Cell layout options for the SuperB Drift Chamber

G. Finocchiaro
INFN – LNF
21- June2012

Geometrical constraints

- R_{min}=265mm $\Delta R_{inner\ stiff.ring}$=10mm
- R_{max}=809mm $\Delta R_{outer\ stiff.ring}$=25mm
- ➔ $\Delta R=(R_{max}-\Delta R_{outer\ stiff.ring})-(R_{min}+\Delta R_{inner\ stiff.ring})$=509mm

General features - I

- Past studies (http://agenda.infn.it/getFile.py/access?contribId=74&sessionId=11&resId=0&materialId=slides&confId=2026) have shown that rectangular cells allow filling up the gas volume more efficiently than hexagonal cells, with less material
  - changing the sign of the stereo angle does not require to leave free radial space, nor layers of guard wires
- A field:wire ratio of 3:1 guarantees reasonably isotropic space-time relations
  - Used successfully by other experiments (CLEO, KLOE)

General features-II

- Two layers of guard wires to shape the electric field at inner and outer boundary regions, and to help clear out low energy particles created by photon conversions on the inner/outer walls
  - $\Delta R_{clearance}$(guard) ~ 5-10mm (can be adjusted)
- No guard wires at the axial/stereo or stereo/axial transitions (http://agenda.infn.it/getFile.py/access?contribId=84&sessionId=25&resId=0&materialId=slides&confId=2303)
- Number of wires on layer *i* with radius R_i and width w_i: $N_i = \frac{2\pi R_i}{w_i}$
- It is convenient if w_i is multiple of π: $w_i = m\pi$

General features-III

- We use stereo wires to measure the polar angle.
- The theta measurement resolution is completely dominated by the SVT precision (http://agenda.infn.it/getFile.py/access?contribId=117&sessionId=42&resId=0&materialId=slides&confId=2026)
- We do want a theta measurement in the DCH:
  - for the z trigger
  - so that the detector has 3D measurements on its own
- The z resolution is probably not critical for us
  - $\sigma(z)=\sigma(x)/\tan(\varepsilon_{stereo})$ – stereo angles (therefore stereo drops) can be kept relatively small

General features-IV

- Maintain the SuperLayer (SL) structure as in *BABAR,* with *k*=4 layers per SL.
  - This allows e.g. to use the same algorithms for track segment finding in the trigger
- Keep constant the number of cells per layer in each SL
  - The cell width slightly increases across the SL
- ΔN=16 cell increment when going to the next SL
- Cell height *h* ~ 12mm (similar to *BABAR*)
- As a safety measure against higher track and background density in the inner region, make the cells shorter (~10mm) and narrower

A few possible arrangements

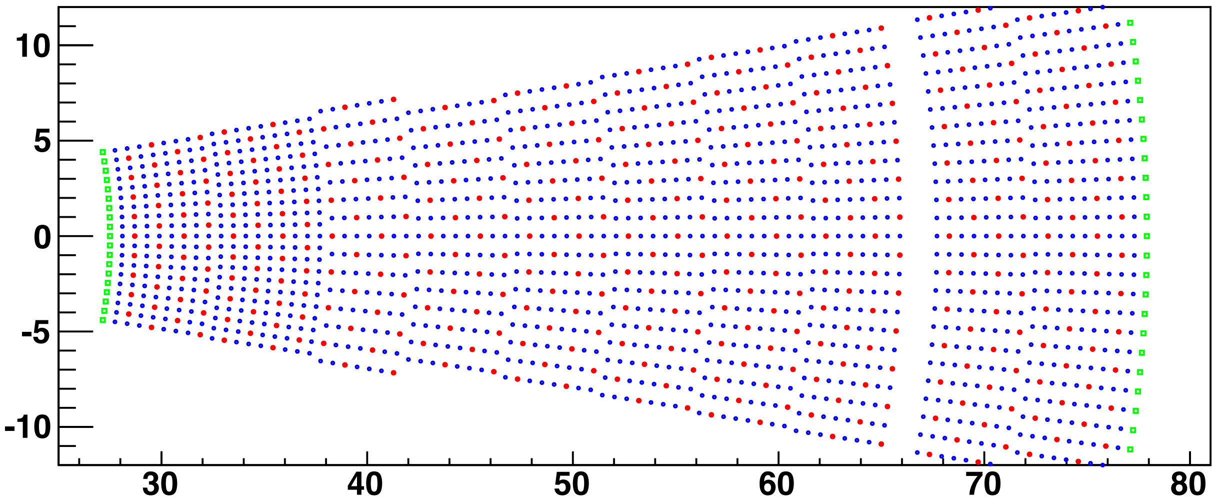
N_{layers}/ h_{cell} (mm) (axial in)	N layer (stereo)	N layer (ax. out)	N cells axial 1	N cells stereo 1	stereo drop (mm)	ε_{st} (mrad)	N layers/ N cells TOT
10/10mm	24	8	160	128	10	72/89	42/7872
8/10mm	24	10	176	128	10	70/88	42/7872
10/10mm	24	8	176	128	10	72/89	42/8032
8/12mm	24	8	176	128	12	78/97	40/7360
8/10mm	24	11+1	160	128	8	63/78	43+1/8000

- In cases 1-4 h=10mm for SL n. 1 and 2, h=12mm from SL n. 3 outwards
- In case 5 h=10mm for SL n. 1 and 2, h=12mm from SL n. 3 outwards
- The outermost guard layer could be replaced with one more active layer (CLEO-III did this

A few possible arrangements

N layers/ h_{cell} (mm) (axial in)	N layer (stereo)	N layer (ax. out)	N cells axial 1	N cells stereo 1	stereo drop (mm)	ε_{st} (mrad)	N layers/ N cells TOT
10/10mm	24	8	160	128	10	72/89	42/7872
8/10mm	24	10	176	128	10	70/88	42/7872
10/10mm	24	8	176	128	10	72/89	42/8032
8/12mm	24	8	176	128	12	78/97	40/7360
8/10mm	24	11+1	160	128	8	63/78	43+1/8000

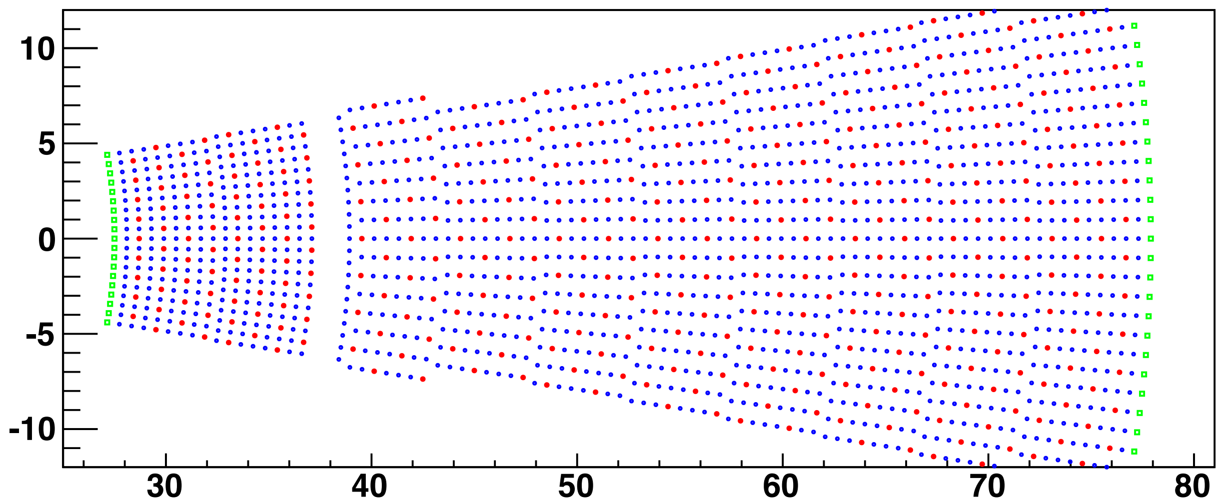
Hole map at z=0 (DCH center)



A few possible arrangements

N_{layers}/ h_{cell} (mm) (axial in)	N layer (stereo)	N layer (ax. out)	N cells axial 1	N cells stereo 1	stereo drop (mm)	ε_{st} (mrad)	N layers/ N cells TOT
10/10mm	24	8	160	128	10	72/89	42/7872
8/10mm	24	10	176	128	10	70/88	42/7872
10/10mm	24	8	176	128	10	72/89	42/8032
8/12mm	24	8	176	128	12	78/97	40/7360
8/10mm	24	11+1	160	128	8	63/78	43+1/8000

Hole map at the endplates



ADDITIONAL SLIDES

A few sample plots for the cell configuration with drop=12mm (and h_{in}=12mm, h_{out}=12mm)

Some geometrical relationships

$$\varepsilon_j = \operatorname{atan}\left(\frac{2\delta}{L(R^j_{\mathrm{E.P.}})}\sqrt{\frac{2R^j_{\mathrm{E.P.}}}{\delta}-1}\right)$$

Stereo angle as a function of the stereo drop δ, of R_{EP}, and of the DCH length $L(R_{EP})$

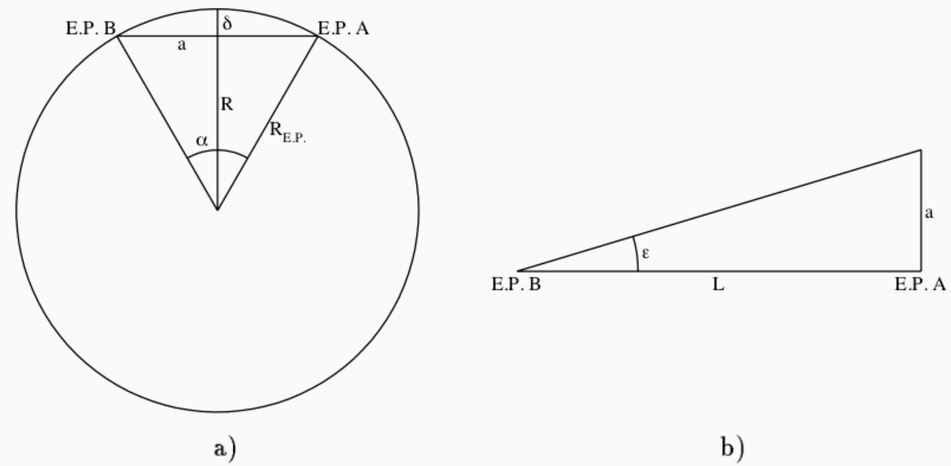


Fig. 4: *Illustration of the parameters in the text. a): the chamber as seen from one End-Plate; b) top view.*

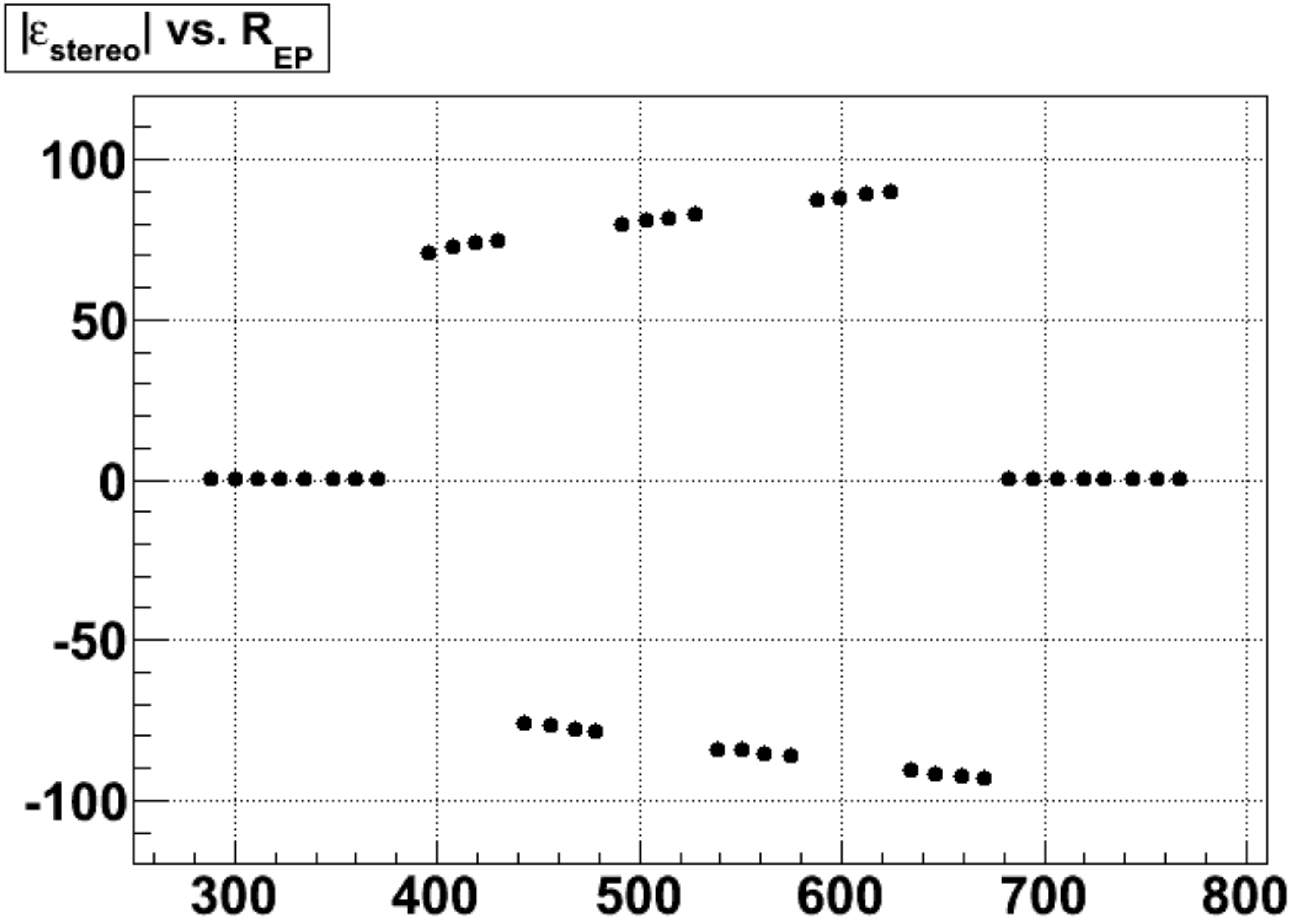
$$R(z) = \sqrt{R^2_{z=0} + (z \cdot \tan\varepsilon)^2}$$

Wire radial posizion as a function of the stereo angle and z

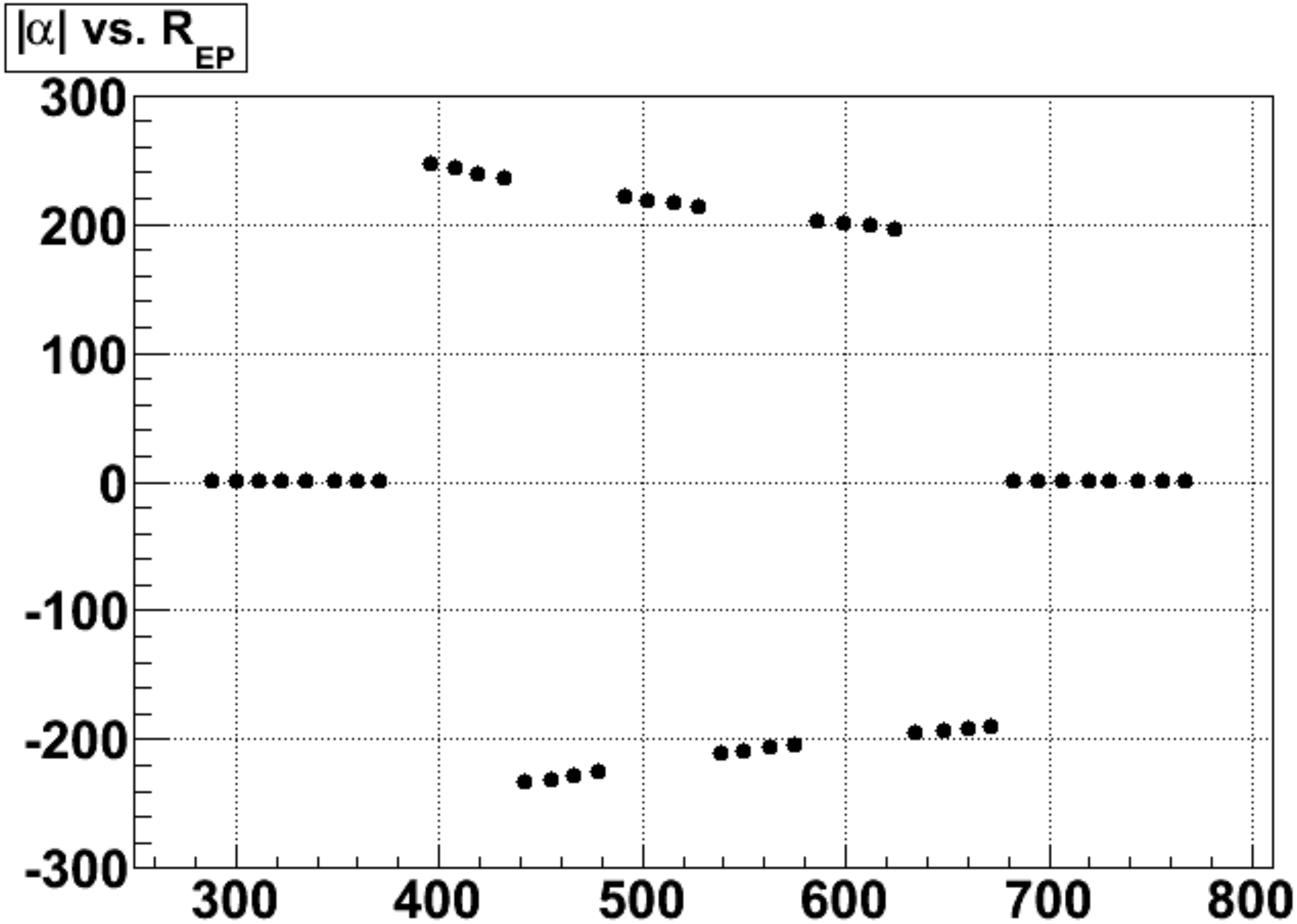
$$\alpha = \operatorname{atan}\left(\frac{\delta}{R_{z=0}}\sqrt{2\frac{R_{z=0}}{\delta}+1}\right)$$

Angle α as a function of δ and R_{EP}, (the angle shown in the figure is actually 2α)
*The relation **α=acos($R_{z=0}$/R_{EP})** also holds*

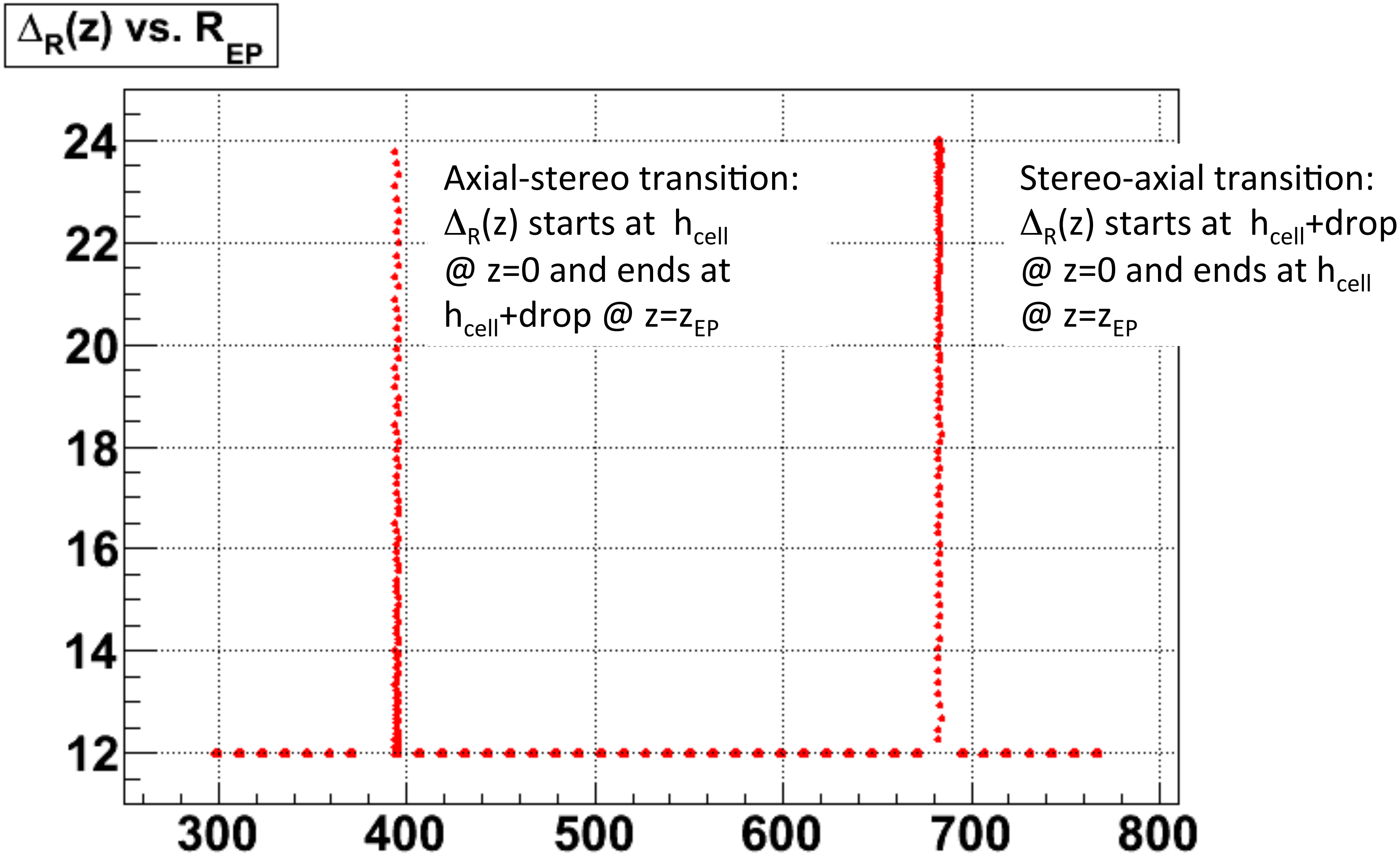
Stereo angle vs R_{EP}



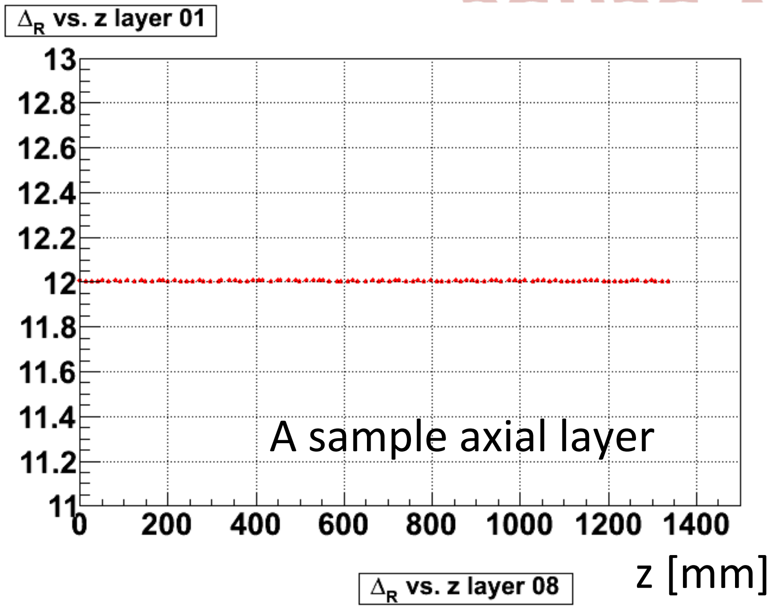
Angle α vs R_{EP}

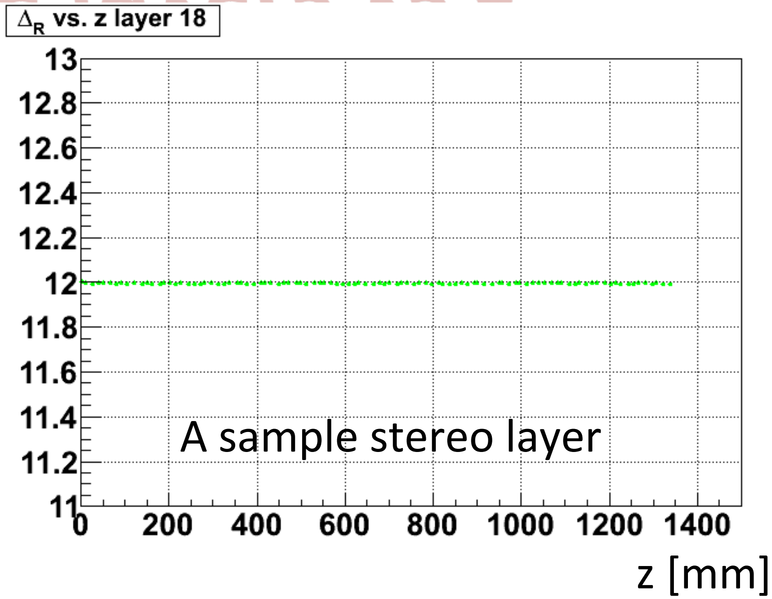


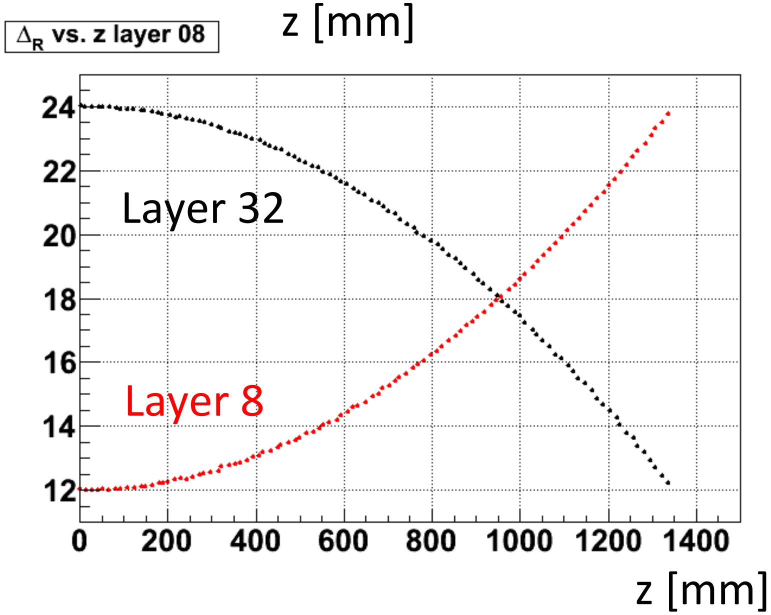
Radial separation between sense wire layers vs R_{EP}



Radial separation between sense wire layers vs z

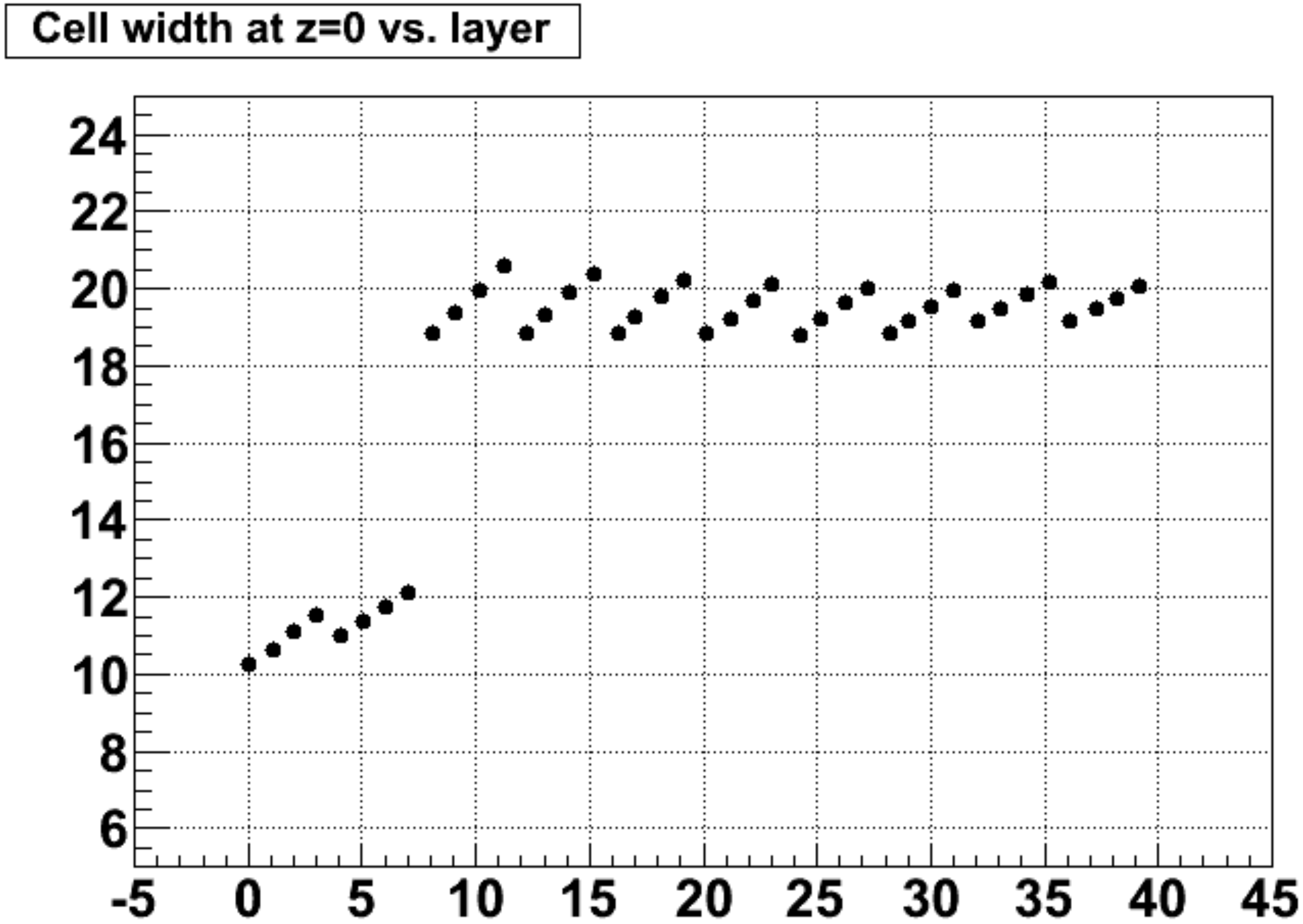




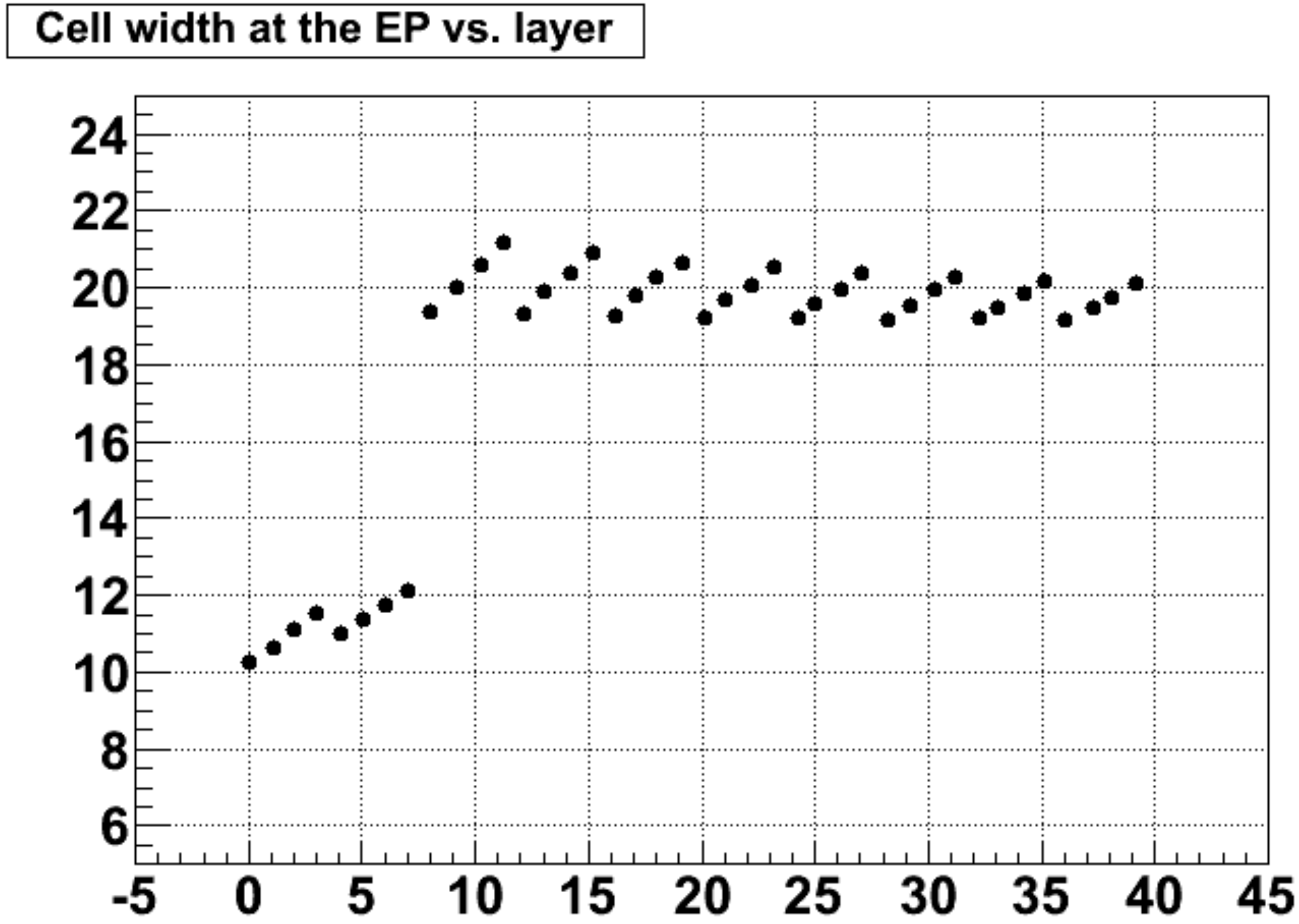


Except for the two transition layers, the radial cell separation is constant *for any z*

Cell width @ z=0 vs. layer



Cell width @ R_{EP} vs. layer



$\Delta w/w|_{max}$=±4.5%

$\Delta w/w|_{min}$=±2.5%

$\Delta w/w|_{max}$=±6%