

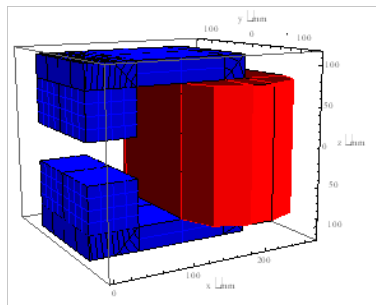
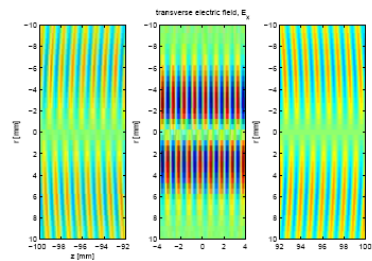
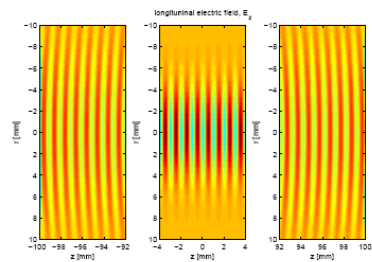
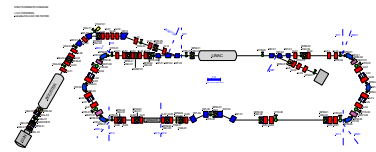
# Microbunching experiments on ALICE

David Holder

*The Cockcroft Institute*

*and the University of Liverpool Department of Physics.*

7<sup>th</sup> October 2009



# Project Outline

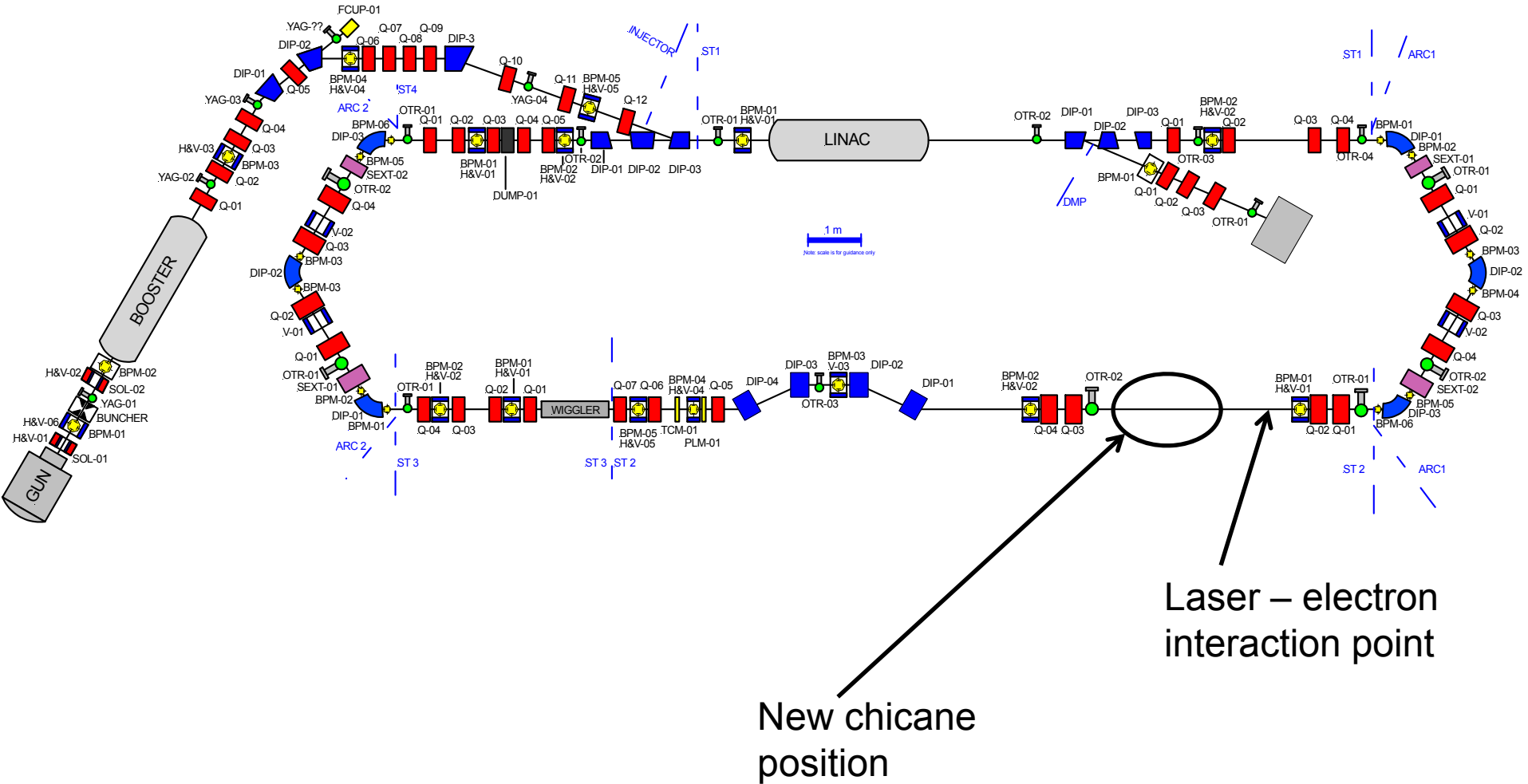
- **Phase 1:** Use of longitudinally (radially) polarised terahertz beam to produce energy modulation in ALICE electron beam; sub topics:
  - Generation of longitudinally (radially) polarised terahertz beam;
  - New lattice optics to get focus at interaction point;
  - Installation of streak camera to observe the modulation on OTR screen in a dispersive section;
  - Modelling of the interaction in Matlab or VORPAL

# Project Outline

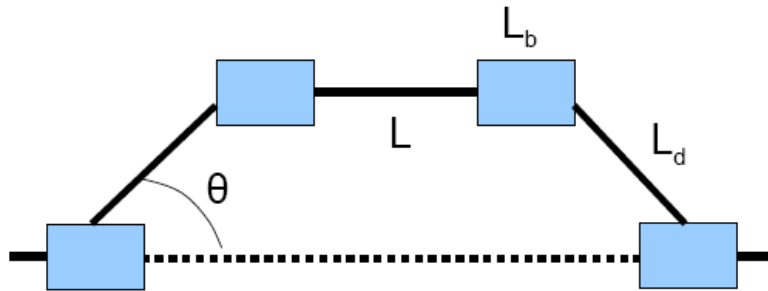
- Phase 2: Conversion of energy modulation into density modulation (bunching); sub topics:
  - Engineering design of addition chicane (magnets, vessel, diagnostics, power supplies);
  - New lattice optics to get required  $R_{56}$ .

# Proposed ALICE Microbunching Layout

ERLP SCHEMATIC DIAGRAM  
v.0.2 (15/06/2006)  
extracted from AO-180/10078/E



# Four dipole chicane (BDM)



$$R_{56} = \frac{1}{L_B^2 \theta} 4L_B^3 \theta - L_B^3 [-2 + 11 \cos \theta - 6 \cos 2\theta + \cos 3\theta] \sin \theta$$

$$+ L_B^2 L_D \theta [9 - 16 \cos \theta + 5 \cos 2\theta] \sin^2 \theta$$

$$+ 2L_B [-L_B^2 + L_D^2 \theta^2 + 2L_B^2 \cos \theta - 3L_D^2 \theta^2 \cos \theta] \sin^3 \theta$$

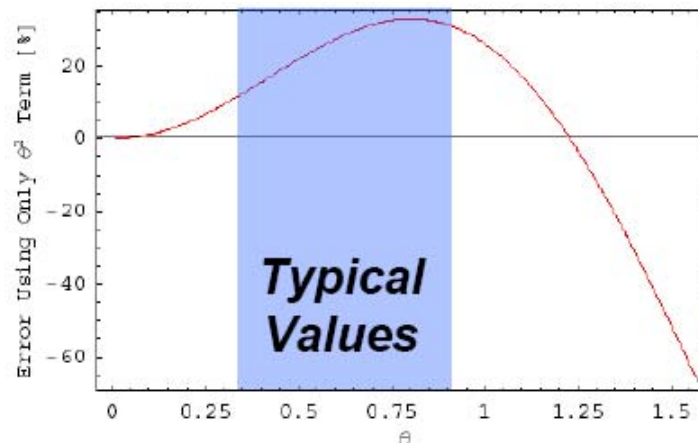
$$+ [-2L_B^2 L_D + L_D^3 \theta^3] \sin^4 \theta$$

**Usual Linear Term**

**Power Series:**

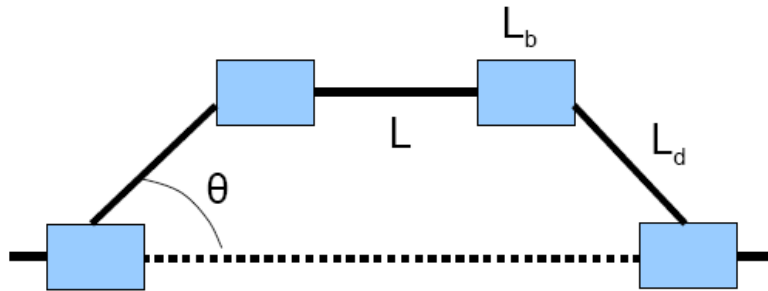
$$R_{56} = \left( -\frac{4}{3} L_B - 2L_D \right) \theta^2 + \left( -\frac{23}{15} L_B - \frac{10}{3} L_D - 2 \frac{L_D^2}{L_B} \right) \theta^4 + O(\theta^6)$$

**Error Using 1<sup>st</sup> Term:**

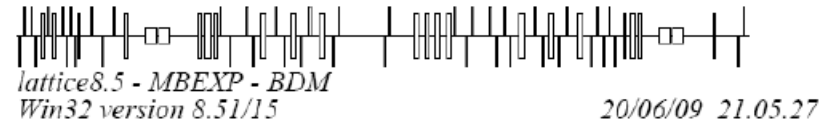


# Chicane Parameters (BDM)

- $R_{56} \approx 3$  cm
- Number of magnets 4
- Total length  $< 2$  m
- Beam offset  $\approx 7$  cm
- Magnet length ( $L_b$ )  $\approx 15$  cm (10)
- Dipole separation ( $L_d$ )  $\approx 20$  cm (10)
- Central drift length ( $L$ )  $\approx 20$  cm
- Additional quadrupoles?
- More diagnostics?

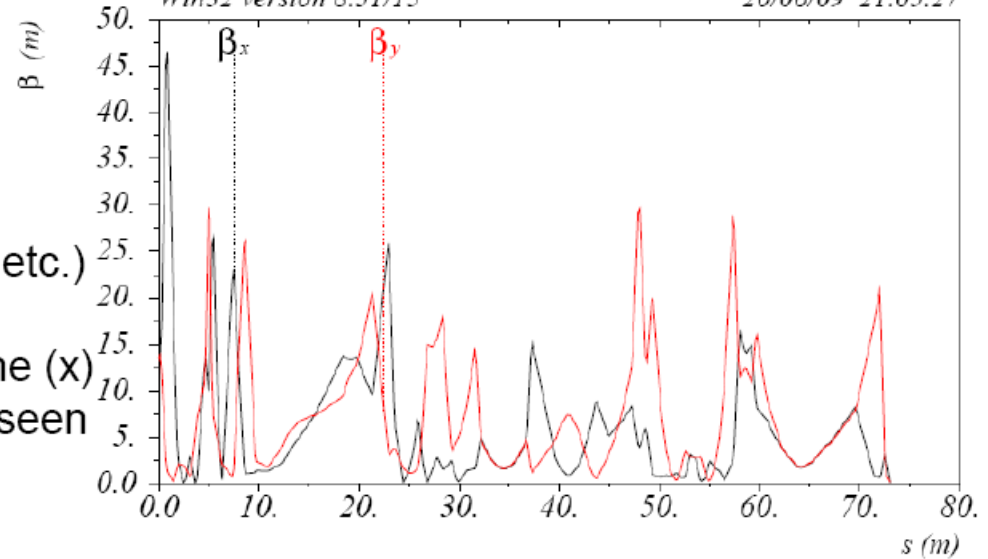


# New lattice optics (BDM)



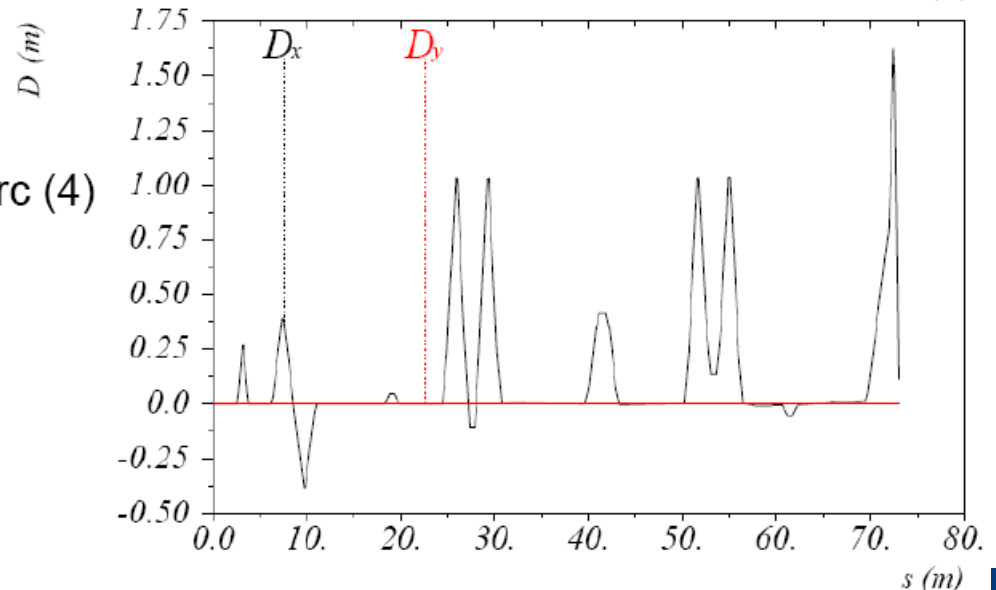
Purpose:

- Achieve waist @ the IP (x & y)
- Make this waist tunable (scans etc.)
- Impose modulation
- Achieve waist @ OTR in chicane (x)
- Contribution should be **clearly** seen

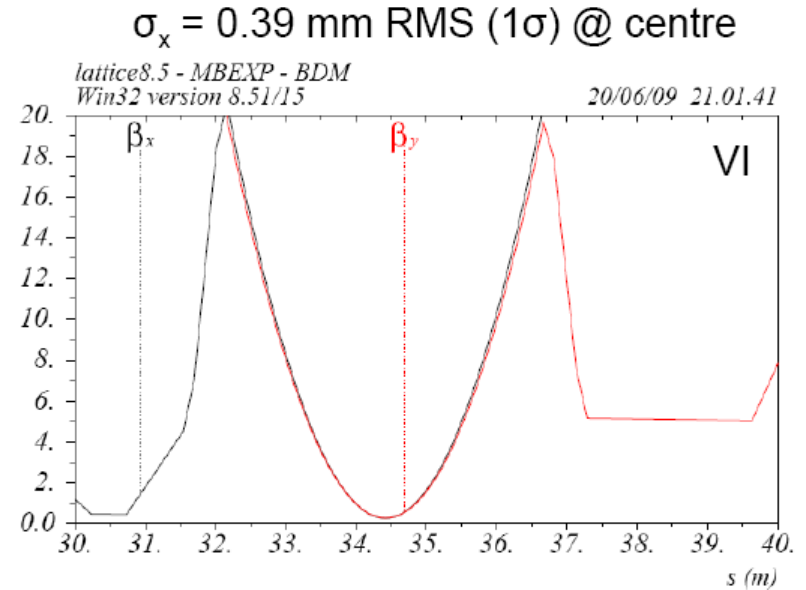
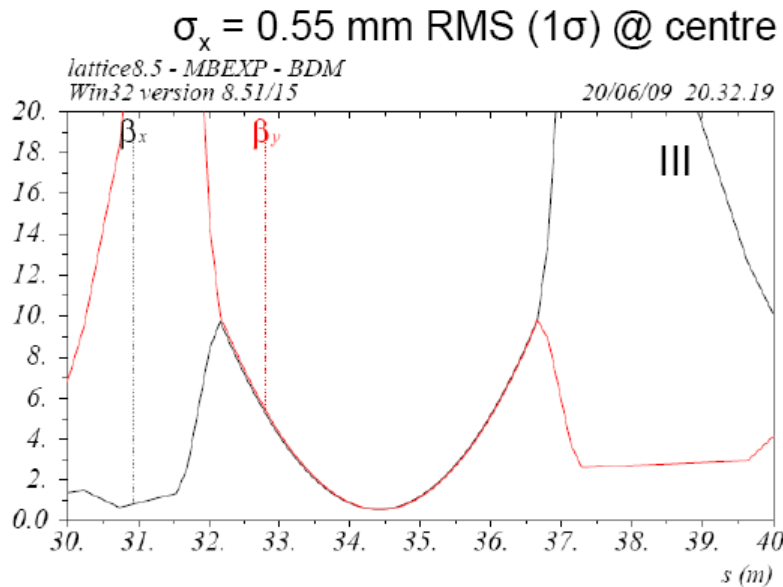
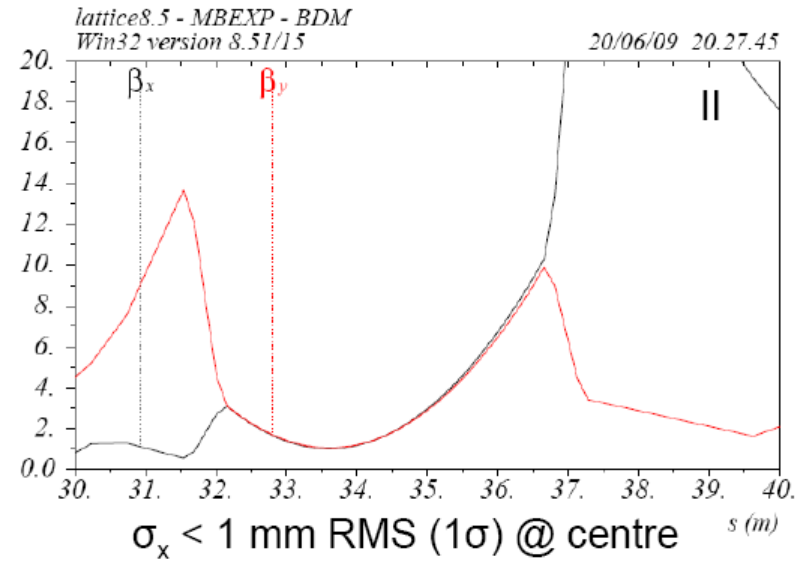
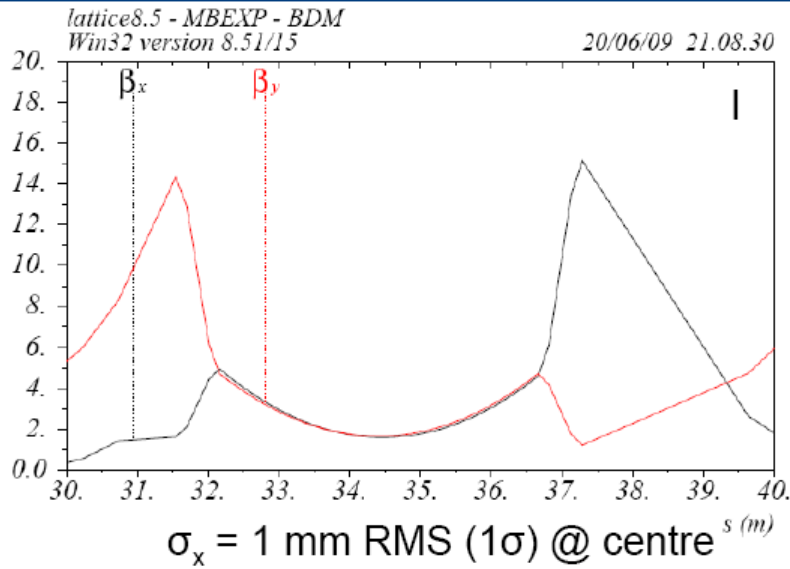


Available:

- Quadrupoles before outward arc (4)
- Quadrupoles after arc:
  - 2 for first waist
  - 2 for second waist

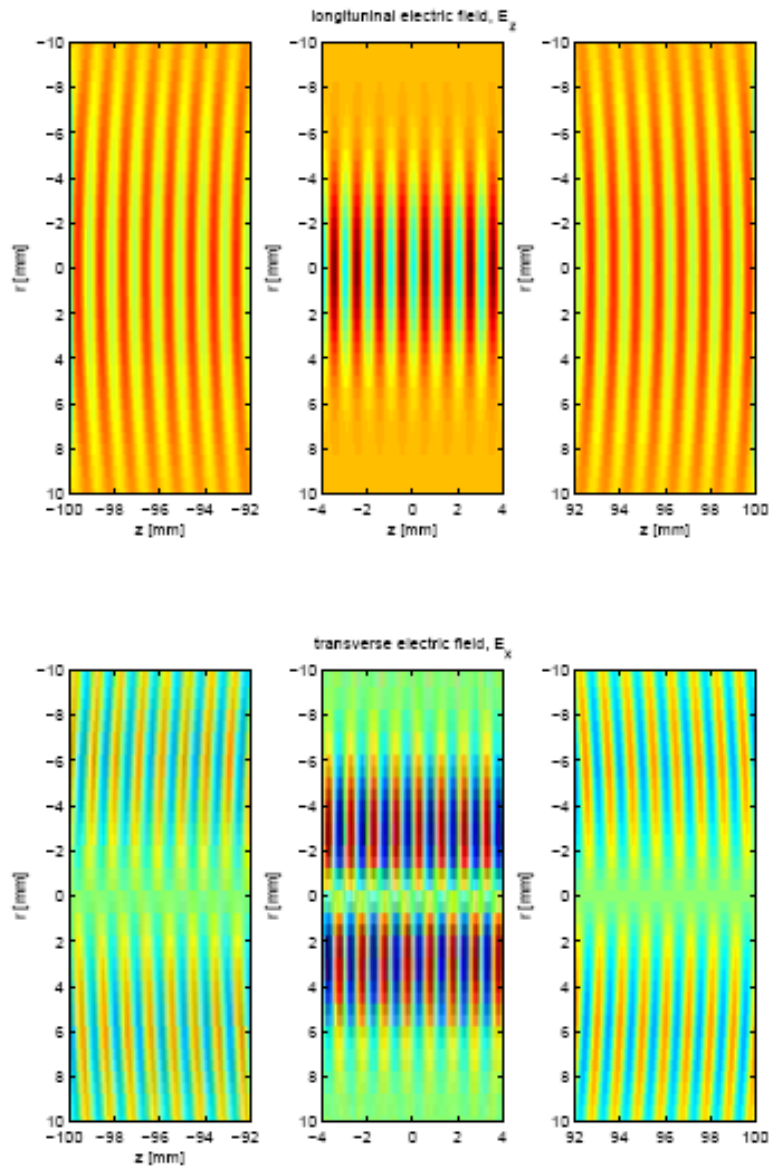


# New lattice optics (BDM)

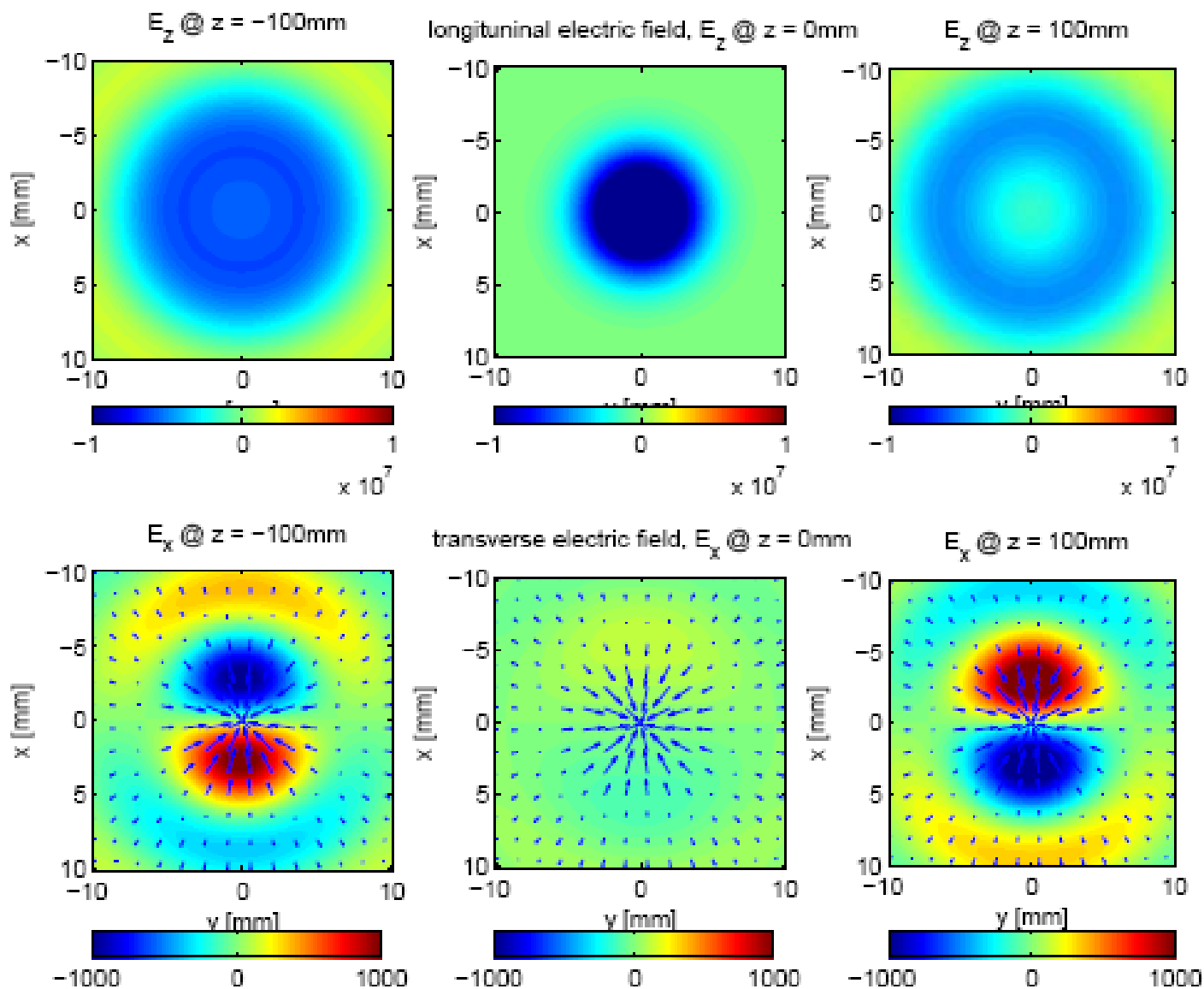




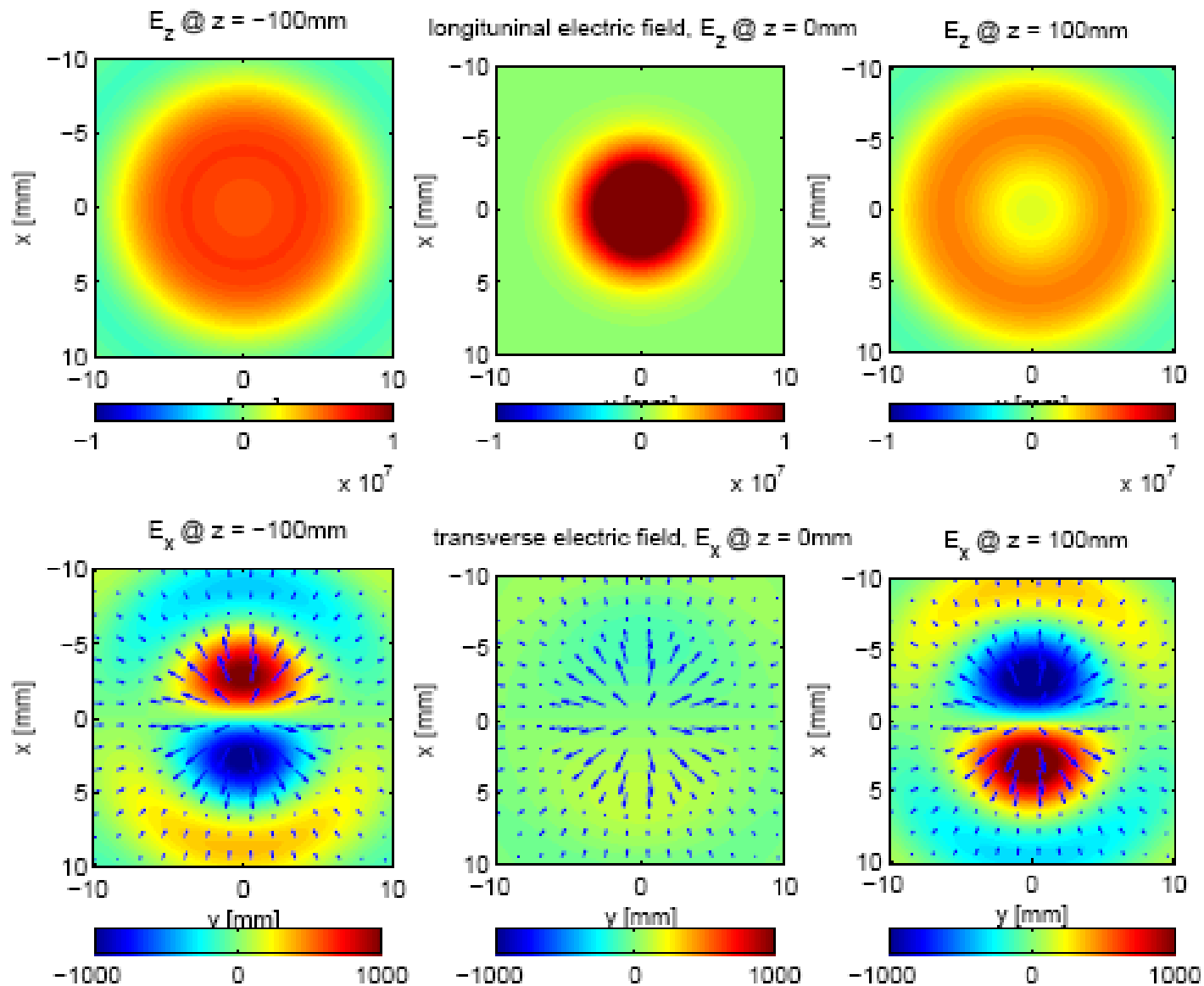
# Matlab Simulation Results (focus at $z = 0$ ) (SPJ)



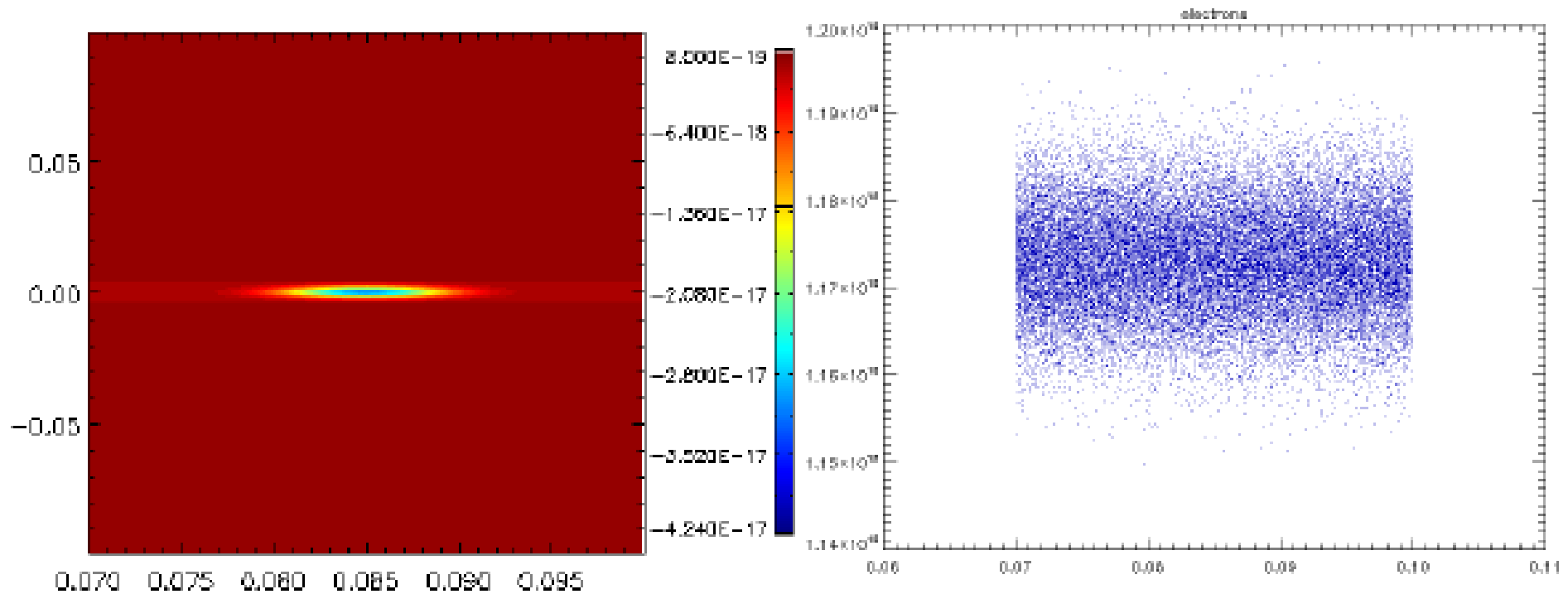
# Matlab Simulation Results (SPJ)



# Matlab Simulation Results $+\pi$ (SPJ)



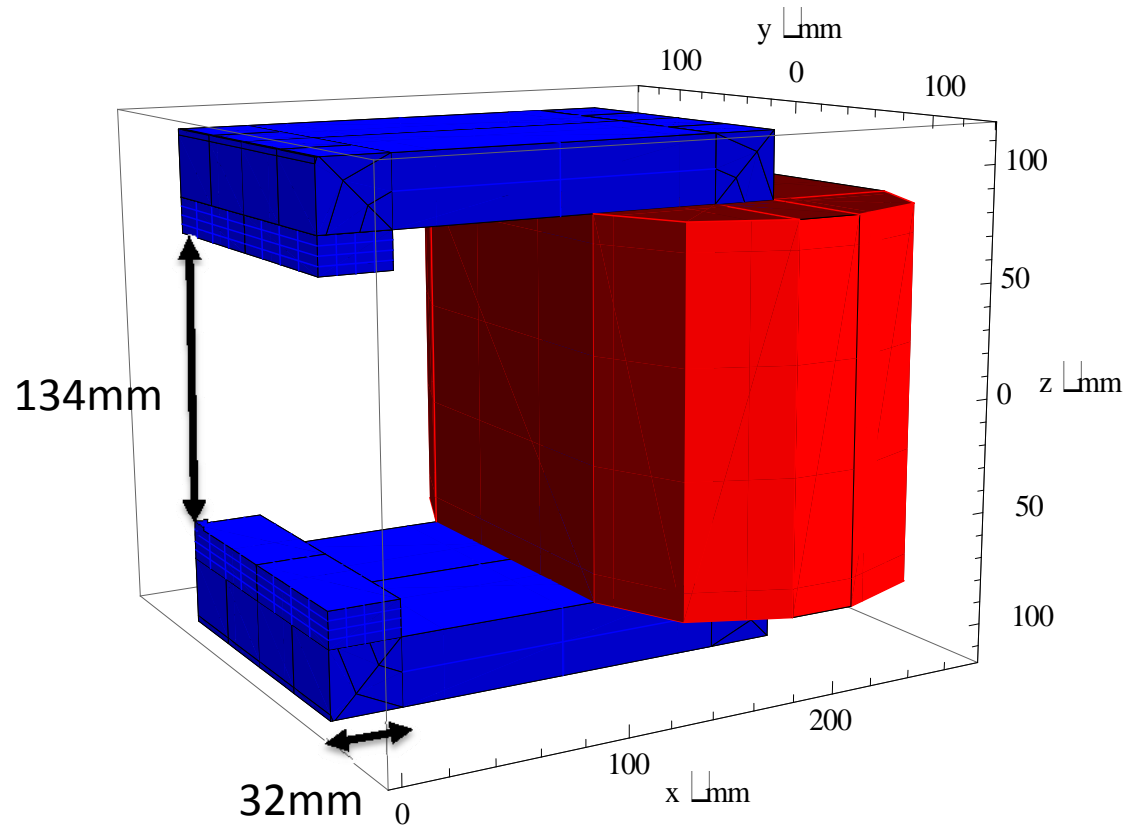
# VORPAL Simulation Results (JDA)



Laser field?

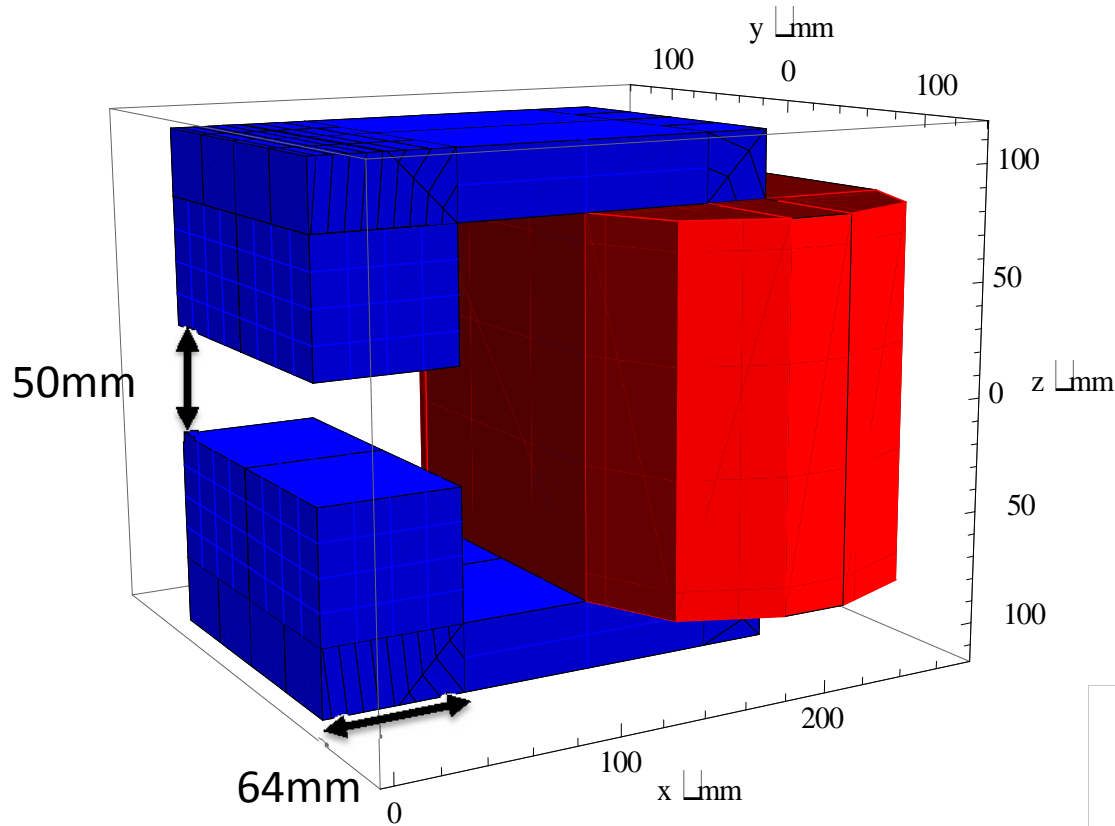
Electron distribution?

# Present VSTM design (BJAS)

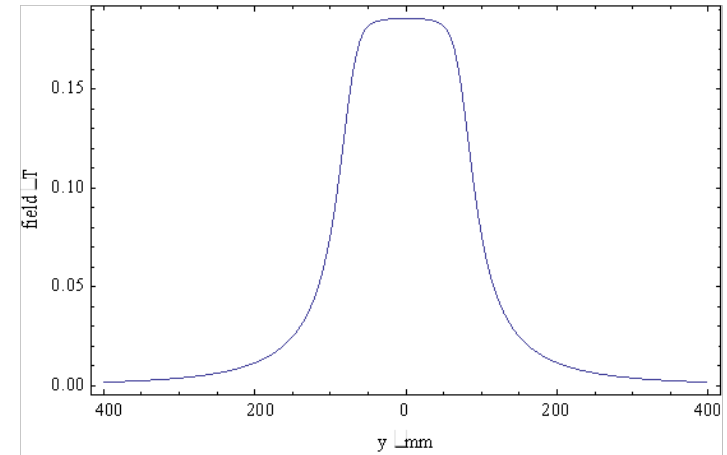


Current: 10A ( $\sim 1.4\text{A}/\text{mm}^2$ )  
Field: 79.2mT

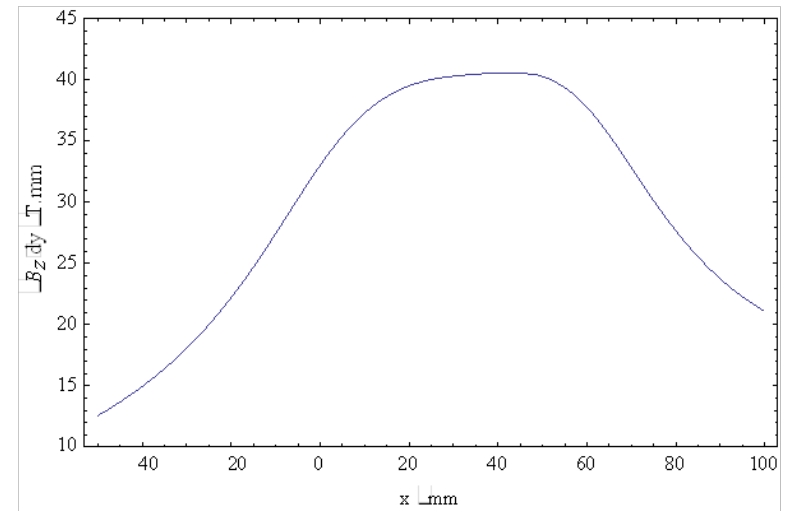
# Possible modified VSTM design (BIAS)



Transverse integrated field profile  
1% good field region: ~25mm  
35MeV deflection: 0.347rad



Longitudinal field profile  
Peak: 0.186T  
Magnetic length: 221mm



# Progress

- Physics design of chicane nearly completed;
- Design/source of dipoles under discussion;
- Relocation of streak camera during next ALICE shutdown;
- Vacuum vessel design and procurement not started – expected to take four months;
- Laser – electron beam interaction to be modelled in Gabriele's code;
- Terahertz radiation source needs refinement.

# Collaborators...

- GB - Gabriele Bassi;
- SPJ - Steven Jamison (ASTeC);
- LBJ - Lee Jones (ASTeC);
- BDM - Bruno Muratori (ASTeC);
- DWN - David Newton;
- BJAS - Ben Shepherd (ASTeC);
- JDS – Jonny Smith (Lancaster);
- PHW - Peter Williams (ASTeC);
- AW - Andy Wolski;