



Simulation Studies for Phase I Pixel Upgrade

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On behalf of the Tracker Upgrade Simulations Working Group

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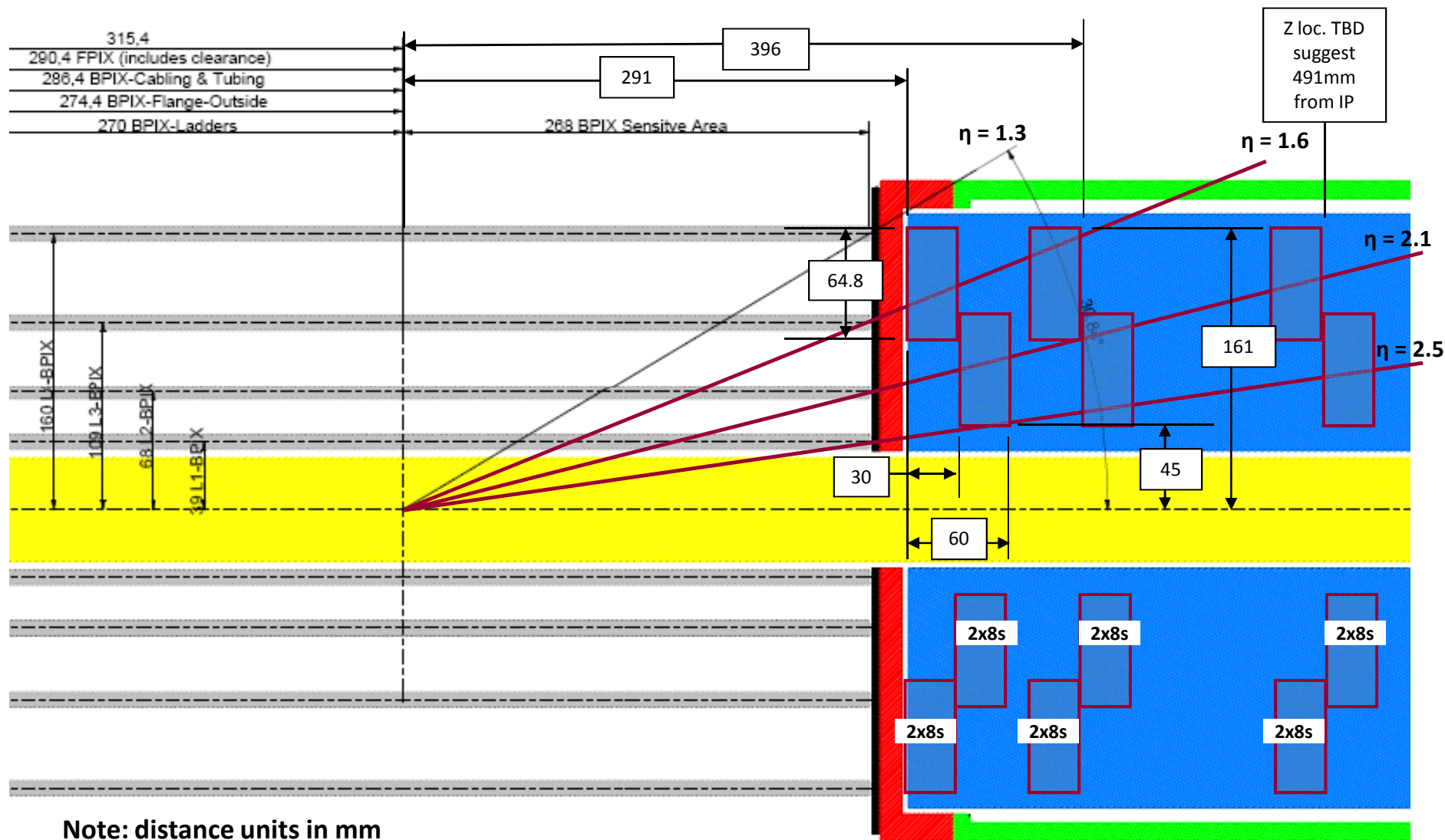


Outline

- ❑ Status of software
 - ❑ Geometry: two different approaches
 - ❑ quick geometry (implemented by A. Tricomi)
 - ❑ detailed geometry (implemented by P. Jindal and N. Parashar)
- ❑ Status of detailed geometry for forward disks
- ❑ Performance Studies with
 - ❑ quick geometry
 - ❑ detailed geometry
- ❑ Summary and Outlook



BPIX/FPIX Envelope Definition for Pixel System



Note: distance units in mm

current FPIX 4 disks at (mean) Z: ± 355 and ± 485 mm



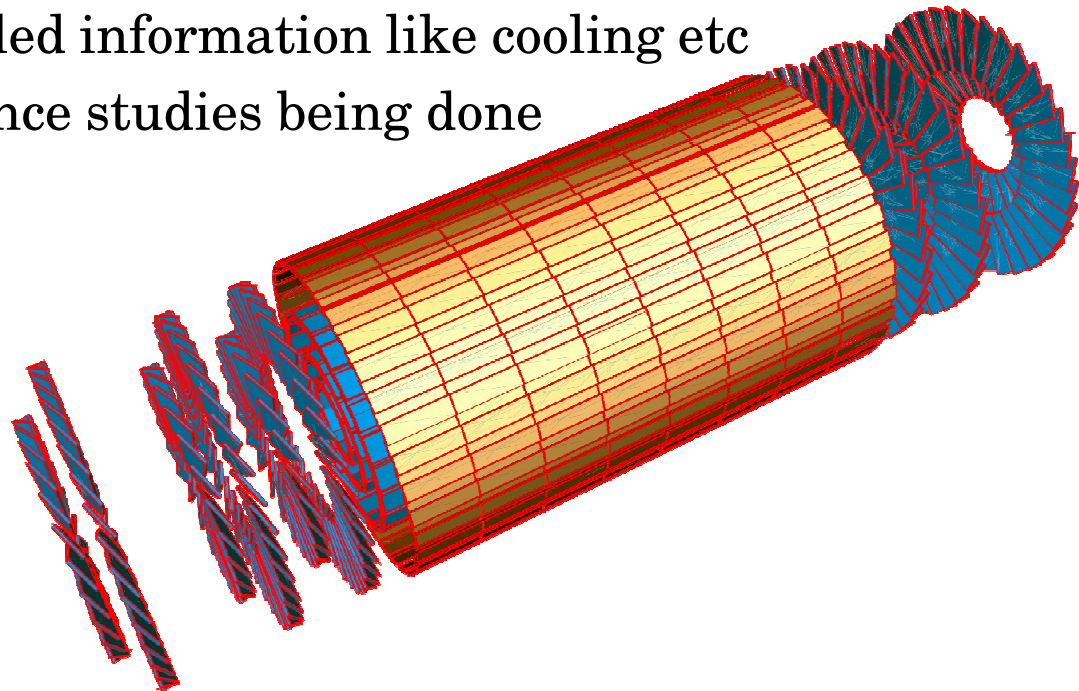
Quick vs Detailed Approach

- ❑ Quick Geometry
 - ❑ Modify current pixel geometry to add a 4th barrel layer and 3rd disk at the new z positions
 - ❑ Rescale material according to the new one
 - ❑ Relatively easy to implement
 - ❑ Quick answer on 4th barrel layer gain
 - ❑ Reasonable enough for performance studies in the barrel region
 - ❑ Seeding
 - ❑ b tagging
 - ❑ Less powerful for 3 disk option
- ❑ Detailed Geometry
 - ❑ Need to rewrite the barrel/Disk geometry
 - ❑ New module structure
 - ❑ More detailed description of materials
 - ❑ Implementation more time consuming
 - ❑ Needed for final performance studies



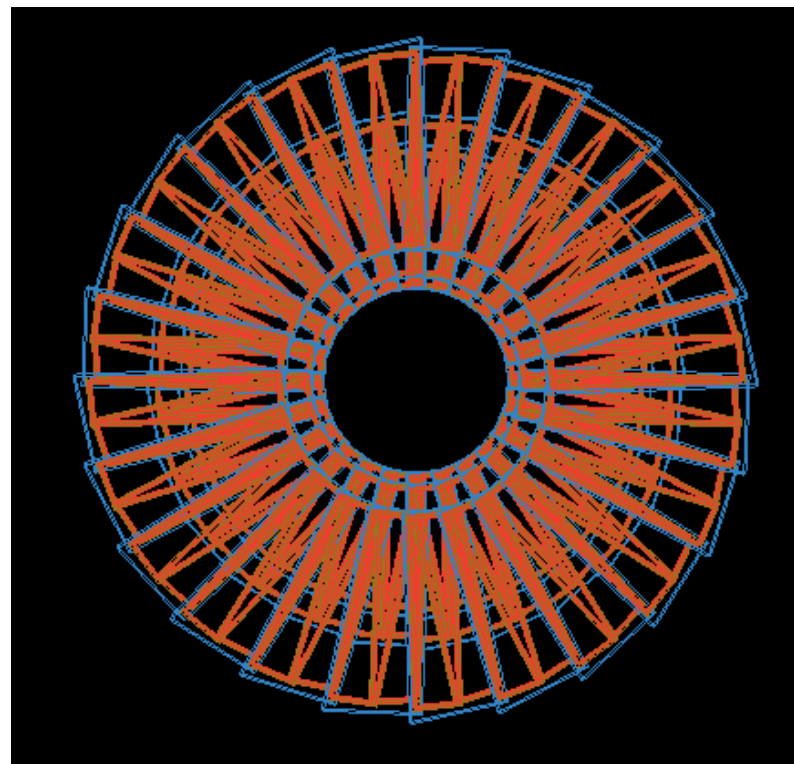
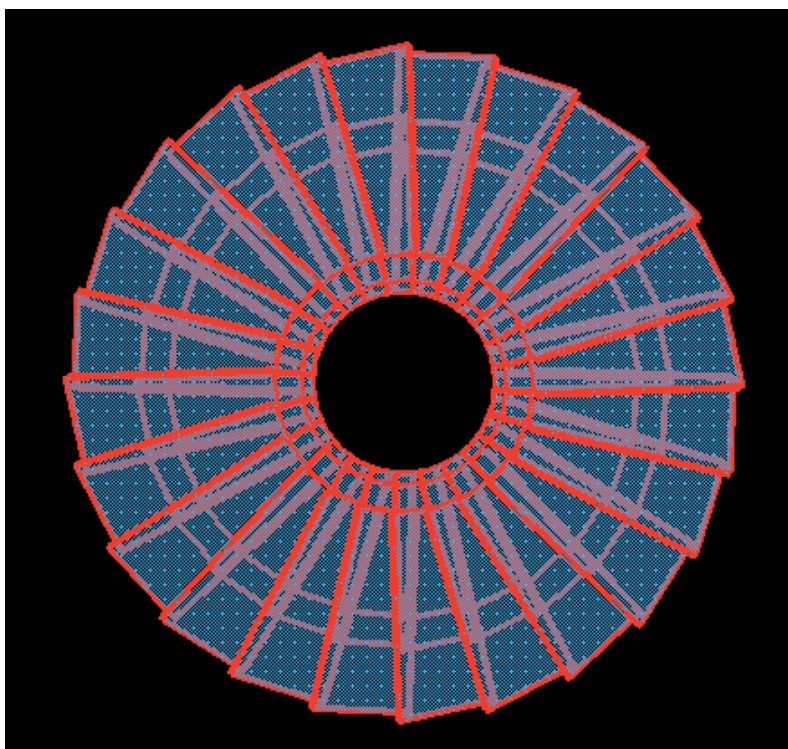
Status of the Detailed Geometry

- ❑ Geometry needed to be rewritten
- ❑ Barrel status – to be done (Xingtao Huang, Angel Lopez)
- ❑ Forward Disks First version of the whole geometry is ready
 - ❑ Need to add the new material description
 - ❑ Add more detailed information like cooling etc
 - ❑ Some performance studies being done





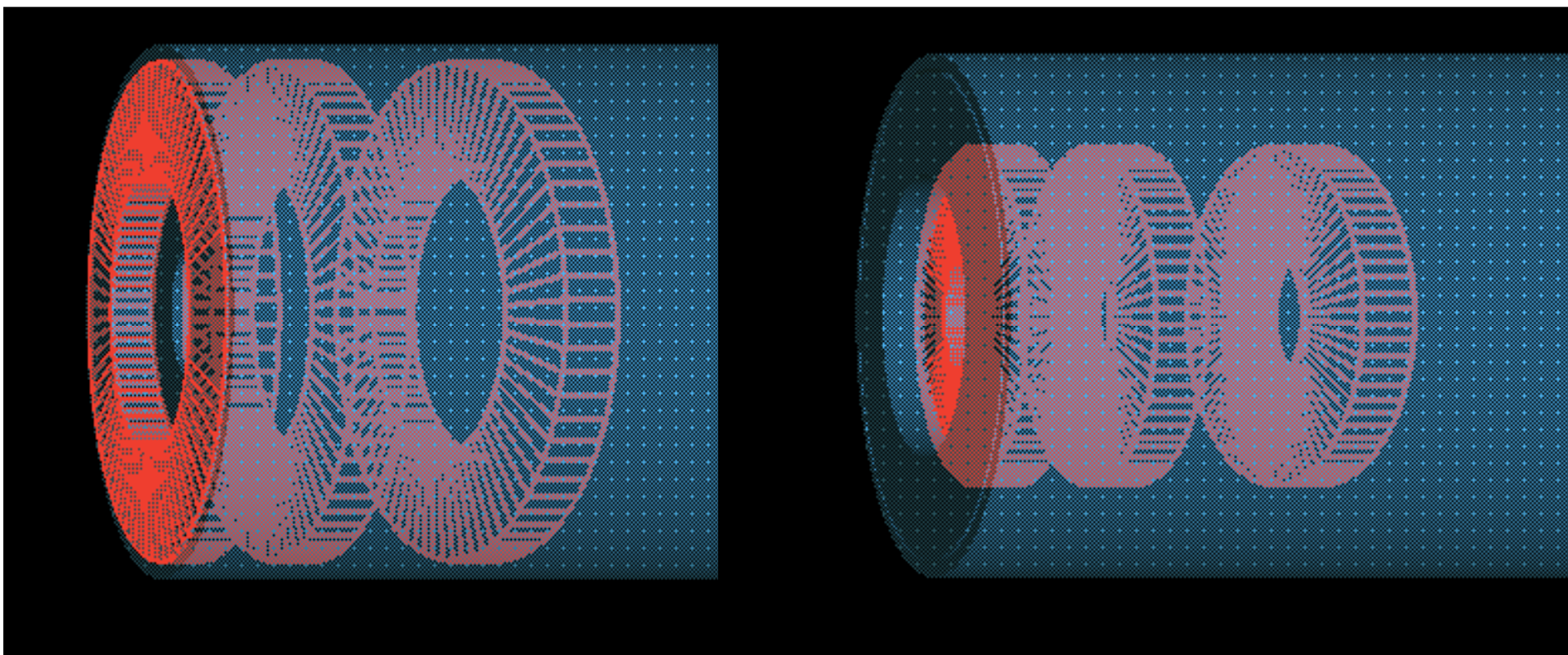
Pixel Forward InnerDisks



The Inner Blade Assembly in X-Y plane. Showing the 2x8 modules on the right



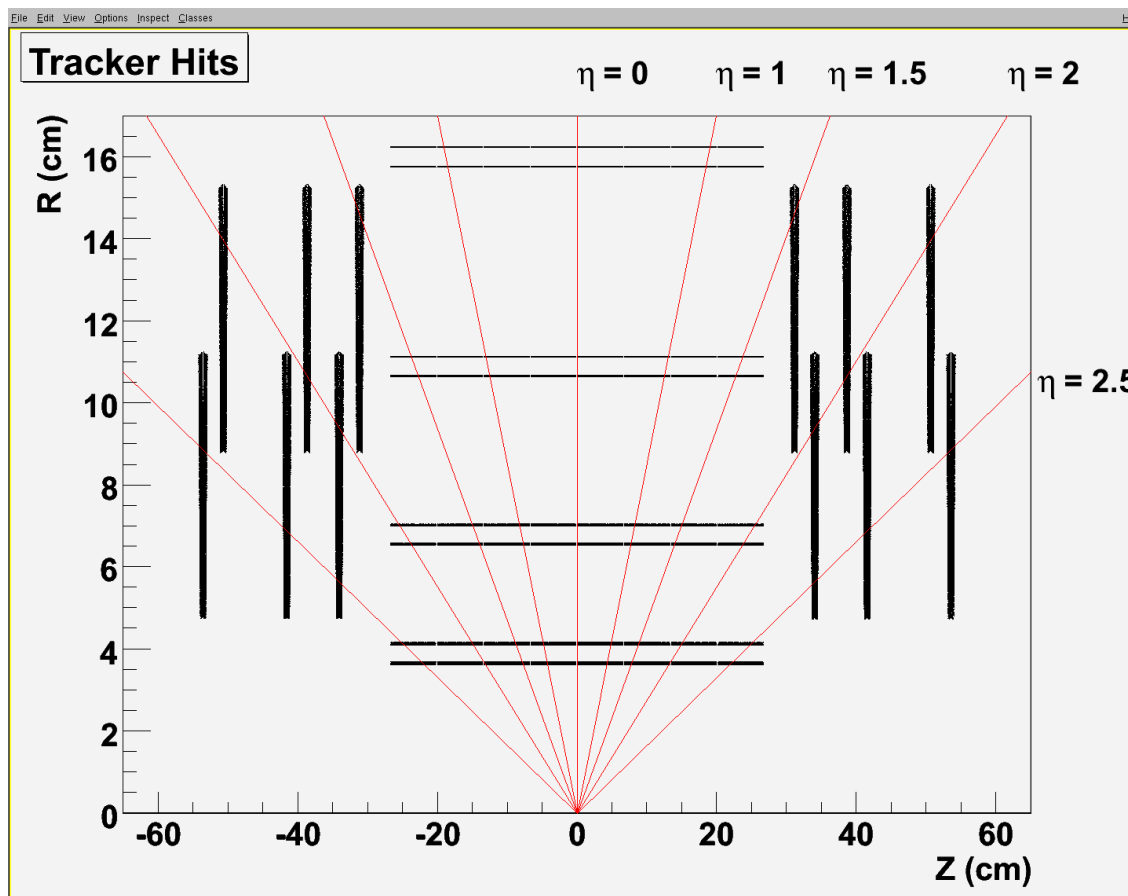
Z-plus Disks



The Outer and Innerer Disks assemblies placed within the service cylinder



Phase I Geometry



H. Cheung

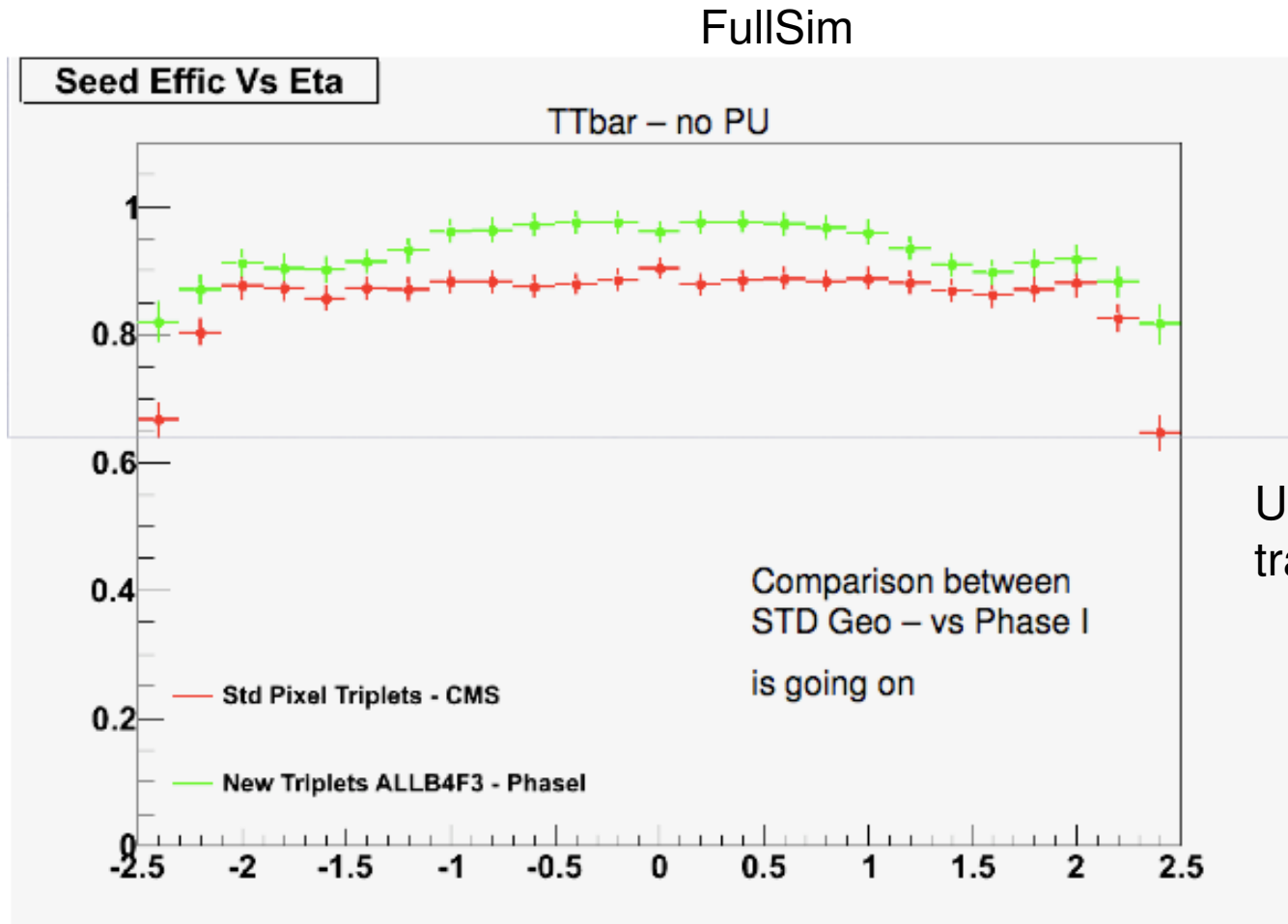
Rechits reconstructed in the Pixel system illustrating the position of disks and barrel layers in the Phase I Pixel system



Performance Studies: Quick Approach



Efficiency: std vs new algorithm



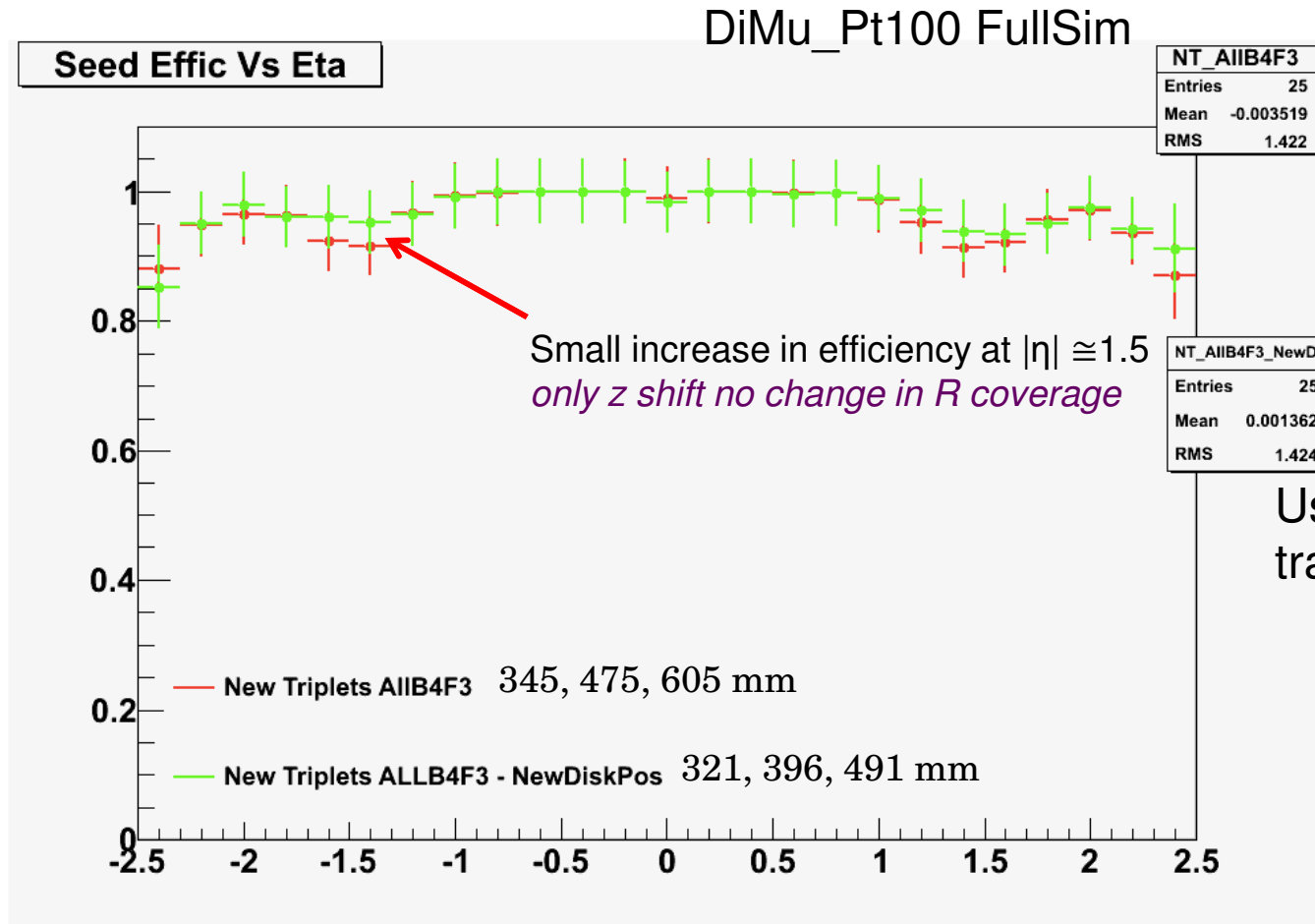
Using iterative tracking

A. Tricomi

We recover in efficiency using all 4 barrel layers and 3 disks



Efficiency: effect of disks z position

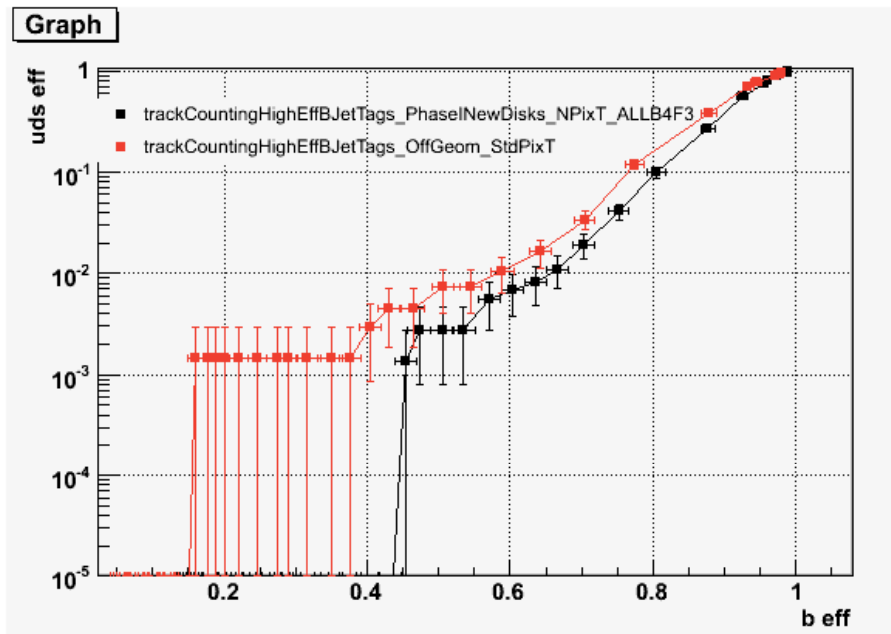


A. Tricomi

Small increase in efficiency at $|\eta| \cong 1.5$



b-tagging Studies

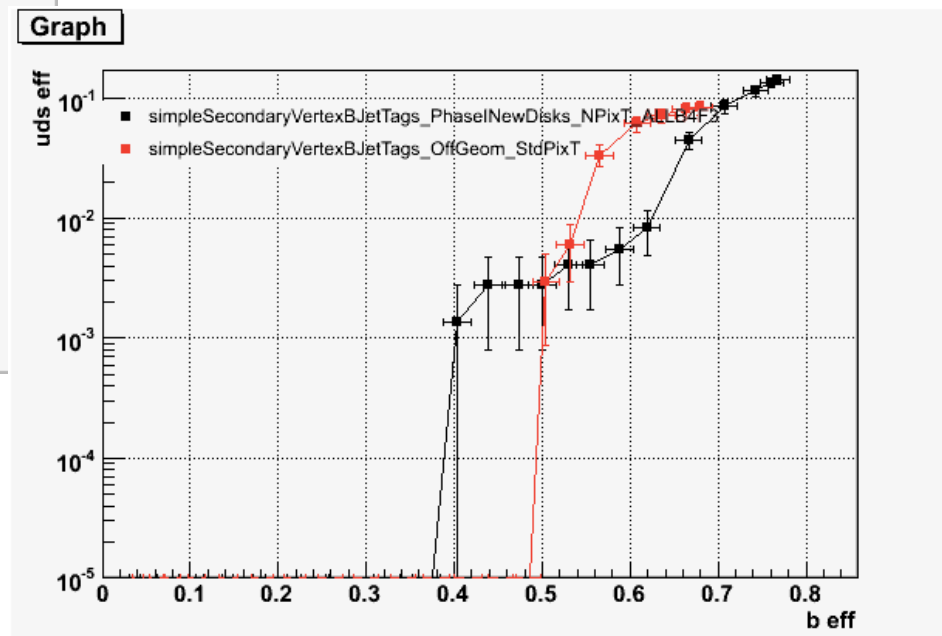


$e_{uds} = 1\%$ $e_b = 58\%$ to 68%

Standard Geometry
Phase I

Using $t\bar{t}$ sample

A. Tricomi



$e_{uds} = 1\%$ $e_b = 54\%$ to 64%



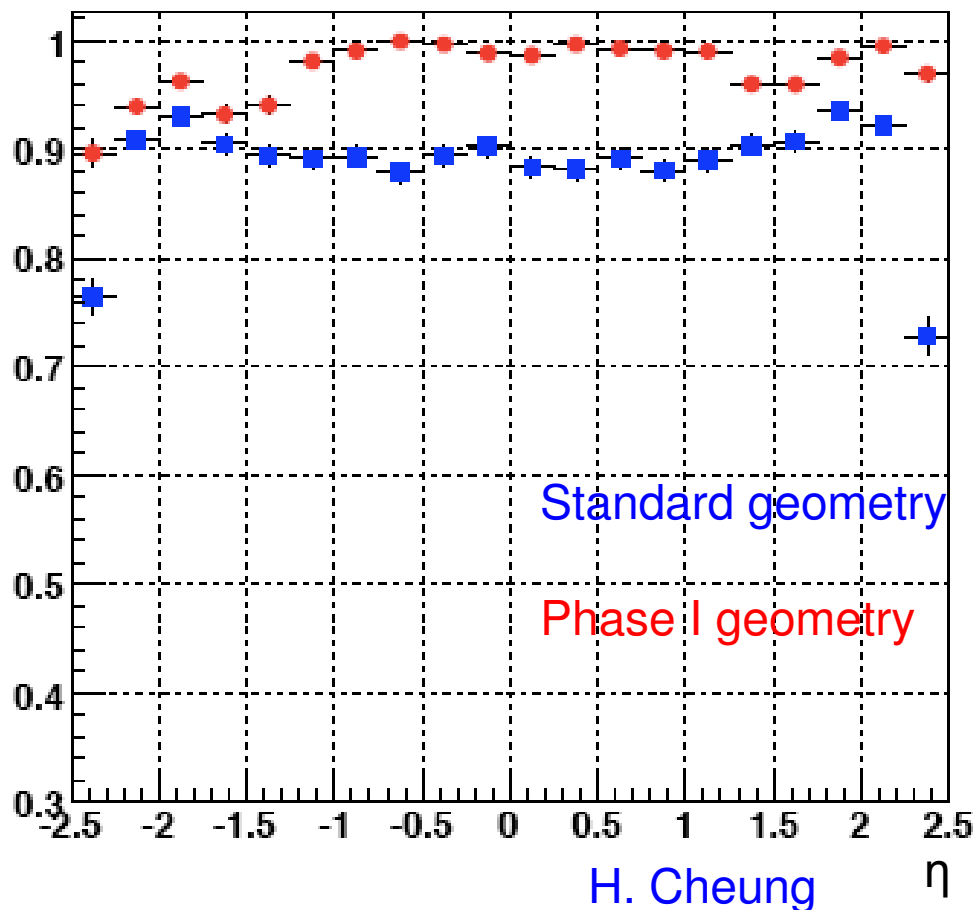
Performance Studies: Detailed Approach



Efficiency

efficiency vs η

dimuons, 1–50 GeV pT gun, 0 pileup, FullSim



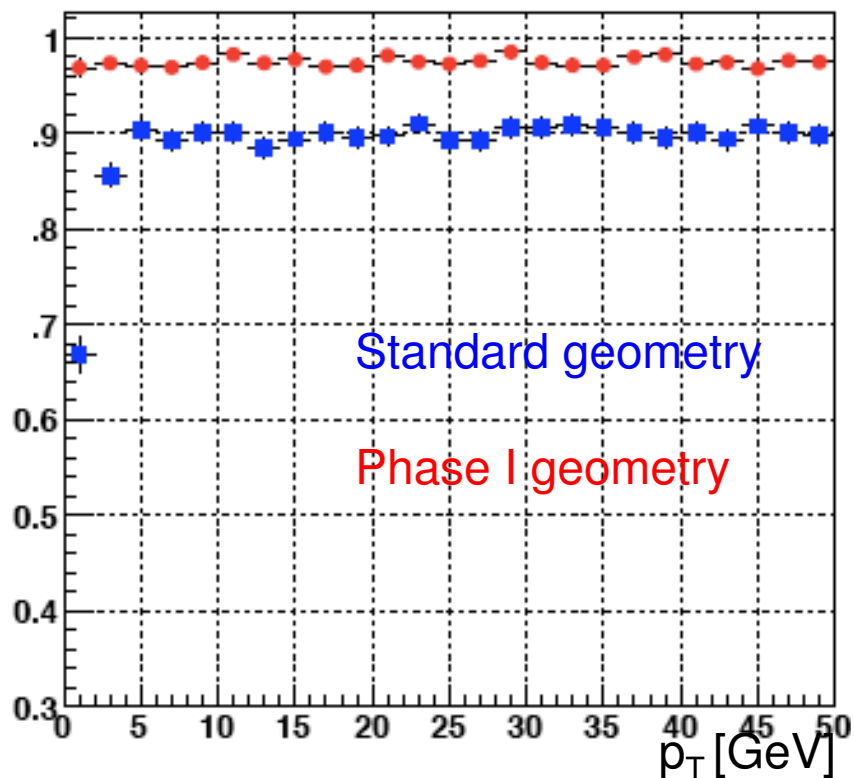
- We are trying to understand if we can have higher efficiency at the same or better fake rate using 4 barrel layers and/or 3 disks
- Compare the efficiencies using triplet seeds (3-out-of-3) for standard CMS geometry and triplet seeds (3-out-of-4) for Phase I geometry
- We see a lower efficiency on the negative side
- Issues with tracking because of local coordinate vs global coordinate systems in the new geometry
- Working on resolving this



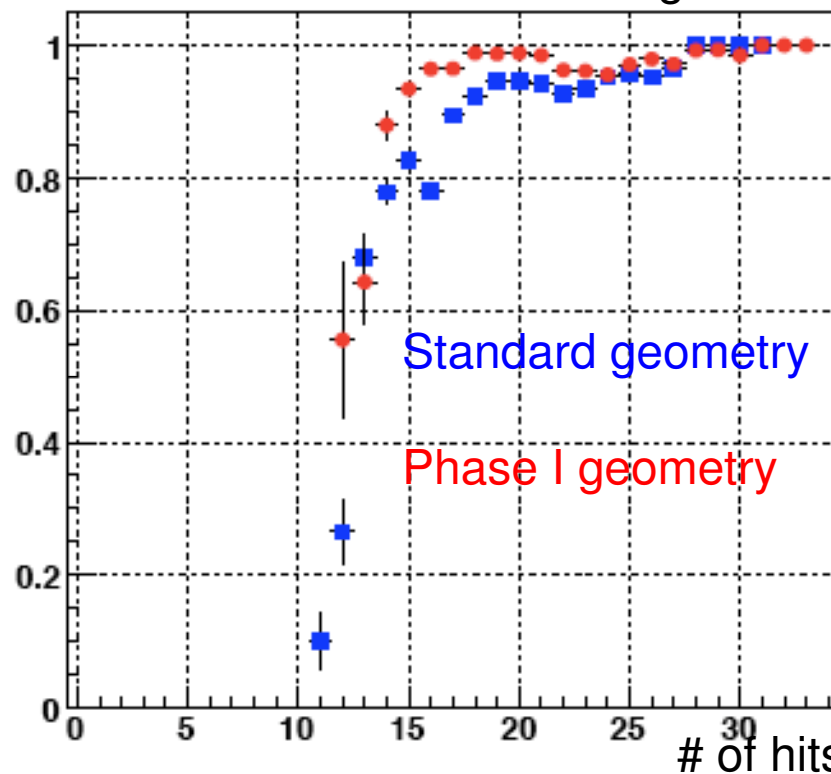
Efficiency

dimuons, 1–50 GeV p_T gun, 0 pileup, FullSim

efficiency vs p_T



efficiency vs hit



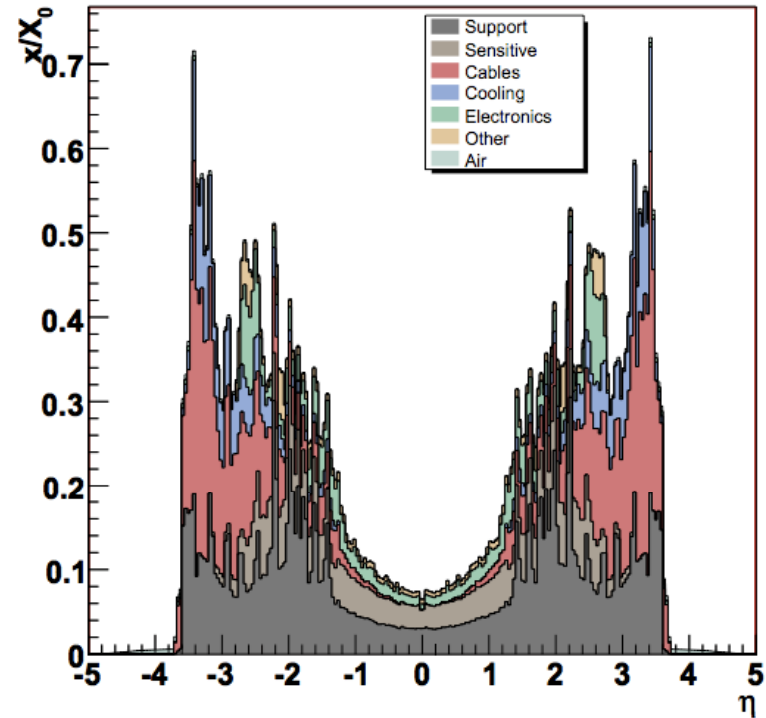
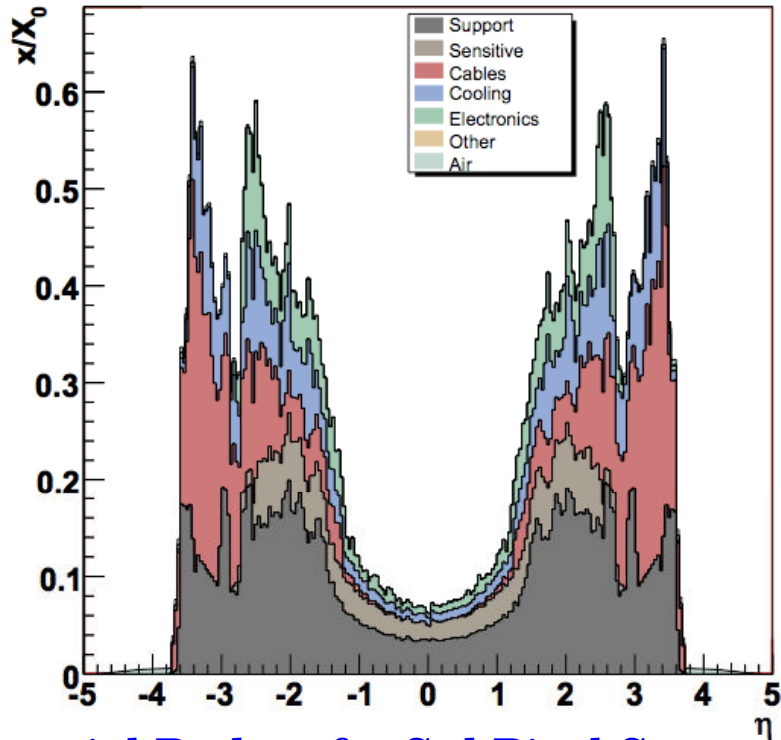
Using non-iterative tracking

H. Cheung

Comparison of the efficiencies using triplet seeds (3-out-of-3) for standard CMS geometry and triplet seeds (3-out-of-4) for Phase I geometry



Material Budget



Material Budget for Std Pixel System

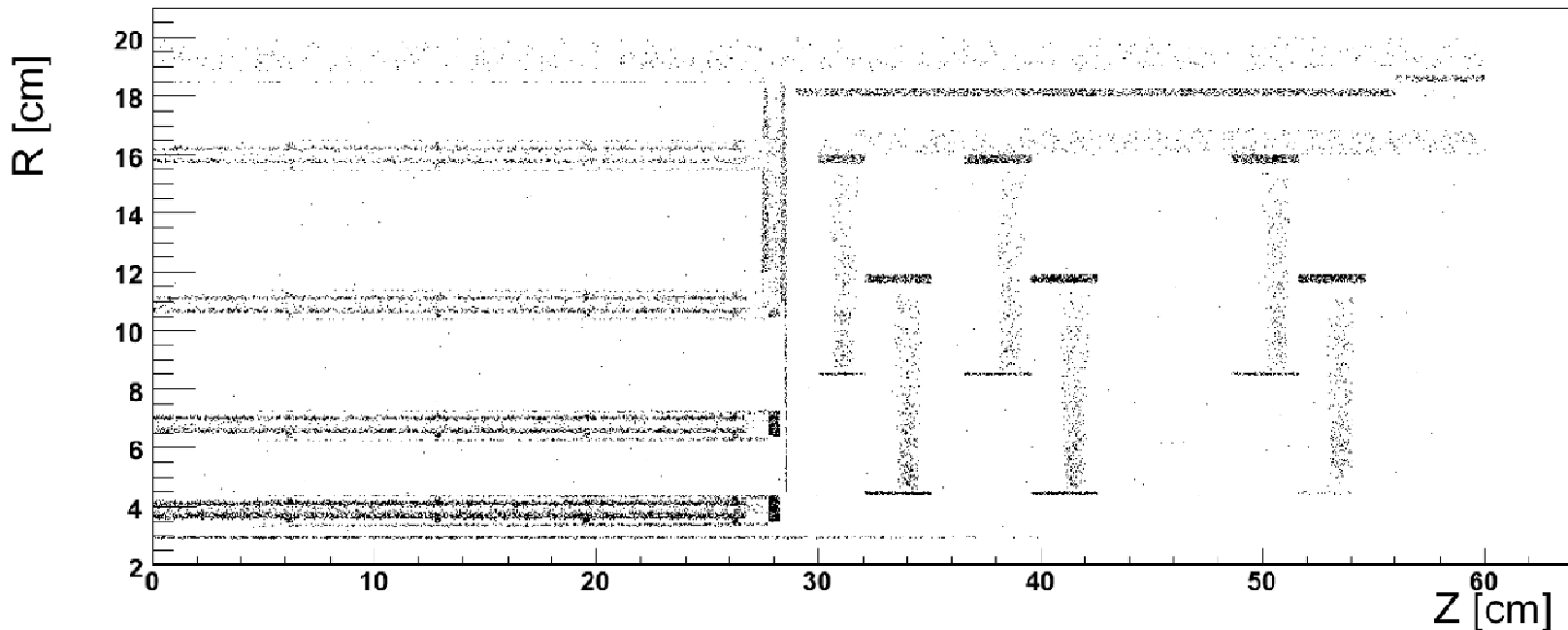
Material Budget for Phase I Pixel System

- The material changes for BPIX implemented by
 - rescaling the corresponding material densities to reproduce the correct new weights
 - $C_6F_{14} \rightarrow CO_2$ with rescaled density of 0.20 g/cm^3
 - Al pipes \rightarrow Steel_Upgrade with rescaled density of 0.49 g/cm^3



Geometry as Implemented

Location of photon conversions in the Full Simulation using Tracking Particle



P. Sheldon



Summary and Outlook

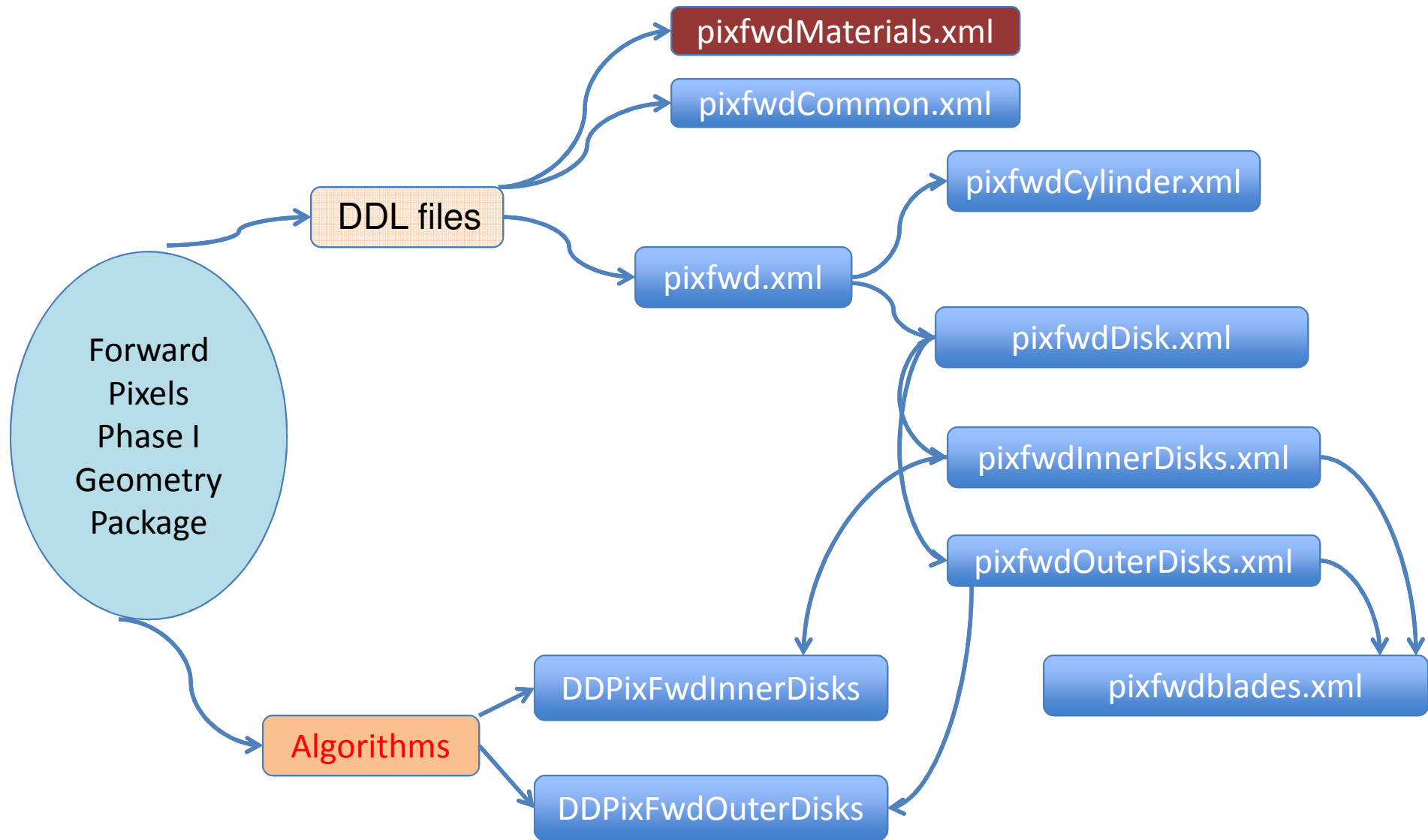
- ❑ A “quick” approach to give first answers on the achievable gain with new design for
 - ❑ Seeding, tracking and b-tagging
 - ❑ Main limitation in the forward part due to difficulty in changing the R coverage
- ❑ First results on seeding look promising to demonstrate the achievable gain with 4 barrel layers/3 disks
 - ❑ With NewTriplets_AllB4F3 efficiency comparable to Standard Global seeding in the barrel region
 - ❑ First results on b-tagging also look promising
- ❑ More detailed studies are going on
- ❑ Full detailed description
 - ❑ Forward disks already implemented
 - ❑ Barrel part – work just starting
- ❑ First look at the material budget with the detailed geometry of disks
- ❑ Improvement in efficiency
 - ❑ See some inefficiency on the negative side. Looking at track reconstruction to resolve this



BackUp

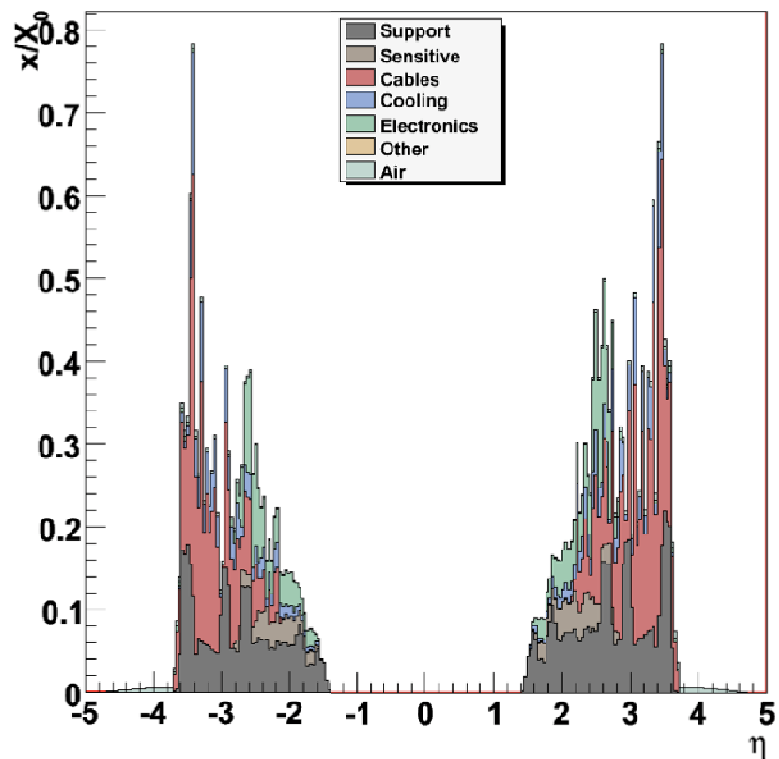


The FPIX Geometry Structure

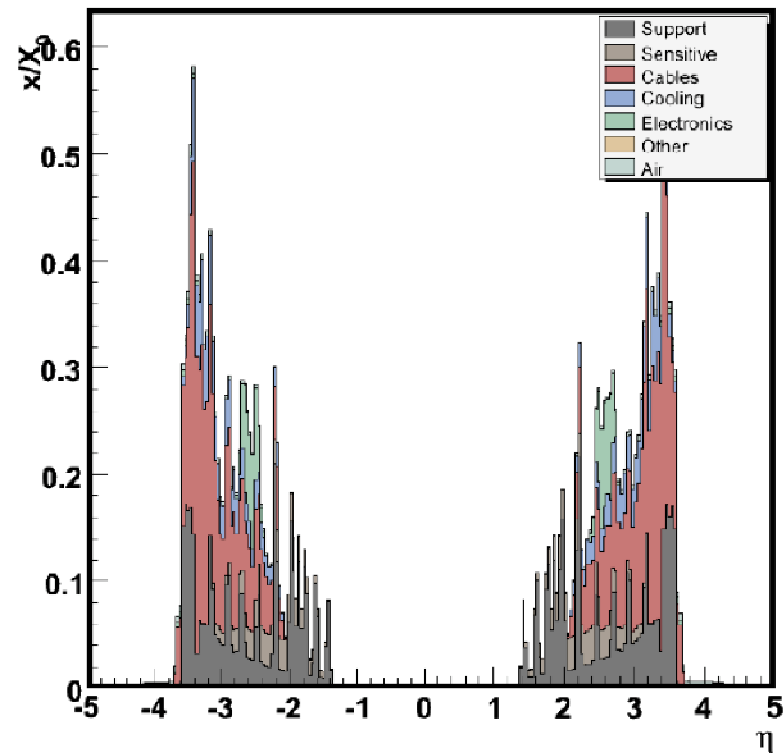




Material Budget



Material Budget for Std FPIX System



Material Budget for Phase I FPIX System