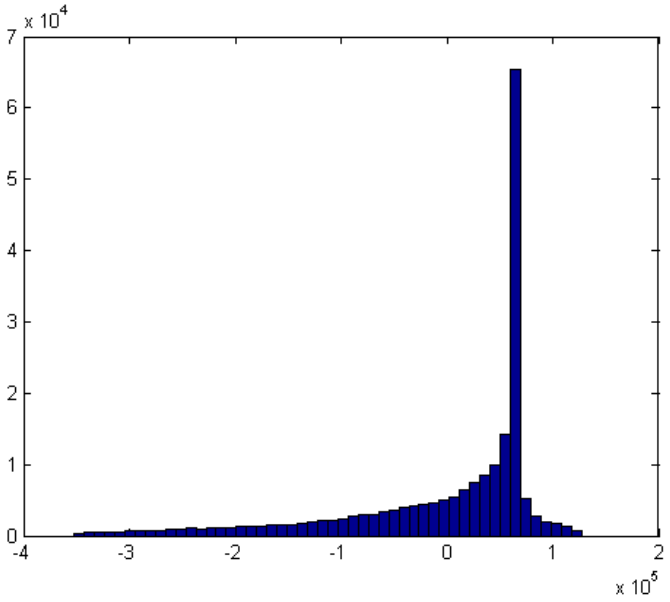
→ 1.5 ps resolution??? (30 keV/c resolution)

Longitudinal phase space, 1nC ASTRA simulation

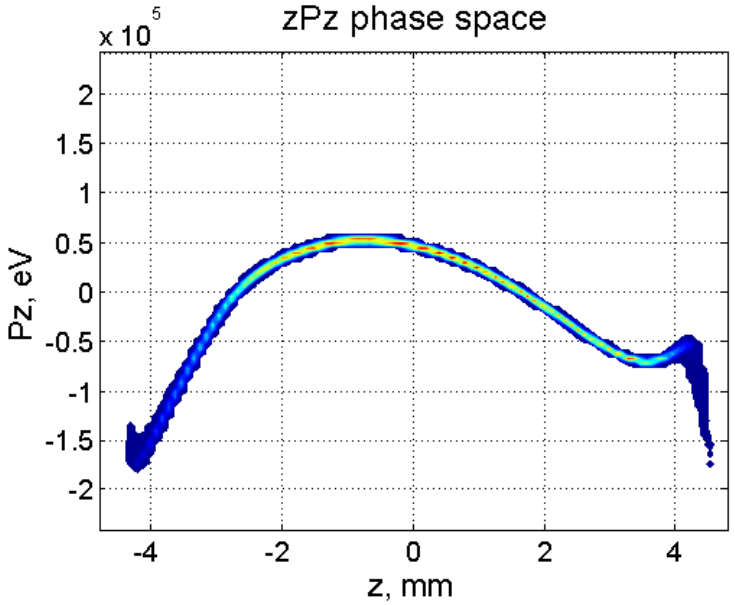


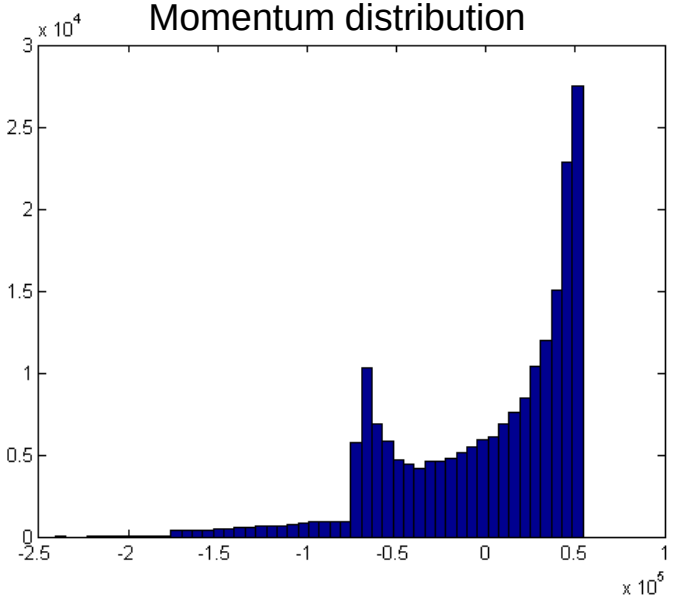




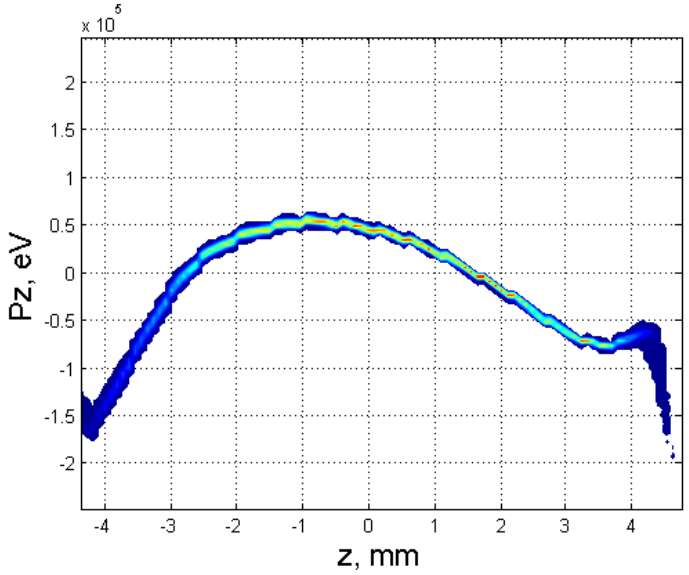


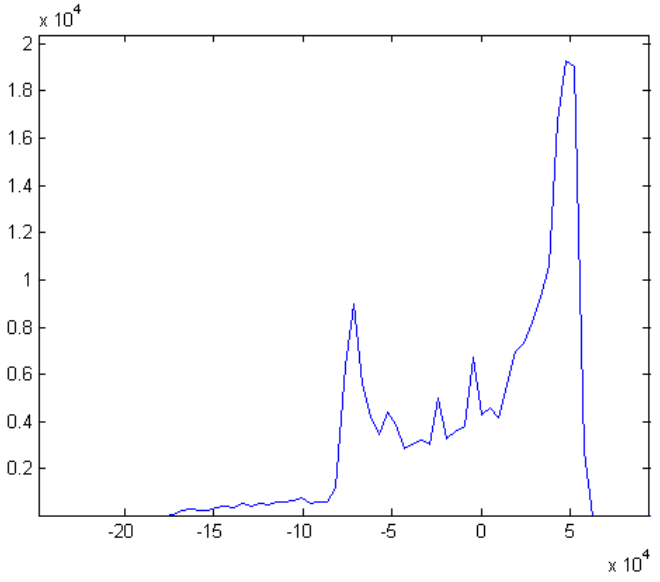
Longitudinal phase space, phase –5





Simulated

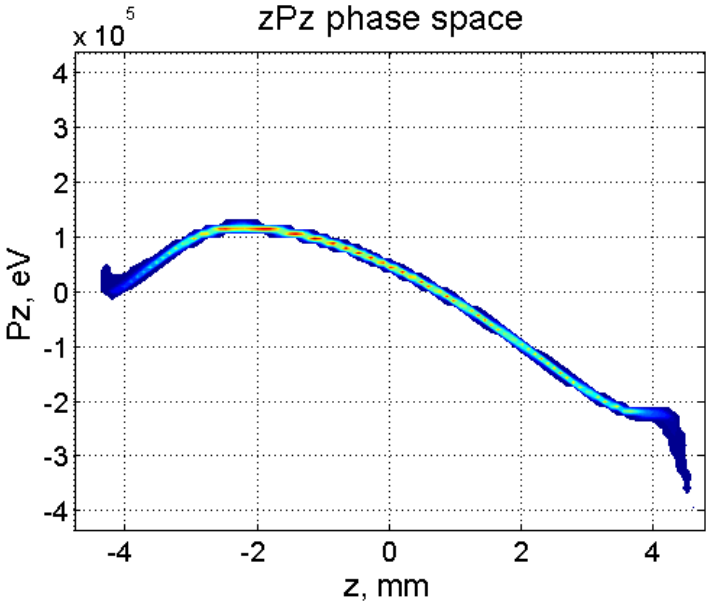


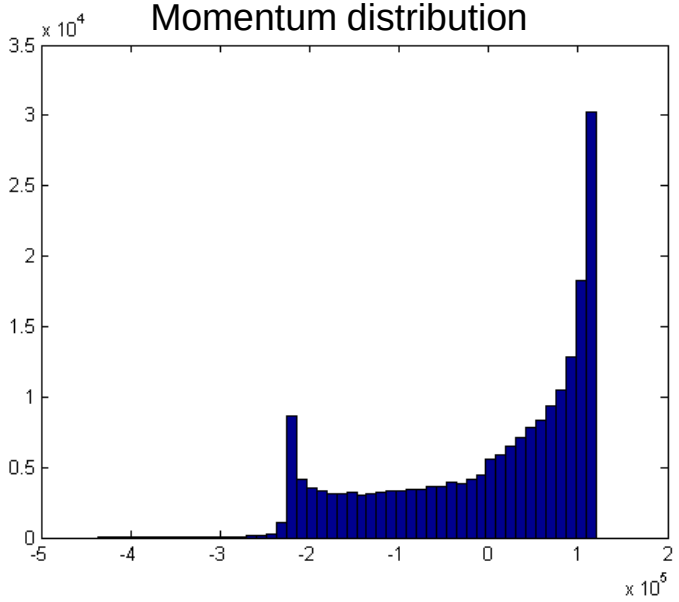


Rotated

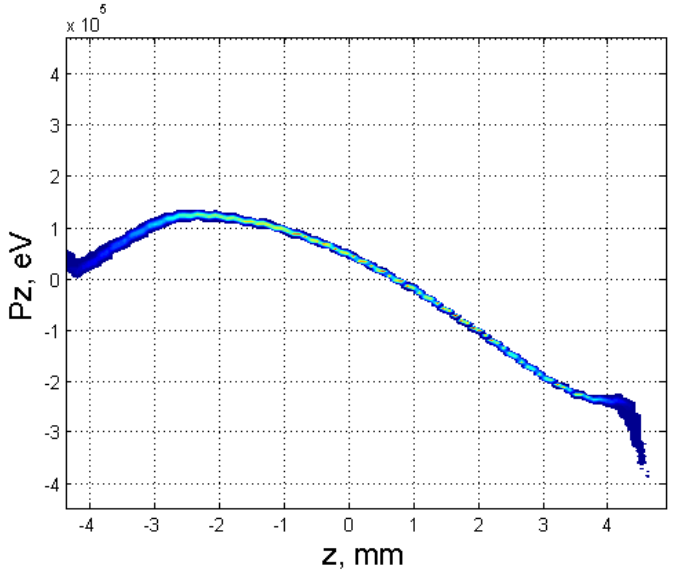
$p_z(z) = p_z(z) + k \cdot z$

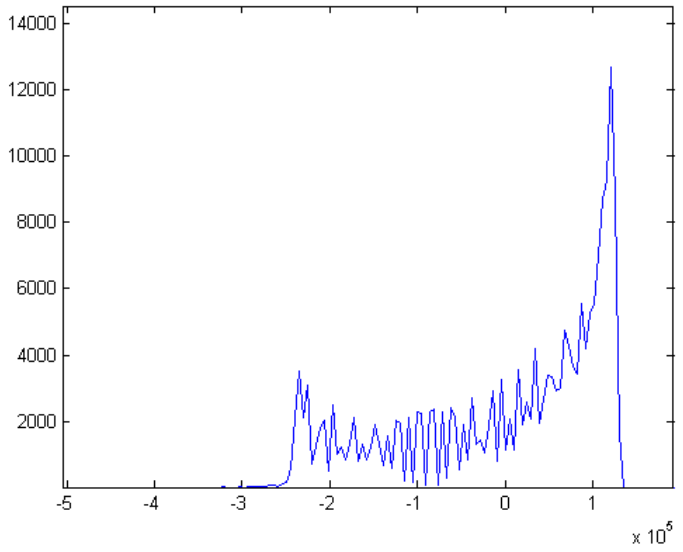
Longitudinal phase space, phase –10





Simulated

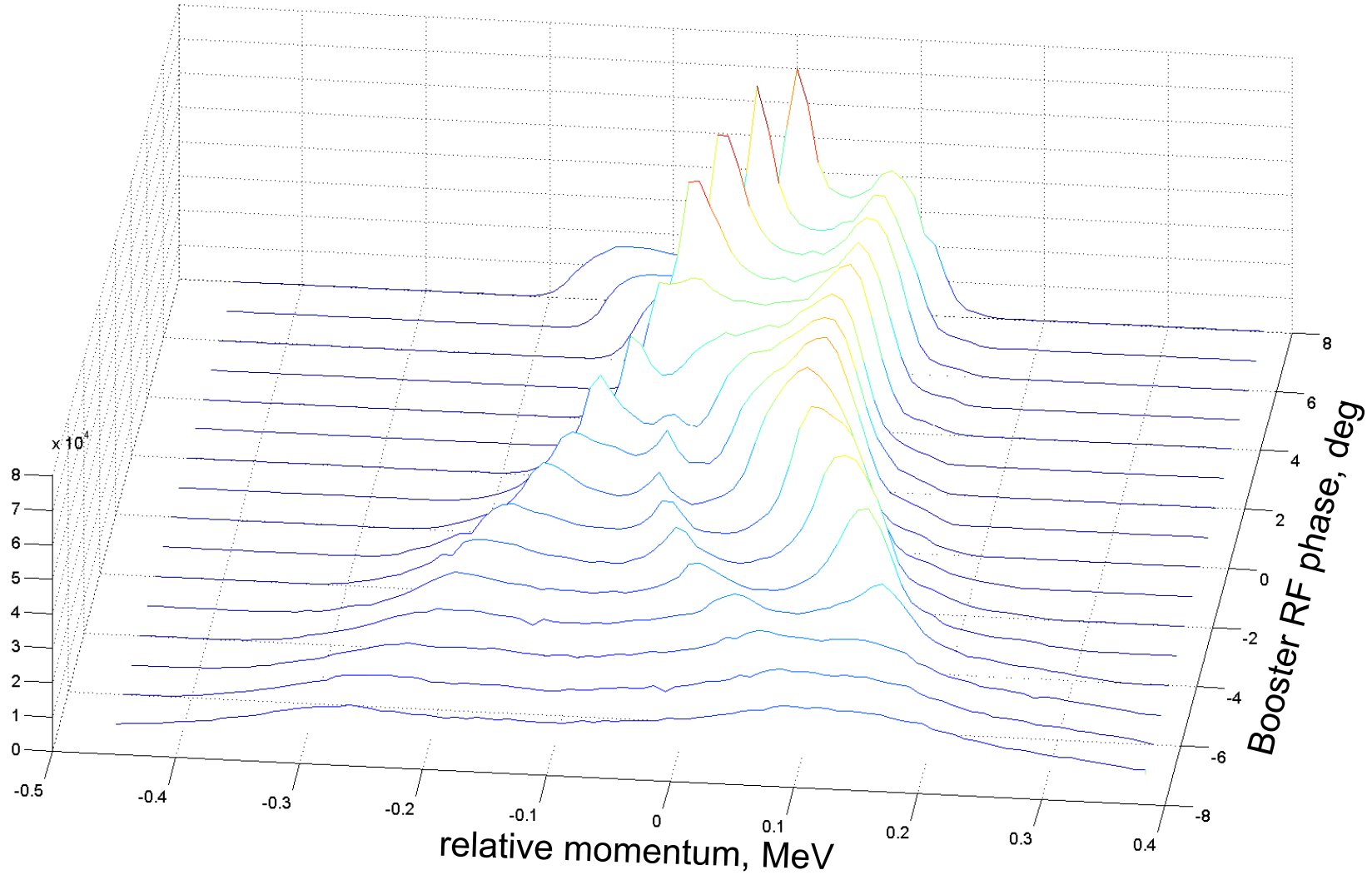




Rotated

$p_z(z) = p_z(z) + k \cdot z$

HEDA1 momentum distributions, 2011.05.06N



Tomographic reconstruction

- How treat the data???

Conclusion

Pros:

- Simple measurements via momentum phase scan
- Quite high temporal resolution*

Cons:

- Sophisticated data treatment
- Not include 90° rotation