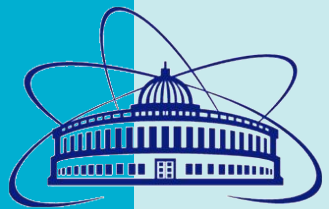

XIII Collaboration Meeting of the MPD Experiment at the NICA Facility

# Simulation of a Mini Beam Beam detector for the MPD.

**Ivonne Maldonado**

April 24th, 2024



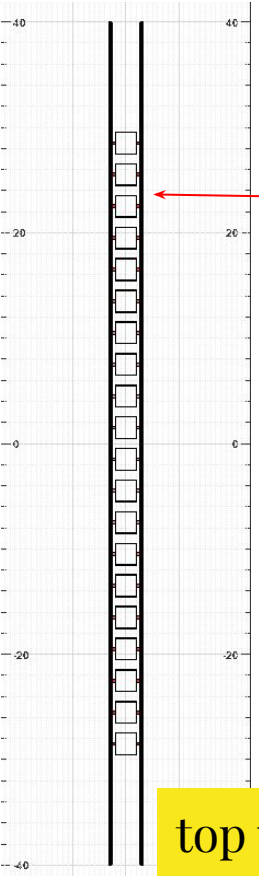
# Outline

1. Introduction
2. MiniBeBe New Geometry
3. DataSet description
4. Results
5. Summary

# Introduction

- MiniBeBe detector was proposed as a wake-up trigger for TOF detector.
- Should be efficient for low multiplicity events like p+p, p+A and A+A.
- Geometry of detector has been suffered several changes from its original design, to be adapted to the Inner Barrel of ITS, a coaxial cylinder of 312 mm of diameter.
- Designed to be used only in Phase 0

# MiniBeBe - Geometry




top view

It consist on 8 **H-shaped** rails.

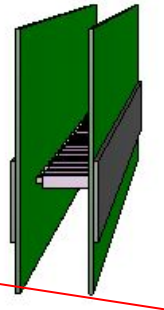
Each rail contains **20 plastic scintillators EJ232** - 20x20x5 $mm^3$ ↠

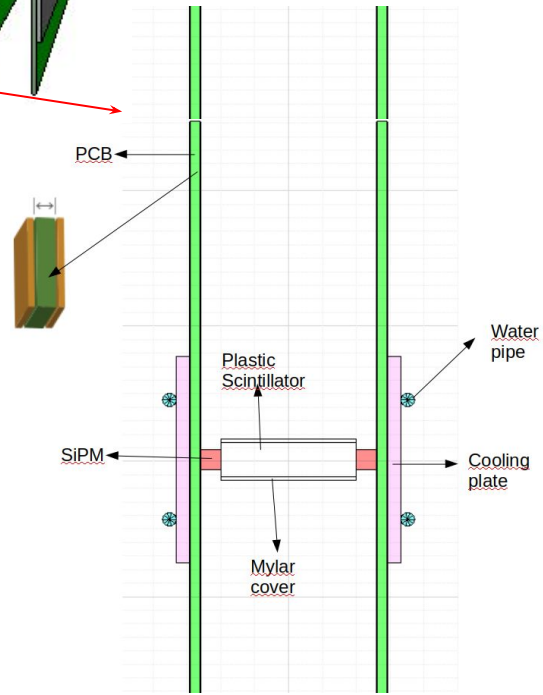
Sensitive area (-30, 30) cm

With two **SiPM Hamamatsu S13360-PE** at each side 3.07x3.07 $mm^2$

Fixed between PCB and Carbon Fiber cold plates (same of ITS)

Electronic boards 800 mm length, 100 mm width






front view

# MiniBeBe - Geometry

It consist on 8 **H-shaped** rails.

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With two **SiPM Hamamatsu S13360-PE** at each side 3.07x3.07 $mm^2$

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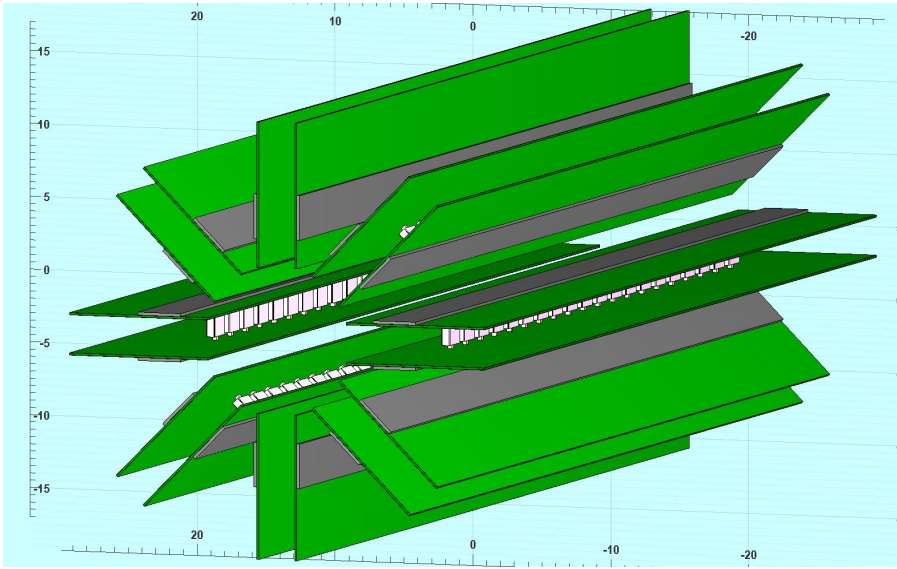
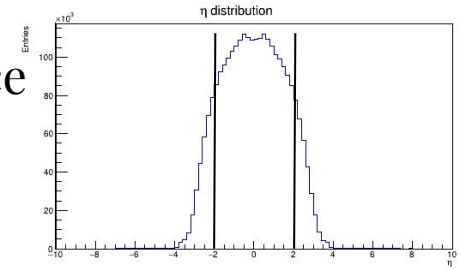


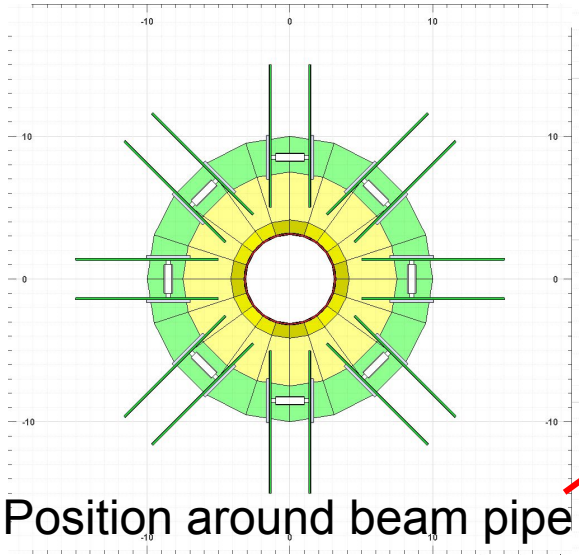

perspective view

# Position in the MPD experiment

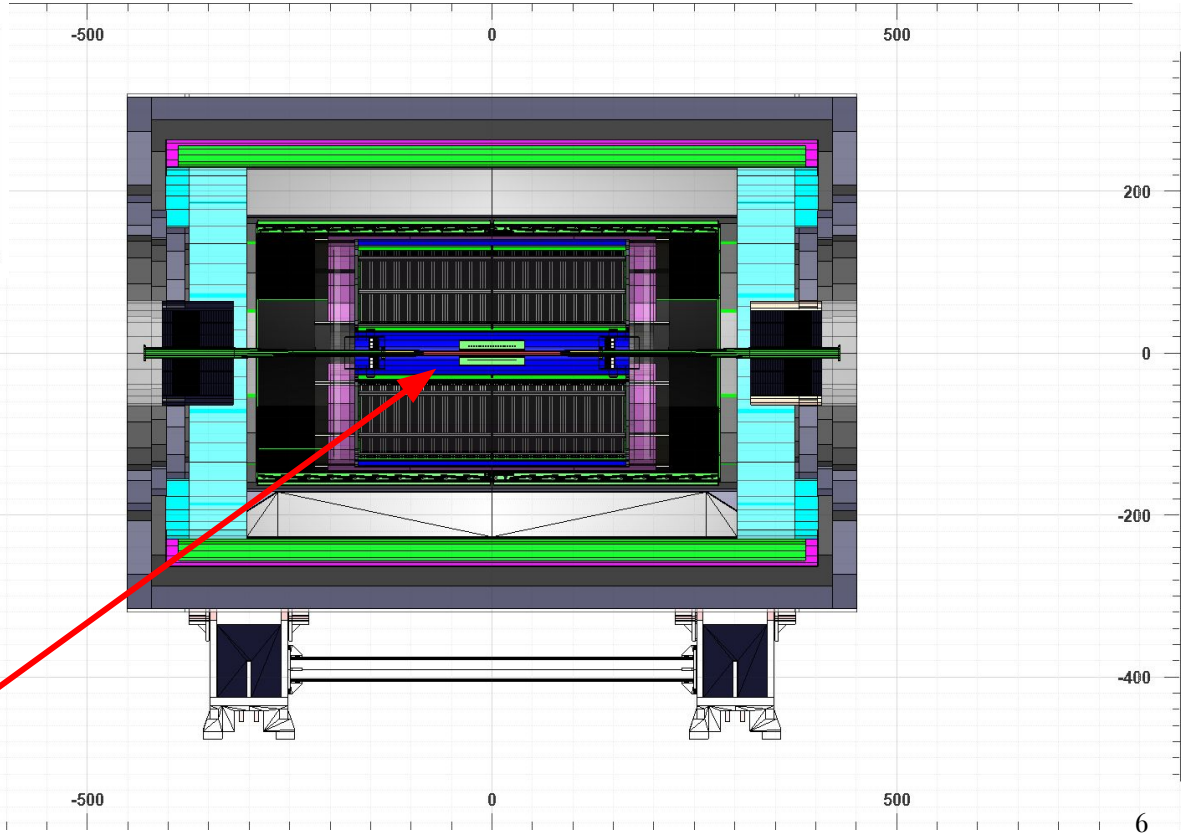
Acceptance

|eta| < 1.9

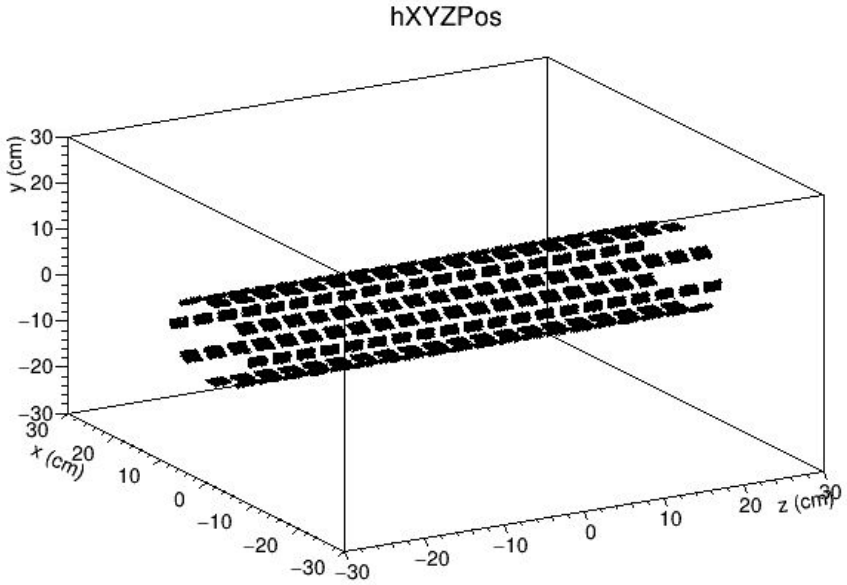


Position around beam pipe



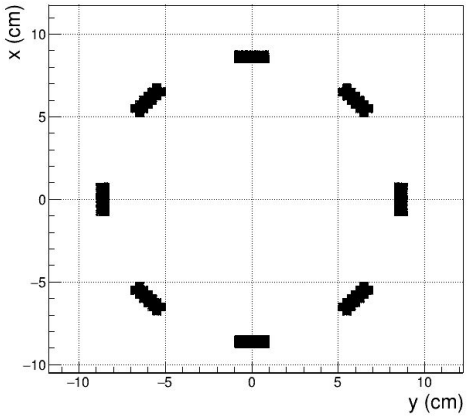
# Interaction of Particles with Plastic Scintillators




Plastic scintillators are distributed uniformly along z-axis between -30 to 30 cm.

8 scintillators at each z-position

We estimate the probability that exist at least 1 MbbPoint at each ring (each z position)



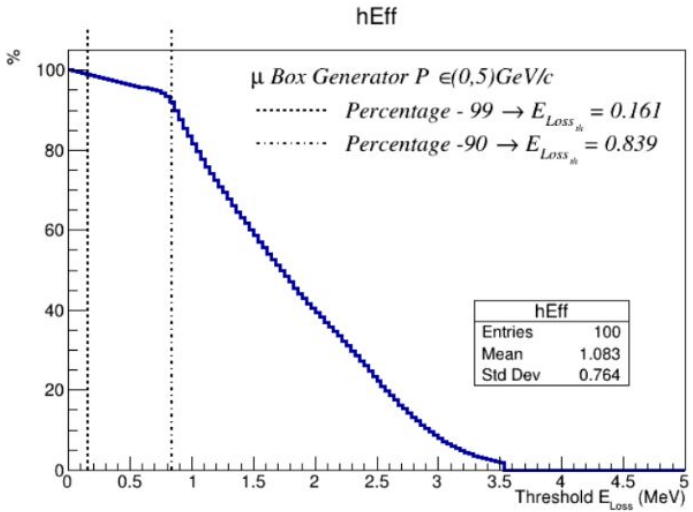
# Data sets analyzed

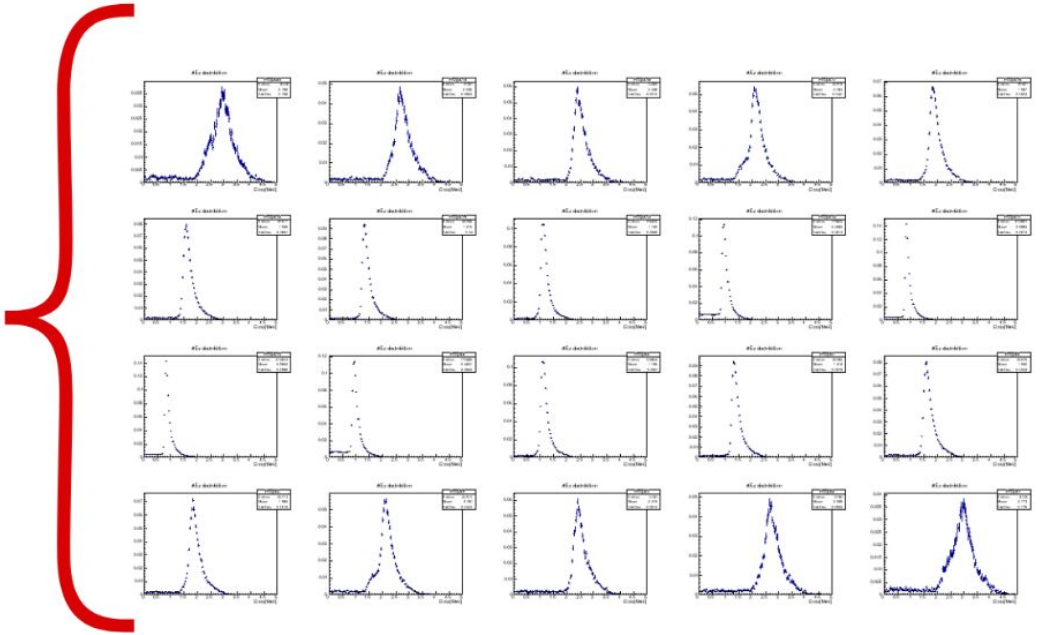
- 5M events of p + p,  200k events of Xe + Xe and 1M events of Bi +Bi collisions at $\sqrt{s}$ = 9.2 GeV with PHSD generator

- Primary vertex smearing $\sqrt{\sigma_z}$ = 50 cm for Trigger Efficiency

- No Primary vertex smearing for Energy loss at plastic scintillators - to estimate threshold energy ➛ BOX generator for $\mu$, PHSD for $\pi$

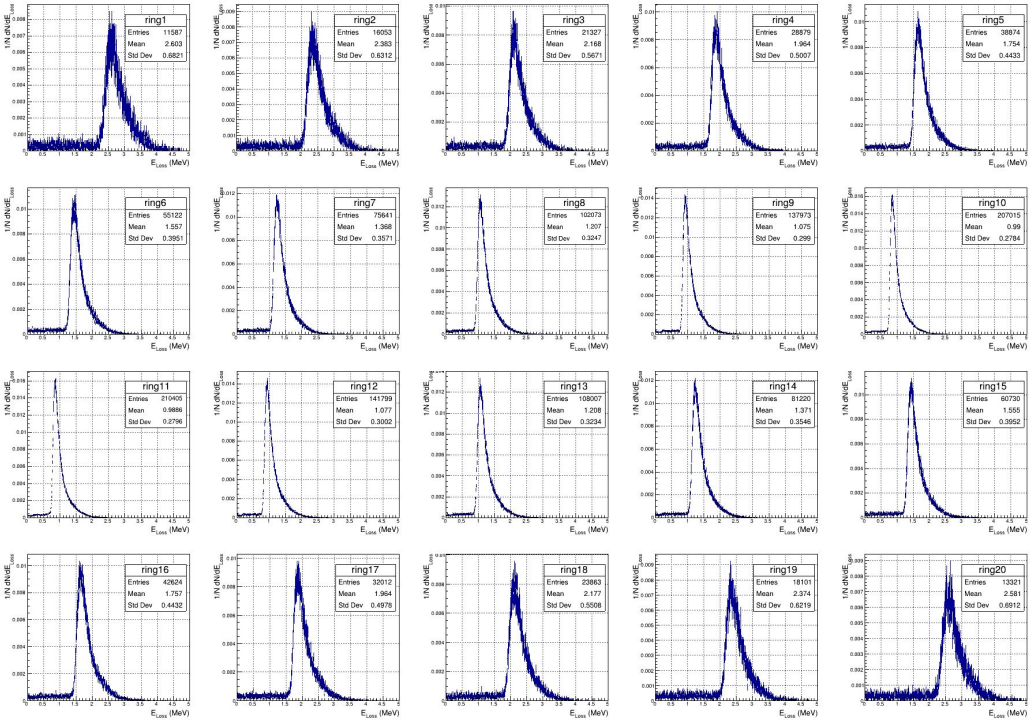
# Energy deposition at each ring

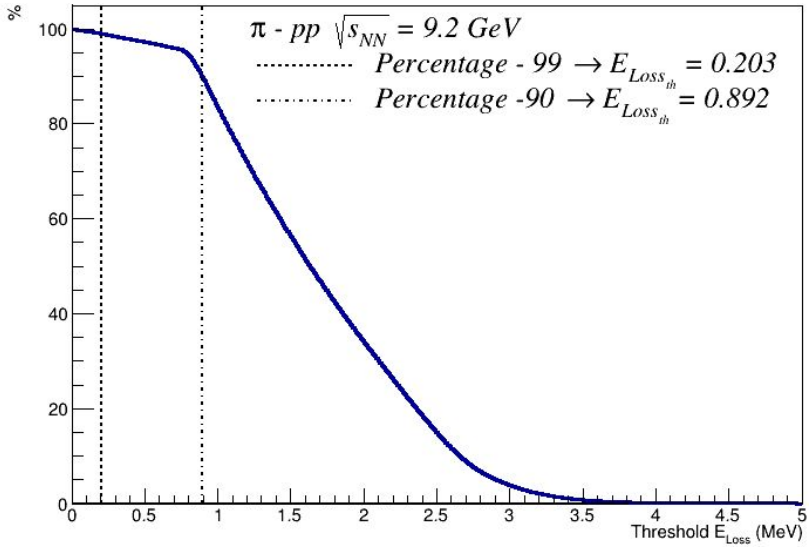


Threshold energy - $E_{Loss}$ = 0.839 MeV for $\mu$, similar value for $\pi$

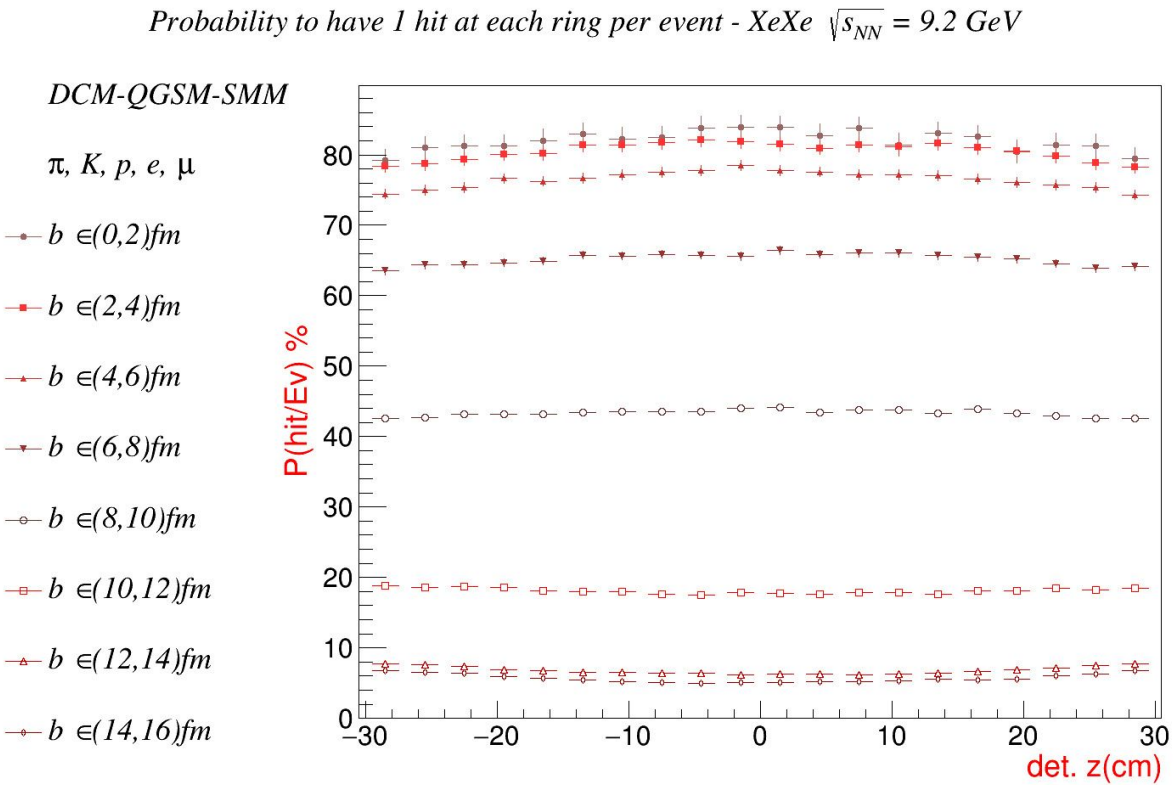
# Energy deposition at each ring



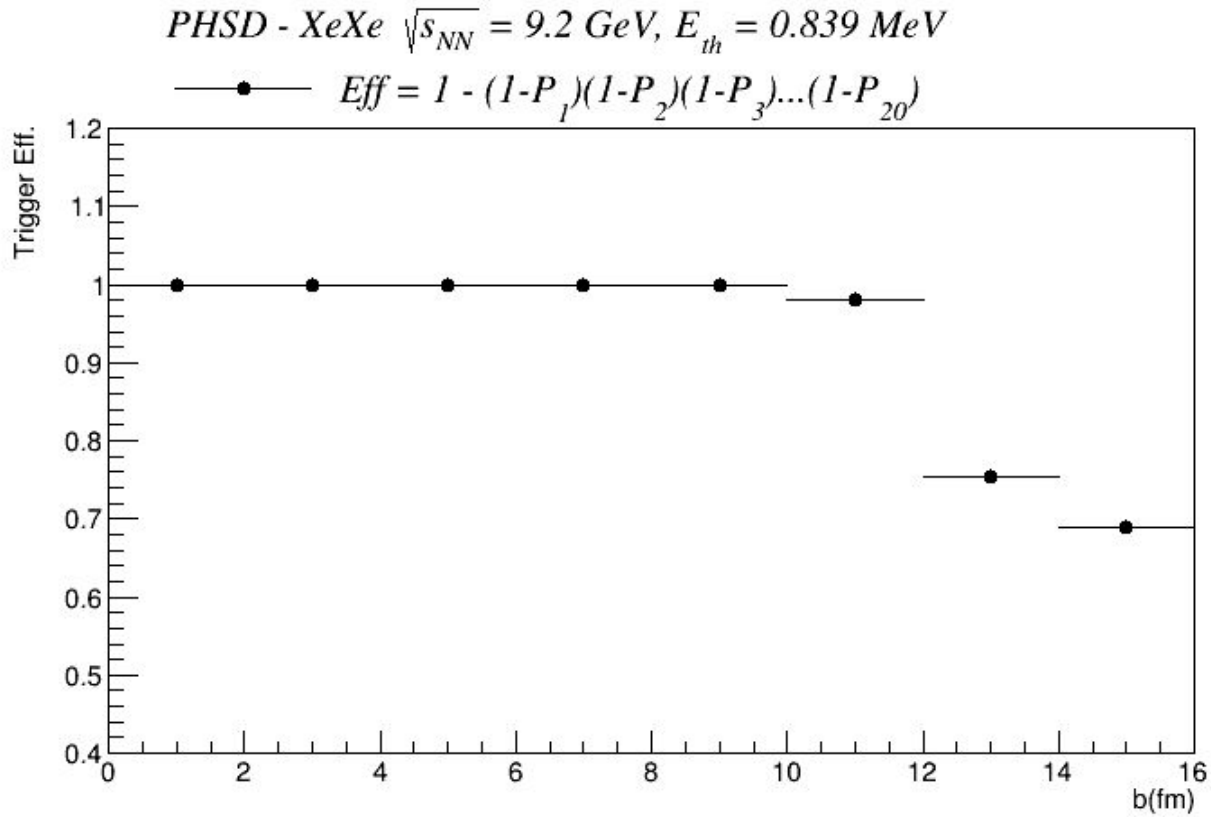

Threshold energy ~ 0.9 MeV

# Xe+Xe collisions, Probability to 1 hit as a function of z - position

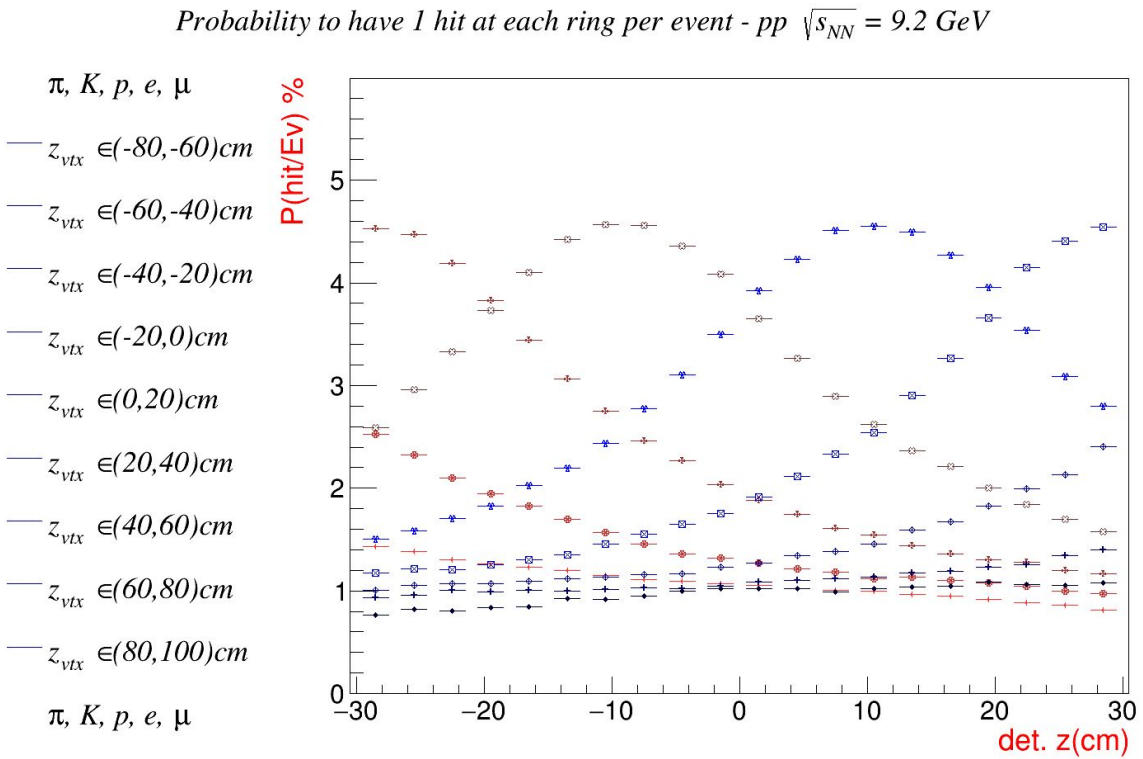



At least one charged MbbPoint at each ring, for events with different impact parameter

# Trigger Efficiency as a function of Impact Parameter for Xe+Xe



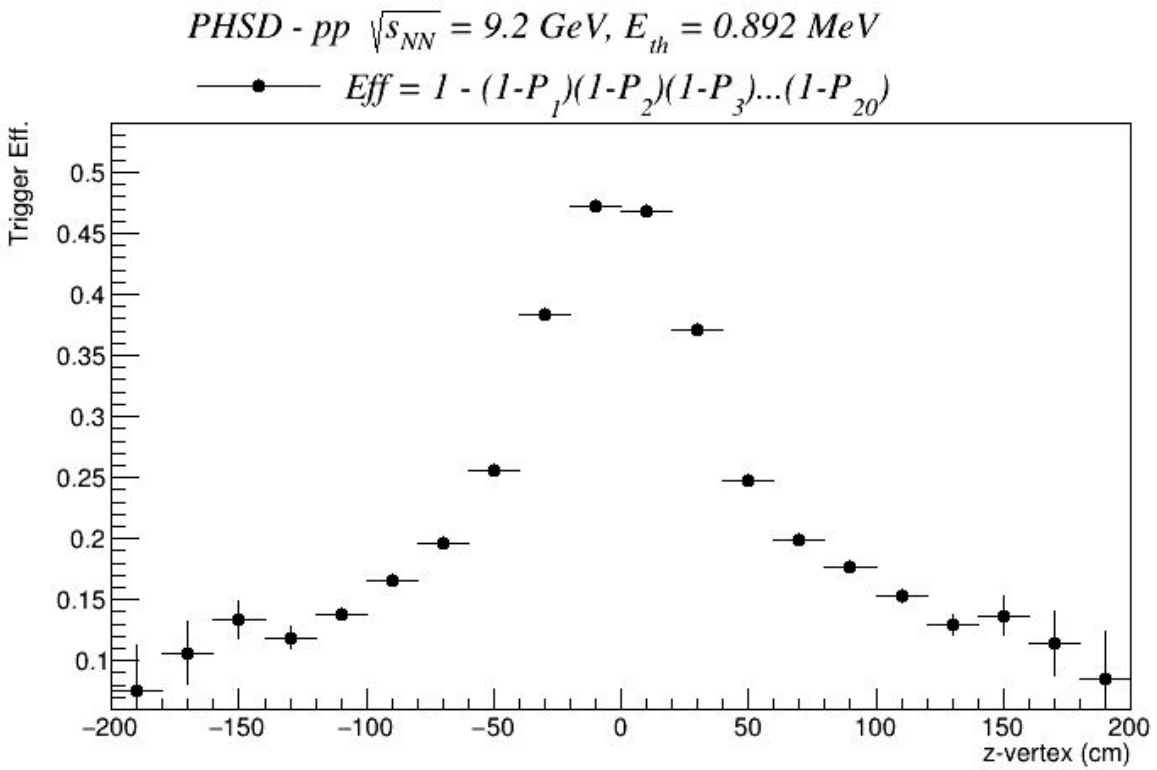
# p+p collisions, Probability to 1 hit as a function of z - position




The smallest collision system

At least one charged MbbPoint at each ring, for events with different primary vertex position

# Trigger Efficiency as a function of Impact Parameter for p+p




Trigger efficiency is not uniform

Trigger Efficiency > 35% only for events with primary vertex ∈ (-40,40)cm

# Material Budget

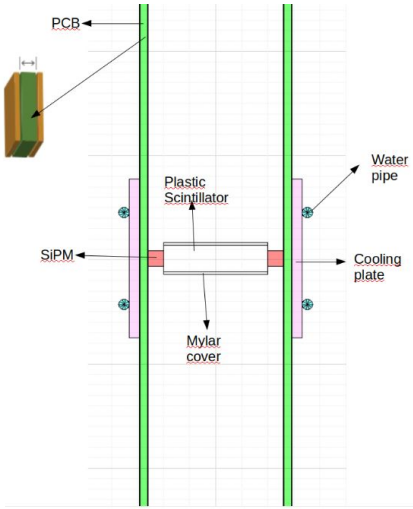
## Radiation Length

The radiation length can be approximated by:

$$X_0 = \frac{716.4 \times A}{Z(Z+1)ln(\frac{287}{\sqrt{Z}})} \quad \left[\frac{g}{cm^3}\right] \qquad (1)$$

For different materials:

$$\frac{W_0}{X_0} = \sum_i \frac{W_i}{X_i} \qquad (2)$$




(a) perspective view

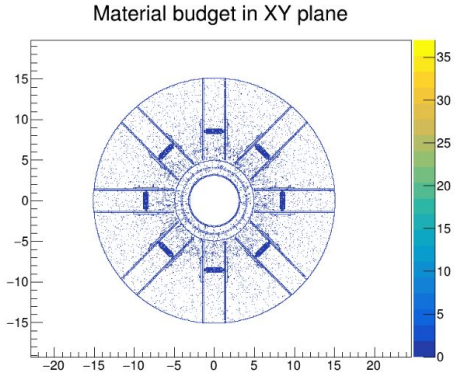
| Element | Dimensions |
|---|---|
| Plastic Scintillator | 20x20x5 $mm^3$ |
| SiPM | 3x3x3 $mm^3$ |
| Mylar cover | thickness = 0.5 mm |
| FR4 | 800x100x1.4 $mm^3$ |
| Copper | 800x10x0.1 $mm^3$ |
| Cooling plate | 800x30.6x2 $mm^3$ |
| Water pipe | radius = 1.025 mm |

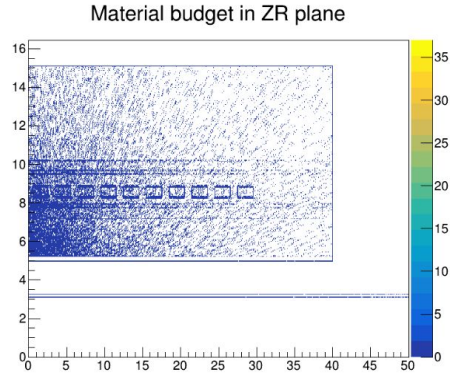
(b) Dimensions of material in the rail used for material budget simulation.

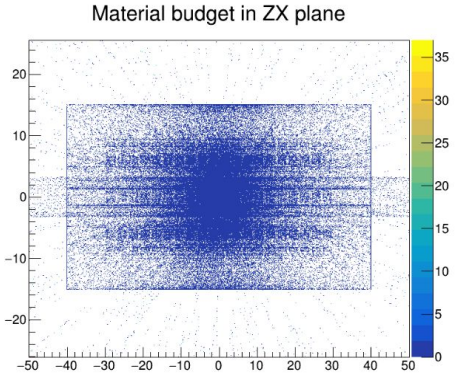
| Element | $X_0$ ($g/cm^2$) | $\rho$ (g/cm3) | $\bar{X}$ (cm) | Average Mat. Budget % |
|---|---|---|---|---|
| Plastic Scintillator & SiPM | 43.3886 | 1.032 | 0.57 | 1.31 |
| Mylar | 39.69 | 1.39 | 0.07 | 0.25 |
| FR4 | 288.67 | 1.86 | 1.25 | 0.80 |
| Copper | 12.86 | 8.96 | 0.10 | 6.83 |
| Carbon-Fiber | 42.11 | 1.383 | 1.30 | 3.09 |
| air | 1.205E-3 | 36.66 | 7.08 | 0.02 |
| water | 35.758 | 1. | 0.253 | 0.7 |

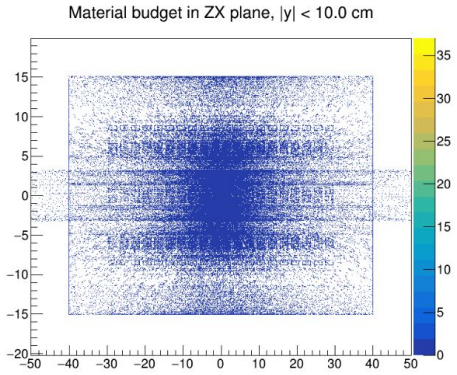
Table 1: Radiation Length $X_0$ and density $\rho$ of materials used in simulation. Also is shown the average distance $\bar{X}$ traveled by particles on each material and the corresponding material budget.

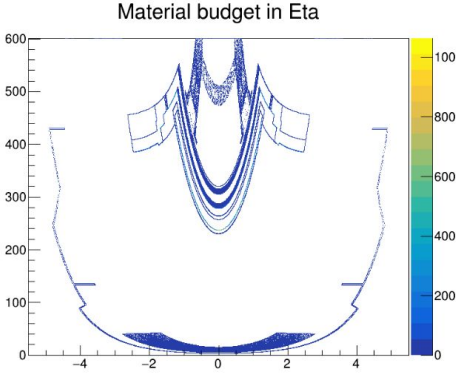
# Projection on material budget in different planes



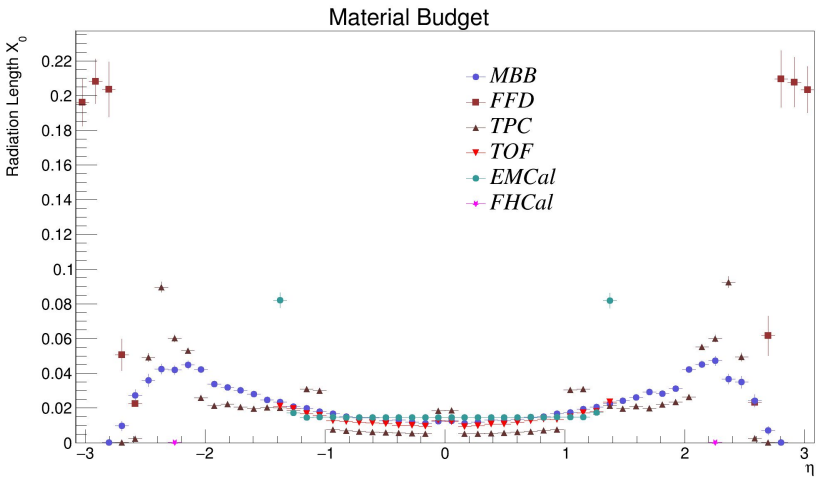



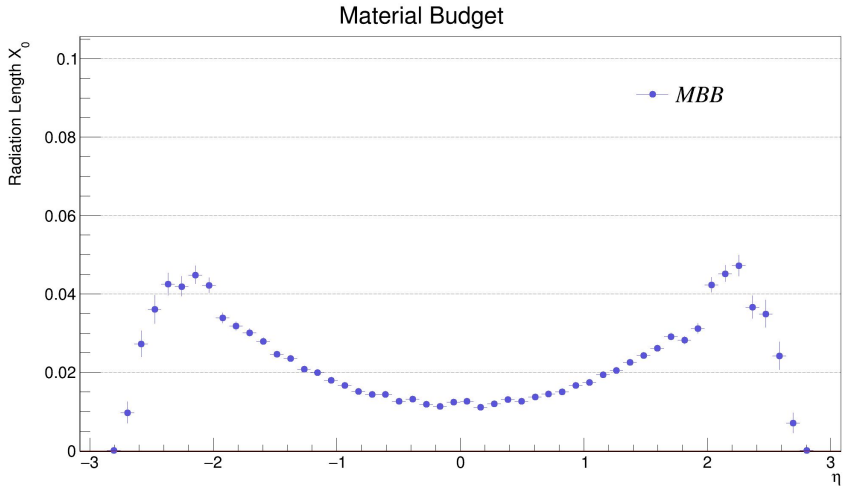



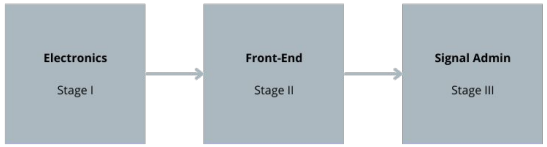
# Average Material Budget



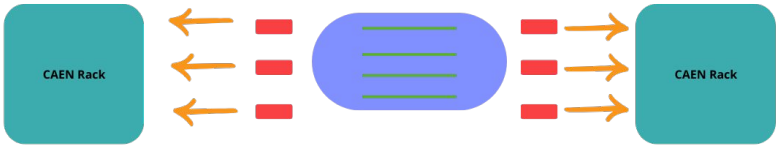

Around 2% for |eta| < 1.9

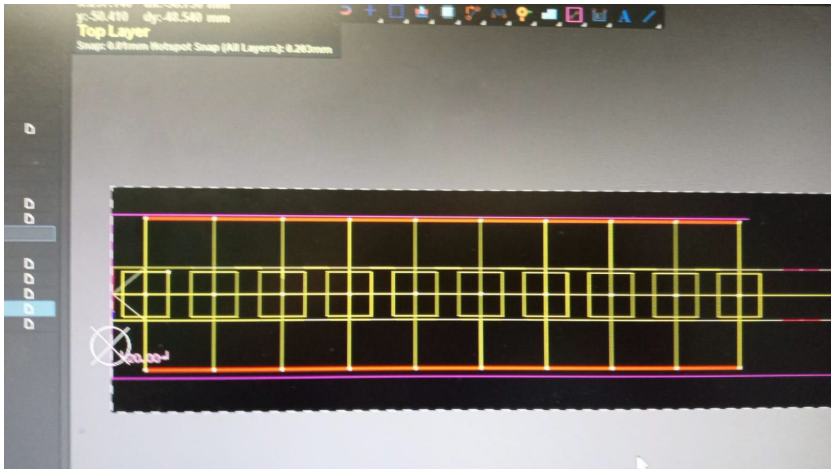
# Status of Electronics



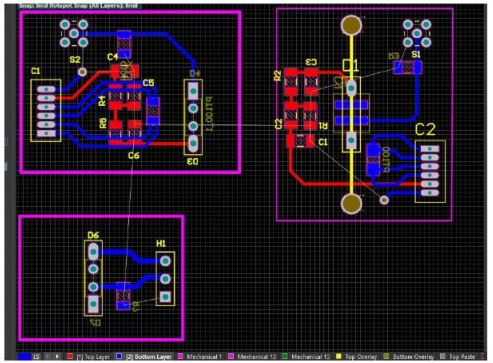

Electronic boards

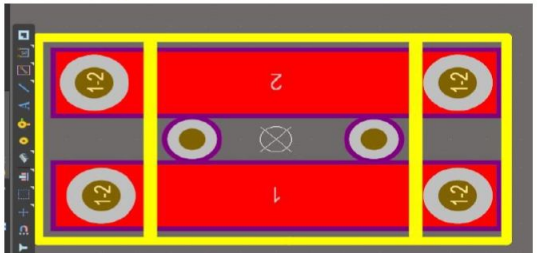
Blue prints



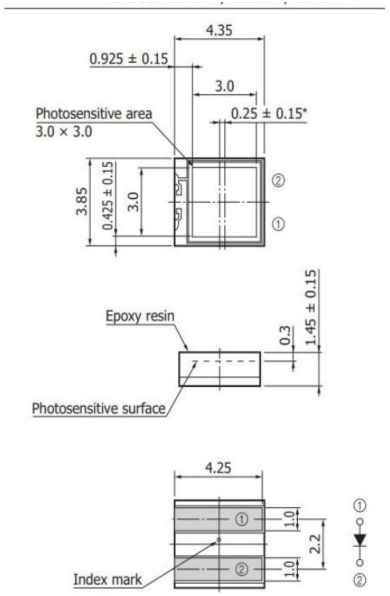




Stage I

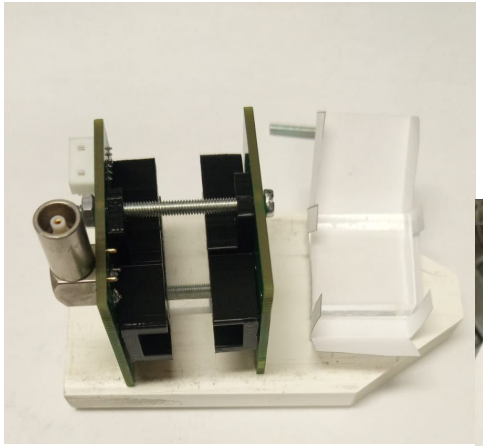


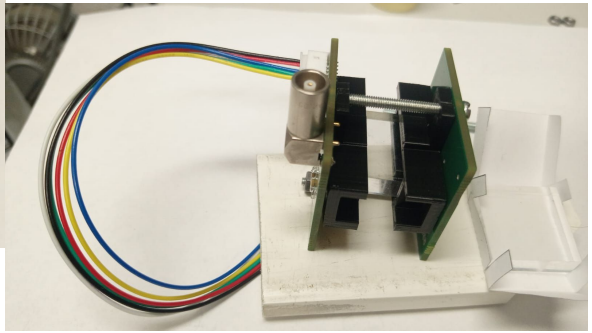


Stage II Stage III

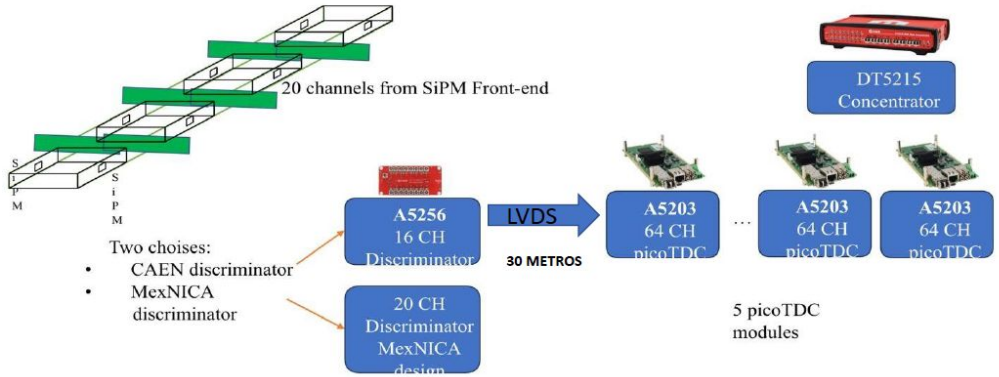


# Electronic Boards





## Rack interconnection




OPCIONES
-caen
-FRONT END

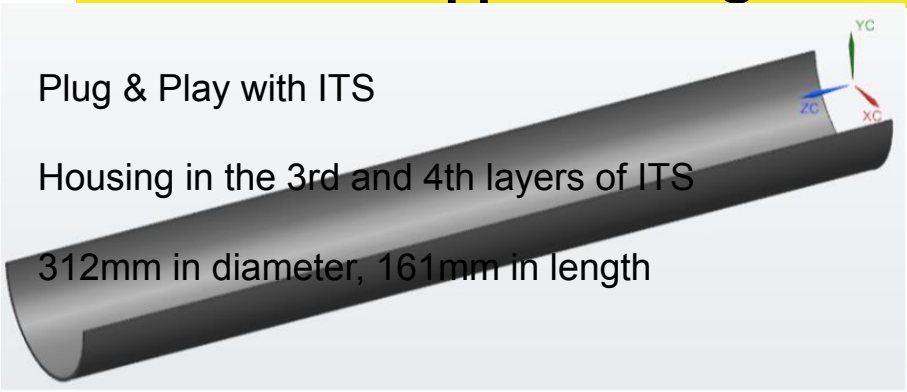
https://www.caen.it/products/a5255/
https://www.caen.it/products/a5256/
https://www.caen.it/products/dt5203/

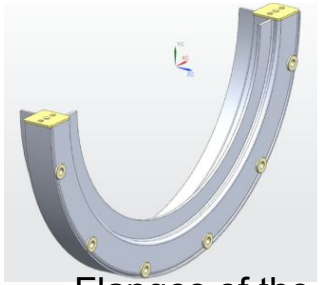
# Mechanical support - Plug & Play MPD-ITS Mechanical Support

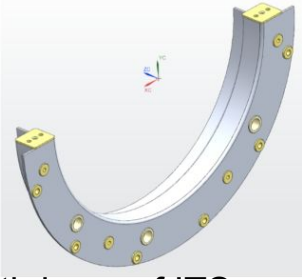
Plug & Play with ITS

Housing in the 3rd and 4th layers of ITS

312mm in diameter, 161mm in length

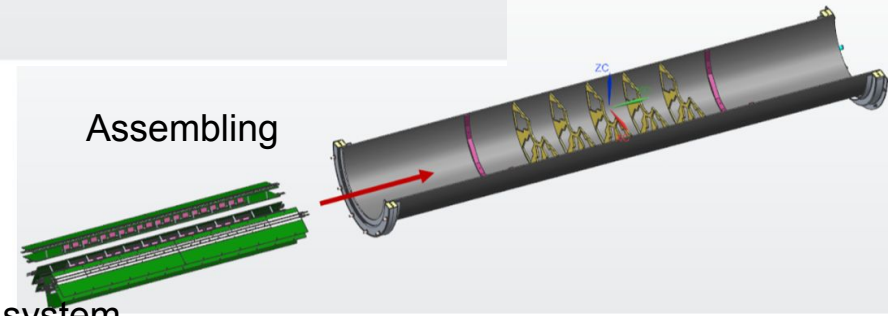


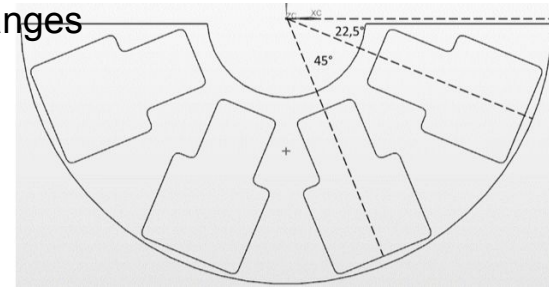


Flanges of the 4th layer of ITS were redesigned
Bushings of 9.3mm

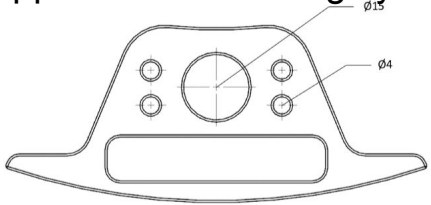
Assembling



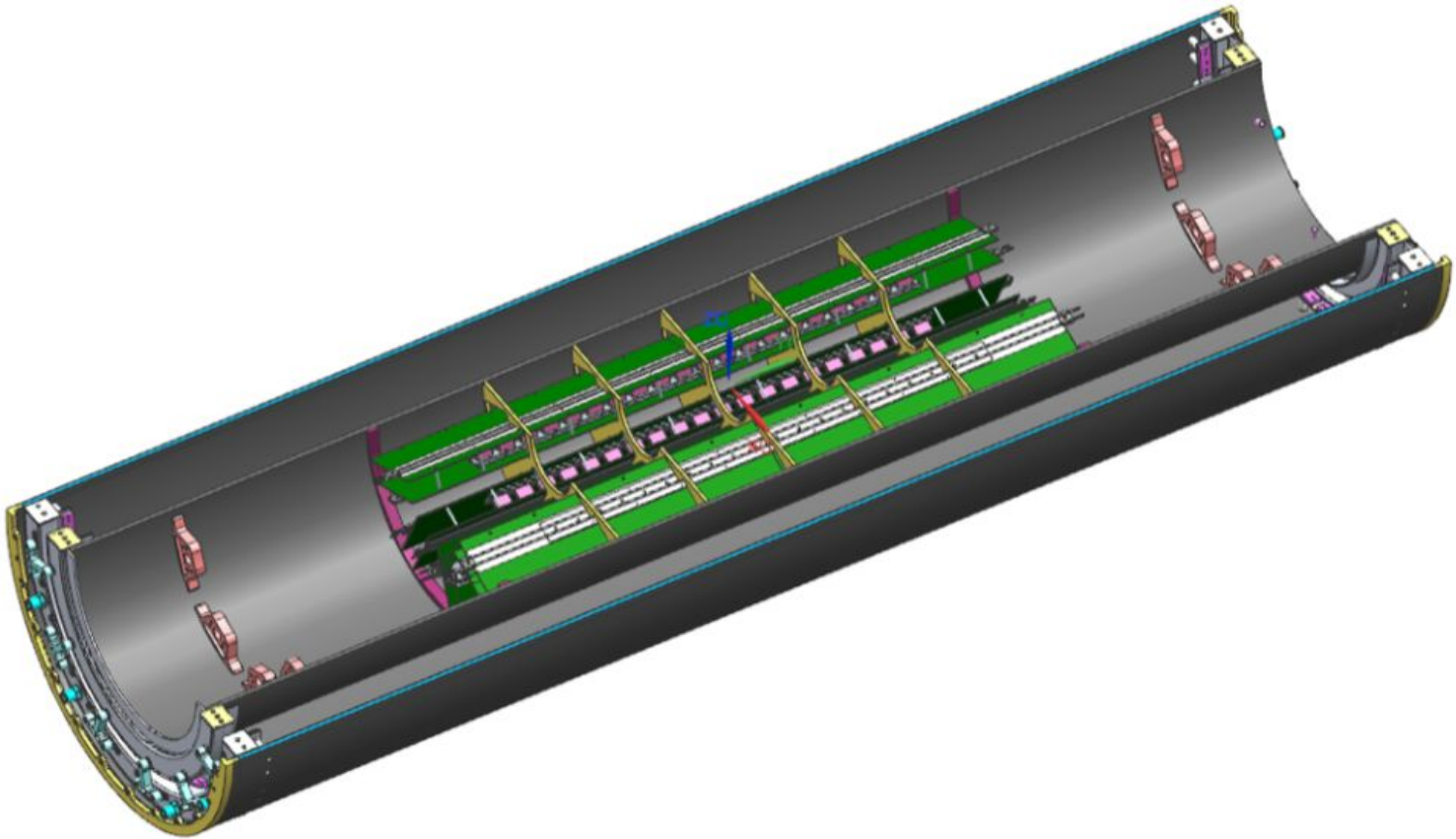

Electronic modules fixed with flanges




Supports fit the cooling system



# Integration to ITS



# Summary

Use of basic geometry and MpdRoot to test trigger efficiency in p+p and Xe+Xe collisions at $\sqrt{s}$ = 9.2 GeV with PHSD generator

For Xe+Xe collisions Trigger efficiency ~ 100% for b < 12fm

For p+p collisions Trigger Efficiency > 35% only for events with primary vertex $\in$ (-40,40)cm

Electronic boards and prototype is ongoing

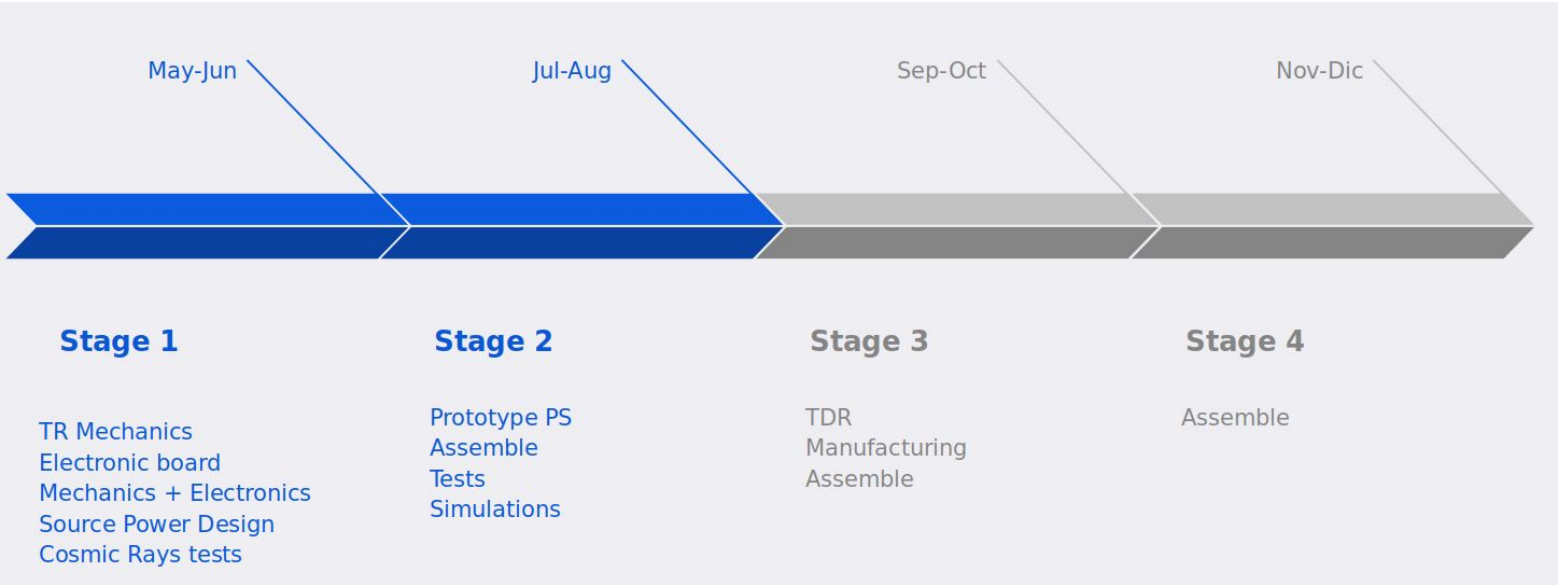
Preliminary design of mechanical support is done

Further studies are planned depending on capabilities of electronic cards

# Thanks for your attention!

# Backup

Deadline: end 2024



# Reaching time as a function of primary vertex position