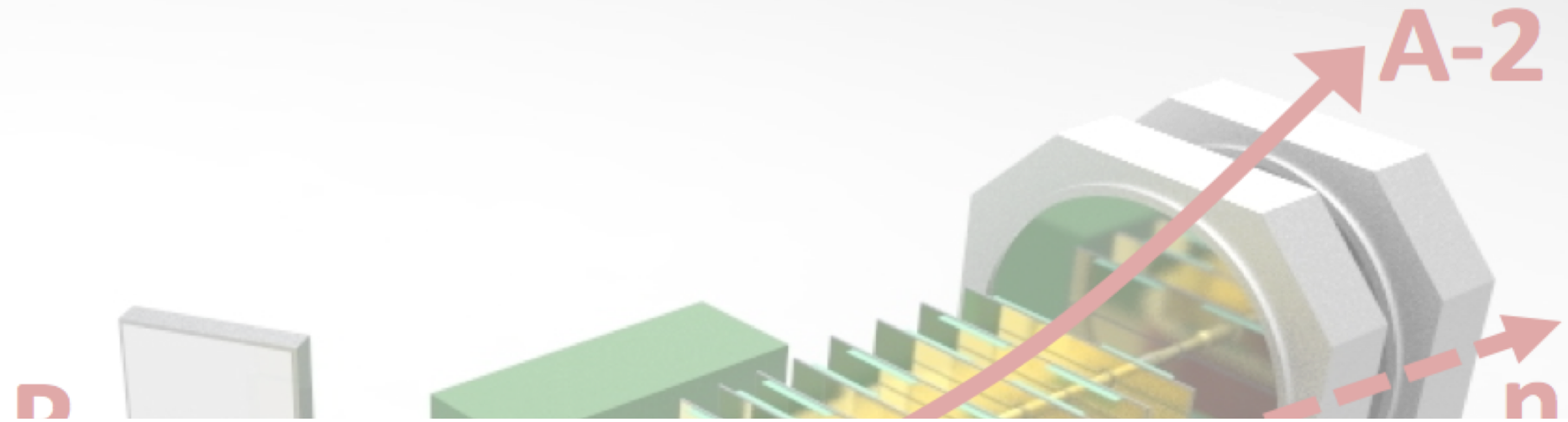
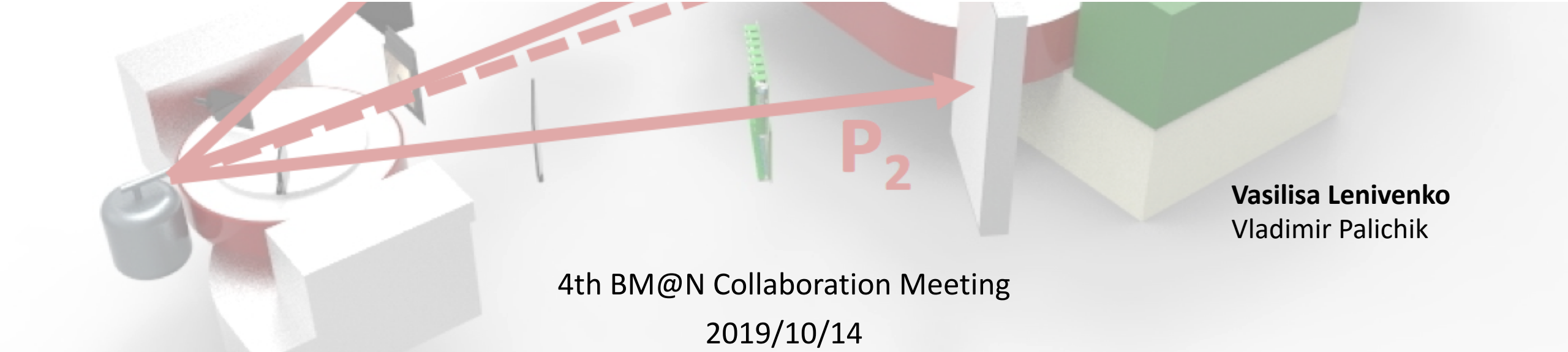


Track Reconstruction in Silicon/MWPC Detectors in SRC Run



Vasilisa Lenivenko
Vladimir Palichik

4th BM@N Collaboration Meeting

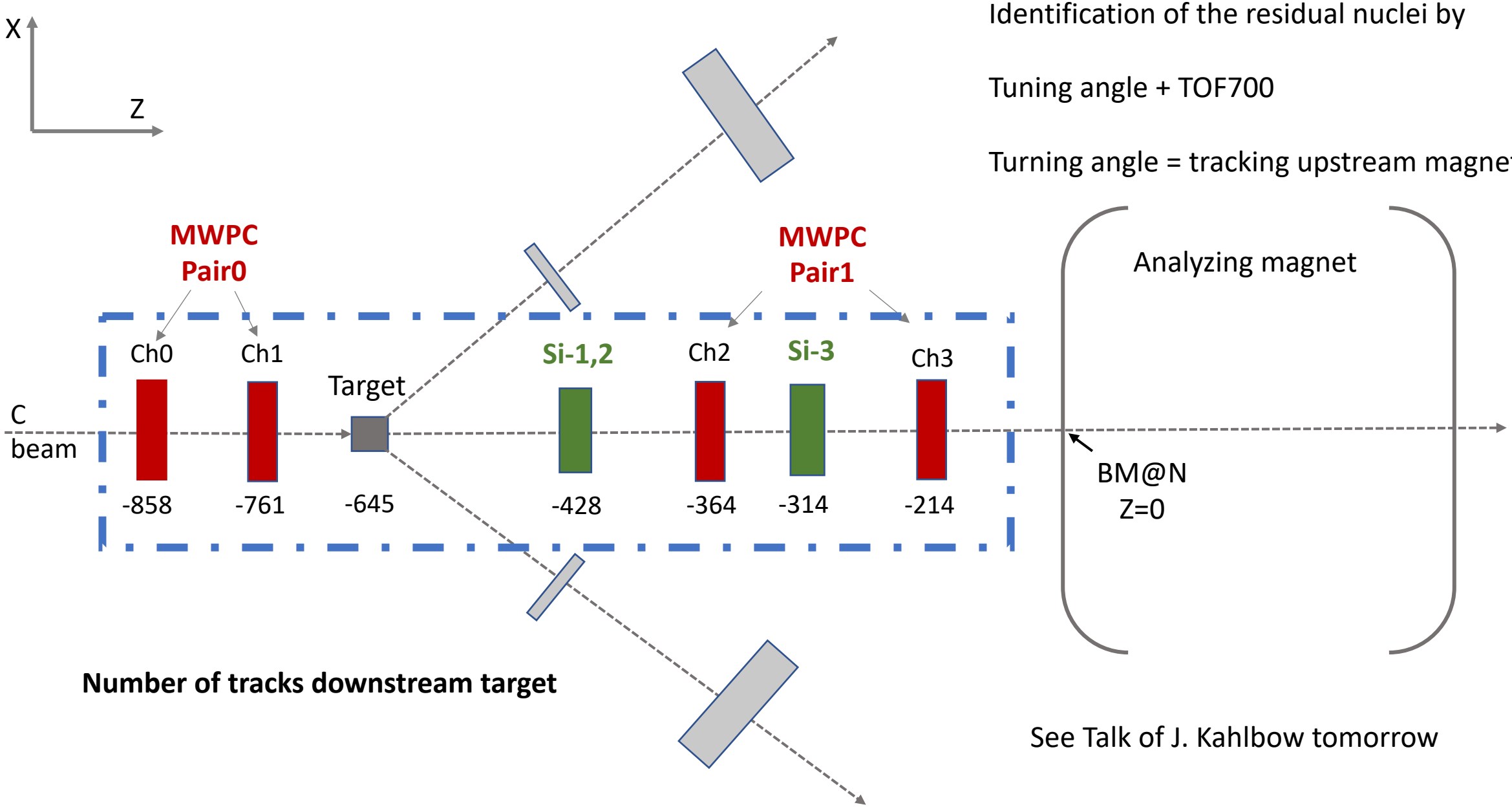
2019/10/14

Tracking Upstream the Analyzing Magnet

Identification of the residual nuclei by

Tuning angle + TOF700

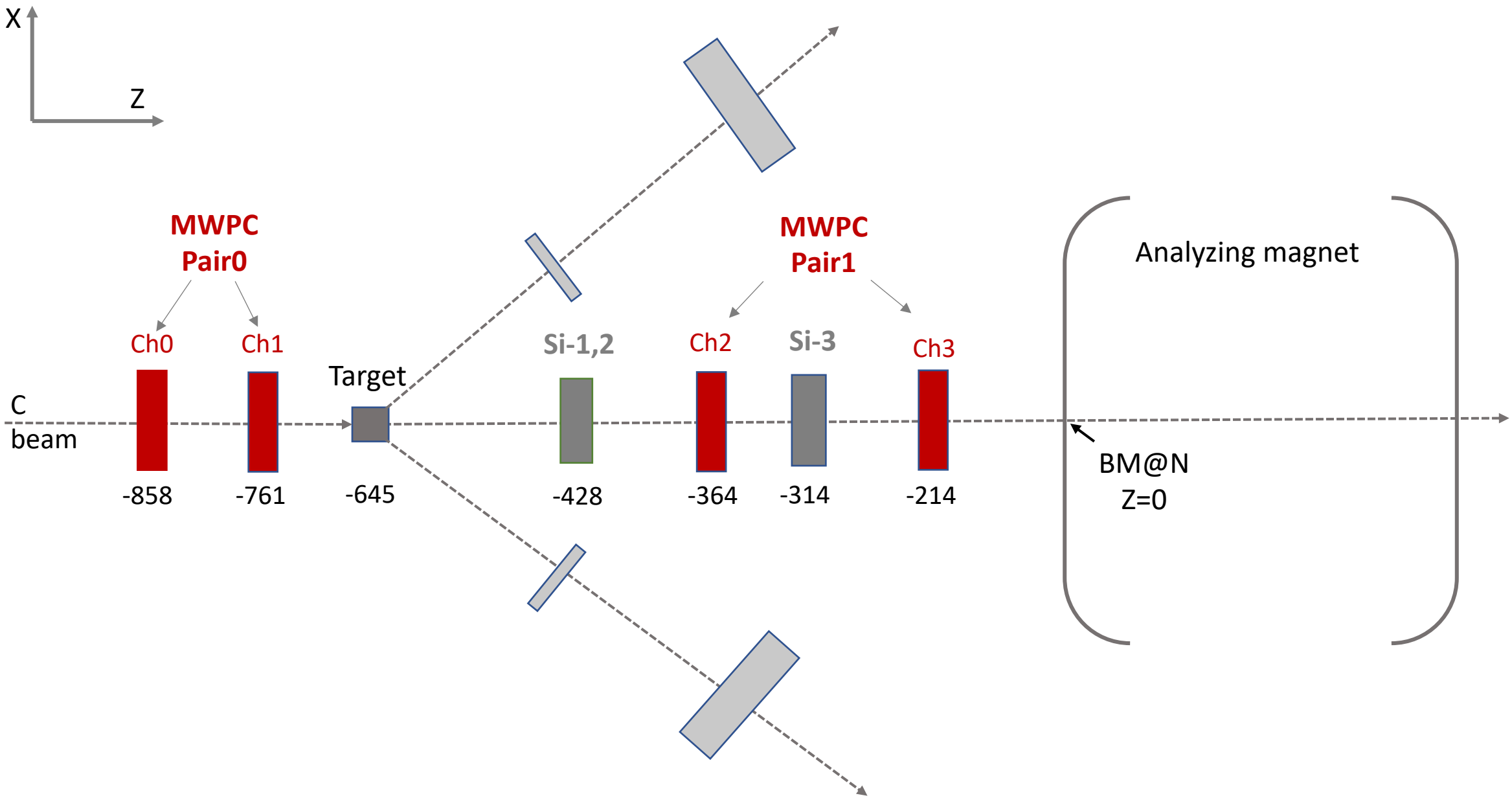
Turning angle = tracking upstream magnet + DCH



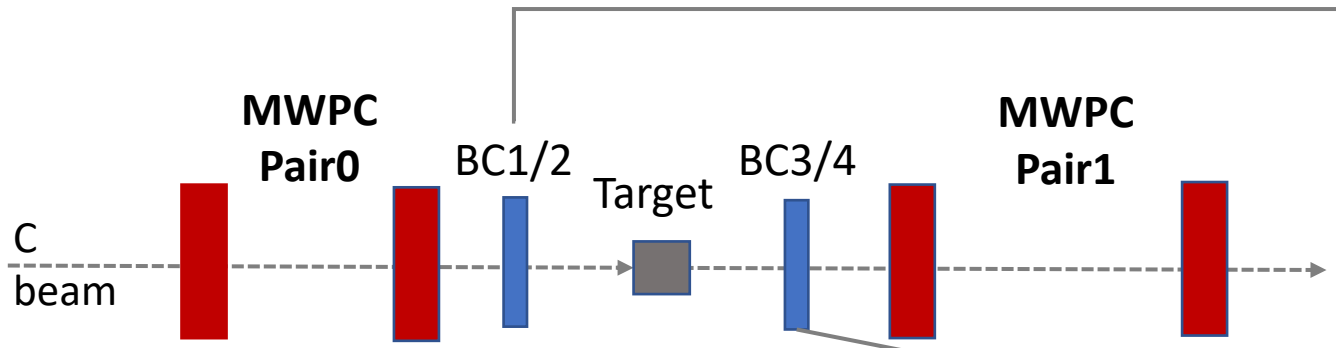
Number of tracks downstream target

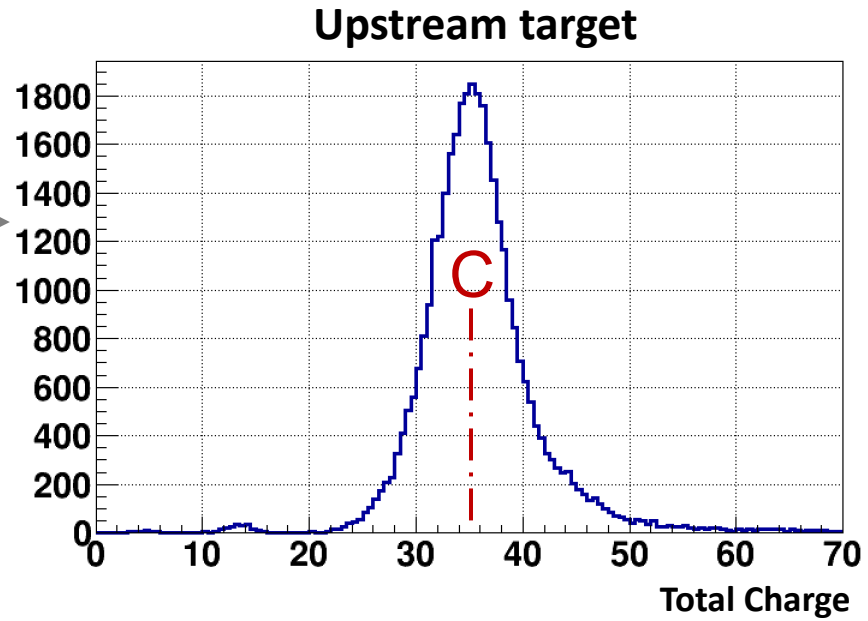
See Talk of J. Kahlbow tomorrow

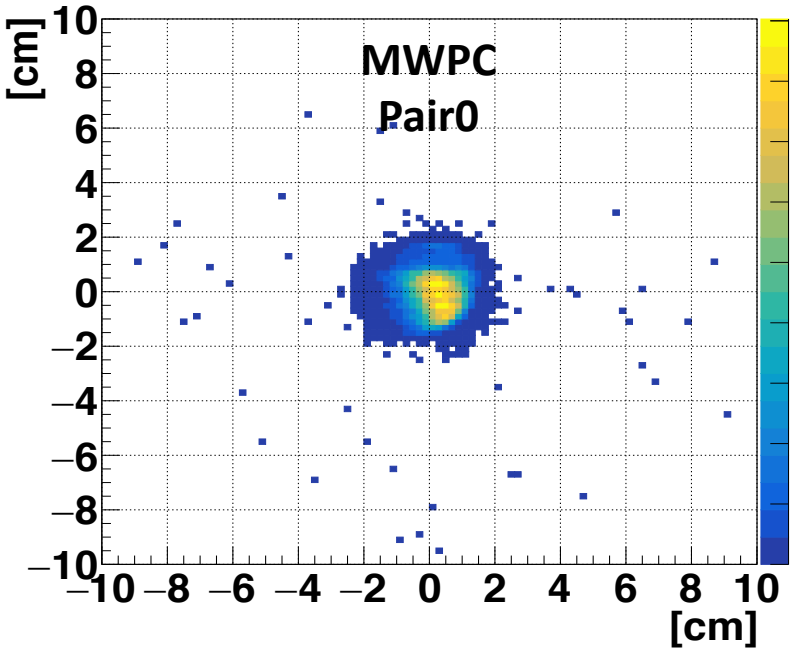
Tracking Upstream the Analyzing Magnet

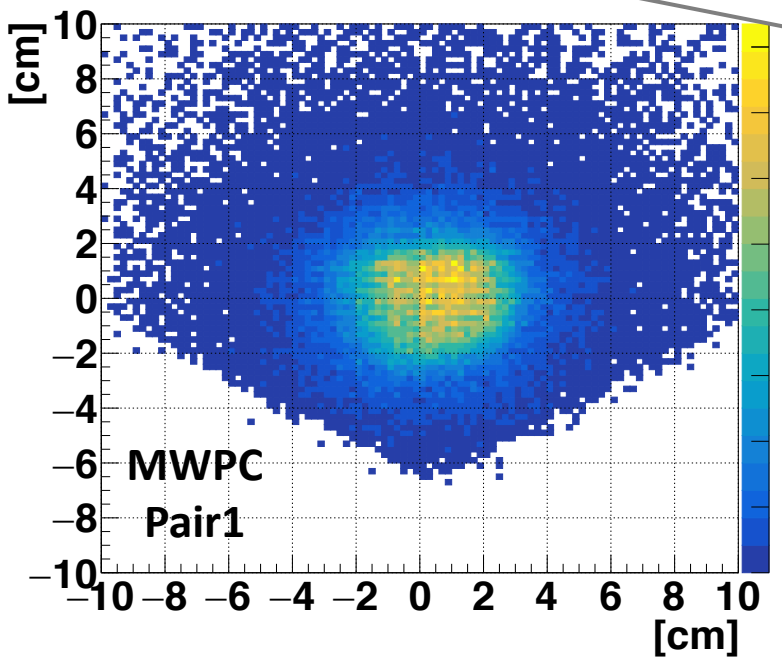


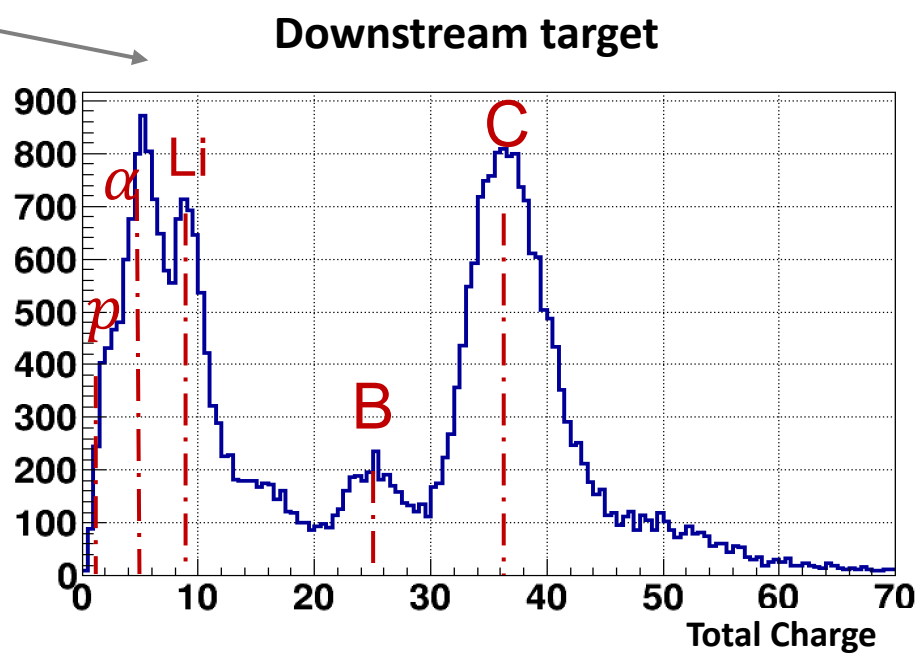
Different Number of Tracks Upstream and Downstream Target





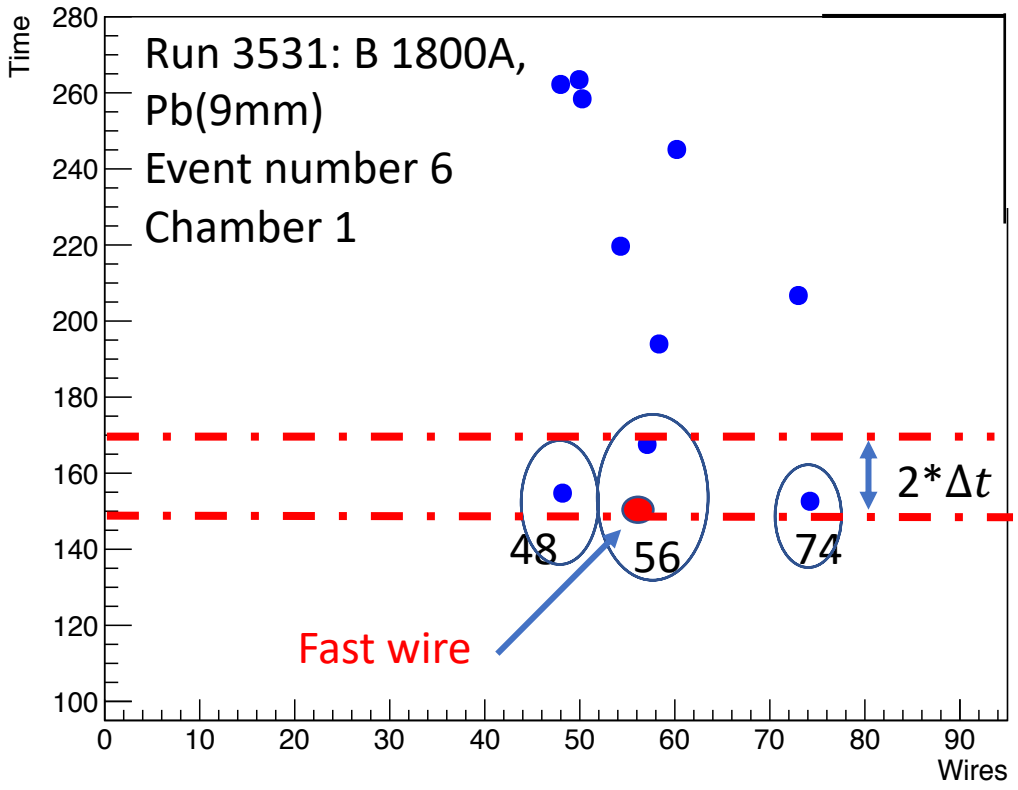






Run 3338, H2 target

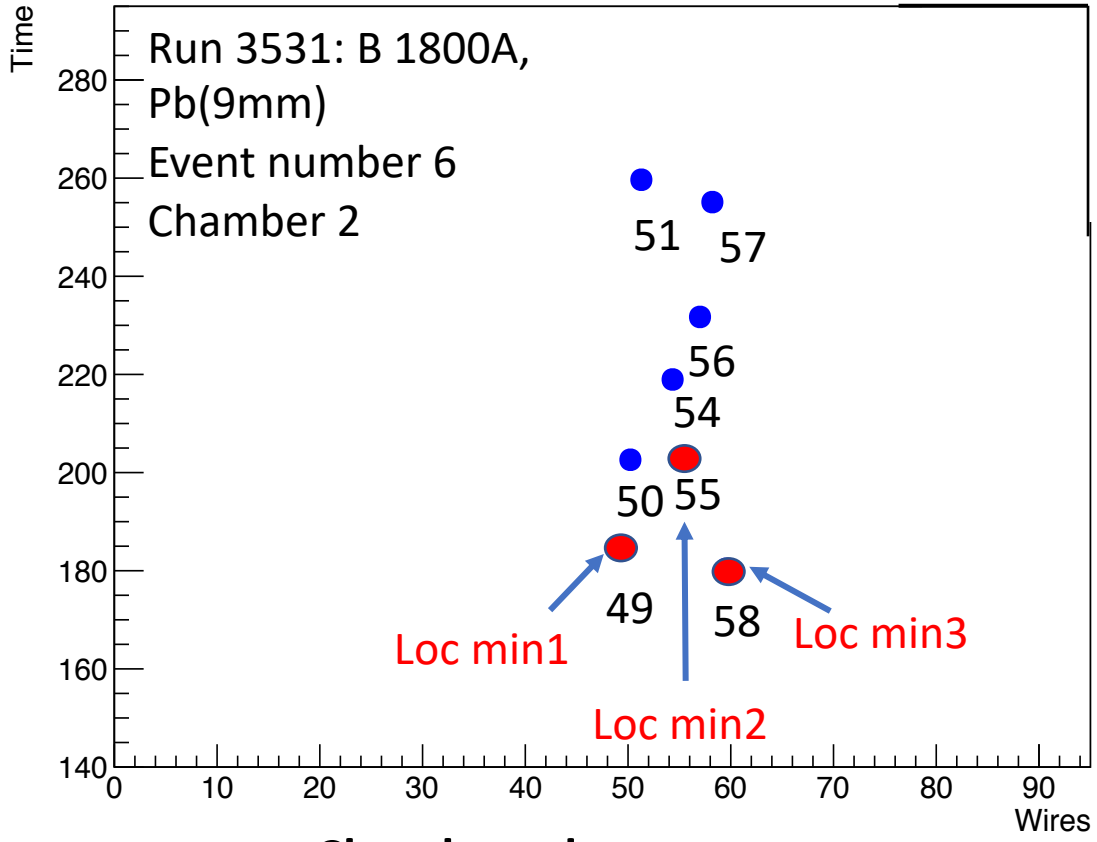
Improved MWPC-clustering



Chambers upstream target: high hit multiplicity

The goal reconstructing one track

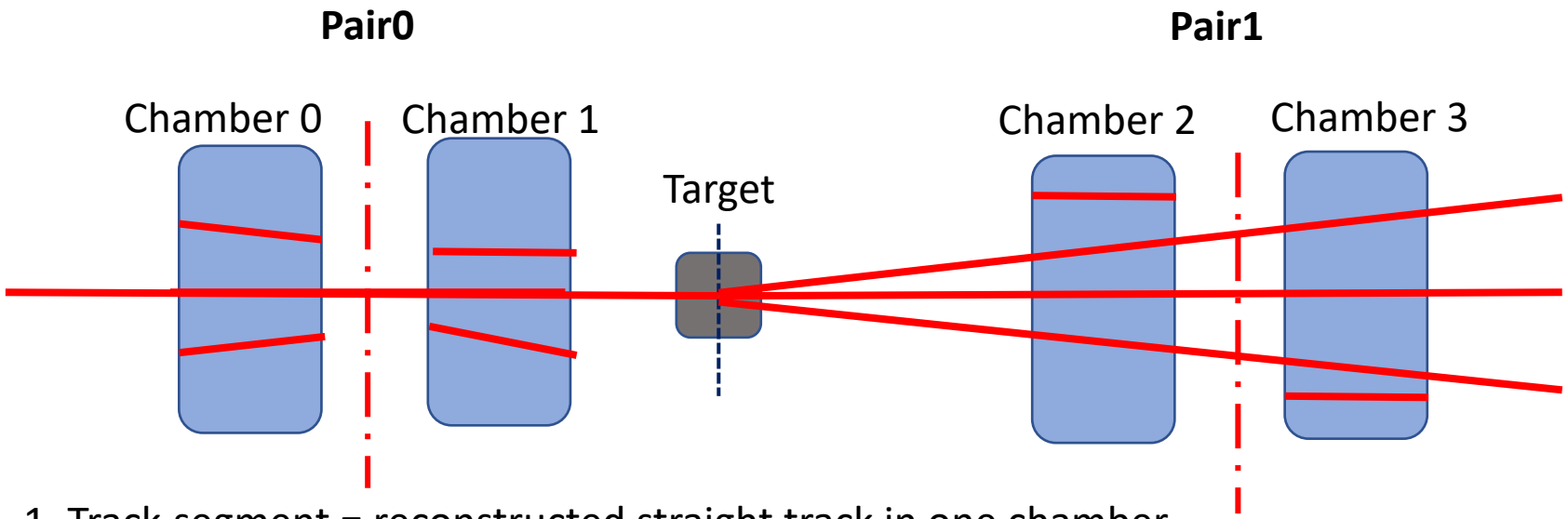
1. Fast wire per plane – hit coordinate
2. Accept wires within $2*\Delta t$ (Δt = time pitch = 8 ns)
3. Combine neighboring wires in one cluster



Chambers downstream target

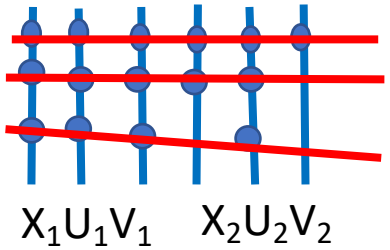
The coordinate of the cluster with a time local minimum

Improved Track Reconstruction in MWPCs



1. Track-segment = reconstructed straight track in one chamber

2. Track-segment formed using

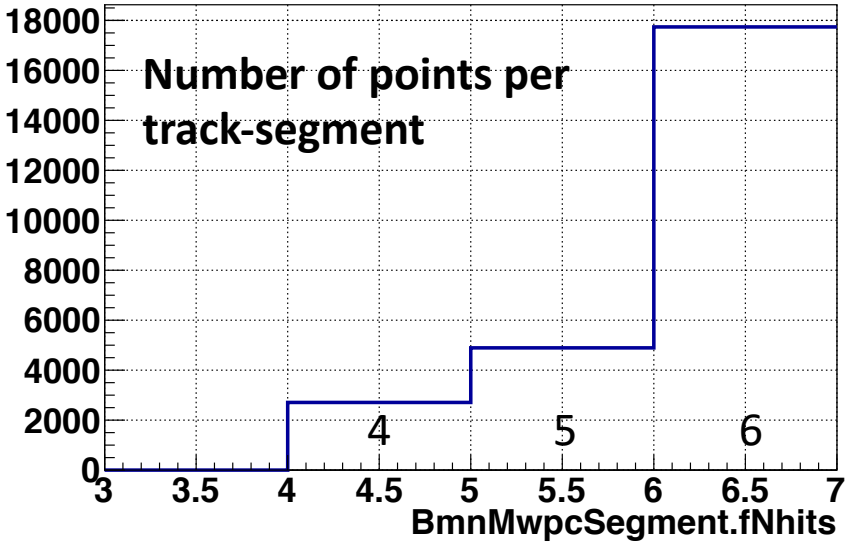


6/6 points per segment
5/6
4/6

3. Reconstruct & fit track-segment in each chamber
4. Extrapolate segments to $Z_{0,1}$= (Z1+Z2)/2 & select best pairs by χ^2 criteria,

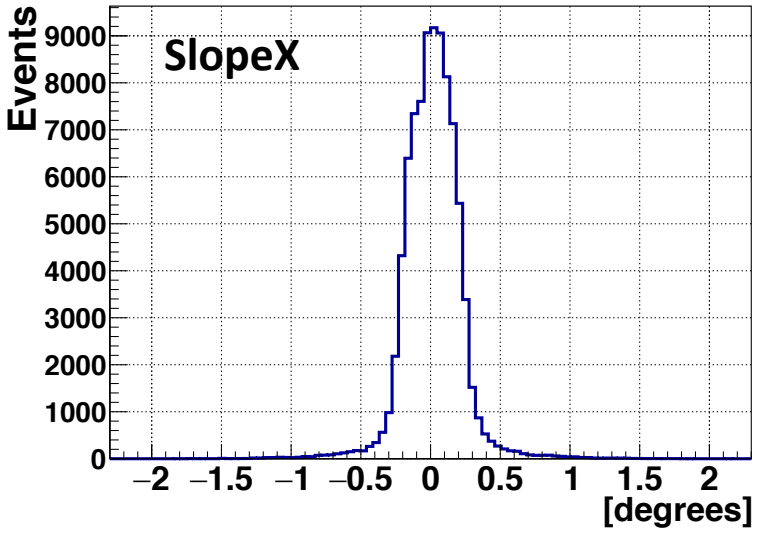
angles are not taken into account

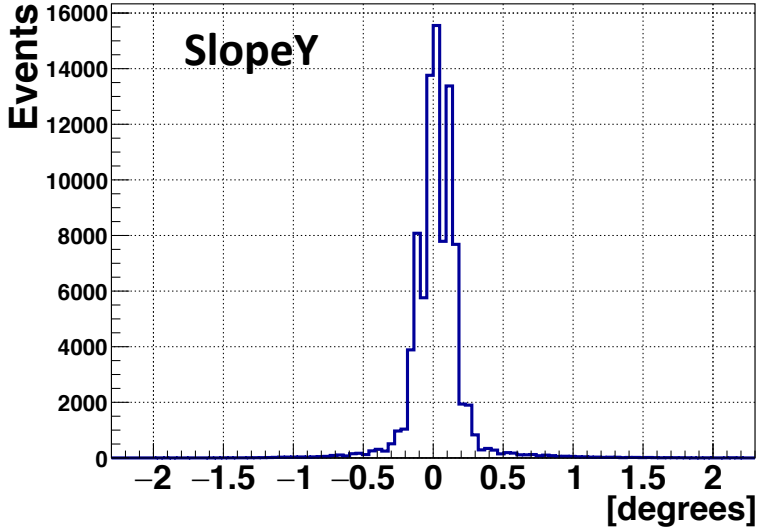
5. MWPC track in Pair0 and Pair1



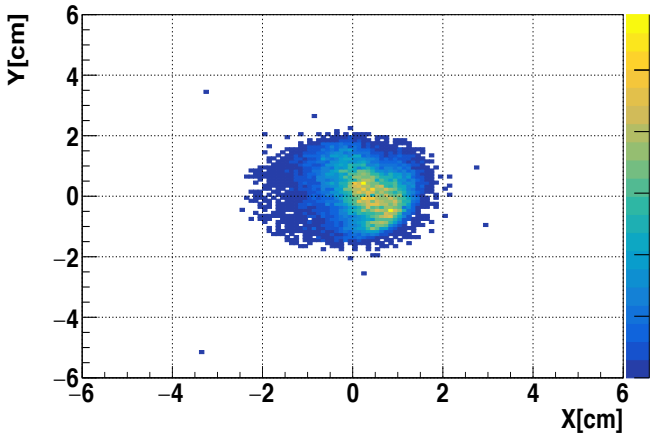
MWPC-Track (Pair1) Parameters after Target

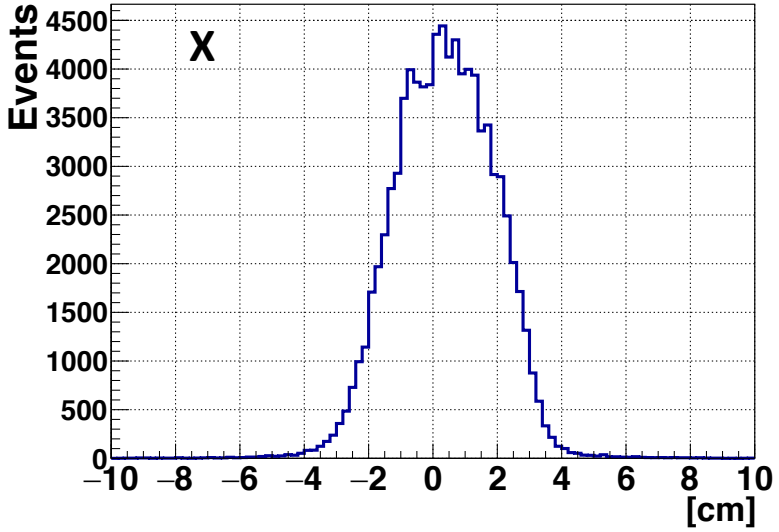
Run 3430, empty target

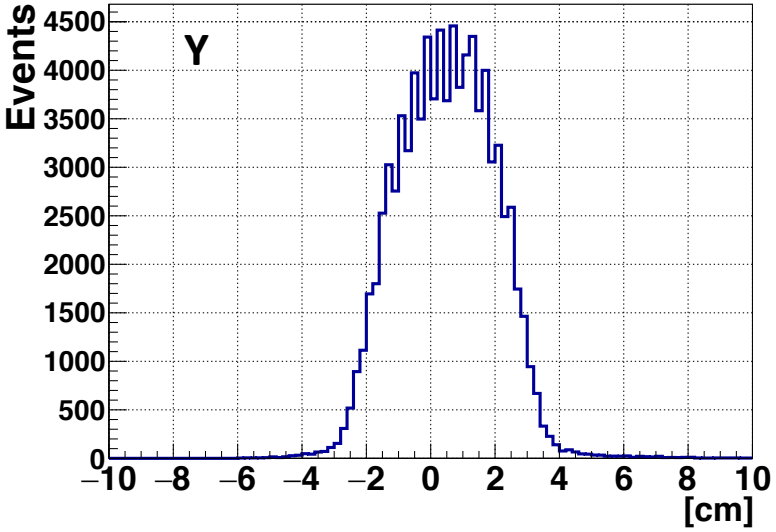




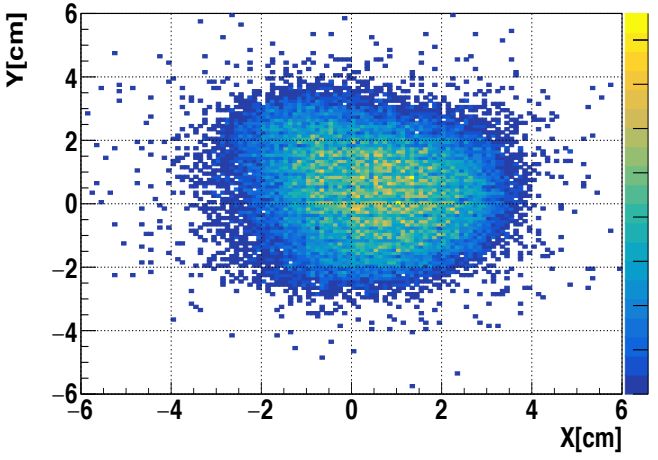
Beam profile upstream target



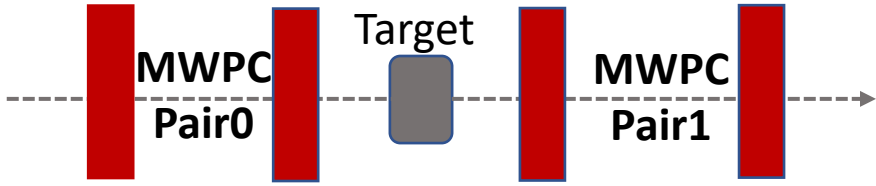




Beam profile downstream target

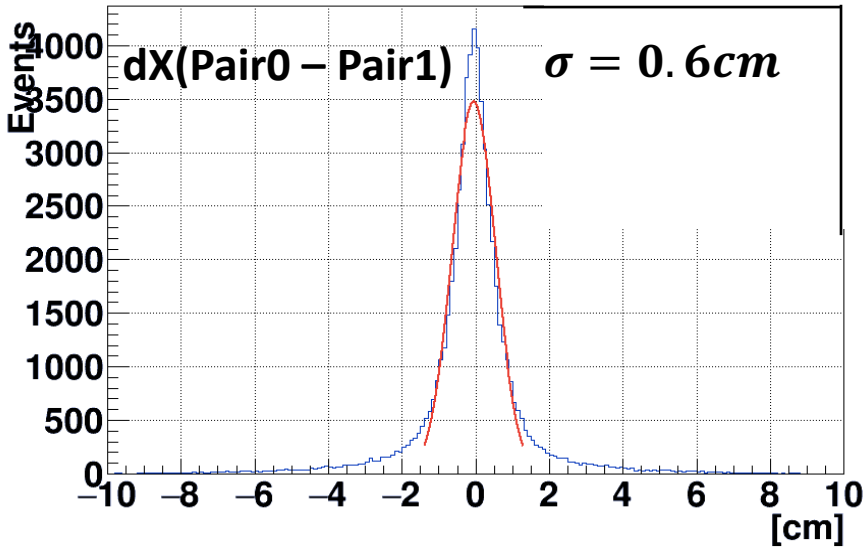


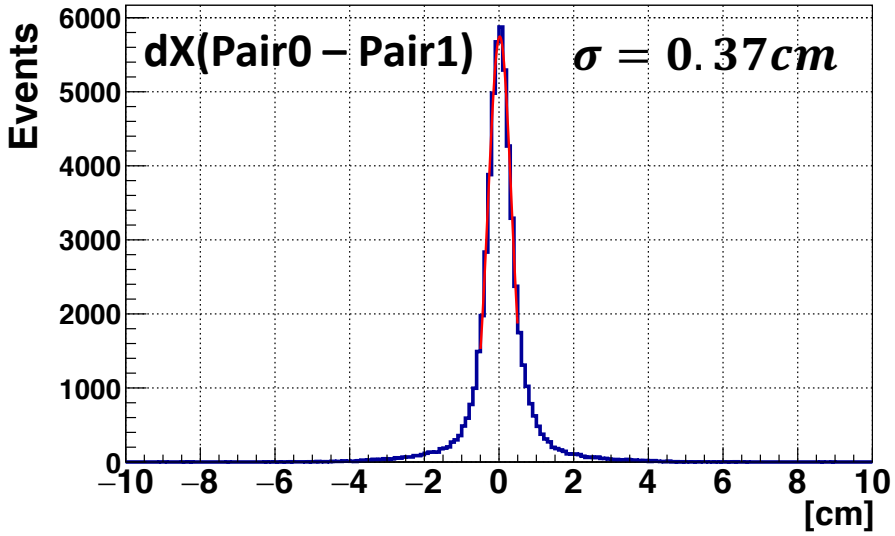
Better Matching in Z Target with Improved Reconstruction



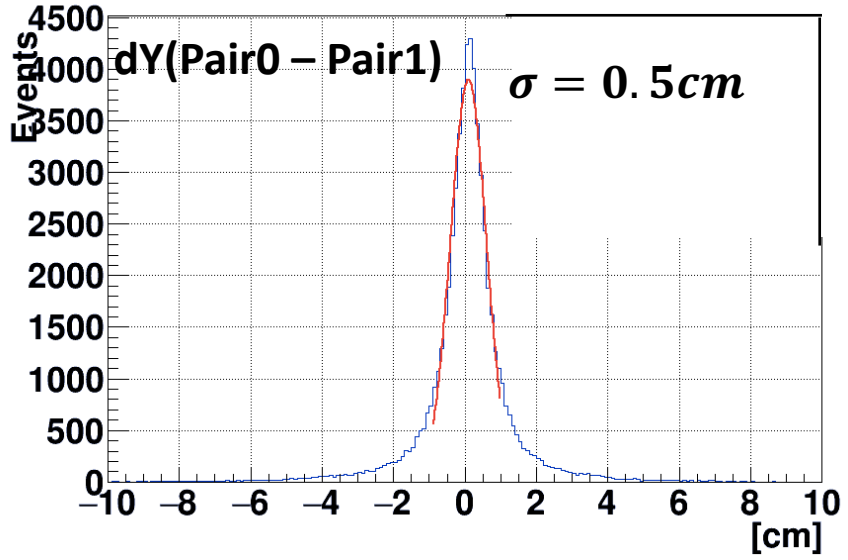
Old clustering and matching → Improved clustering and matching

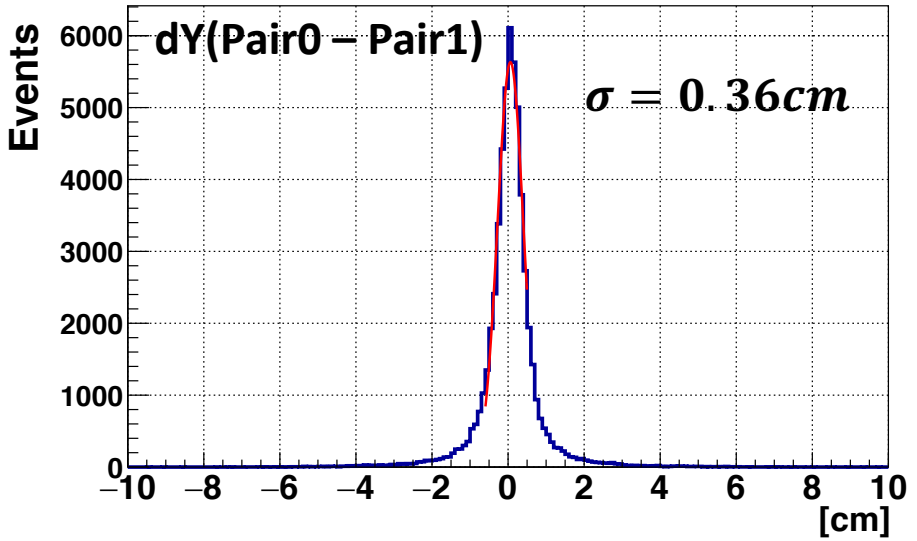
Run 2677
empty target



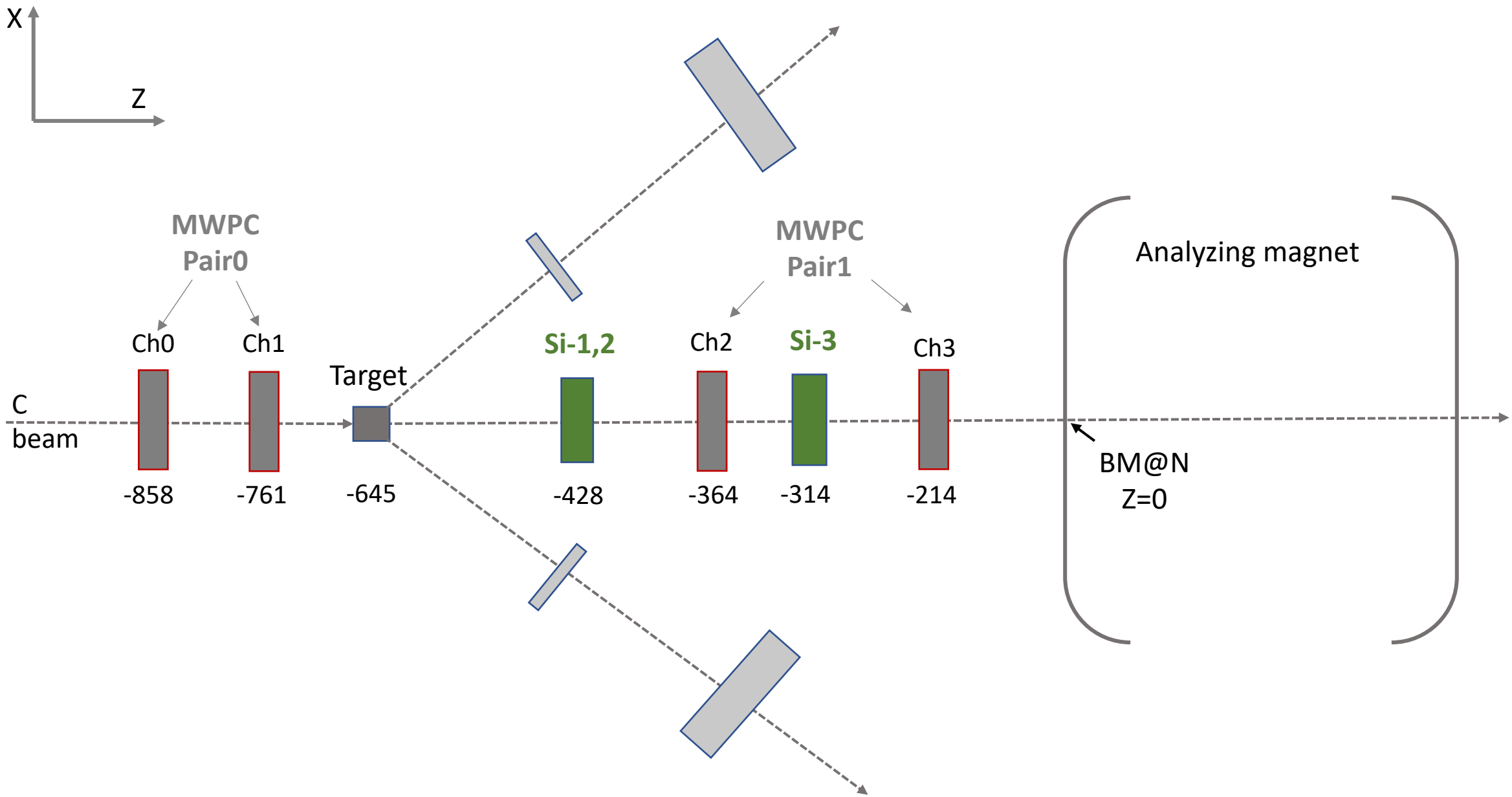


Run 3430
empty target





Tracking Upstream the Analyzing Magnet

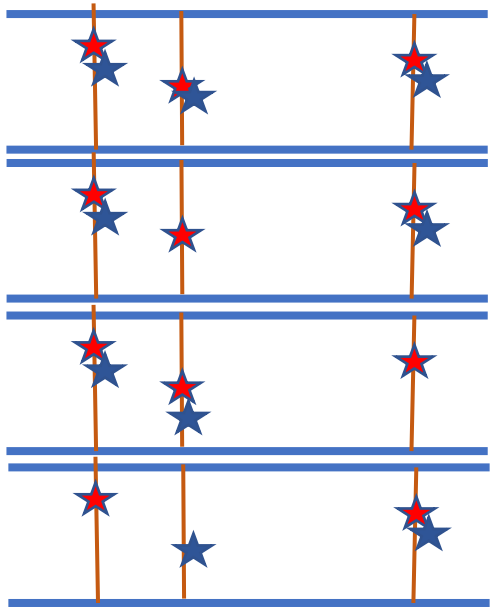


Track Reconstruction in Silicon Detector

1. **X and X’ (2.5°)** neighboring fired strips – cluster center $CoG = \frac{\sum^N A_i * i}{\sum^N A_i}$, A_i – charge amplitude on i–th strip

2. **Track Reconstruction** using various cases

- Case 1: 6 hits (3 spatial points) per track
- Case 2: 1 spatial point in st. 1 and 3 + X / X’ in st.2
- Case 3: 1 spatial point in st. 1 and 2 + X / X’ in st. 3
- Case 4: (X + X’) in (st. 1 + st. 2) + spatial point in st. 3

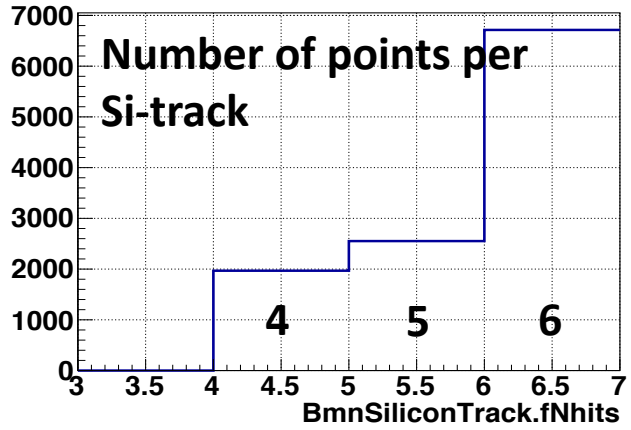


★ - X hit

★ - X’ hit

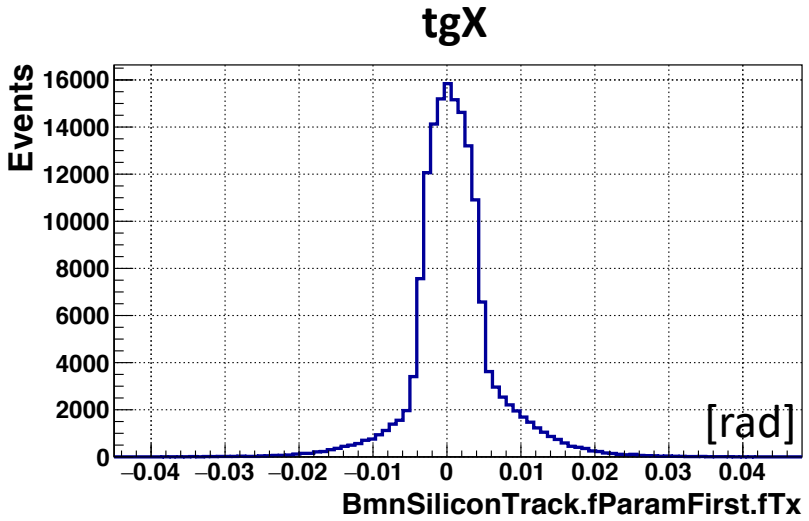
3. **Straight line fit on X & X’** – coordinates, rough Y – coordinate: $Y = \frac{X' - X}{tg 2.5°}$

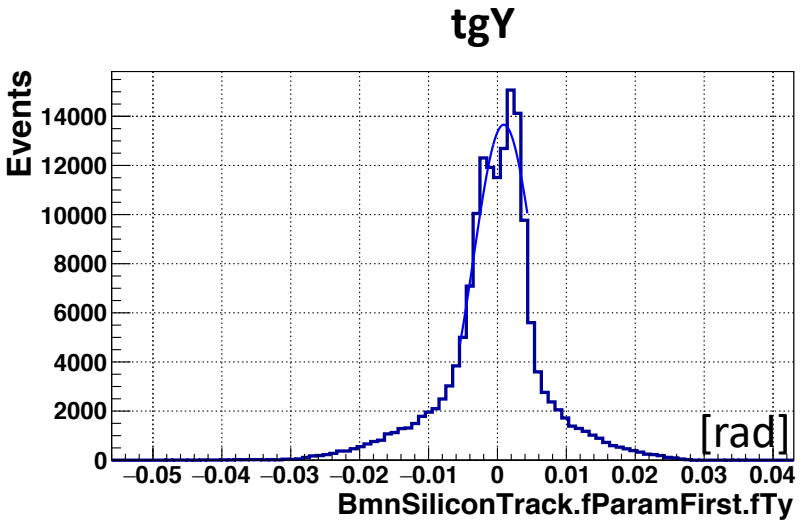
Accepted track goes out from the target area

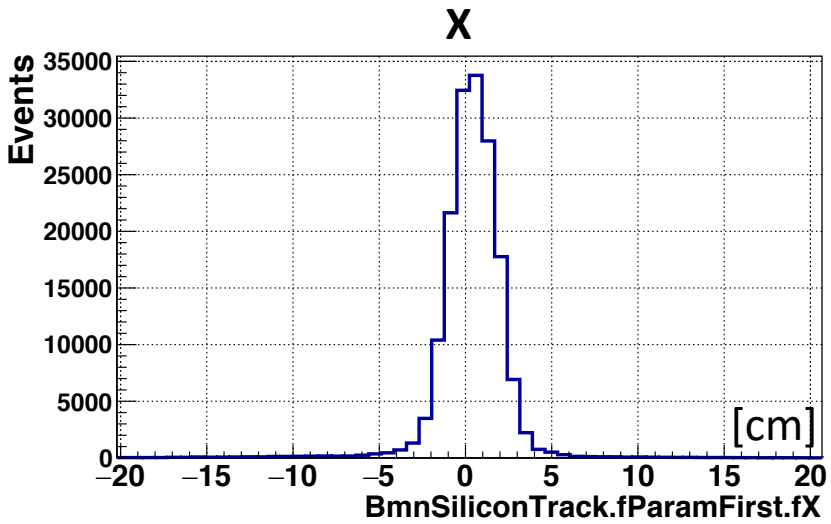


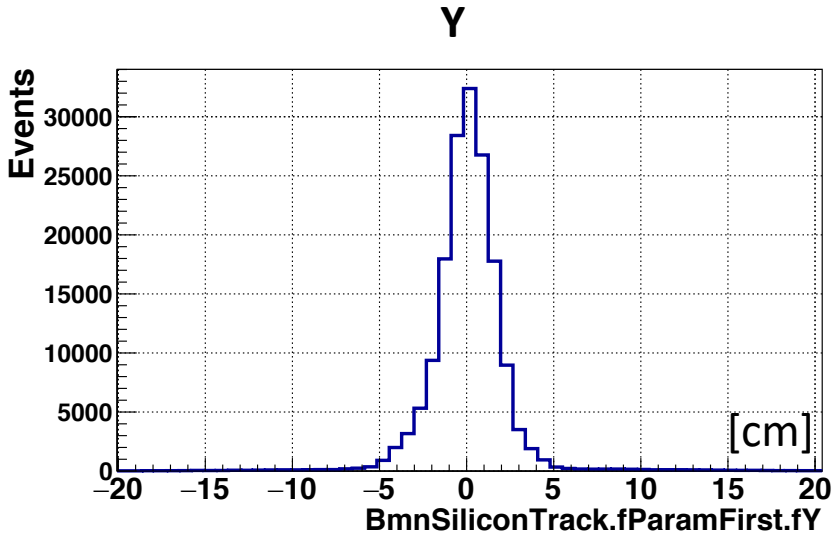
Si-Track Parameters & Beam Profiles in Each Station

Run 3430, empty target

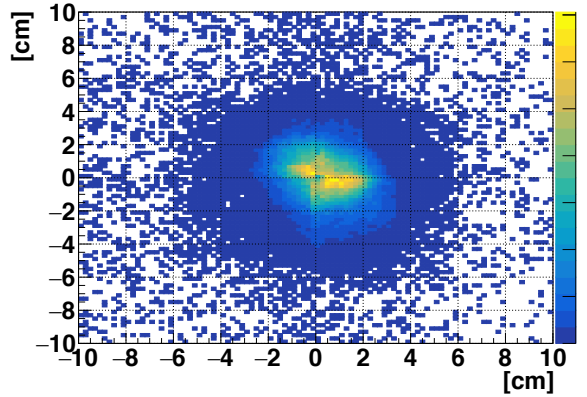




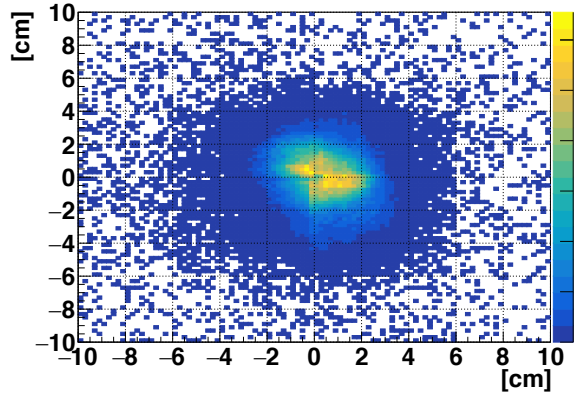




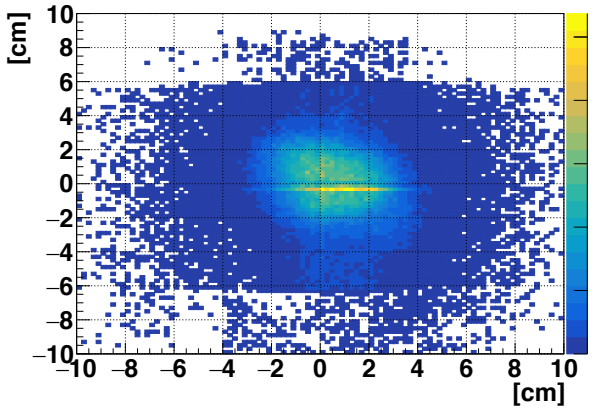
St1



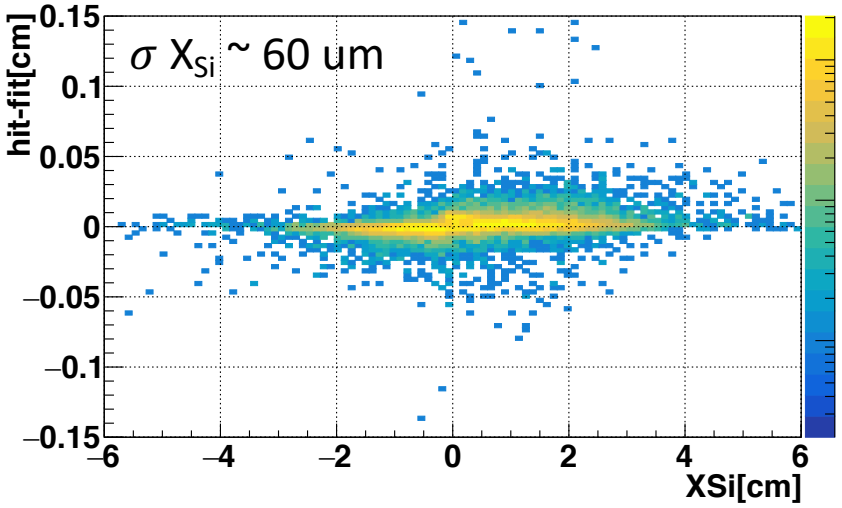
St2

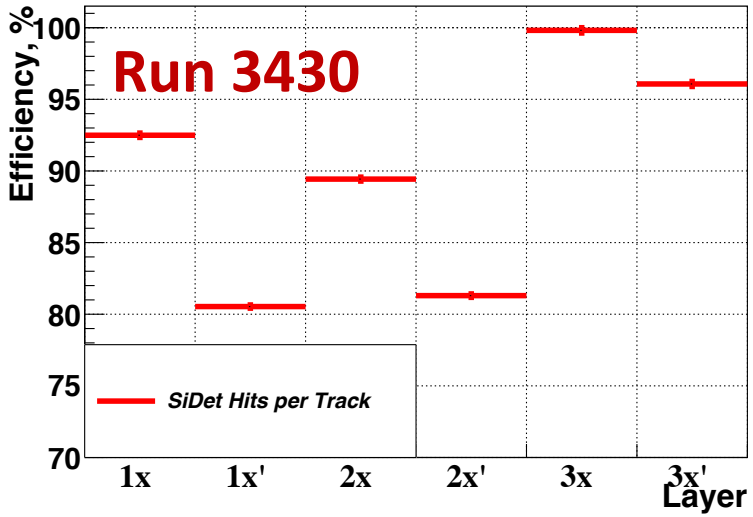


St3



Resolution & Layer Hit Efficiency per Track

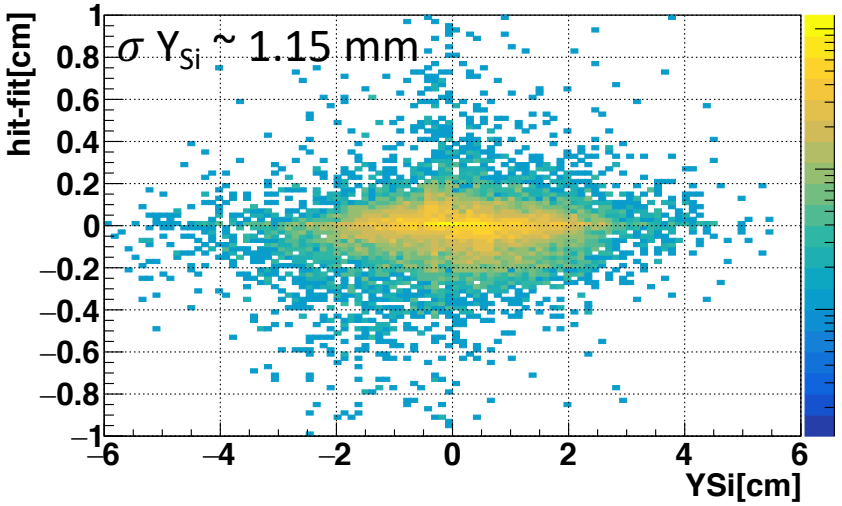


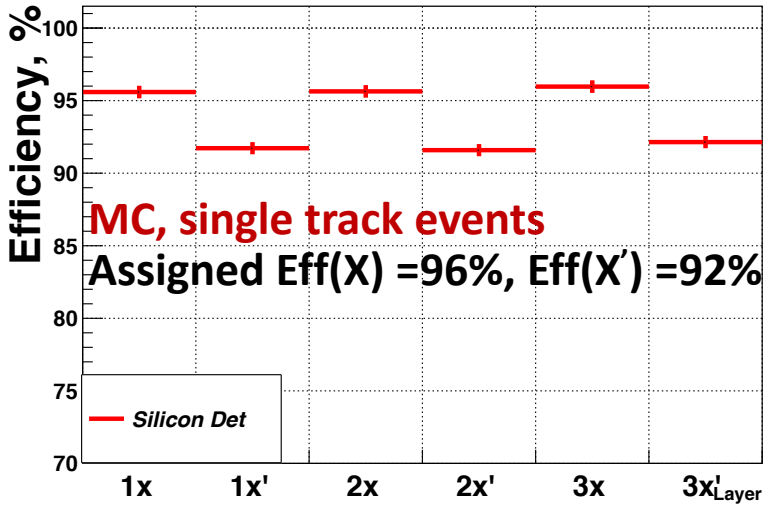


The best efficiency in 3d st with SRC data (by construction)

Some problems with Y-alignment --> to be solved

$$\text{Hit } \boldsymbol{Eff\ per\ track} = \frac{\sum_i^{Num\ tracks}(1, if\ Track_{hit} on\ layer)}{Number\ of\ tracks}$$





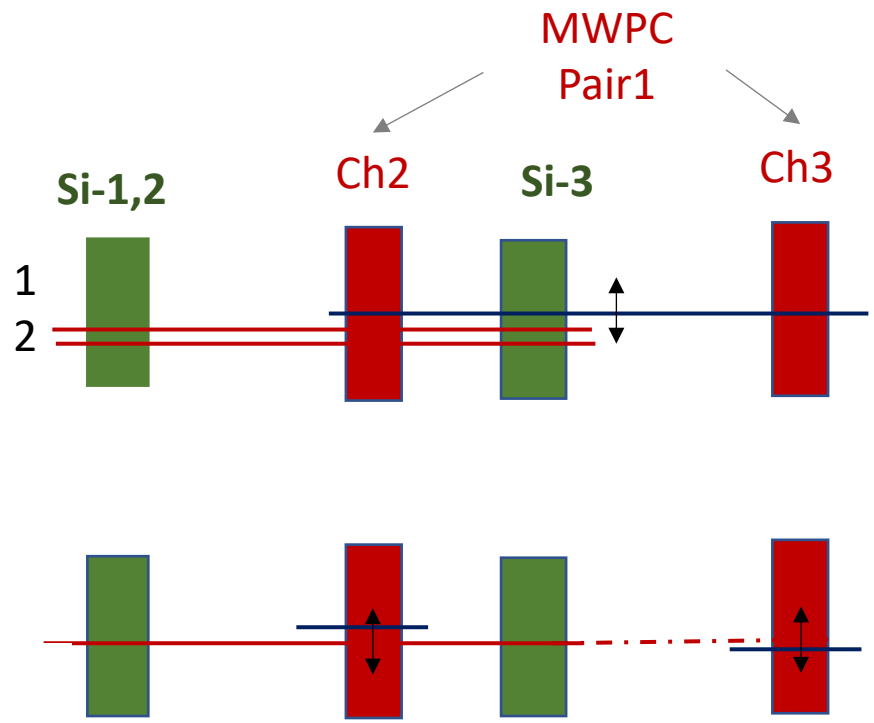
MC data:
Algorithm returns the assigned efficiency → reconstruction works correctly

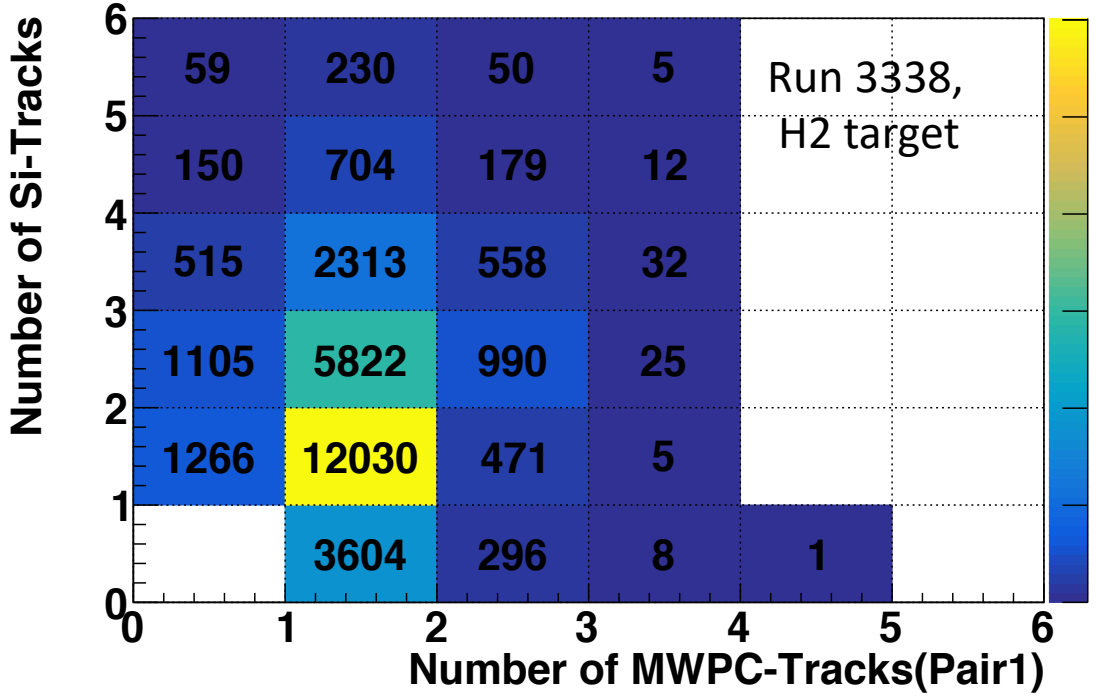
Two Stages of MWPC-Si Matching

Si find more tracks than MWPCs

1. Si Tracks – MWPC Tracks (Pair1) matching with minimal distance

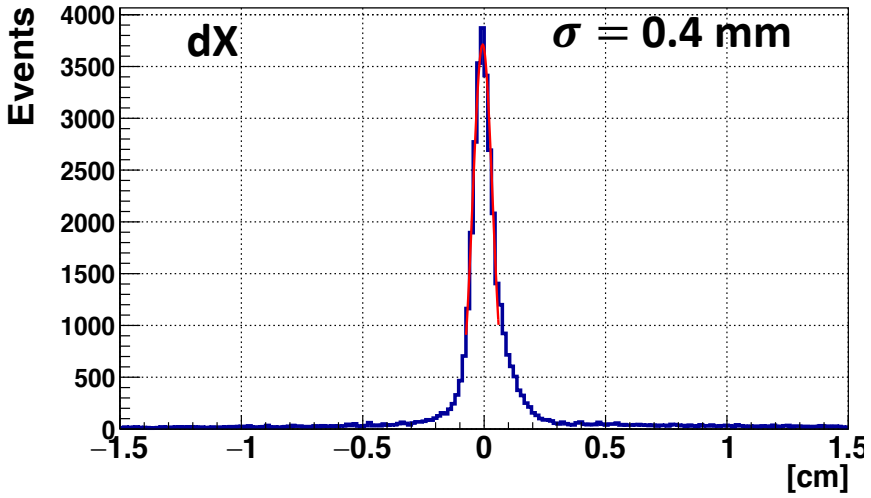
2. Matching of rest Si Tracks with MWPC Segments (Chamber 2 or Chamber 3)

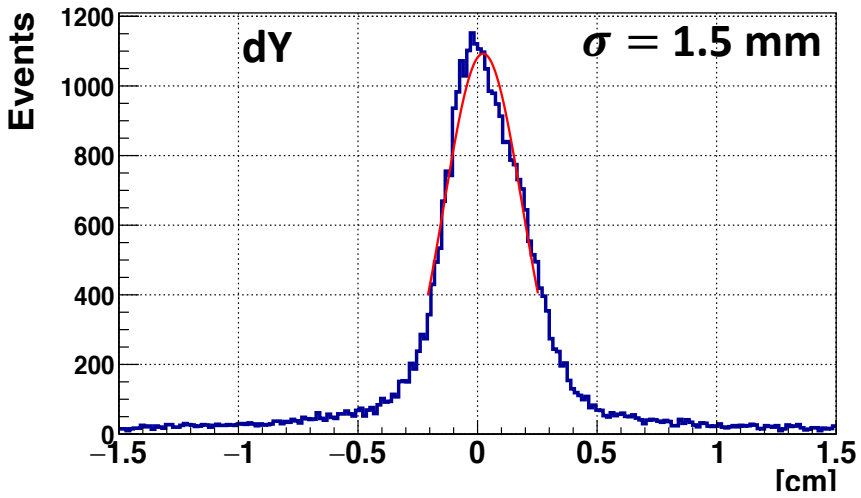


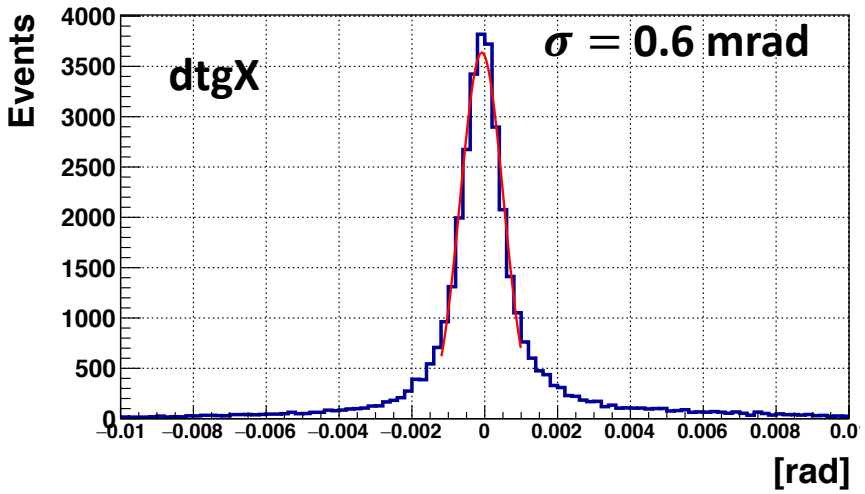


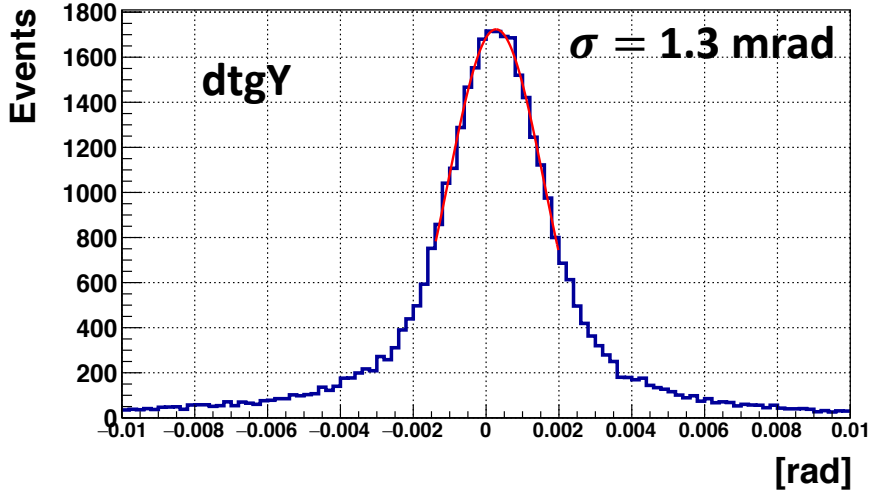
Si – MWPC Matching at Z_{Pair1}

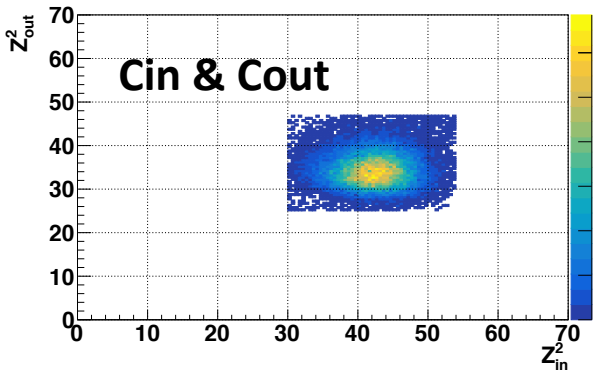
Run 3430, empty target











Precise coordinate in Si
→ extrapolation to MWPC

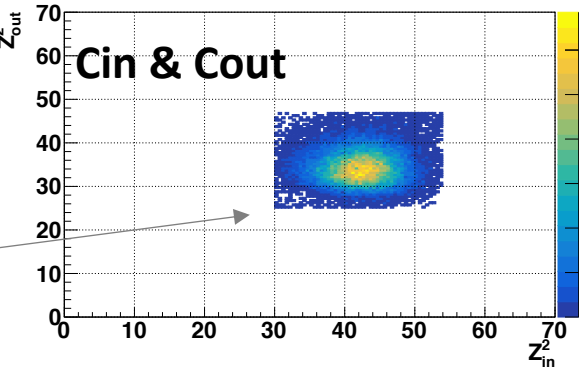
σ X_{Si} ~ 50 um ; σ Y_{Si} ~ 1 mm

σ X_{MWPC} = 2.5/$\sqrt{12}$ [mm]
σ Y_{MWPC} = σ X_{MWPC} * $\sqrt{2}$

Efficiency of Matched Tracks

Run 3430 (empty target)

1. $$\frac{\text{Number of events with} \geq 1 \text{ Si/Pair1 tracks or MWPC−segments}}{\text{Number of events Carbon in \& Carbon out}}$$



before matching

>=1 Si-track **86.8**% MWPC-track 95.8%. MWPC-seg2 99.0% MWPC-seg3 98.8%

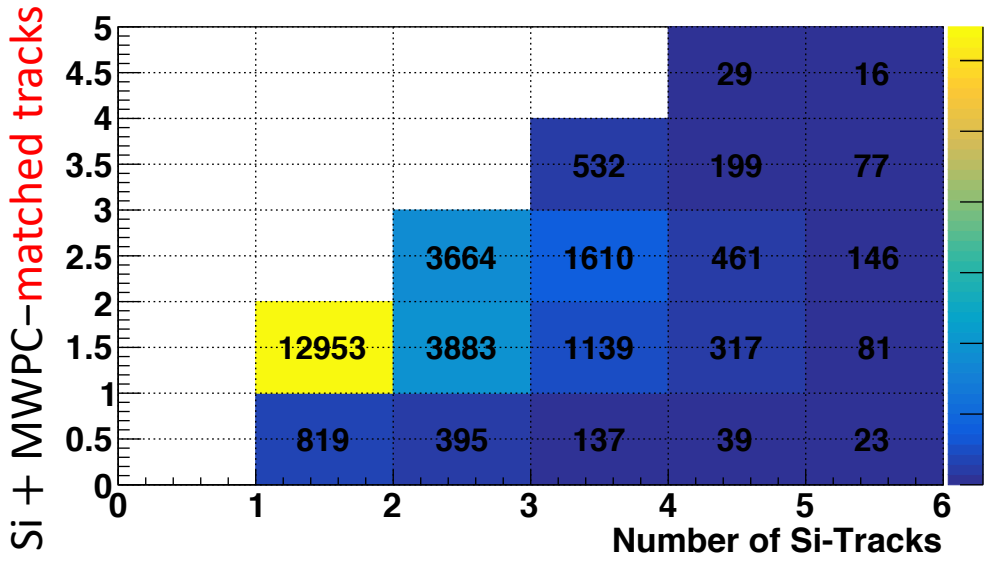
==1 Si-track 67.4 % MWPC-track 95.0% MWPC-seg2 76.3% MWPC-seg3 71.7%

---

2. $$\frac{\text{Number of events with Si+MWPC−matched track}}{\text{Number of events Carbon in \& Carbon out}}$$

>=1 eff = **85.4**%

==1 eff = 65.2%



Run 3338, H2 Target

Summary

✓New MWPC clustering motivated by multiple tracks after target

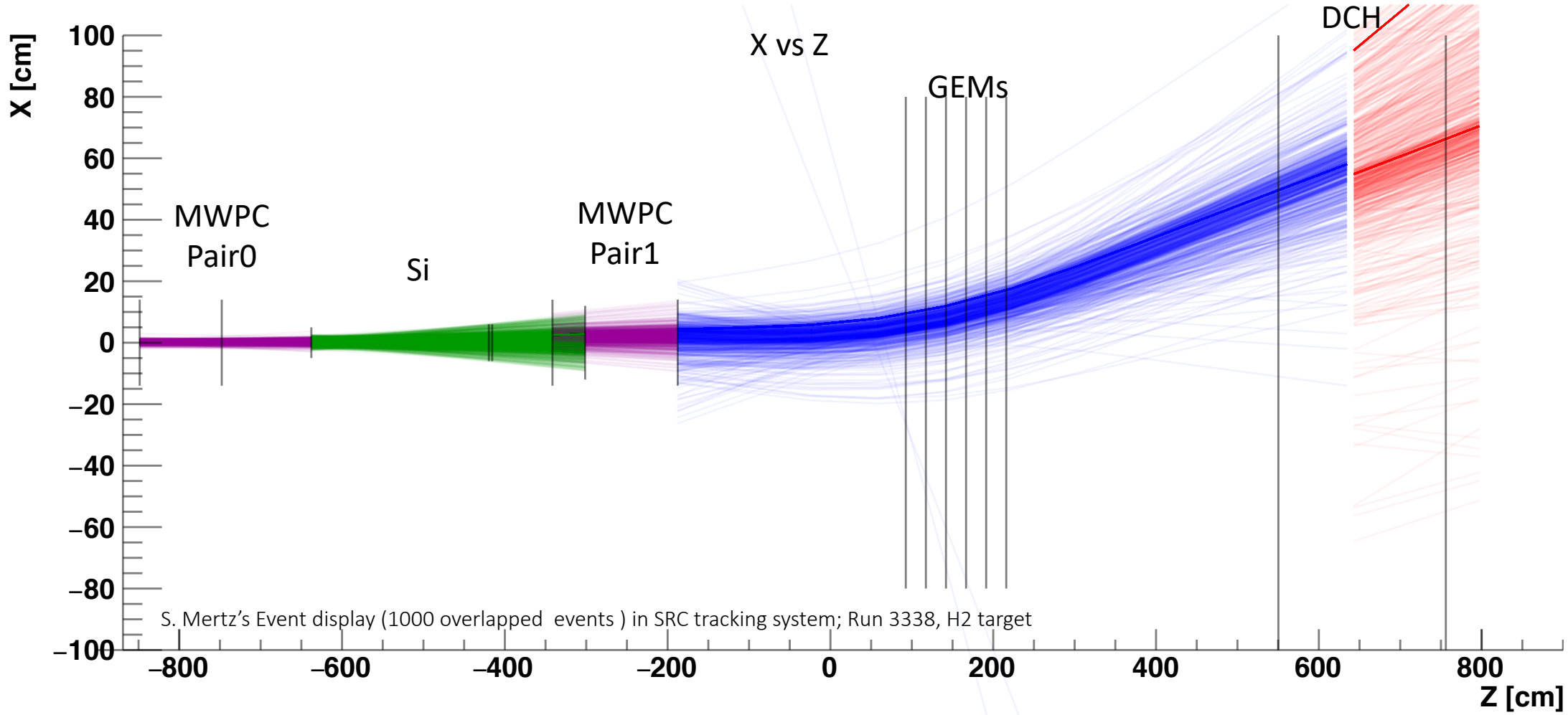
✓Si-track reconstruction – added to the repository

✓MWPC-Si matching - tested

Outlook

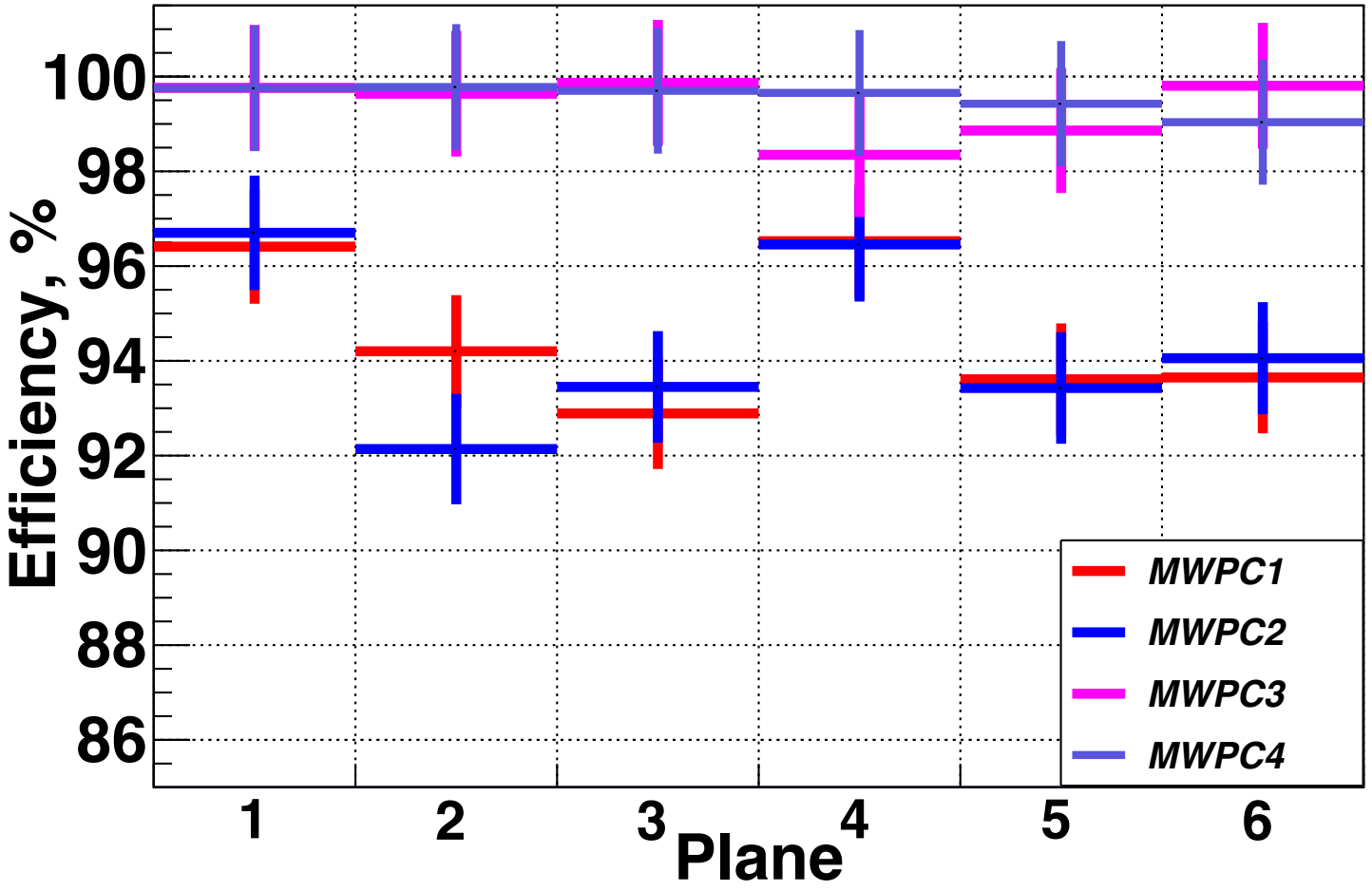
- Fit of the global track MWPC-Si
- Match Si-MWPC system to the Global track (GEM & DCH)

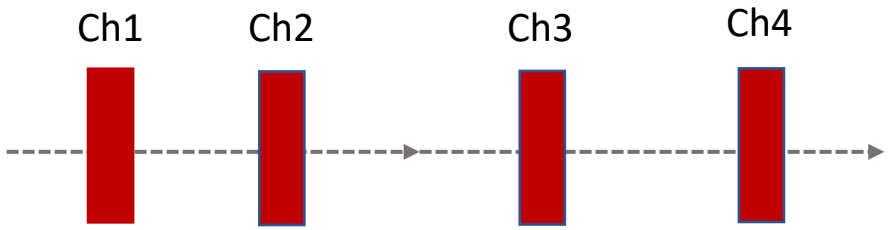
On the way to the global tracking



Thank you for your attention!

Internal MWPC efficiency





$$\frac{\sum_i^{Number\ of\ tracks}(1, if\ Track_{hit} on\ layer)}{Number\ of\ tracks}$$

Expected Silicon detector coordinate resolution

$\Delta x = 0.95$ [mm]; $\Delta x' \approx 0.103$ [mm];

$$\sigma_x = \frac{\Delta x}{\sqrt{12}};\ \sigma_{x\prime} = \frac{\Delta x\prime}{\sqrt{12}};$$

$$\mathrm{Y} = \frac{X' - X}{tg2.5^\circ} \quad => \quad \sigma_y = \frac{\sqrt{{\sigma_{x\prime}}^2 + {\sigma_x}^2}}{tg2.5^\circ};$$

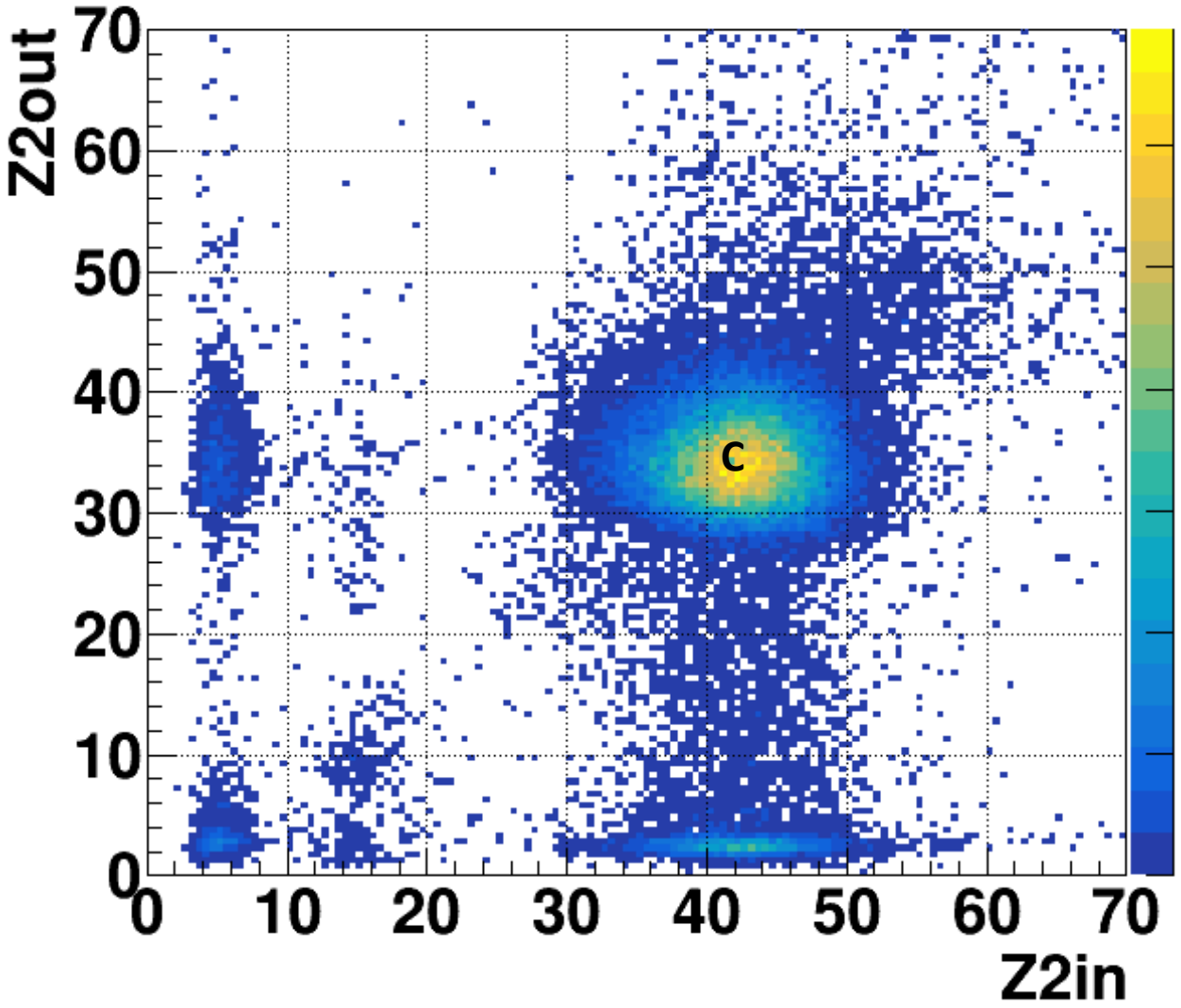
$\boldsymbol{\sigma_x} \approx 0.05$ [mm]; $\boldsymbol{\sigma_y} \approx 1.15$ [mm];

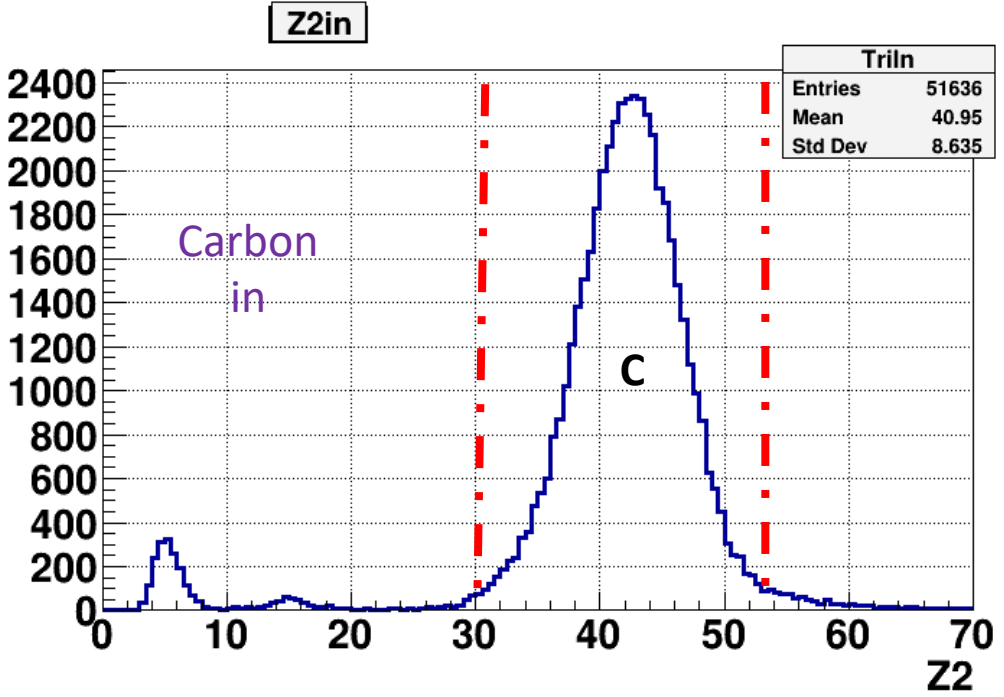
What is possible Z^2 for X?

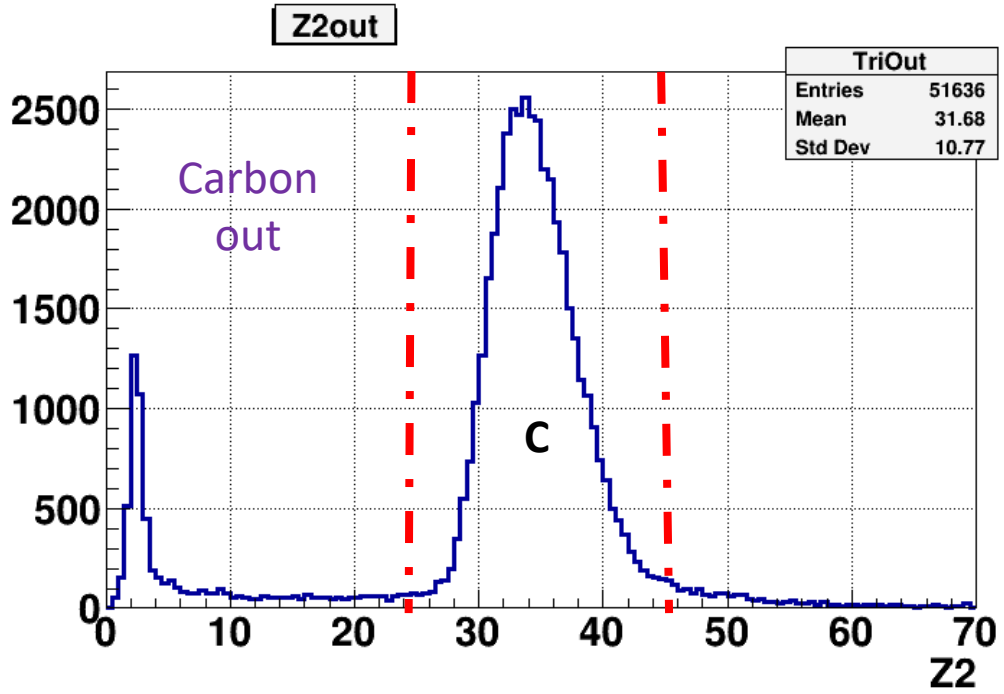
$$^{12}C(p,2p)^{11}_{5}X$$

Possible Z^2	# Tracks	Possibilities (Ztot=5)	A/Z
25	1	B	
17	2	Be + p	
13	2	Li + He	
11	3	Li + 2p	
9	3	2He + p	
7	4	He + 3p	
5	5	5p	

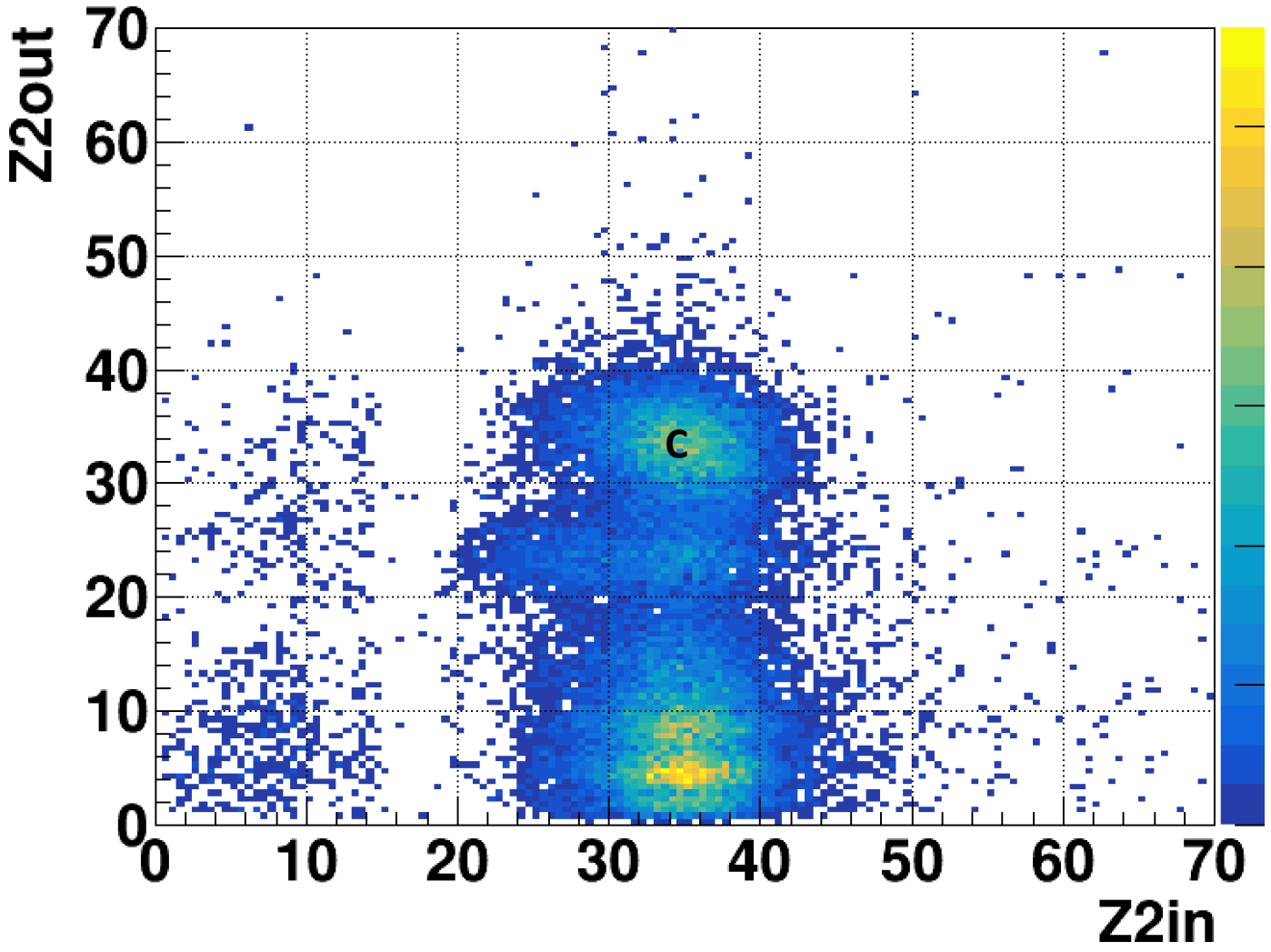
Run 3430 (empty target)

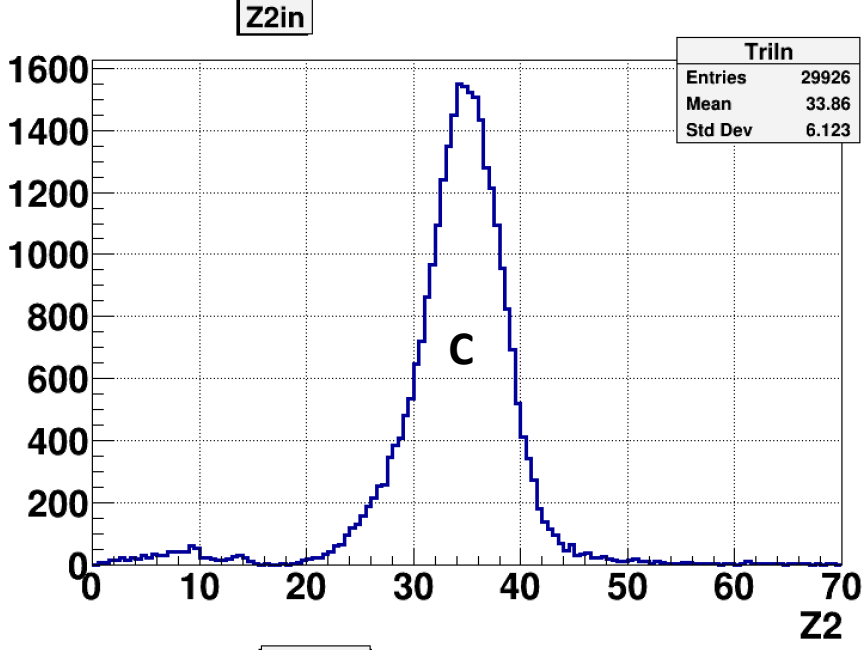


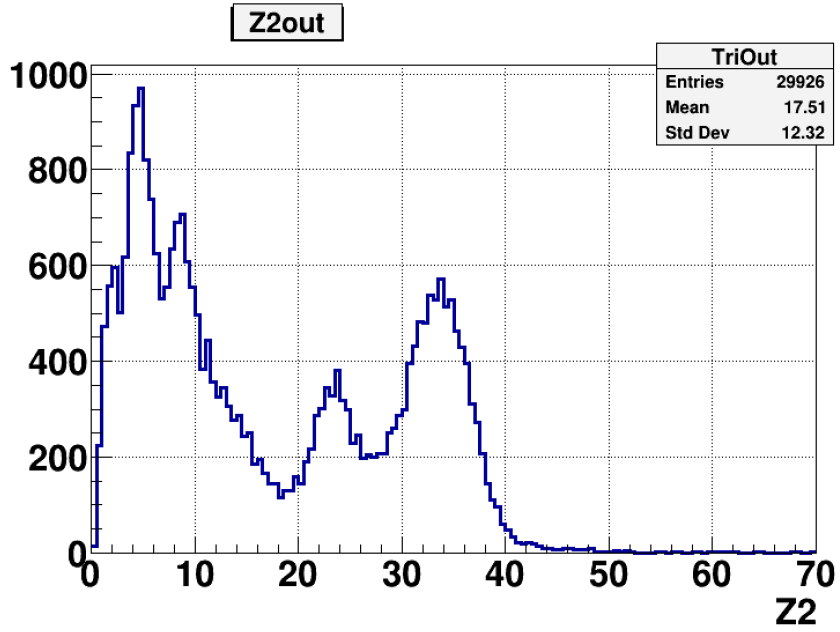




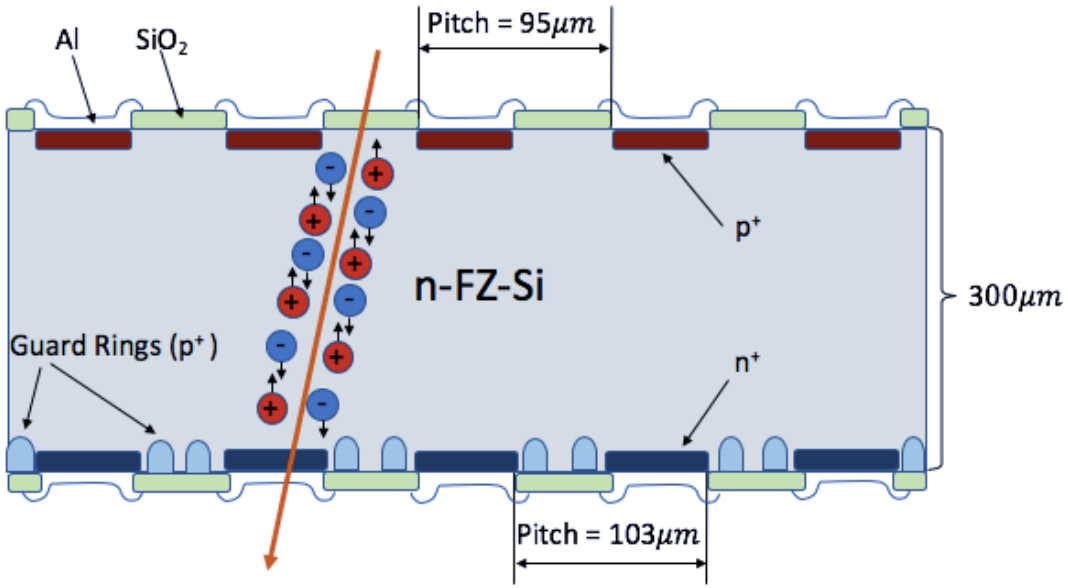
Run 3535 (Lead1 target)







Silicon Tracking detector



Double-Sided Silicon Detectors (DSSD)

- 2-coordinate Si strip detector

Capability of stable operation in conditions of high loadings up to 10^6 Hz/cm^2
Response time is 10-15 ns
Coordinate resolution ~ 50 μm

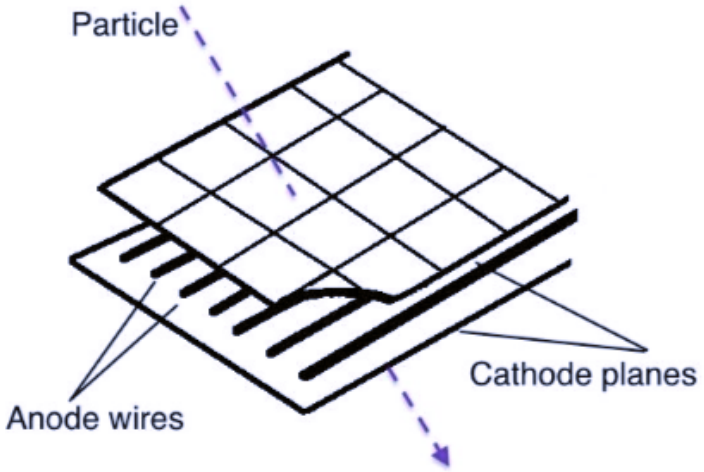
640 X strips with 0˚
640 X' strips with 2.5˚
The pitch of X strips : 95 μm
The pitch of X' strips :103 μm.
Thickness of detectors is 300 μm

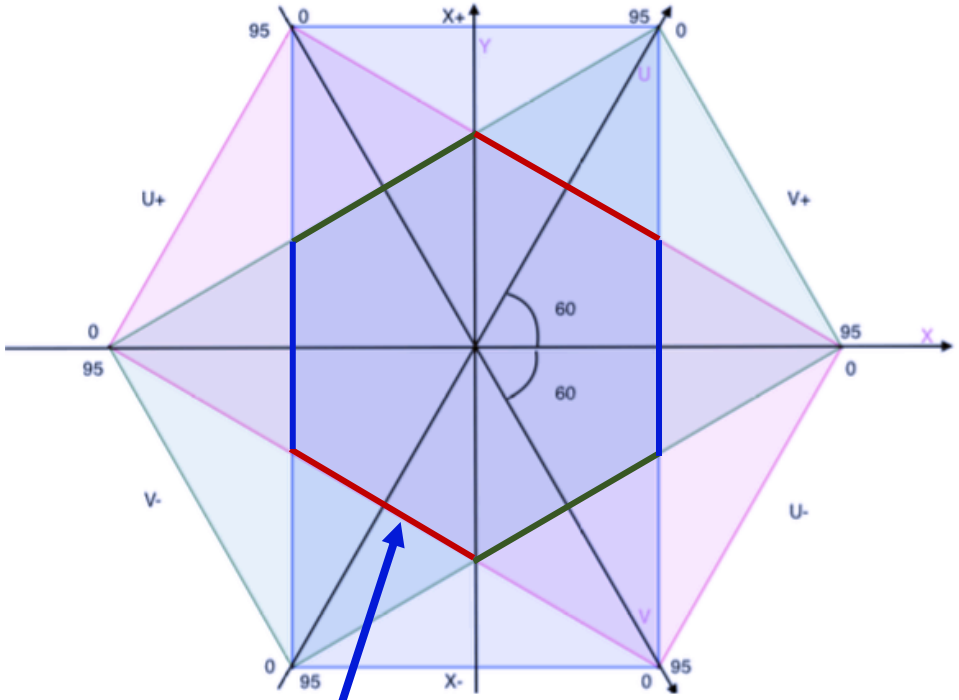
Full sensitive size of 12 x 12 cm^2

Full sensitive size of 25 x 25 cm^2

The contribution to the collected charge value is given by both electron and hole flow.

Multi Wire Proportional Chambers





Each MWPC has 6:
two **X**, two **U** and two **V**-planes
with wire angles 0°,±60°.
Wire pitch is d = 2.5 mm.
Coordinate resolution is $^{d}/_{\sqrt{12}}$ = 0.72 mm.

$$U = \frac{x + \sqrt{3}y}{2},$$

$$V = \frac{x - \sqrt{3}y}{2},$$

This point should satisfy the following condition:

$V + U - X = 0$

The intersection of these planes is a working area.