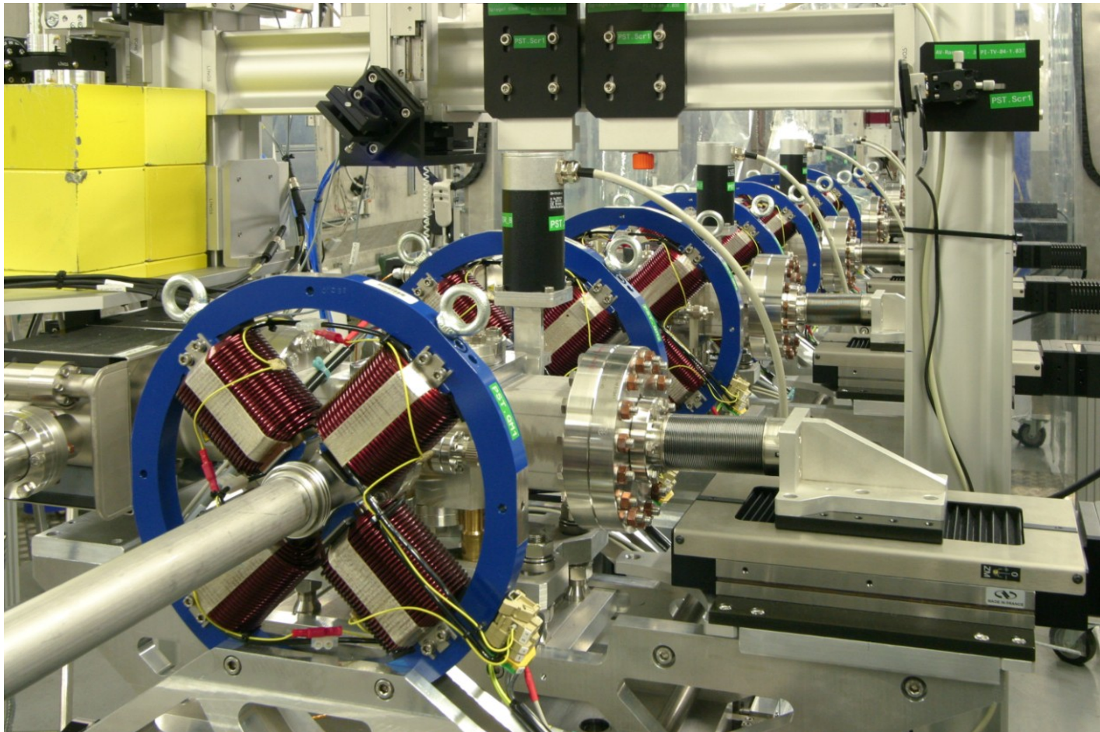
Improvement of the tomographic reconstruction procedure at PITZ.

- > Tomographic reconstruction of the transverse phase space at PITZ
- > Motivation: refined calculation of rotations
- > V-Code simulations
- > Simulation results
- > Summary and outlook

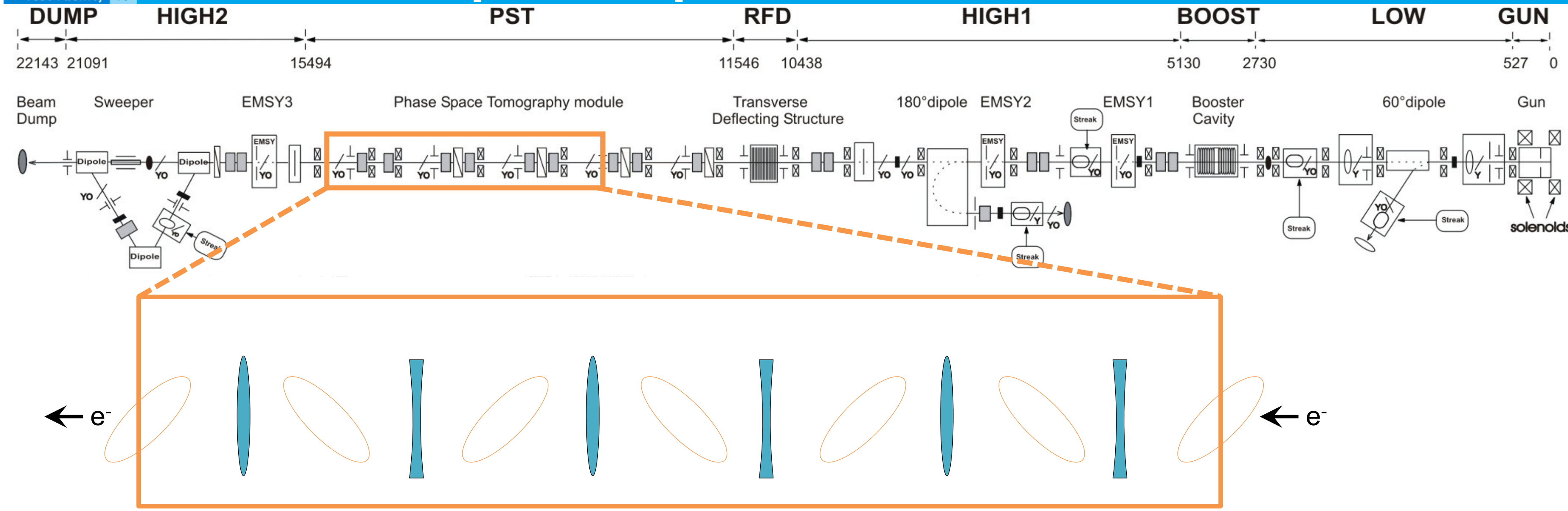


Georgios Kourkafas
PITZ Physics Seminar
01.11.2012

HELMHOLTZ ASSOCIATION

DESY

Tomographic reconstruction of the transverse phase space at PITZ



1) Quadrupoles form a FODO lattice and oppose a complete 180° rotation in the transverse phase space

Tomographic reconstruction of the transverse phase space at PITZ

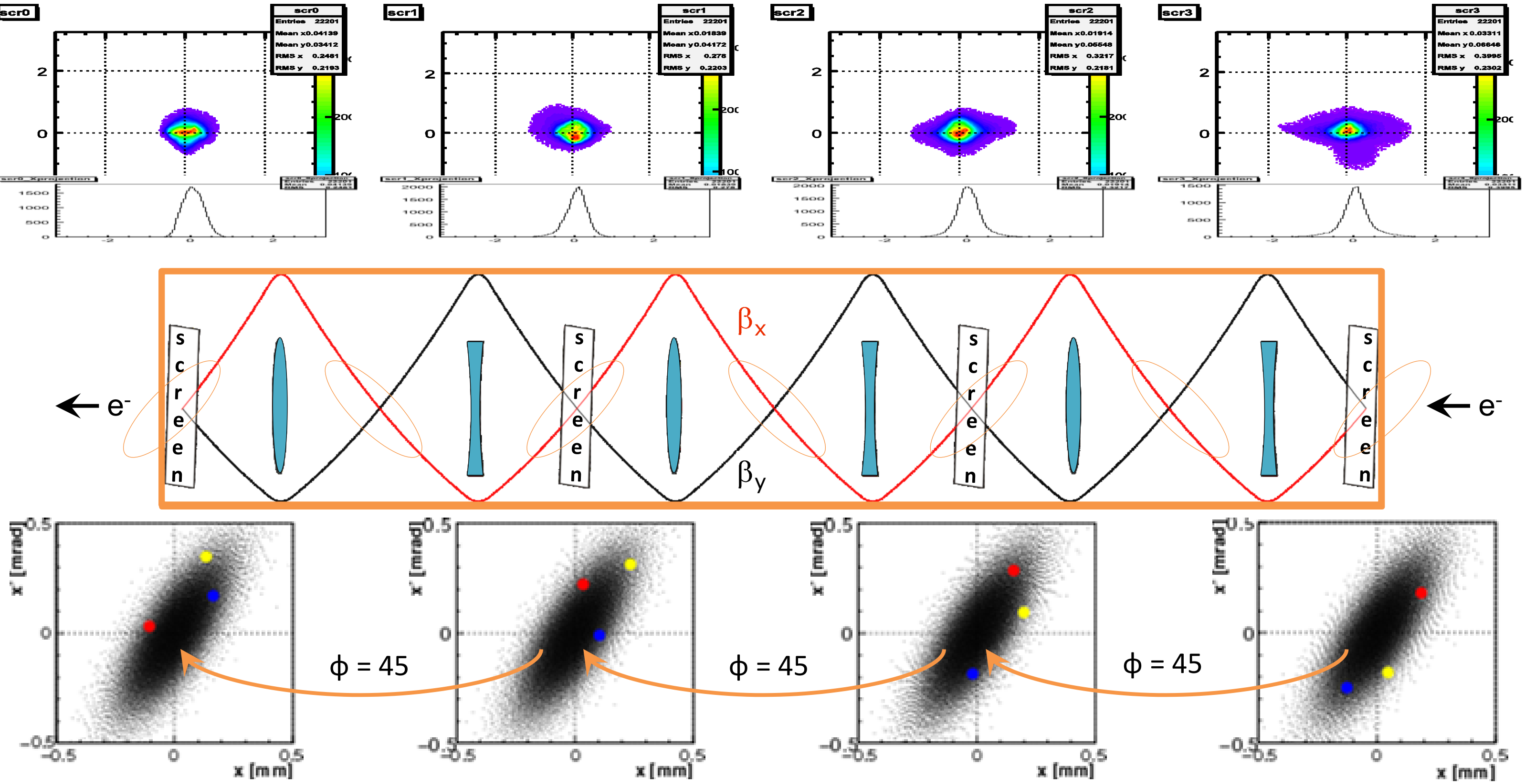


Image courtesy:
G. Asova

2) Screens capture projections of both transverse planes at equidistant phase advance values (= projection angles)

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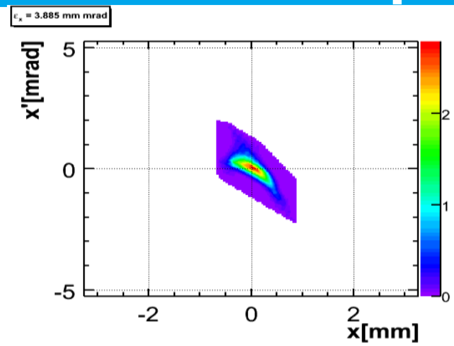

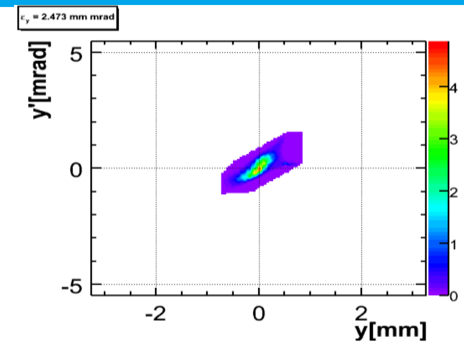

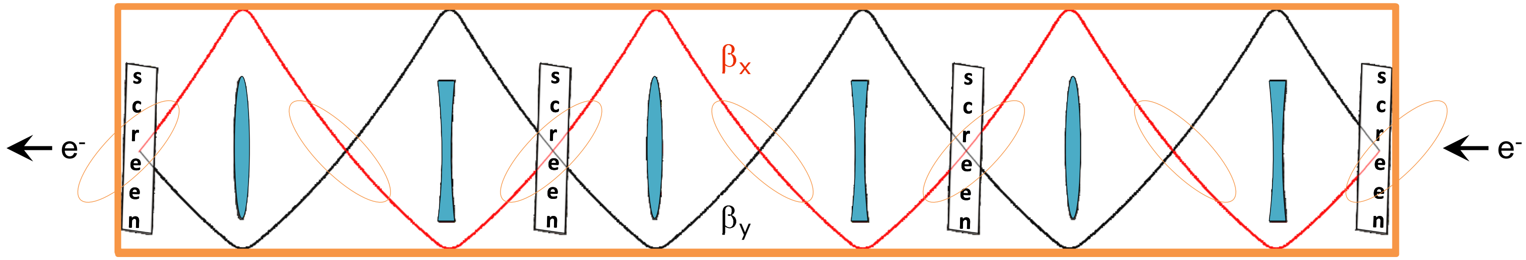

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2) Screens capture projections of both transverse planes at equidistant phase advance values (= projection angles)

3) Reconstruction using the Maximum ENTropy algorithm (MENT) with the corresponding transport matrices

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- Use V-Code for a more realistic beam transport in the FODO lattice → refine the calculated rotation of the projections

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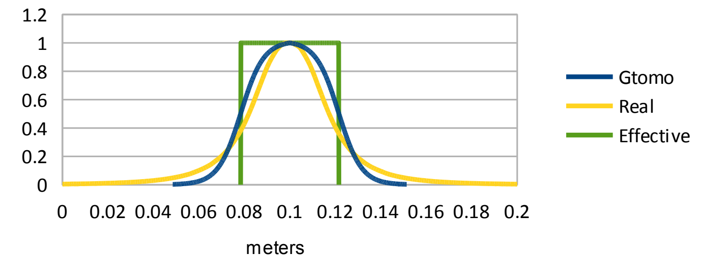
  - Current approach (Gtomo) vs. measured (Real) longitudinal profile of the quadrupole gradient →



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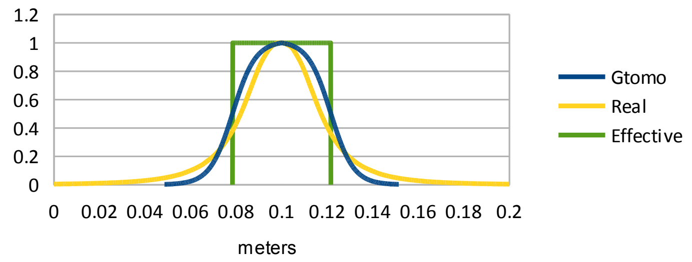

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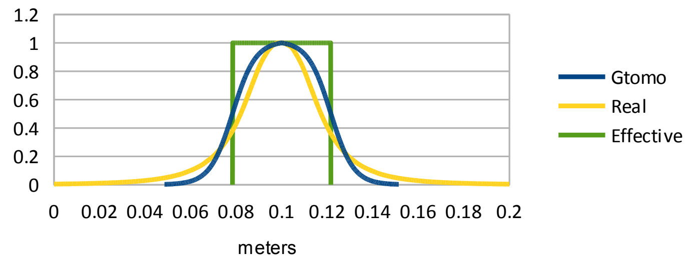

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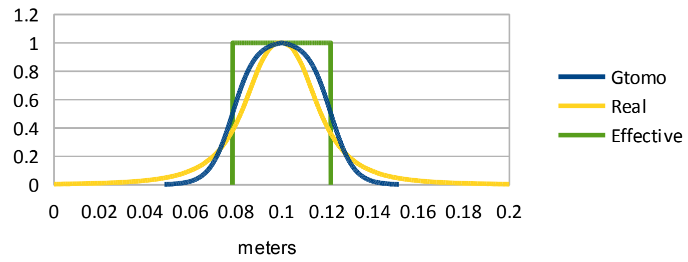

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- The beam enters the FODO lattice perfectly matched (ideal case) and non-linear space charge is excluded.

Simulation results (I)

Phase advance mismatch at each screen (n=1,2,3): $\boxed{n \cdot 45^o - \varphi_n}$, $\varphi_n = \int_{z_0}^{z} \frac{dz}{\beta(z)}$

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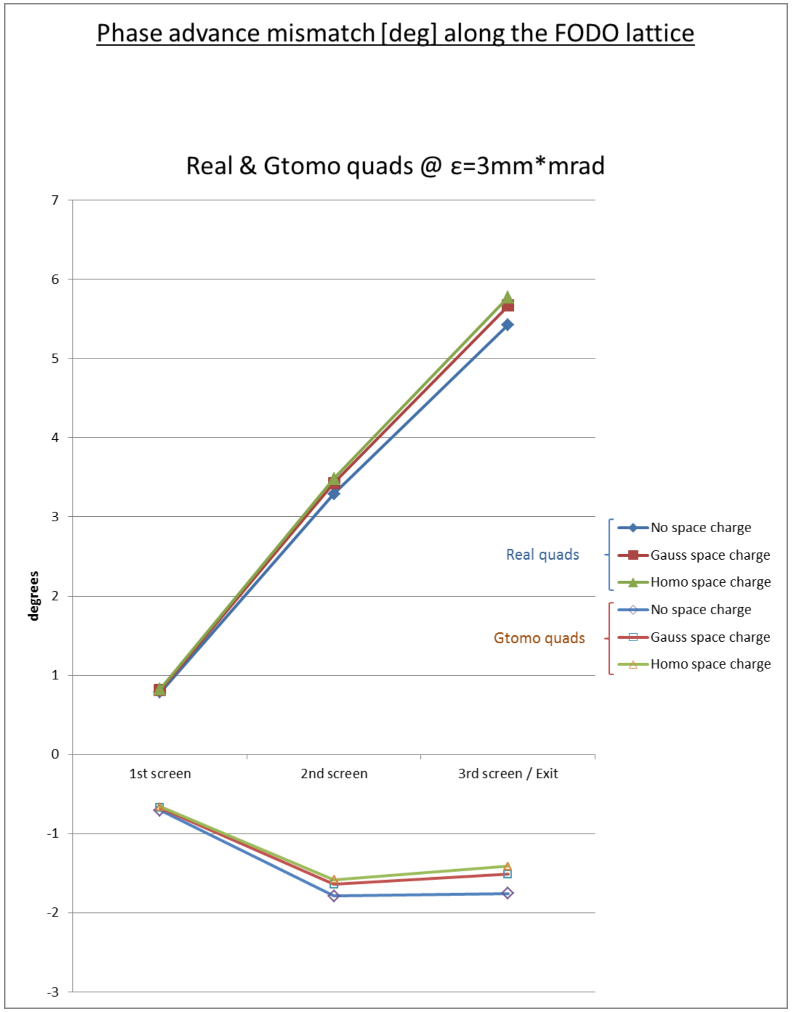

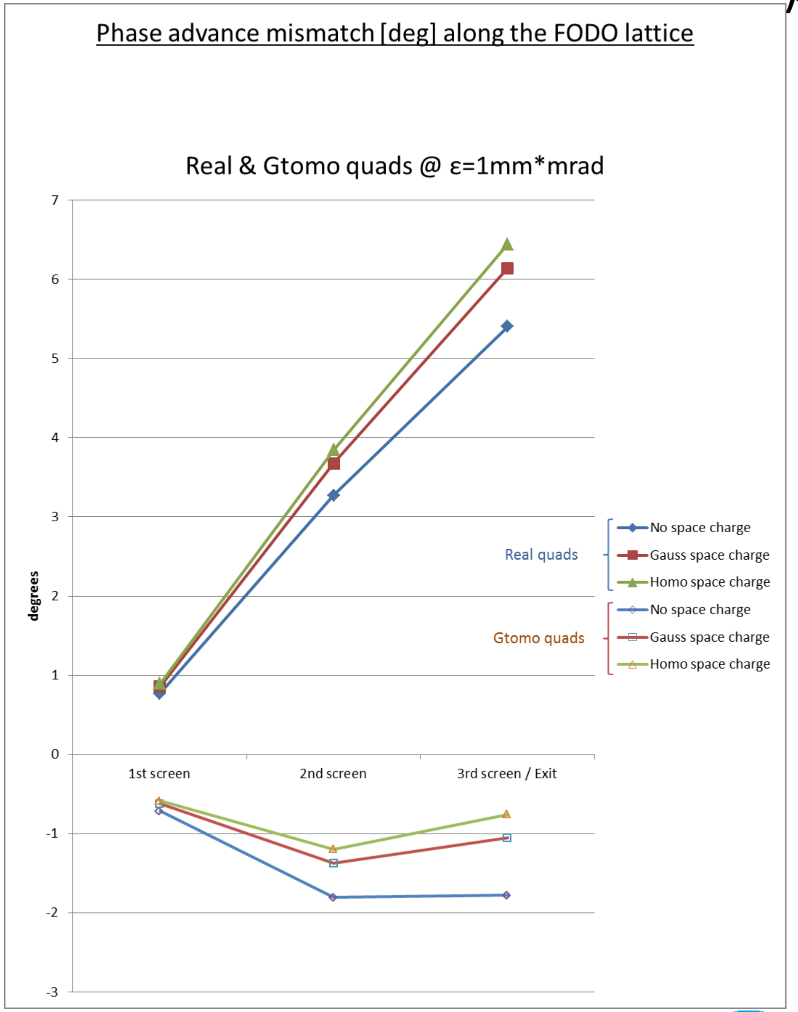

Simulation results (II)

> Concerning the linear space charge:

- When space charge is neglected, the emittance (or charge density) does not influence the simulation result
- The influence of linear space charge increases as the emittance gets smaller
- Gaussian distribution of the linear space charge leads to a smaller mismatch compared to the homogeneous distribution, at about 30%
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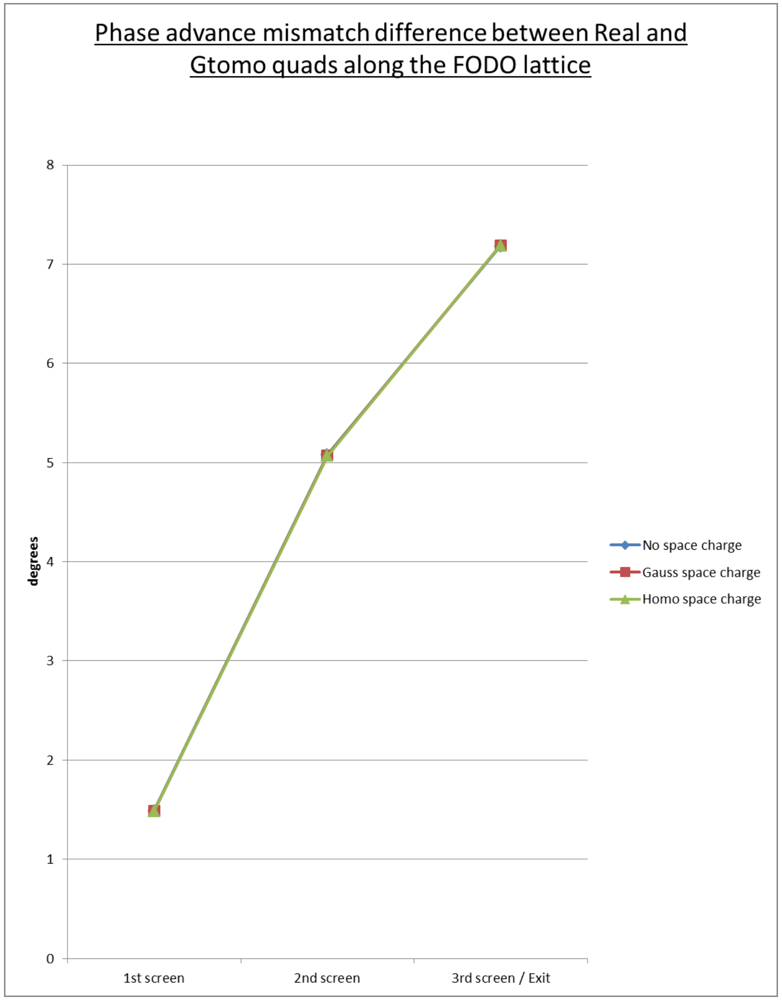
> Concerning the gradient profile, a much bigger discrepancy is introduced:

- The matching is worse in the Real case up to a factor of 3 compared to the Gtomo case
- Neither space charge nor emittance value have an effect on this discrepancy
- The mismatch difference between the two setups has a maximum value of 7.2° at the exit of the lattice

Simulation results (III)



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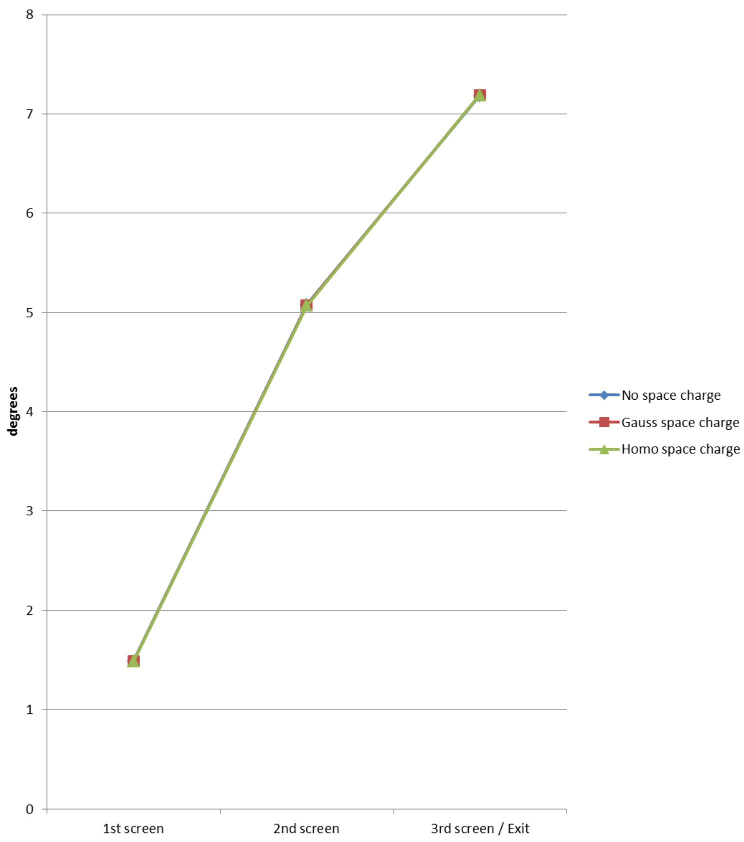
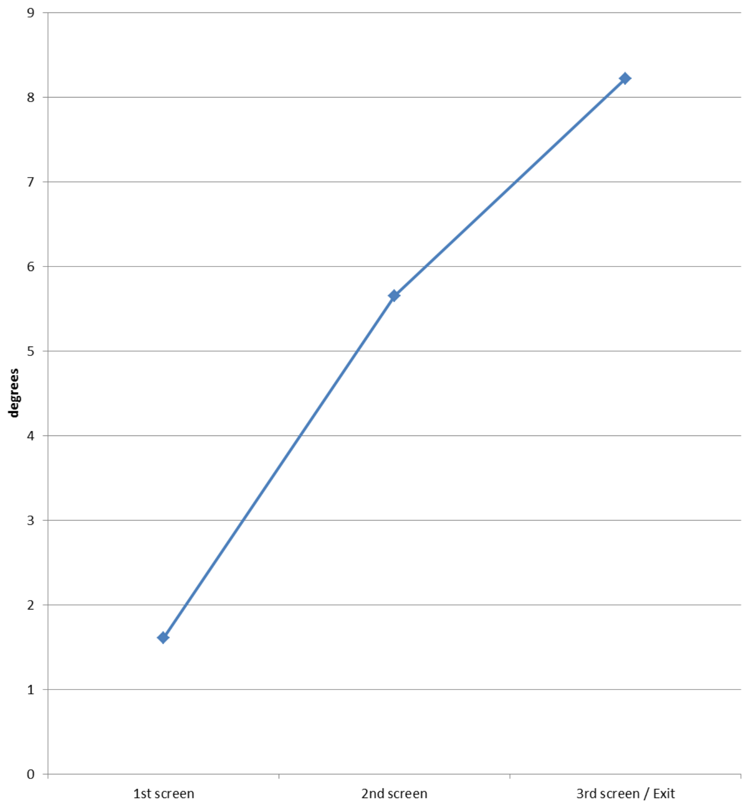
Phase advance mismatch difference between Real and Gtomo quads along the FODO lattice



Phase advance mismatch difference between Real and Gtomo quads including homogeneous linear space charge along the FODO lattice

@ ε=1mm*mrad



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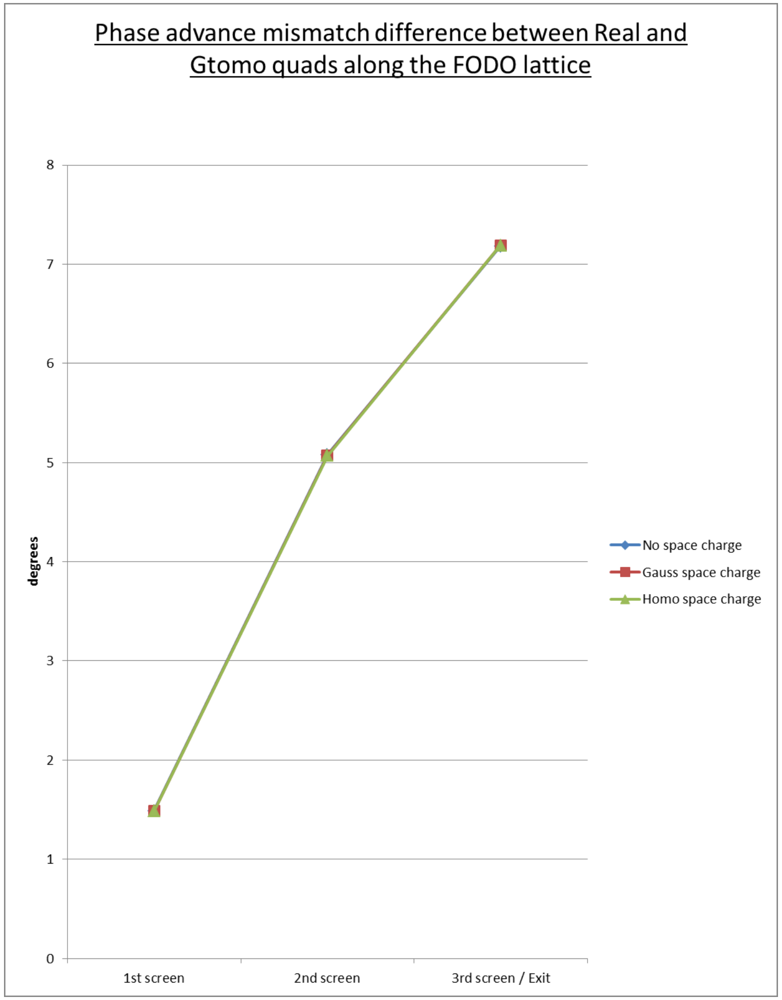
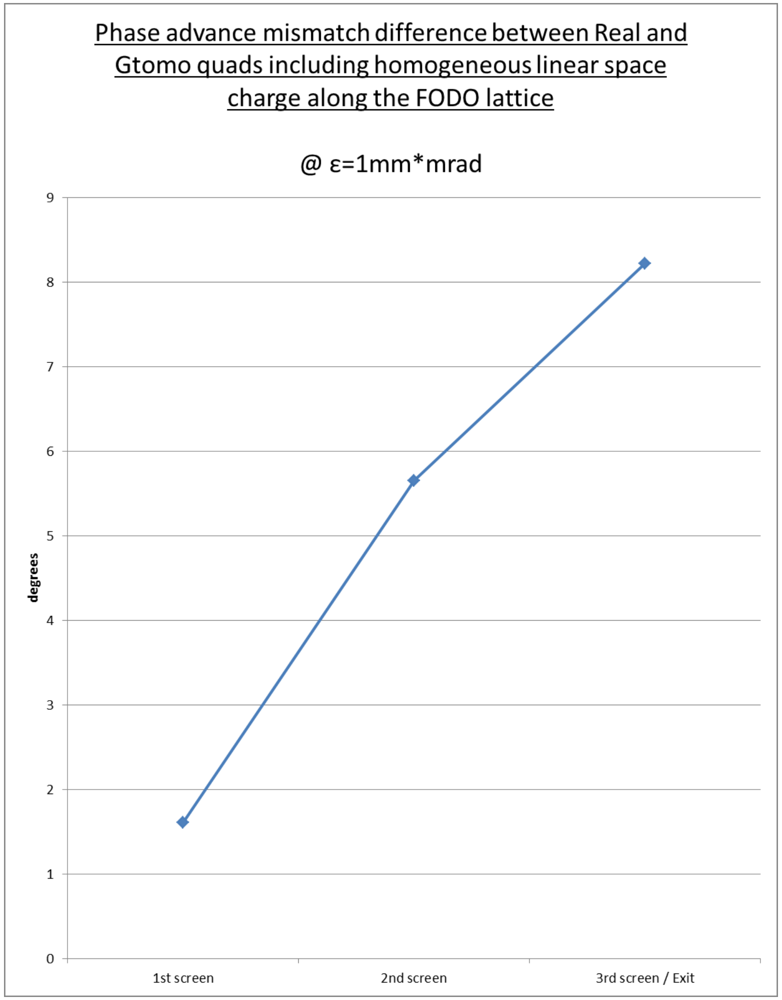




> N.B.: A phase advance mismatch affects the reconstruction more than a plain angle mismatch, due to the beam shearing.

Summary and outlook

> Fringe fields and linear space charge introduce additive mismatches along the FODO lattice, up to a maximum of 8.2º for an initially matched beam

> Next steps:

- Reconstruct data using the refined transport matrices and evaluate the difference on the resulting phase space
- Add feature in the tomography code: manual input of the transport matrices
- Implement the new treatment (fringe fields + linear space charge) in the tomography code

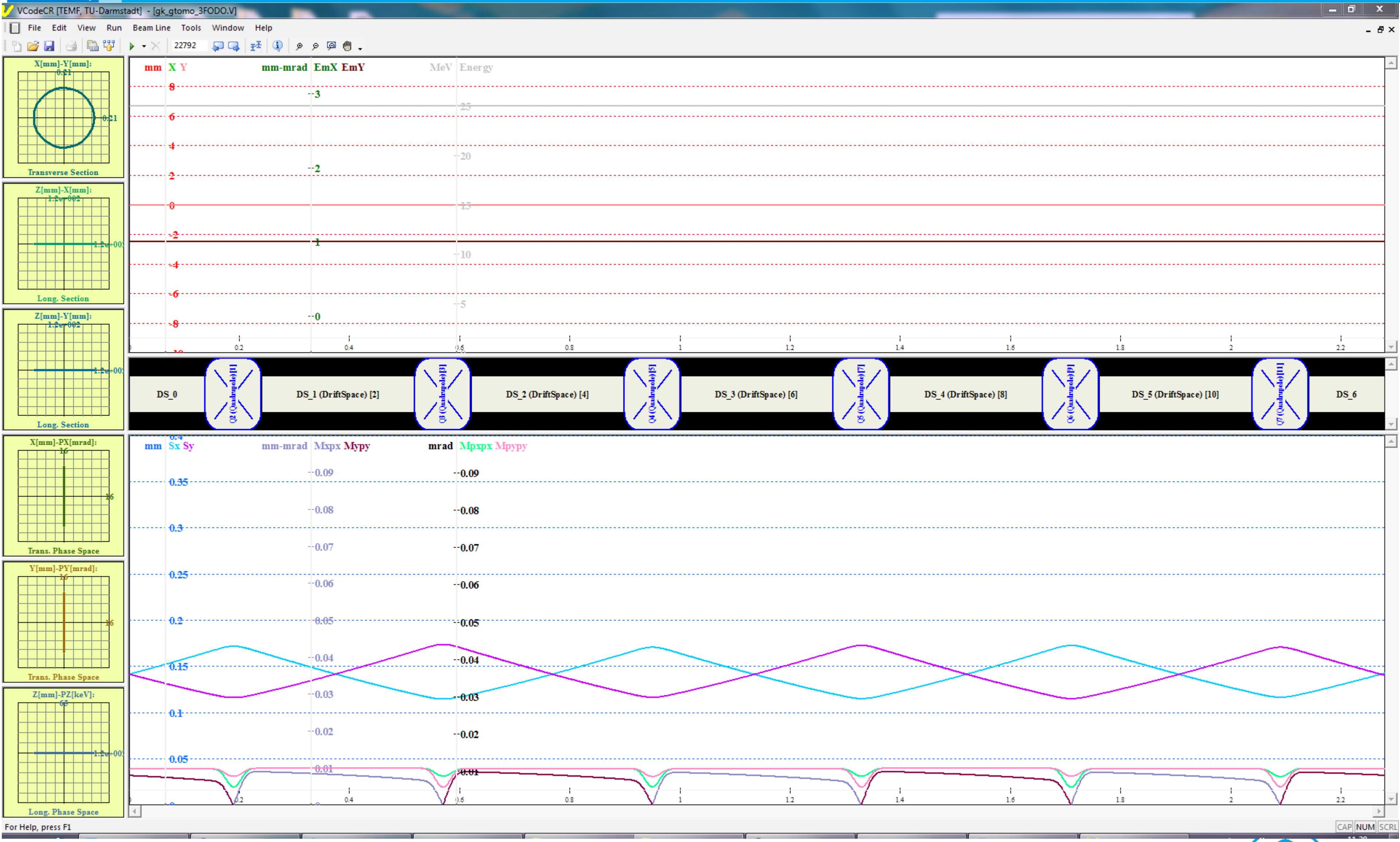
> The non-linear space-charge effect is still excluded, but is expected to have a stronger impact → subject to future investigation

Thanks to Barbara Marchetti and Dmitriy Malyutin.

THE END.

Backup Slides

V-Code screenshot



V-Code screenshot

$$G(z) = \frac{k}{1 + e^{\frac{2 \cdot (2 \cdot \| \Delta z \| - L_{eff})}{Q_{bore}}}}$$