GEANT MODELING AND COMPARISON WITH SOLIDWORKS MODEL

Jonathan Bouchet

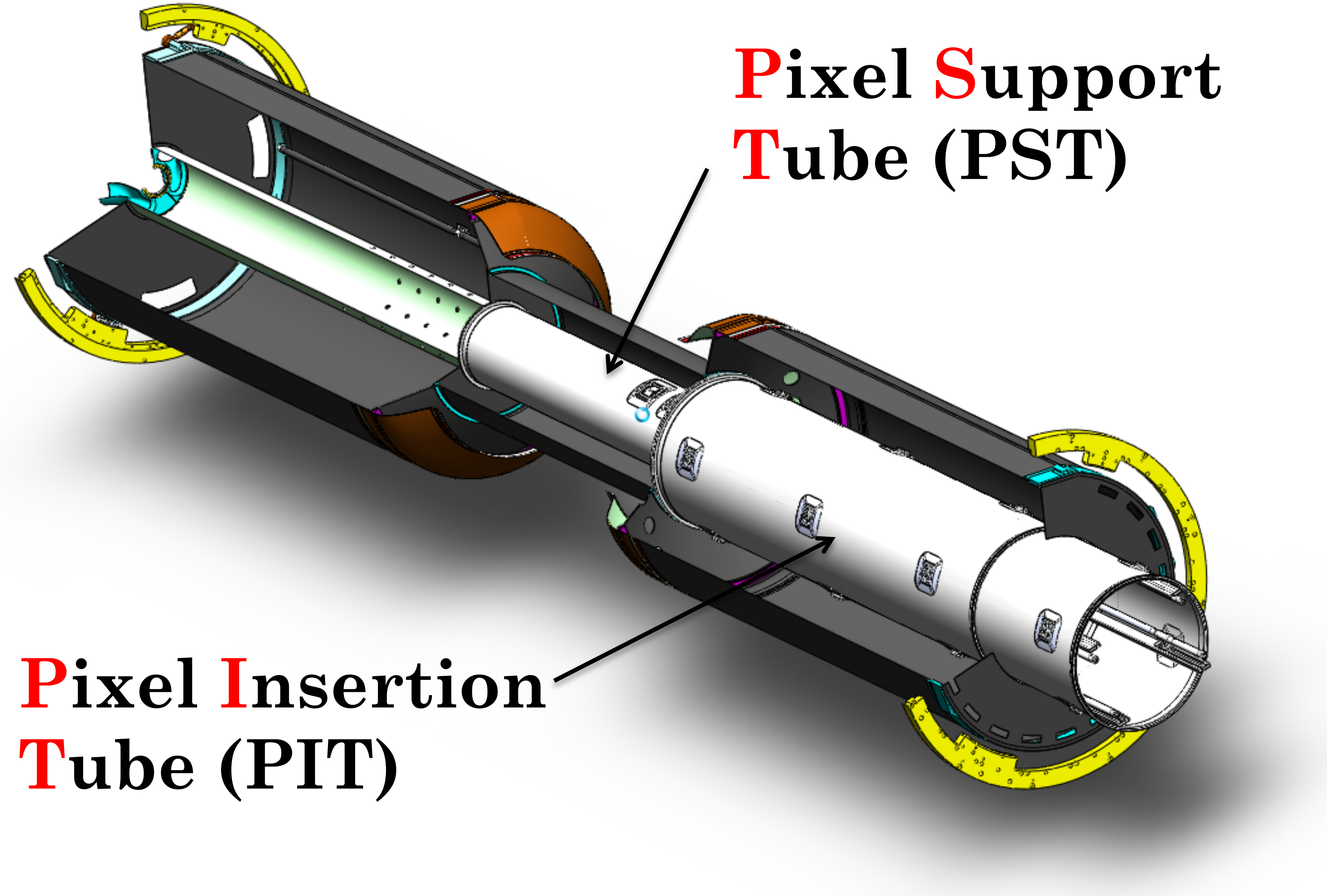
OUTLINE

Overview of the AgML implementation of the PIXEL detector (**PXL**), Middle Support Cylinder (**MSC**) and **beam pipe.**

1. Beam Pipe :
    1. Comparison with BrushwellMann drawing.
    2. Radiation length, dimensions.
2. PXL and MSC :
    1. Comparison of SolidWorks model (SW) and GEANT modeling :
    2. The details of implementation (naming, dimensions of volumes).
    3. Check of radiation length.

Disclaimer : this talk only covers the details of the geometry implementation ; STAR-software (reconstruction, etc..) issues are addressed in the next talk.

SW MODEL OF THE PXL+MSC



Middle Support Cylinder = **PST** + **PIT**

AGML : ABSTRACT GEOMETRY MODEL LANGUAGE (*)

- STAR geometry is implemented in the Advanced Geant Interface (using GEANT3) :
  - Mortran pre-processor.
  - Several source codes are used for 1) simulation 2) conversion to TGeo (reconstruction) 3) conversion to Sti (tracking).
  - Sti cannot handle complex shapes.
  - No path forward to GEANT4, …
- Change to AgML will allow :
  - Use of better simulation packages (GEANT4).
  - Unified geometry model : no differences in simulation, reconstruction and tracking.
  - Remove dependence on Jurassic technologies such as Mortran and ZEBRA.

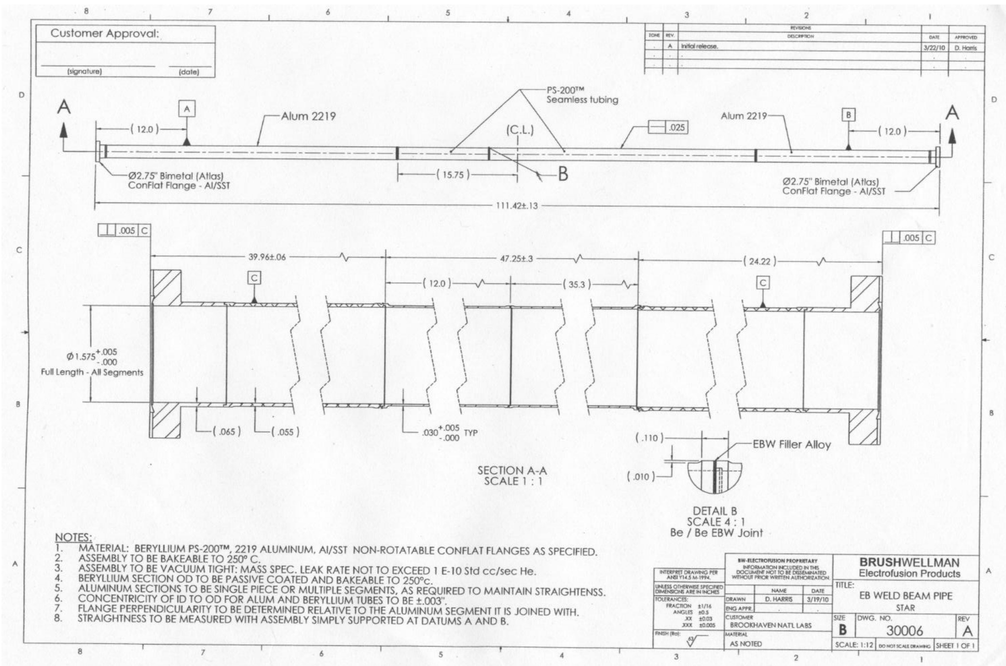
(*) J. Webb : -Collaboration Meeting, tracking review
-STAR upgrade workshop

Representation of radiation length

- Estimation of material budget for geometry dev13 [AgML].
- Use of the existing command line in STARSIM to plot the material for a given window η , ϕ, Rmin, Rmax.
- Use of StarBASE (*) code plot radiation length vs. η , ϕ :
  - Parameters : η , ϕ ranges, binning , as well as the number of triggers per bins can be set up : more handy than the STARSIM command.
  - It plots the radiation length for a given GEANT volume, not by choosing the [Rmin,Rmax] range from the STARSIM command.
- Both methods use 10GeV geantinos.

(*) : http://drupal.star.bnl.gov/STAR/blog/jwebb/2010/feb/11/
howto-generate-geometry-material-differential-plots-using-starbase

1.New Beam Pipe



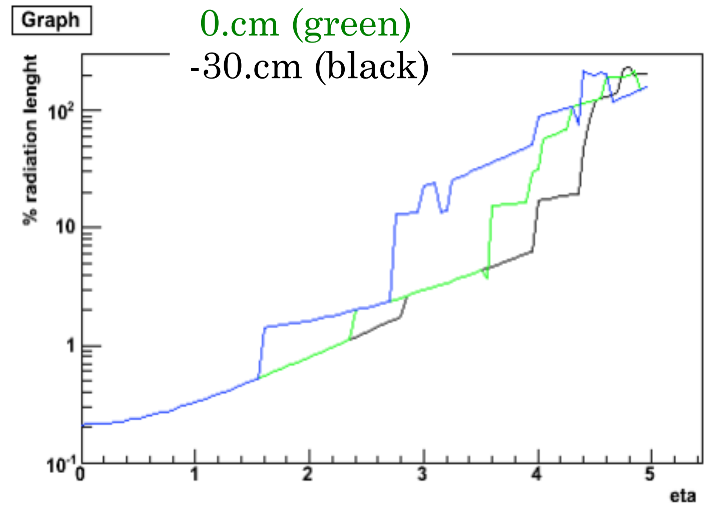


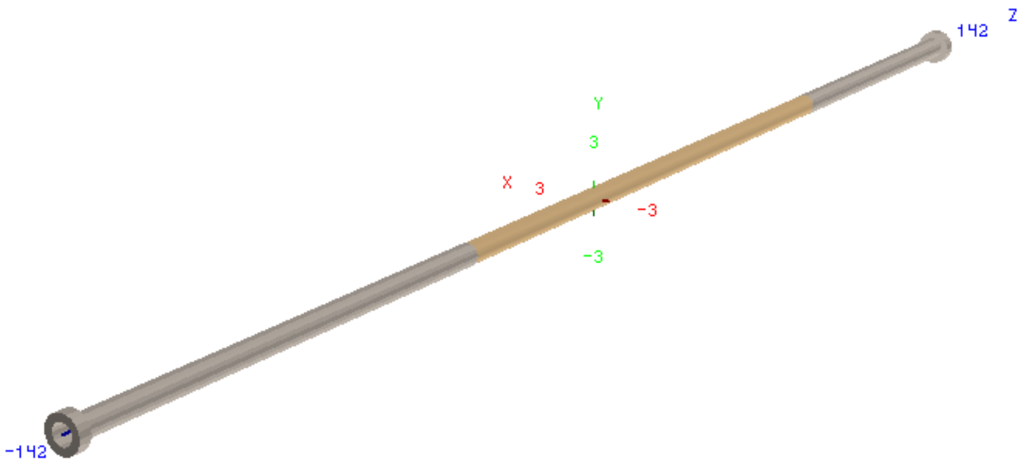
Figure 3. Prelininary new beam pipe.

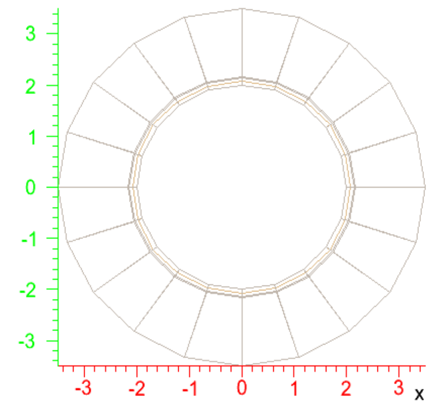
- The input was the Brushwellman drawing.
- Coded as 3 sections of aluminum (edges) and beryllium (central part).
- For | η |<1, the estimated radiation length is ~ 0.2-0.3 % X_0

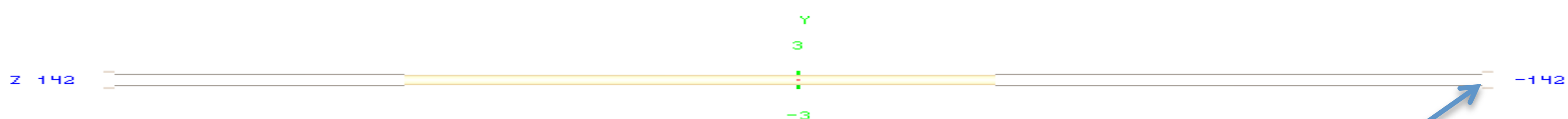
Figure3 : "Effective Thickness of the HFT Beam Pipe,. Beavis, August 26, 2009"

*Beam pipe has been coded by Amilkar Quintero

DIMENSIONS OF THE BEAM PIPE



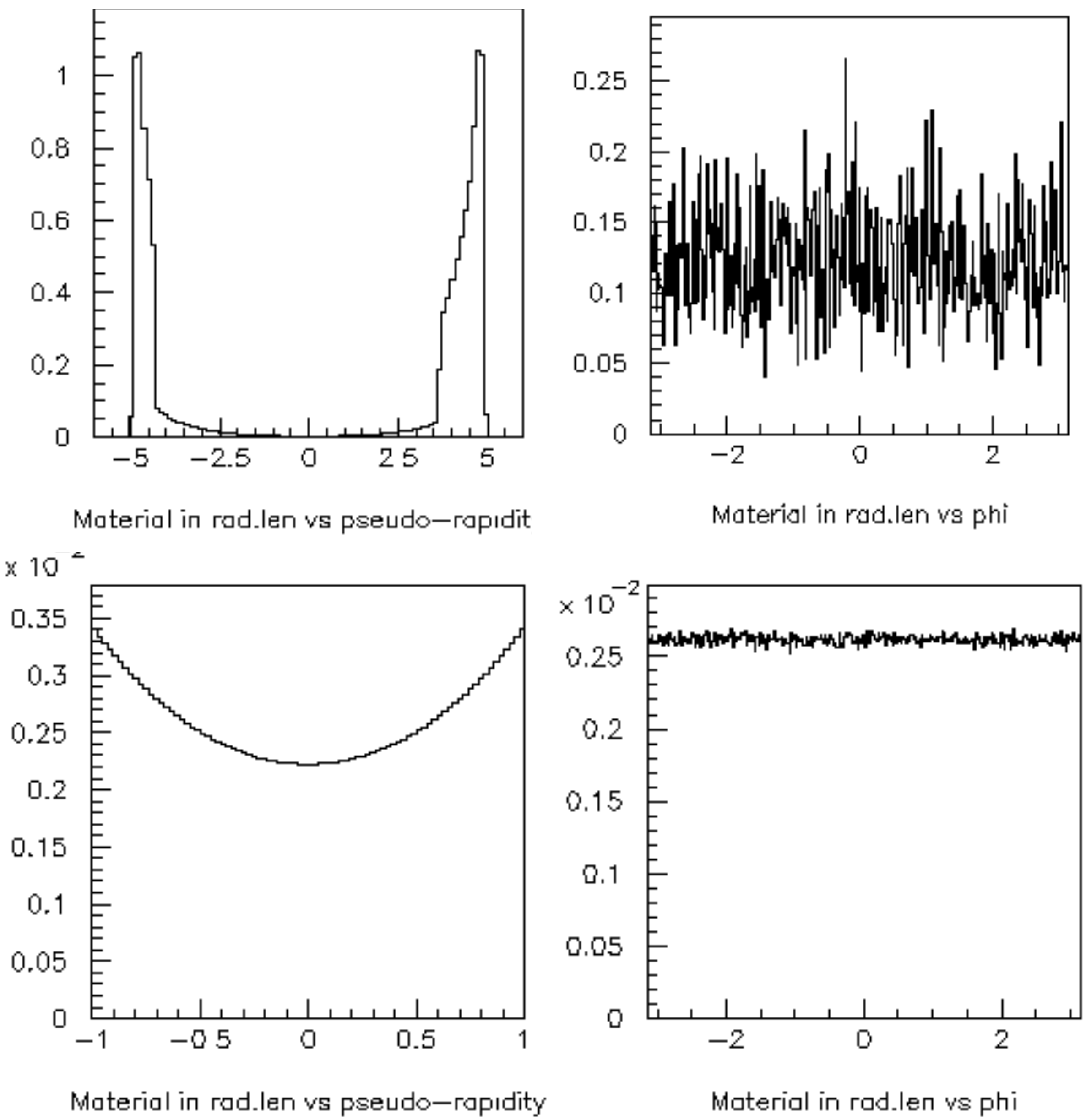




Note : the length of the flanges is arbitrary because it was not specified in the drawing.

				flange
Zrange (inches)	-54.71 ; -15.75	-15.75 ; 31.5	31.5 ; 55.71	-55.71; -54.71
Rmin;Rmax (inches)	0.7875; 0.8525	0.7875; 0.8175	0.7875; 0.8525	0.7875; 1.375
Material	Aluminum	Beryllium	Aluminum	Aluminum

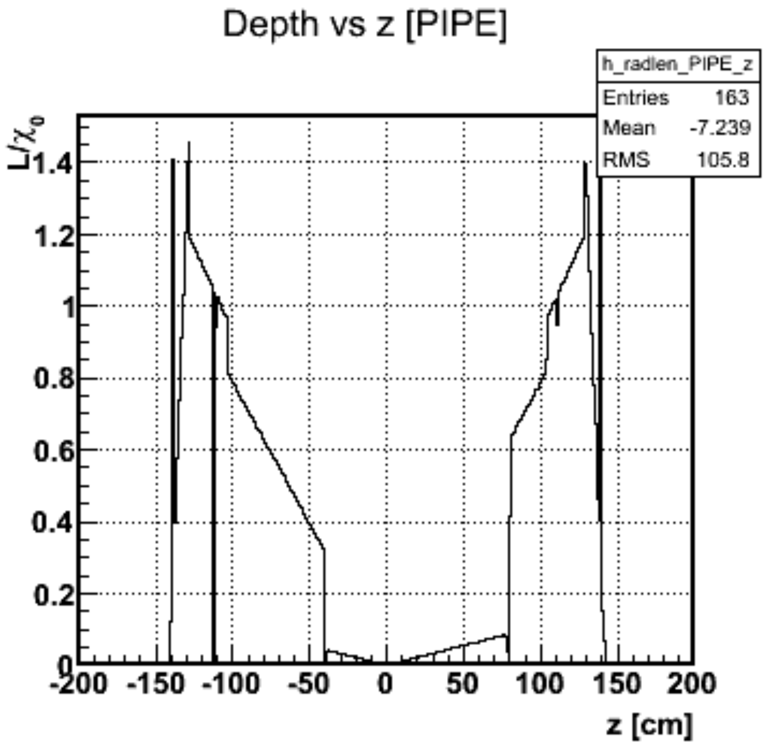
Radiation length of the beam pipe

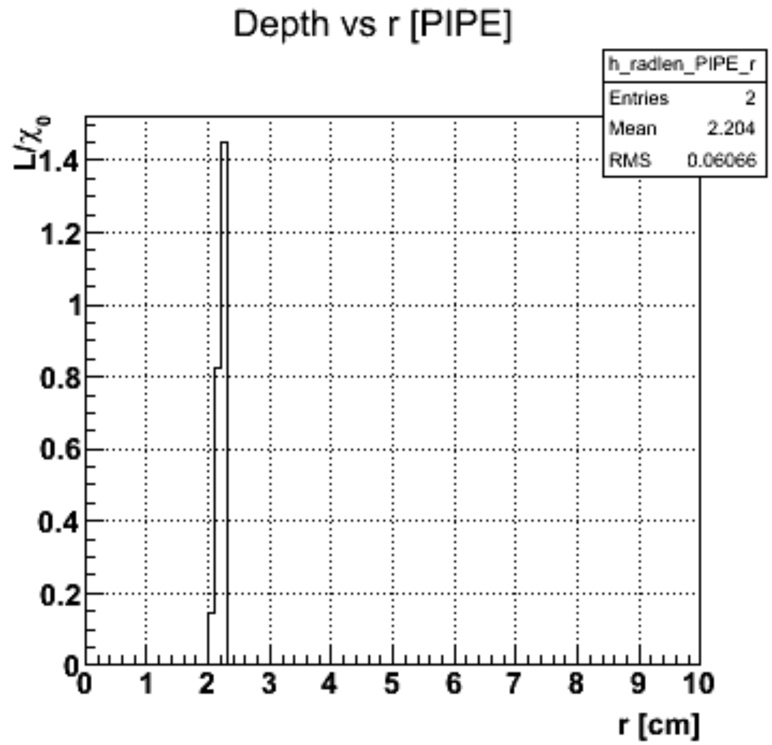


For $|\eta|<6$

For $|\eta|<1$

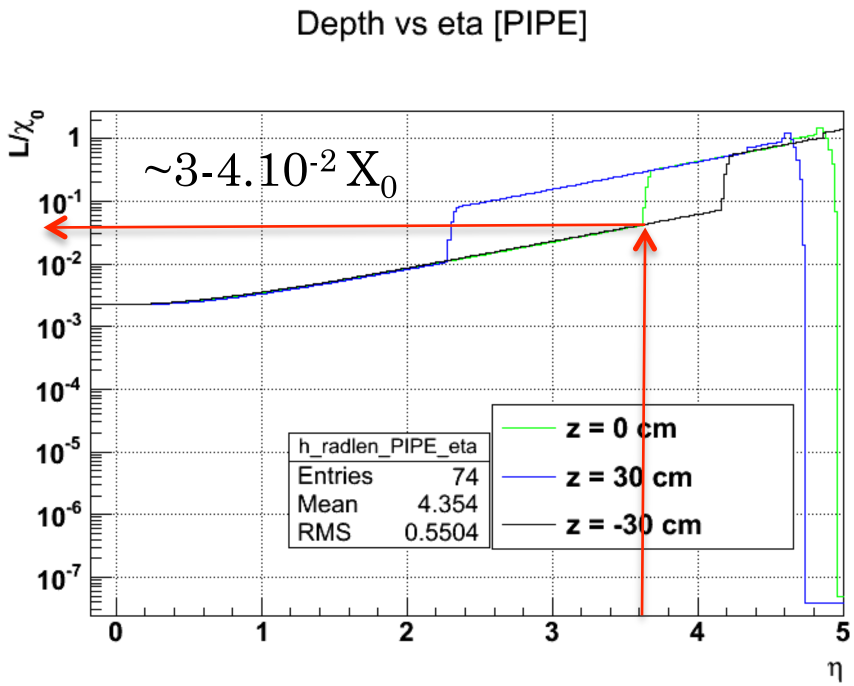
Radiation length of the beam pipe





- The dimensions (length, radii) are agree with the Brushwellman drawing.
- As seen in previous slide, there is more material budget for large Z :
  - in the central region where the pixel stands, the radiation is very low.

Comparison of the radiation length



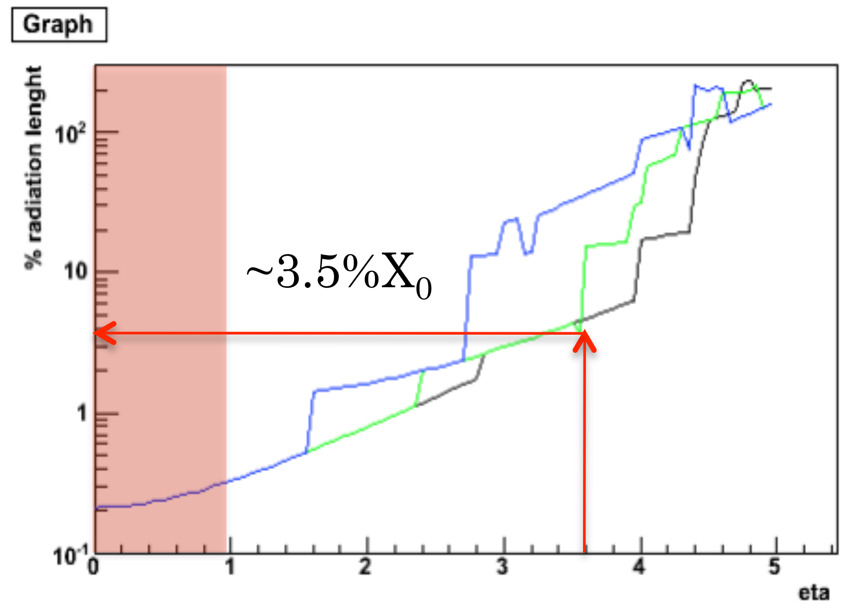
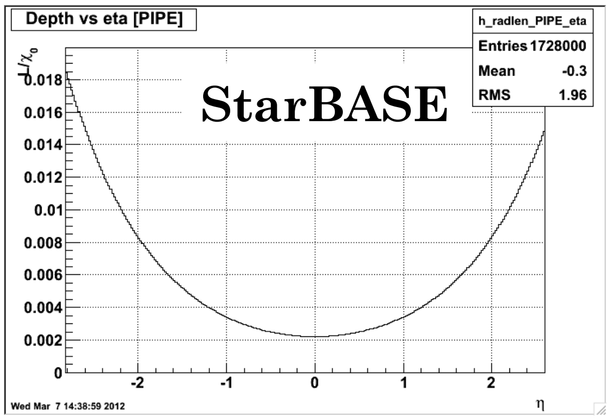
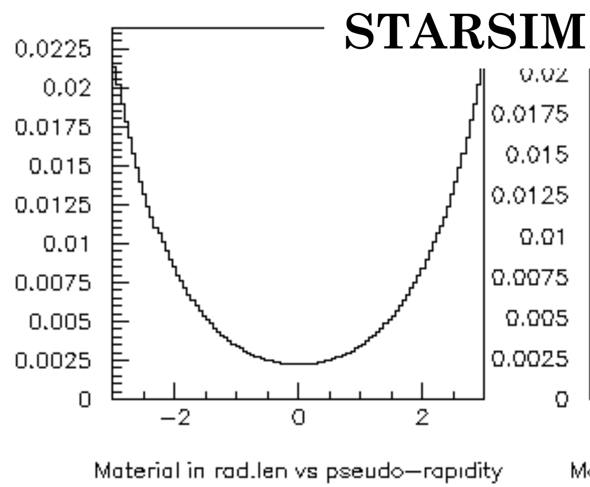


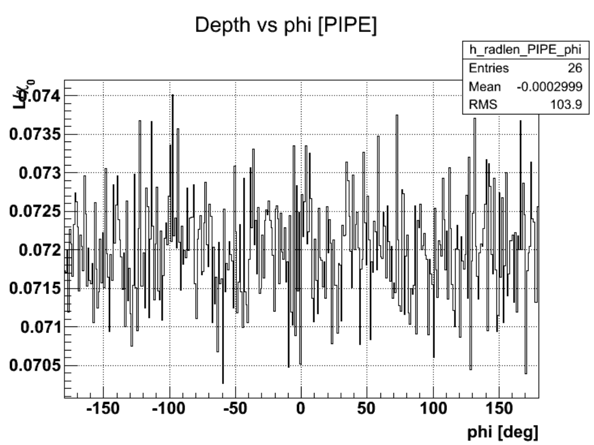
Figure 3. Prelininary new beam pipe.

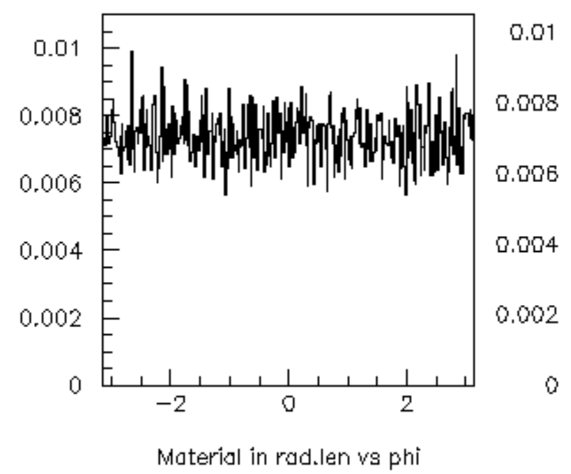
- The ordering of the radiation length profile vs. vertices positions is OK but the eta values of the change in profile are not completely agree
- Compatibility of both simulations ?

Comparison between methods used to plot the radiation length



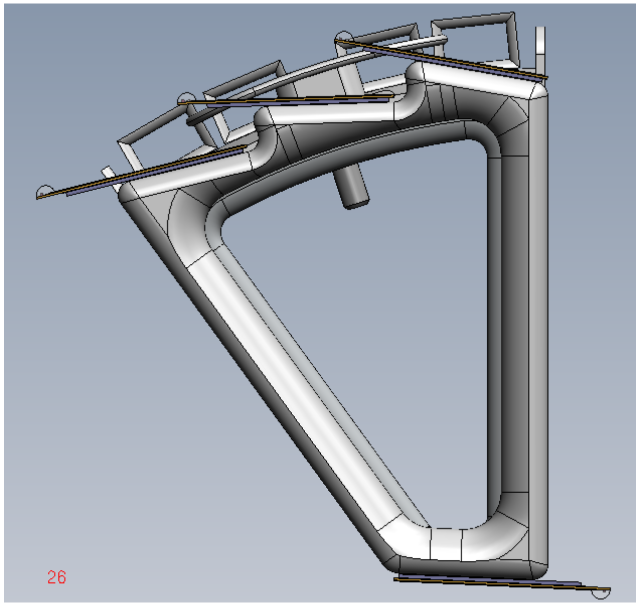


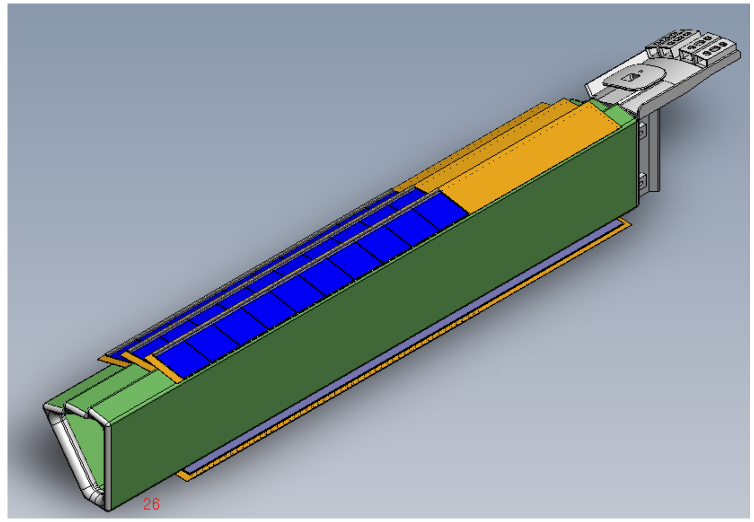


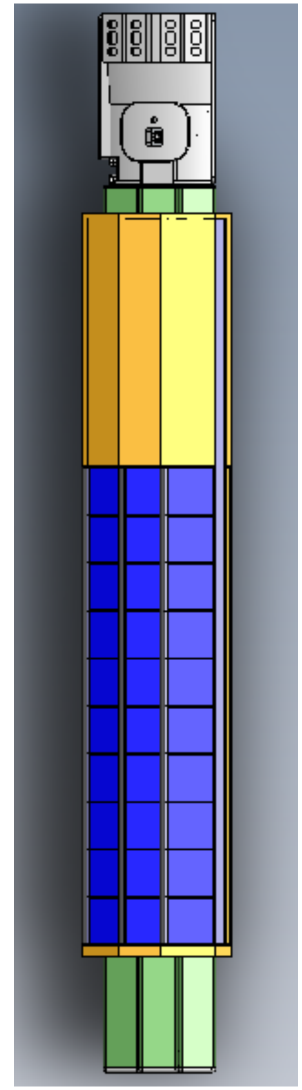


- The radiation length vs. η (top) and ϕ (bottom) shows the SAME profile for both methods.

2.PXL (SW)







- The input for the PIXEL (ladder + sector) dimensions/ shapes is the SW representation.
- Flemming has done a translation of SW model to TGeo geometry.
  - It provides directly the shape, dimensions of the elements and then simplifies their implementation in AgML.
- The idea was to code 1 sector and then duplicate it x10

1ST ITERATION : SECTOR SUPPORT + ACTIVE SILICON

This is the first version (in CVS since december) of the PXL in AgML.
Volume naming convention.

- PLAC = active silicon ladder : it was the name used in UPGR15.
- PXCA-PXCB-PXCC-PXCD,PXCE PXCF,PXGH,PXCH are the corners, starting from the bottom right (↑) :

Pi**X**el **C**orner **A** …

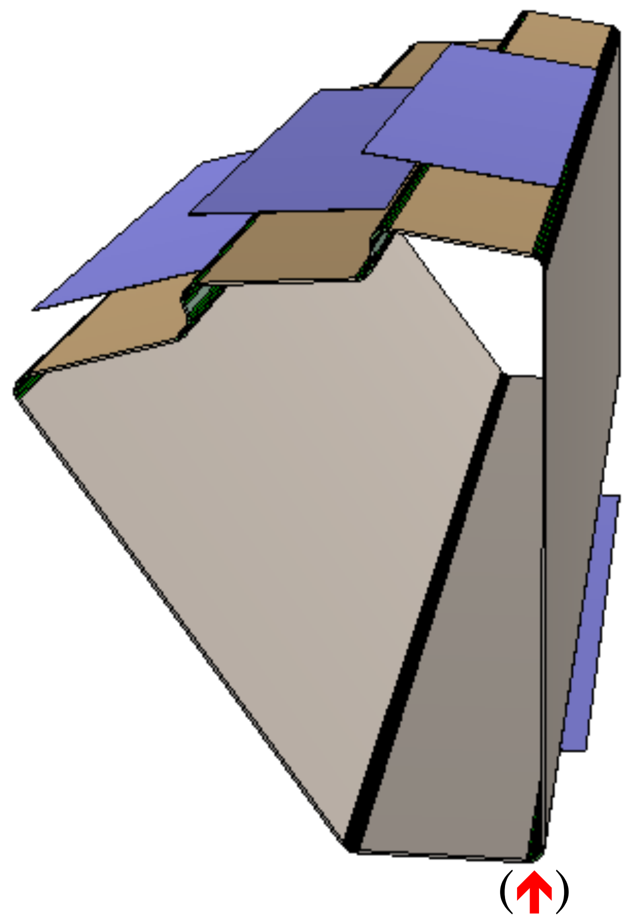
- PXTR-PXTM-PXTL are the planes supporting the active silicon on the top :

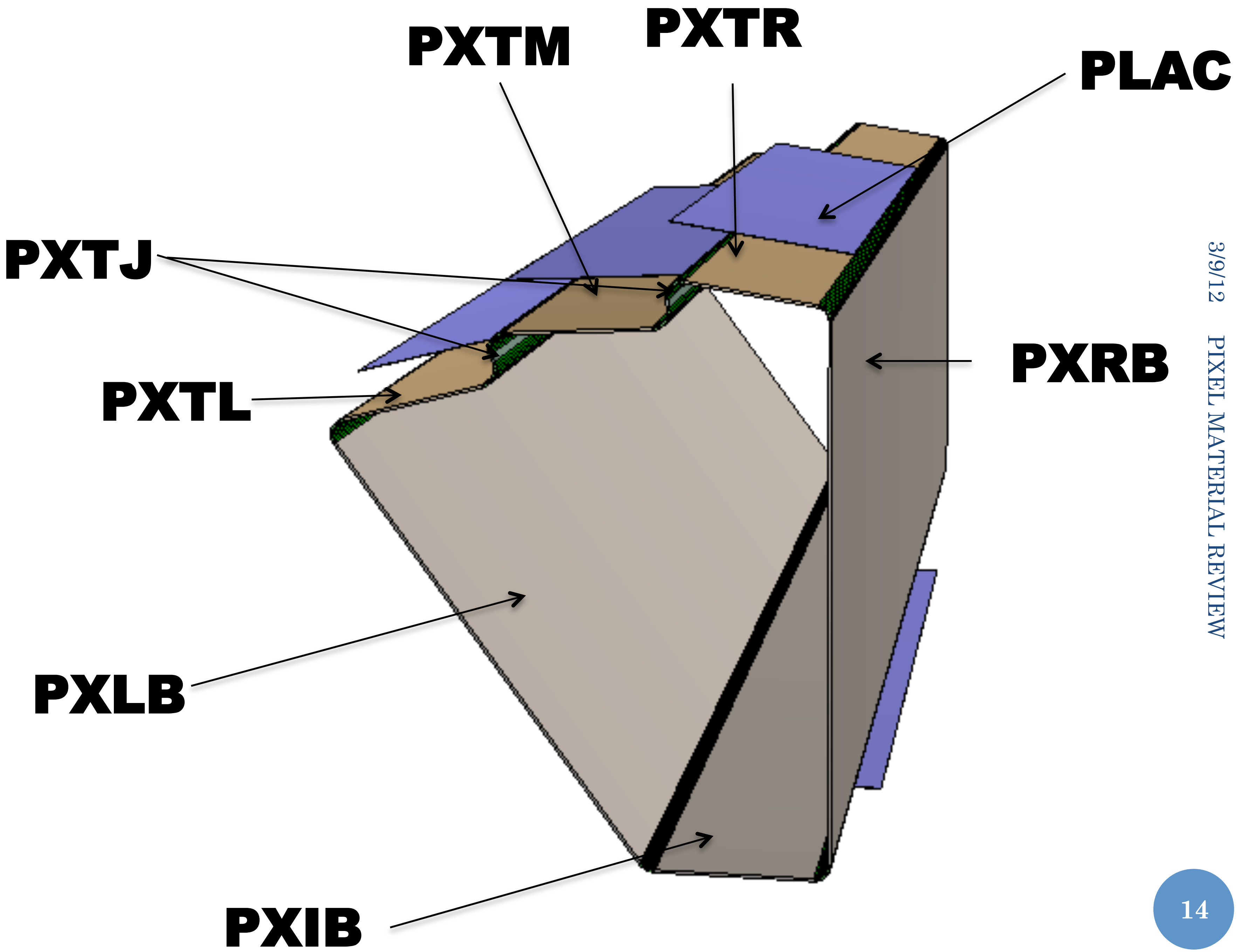
Pi**X**el **T**op **R**ight , **P**i**X**el **T**op **M**iddle, **P**i**X**el **T**op **L**ef**t**.

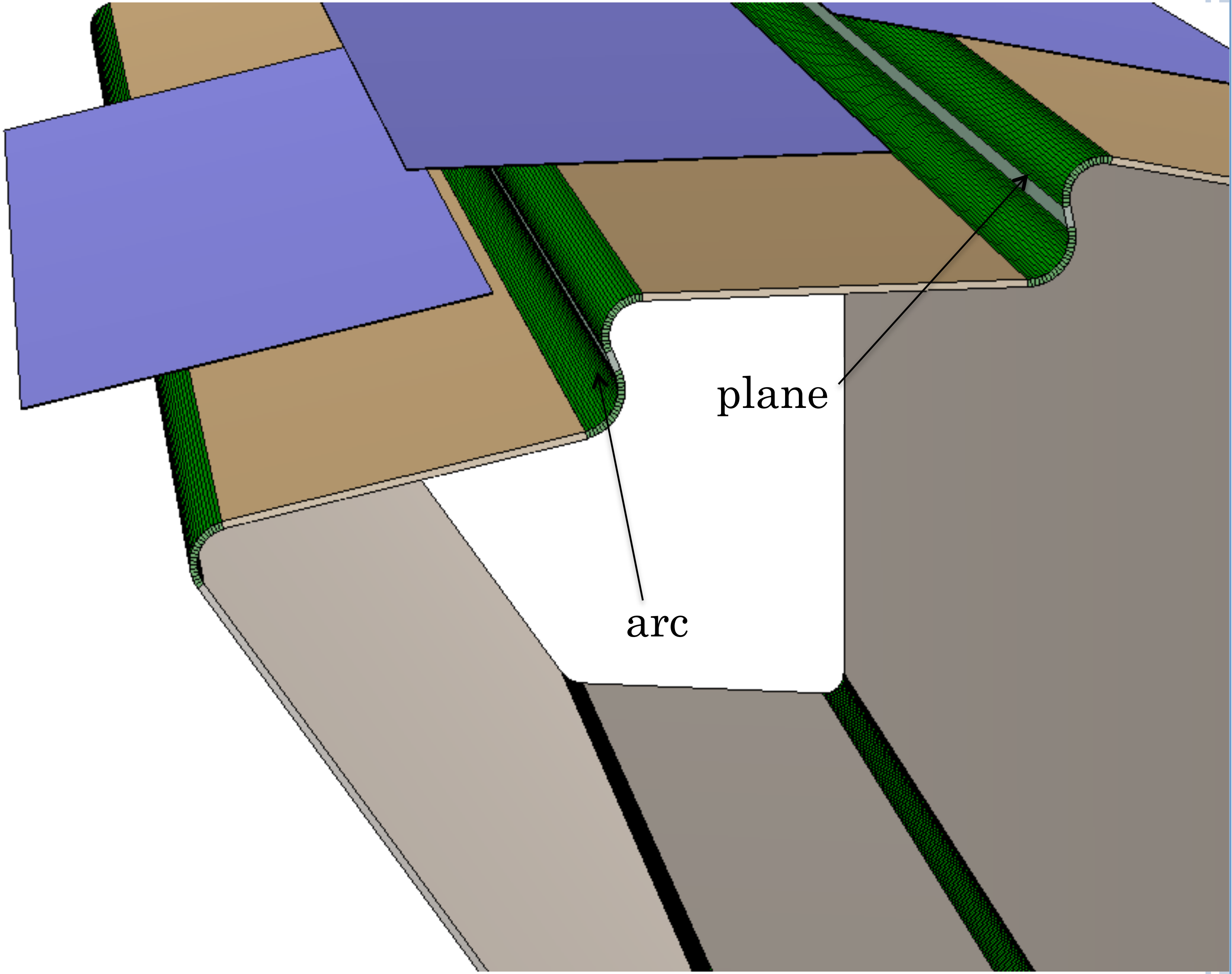
- PXTJ are the 2 planes joining the planes on the top :

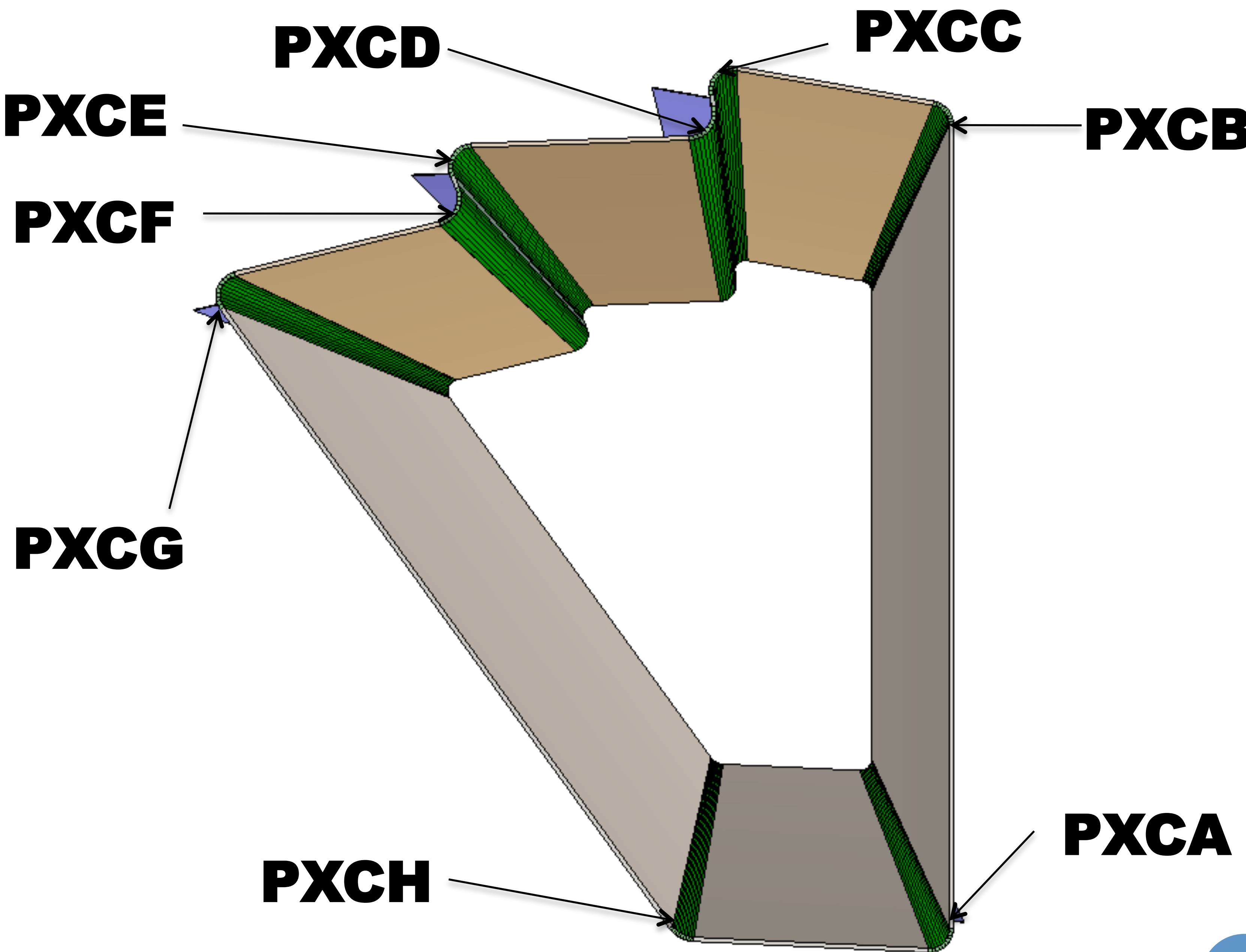
Pi**X**el **T**op **J**oin

- PXLB, PXRB, PXIB are the planes on front of the beam pipe and between 2 sectors (**P**ixel **L**ow **B**eam, **P**ixel **R**ear **B**eam , **P**ixel **I**nner **B**eam).

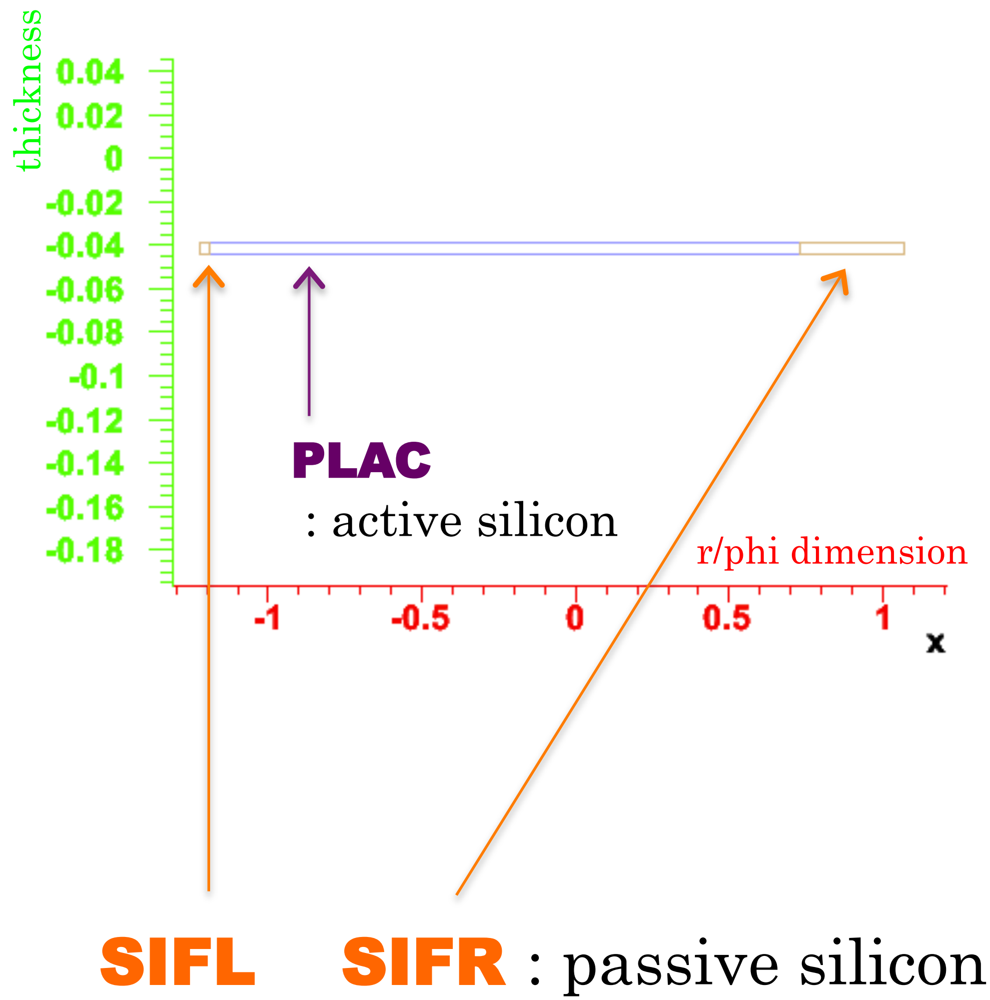


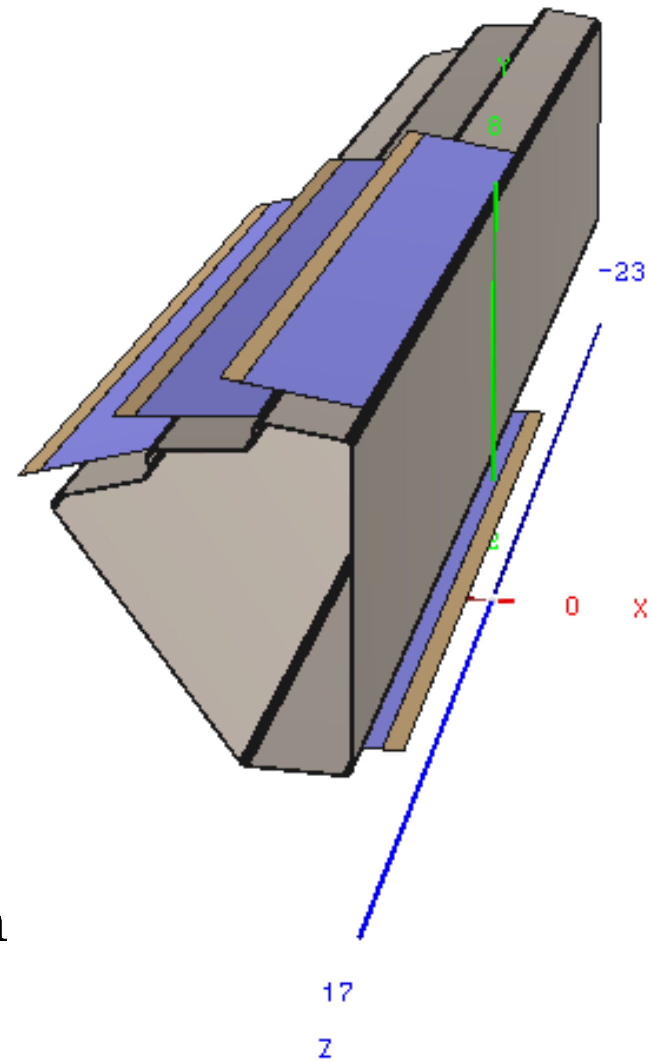

PXTM
PXTR
PLAC
PXTJ
PXTL
PXRB
PXLB
PXIB


plane
arc


PXCD
PXCC
PXCE
PXCB
PXCF
PXCG
PXCH
PXCA

2ND ITERATION : FINE DETAILS OF A LADDER

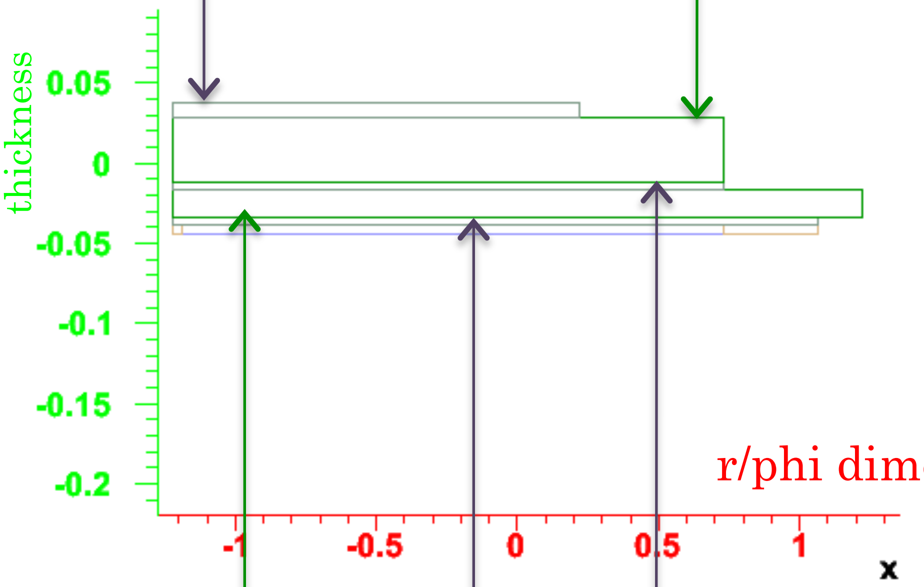


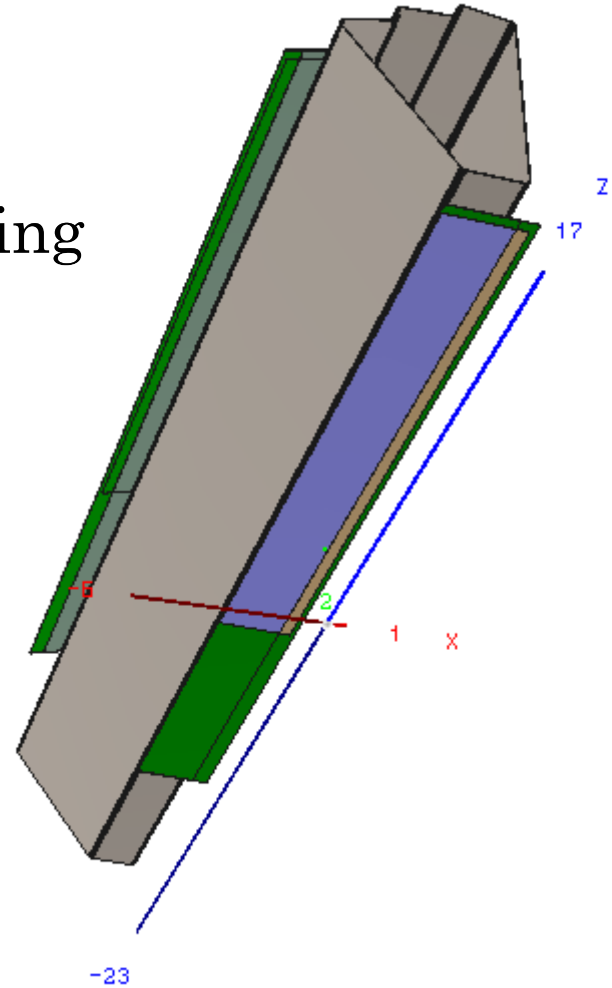


ALL LAYERS TOGETHER

GLUC : glue (adhesive)

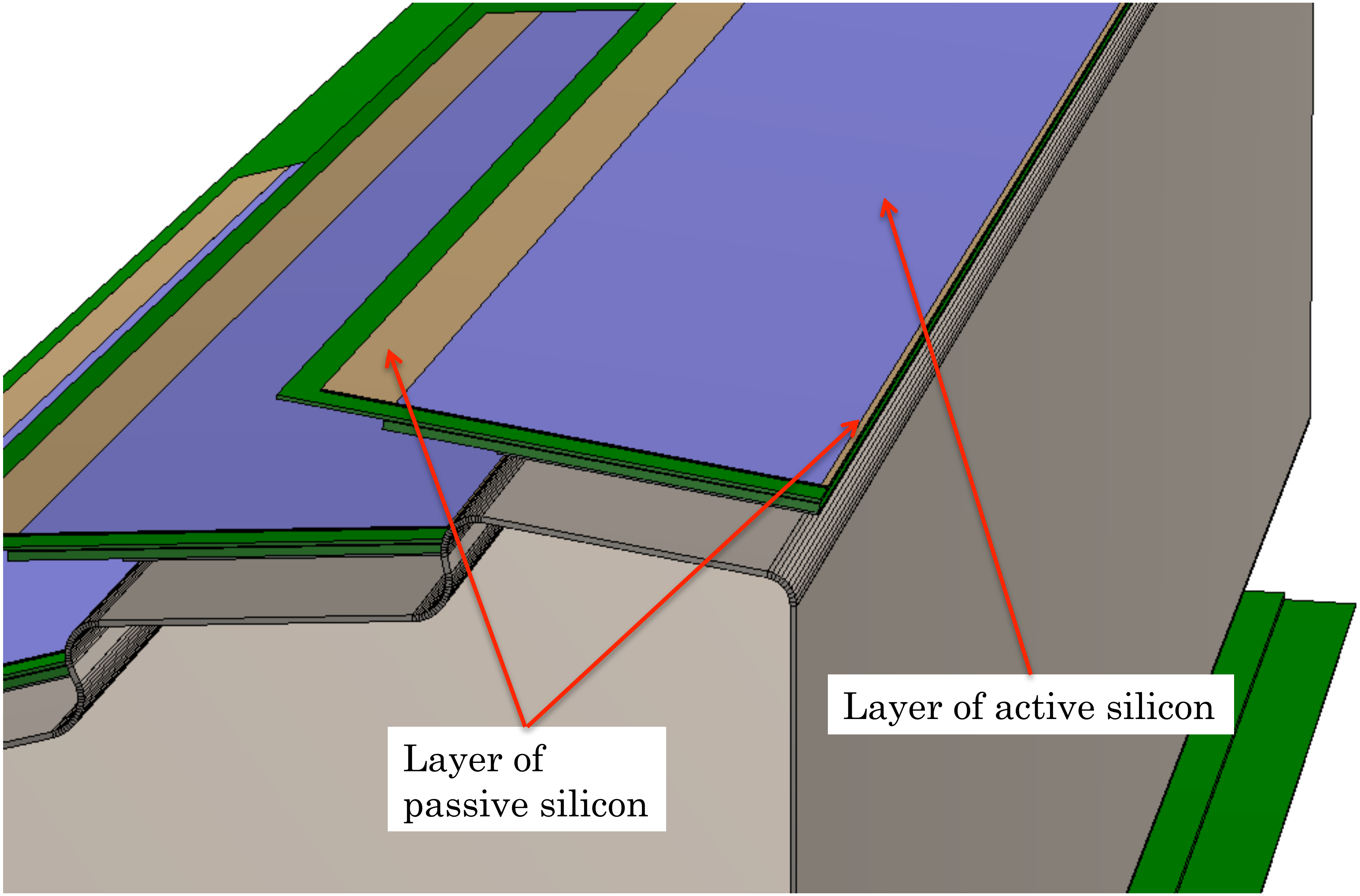
CFBK : Carbon Fiber BacKing





GLUA, **GLUB** : glue (adhesive)

ALCA : Aluminum Cable

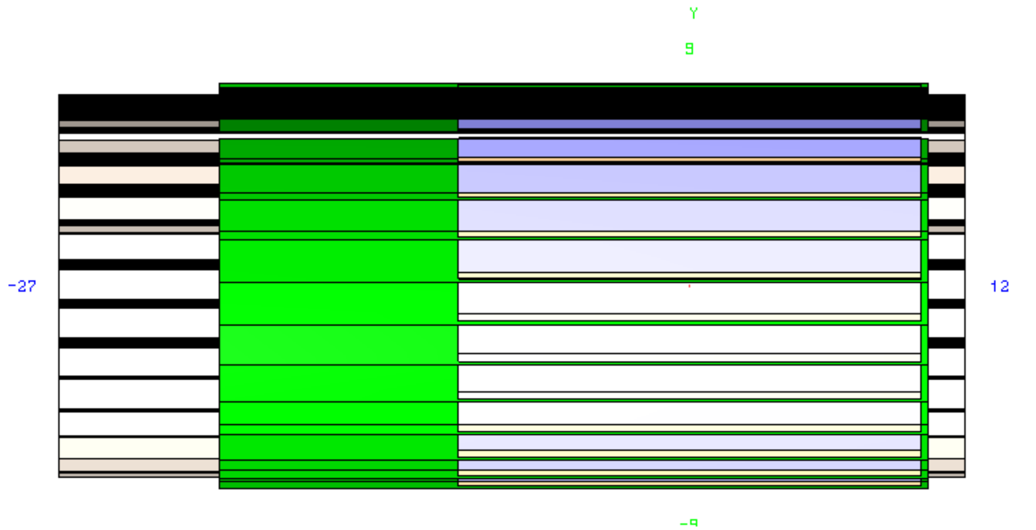

Layer of active silicon
Layer of
passive silicon

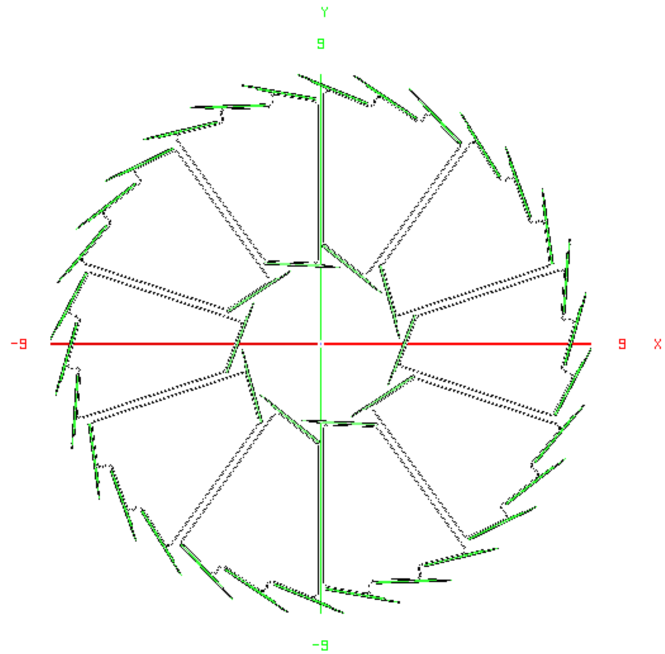
SUMMARY OF MATERIAL BUDGET

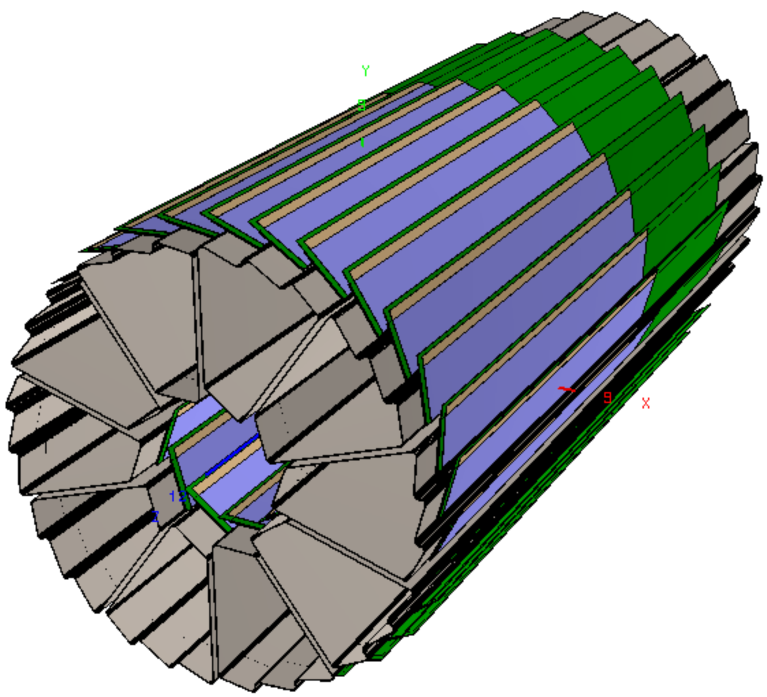
GEANT NAME	piece	shape	Composition / mixture	Radiation length [cm]	Density[g/cm^3]
PLAC	Silicon active	box	Si	9.36	2.33
SIFR	Silicon passive	box	Si	9.36	2.33
SIFL	Silicon passive	box	Si	9.36	2.33
GLUA	adhesive	box	O(0.164) C(0.763) H(0.073)	34.7	1.2(*)
GLUB	adhesive	box	O(0.164) C(0.763) H(0.073)	34.7	1.2(*)
GLUC	adhesive	box	O(0.164) C(0.763) H(0.073)	34.7	1.2(*)
ALCA	Aluminum cable	box	Al	23.7(*)	2.7(*)
CBFK	Carbon Fiber backing	box	C	68(*)	1.3(*)

(*):forced
Calculated by GEANT

Overview of the PIXEL

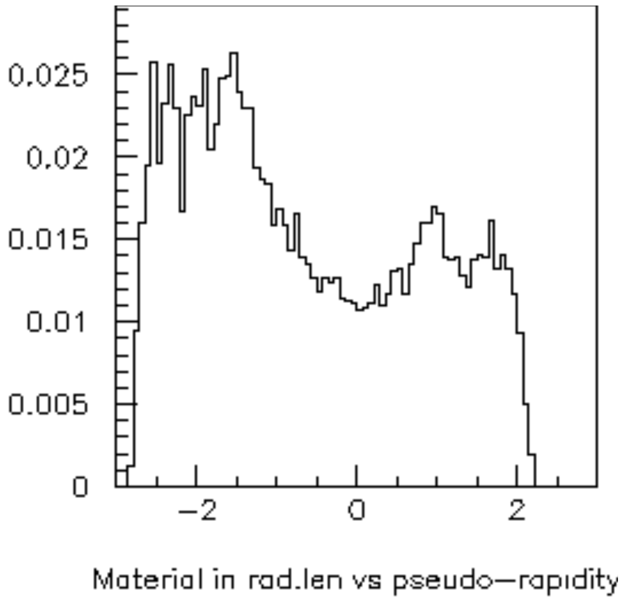


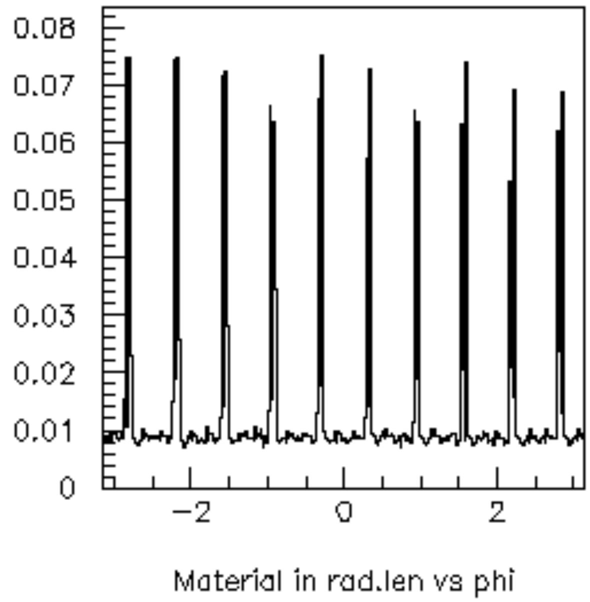




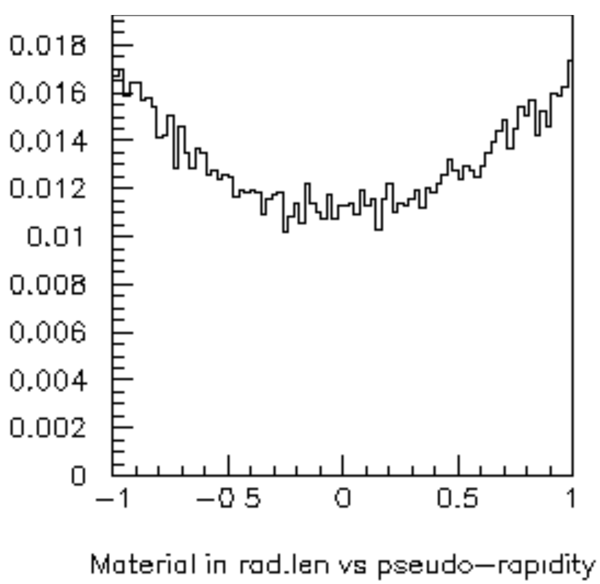
REVIEW

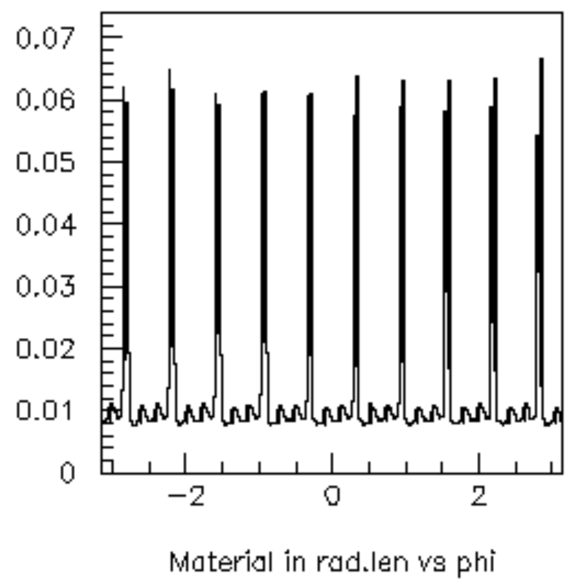
PIXEL DETECTOR RADIATION LENGTH





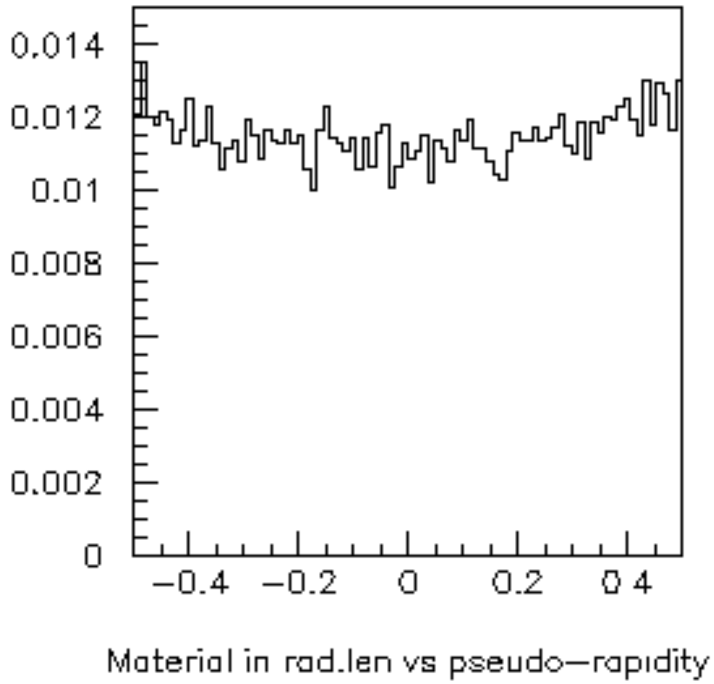
For | η |<3

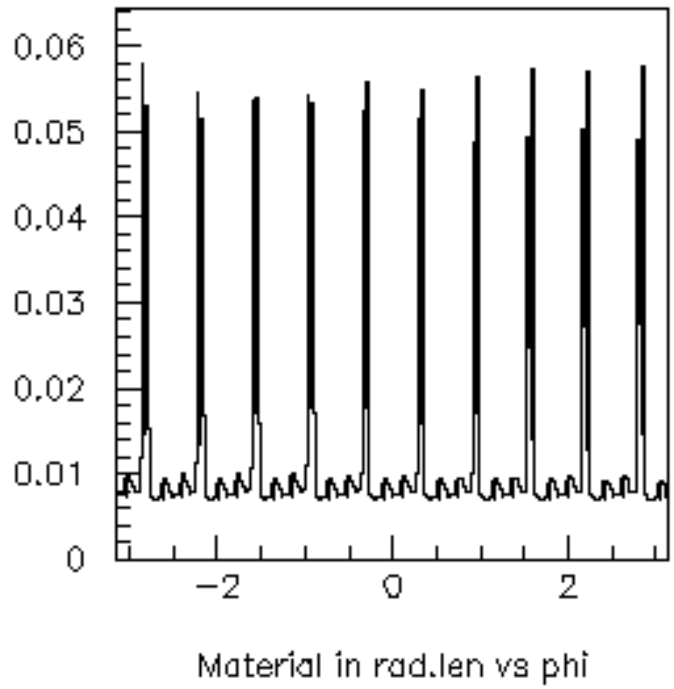




For | η |<1

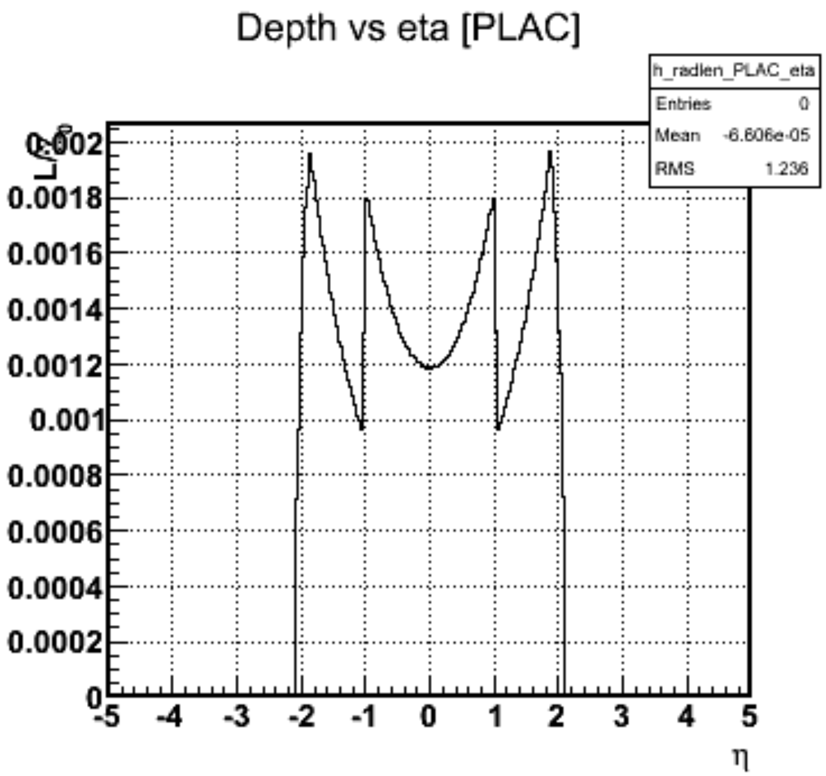
PIXEL DETECTOR RADIATION LENGTH , FOR |ETA|<.5

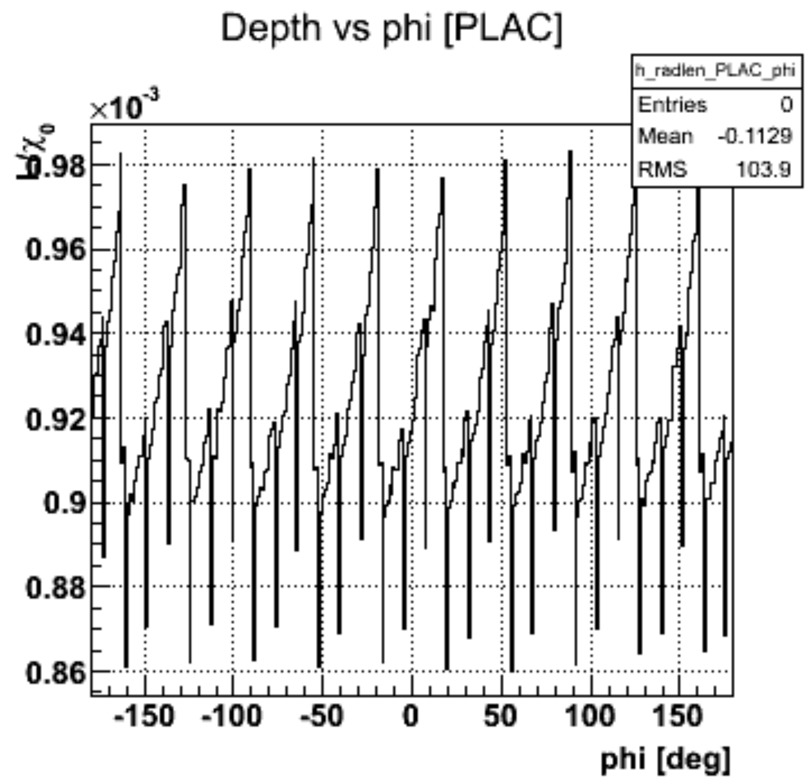




- Peaks in the azimuthal profiles comes from tracks crossing the entire pixel support.
- Other small peaks are the overlaps between ladder.

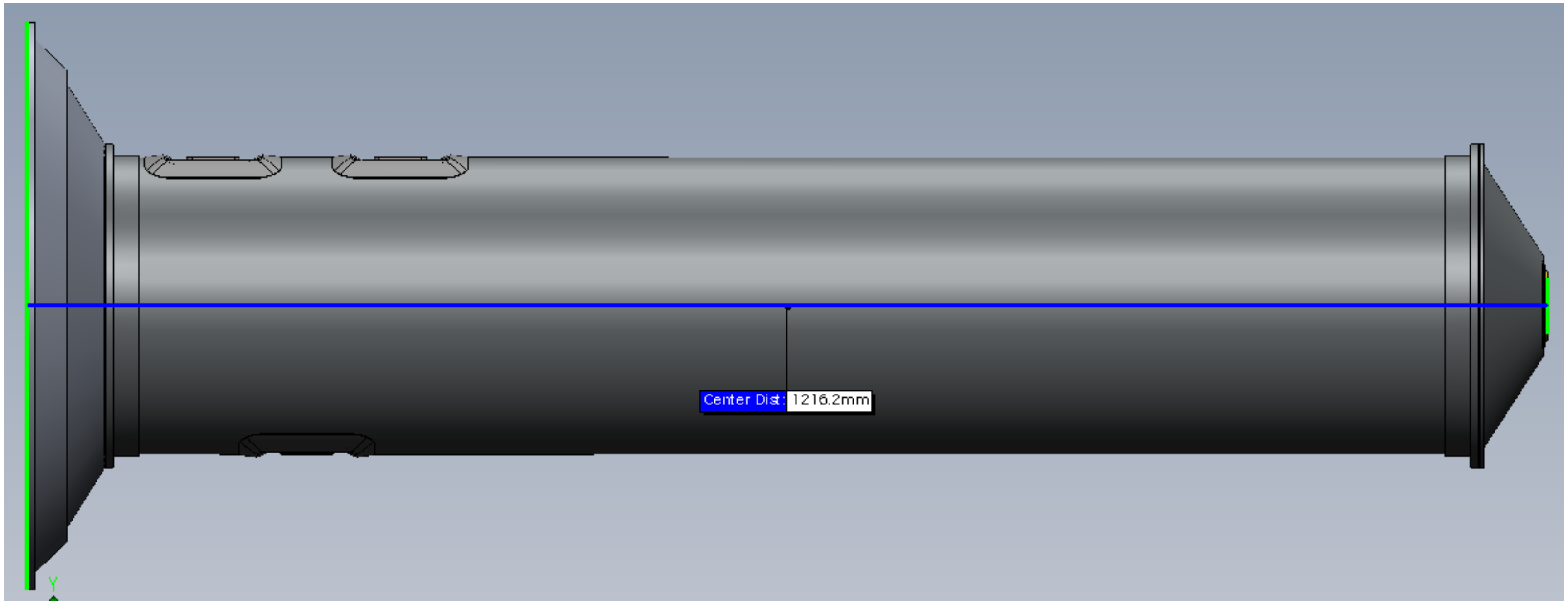
SILICON SENSITIVE RADIATION LENGTH

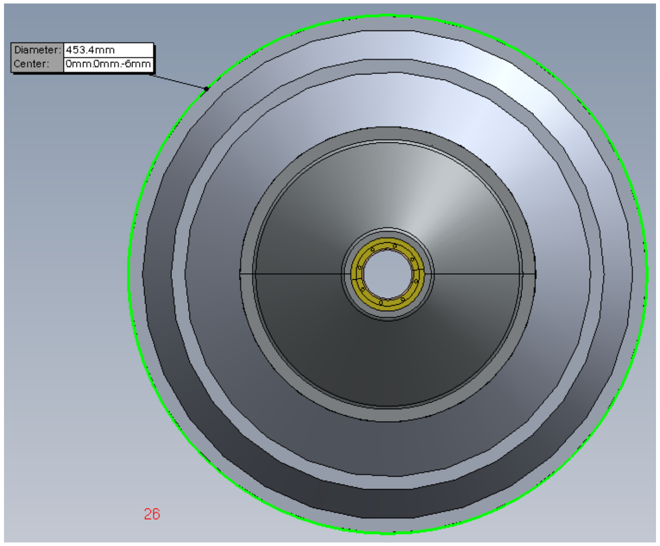


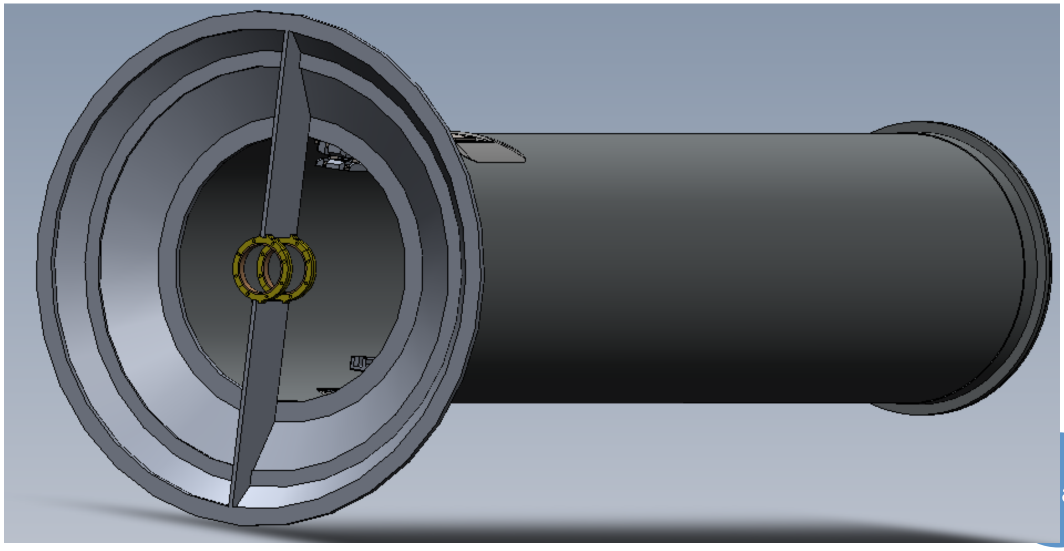


- For 1 layer of active silicon, the expected radiation length is 0.0677% (see slide 40).
- then for 2 ladders (inner and outer), the radiation length should be : 0.1354%

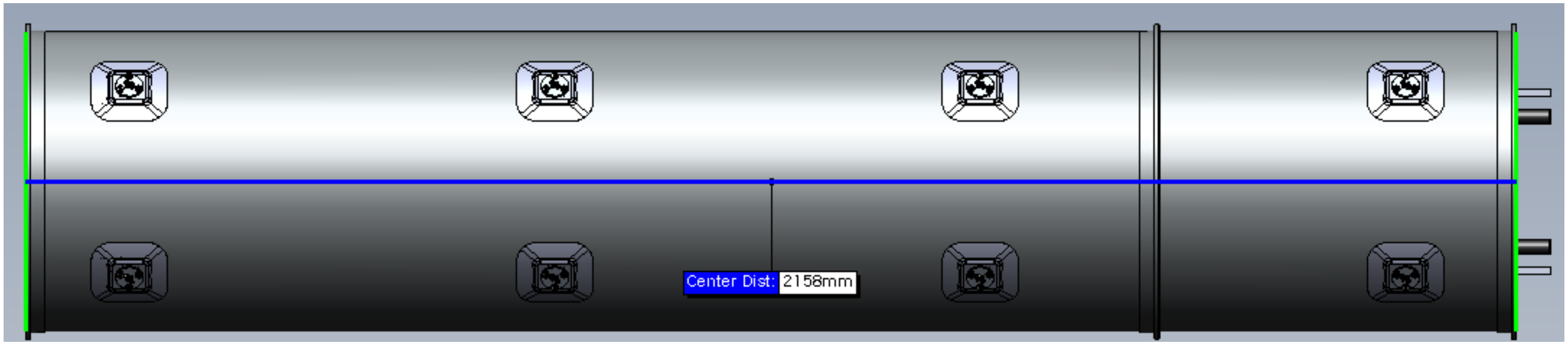
3.1 SW model of the PST

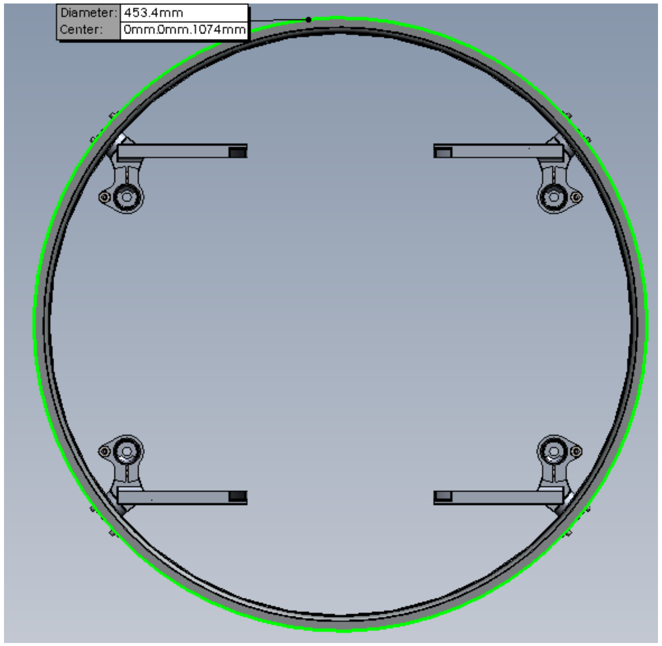


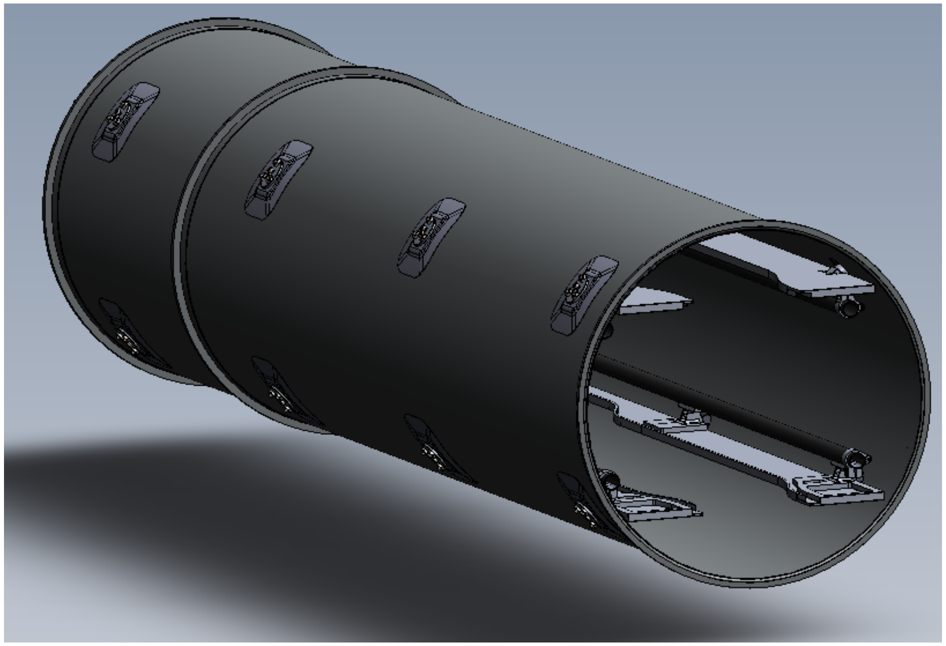




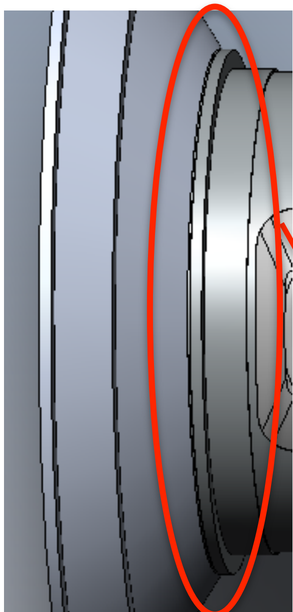
3.2 SW MODEL OF THE PIT



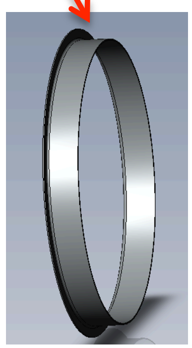




EXAMPLE OF IMPLEMENTATION



Length(Z) = 6mm
Outer = 259mm
Inner = 239 mm



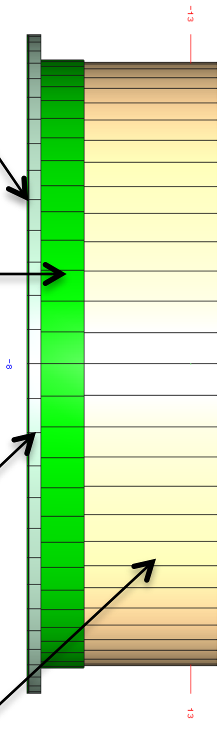
Length(Z) = 25mm
Outer1 = 239 mm
Inner1 = 237 mm
Length(Z) = 1mm
Outer2 = 259mm
Inner2 = 239mm

LFBA : Left Flange Base part A

LFBB : Left Flange Base part B

LFBK : Left Flange BacKer

APTS : A Pipe Tube Shell



EXAMPLE OF NAMING CONVENTION : BEAM PIPE SUPPORT CONE

RFBA : Right Flange Base part A

RFBB : Right Flange Base part B

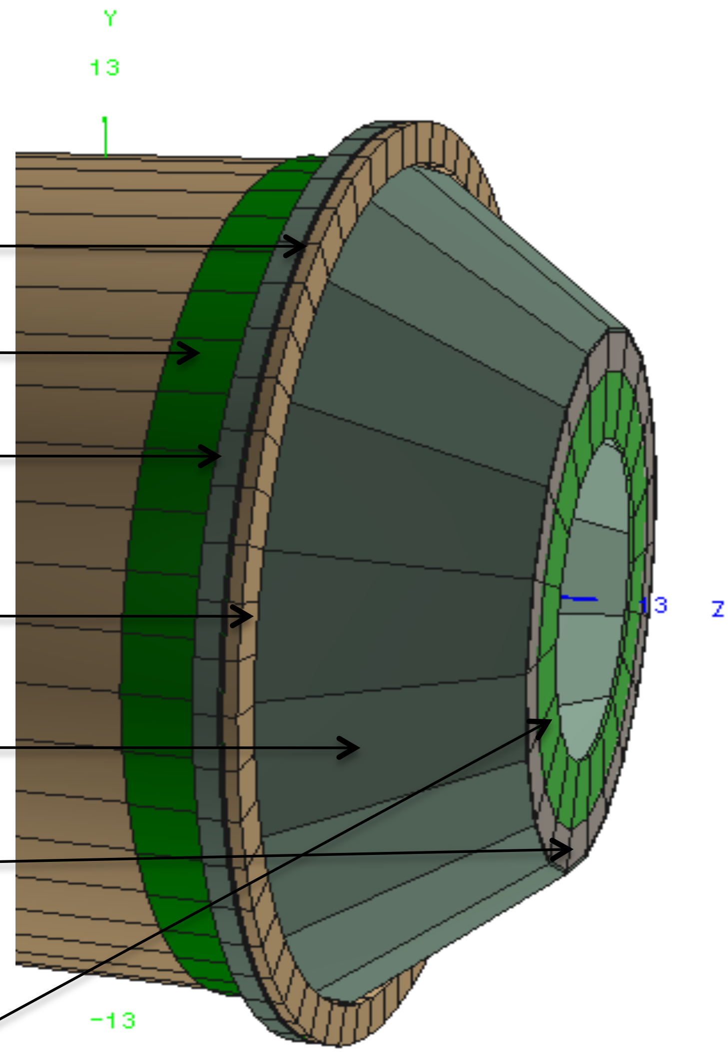
RFBK : Right Flange BacKer

ABPR : A Beam Pipe Ring

BPPC : Beam Pipe PolyCon

EBPP : End Beam Pipe Polycon

RBPP : Ring Beam Pipe Polycon



Example of Naming convention : MSC transition plate

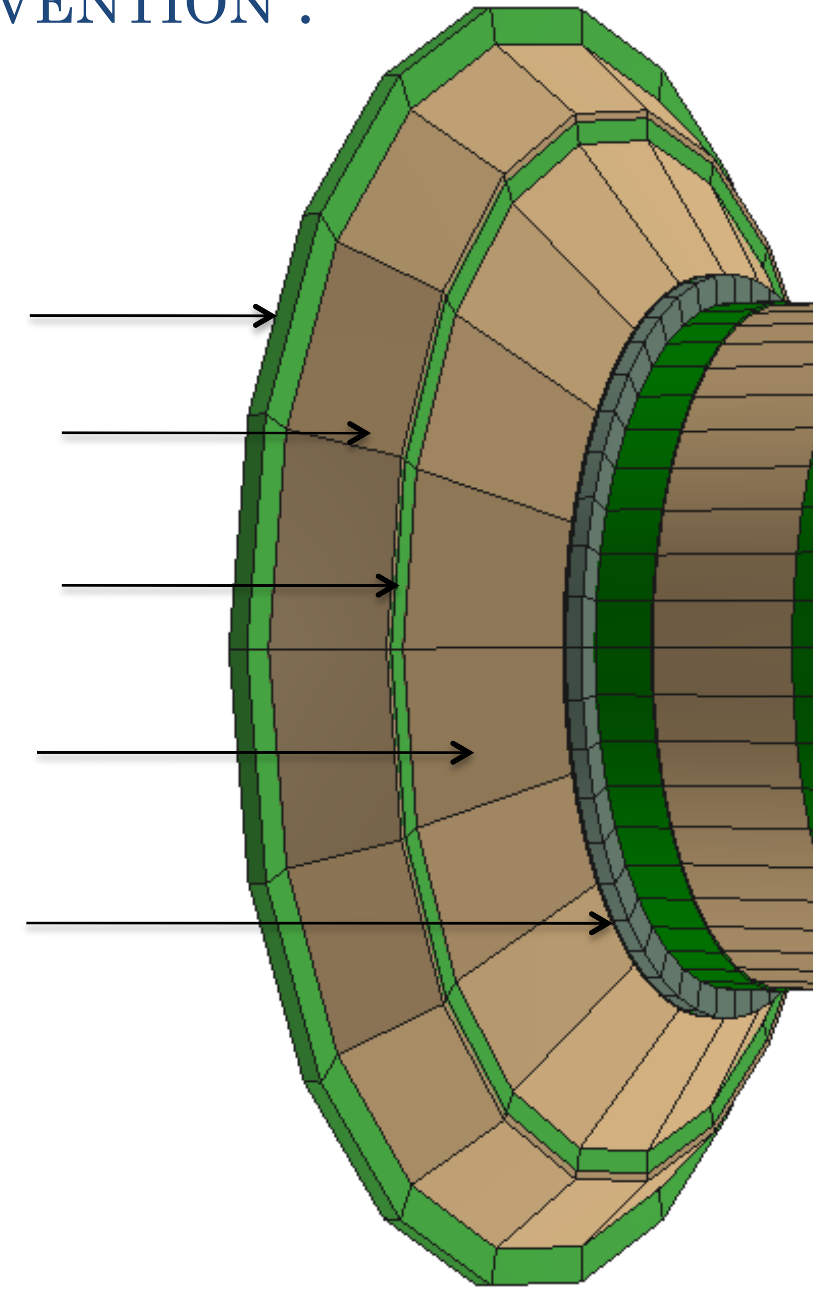
MTPA : Msc Transition Plate part A

MTPB : Msc Transition Plate part B

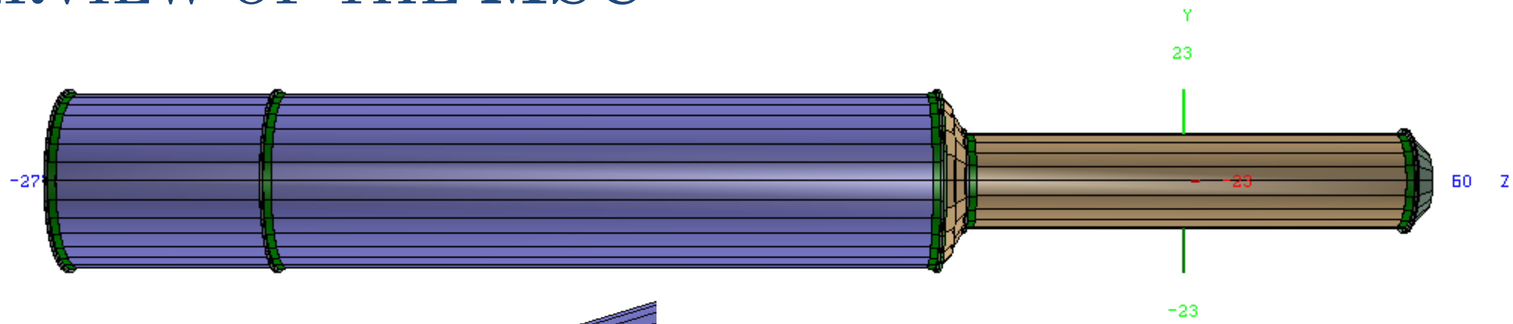
MTPC : Msc Transition Plate part C

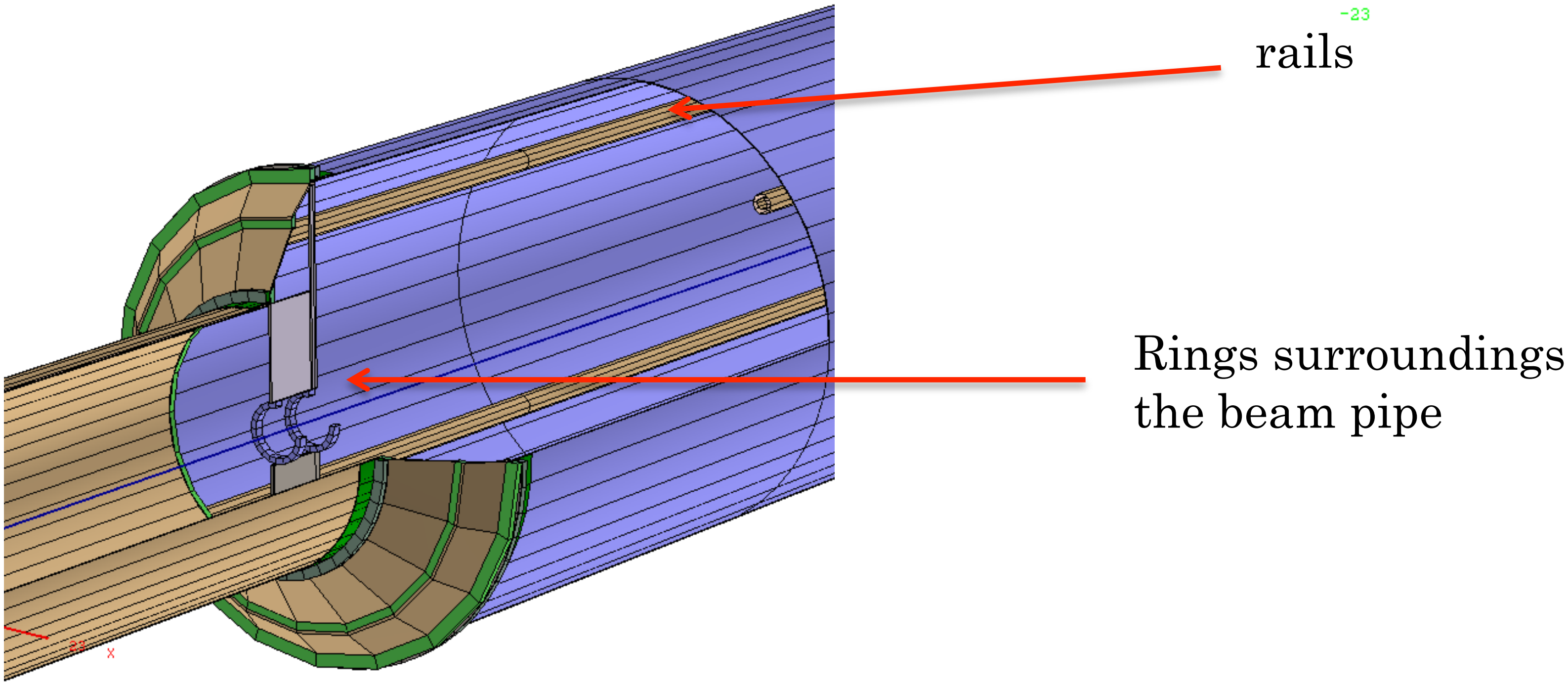
MTPD : Msc Transition Plate part D

MTPE : Msc Transition Plate part E



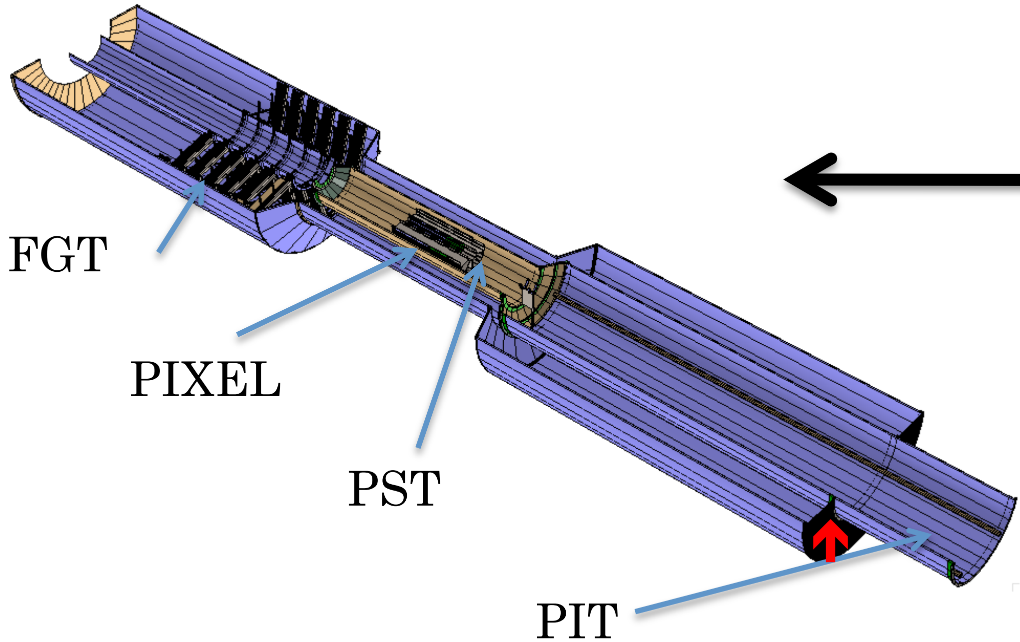
Overview of the MSC





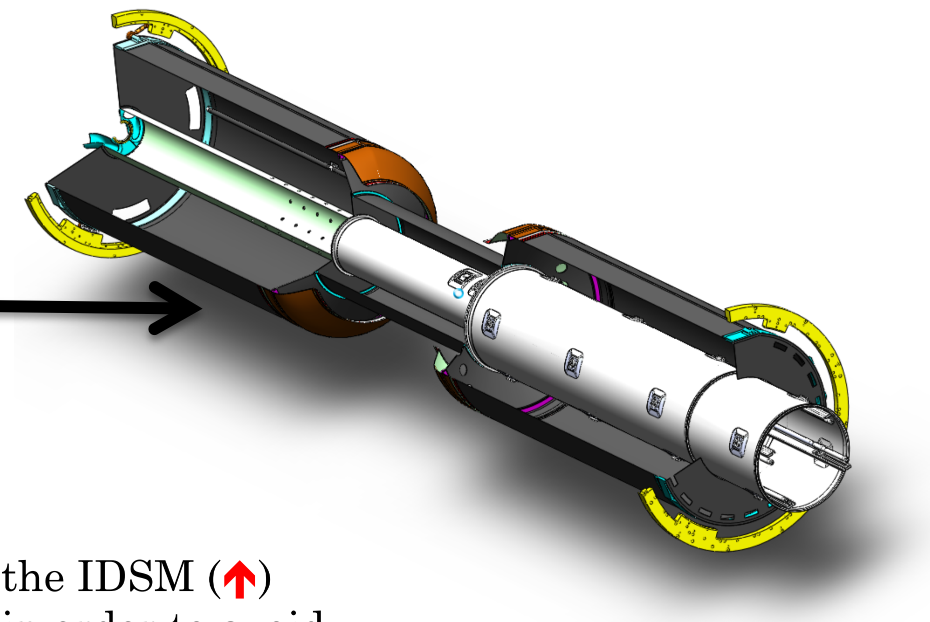
•: temporary until implementation of real material (slide 39)

GEANT NAME	piece	Composition / mixture	Radiation length	density
ALL(*)	Carbon Fiber	C	23.9	1.3(*)



AgML model

SW model



Note : in this version, the inner radii of the IDSM (↑) has been changed from the coded value in order to avoid overlap with the PIT.

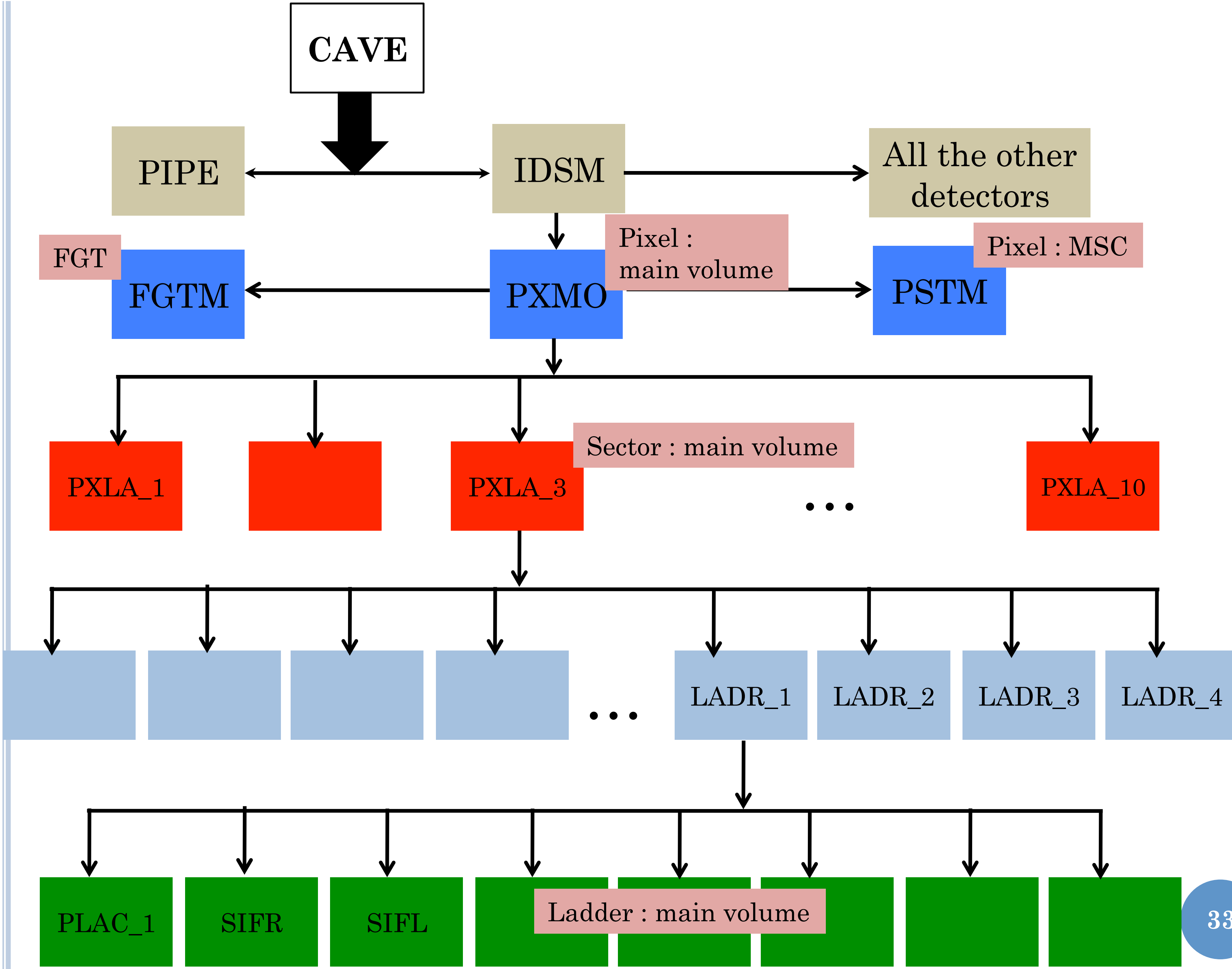
GEANT VOLUMES : HIERARCHY

- Volumes have to be organized by level in order for GEANT to find energy loss, impact point in each volumes/layers.
- The current status is :
  - The IDSM includes the PIXEL and MSC.

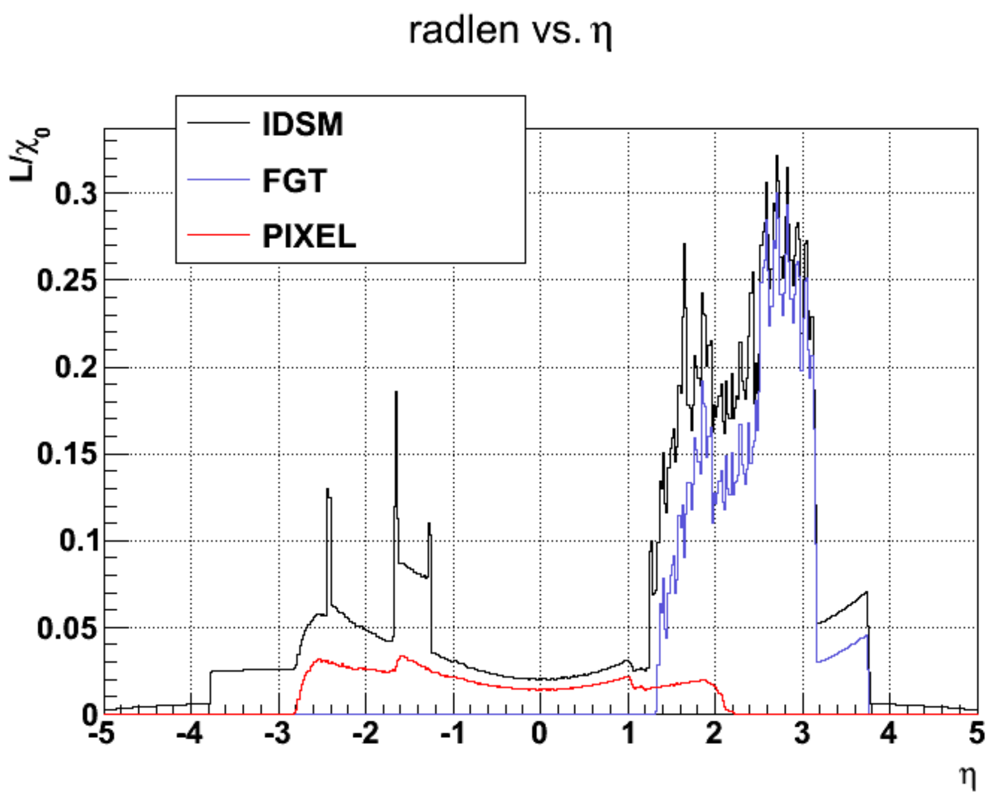
    ➔Issue : the MSC has a larger Z extension than the IDSM.
  - The beam pipe is at the same level of the IDSM.
  - The IDSM does not include the beam pipe.

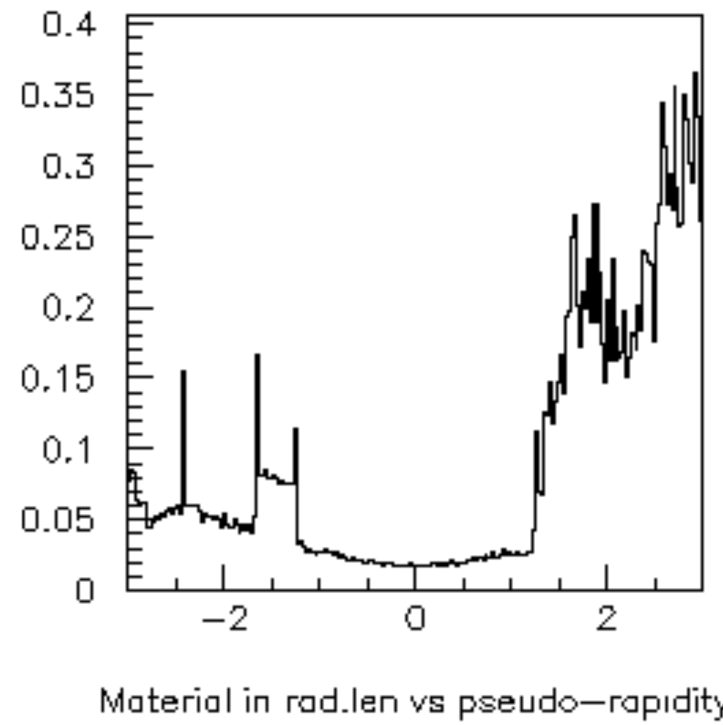
    ➔Issue 1 : the beam pipe has a larger extension in Z than the IDSM.

    ➔Issue 2 : the beam pipe is inside the PIXEL, therefore it should be placed INSIDE the PIXEL/IDSM.
  - The MSC is placed with respect the center of the IDSM.
    - It is then placed at the center of STAR.
  - The pixel detector is not placed at the center of the IDSM because the active silicon are not symmetric along a ladder.
    - there's a offset of the whole sector in order to have the center of the active silicon placed at (0,0,0).


CAVE
PIPE
IDSM
All the other detectors
FGT
FGTM
PXMO
Pixel : main volume
PSTM
Pixel : MSC
PXLA_1
PXLA_3
Sector : main volume
PXLA_10
…
…
LADR_1
LADR_2
LADR_3
LADR_4
PLAC_1
SIFR
SIFL
Ladder : main volume

Radiation length breakdown





- Left : using StarBASE ; it does not include the beam pipe material.
- Right : using STARSIM ; it does include all material (beam pipe + PXL + FGT + IDSM) in |eta|<3
- There is more material (red histogram) for the PXL in eta<0 (Z<0) because the silicon ladder is asymmetric with respect the ladder support.

SUMMARY

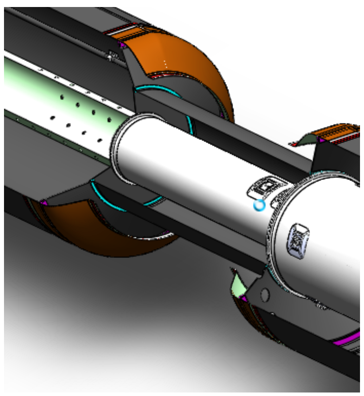
- PIXEL detector geometry has been implemented in AgML.
- It has the fine details inherent to the PIXEL/CMOS sensor and then necessary for tracking evaluation.
- The support material of the PIXEL, as well as the new beam pipe (requirement) have also been implemented.
- Material, radiation length and dimensions look agree with the input source (SW, Brushwellman drawing).

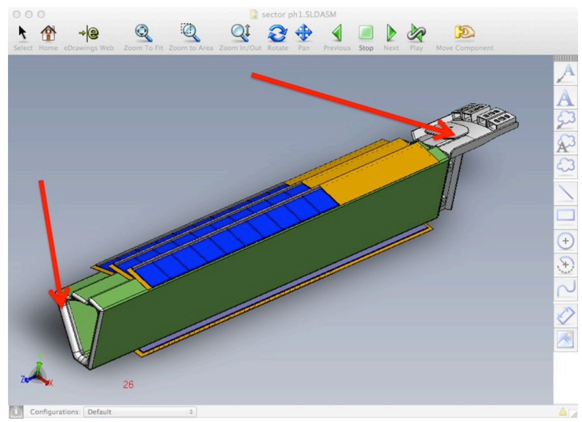
NEXT STEPS

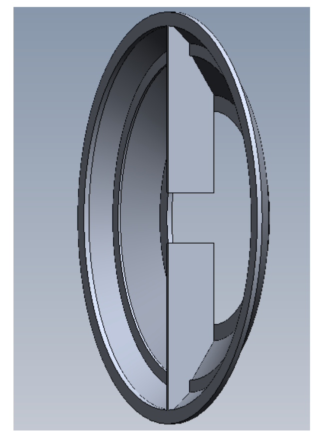
- Refine material budget for the MSC (slide 39)

- Remaining “big” parts of the MSC and some corrections :

shrouds







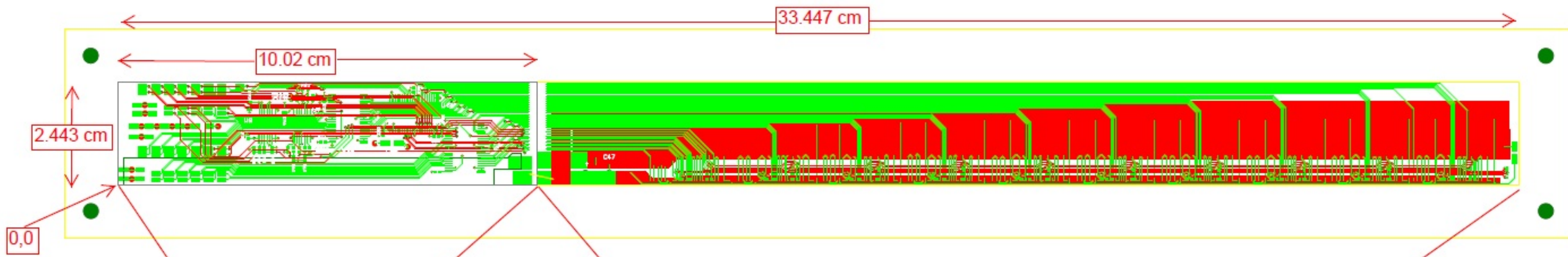
- Representation of ladder’s cables (slide 38)

- Look at the GEANT tree for optimization.

END

Cables on a ladder

STAR PXL Detector
Ultimate ladder cable prototype
Draft single power version



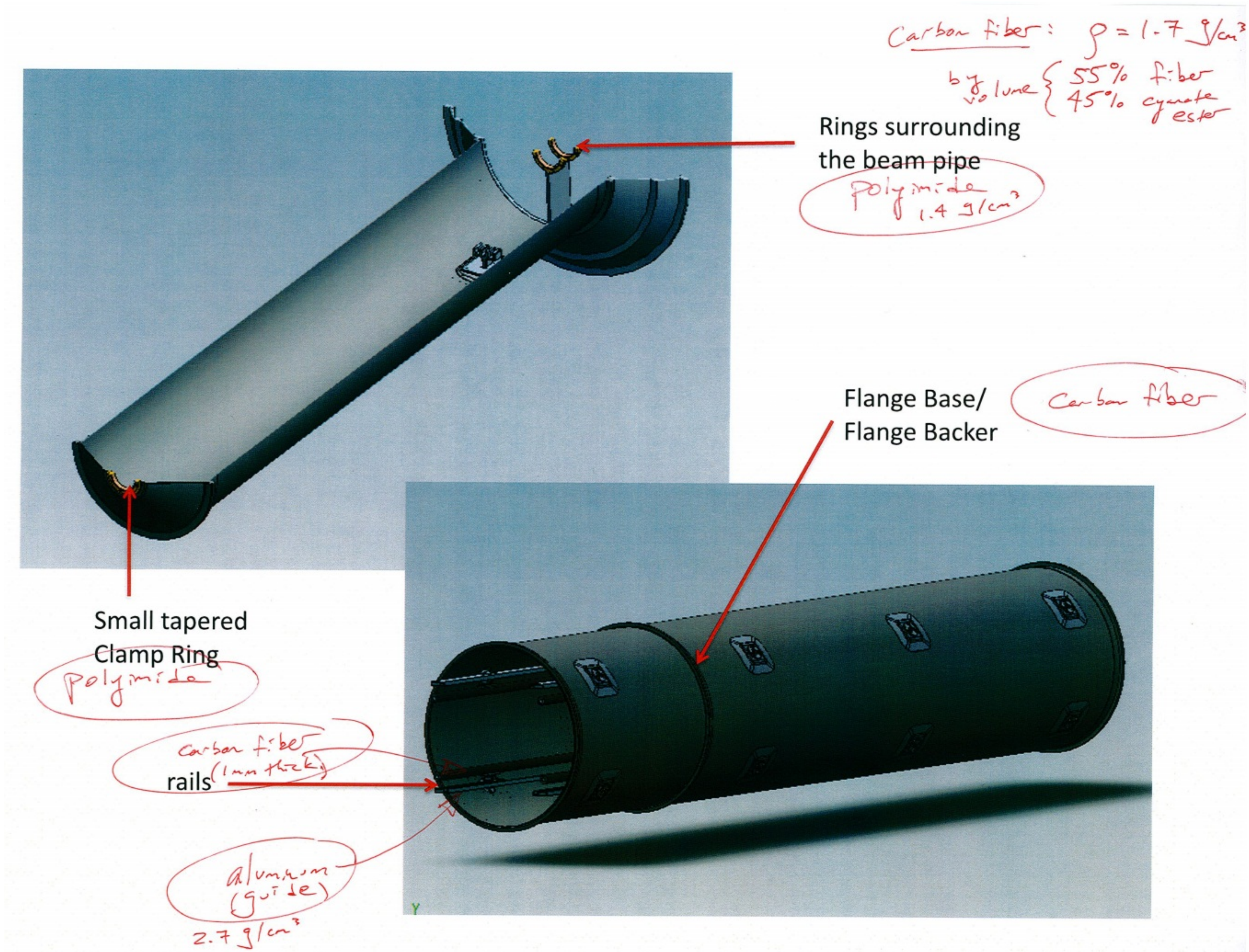
driver section
4 layer with copper traces
TOP, PWR, GND, BOT
adhered to the tab of kapton
coming from the sensor section

Sensor section
2 layer with Cu (later Al) traces.
TOP, BOT
wire bonded across gap to the buffer section

The diced size of Ultimate is 2.024 x 2.273 cm
The corner of sensor # 1 is located at 12.692, 0.163
This design has the following characteristics:
1. Common power routing for VDDA, VDDD for sensors.
2. Soldered wires to carry signals and power to/from cable.
3. Wire bond connections between cable types.

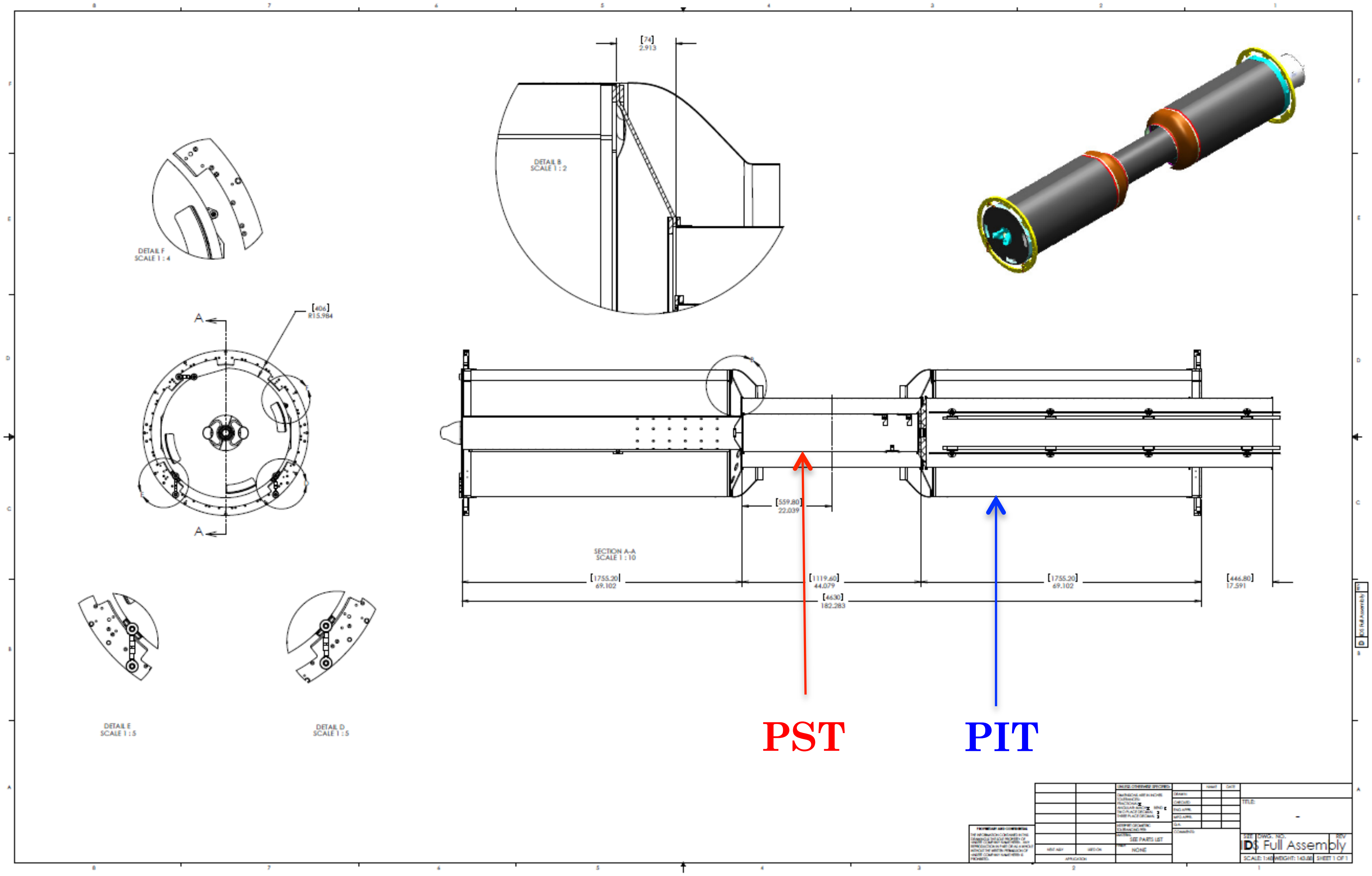
Leo Greiner
10/7/2011

MATERIAL FOR SOME PARTS OF THE MSC



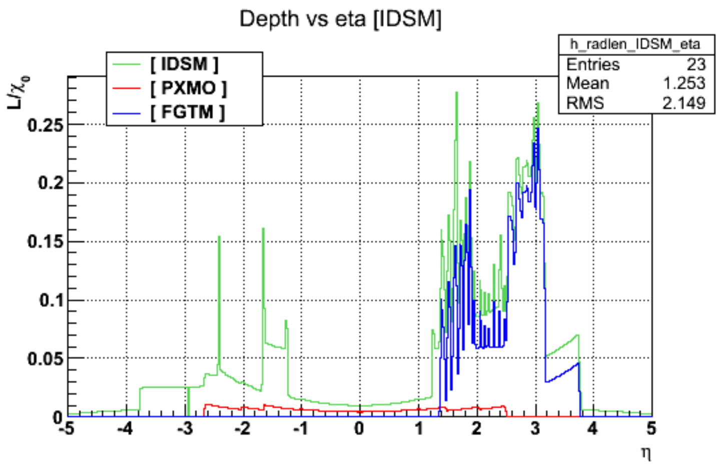
From Joe Silber

IDS ENVELOPE/INTERFACE DRAWING

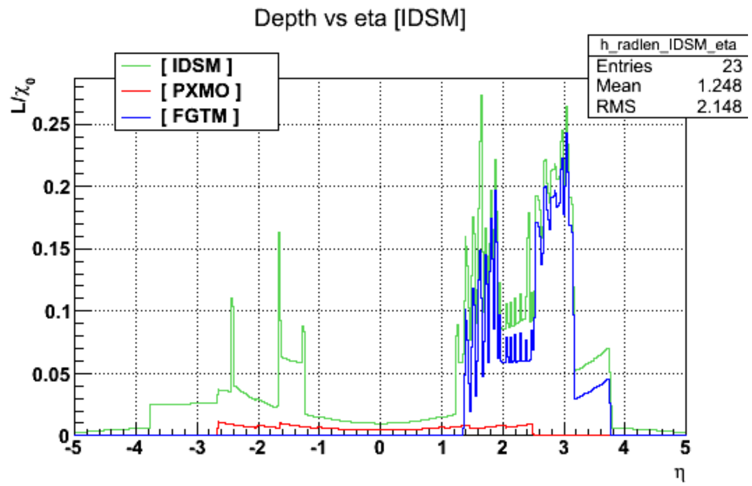


RADIATION LENGTH VS η FOR IDSM, PIXEL, FGT

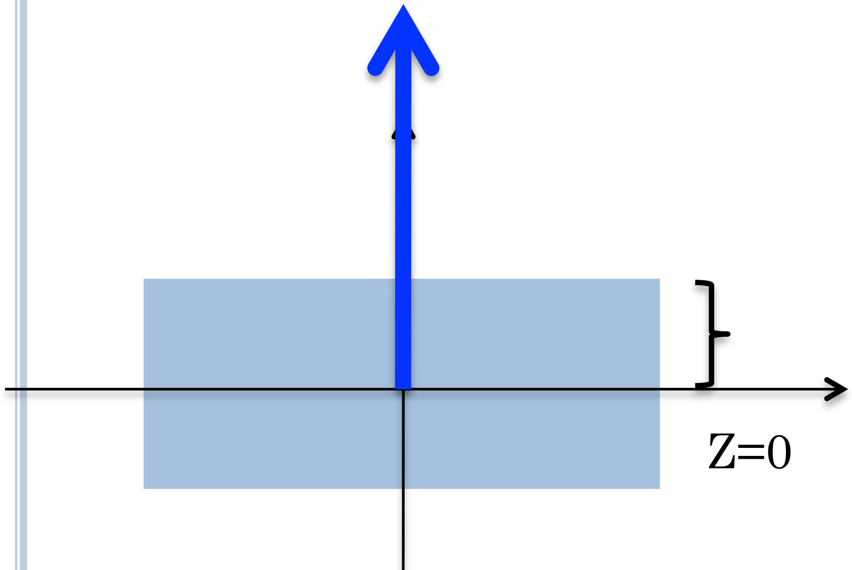
- Default parameters are :
  - Ntrig = 4
  - d ϕ =.2
  - d η = .1
  - | η |<6
  - | ϕ |<1 deg.



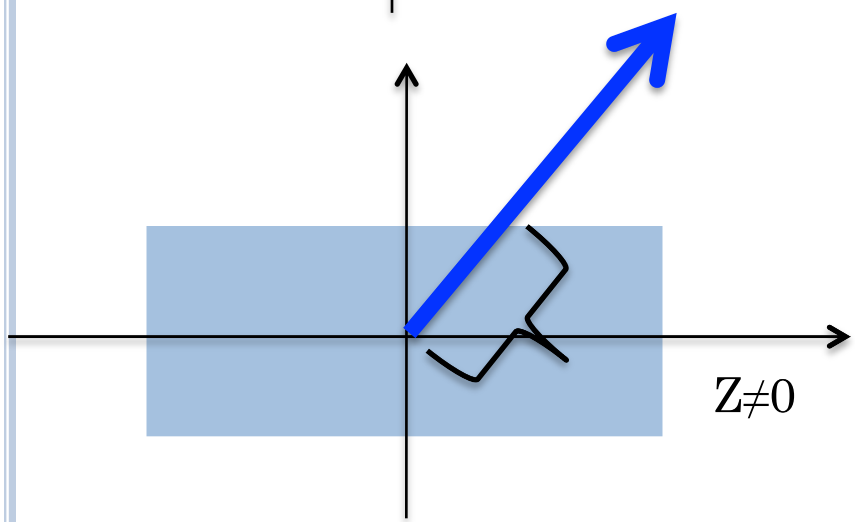
- Same with Ntrig =100
- Increasing the # of triggers give a slightly better resolution



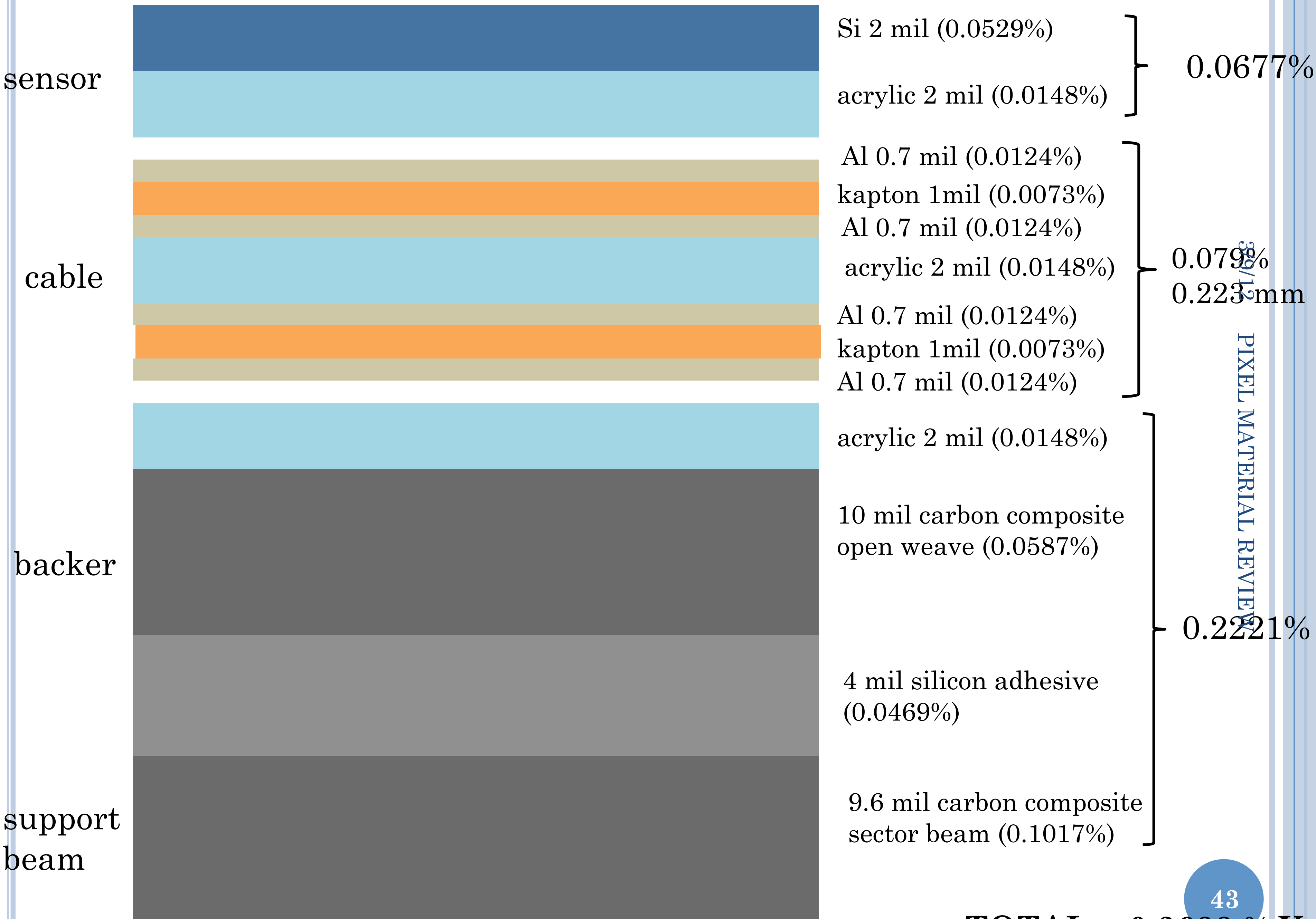
EXPLANATION OF THE "RADLEN VS. Z/ETA" PROFILE



Real length of material crossed by the particle



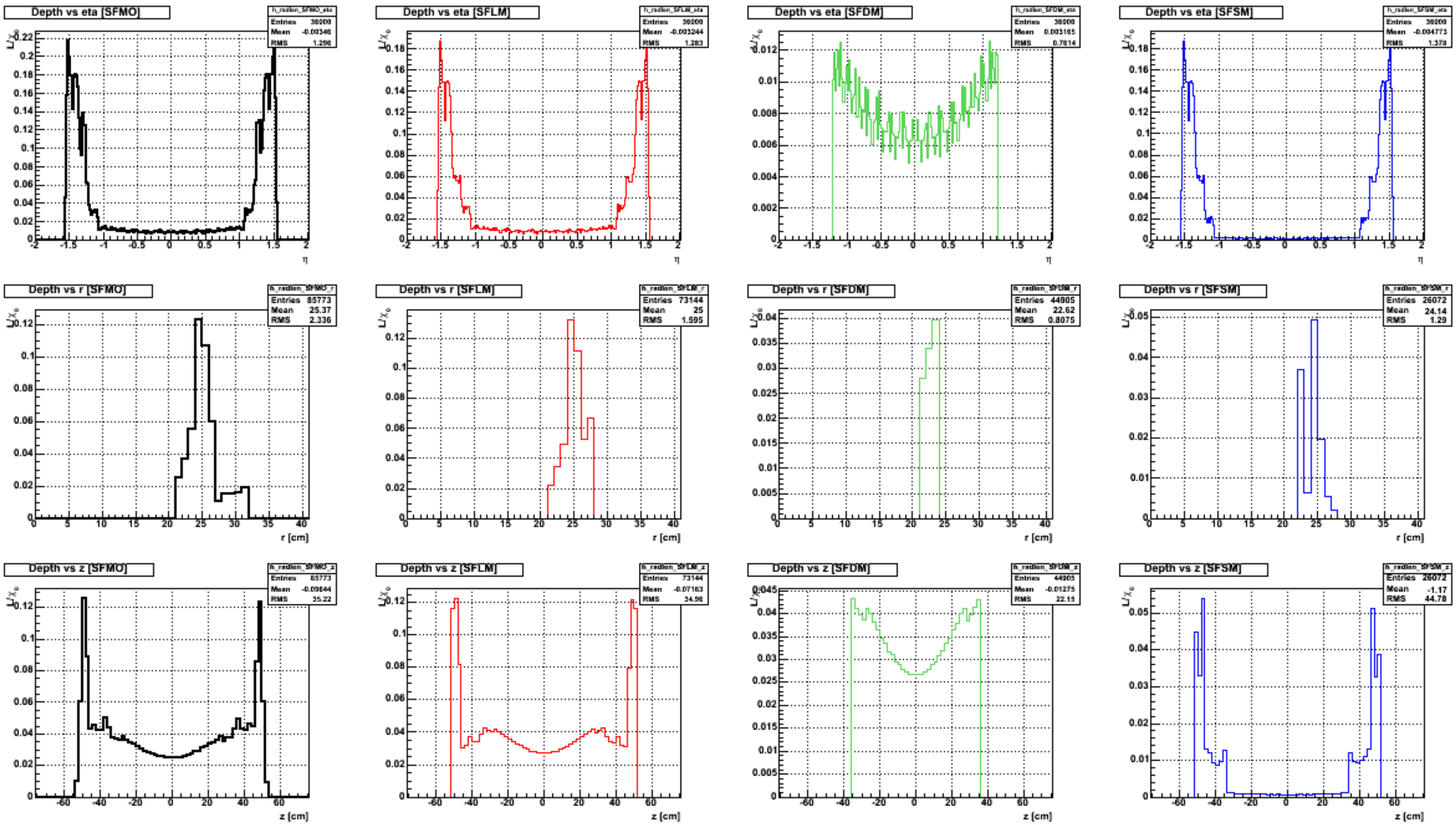
Real length of material crossed by the particle

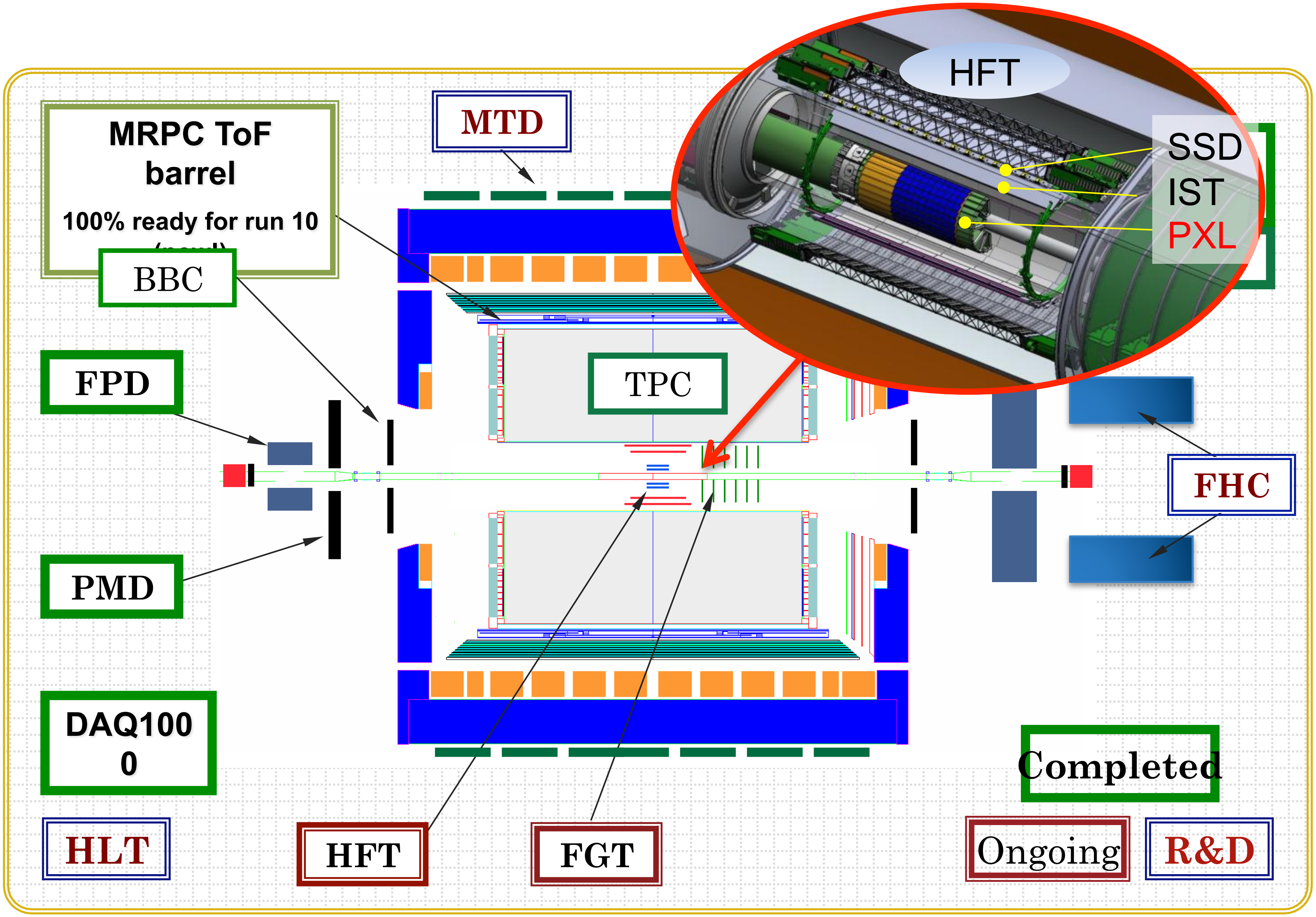


TOTAL = 0.3688 % X_0

CHECK WITH THE [SSD] VOLUME

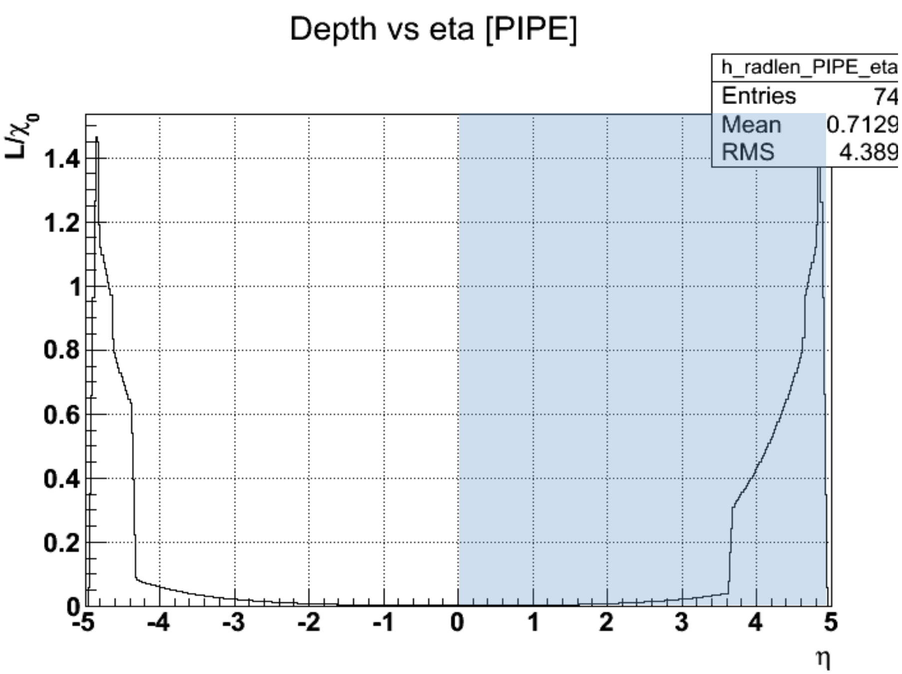
ALL "SSD"	SSD LADDERS	ACTIVE SILICON	RDO

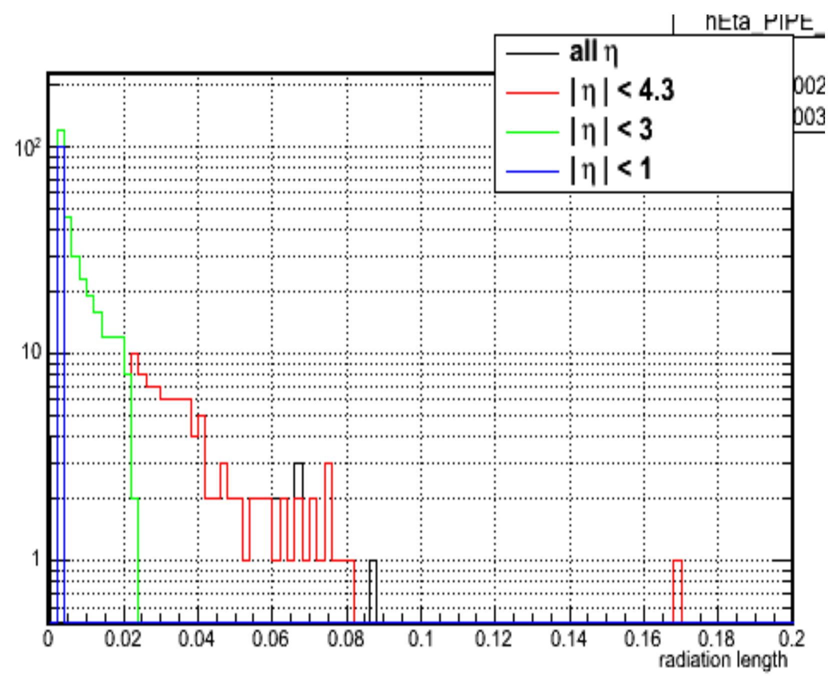




➔ This review is focused on the PXL and its support structure

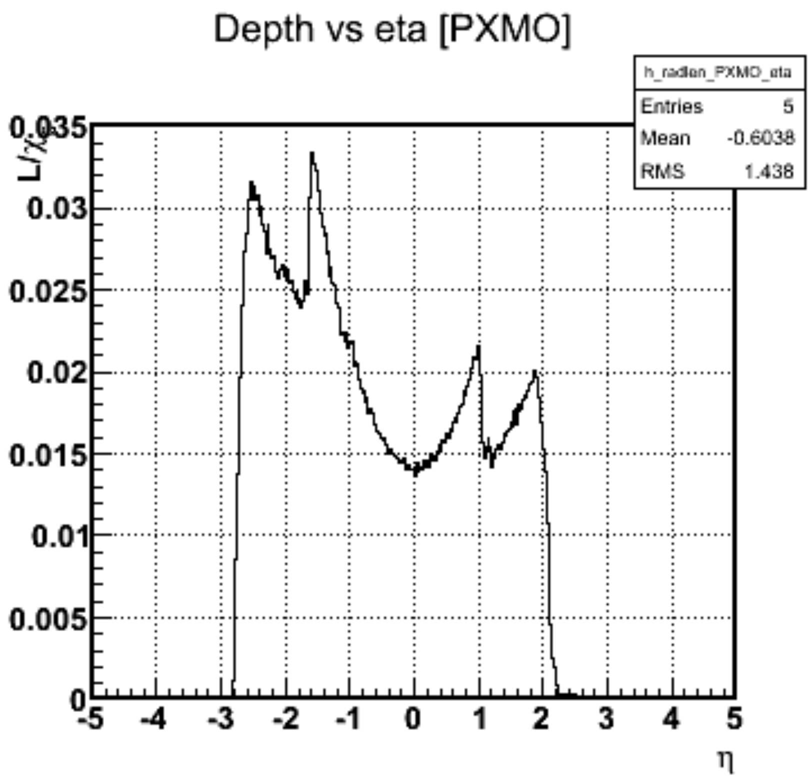
RADIATION LENGTH OF THE BEAM PIPE (STARBASE)

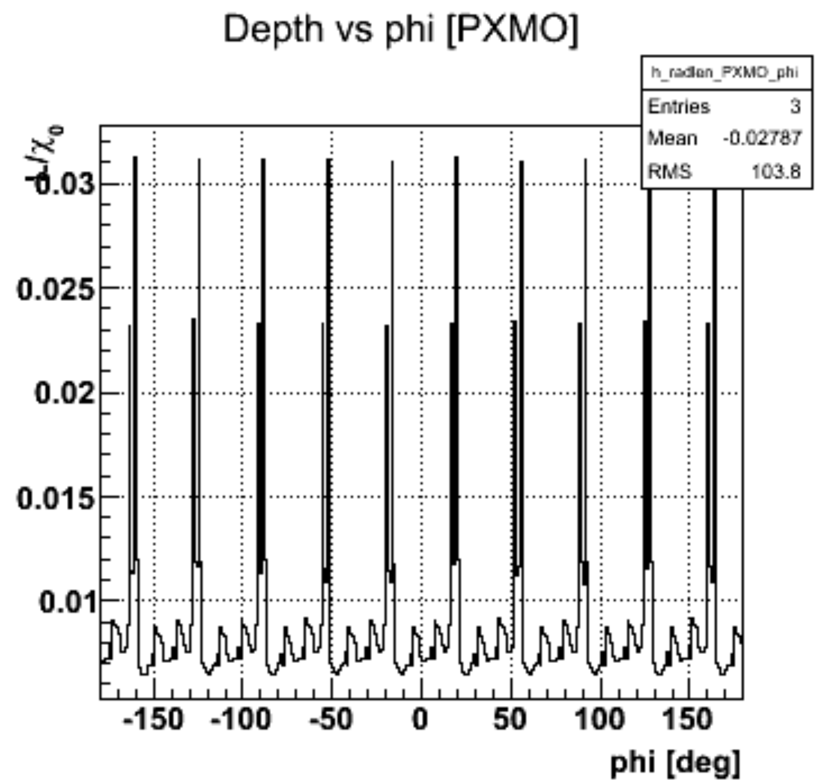




At mid rapidity (| η |<1), the radiation length is ~ 0.25%X0

PIXEL DETECTOR [PXMO VOLUME]
RADIATION LENGTH





- right : radiation length vs. azimuth.
- We observe double peaks (high radiation length) for tracks crossing the entire sector support
- Other small peaks are the overlaps between ladder.