

Tracker Upgrade Simulation Software & Strawman Geometries

Eric Brownson, Vanderbilt University
on behalf of Tracker Upgrade Simulations WG

CMS Upgrade Workshop
October 29, 2009

Strawman Geometries

- Quick word about Phase I
- Hybrid
- Long Barrel

Technical Work

- Module Info Tool
- ADC Counts in Stack Layers
- Pixel Inefficiency

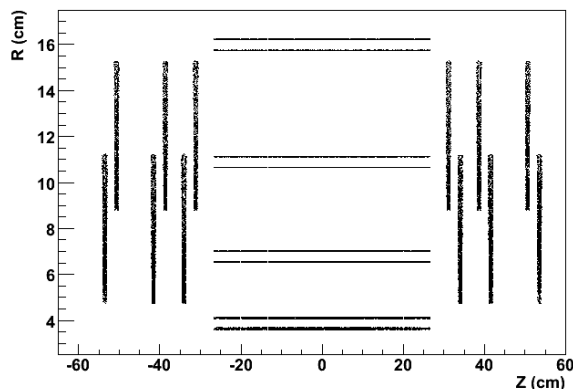
Material Budget Studies

- Neutrino Studies
- Photon Conversions

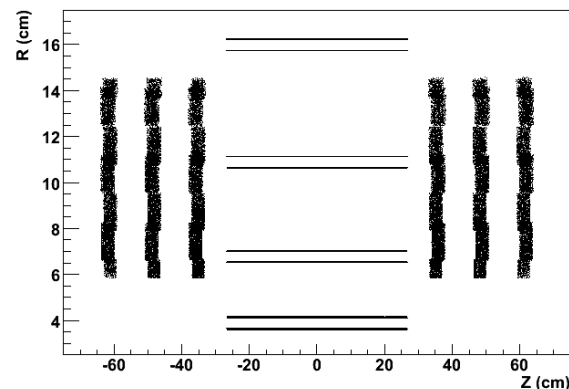
Two versions of phase I

- Work on 'Realistic' phase I is ongoing
 - See Pratima Jindal's talk from yesterday
- For stability a 'Quick' phase I is used in phase II strawmen
 - Same inner pixel as present geometry but with a 3rd disk & 4th barrel layer

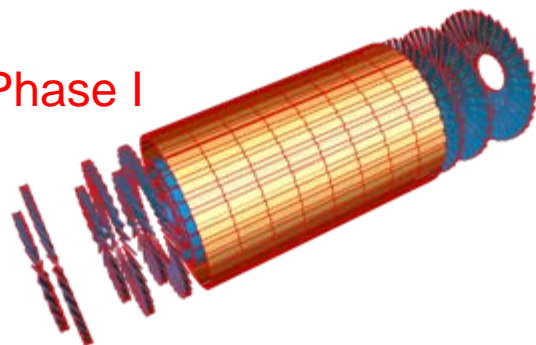
Tracker Hits for Realistic Phase I



Tracker Hits for Quick Phase I



Realistic Phase I

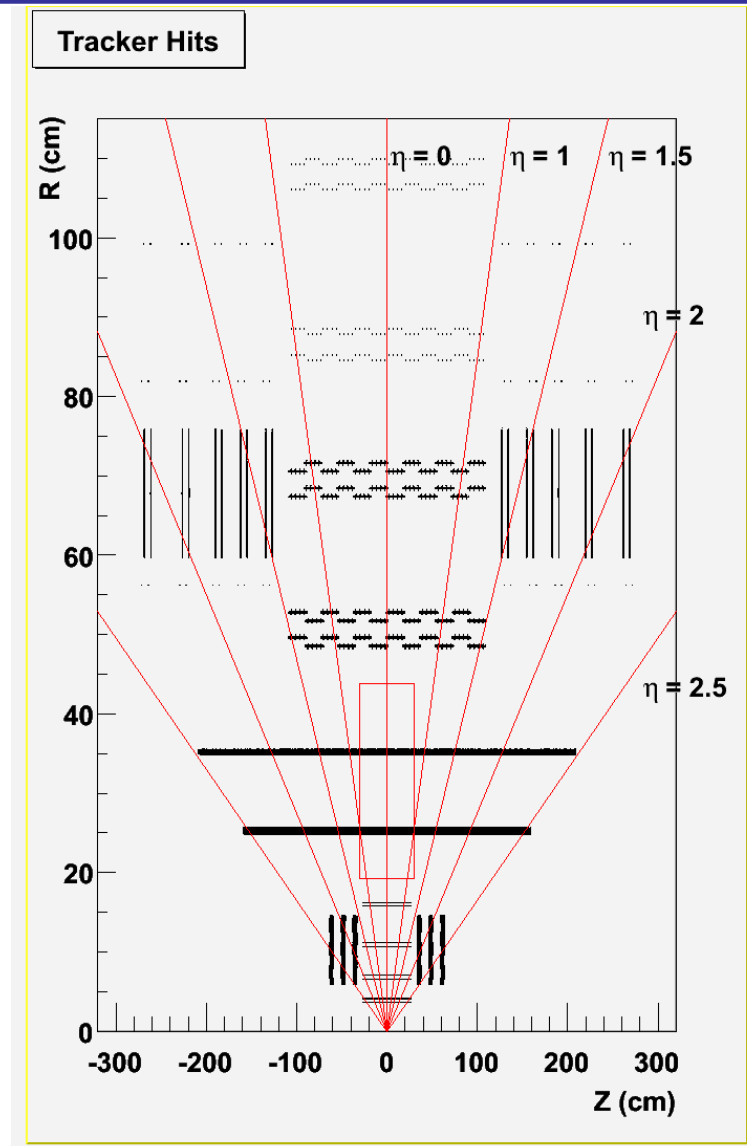


		Active Surface (cm ²)	# channels
Barrel - Pixels	Present Geometry	7,558.26	47,923,200.00
	"Quick" Phase I	13,772.85	87,326,720.00
	Realistic Phase I	13,772.85	87,326,720.00
Forward - Pixels	Present Geometry	2,834.36	17,971,200.00
	"Quick" Phase I	4,251.54	26,956,800.00
	Realistic Phase I	7,567.59	47,923,200.00
Total - Pixels	Present Geometry	10,392.62	65,894,400.00
	"Quick" Phase I	18,024.39	114,283,520.00
	Realistic Phase I	21,340.44	135,249,920.00



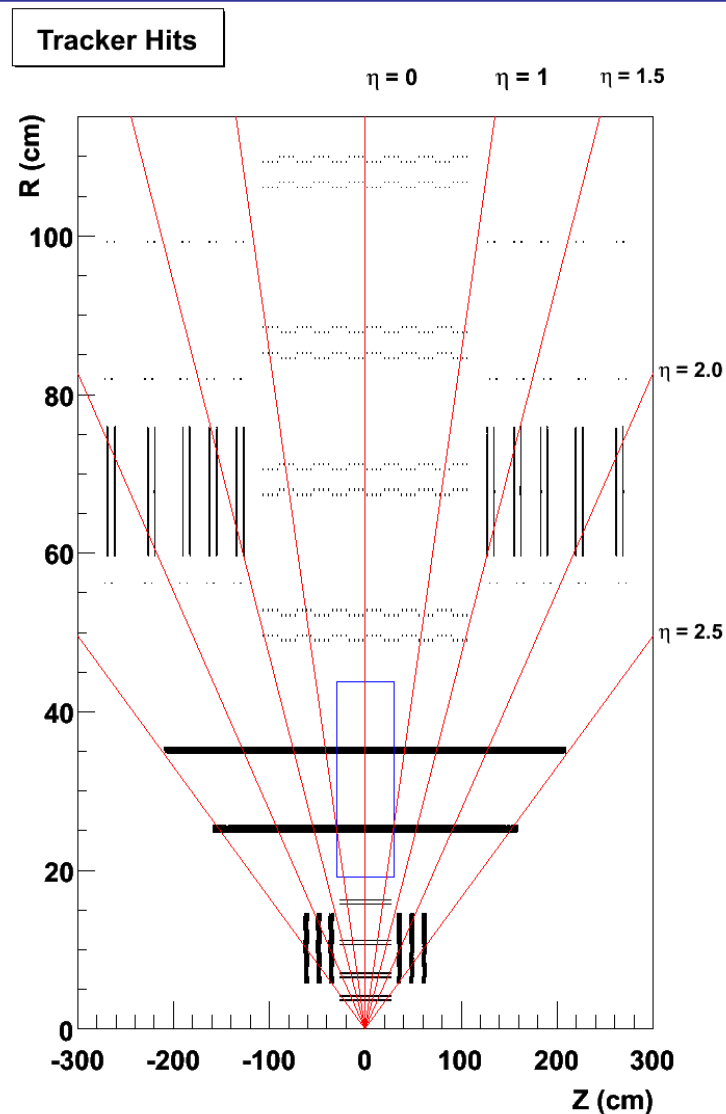
Inner Pixels: as noted for Phase I

- pT pixel Layers
 - 100 μm x 2 mm pitch
 - 200 μm thickness
 - Sensor z-gap = 0.8 mm
- OB: Short strips
 - TOB 1,2,5,6 (1/4 length)
 - Increased granularity in z-phi rings
- Endcap: Short strips
- 270M pixels, 12M strips



- Inner Pixels: as noted for Phase I
- pT pixel Layers
 - 100 μm x 2 mm pitch
 - 200 μm thickness
 - Sensor z-gap = 0.8 mm
- OB: Short strips
 - TOB 1,2,5,6 (1/4 length)
 - All layers are mono
 - Increased granularity in z-phi rings
- Endcap: Short strips
- 270M pixels, 9M strips

Latest Twiki recipe is the Hybrid Mono with improved material description (shown later)



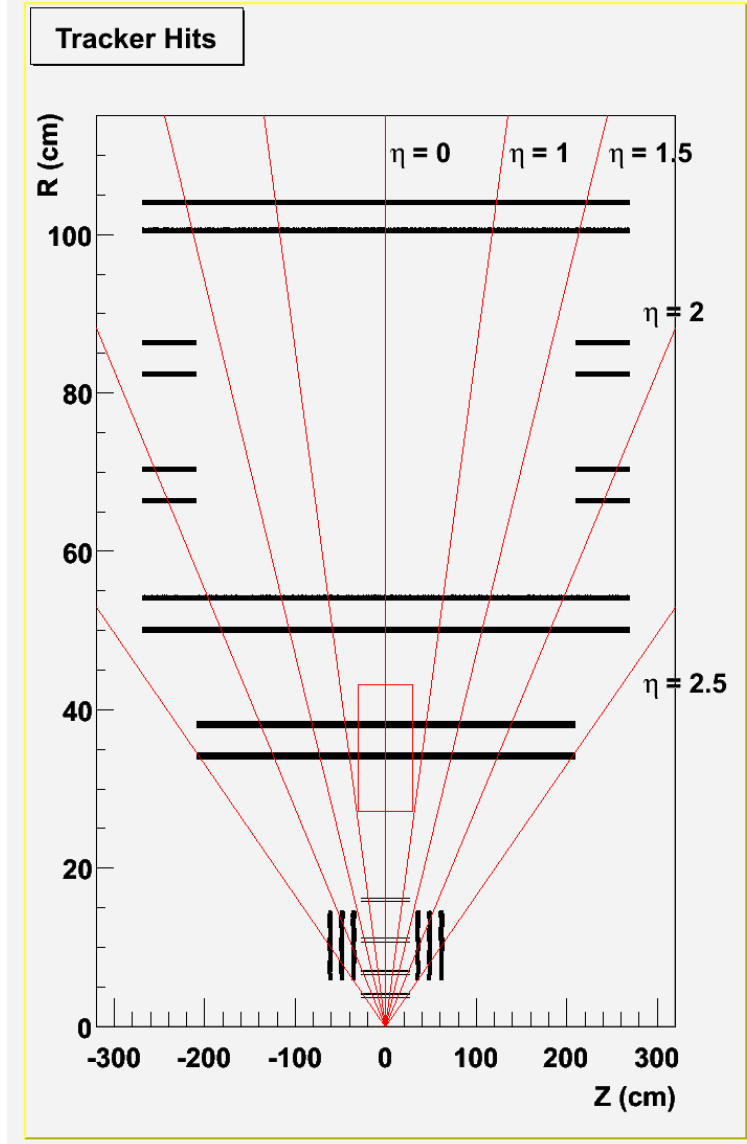
Default Long Barrel:

- Inner Pixels: as noted for Phase I
- pT pixel layers
 - 100 mm x 1 mm pitch
 - 200 mm thickness
 - Sensor z-gap = 0.8 mm
- 3,500M pixels

Alternate Long Barrel:

- Same as “tag029” but with 250 μm x 2 mm pitch in pT layers
- 780M pixels

Latest Twiki recipe is the “tag029” Long Barrel with improved material description (described later)



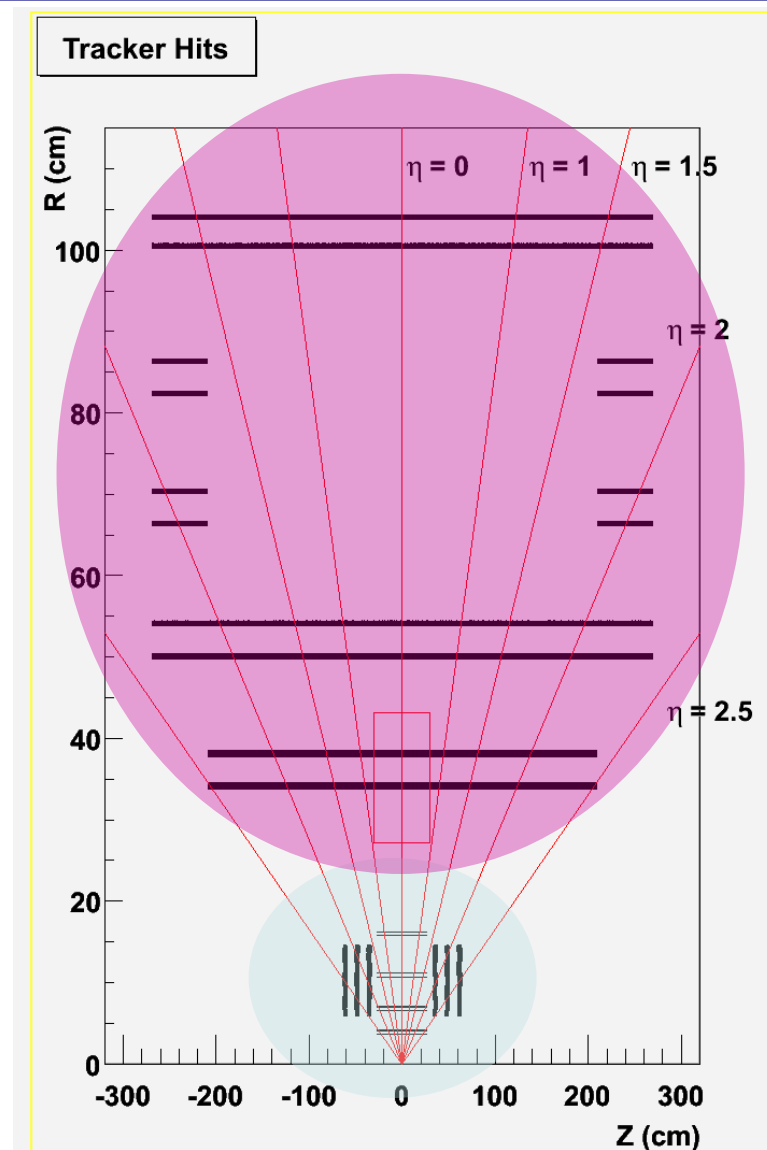
- Gives detailed information about the geometry setup
- Despite its name it works with standard geometry & both phase I geometries

		Active Surface (cm ²)	# modules	# channels
Barrel - Pixels	Standard Geometry	7,558.26	768.00	47,923,200.00
	Default Hybrid	319,348.85	4,544.00	240,024,320.00
	Hybrid Mono	319,348.85	4,544.00	240,024,320.00
	Default LB	3,218,152.85	35,600.00	3,509,726,720.00
	Alternate LB	3,318,364.85	35,600.00	754,694,720.00
Endcap - Pixels	Standard Geometry	2,834.36	672.00	17,971,200.00
	Default Hybrid	4,251.54	1,008.00	26,956,800.00
	Hybrid Mono	4,251.54	1,008.00	26,956,800.00
	Default LB	4,251.54	1,008.00	26,956,800.00
	Alternate LB	4,251.54	1,008.00	26,956,800.00
Barrel - Strips	Standard Geometry	1,103,896.70	7,932.00	4,884,480.00
	Default Hybrid	669,696.00	15,360.00	9,584,640.00
	Hybrid Mono	481,343.70	11,040.00	7,372,800.00
	Default LB	0.00	0.00	0.00
	Alternate LB	0.00	0.00	0.00
Endcap - Strips	Standard Geometry	902,046.70	7,216.00	4,431,872.00
	Default Hybrid	396,820.50	2,720.00	2,088,960.00
	Hybrid Mono	396,820.50	2,720.00	2,088,960.00
	Default LB	0.00	0.00	0.00
	Alternate LB	0.00	0.00	0.00
Total	Standard Geometry	2,016,336.02	16,588.00	75,210,752.00
	Default Hybrid	1,390,116.89	23,632.00	278,654,720.00
	Hybrid Mono	1,201,764.59	19,312.00	276,442,880.00
	Default LB	3,222,404.39	36,608.00	3,536,683,520.00
	Alternate LB	3,322,616.39	36,608.00	781,651,520.00

Keep Inner Pixel the same

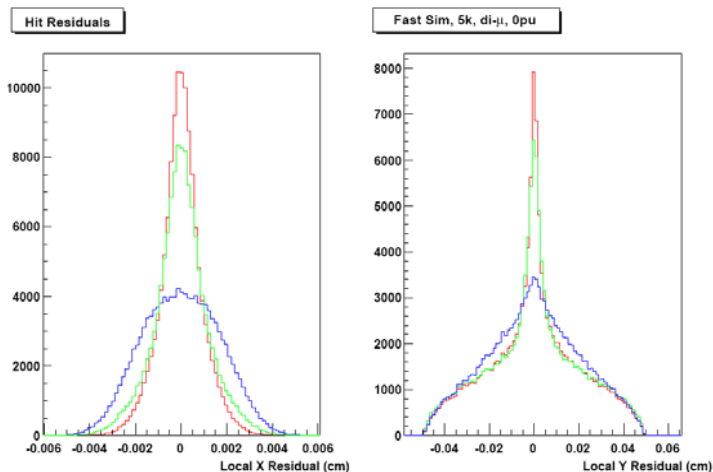
Stack Layers, 3 options:

- Current 8 bit
 - Consistent with inner tracker
- 3 bit (Configurable)
 - Offers a more limited ability to refine position
- 1 bit
 - Highest data reduction
 - Less position calculation ability
 - dependant on cluster size



Default LB (100 μm x 2 mm pitch)

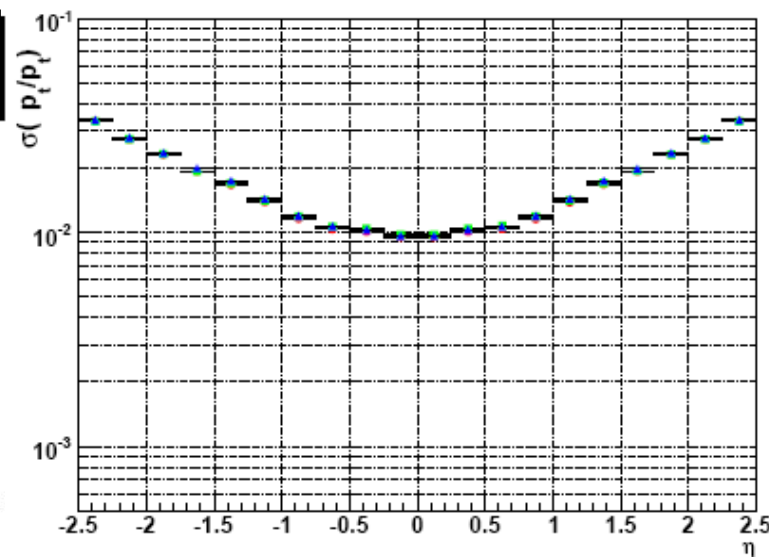
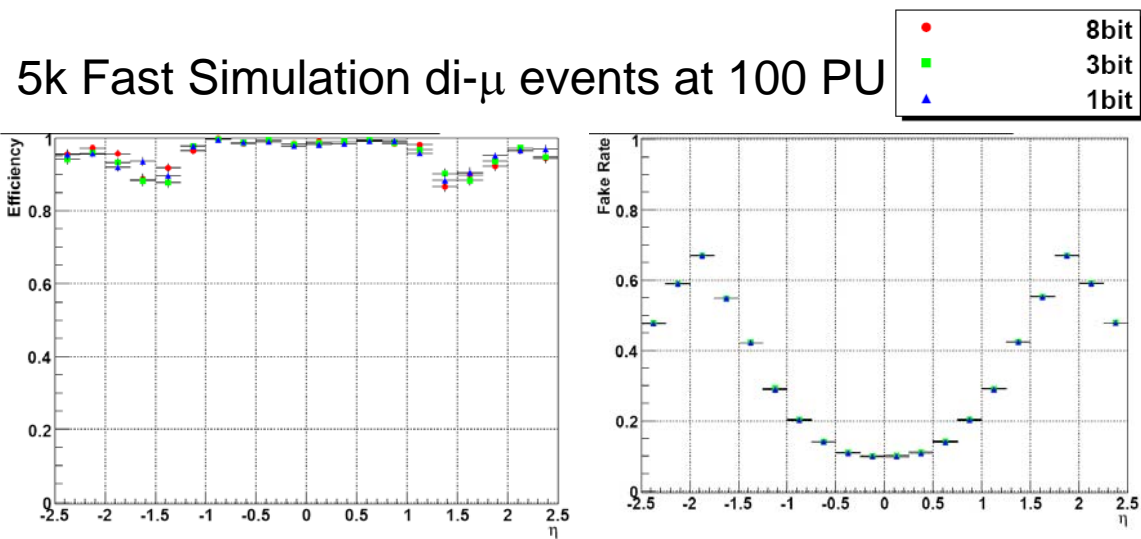
- Calculate position from charge sharing
 - Will only change position calculation for hits spread over multiple pixels
- Position residual changes but not enough to affect track finding



$$residual_X = RecHit_X - SimHit_X$$

Works in Fast & Full Simulation

5k Fast Simulation di- μ events at 100 PU



Pixel Efficiency



THE REC. HITS DISTRIBUTION

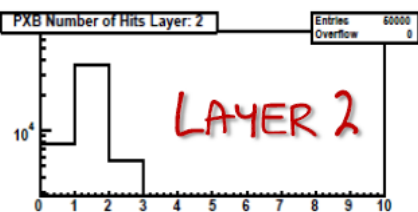


so many more hits but they are narrow.

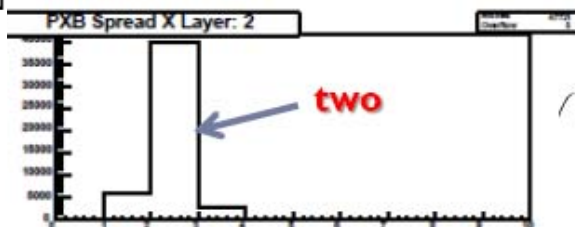
EXAMPLE

for Barrel Layer 2: the cluster size in units of pixels

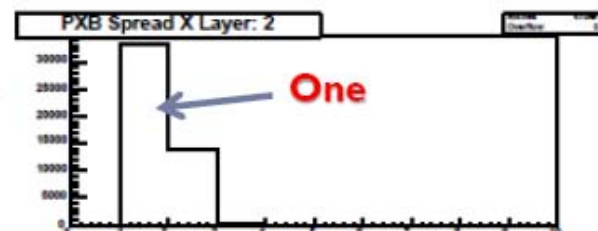
Efficiency = 100%



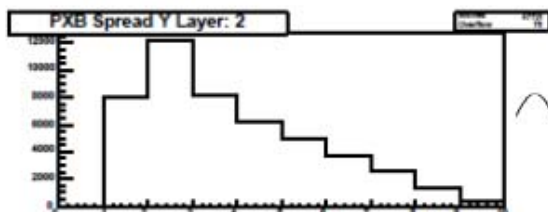
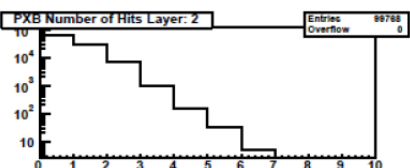
eff = 100%



eff = 60%



Efficiency = 60%



H. MENDEZ/C. POLLACK [PIXEL INEFFICIEN

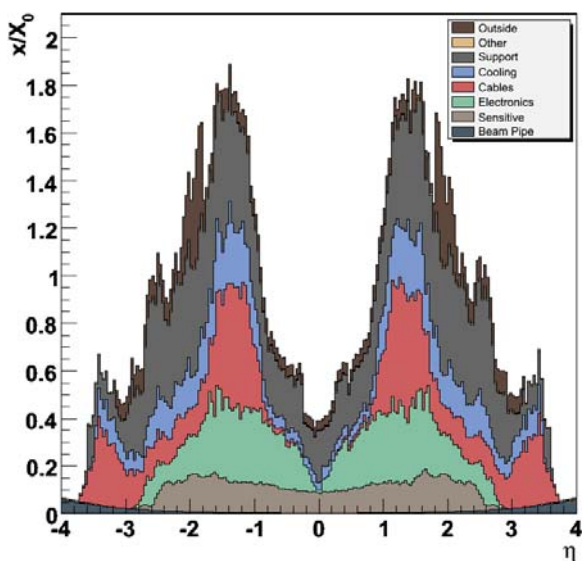


Detailed comparison between standard, hybrid & long barrel only reasonable if material description is ok

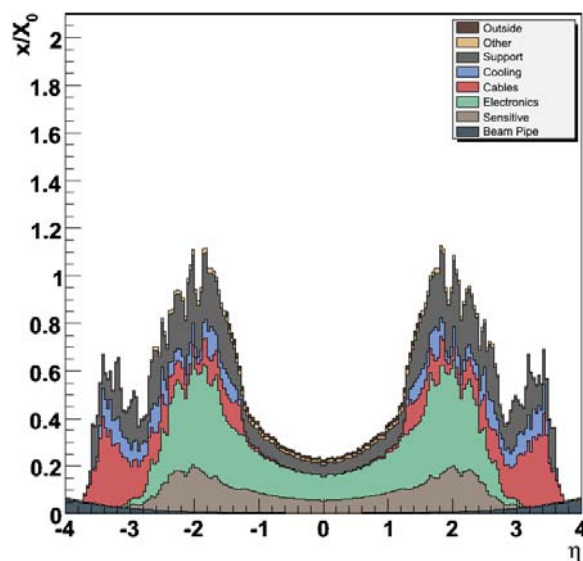
- Compare materials with Duccio's estimate (Harry & P. Sheldon) **Ongoing ...**
- Compare Full & Fast Simulation **Ongoing...**
- Implement mono layers from Hybrid (Carlo) **Done! Being used for comparison with stereo layers**

- Made in CMSSW_2_2_6
- Full Simulation, made by swimming neutrinos through the detector

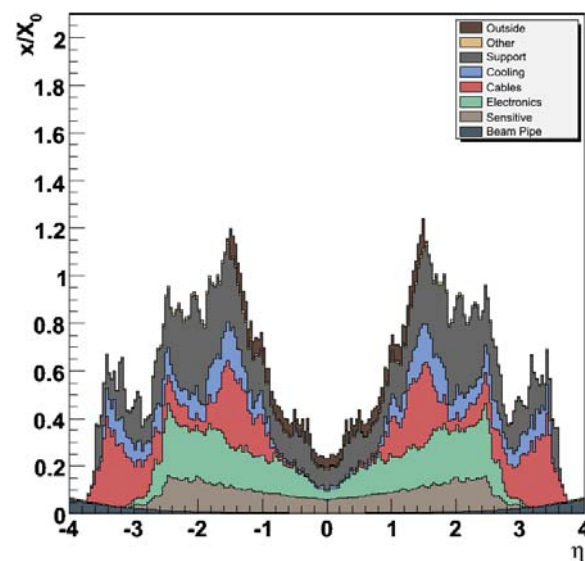
Tracker Material Budget



Tracker Material Budget



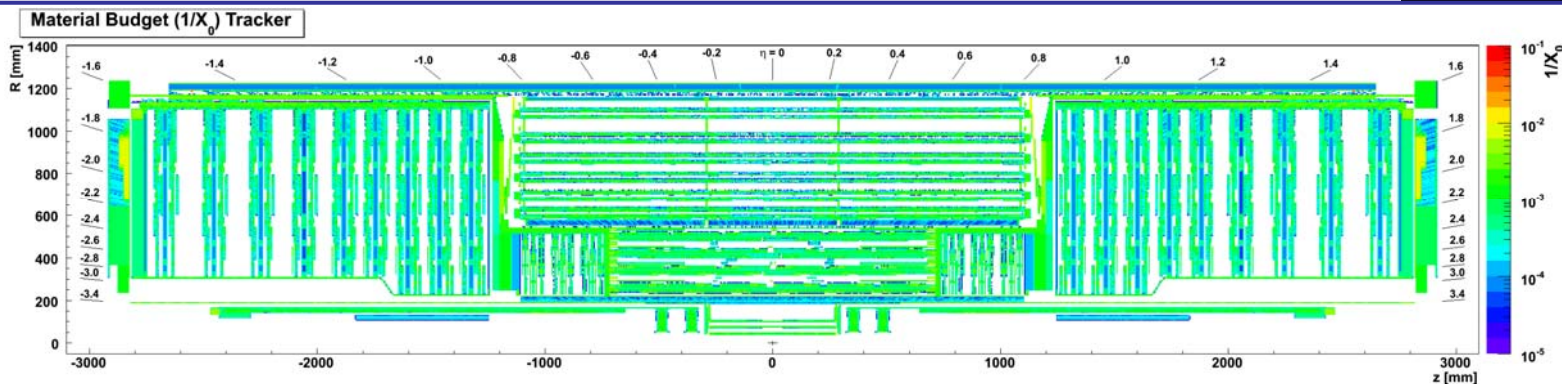
Tracker Material Budget



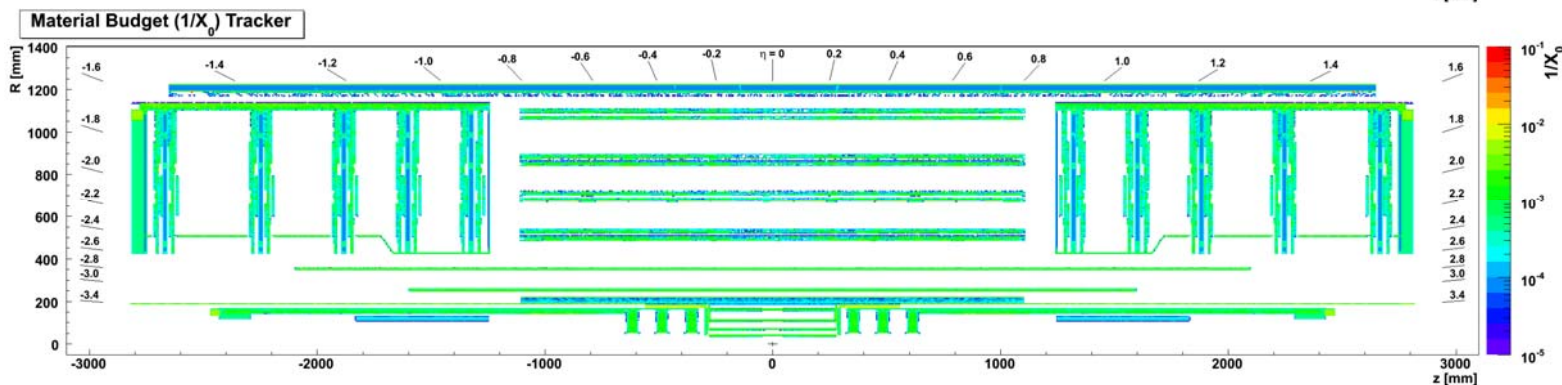


Contributions to Phase 2 geometry: Eric Brownson,
Harry Cheung, Carlo Cinvinini, Mario Galanti, Mark Pesaresi,
Ivan Reid, Alessia Tricomi, Mike Weinberger

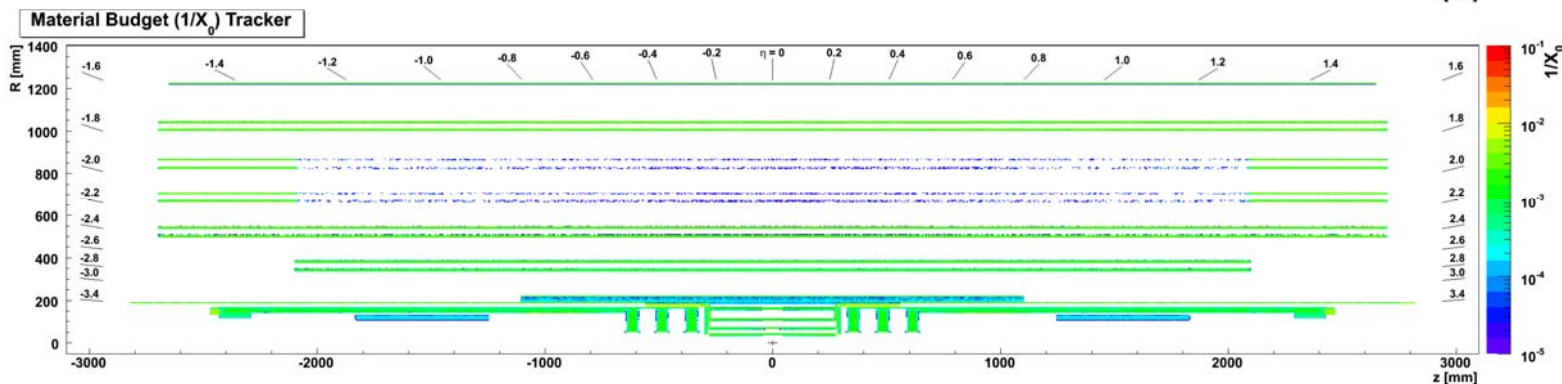
StdGeo



Hybrid



Long Barrel

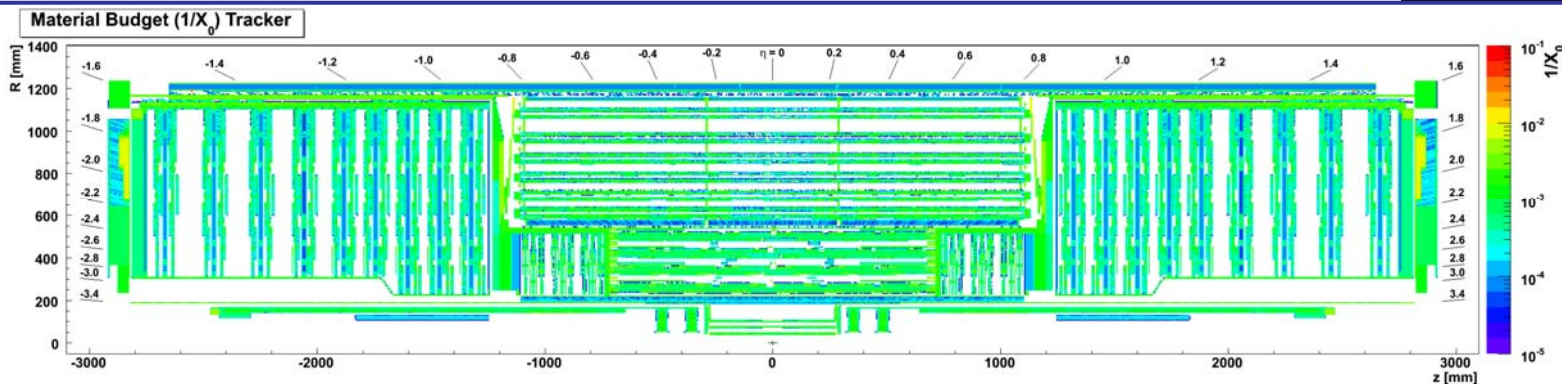


Current Geometries

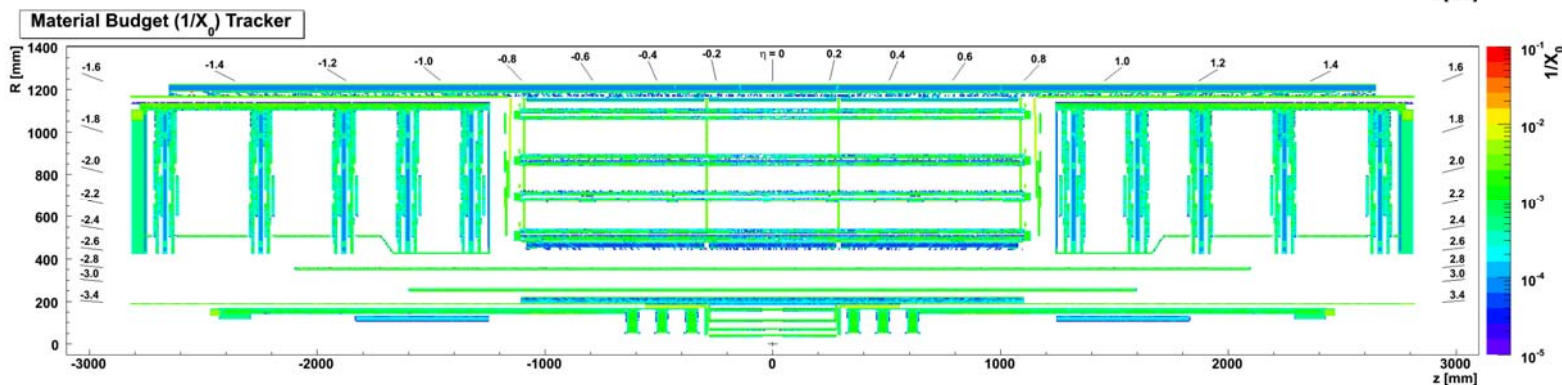


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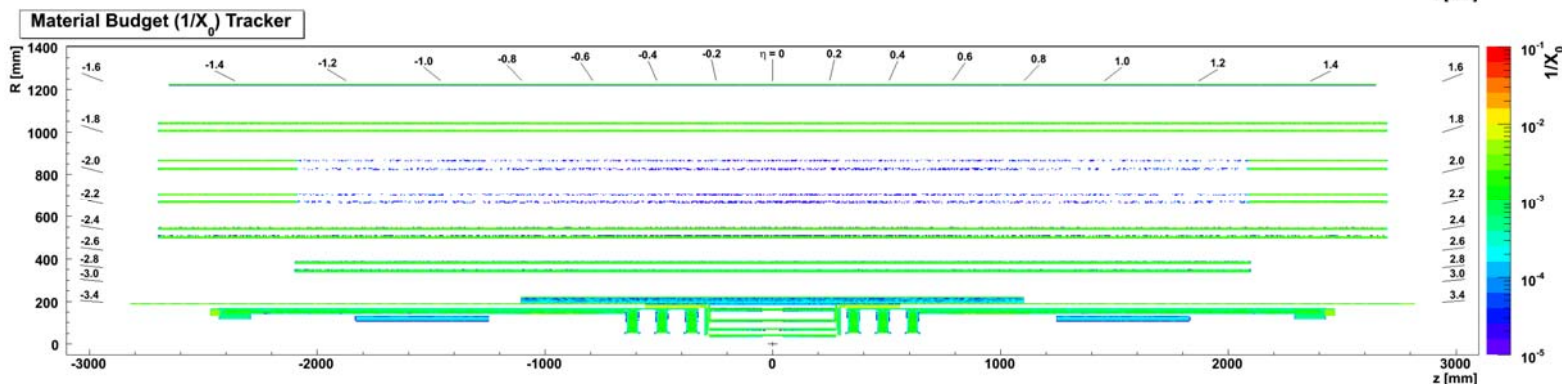
StdGeo



Hybrid



Long Barrel



Material in Geant4 Simulation



- From Full Sim Geometry files: created printout and import to spreadsheet
 - e.g. Standard geometry first pixel barrel layer

Harry Cheung

LV	4	PixelBarrelLayer0	1	PixelBarrelLayer0	1.94E+06	Air	301522	1	thk	12.2817	x/XO	4.07E-05	2.152343	0.020500
LV	5	PixelBarrelLadderHalf	4	PixelBarrelLadderHalf	28946.6	Air	301522	4	thk	0.733351	x/XO	2.43E-06		
LV	6	PixelBarrelCableBoxHalf	1	PixelBarrelCableBoxHalf	9240.72	Air	301522	4	thk	0.23411	x/XO	7.76E-07		
LV	7	PixelBarrelCable1Half	2	PixelBarrelCable1Half	461.295	Pix_Bar_Cable	120.742	8	thk	0.0233735	x/XO	0.000193582		
LV	7	PixelBarrelCable2Half	2	PixelBarrelCable2Half	326.625	Pix_Bar_Cable	120.742	8	thk	0.0165499	x/XO	0.000137068		
LV	7	PixelBarrelCable3Half	2	PixelBarrelCable3Half	191.955	Pix_Bar_Cable	120.742	8	thk	0.00972623	x/XO	8.05538E-05		
LV	7	PixelBarrelCable4Half	2	PixelBarrelCable4Half	57.285	Pix_Bar_Cable	120.742	8	thk	0.00290259	x/XO	2.40E-05		
LV	6	PixelBarrelModuleBoxHalf	1	PixelBarrelModuleBoxHalf	17203	Air	301522	4	thk	0.435831	x/XO	1.45E-06		
LV	7	PixelBarrelModuleHalfMinus	4	PixelBarrelModuleHalf	2150.37	Air	301522	16	thk	0.217916	x/XO	7.23E-07		
LV	8	PixelBarrelSensorHalf	1	PixelBarrelSensorHalf	193.606	Silicon	93.6762	16	thk	0.0196198	x/XO	0.000209443		
LV	9	PixelBarrelActiveHalf	1	PixelBarrelActiveHalf	149.591	Silicon	93.6762	16	thk	0.0151593	x/XO	0.000161827		
LV	8	PixelBarrelBaseHalf	1	PixelBarrelBaseHalf	257.742	Pix_Bar_Baseplate_Half	79.516	16	thk	0.0261192	x/XO	0.000328477		
LV	8	PixelBarrelROChipHalf	1	PixelBarrelROChipHalf	115.882	Silicon	93.6762	16	thk	0.0117433	x/XO	0.000125361		
LV	8	PixelBarrelHybridHalf	1	PixelBarrelHybridHalf	29.458	Pix_Bar_Hybrid_Half	21.4483	16	thk	0.00298523	x/XO	0.000139183		
LV	8	PixelBarrelCapacitorHalf	1	PixelBarrelCapacitorHalf	12	Barium_Titanate	18.5389	16	thk	0.00121606	x/XO	6.55953E-05		
LV	8	PixelBarrelCapacitorStripHalf	1	PixelBarrelCapacitorStripHalf	16.25	Pix_Bar_Capacitor	50.2094	16	thk	0.00164675	x/XO	3.28E-05		
LV	8	PixelBarrelTBMHalf	1	PixelBarrelTBMHalf	4.608	Silicon	93.6762	16	thk	0.000466968	x/XO	4.98E-06		
LV	7	PixelBarrelModuleHalfPlus	4	PixelBarrelModuleHalf	2150.37	Air	301522	16	thk	0.217916	x/XO	7.23E-07		
LV	8	PixelBarrelSensorHalf	1	PixelBarrelSensorHalf	193.606	Silicon	93.6762	16	thk	0.0196198	x/XO	0.000209443		
LV	9	PixelBarrelActiveHalf	1	PixelBarrelActiveHalf	149.591	Silicon	93.6762	16	thk	0.0151593	x/XO	0.000161827		
LV	8	PixelBarrelBaseHalf	1	PixelBarrelBaseHalf	257.742	Pix_Bar_Baseplate_Half	79.516	16	thk	0.0261192	x/XO	0.000328477		
LV	8	PixelBarrelROChipHalf	1	PixelBarrelROChipHalf	115.882	Silicon	93.6762	16	thk	0.0117433	x/XO	0.000125361		
LV	8	PixelBarrelHybridHalf	1	PixelBarrelHybridHalf	29.458	Pix_Bar_Hybrid_Half	21.4483	16	thk	0.00298523	x/XO	0.000139183		
LV	8	PixelBarrelCapacitorHalf	1	PixelBarrelCapacitorHalf	12	Barium_Titanate	18.5389	16	thk	0.00121606	x/XO	6.55953E-05		
LV	8	PixelBarrelCapacitorStripHalf	1	PixelBarrelCapacitorStripHalf	16.25	Pix_Bar_Capacitor	50.2094	16	thk	0.00164675	x/XO	3.28E-05		
LV	8	PixelBarrelTBMHalf	1	PixelBarrelTBMHalf	4.608	Silicon	93.6762	16	thk	0.000466968	x/XO	4.98E-06		
LV	6	PixelBarrelCFStripHalf	1	PixelBarrelCFStripHalf	1742	Carbon fibre str.	249.142	4	thk	0.044133	x/XO	0.00017714		
LV	5	PixelBarrelLadderFull	16	PixelBarrelLadderFull	54144.6	Air	301522	16	thk	5.48694	x/XO	1.82E-05		
LV	6	PixelBarrelCableBoxFull	1	PixelBarrelCableBoxFull	17284.8	Air	301522	16	thk	1.75162	x/XO	5.81E-06		
LV	7	PixelBarrelCable1Full	2	PixelBarrelCable1Full	461.295	Pix_Bar_Cable	120.742	32	thk	0.093494	x/XO	0.000774329		
LV	7	PixelBarrelCable2Full	2	PixelBarrelCable2Full	326.625	Pix_Bar_Cable	120.742	32	thk	0.0661994	x/XO	0.000548272		
LV	7	PixelBarrelCable3Full	2	PixelBarrelCable3Full	191.955	Pix_Bar_Cable	120.742	32	thk	0.0389049	x/XO	0.000322215		
LV	7	PixelBarrelCable4Full	2	PixelBarrelCable4Full	57.285	Pix_Bar_Cable	120.742	32	thk	0.0116104	x/XO	9.61585E-05	0.262761	0.002176
LV	6	PixelBarrelModuleBoxFull	1	PixelBarrelModuleBoxFull	32178.2	Air	301522	16	thk	3.2609	x/XO	1.08E-05		
LV	7	PixelBarrelModuleFullMinus	4	PixelBarrelModuleFull	4022.28	Air	301522	64	thk	1.63045	x/XO	5.41E-06		
LV	8	PixelBarrelSensorFull	1	PixelBarrelSensorFull	353.047	Silicon	93.6762	64	thk	0.143109	x/XO	0.0015277		
LV	9	PixelBarrelActiveFull	1	PixelBarrelActiveFull	299.182	Silicon	93.6762	64	thk	0.121275	x/XO	0.00129461		
LV	8	PixelBarrelBaseFull	2	PixelBarrelBaseFull	89.5104	Pix_Bar_Baseplate_Full	64.5051	128	thk	0.0725669	x/XO	0.00112498		
LV	8	PixelBarrelROChipFull	1	PixelBarrelROChipFull	232.755	Silicon	93.6762	64	thk	0.0943483	x/XO	0.00100717		
LV	8	PixelBarrelHybridFull	1	PixelBarrelHybridFull	53.768	Pix_Bar_Hybrid_Full	30.7161	64	thk	0.0217951	x/XO	0.000709565		
LV	8	PixelBarrelCapacitorFull	1	PixelBarrelCapacitorFull	12	Barium_Titanate	18.5389	64	thk	0.00486425	x/XO	0.000262381		
LV	8	PixelBarrelCapacitorStripFull	2	PixelBarrelCapacitorStripFull	16.25	Pix_Bar_Capacitor	50.2094	128	thk	0.013174	x/XO	0.000262381		
LV	8	PixelBarrelTBMFull	1	PixelBarrelTBMFull	4.608	Silicon	93.6762	64	thk	0.00186787	x/XO	1.99E-05		
LV	7	PixelBarrelModuleFullPlus	4	PixelBarrelModuleFull	4022.28	Air	301522	64	thk	1.63045	x/XO	5.41E-06		
LV	8	PixelBarrelSensorFull	1	PixelBarrelSensorFull	353.047	Silicon	93.6762	64	thk	0.143109	x/XO	0.0015277		
LV	9	PixelBarrelActiveFull	1	PixelBarrelActiveFull	299.182	Silicon	93.6762	64	thk	0.121275	x/XO	0.00129461		
LV	8	PixelBarrelBaseFull	2	PixelBarrelBaseFull	89.5104	Pix_Bar_Baseplate_Full	64.5051	128	thk	0.0725669	x/XO	0.00112498		
LV	8	PixelBarrelROChipFull	1	PixelBarrelROChipFull	232.755	Silicon	93.6762	64	thk	0.0943483	x/XO	0.00100717		
LV	8	PixelBarrelHybridFull	1	PixelBarrelHybridFull	53.768	Pix_Bar_Hybrid_Full	30.7161	64	thk	0.0217951	x/XO	0.000709565		
LV	8	PixelBarrelCapacitorFull	1	PixelBarrelCapacitorFull	12	Barium_Titanate	18.5389	64	thk	0.00486425	x/XO	0.000262381		
LV	8	PixelBarrelCapacitorStripFull	2	PixelBarrelCapacitorStripFull	16.25	Pix_Bar_Capacitor	50.2094	128	thk	0.013174	x/XO	0.000262381		
LV	8	PixelBarrelTBMFull	1	PixelBarrelTBMFull	4.608	Silicon	93.6762	64	thk	0.00186787	x/XO	1.99E-05	0.542310	0.005789
LV	6	PixelBarrelCFStripFull	1	PixelBarrelCFStripFull	3484	Carbon fibre str.	249.142	16	thk	0.353064	x/XO	0.00141712	0.587836	0.007051
LV	7	PixelBarrelCFStripHoleFull	16	PixelBarrelCFStripHoleFull	60.5	Air	301522	256	thk	0.0980958	x/XO	3.25E-07	0.254968	0.001023
LV	5	PixelBarrelLayer0CoolTube	18	PixelBarrelLayer0CoolTube	6661.37	Aluminium	88.9253	18	thk	0.759436	x/XO	0.00854015	0.242215	0.002724
LV	6	PixelBarrelLayer0Coolant	1	PixelBarrelLayer0Coolant	4536.79	C6F14_F2_-20C	187.454	18	thk	0.517221	x/XO	0.00275919	0.759436	0.005483

- Look at Full Sim Geometry files: created spreadsheet
 - E.g. Hybrid Geant4 volumes for first stack layer (pT layer)

4	PixelBarrelLayerStack0	1	PixelBarrelLayerStack0	5.64E+07	Air	PixelBarrelLadder	301522	1	thk	11.1547	x/XO	3.70E-05	1.884432	0.025429
5	PixelBarrelLadderDownStack0	18	PixelBarrelLadder	474880	Air	PixelBarrelLadder	301522	18	thk	1.69094	x/XO	5.61E-06		
6	PixelBarrelModuleBoxDown	1	PixelBarrelModuleBox	237440	Air	PixelBarrelModuleBox	301522	18	thk	0.845469	x/XO	2.80E-06		
7	PixelBarrelModuleDown	32	PixelBarrelModule	7387.54	Air	PixelBarrelModule	301522	576	thk	0.84177	x/XO	2.79E-06		
8	PixelBarrelSensor	1	PixelBarrelSensor	1983.25	Silicon	PixelBarrelSensor	93.6762	576	thk	0.225981	x/XO	0.00241236		
9	PixelBarrelActiveStack0	1	PixelBarrelActive	1927.84	Silicon	PixelBarrelActive	93.6762	576	thk	0.219667	x/XO	0.00234496		
8	PixelBarrelHybrid	1	PixelBarrelHybrid	2020.09	Pix_Bar_Hybrid_Full	PixelBarrelHybrid	30.7161	576	thk	0.230178	x/XO	0.00749371		
6	PixelBarrelCFStrip	1	PixelBarrelCFStrip	118720	Carbon fibre str.	PixelBarrelCFStrip	249.142	18	thk	0.422734	x/XO	0.00169676		
5	PixelBarrelLadderUpStack0	18	PixelBarrelLadder	474880	Air	PixelBarrelLadder	301522	18	thk	1.69094	x/XO	5.61E-06		
6	PixelBarrelCableBox	1	PixelBarrelCableBox	169600	Air	PixelBarrelCableBox	301522	18	thk	0.603906	x/XO	2.00E-06		
7	PixelBarrelCable1	2	PixelBarrelCable1	1312.91	Pix_Bar_Cable	PixelBarrelCable1	120.742	36	thk	0.00934991	x/XO	7.74E-05		
7	PixelBarrelCable2	2	PixelBarrelCable2	1283.59	Pix_Bar_Cable	PixelBarrelCable2	120.742	36	thk	0.00914116	x/XO	7.57E-05		
7	PixelBarrelCable3	2	PixelBarrelCable3	1254.28	Pix_Bar_Cable	PixelBarrelCable3	120.742	36	thk	0.00893241	x/XO	7.40E-05		
7	PixelBarrelCable4	2	PixelBarrelCable4	1224.97	Pix_Bar_Cable	PixelBarrelCable4	120.742	36	thk	0.00872366	x/XO	7.23E-05	0.036147	0.000299
6	PixelBarrelModuleBoxUp	1	PixelBarrelModuleBox	237440	Air	PixelBarrelModuleBox	301522	18	thk	0.845469	x/XO	2.80E-06		
7	PixelBarrelModuleUp	32	PixelBarrelModule	7387.54	Air	PixelBarrelModule	301522	576	thk	0.84177	x/XO	2.79E-06		
8	PixelBarrelSensor	1	PixelBarrelSensor	1983.25	Silicon	PixelBarrelSensor	93.6762	576	thk	0.225981	x/XO	0.00241236		
9	PixelBarrelActiveStack0	1	PixelBarrelActive	1927.84	Silicon	PixelBarrelActive	93.6762	576	thk	0.219667	x/XO	0.00234496		
8	PixelBarrelHybrid	1	PixelBarrelHybrid	2020.09	Pix_Bar_Hybrid_Full	PixelBarrelHybrid	30.7161	576	thk	0.230178	x/XO	0.00749371		
6	PixelBarrelCFStrip	1	PixelBarrelCFStrip	118720	Carbon fibre str.	PixelBarrelCFStrip	249.142	18	thk	0.422734	x/XO	0.00169676		
6	PixelBarrelReadoutBox	1	PixelBarrelReadoutBox	118720	Air	PixelBarrelReadoutBox	301522	18	thk	0.422734	x/XO	1.40E-06		
7	PixelBarrelReadout	32	PixelBarrelReadout	3693.77	Air	PixelBarrelReadout	301522	576	thk	0.420885	x/XO	1.40E-06		
8	PixelBarrelRCChip	4	PixelBarrelRCChip	2.304	Silicon	PixelBarrelRCChip	93.6762	2304	thk	0.00105011	x/XO	1.12E-05	0.453012	0.004836
8	PixelBarrelHybridTop	1	PixelBarrelHybridTop	505.022	Pix_Bar_Hybrid_Full	PixelBarrelHybridTop	30.7161	576	thk	0.0575445	x/XO	0.00187343	1.363369	0.020254
5	PixelBarrelLayerStack0CoolTube	18	PixelBarrelLayerStack0CoolTube	8960	Steel_Upgrade	PixelBarrelLayerStack0CoolTube	282.365	18	thk	0.0319045	x/XO	0.00011299	0.007292	0.000026
6	PixelBarrelLayerStack0Coolant	1	PixelBarrelLayerStack0Coolant	6912	CO2_Upgrade	PixelBarrelLayerStack0Coolant	1780.36	18	thk	0.024612	x/XO	1.38E-05	0.031904	0.000040

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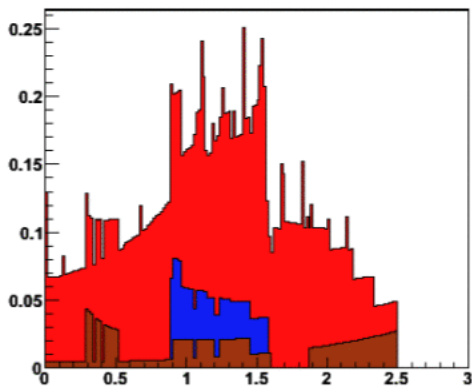
- Material in Fast Simulation approximated by thin layers
 - Given simply in code (Python file)
- Compare to Duccio's material numbers
 - Cannot see how to get comparable number in numbers given so take from figures at eta = 0 at last talk (Oct. 2nd)
 - TOB layers: ~ 0.067 to $0.095 x/X_0$ for 4 TOB layers

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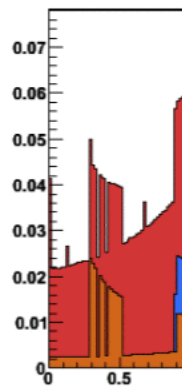
Material estimates - I

- GBTs integrated at the end of the rods
- TOB-like mechanics

Radiation Length by Category



Interaction Length

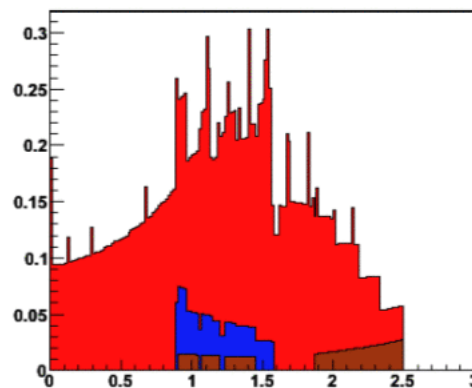


Material estimates - IV

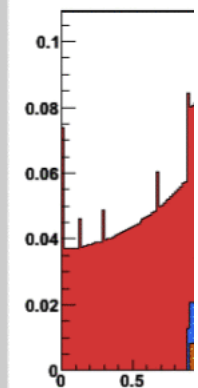
➤ Cross-check:

- Which part of the difference is due to mechanics?
 - Use 2 mm CF thickness in barrel geometry with EndCaps
 - Same thickness automatically applied to EndCap disks

Radiation Length by Category

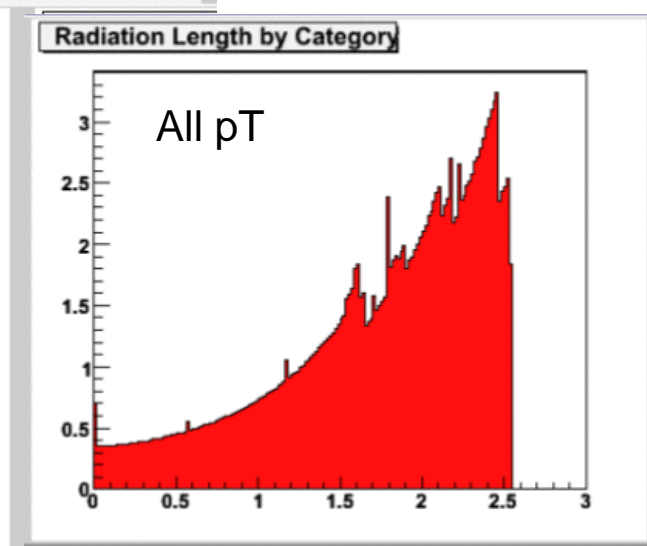
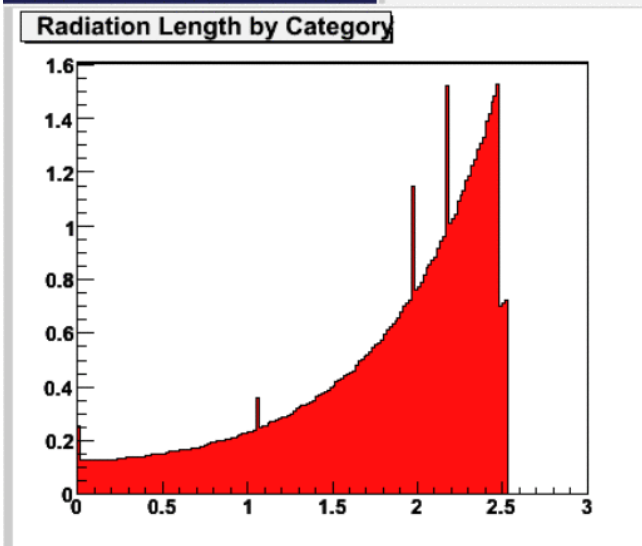
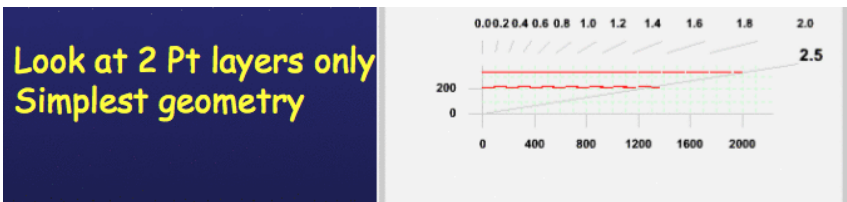


Interaction Length



- Compare to Duccio's material numbers
 - Cannot see how to get comparable number in numbers given so take from figures at eta = 0 at last talk (Oct. 2nd)
 - pT layers (Hybrid) $\sim 0.125 / 2 = 0.063 x/X_0$
 - pT layers (all pT) $\sim 0.35 / 6 = 0.058 x/X_0$

Harry Cheung



Compare Material Numbers



- Look at summary numbers from geometry files and compare
 - Need to make fast simulation and full sim use same numbers
 - Need to study with material numbers from Duccio

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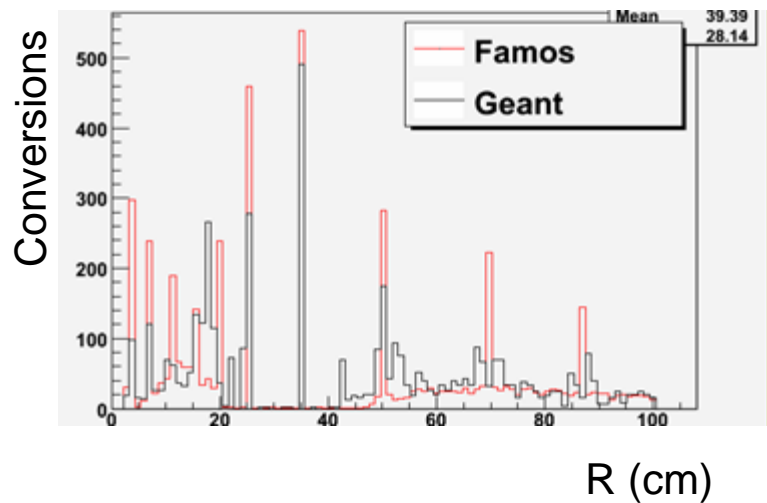
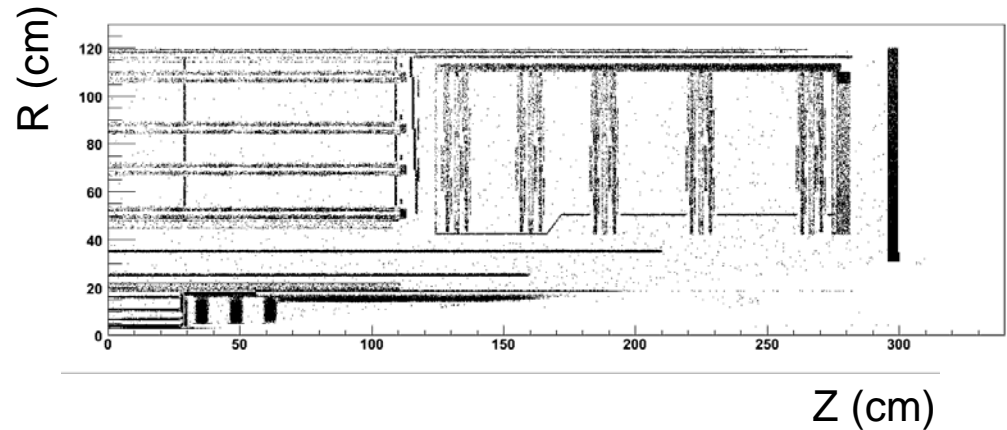
Standard Geometry	Numbers from Geometry files	
	x/x0 (Fast Simulation)	x/x0 (Full Simulation)
Beam pipe	0.00265	0.00227
PXB Layer 1	0.02170	0.02050
PXB Layer 2	0.02170	0.02032
PXB Layer 3	0.02170	0.02026

Hybrid Geometry	Numbers from Geometry files		From Duccio's Material Plots
	x/x0 (Fast Simulation)	x/x0 (Full Simulation)	
PXB Layer	0.0217	0.0163	
Stack Layer	0.0354	0.0249	0.063
TOB layer (mono)	0.0220		0.0168 – 0.0238

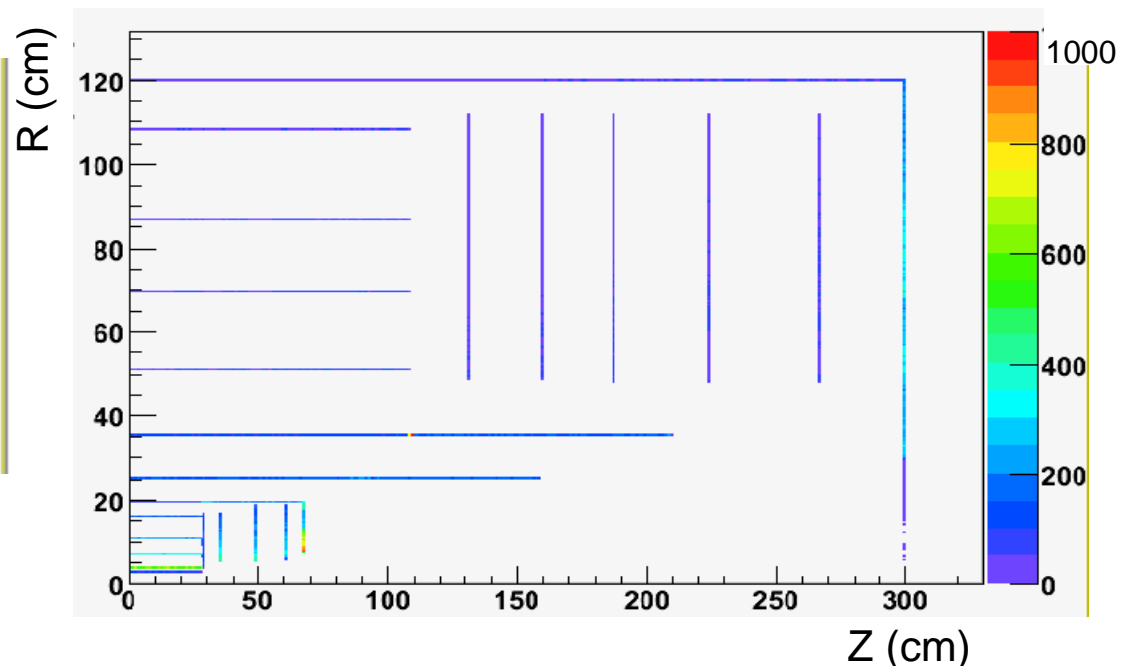
Long barrel	Numbers from Geometry files		From Duccio's Material Plots
	x/x0 (Fast Simulation)	x/x0 (Full Simulation)	
PXB Layer	0.0217	0.0163	
Stack Layer	0.0307 – 0.0354	0.0266	0.058

Looking at position of γ conversions

- Direct measurement of radiation length
- Works in both Full & Fast Simulation



Paul Sheldon





Next Steps



Pixel efficiency

- Study implications of pixel inefficiency

Material Budgets

- Continue ongoing progress

Study Occupancies

- Compare Fast & Full Sim
- Addition of Delta Rays, Out of Time Pile Up, etc ...

Moving to CMSSW_3_3_x

- Still to be decided the timescale (after FNAL workshop) I. Reid is checking code differences and exploring problems/issues

Pixel Stack Overlap

- Pixel stack positioning needs to be adjusted

LB Geometry

- Need to modify to solve the lack of coverage at low radii (E. Brownson)



Backup Slides



- 1_8_4 tracking
- Triplet seeds (3-out-of-4)
- `process.mergedtruth.volumeRadius = cms.double(100.0)`
- `process.mergedtruth.volumeZ = cms.double(900.0)`
- `process.mergedtruth.discardOutVolume = cms.bool(True)`
- `layerList = cms.vstring('BPix1+BPix2+BPix3',
 'BPix1+BPix3+BPix4',
 'BPix2+BPix3+BPix4',
 'BPix1+BPix2+BPix4',
 'BPix1+BPix2+FPix1_pos',
 'BPix1+BPix2+FPix1_neg',
 'BPix1+FPix1_pos+FPix2_pos',
 'BPix1+FPix1_neg+FPix2_neg',
 'BPix1+FPix2_pos+FPix3_pos',
 'BPix1+FPix2_neg+FPix3_neg',
 'FPix1_pos+FPix2_pos+FPix3_pos',
 'FPix1_neg+FPix2_neg+FPix3_neg')`



Tracking Performance



- Using definitions as in MultiTrackValidator

- Efficiency

$$\epsilon = \frac{\text{no. TPs associated to RecoTracks}}{\text{no. of TPs}}$$

TP = Tracking Particle (= "sim track/truth")
TP associated if 50% hits matched

- Fakerate

$$f = \frac{\text{no. Reco Tracks not associated to TPs}}{\text{no. of Reco Tracks}}$$

Reco trk assoc if 75% hits matched

- Modifications to drop unstable particles from TP (generator/truth) list

- ◆ Only take TPs originating from $r < 10$ cm and $|z| < 90$ cm from (0,0)

- Tracking Performance using MultiTrackValidator package

- ◆ Used by the Tracking DPG

<https://twiki.cern.ch/twiki/bin/view/CMS/TrackingPerformancePlots>

- Pileup generated (Fast sim: in-time pileup only) Poisson averages =

- ◆ LHC: 0, 5 (2×10^{33}), 25 (10^{34})
- ◆ SLHC Phase 1: 50 (2×10^{34}), 100 (4×10^{34})
- ◆ SLHC Phase 2: 250 (10^{35})