

Bunch Compressor for Intense Proton Beams

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HIC for FAIR Workshop
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ARMADILLO – Arc Magnetic Dipole Chicane with Large Aperture Longitudinally Focusing Cavities

Mobley-Buncher: (μA -Proton Beams)

Kicker

→ separation of the micro bunches

Bending system (1 Dipole)

→ “weak” focusing

→ path length differences

→ longitudinal compression

Improvements for 150mA Proton Beams:

2 main dipoles (gradient)

→ more parameters for beam dynamics

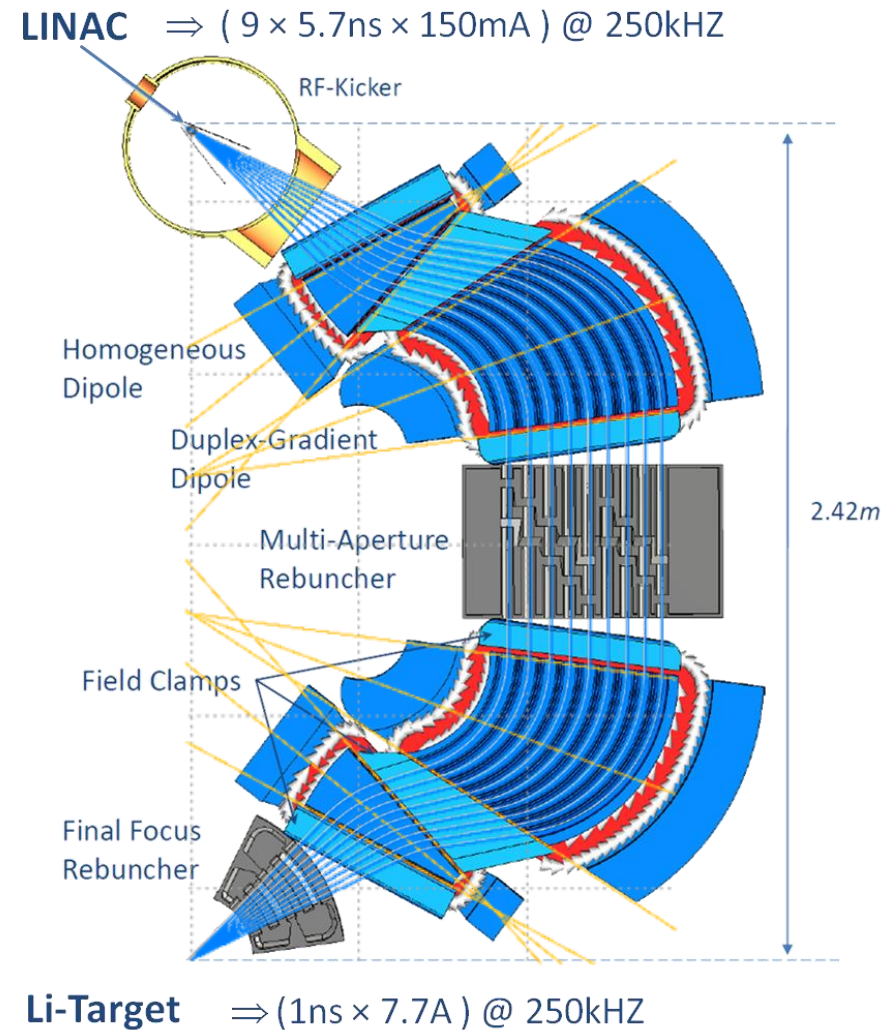
2 auxiliary dipoles (homogeneous)

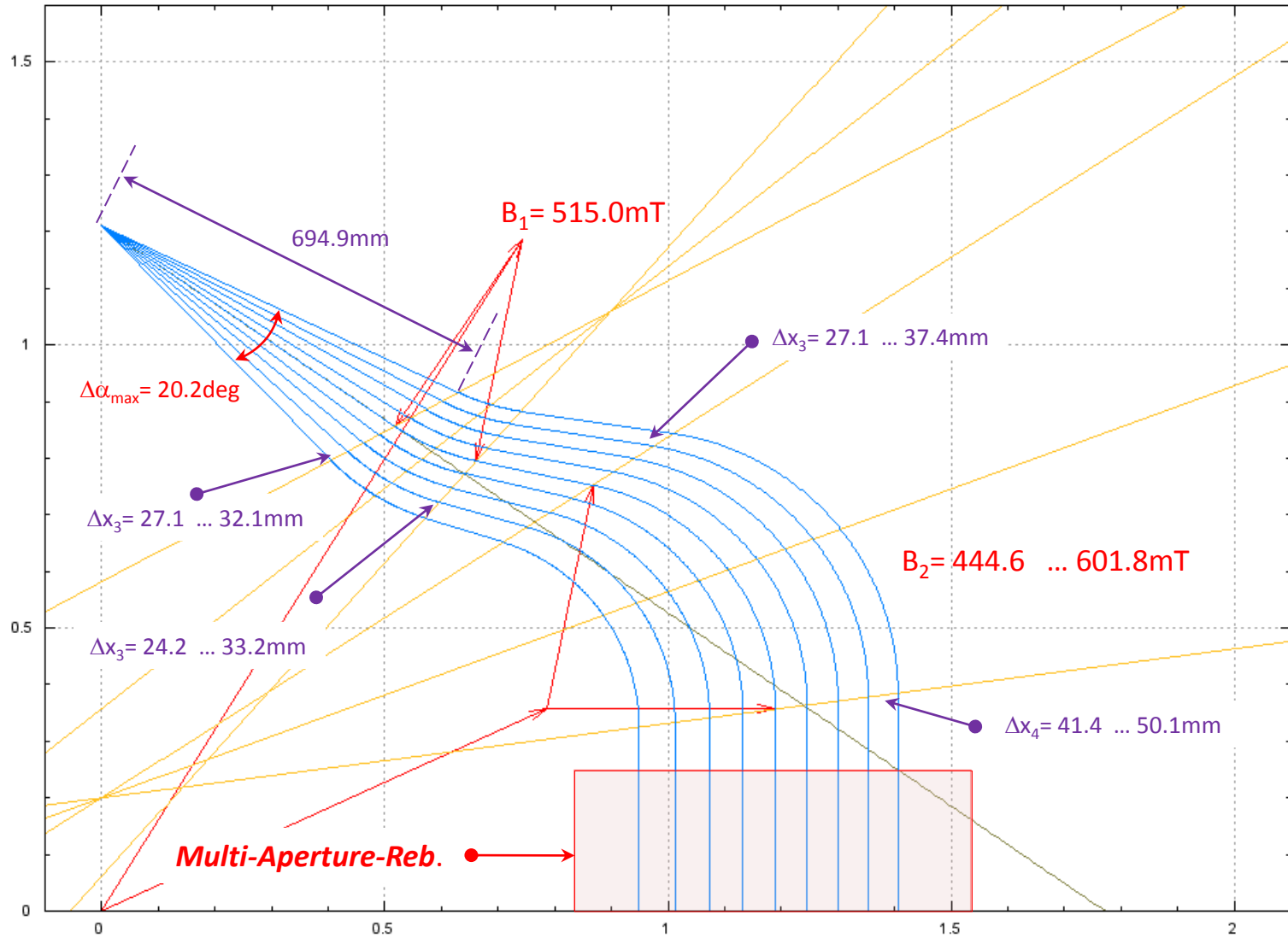
→ linear separation of the trajectories

→ momentum exchange in trans. plane

2 rebuncher cavities

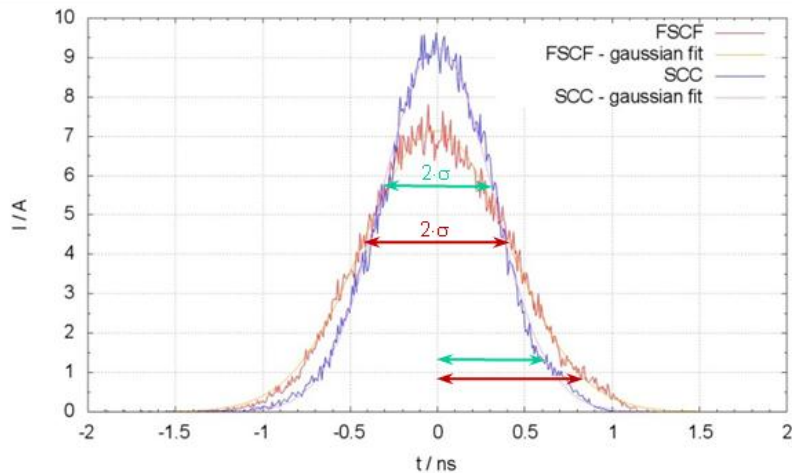
→ longitudinal beam dynamics





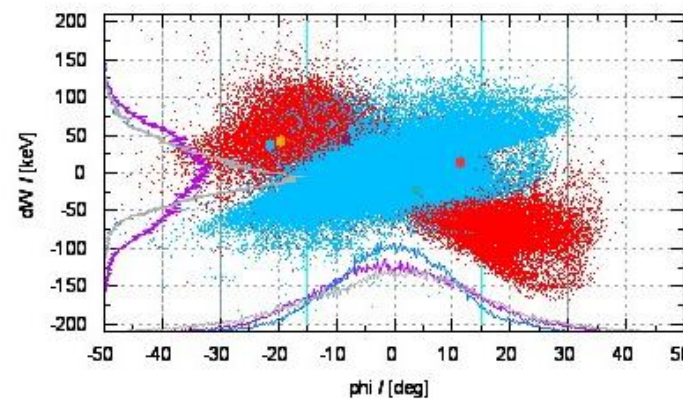
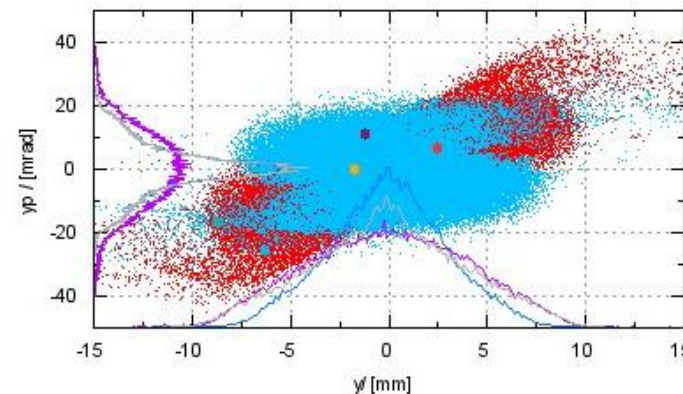
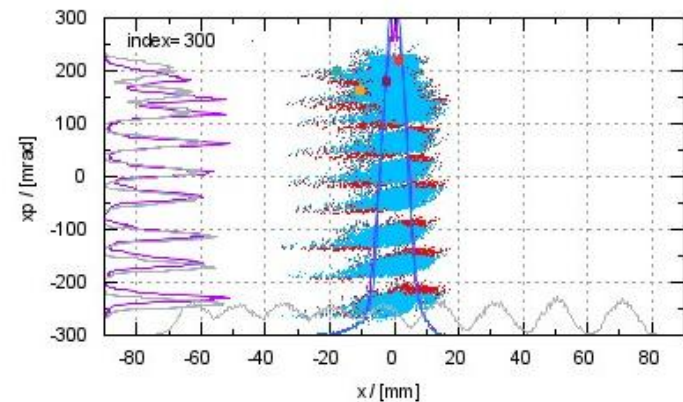
=> **Transverse distances** sufficient for **beam dynamics** and **cavity design...**

Beam properties at the Li-Target

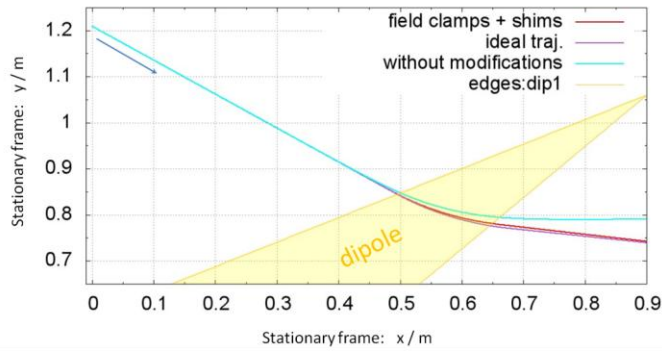


⇒ Requirements can be reached at full *space charge force*!

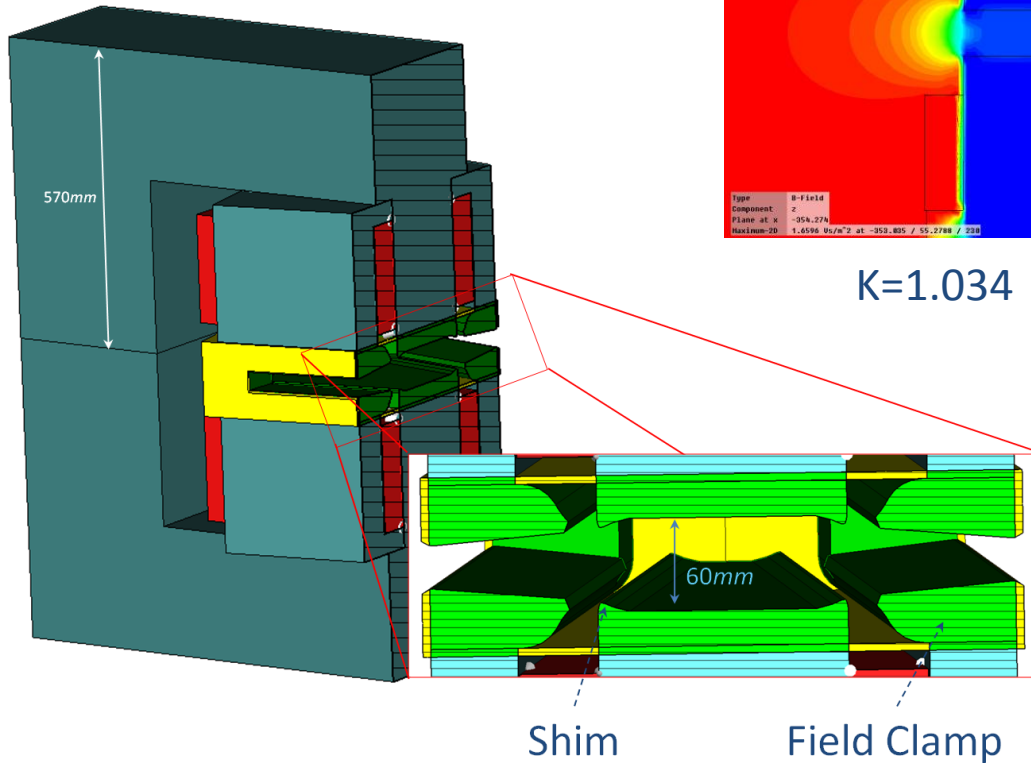
		2·σ FSCF	2·σ SCC	Δ(2·σ)
x	mm	7.86	6.92	-12%
y	mm	8.90	7.02	-21%
z	mm	16.52	12.38	-25%
φ @87.5MHz	deg	26.46	19.80	-25%
ΔT	ns	0.84	0.63	-25%
ΔW	keV	104.6	55.0	-47%



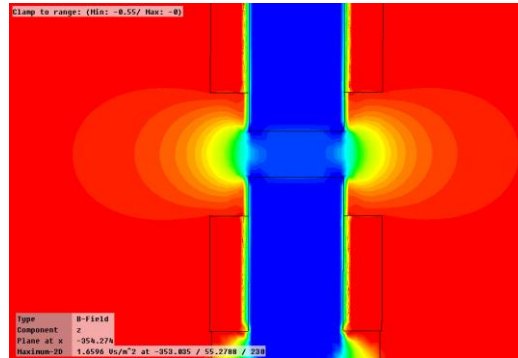
Bunch Center Motion



⇒ improved magnet design fulfills the *beam dynamics requirements.*

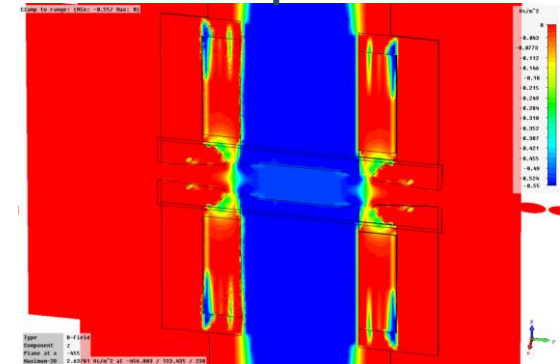


Without Modifications



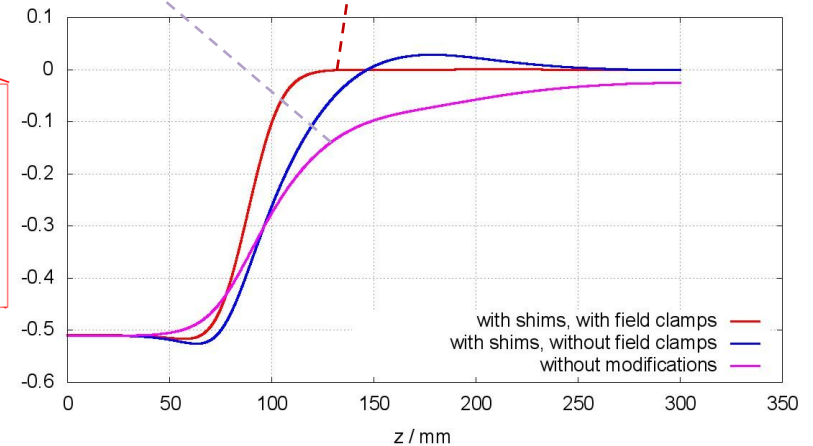
$K=1.034$

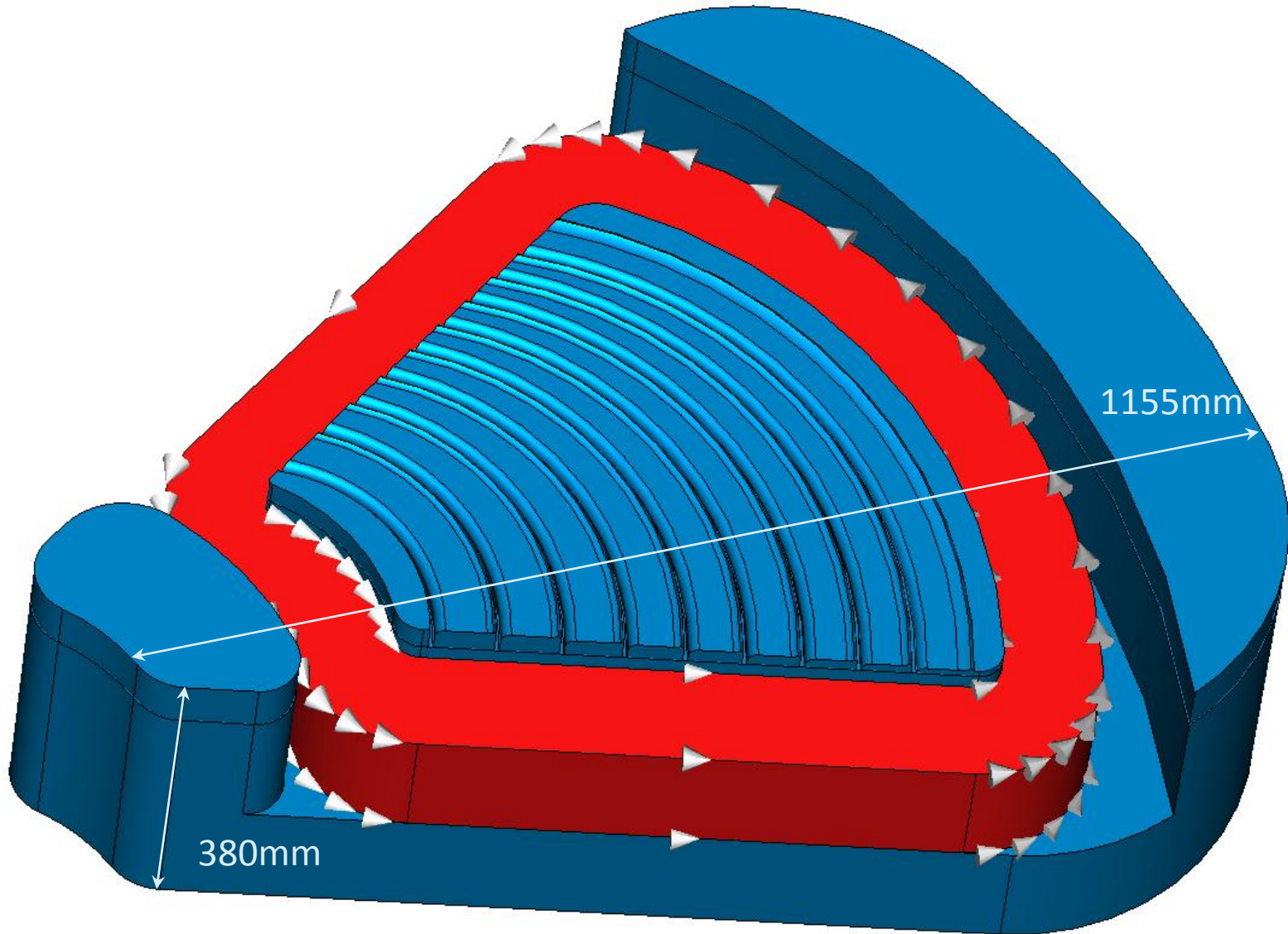
Field Clamps + Shims

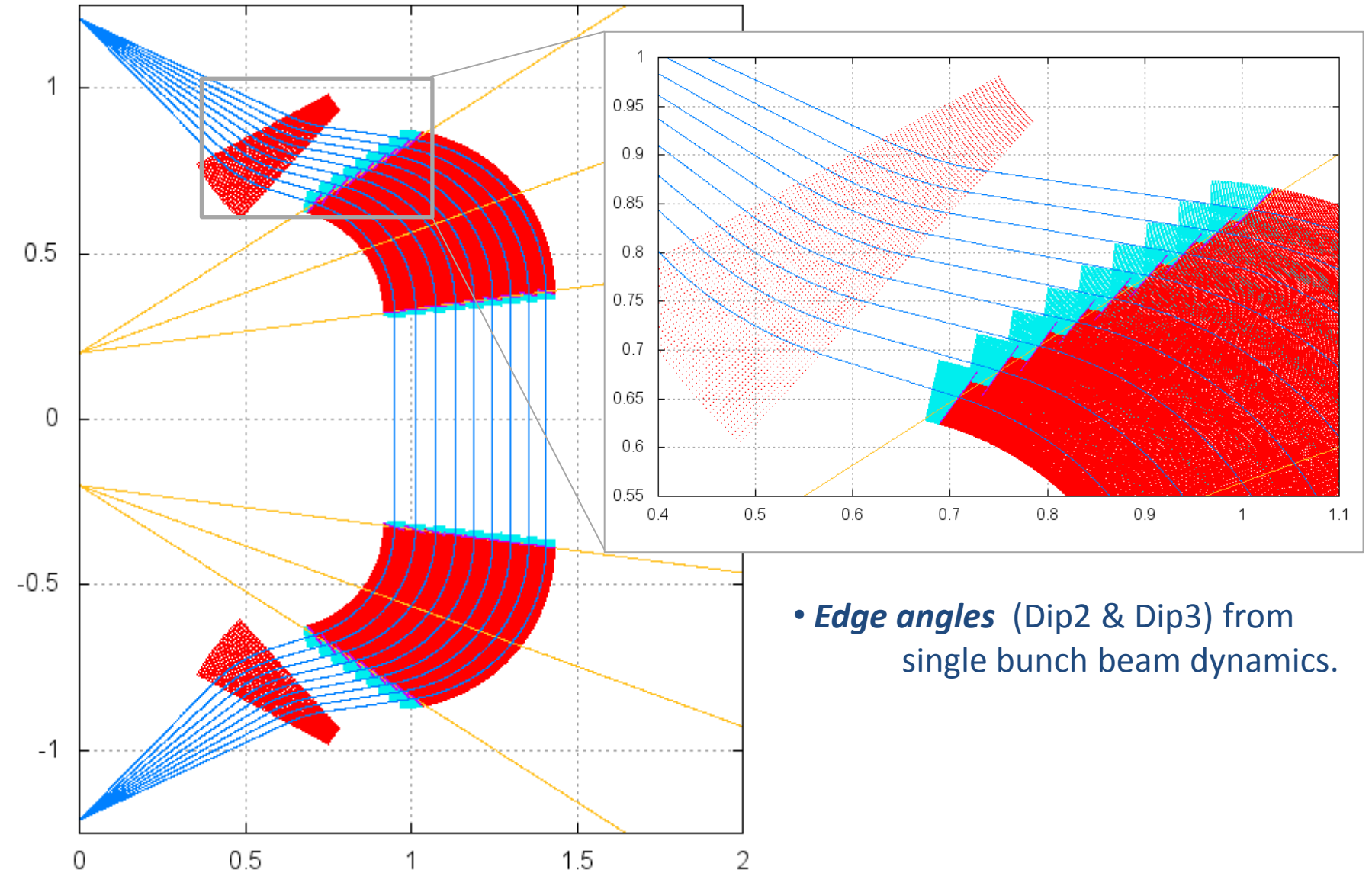


$K=0.098$

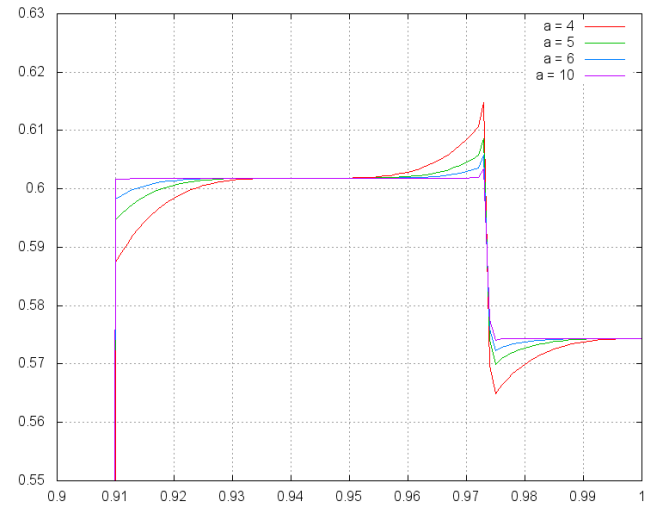
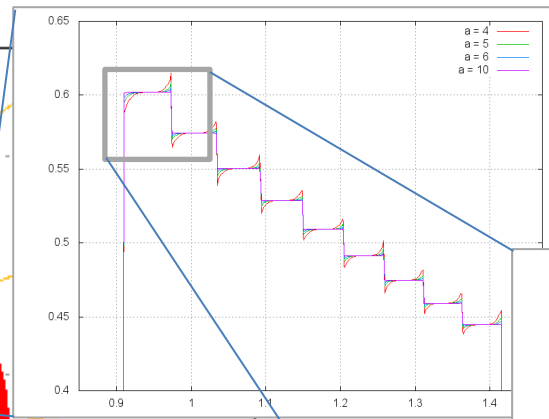
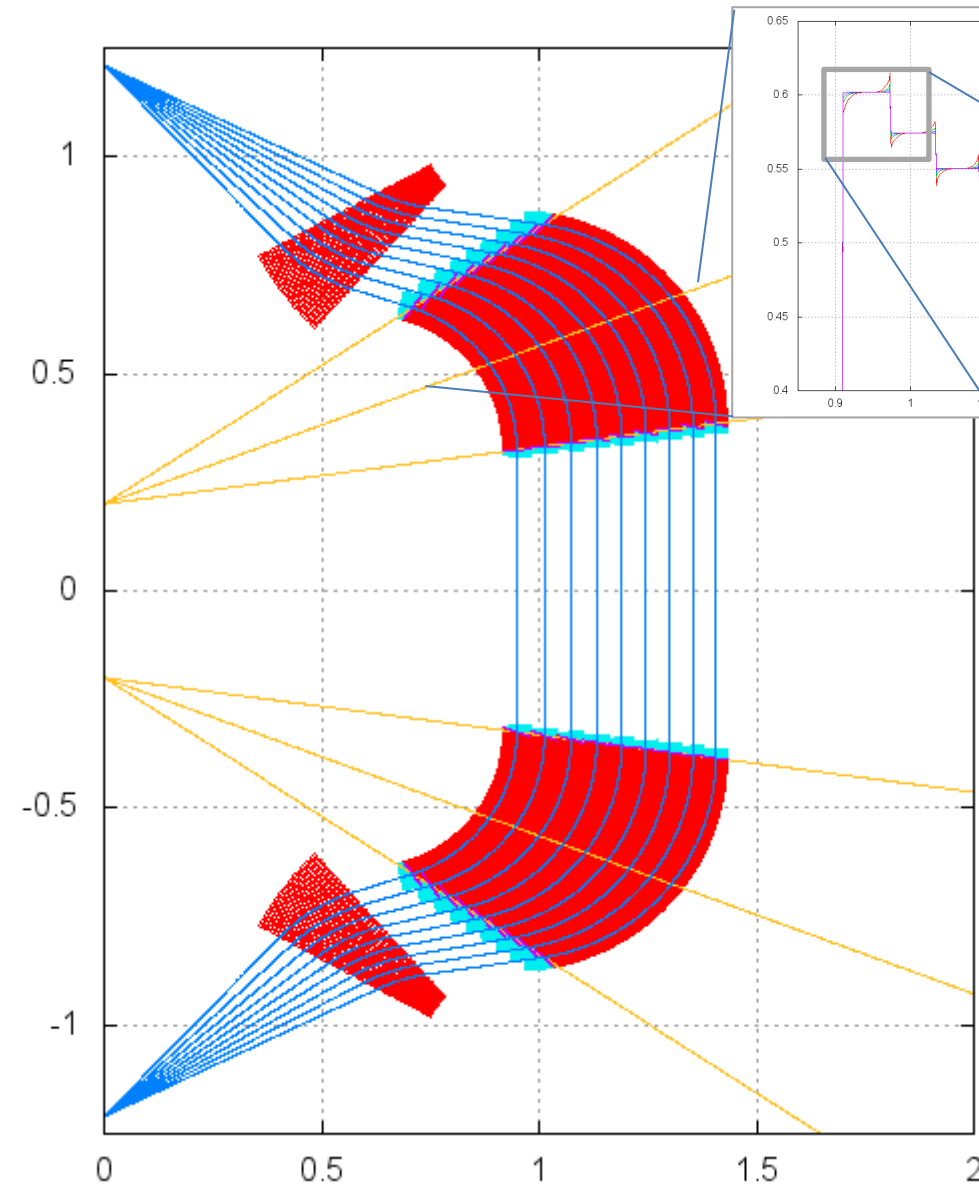
Vertical Component of the Fringing Fields



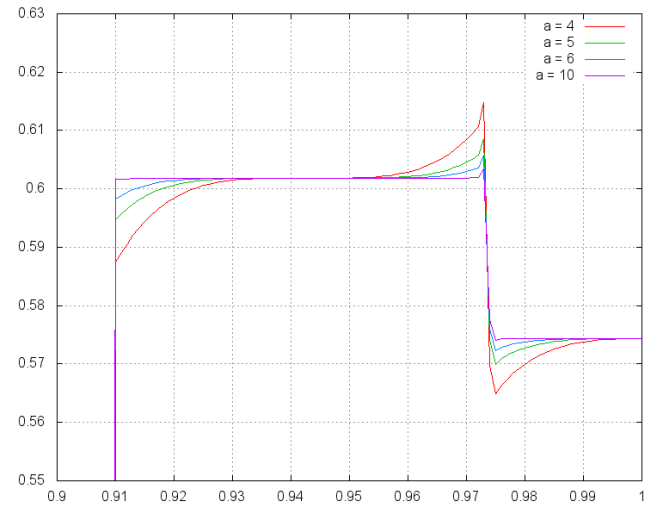
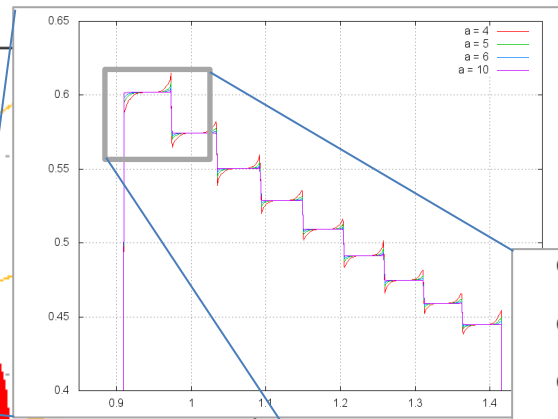
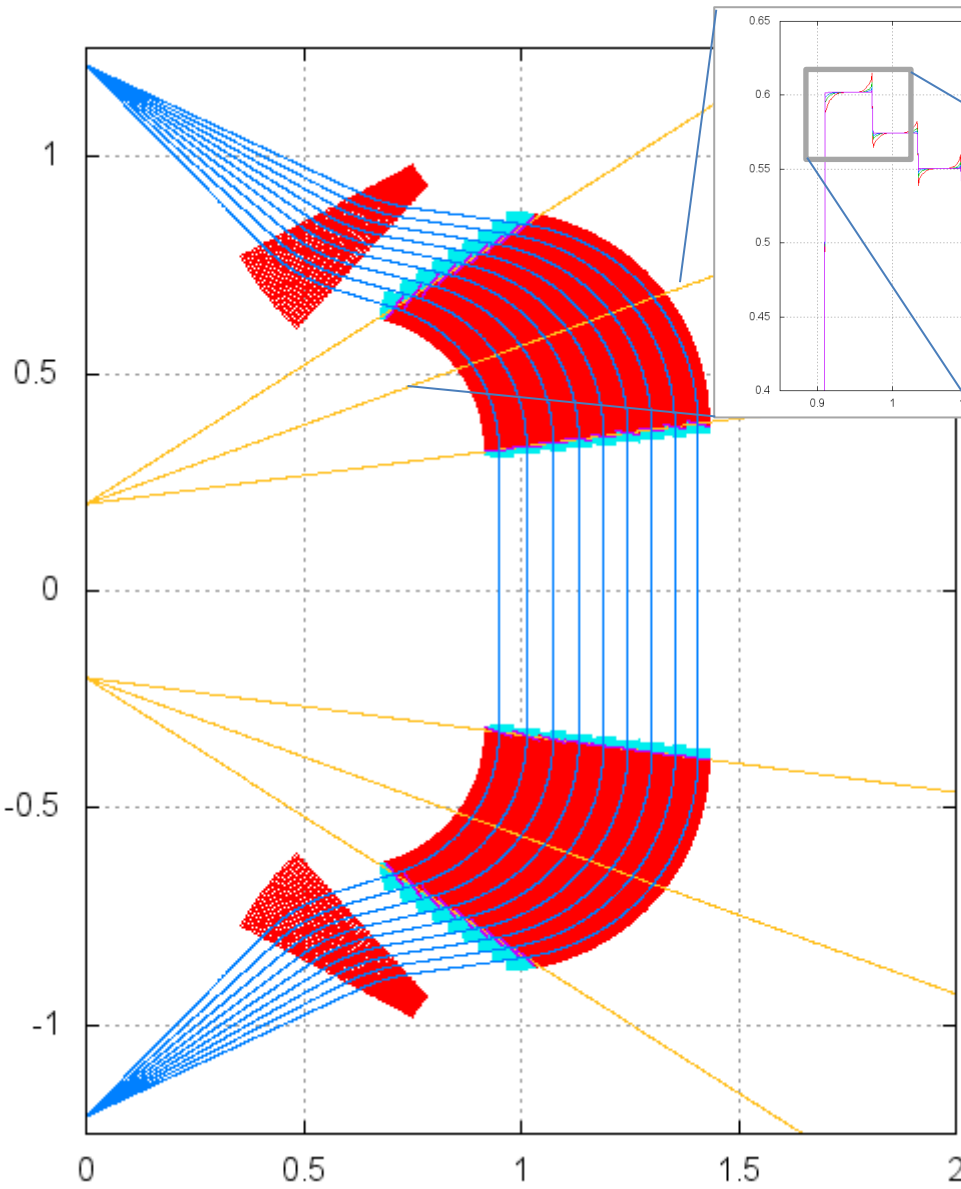




- **Edge angles** (Dip2 & Dip3) from single bunch beam dynamics.



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- Idealized fields for **transverse gradient** optimization.
- **PIC** for arbitrary field distribution.

Geometry:

drifts, bends, distances, angles
mag. Fields, gradients

Kicker:

Kicker shape, Voltage, Entrance phase
Analytic, numerical estimation
Measurement at scaled model

Single Bunch Beam Dynamics:

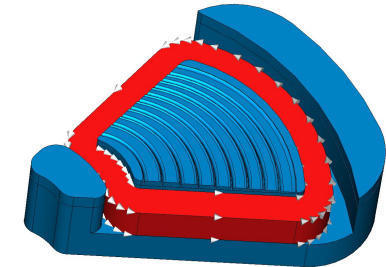
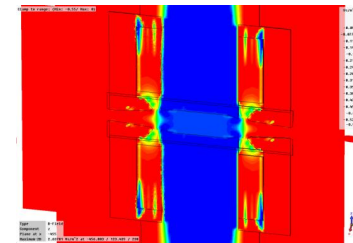
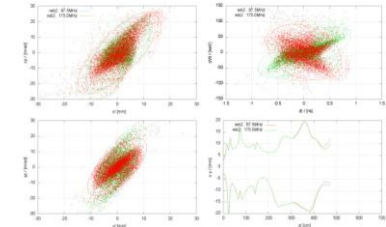
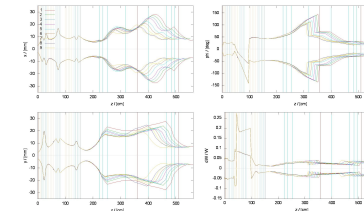
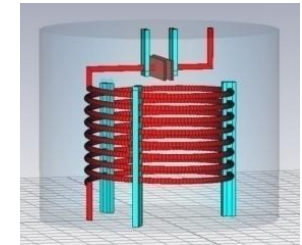
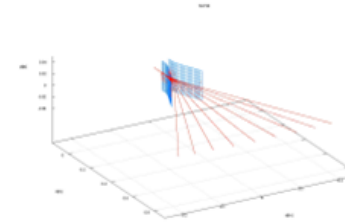
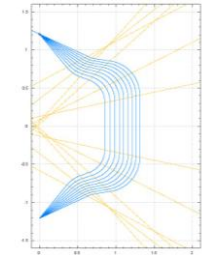
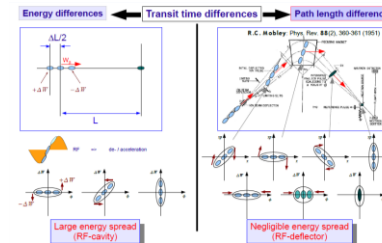
16 parameter each trajectory
LINAC+ bunch compressor
Particle swarm optimization

Magnet Design:

EM-Studio: 3D-Fields
Yoke, field clamp design
Auxiliary dipole (homogenous)
Main dipole (gradient)

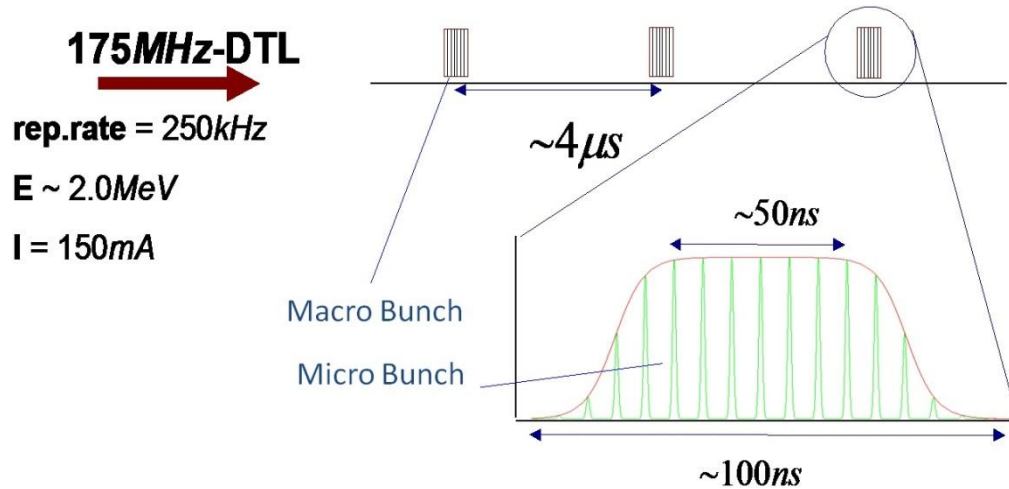
Multi Bunch Beam dynamics:

Front to end simulation + merging scenario



Vielen Dank für Ihre Aufmerksamkeit!

Entrance Pulse-Structure:



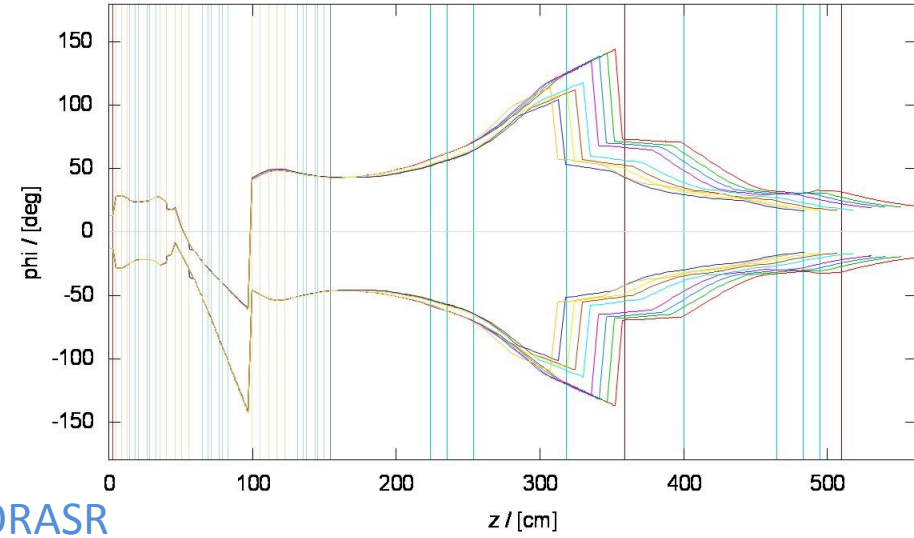
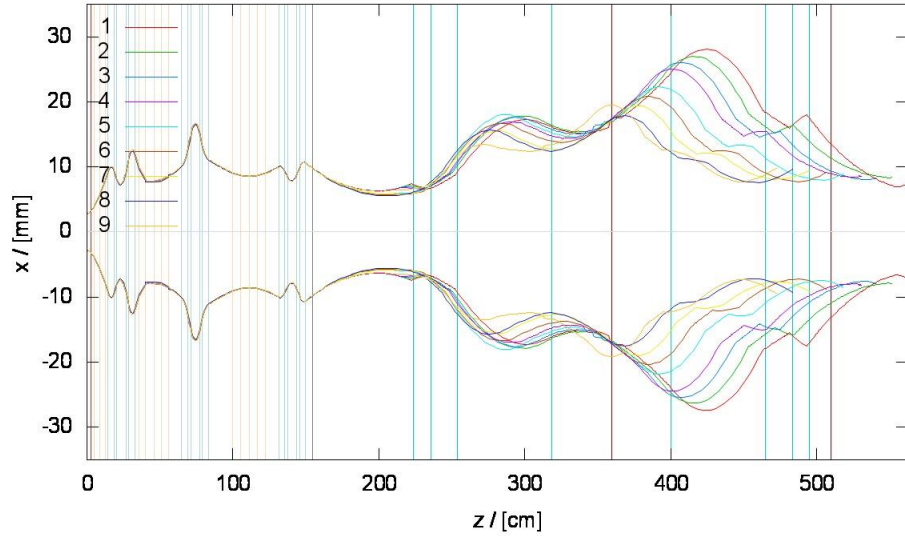
Macro pulsing => LEBT

Micro pulsing => LINAC

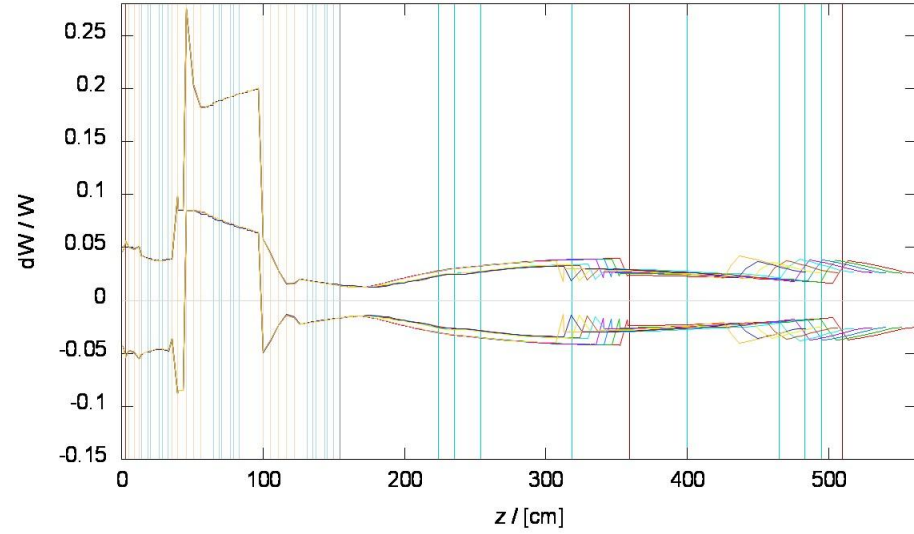
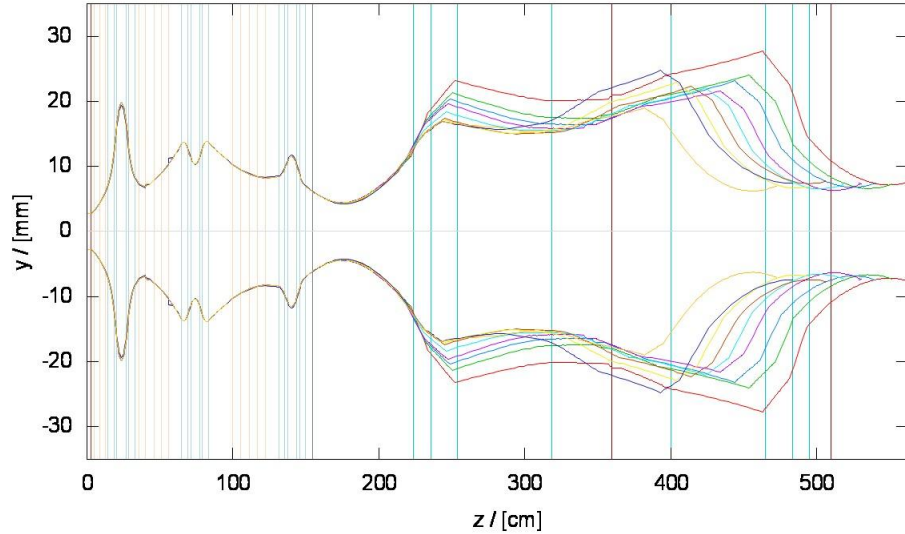
Target Pulse Parameters:

=> Experimental requirements
for TOF-measurements.

- Beam size: r_{rms} < 10 mm
- Energy Spread: $(\Delta E/E)_{\text{rms}}$ < 5 %
- Pulse length: Δt \approx 1 ns
- Charge: Q \approx 7.7 nC



LORASR



=> Solution was found for *all trajectories* at full space charge forces...