DCH Summary

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For the DCH group

XII SuperB Meeting
Annecy, 19 March 2010

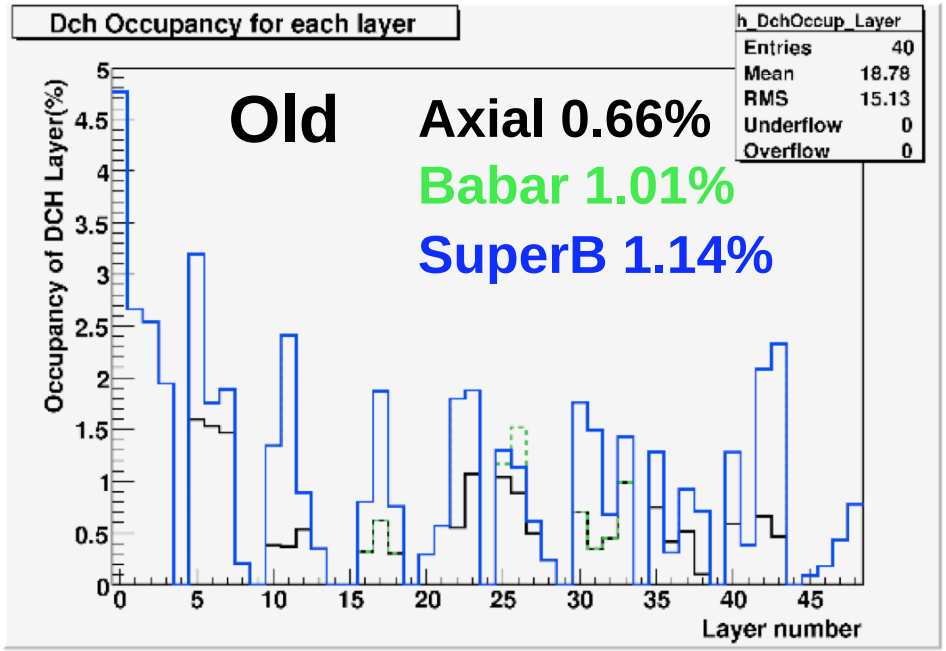
Topics Discussed in This Meeting

- Background studies
- Cell and gas optimization
- DCH Readout architecture
- R&D work

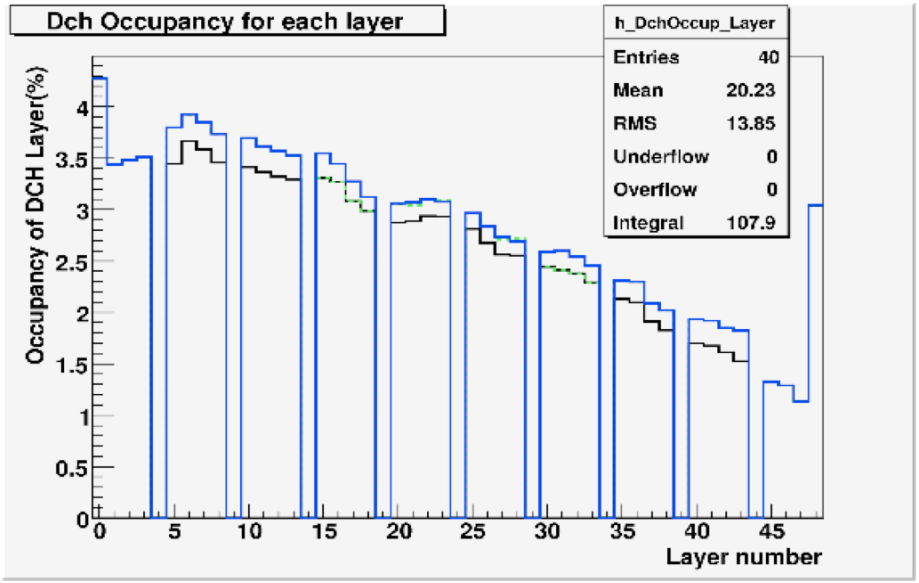
Occupancy

R. Cenci

- Higher stat, total occupancy: **2.5%** with RMS ~0.6%
- New results not really compatible with old ones
- Stereo layers do not make much difference for bkg, less than 0.5%
  - Maybe related to step size issue

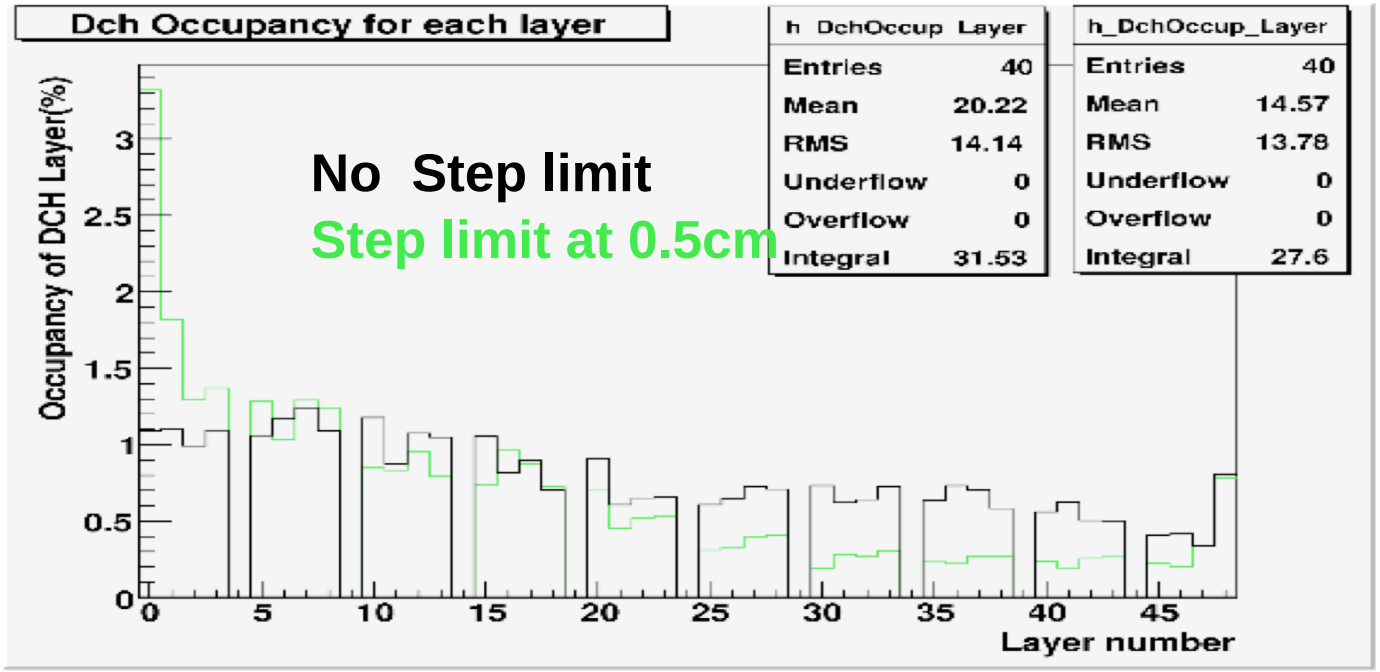


Axial 2.48%
Babar 2.60%
SuperB 2.64%



2photons (aka Pairs) bkg

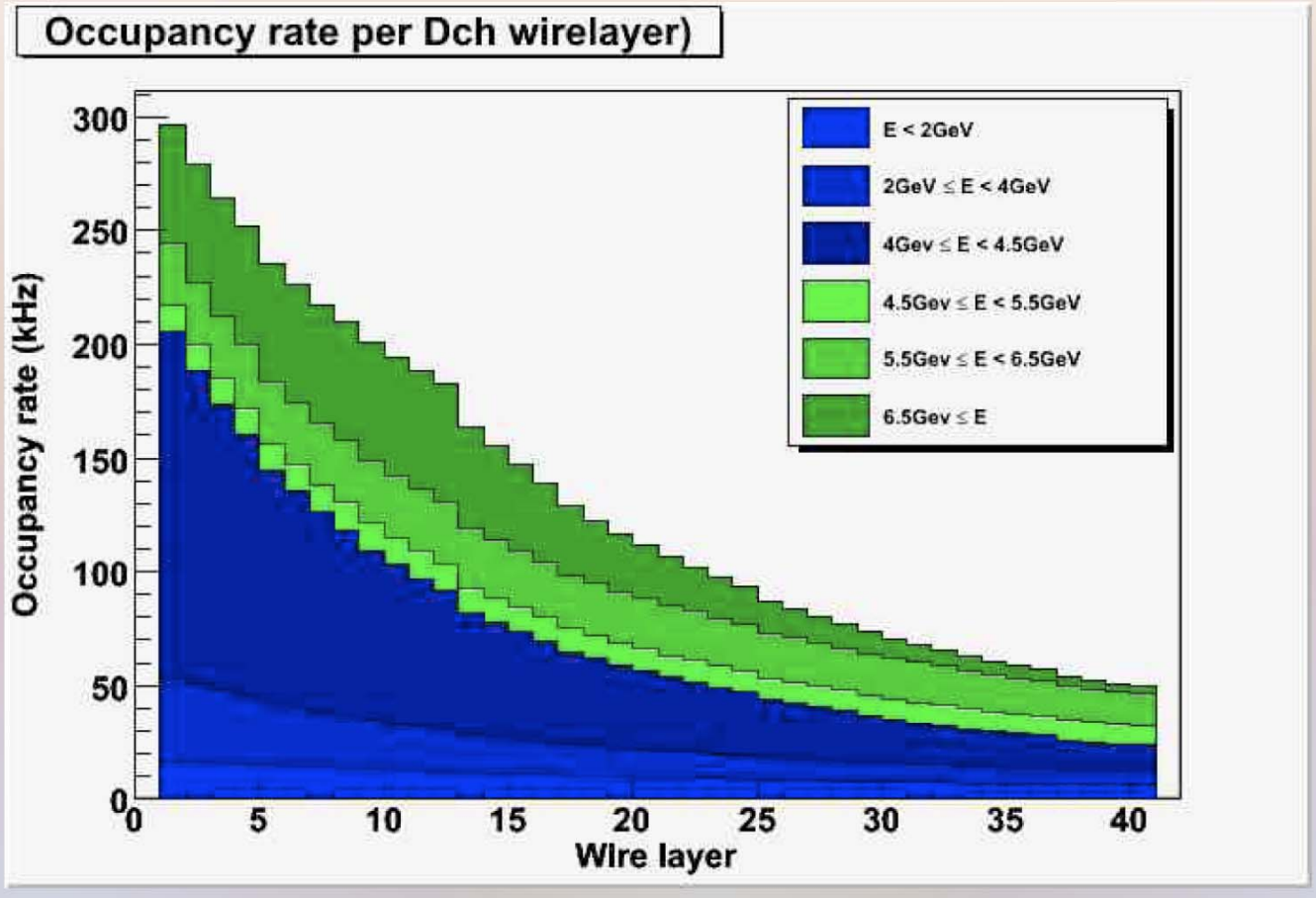
- I simulate again with the new geometry the 2photons bkg (40k evts)
- I tried to understand any difference using different step size
- Weird difference, total occupancy is similar anyway
- Excess on first layers is understood: w/o step limit you have hits with long step starting on chamber wall not assigned to right cells



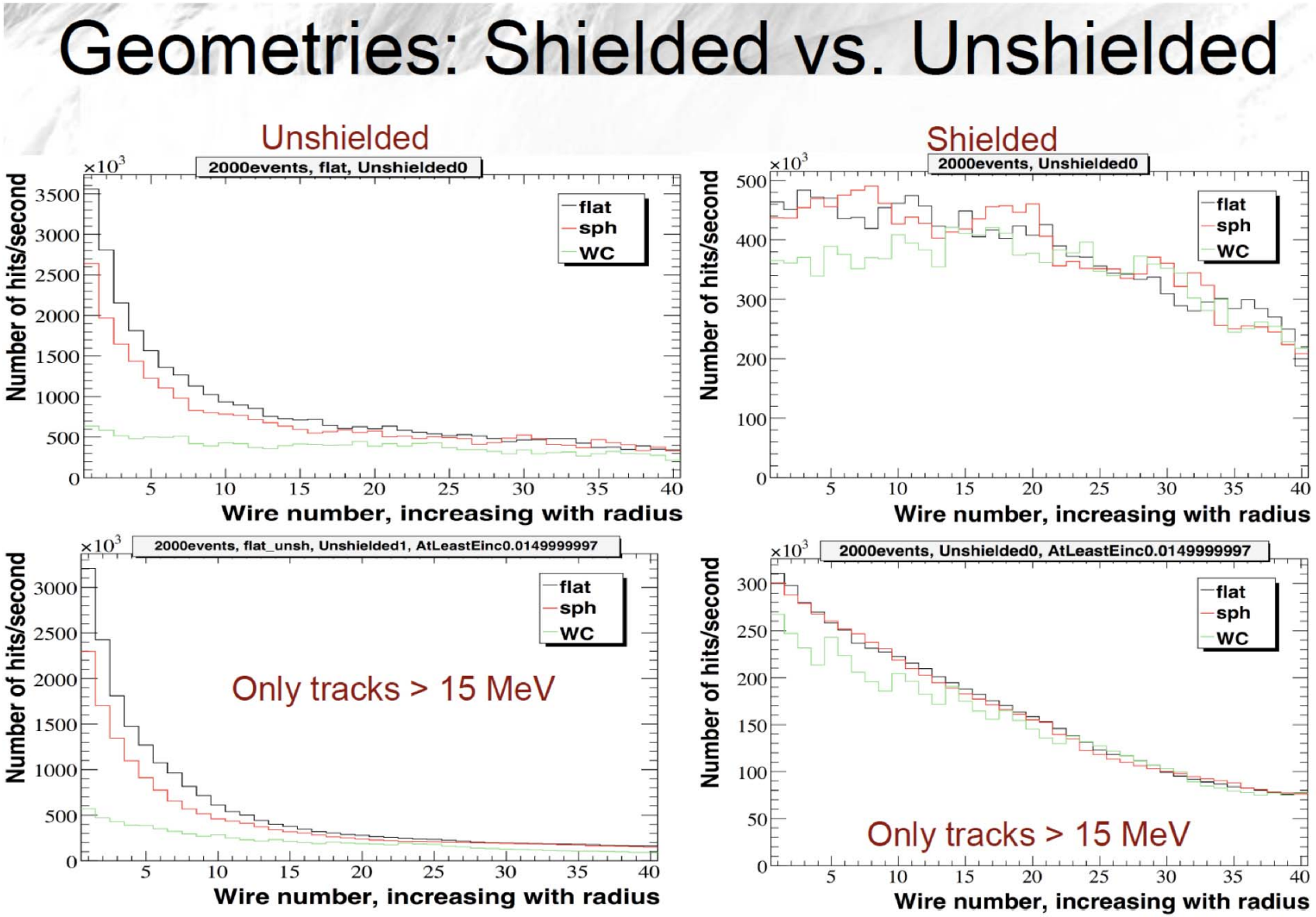
D. Swersky

“Large angle Bhabhas”, FastSim

Baseline Geometry: Occupancy Rates



“Large angle Bhabhas, FullSim



Background Occupancy Summary

- Small-angle rad. bhabha: ~2%. Need to clarify a few points:
  - why larger (x3) than previous estimates
  - dependence on axial/stereo wire orientation not as expected
  - dependence on GEANT4 step length
- Pairs: 0.5-1.0%
- Large-angle rad. Bhabha: 0.4%
- Some indication that conical endplates are not required after all

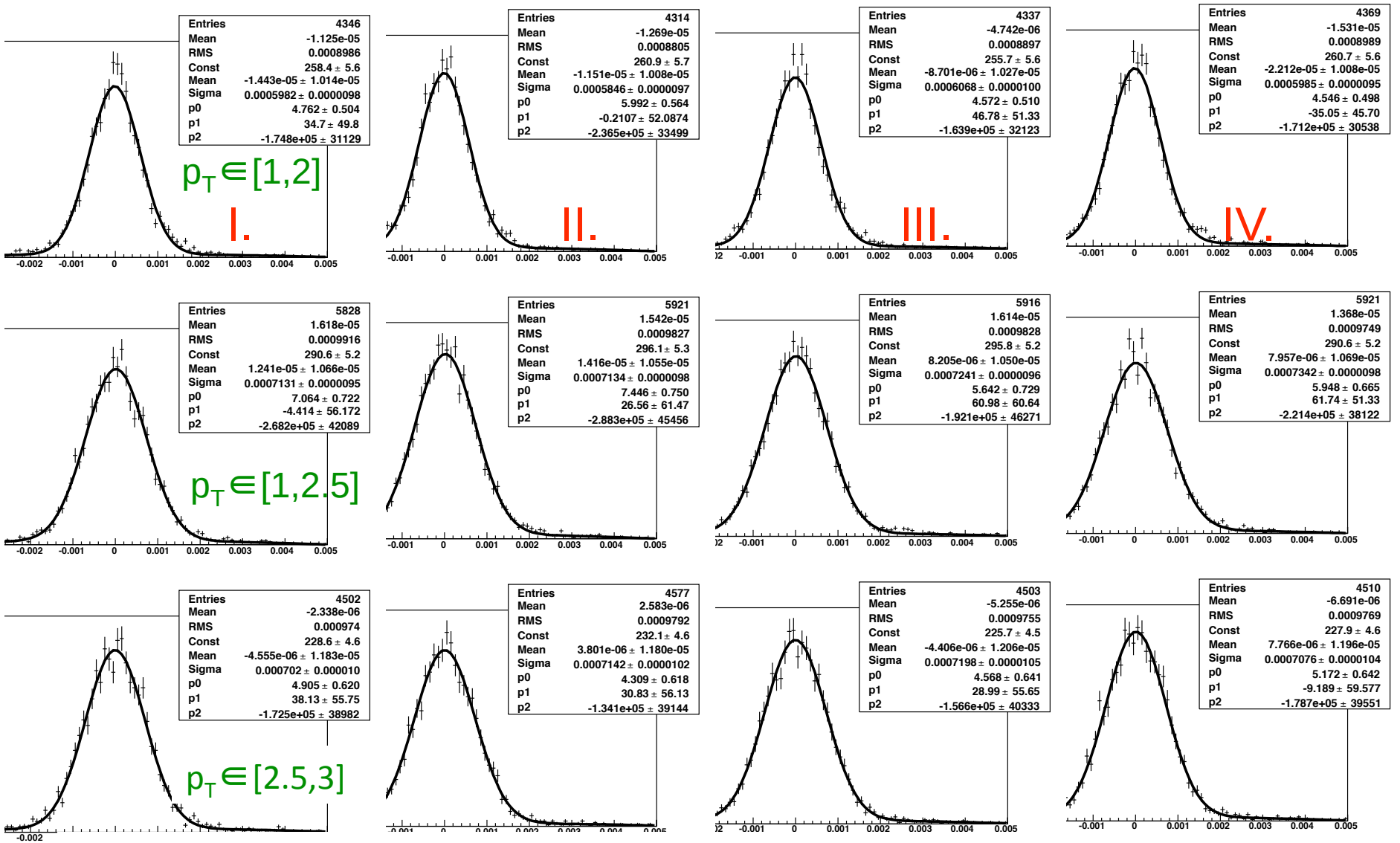
Topics Discussed in This Meeting

- Background studies
- Cell and gas optimization
  1. Axial/stereo layer arrangement
  2. Material from drift cell layout and gas mixture
- DCH Readout architecture
- R&D work

1. Stereo Angle Layout

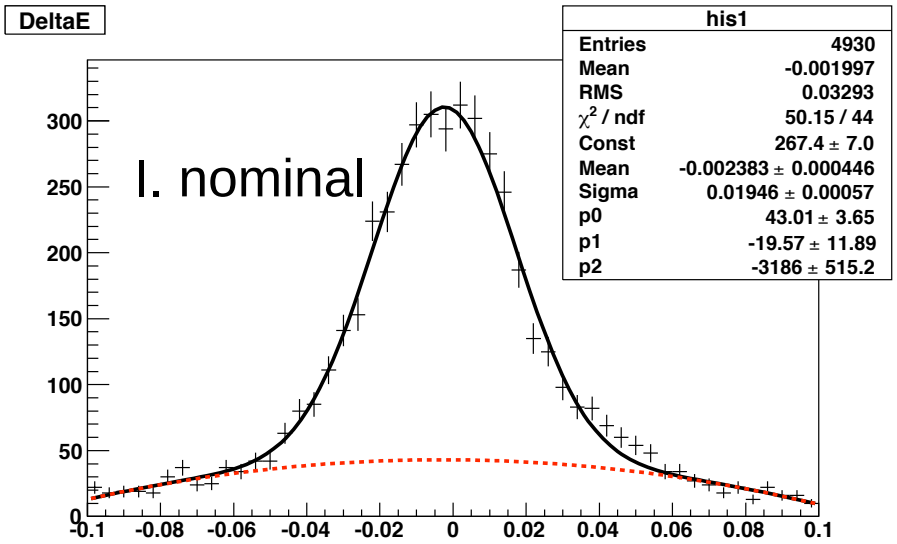
- Study effect on tracking of arrangement of stereo/axial layers by comparing (**`BToPiPi`** and **`BToDstarK`**) four different configurations:
  I. "Nominal": AUVAUVAUVA
  II. "Axial": AAAAAAAAAA
  III. "Stereo SL" : AUVUVUVUVA
  IV. "Stereo layers" Auvuv…..uvuvA

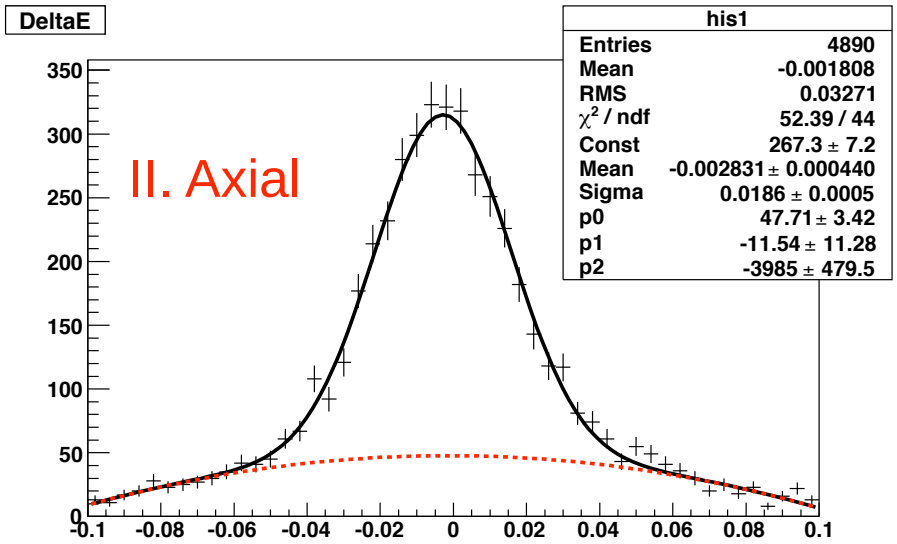
BToPiPi: cosθ vs. Stereo Angle Layout

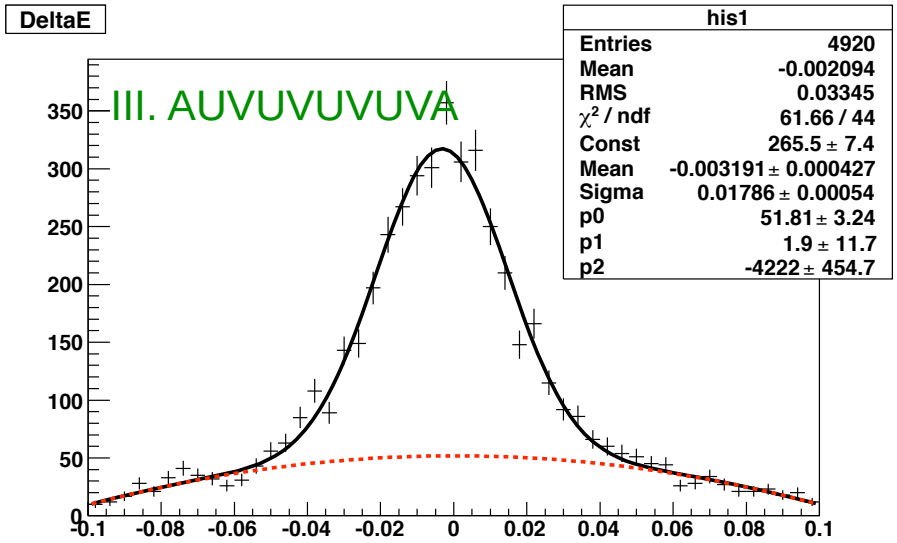


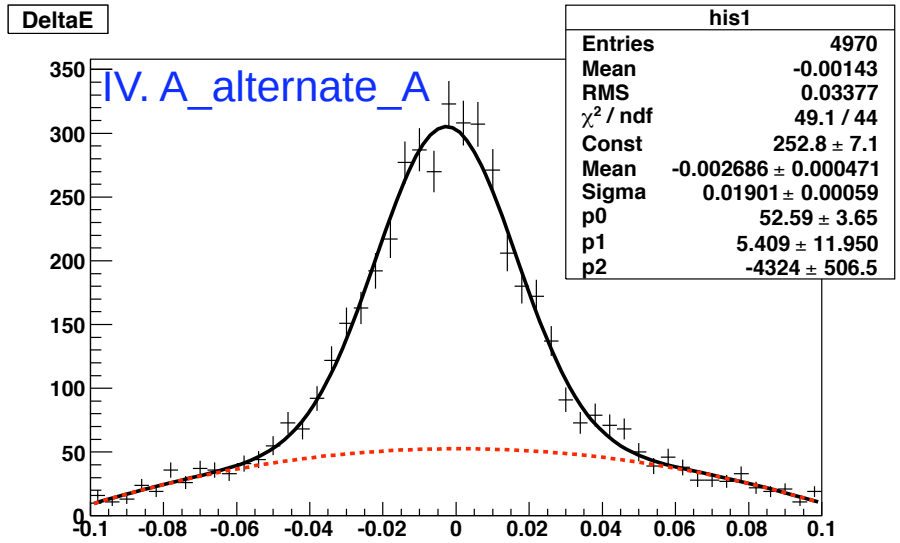
Negligible effect in cosθ resolution (as well as in ΔE, φ, p_T…)

BToDstarK: ΔE vs. Stereo Angle Layout









Small effects also in events with softer tracks

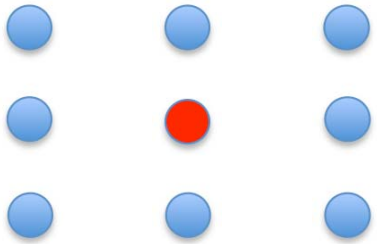
Stereo Angle Layout: (Preliminary) Conclusions

- No stringent constraints from tracking on number and arrangement of stereo layers
  - will confirm result using
    - different SVT efficiencies (FastSim default ≥95% used here)
    - different channels (reco efficiency of long-lived particles?)
- This is good news: more freedom to cope with bkg occupancies from low pt curling tracks (which fire many stereo layers)
- Stricter requirements probably imposed by θ measurement in L1 trigger (to be investigated)

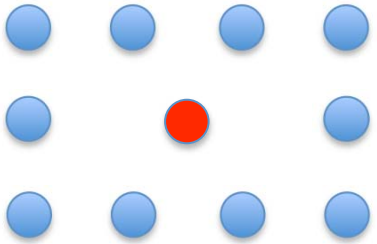
2. Drift Cell Layout Study

Two square cells layouts of 11 SL with 4 layers each: **AA UV UV UV UV A**

- ✓ h=12mm; w=π×6mm (in first 8 A layers w=π×3mm) $R_{cylinder}$=21.2cm



- ✓ 3:1 field:sense ratio - 7972 sense 20μm⌀ wires, 1554 guard 80μm⌀ wires, 25150 field 80μm⌀(*) wires



(*) True for square cells. Calculation to be repeated for rectangular cells

- ✓ 4:1 field:sense ratio - 7972 sense 20μm⌀ wires, 2331 guard 80μm⌀ wires, 33739 field 60μm⌀(*) wires

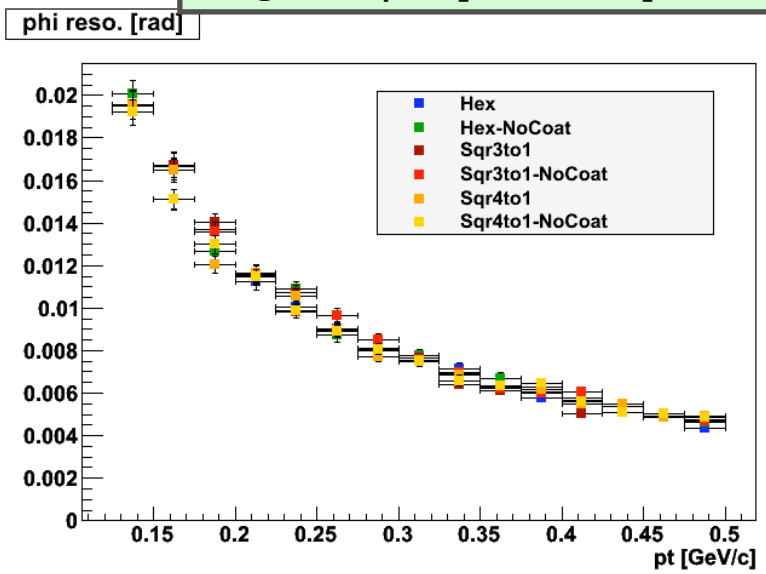
Drift cell-Gas mixture
Material Budget Comparison

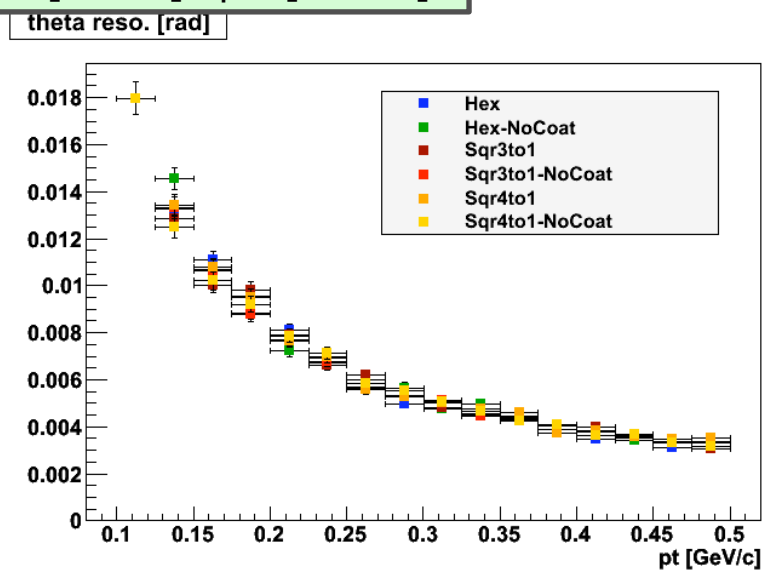
	$\rho(g/cm^3)$ x1 0^4 coating/nocoating	$X0(g/cm^2)$ coating/nocoating	X0(m) coating/nocoating
80%He-20%iC_4H_{10}	6.3	50.8	805
80%He-20%iC_4H_{10}-hex	10./9.5	27.3/33.3	270/350
80%He-20%iC_4H_{10}-sqr3:1	9.0/8.5	27.9/34.4	310/400
80%He-20%iC_4H_{10}-sqr4:1	8.5/8.1	27.9/35.1	320/430
90%He-10%iC_4H_{10}	4.0	56.2	1410
90%He-10%iC_4H_{10}-hex	7.7/7.2	24.5/30.9	320/430
90%He-10%iC_4H_{10}-sqr3:1	6.7/6.2	24.8/31.8	370/510
90%He-10%iC_4H_{10}-sqr4:1	6.3/5.8	24.6/32.5	390/560
80%He-20%CH_4	2.7	62.0	2340
80%He-20%CH_4-hex	6.4/5.9	22.3/28.7	350/490
80%He-20%CH_4-sqr3:1	5.4/4.9	22.2/29.3	410/600
80%He-20%CH_4-sqr4:1	5.0/4.5	21.8/30.0	440/660

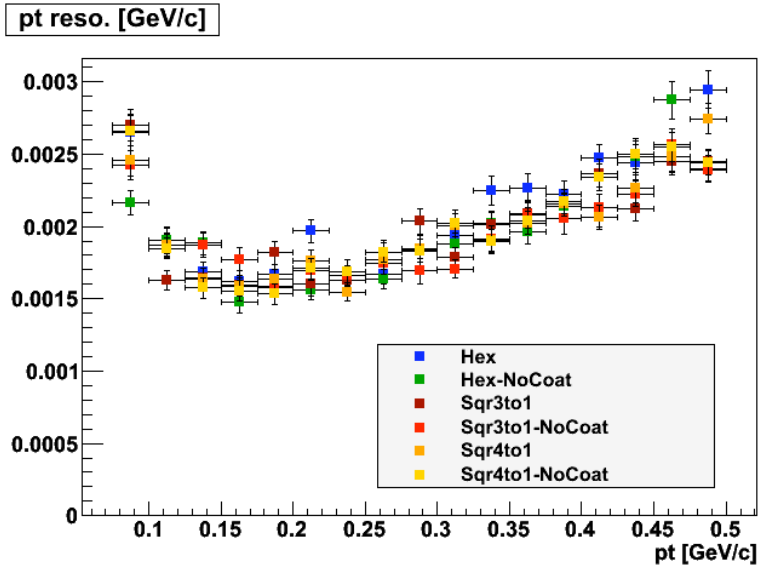
BABAR

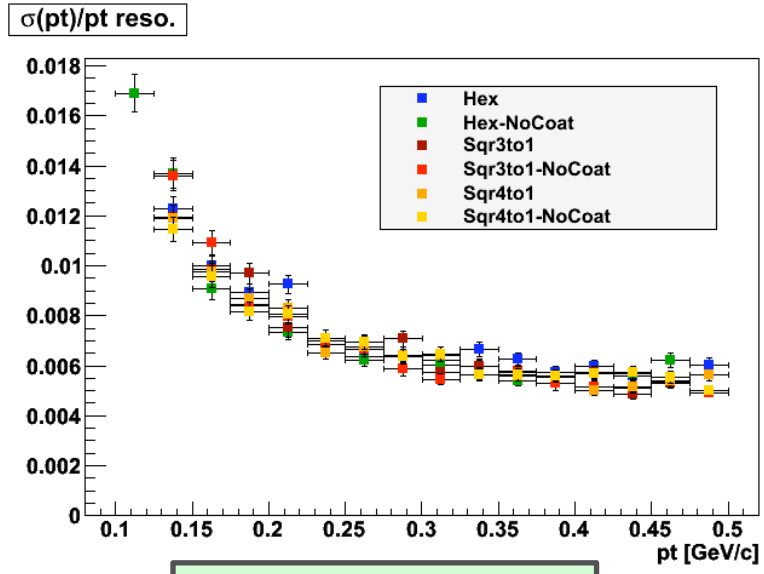
Tracking Performance vs. Cell Layout – "low" p_T

single π^+ $p \in [0.05,4.5]$GeV/c ; $\cos\theta \in [-1,+1]$; $\phi \in [0,360]^o$





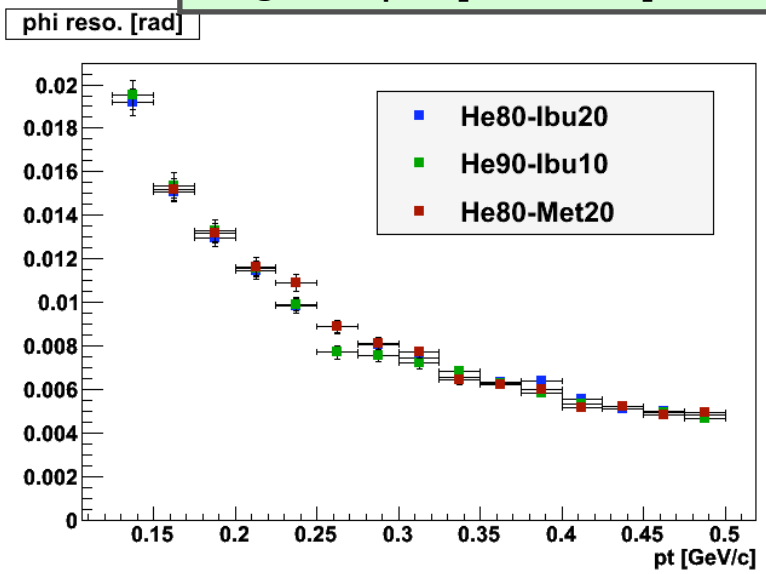


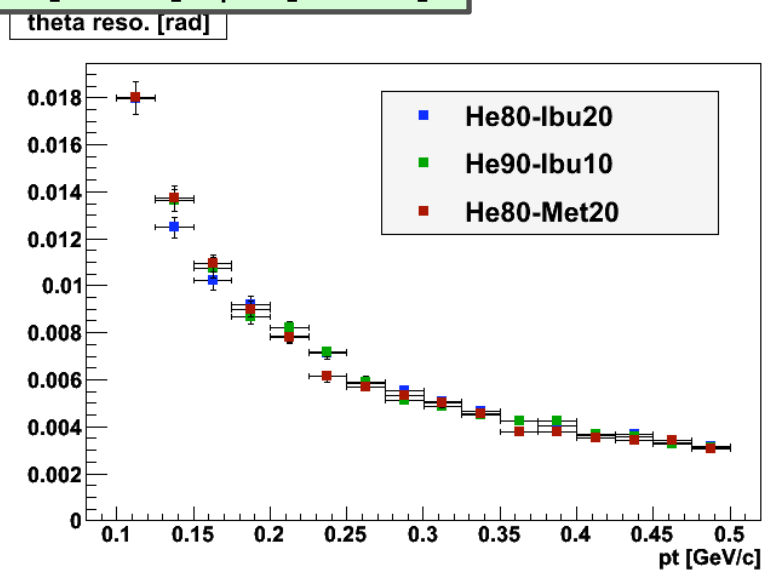


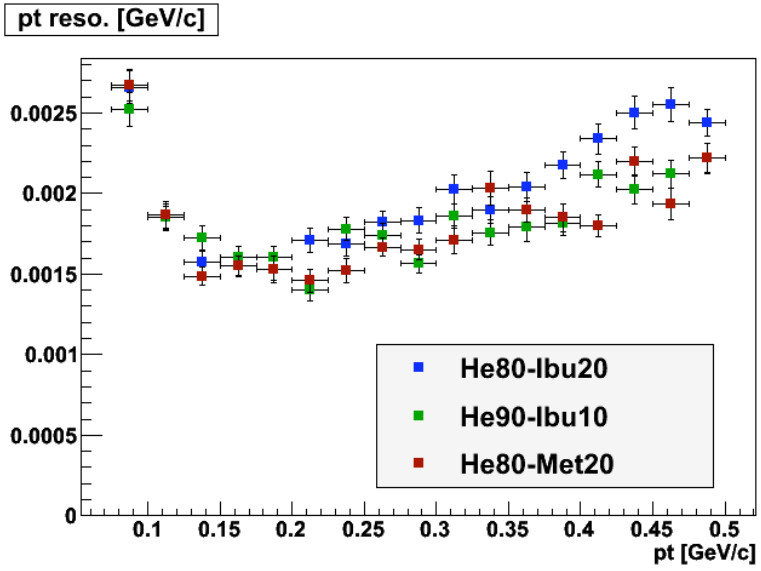
80%He-20%iC_4H_{10}

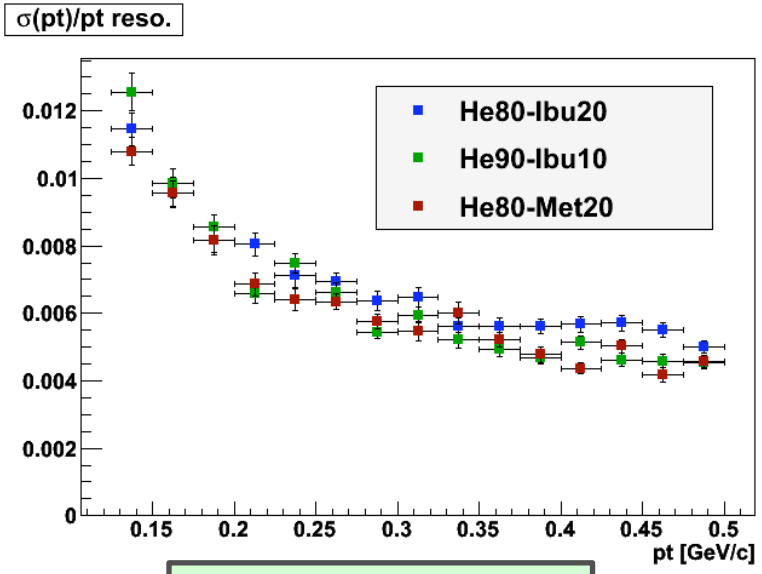
Tracking Performance vs. Gas Mixture – "low" p_T

single π^+ $p \in [0.05,4.5]$GeV/c ; $\cos\theta \in [-1,+1]$; $\phi \in [0,360]^o$









Sqr 4:1 No Coating

Stereo Drift Cell Layout Summary

- Square cells with 3:1 or 4:1, and un-plated field wires allow substantial reduction of DCH material.
  - 15-20% improvement in momentum measurement at lower momenta
- Gas mixtures lighter than *BABAR*'s 80%He-20%iC_4H_{10} *might* be used to further reduce material
  - Delicate trade-off with spatial and dE/dx resolutions, and stability of operation

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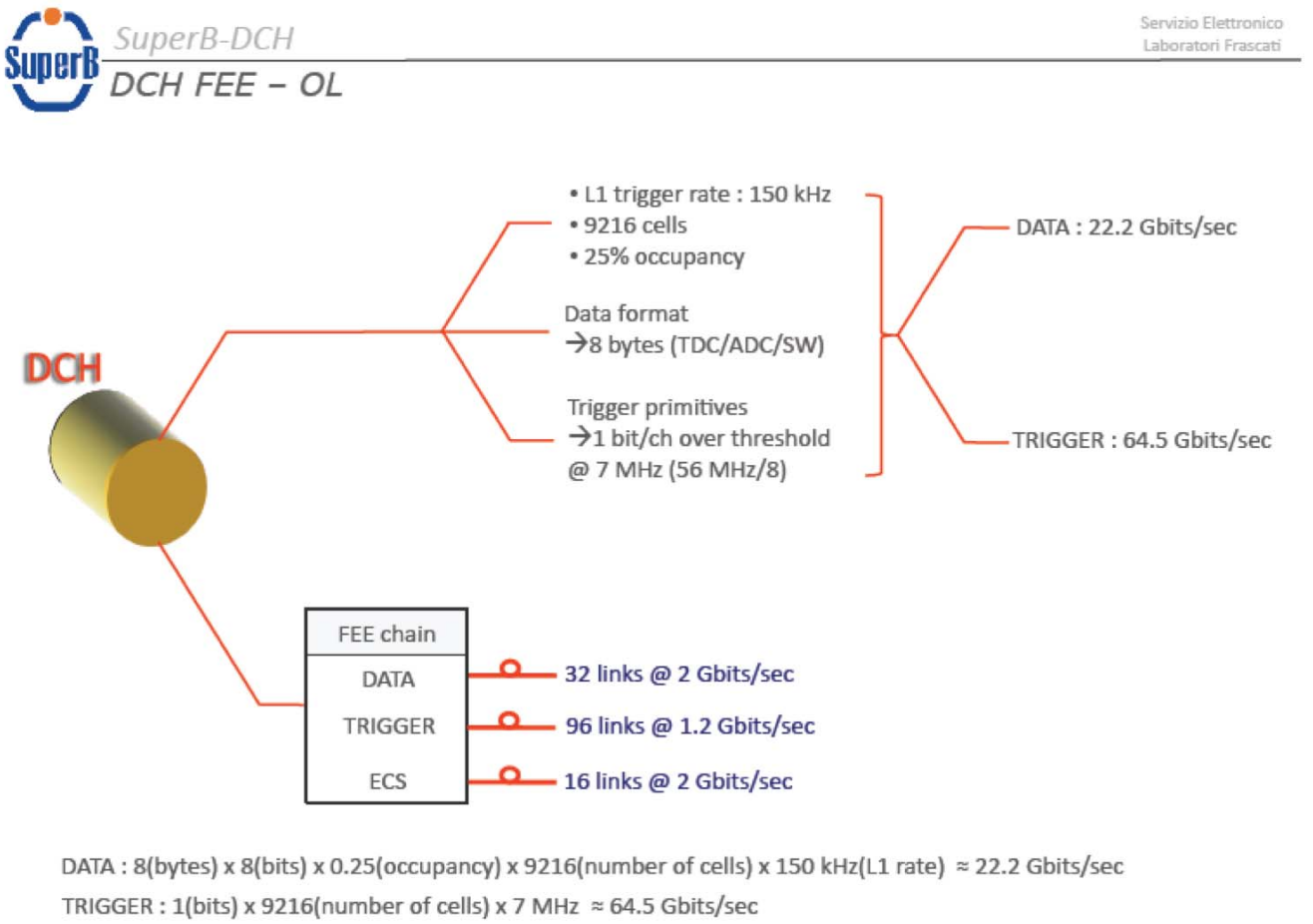
- Background studies
- Cell and gas optimization
- DCH Readout architecture
- R&D work

DCH ReadOut Architecture

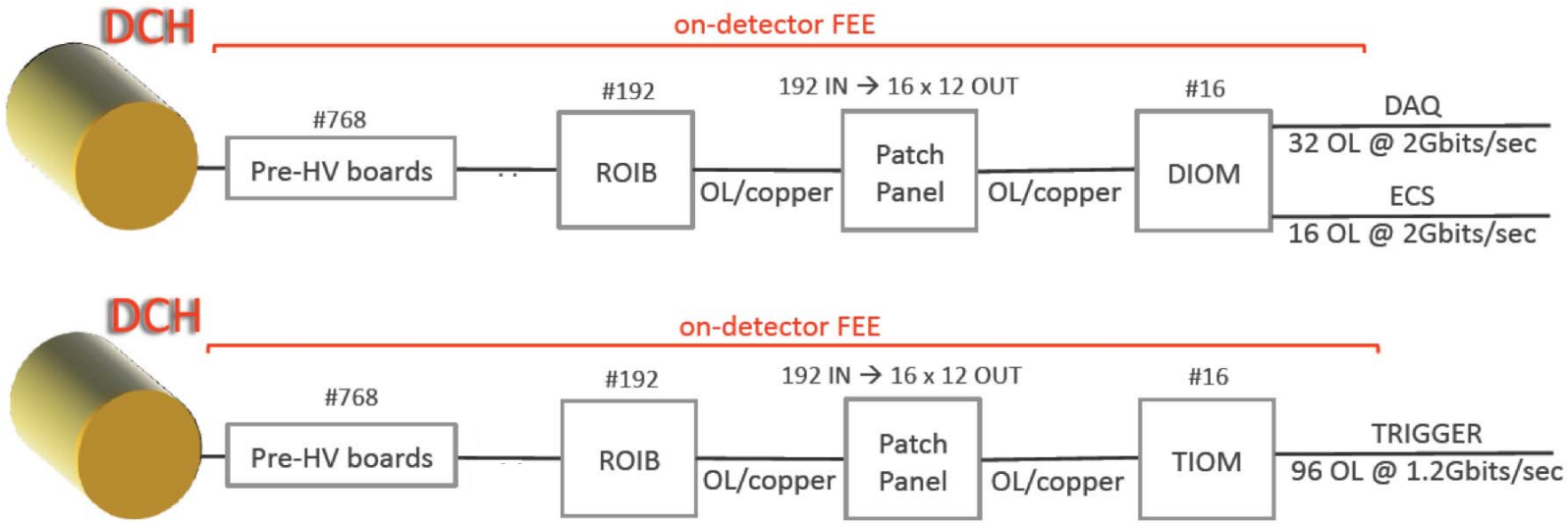
- Detailed estimate of number of DAQ Optical Links



G. Felici

FEE Design à la *BABAR*

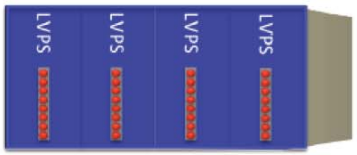
DCH FEE – BaBar like scenario



on-detector cooled box

Main concerns :

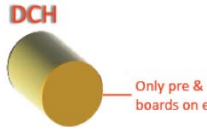
- Power Dissipation (≈ 1.5 kW)
- Material budget (boards/shielding/boxes/cooling/ support structure/LVPS cables)



off-detector High Current PS

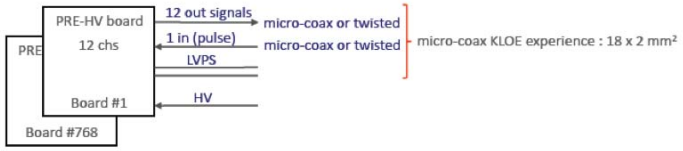
FEE Design à la KLOE

DCH FEE – KLOE like scenario : on-detector electronics

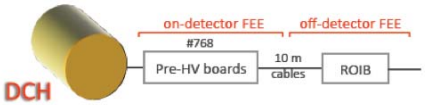


Only pre & HV distrib boards on end-plate

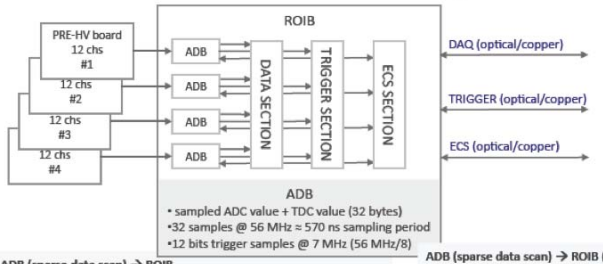
- 768 pre & HV boards (12 chs)
- 9216 out cables (micro-coax or twisted)
- 768 in pulsing cables (micro-coax or twisted)
- 1536 LVPS cables
- 384 in HV cables (from HV filter boxes)
- PD (estimate) ≈ 200W → air flow cooling



DCH FEE – KLOE like scenario : off-detector electronics (I)



- Hosts 4 ADB boards
- Receives 48 analog input signal
- Manages preamplifier boards (LVPS & pulsing)
- Manages ECS interface
- Generates both DAQ and Trigger data output
- Implements FEX on ADB data (≈ factor 4 in data size)

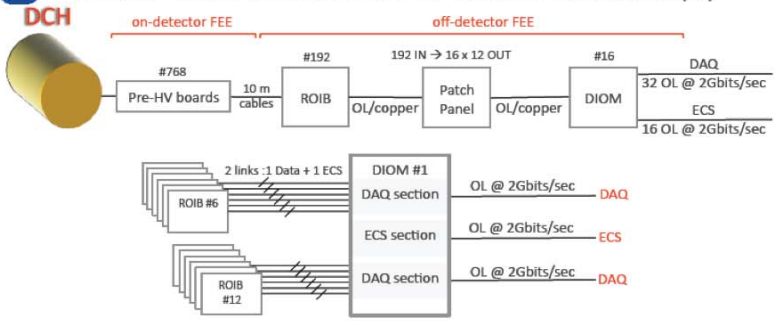


ADB (sparse data scan) → ROIB
- Data size : 12 channels/ADB
  - 12 (chs) x 0.25 (occupancy) x 32 (bytes) x 8 (bits) ≈ 768bits
- 8b data bus @ 56 MHz (448 Mbits/sec)
  - 224 Mbits/sec bus BW (***protocol overhead + FEX***)
- RO time : 615 (bits) @ 224 Mbits/sec ≈ *3.4 μs*

OR

ADB (sparse data scan) → ROIB (exploiting ADB latency buffer)
- Data size : 12 channels/ADB
  - 12 chs @ 25% occupancy ≈ 3 chs/ADB
- Processing the first pipeline event while writing the last the (FEX implemented in ADB)
  - 8 (bytes) x 3 (chs) @ 56 MHz (CLK) ≈ 1 μs (multiplexed RO - overhead included)

DCH FEE – KLOE like scenario : off-detector electronics (II)

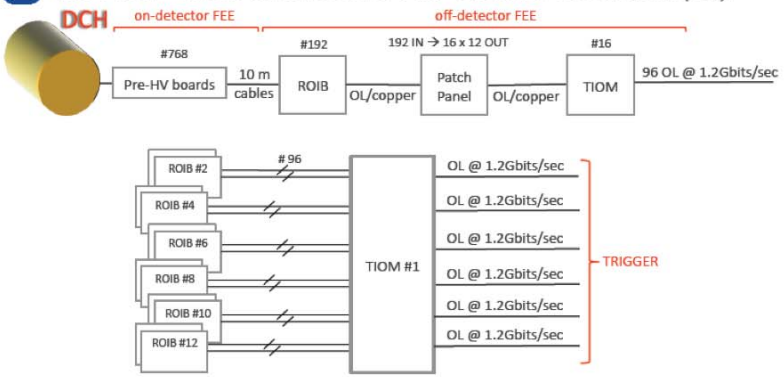


ROIB (FEX) → DIOM (parallel RO)
- Data size : 12 channel/ADB - 25% occupancy - 4 ADB
  - 3 (chs) x 4 (ADB) x 8 (bytes (FEX)) x 8 (bits) ≈ 768 bits
- 224 Mbits/sec data link (*using both edges of the 56 MHz clk – 2 bits bus*)
- RO time @ 224 Mbits/sec ≈ 3.4 μs

DIOM → DAQ
- 12 ROIB/DIOM (2 x 6 ROIB)
- Data size : 768 bits (ROIB event data out) x 6 (ROIBs) ≈ 4608 bits

DIOM data RO (2 Gbits/sec) = 2.9 μs (25% overhead included)

DCH FEE – KLOE like scenario : off-detector electronics (III)



ADB → ROIB
- 12 channels/ADB
  - 12 (chs) x 1 (bit) = 12 bits
- 12 (bits) @ 7 MHz (56 MH/8) = 84 Mbits/sec

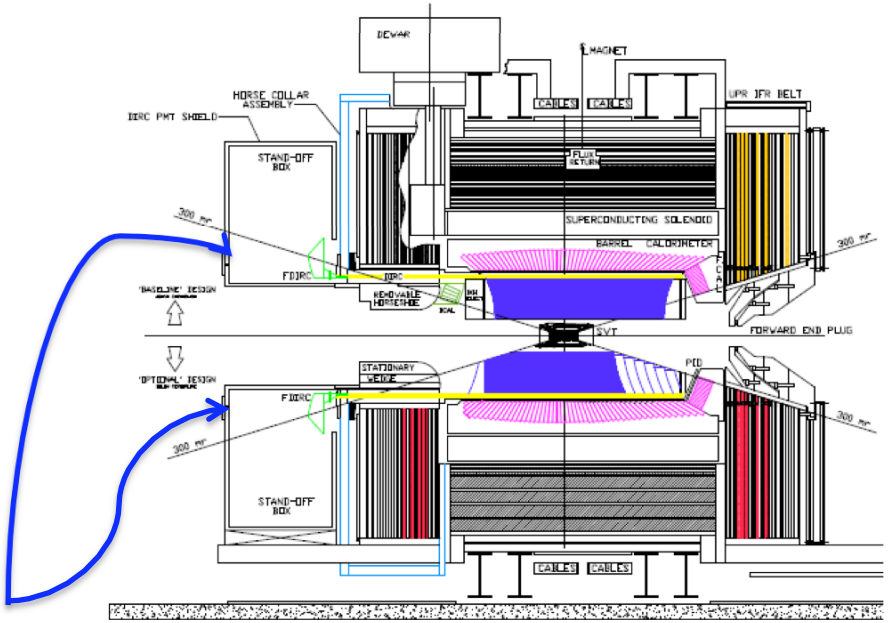
ROIB → TIOM
- 12 channel/ADB – 4 ADB
  - 12 (chs) x 4 (ADB) x 1 (bits) = 48 bits
- 48 (bits) @ 7 MHz (56 MHz/8) = 336 Mbits/sec
- 192 (ROIB) x 336 Mbits/sec ≈ 80.6 Gbits/sec (25% overhead included)

→ TIOM readout = 96 links @ 1.2 Gbits/sec

Conclusions

- DCH FEE layout has been outlined: 2 possible scenarios
  - Only Pre/Shaper on the end-plate
    → We must foresee room for off-detector electronics (more than 20 crates)
  - All FEE chain on end-plate
    →Concerns about PD, material budget and radiation environment

It seems there should have enough space to bring out 10000 signal cables



… and host the crates!

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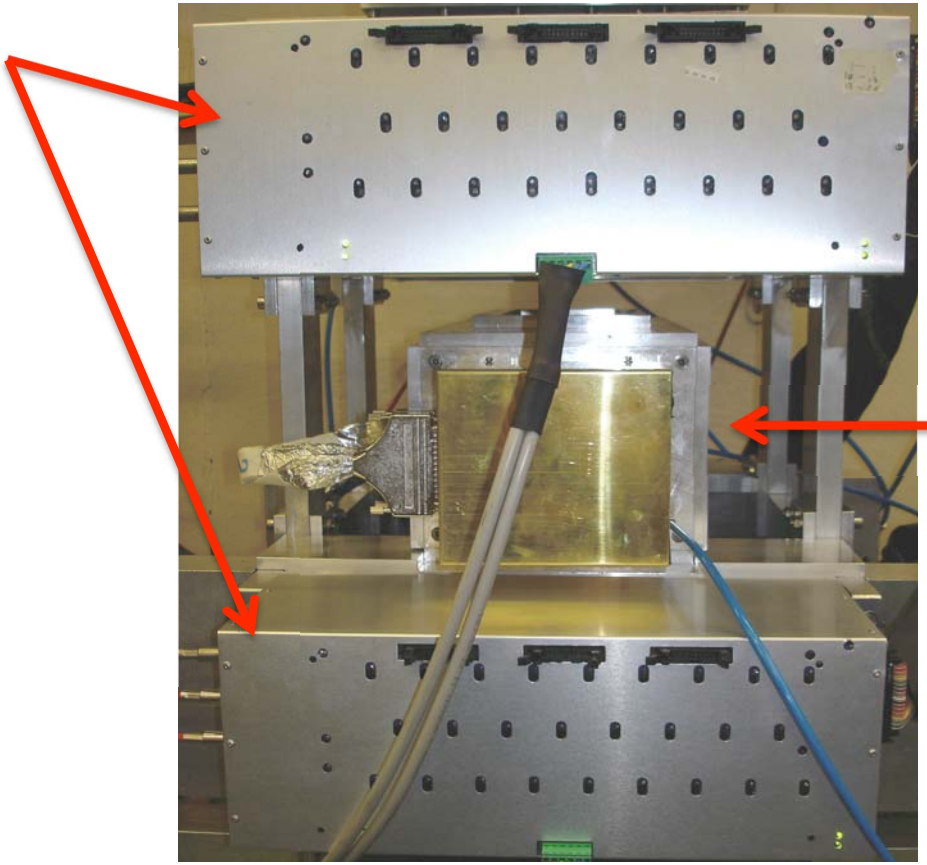
- Background studies
- Cell and gas optimization
- DCH Readout architecture
- R&D work
  - First results from LNF setup
  - TRIUMF prototype design

Experimental Setup

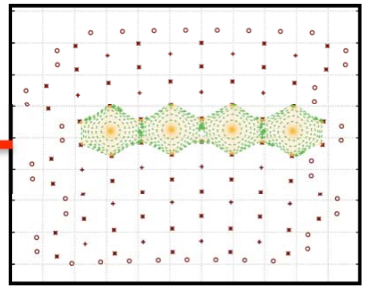
LST Telescope:

- Two identical assemblies of 26 tubes each
- 3 cm diameter, 100 µm wires
- 40%-60% Ar-iC_4H_{10} mixture

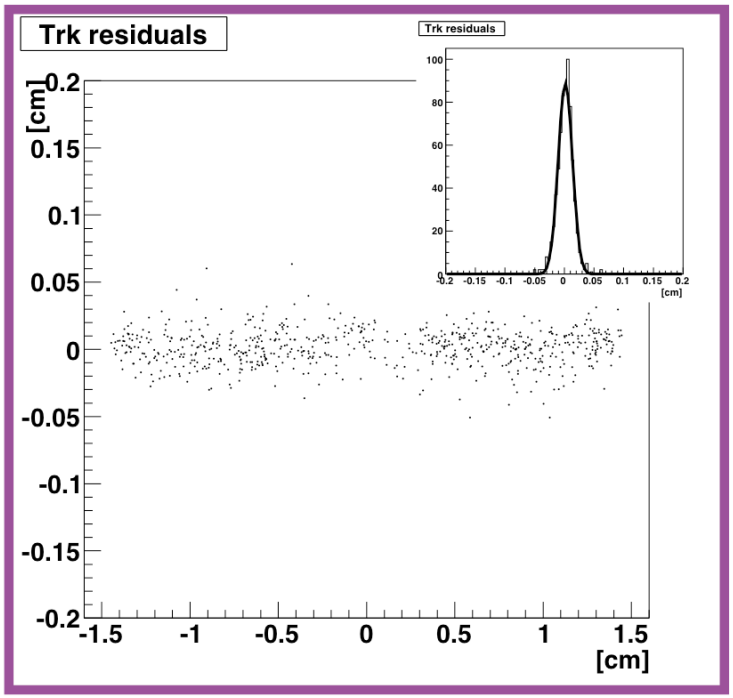


Prototype 1

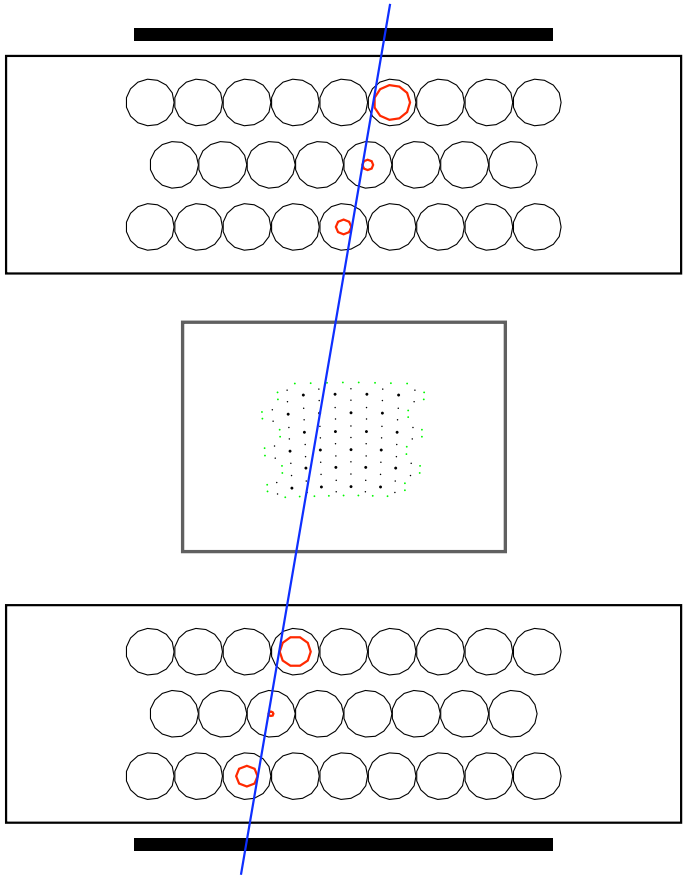
- 6x4 hexagonal cells à la *BABAR*
  - Guard wires to ensure uniformity of electric field among cells
  - Aluminized mylar windows on entrance-exit faces



Tracks extrapolated in Proto1

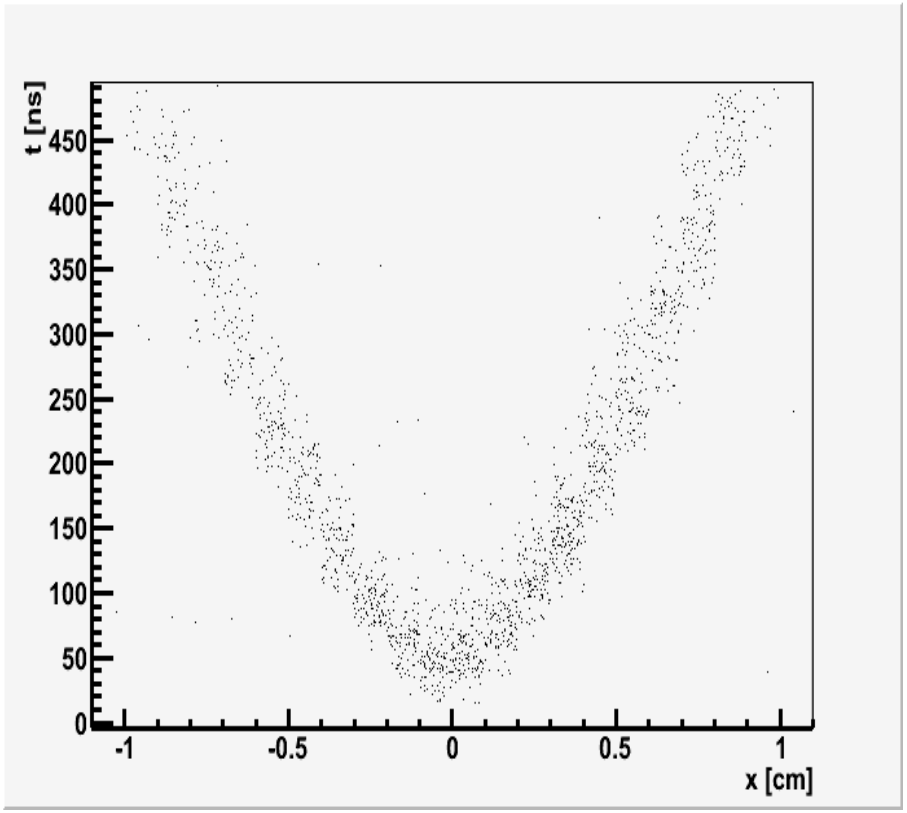


Telescope single tube spatial resolution ~100μm

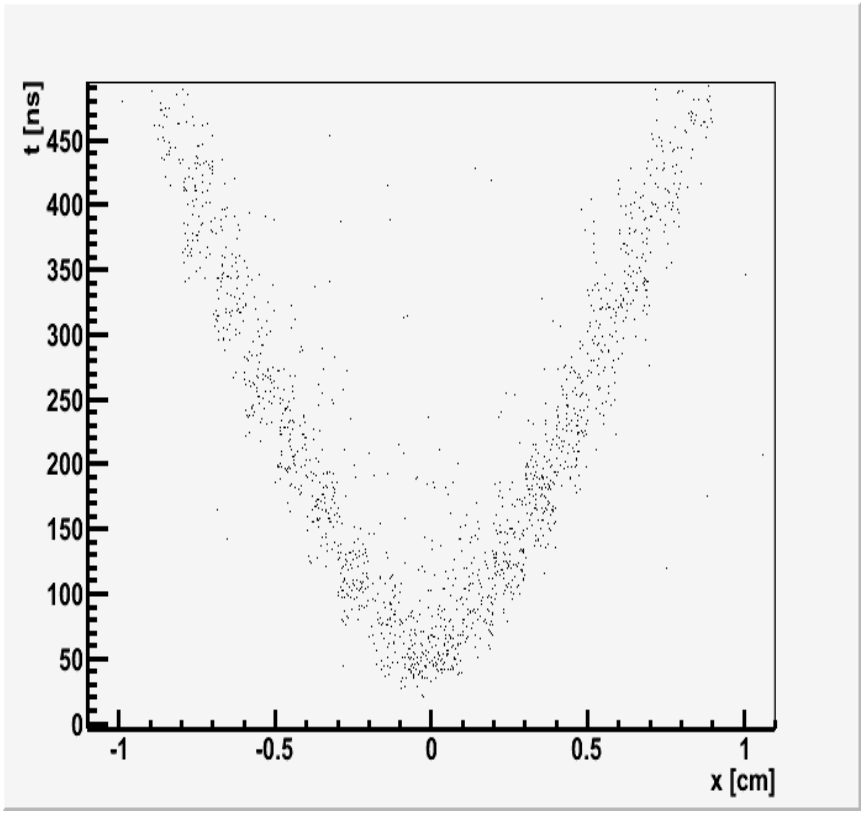


Expected extrapolation accuracy on drift chamber prototype ≤70μm

Space-Time Relations

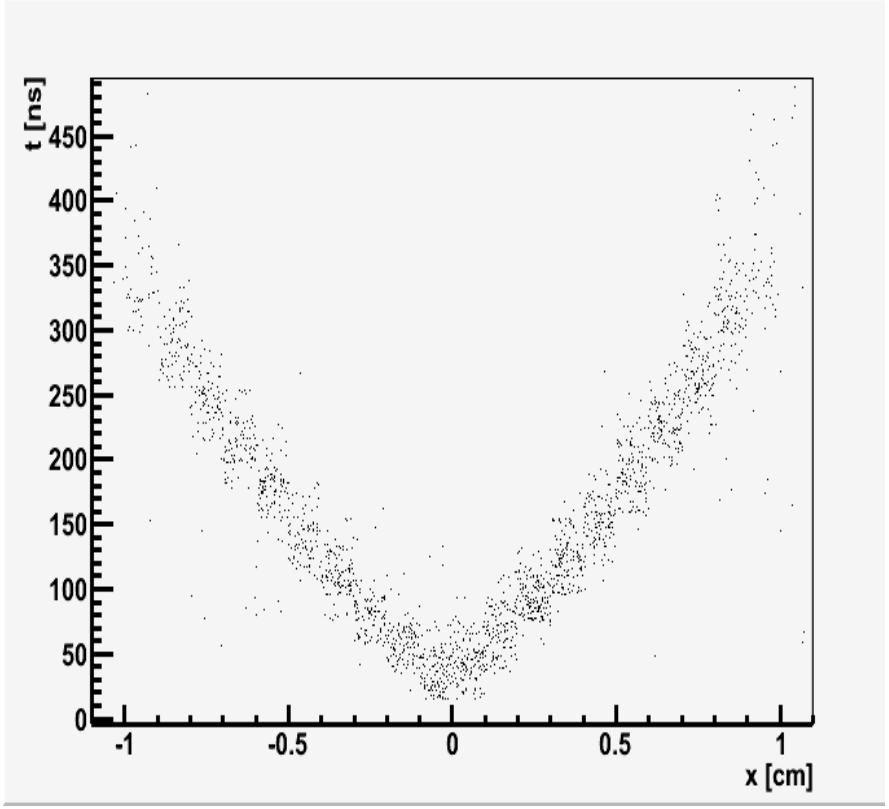


80%He-20%iC_4H_{10} @ HV=1960V

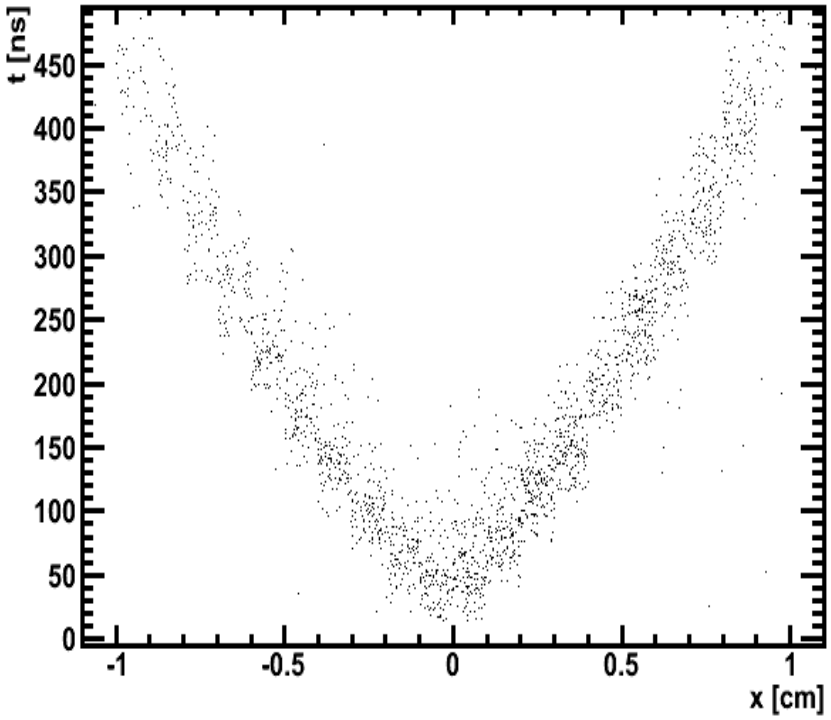


90%He-10%iC_4H_{10} @ HV=1710V

Space-Time Relations



63%He-37%CH_4 @ HV=2510V



79%He-21%CH_4 @ HV=2210V

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- R&D work
  - First results from LNF setup
  - TRIUMF prototype design

Prototyping Status and Plans at TRIUMF

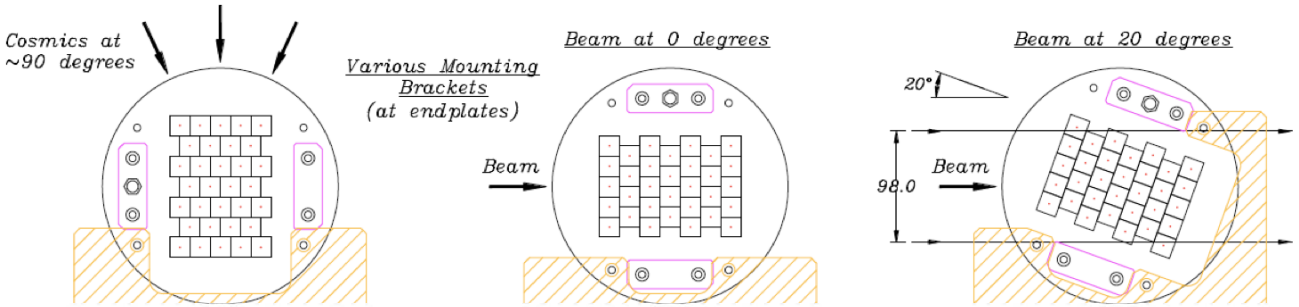
C. Hearty

Goals

- Establish benefits and practicality of cluster counting for particle identification and tracking.
- Provide a test bed for testing gases and electronics.

- 32 active cells plus border cells & guard wire
- Square 9 mm half-cell.
  - other options are possible
- 2700 mm length to check impact of transmission, attenuation, impedance matching.
- Test with cosmic rays, possibly with magnet, and in test beam.

Brackets to hold the prototype at various angles



Proposed Operations

- Aim for cosmic operation in August and September, test beam starting October.
- Solenoid is available for cosmic tests (too much material for beam), 0.7–1.0 T.