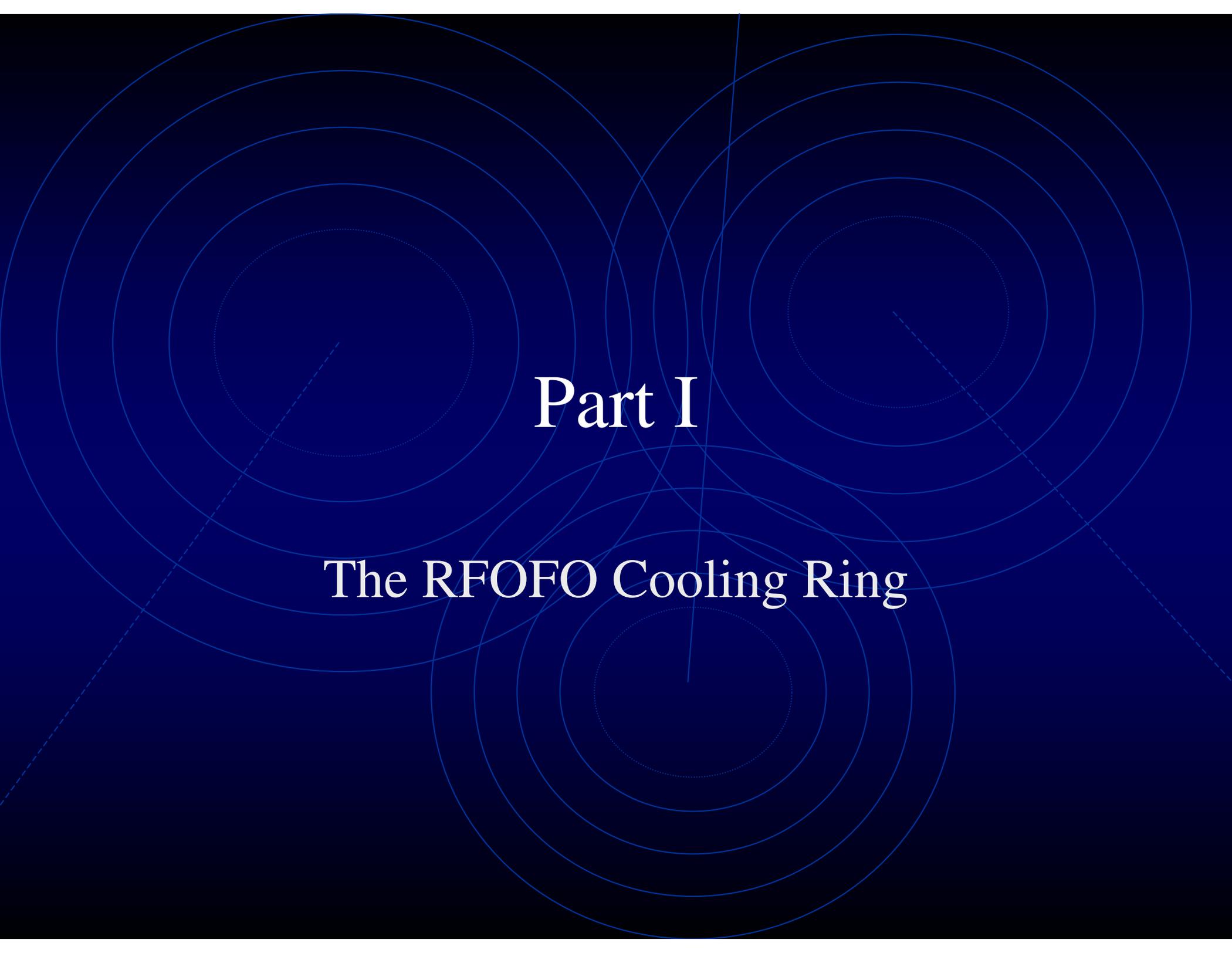# Cooling Ring Studies with GEANT

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Outline of the talk

- ## Part I: RFOFO Ring
  - ### What's New (since MCCM @ Riverside '04)
    - "standard" beam
    - comparison with ICOOL
    - Results published in MUCOOL-Note 298 (Oct.'04)
- ## Part II: Small Dipole Ring ("Kirk-Garren")
  - ### Preliminary results
    - dynamic aperture with realistic field maps

Part I

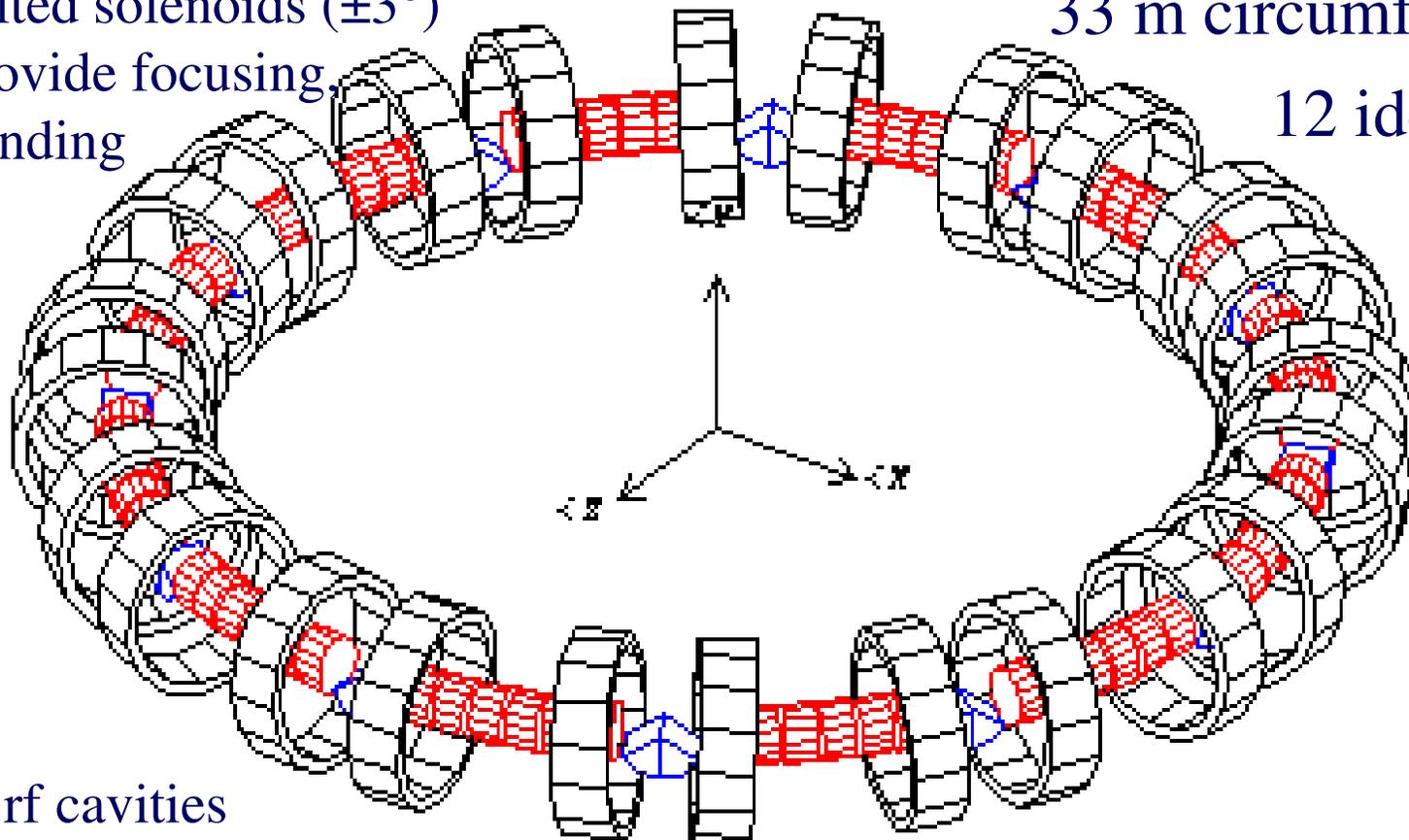## The RFOFO Cooling Ring

The RFOFO Ring

Tilted solenoids (±3°) provide focusing, bending

33 m circumference:

12 identical cells

6 rf cavities (201 MHz) per cell
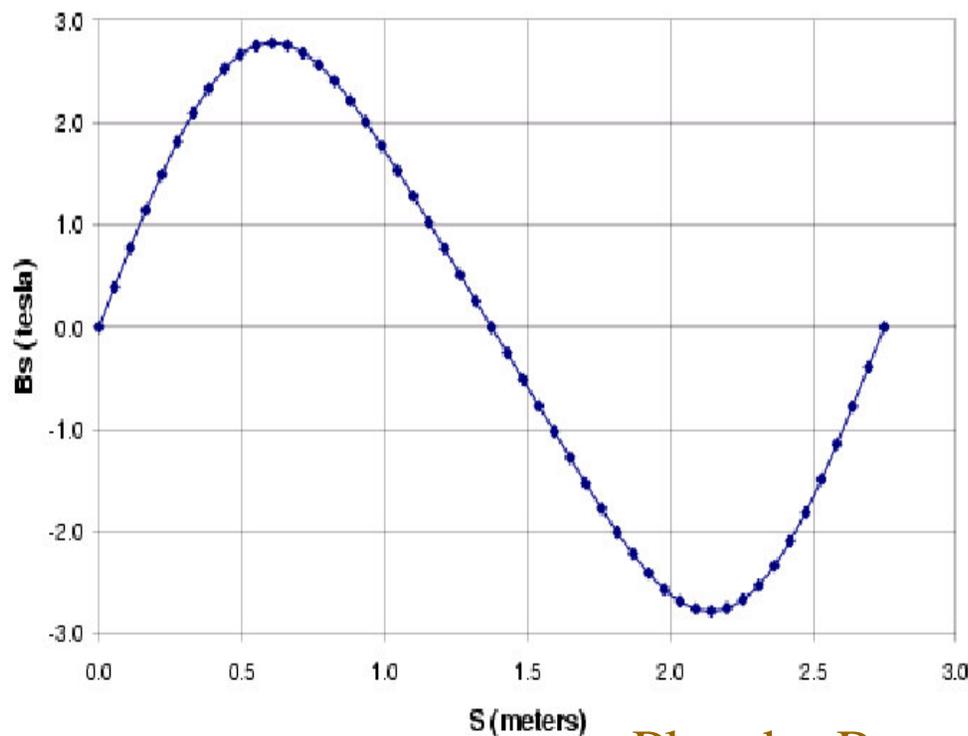
LH_2 wedges (110°)

Simulation software

- MUC_GEANT
  - Data-driven GEANT 3.21 (from R. Raja)
  - A few improvements
    - Better interface with ICOOL, ECALC9
    - more flexibility – the software can be used with other cooling channels without major code changes
  - Field maps – R. Godang (Mississippi)
    realistic, from the RFOFO ring geometry

Magnetic fields seen by a "beam"
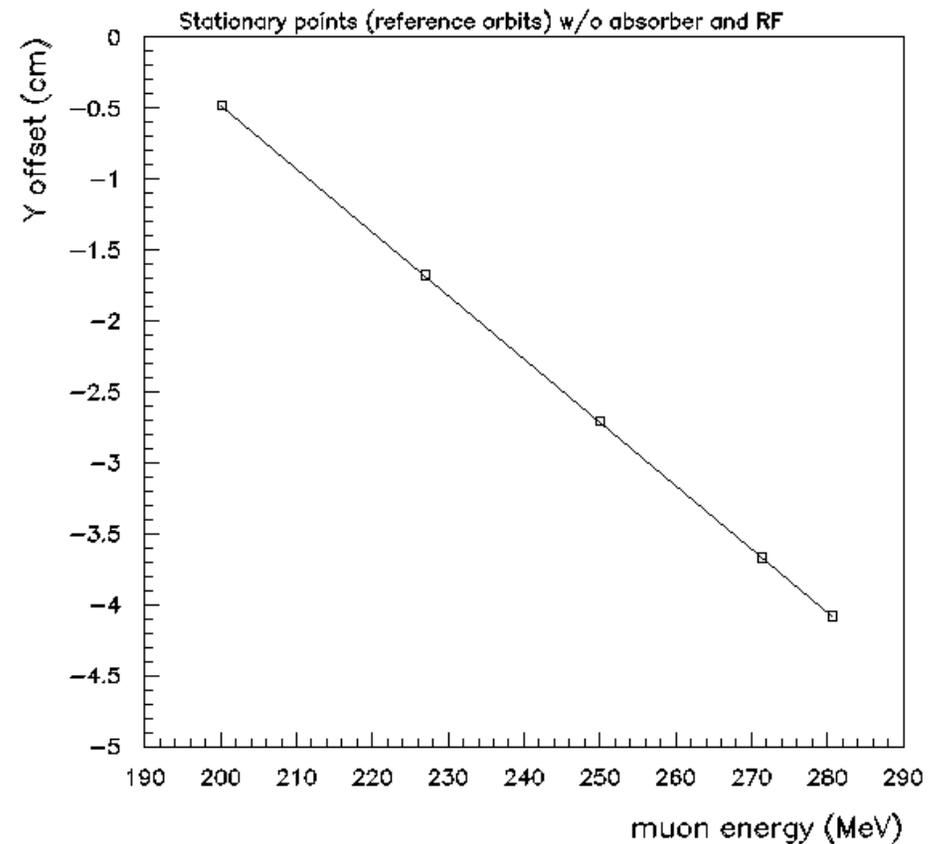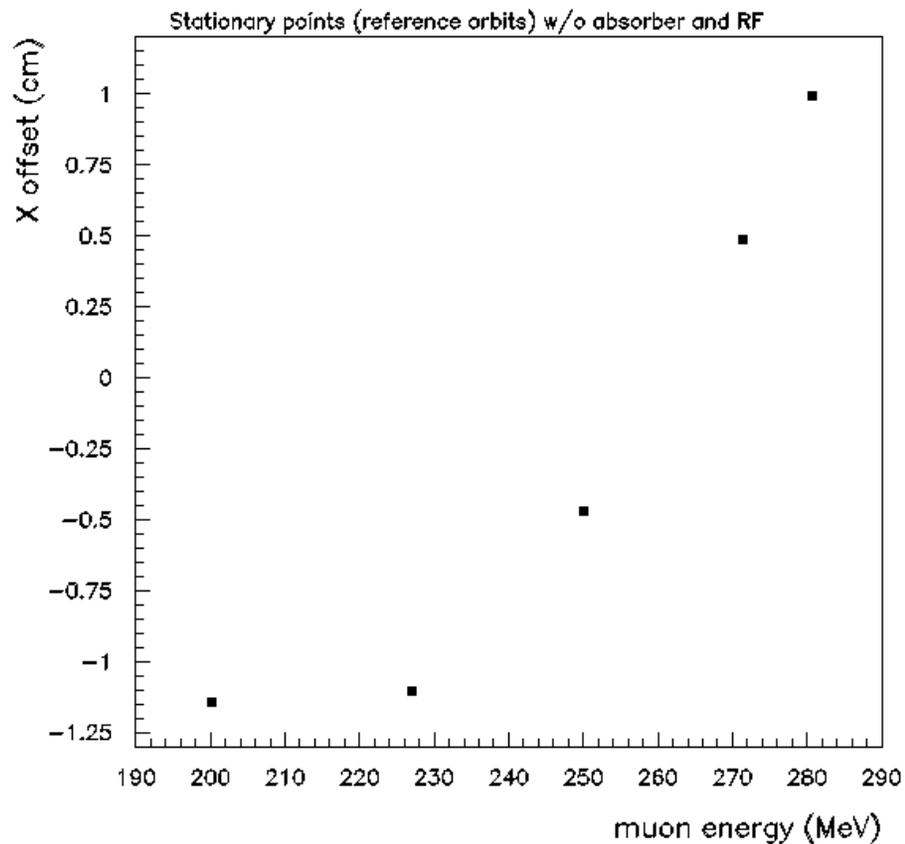
"Bz" in a single cell
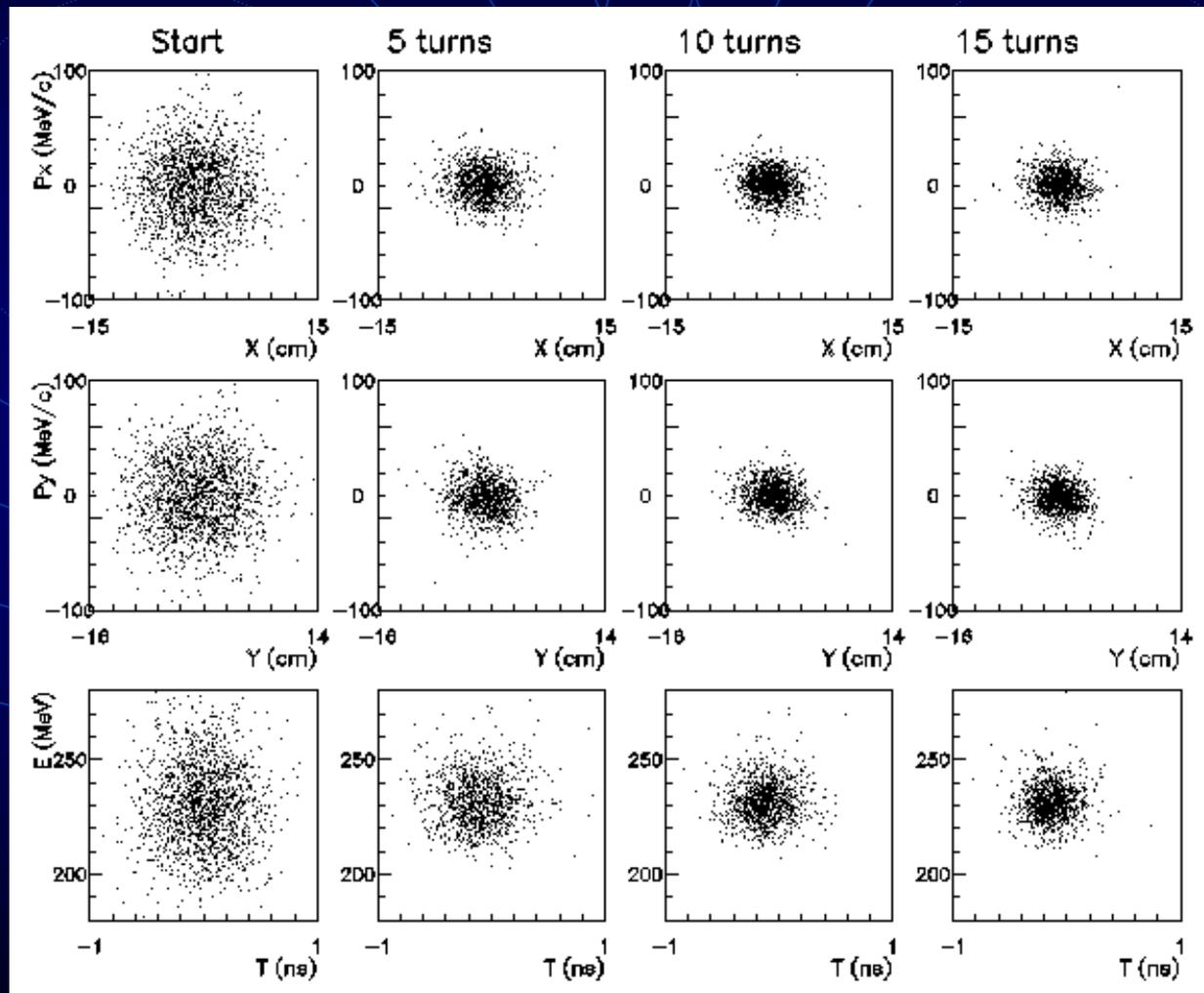
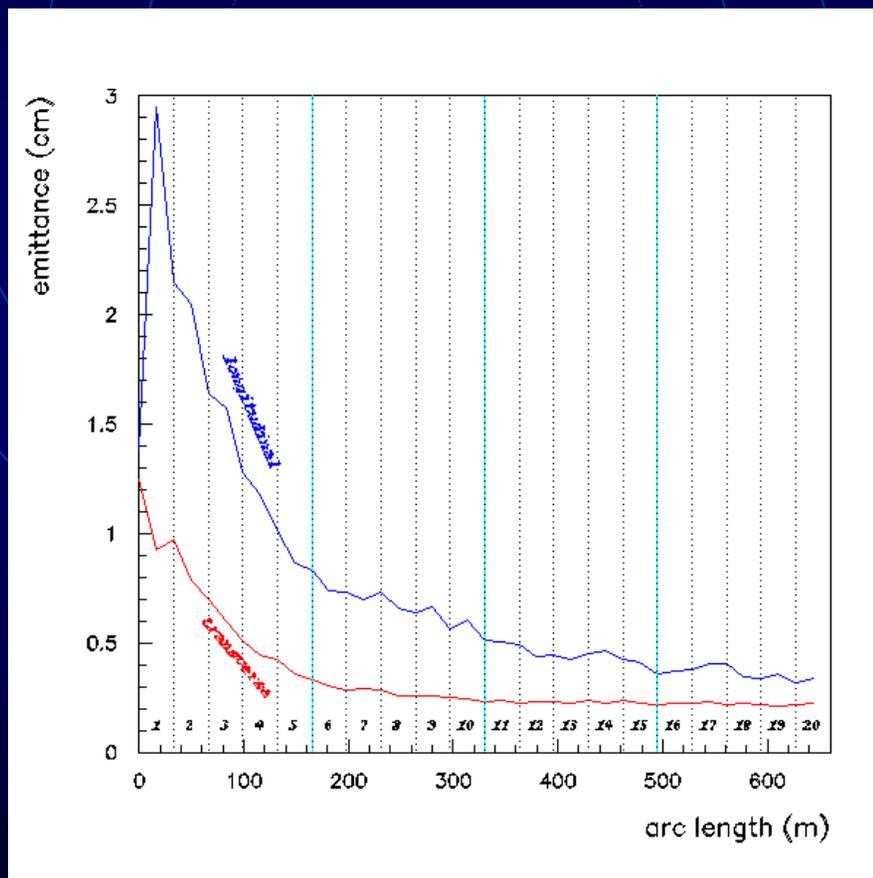Along the ring (global coordinates)
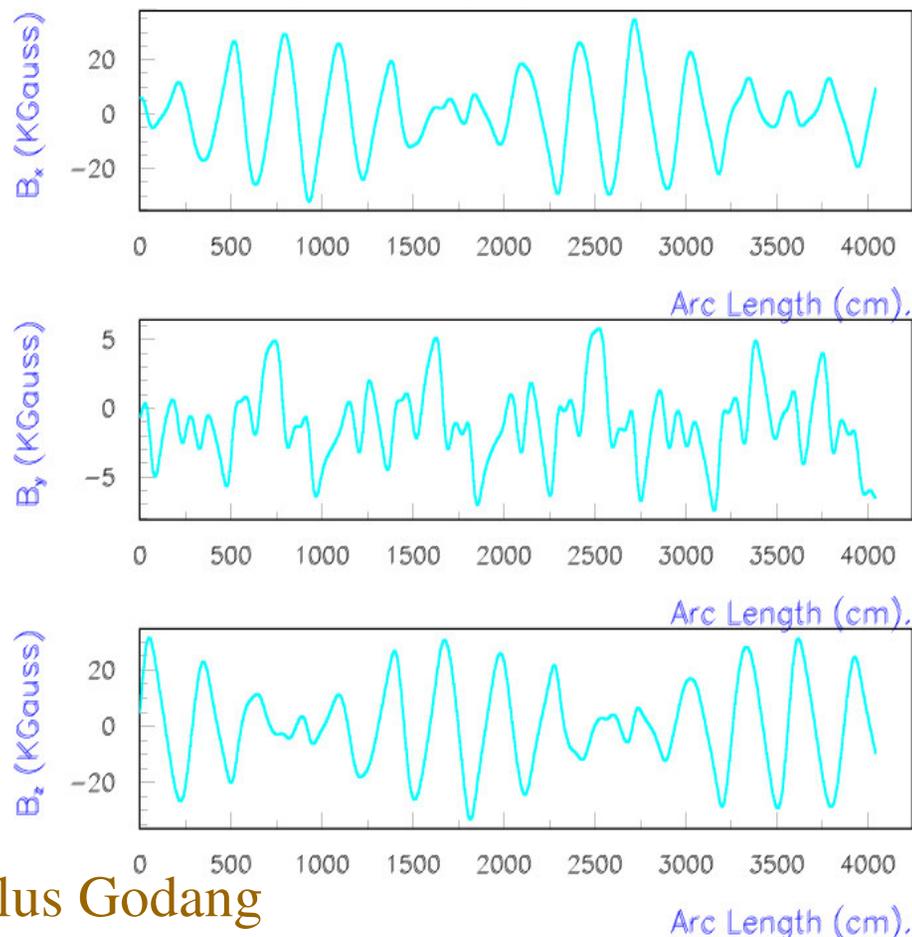
Plots by Romulus Godang

Dispersion functions at the wedges

Cooling of a muon beam

# "Old" (Riverside '04) results

- Unmatched beam
  - Big "jump" in longitudinal emittance

- Non-standard emittance calculation

Changes in RFOFO simulation

- ICOOL input/output format – for003/for009
  - Virtual detectors
  - ECALC9 is used to calculate emittance
- Time information used as input
  - wasn't available in original MUC_GEANT – had to be converted to z coordinate
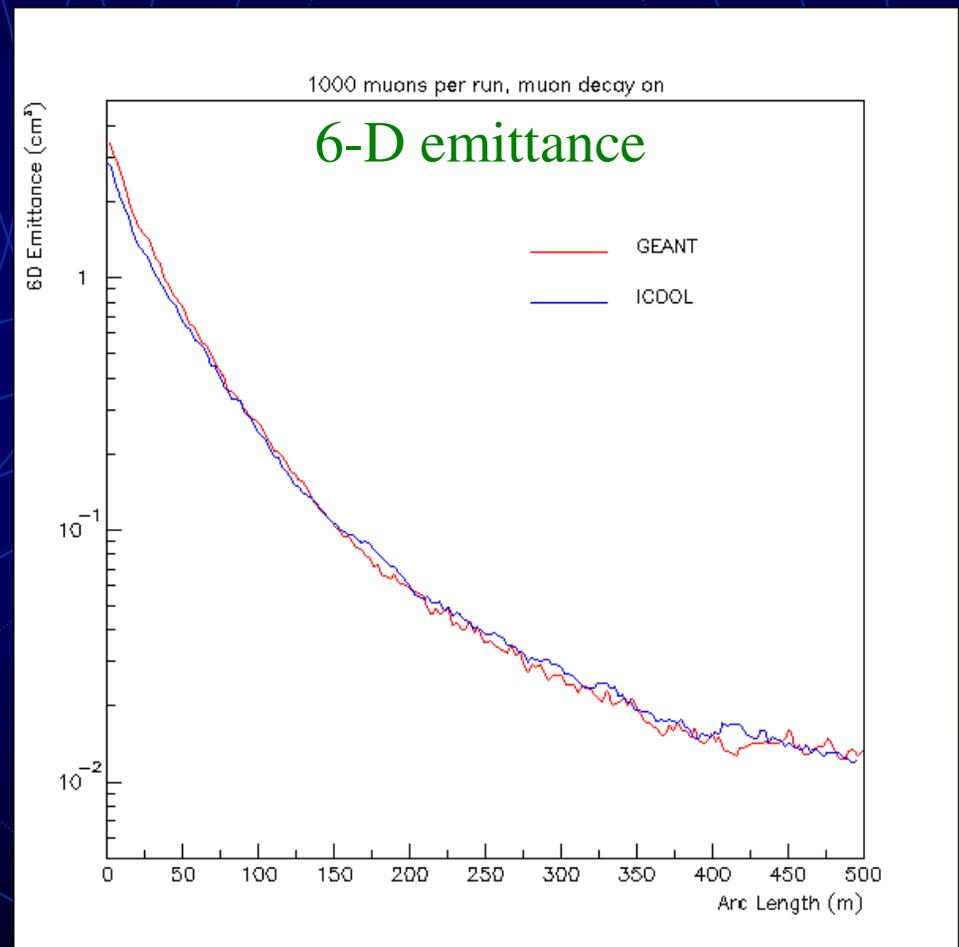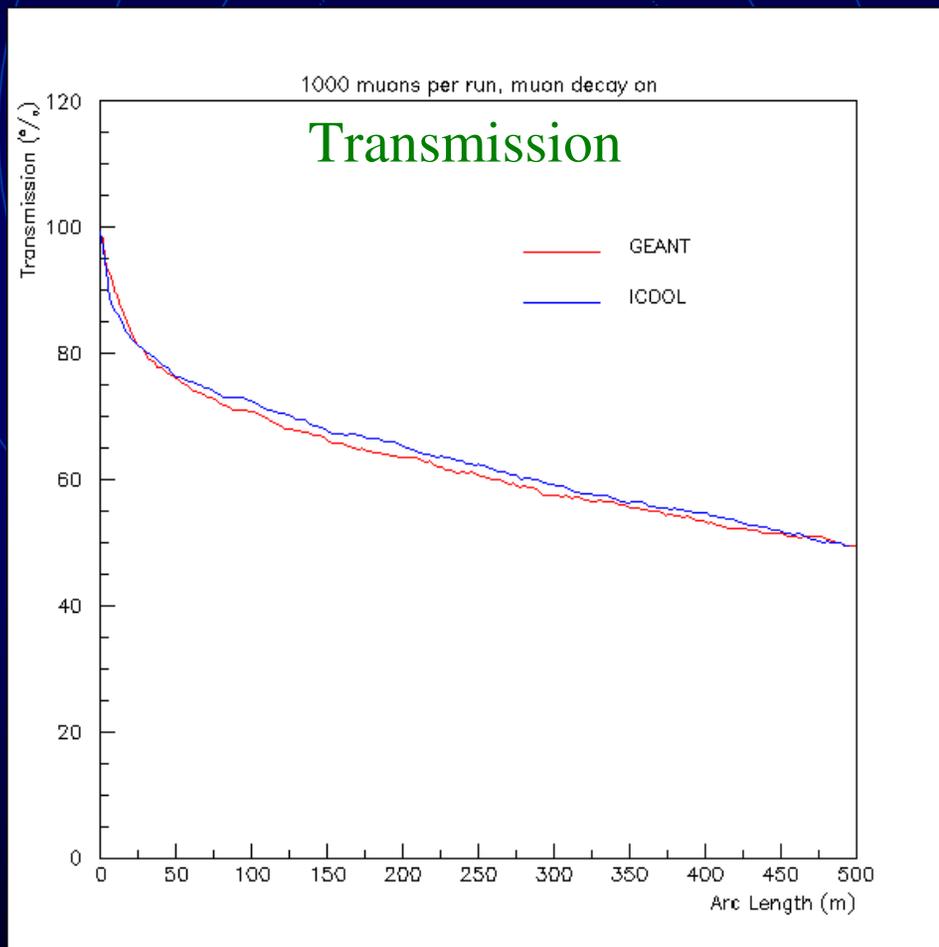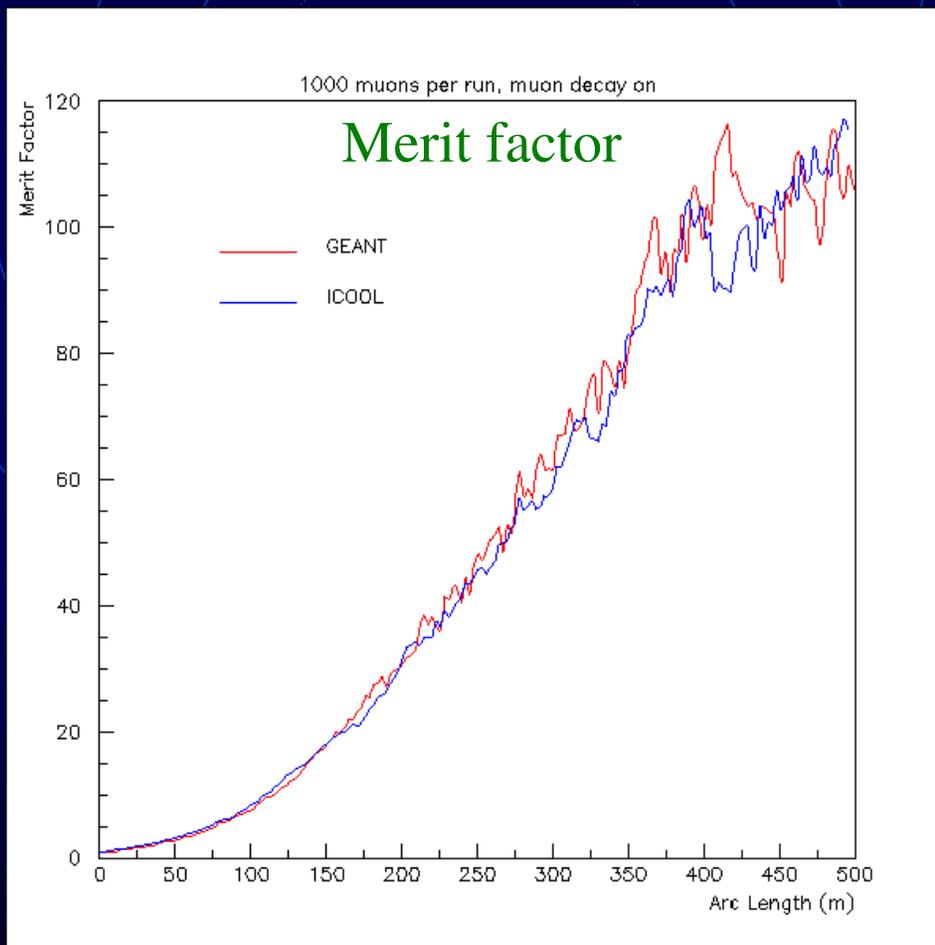- Matched beam (as in MC-Note 264)

Virtual detector planes

Placed between cavities 3&4 in each cell
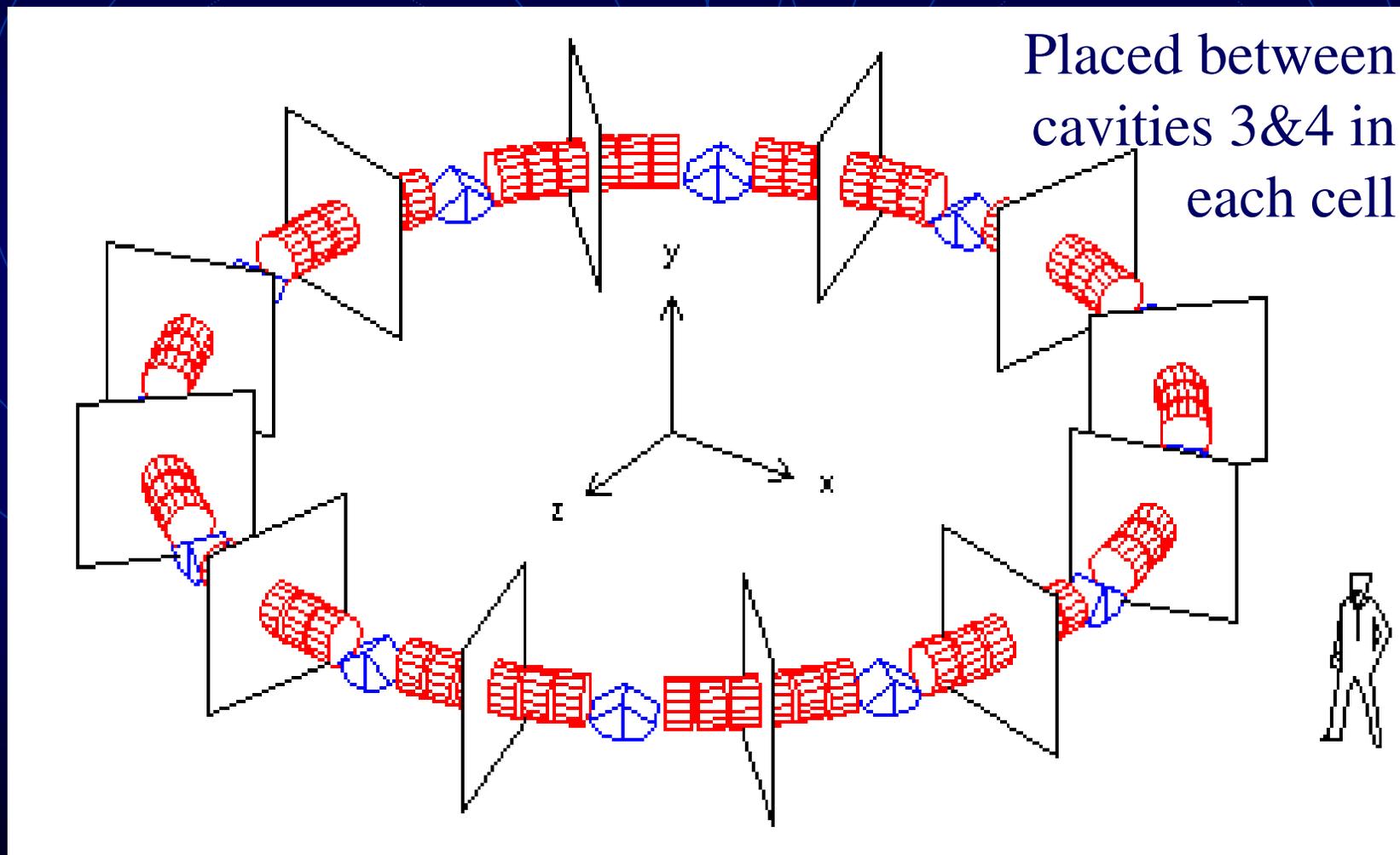
"New" results compared to ICOOL

Transverse emittance

Longitudinal emittance
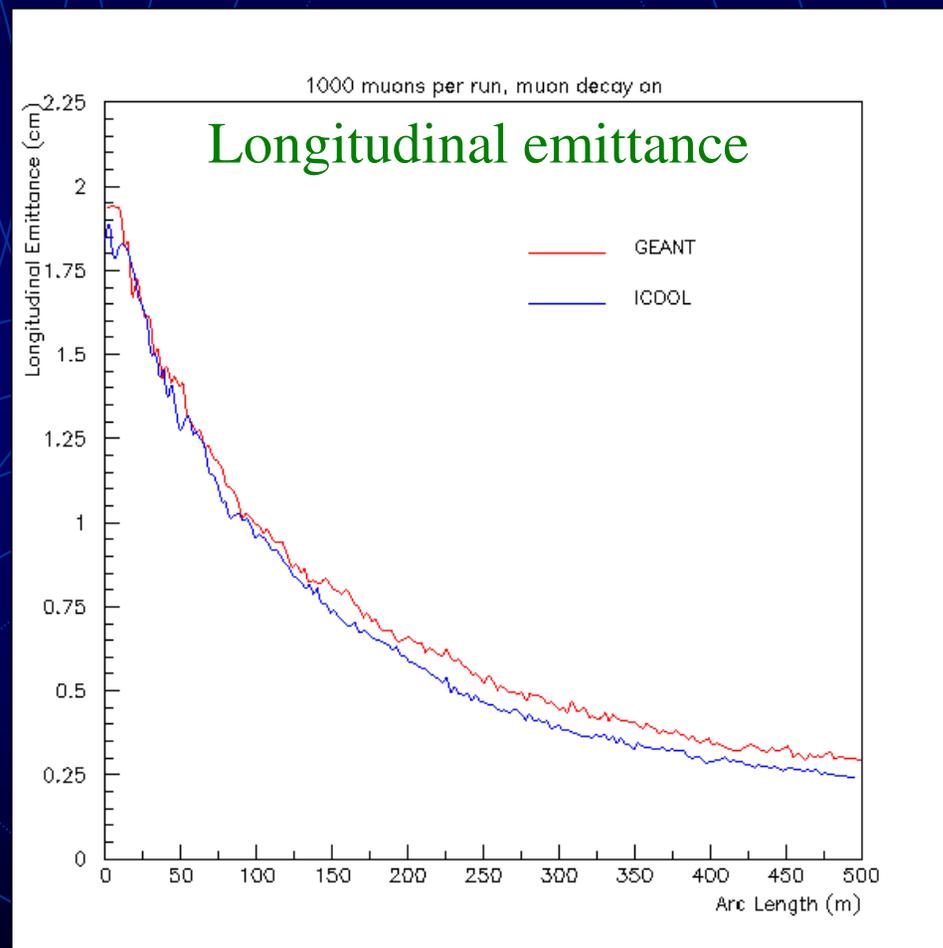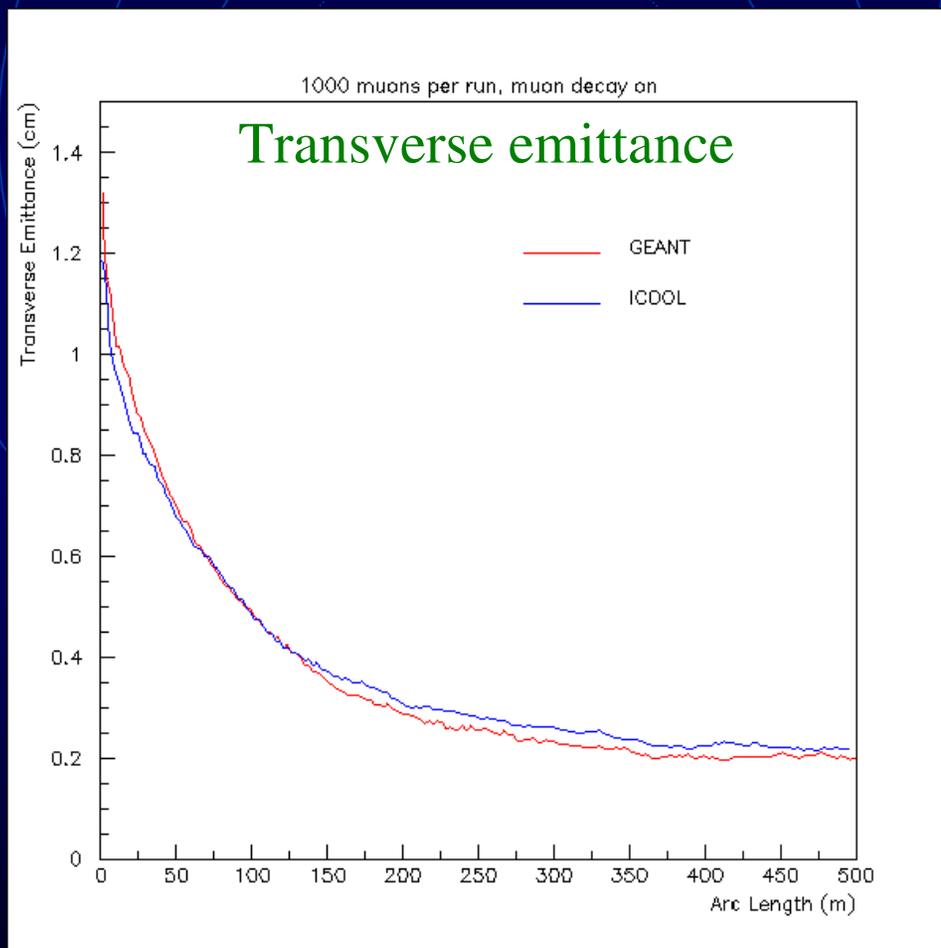
GEANT vs. ICOOL (cont'd)

Merit Factor, other comparisons

	Trans. W/O decay	Trans. With decay	Merit Factor
Balbekov (MC-264)	70%	56%	**55**
ICOOL (Fernow)	--	58%	**66**
GEANT (Old)	64%	51%	**40**
GEANT (NEW)	72%	57%	**70**
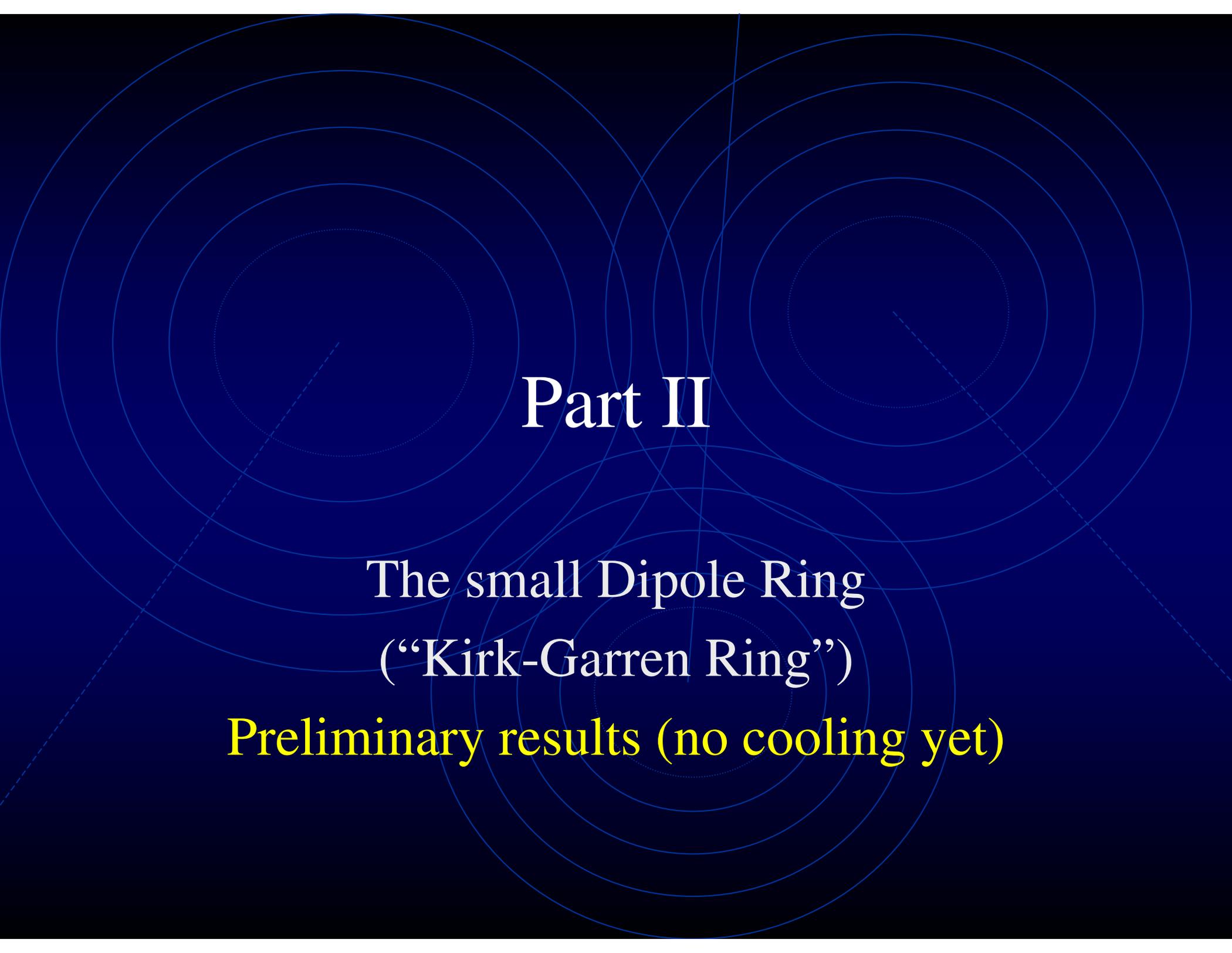
Part II

The small Dipole Ring
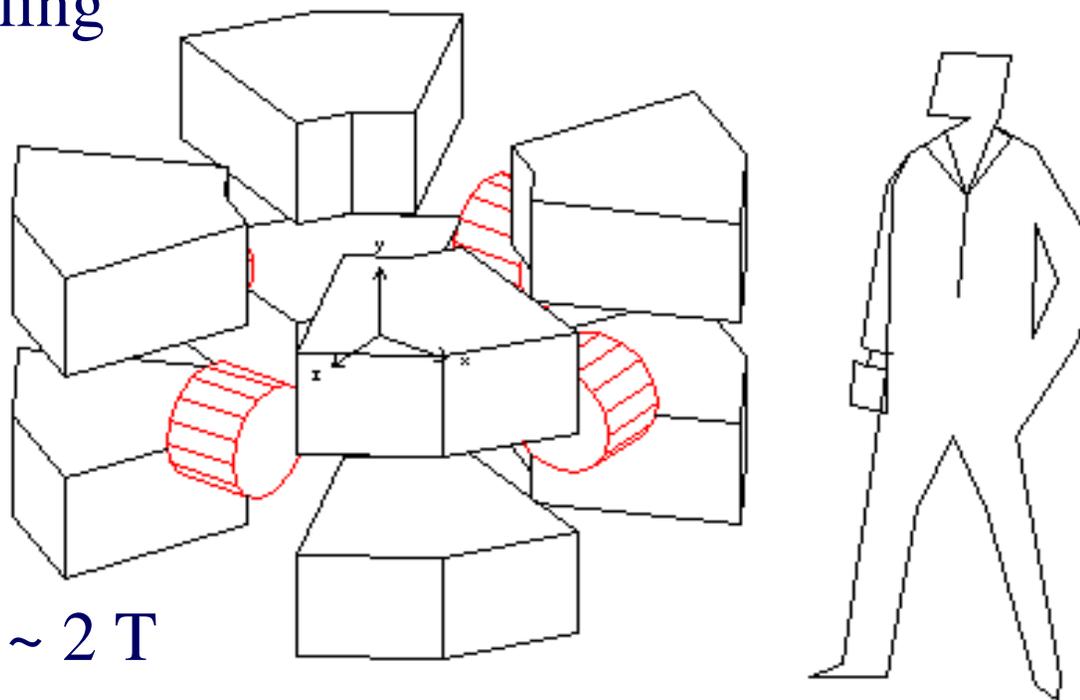("Kirk-Garren Ring")
Preliminary results (no cooling yet)

6D Cooling demonstration Ring

"Weak" (edge) focusing
(ideally) scaling

Filled with
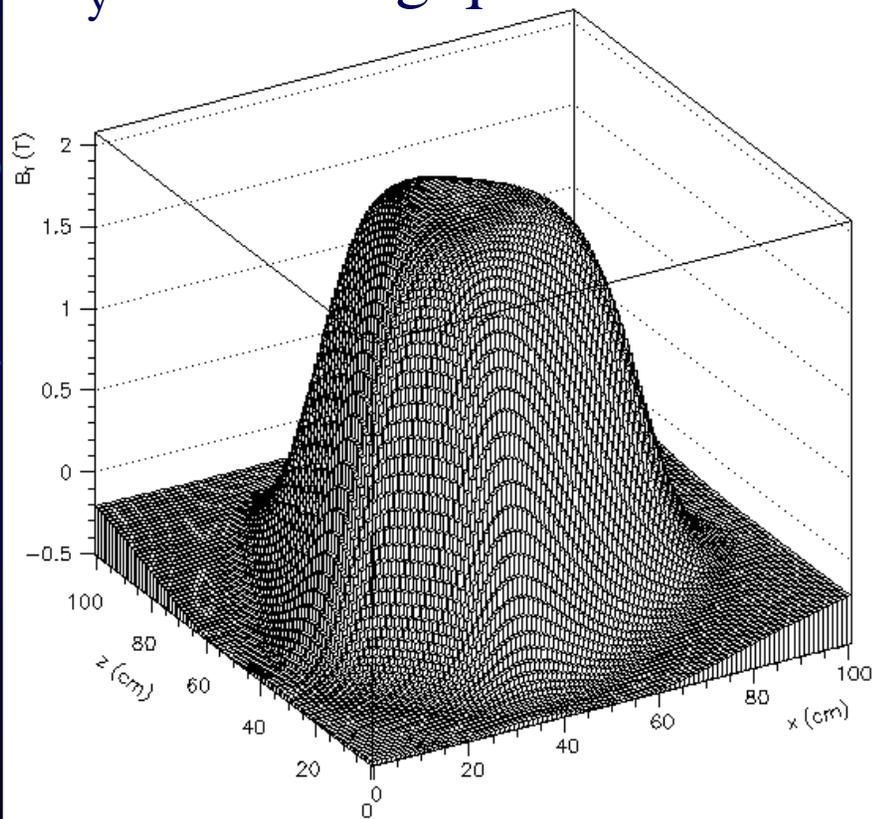~10 Atm.
hydrogen
gas (77K)

Dipole field ~ 2 T
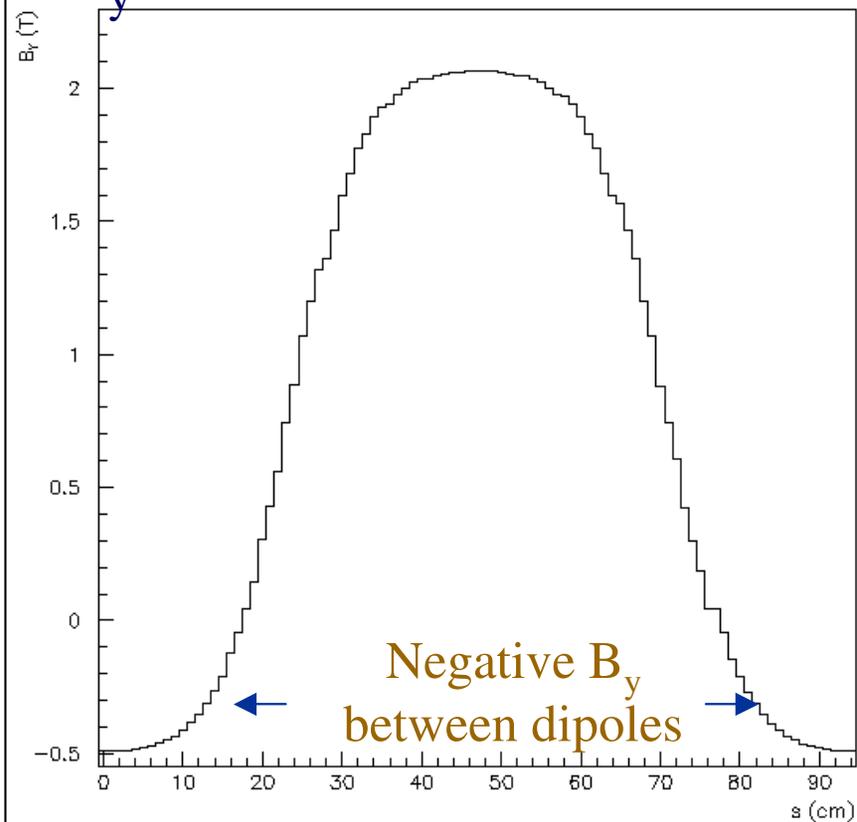
For P_μ~200 MeV/c, the radius should be ~60 cm

For more information, see Harold Kirk's talk later today

Field map – no iron (S. Kahn)

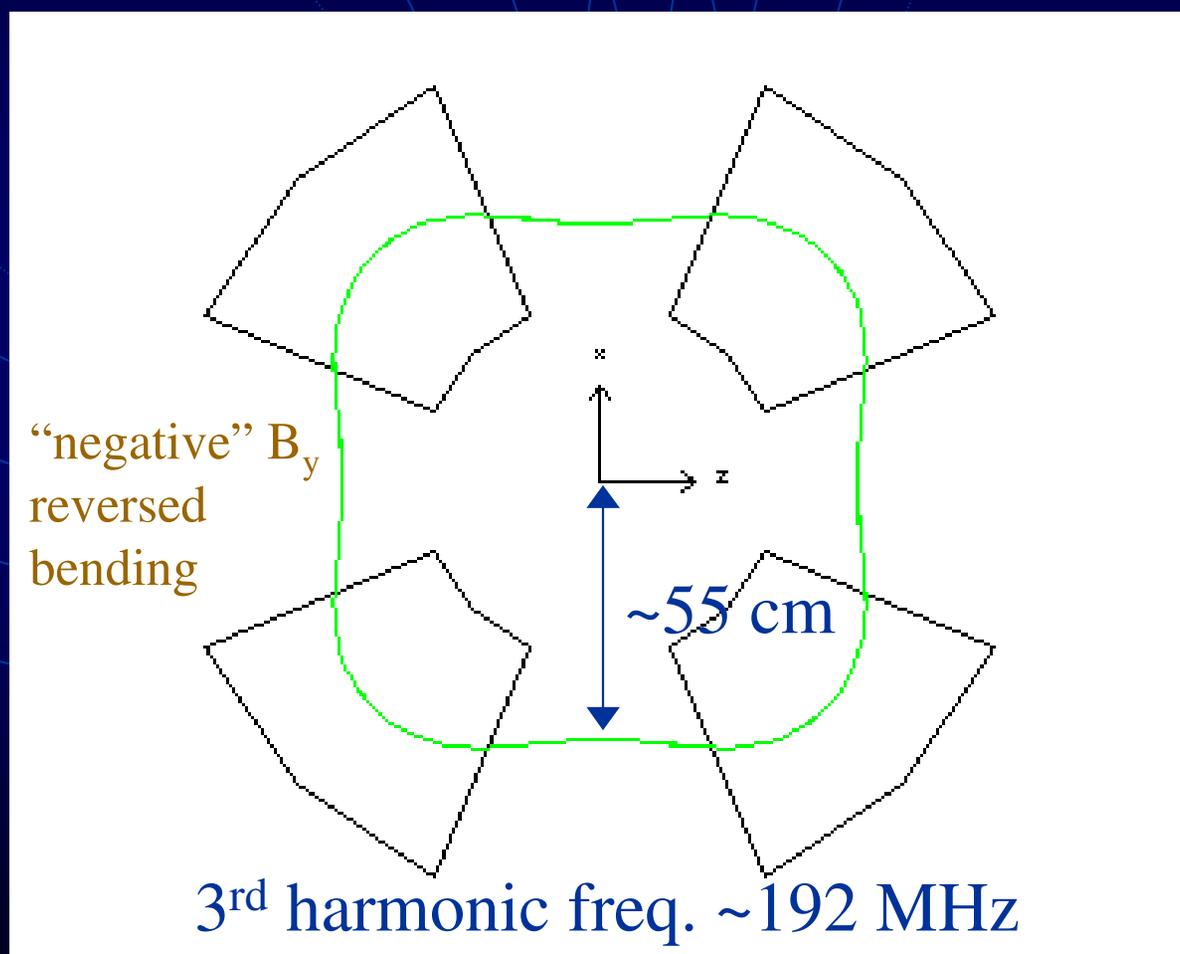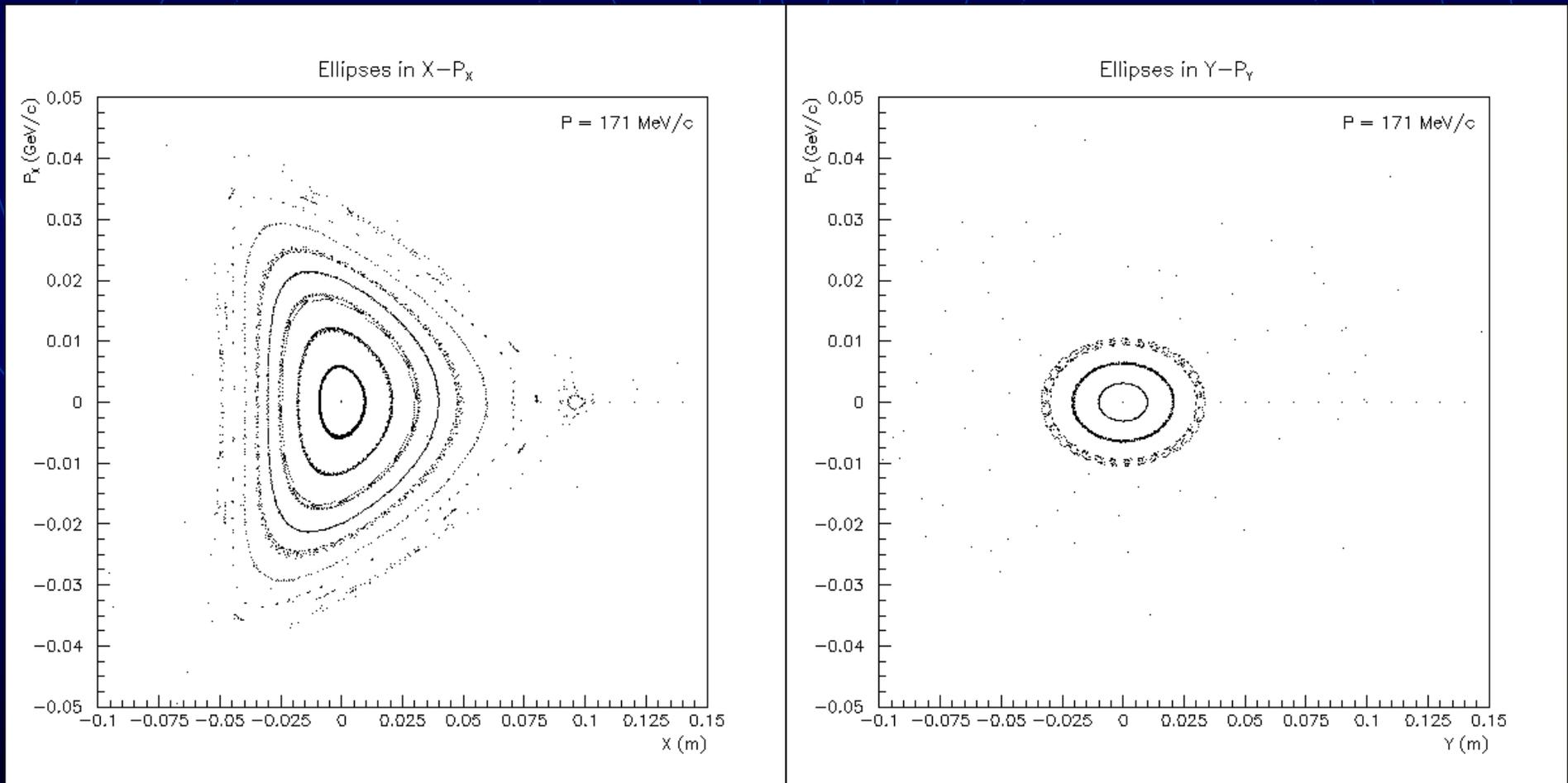**B_y in one ring quadrant**

B_y at R=60 cm

Negative B_y between dipoles

Closed orbit, P=172 MeV/c, no iron

"negative" B_y
reversed
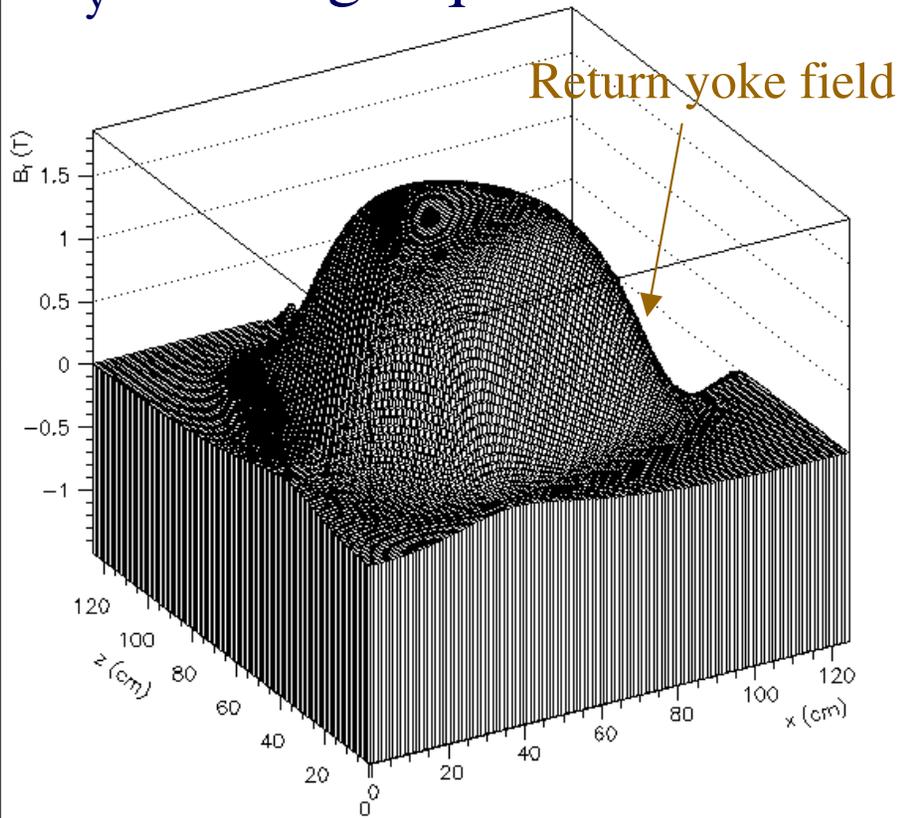bending

~55 cm

3rd harmonic freq. ~192 MHz

Dynamic aperture – no iron

Field map with iron, shaped poles (also from S. Kahn)

B_y in a single quadrant

Return yoke field

B_y at R=60 cm

No negative B_y

Closed orbit, P=172 MeV/c, w/ iron

No "negative" B_y

virtual detector planes

~51 cm

3rd harmonic freq. ~222 MHz
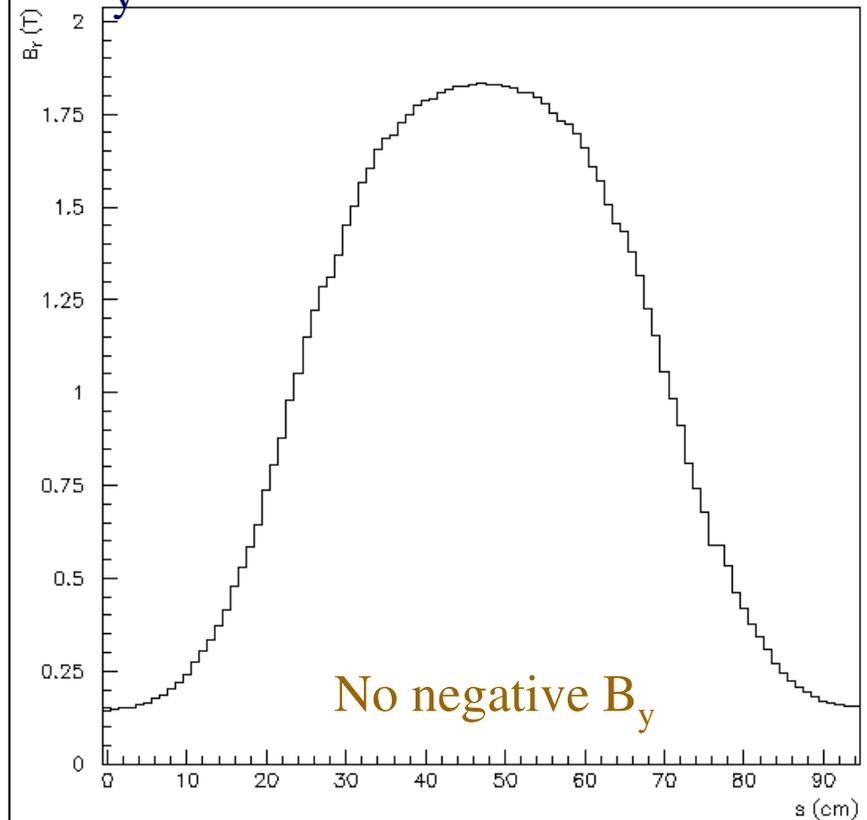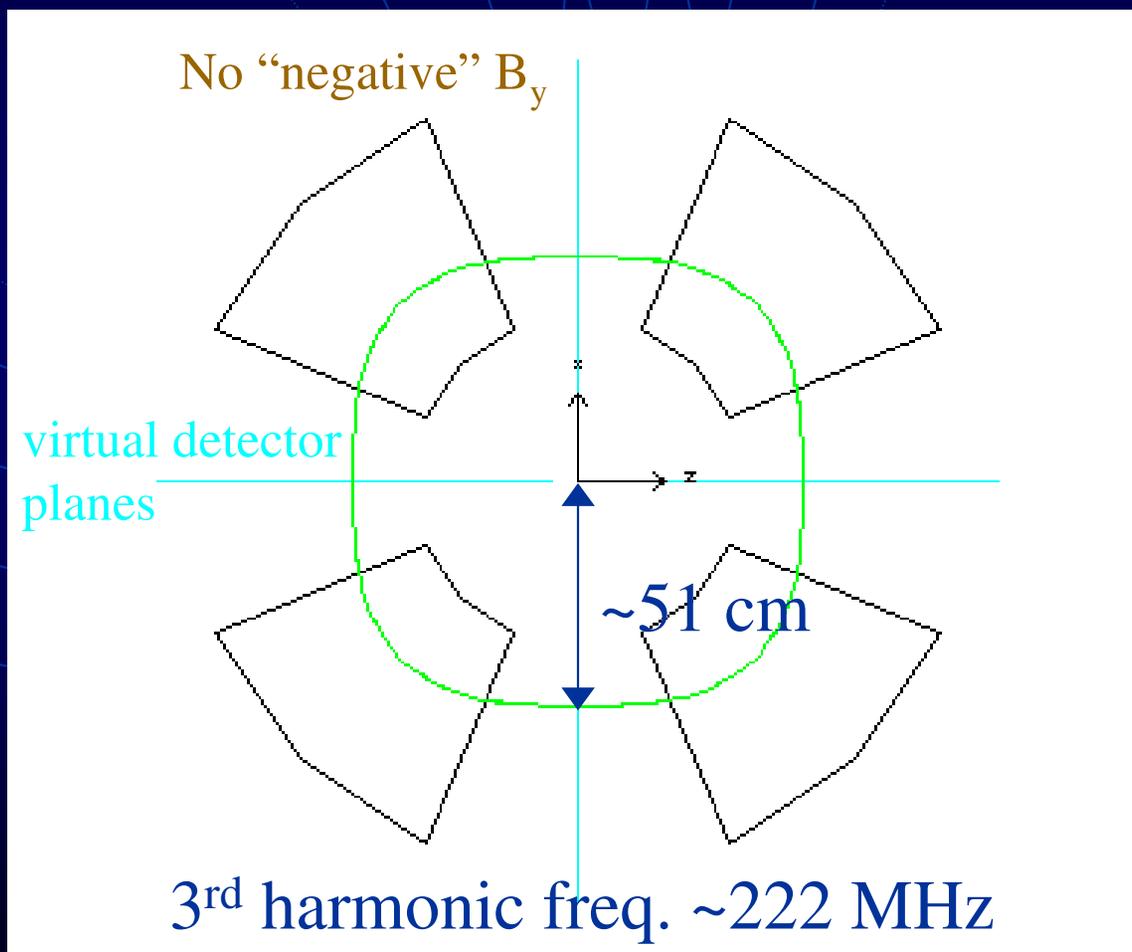
Dynamic aperture – with iron

Improved y acceptance
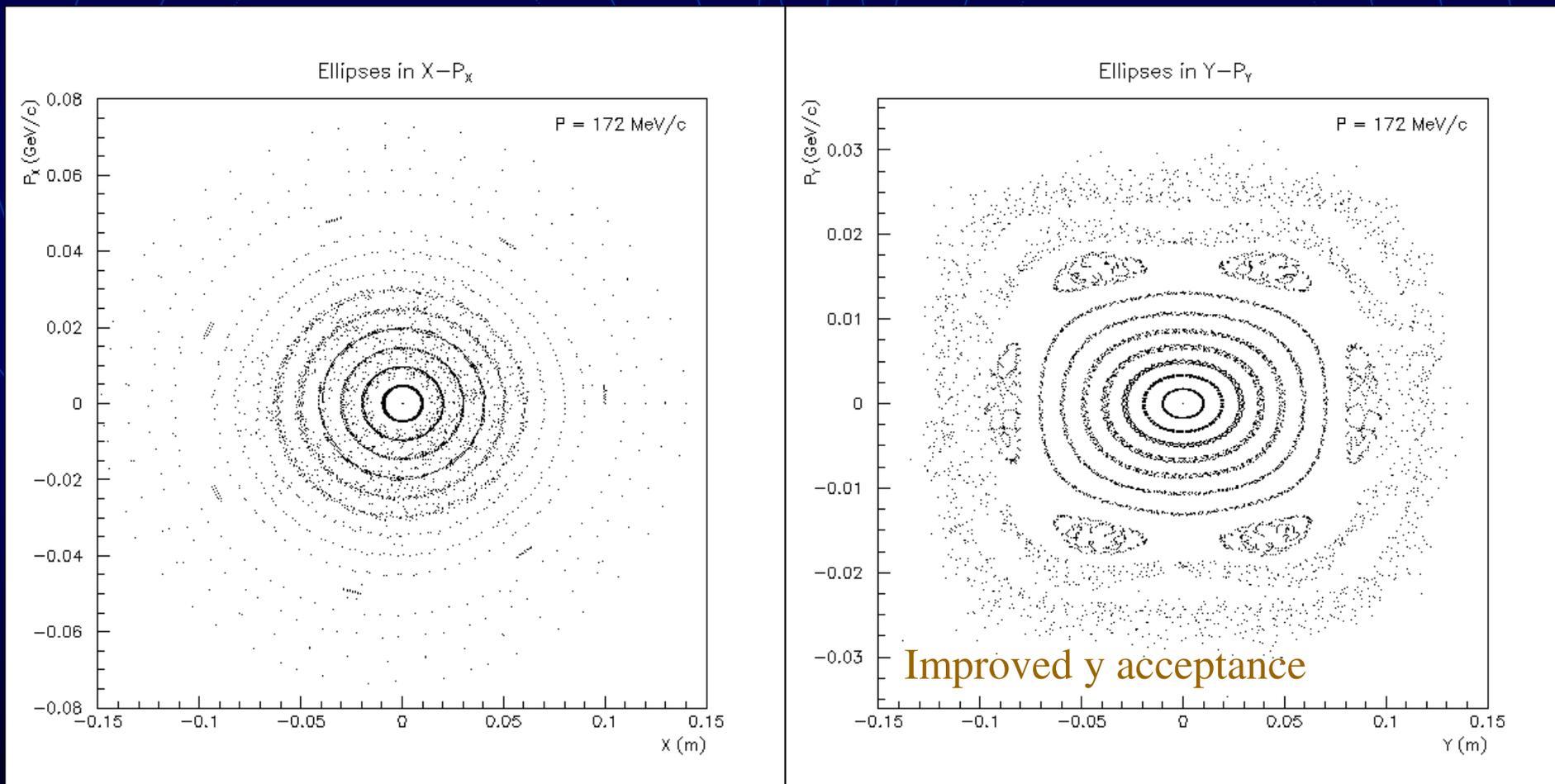
Yet to be done

- Scale field/momentum to achieve "right" frequency for 3rd harmonic (~201.25 MHz)
- Add hydrogen gas and RF cavities – simulate actual cooling
- More realistic simulations
  - Injection through de/dx, or proton/pion decay
  - Detectors in the ring (cooling demonstration!) SciFi planes…

Conclusion

- RFOFO Ring
  - Problems from last year solved
  - MC-Note posted (298)
- Small Dipole Ring
  - So far, no cooling simulations with GEANT
  - Dynamic aperture improved with shaped iron poles, especially in y (realistic field maps from S. Kahn)
  - The goal: simulate the 6D cooling demonstration ring with realistic features