PXD(VXD) Cosmic Test

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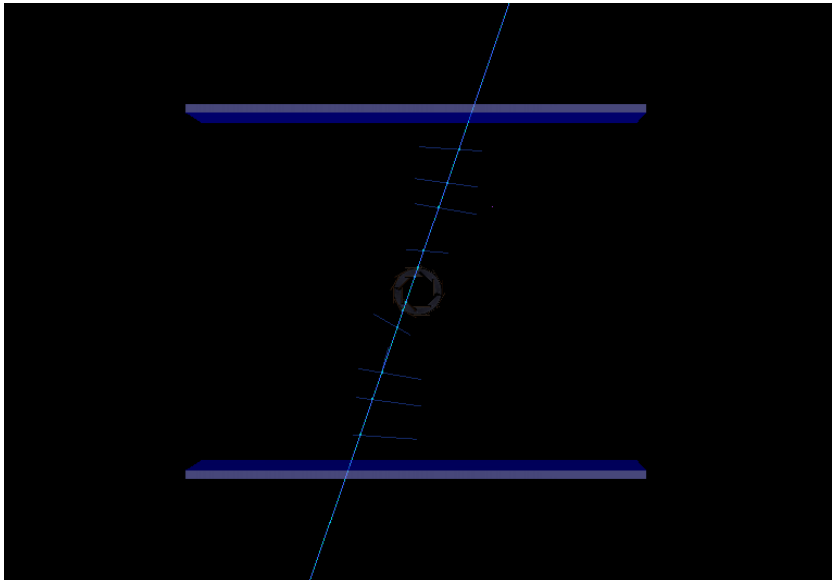
Two main issues I will discuss here:

- Simulation of the PXD/VXD trigger system (scintillators size)

- Tabuk PXD modules cosmic test setup

Setup (simple)

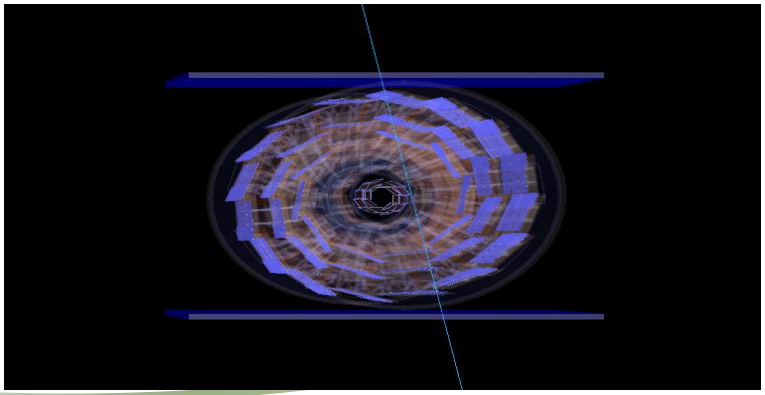
Basf2 simulation with just VXD



Scintillator 1

VXD

Scintillator 2

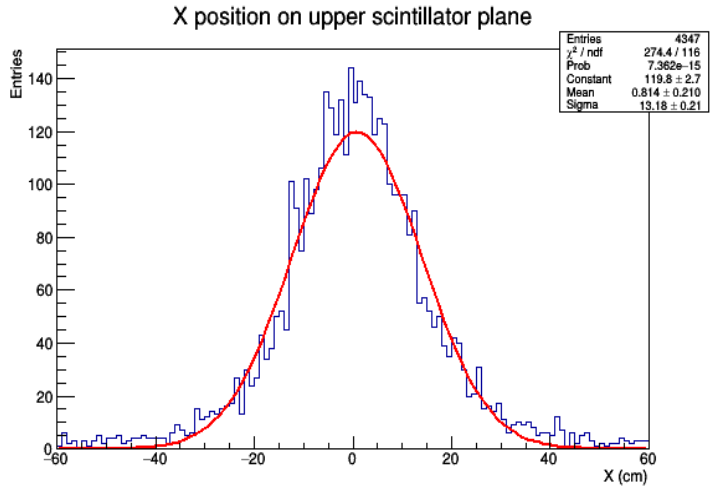


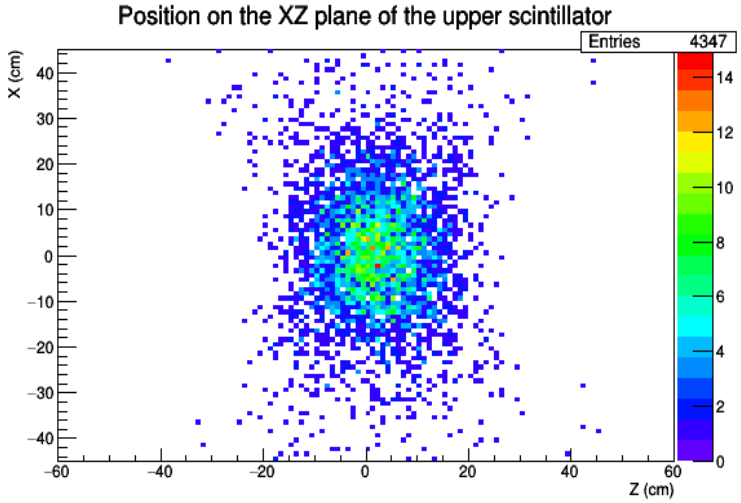
Introduction

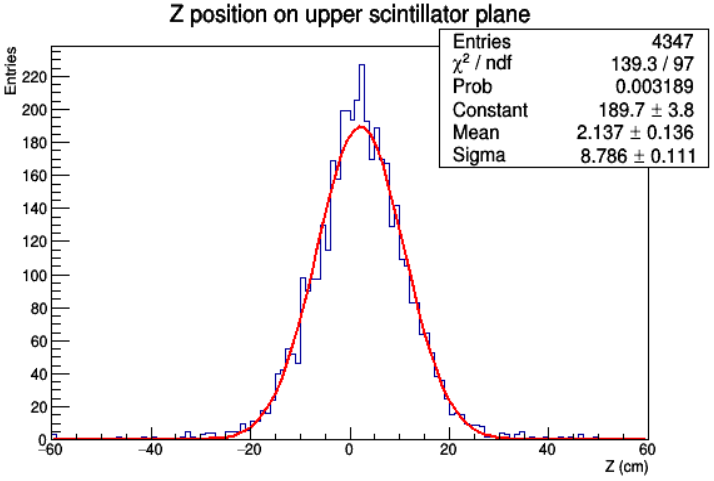
- To estimate trigger efficiency dependence on scintillator dimension we used cosmics generated with Cosmics generator in basf2
- We used default settings of a CDC cosmic generator, i.e. Cosmics are generated (pass inside) in whole CDC volume
- We keep just cosmics tracked (MC track candidates) by the SVD and we require at least one hit in the PXD
- We can extrapolate the position on scintillator plane using momentum components and doca (h: Scintillator y position)
  - x = h*(mcPx/mcPy) + docaX
  - z = h*(mcPz/mcPy) + docaZ

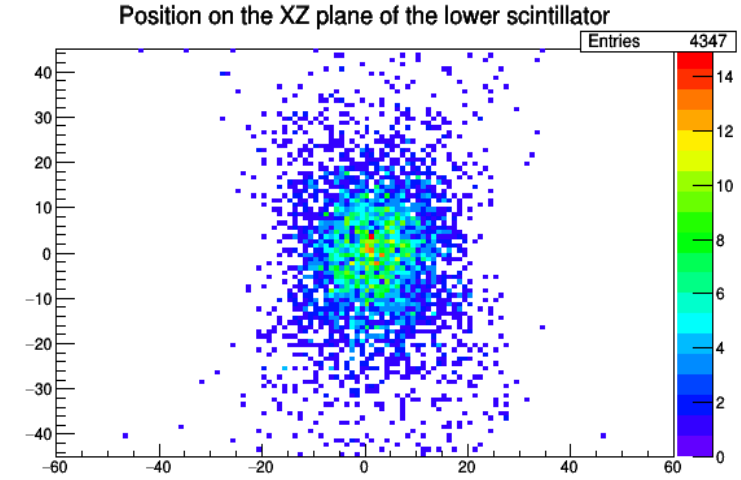
Distributions on scintillator surface

- We assume y=16 cm as installation “height” from IP with at least a PXD hit
- Broader distribution along x-axis w.r.t. z



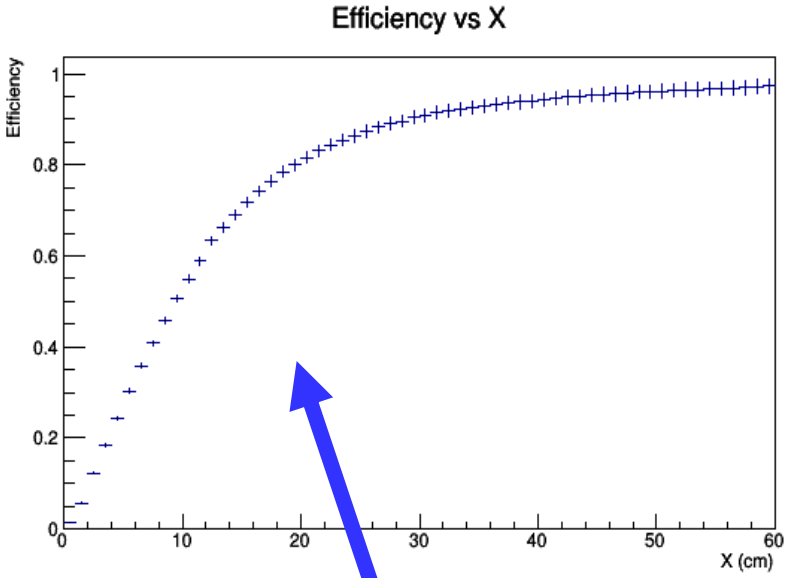


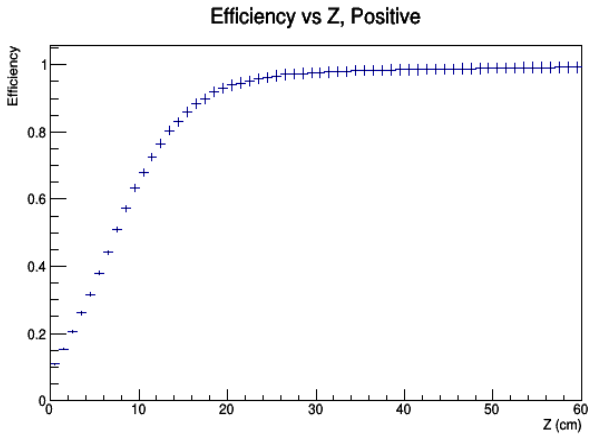


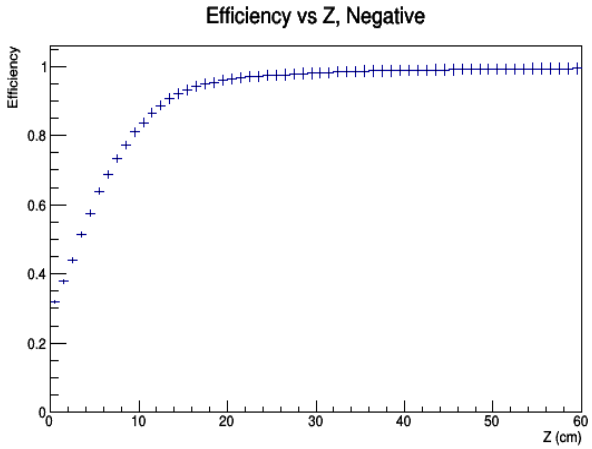


Efficiencies

- Efficiencies on each coordinate are calculated leaving other coordinates free (i.e. → oo)
- z+ and z- are computed separately, x is assumed symmetric (the other z hemisphere is open)
- Normalization is tot # of tracks with at least 1 hit in PXD (about 4.5%)



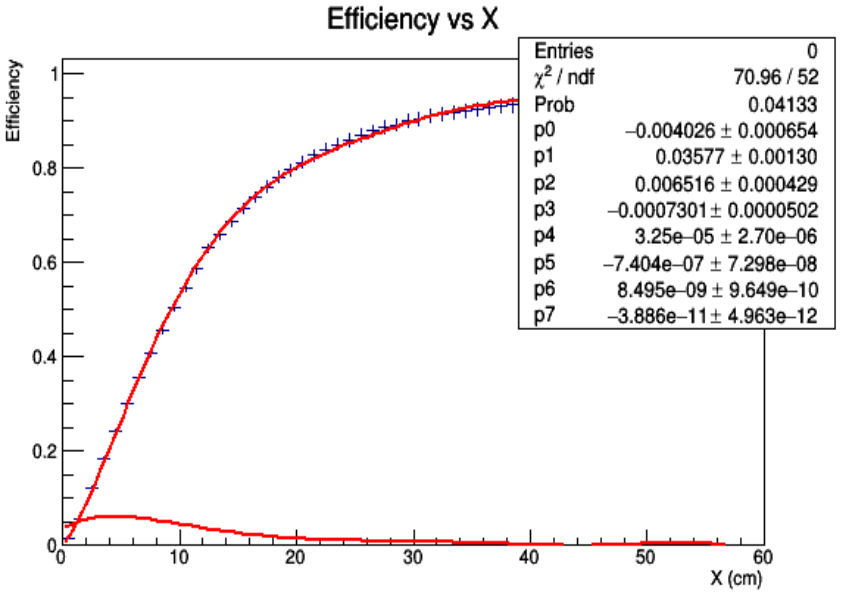


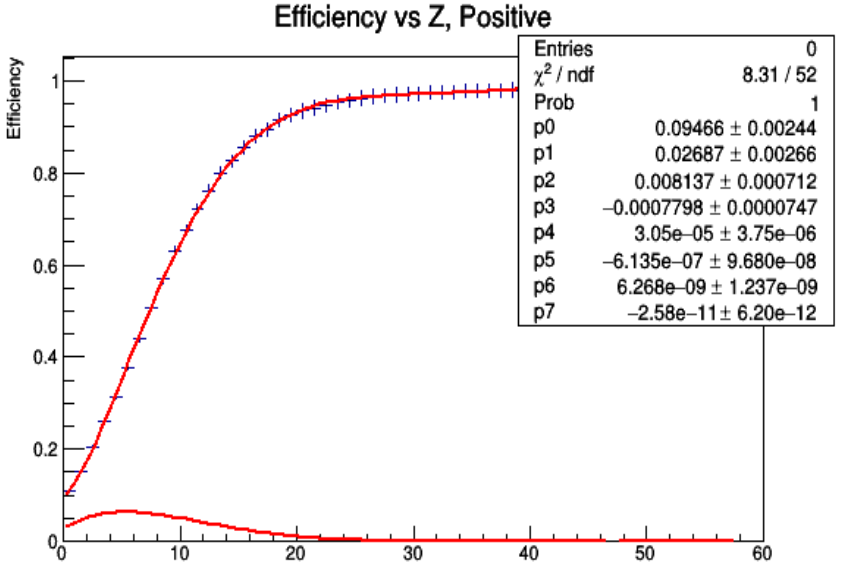


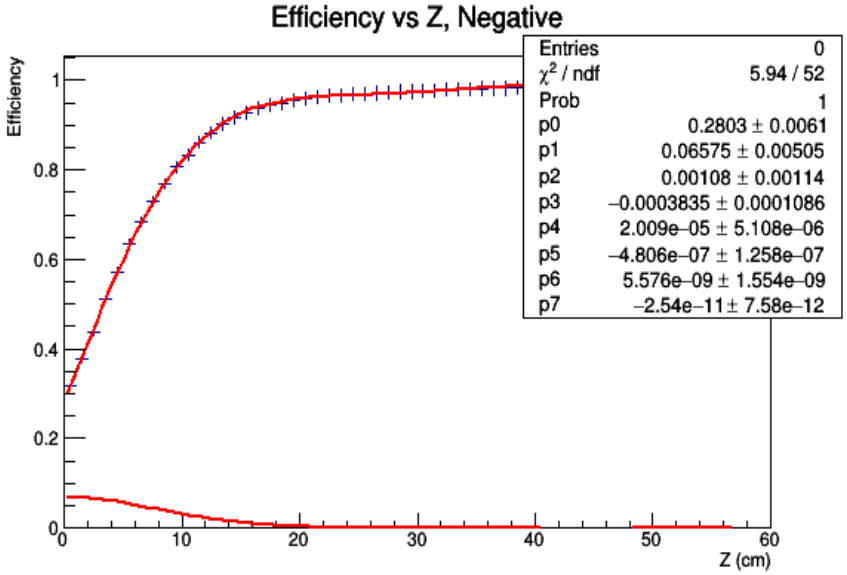
Scintillator half-width !

Fits

- Fits with pol7 look quite good
- Bottom function is the derivative

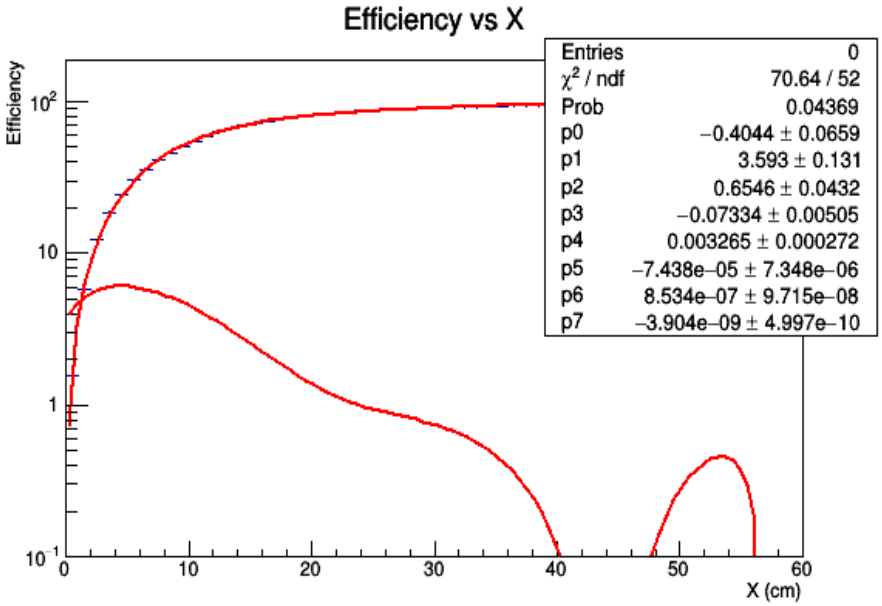


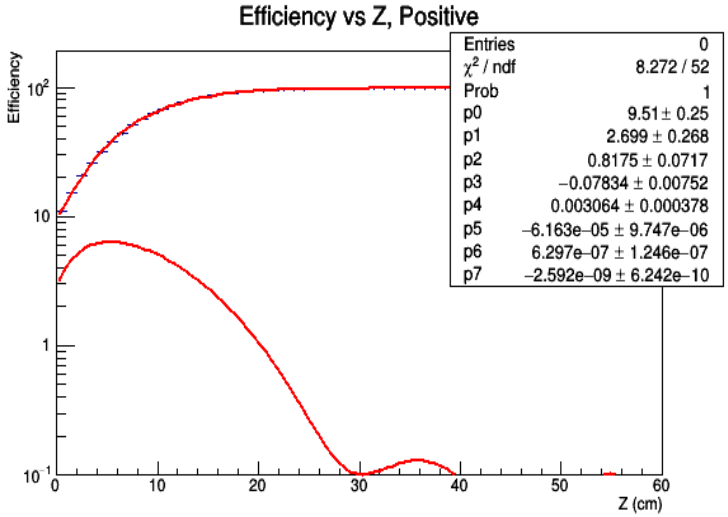


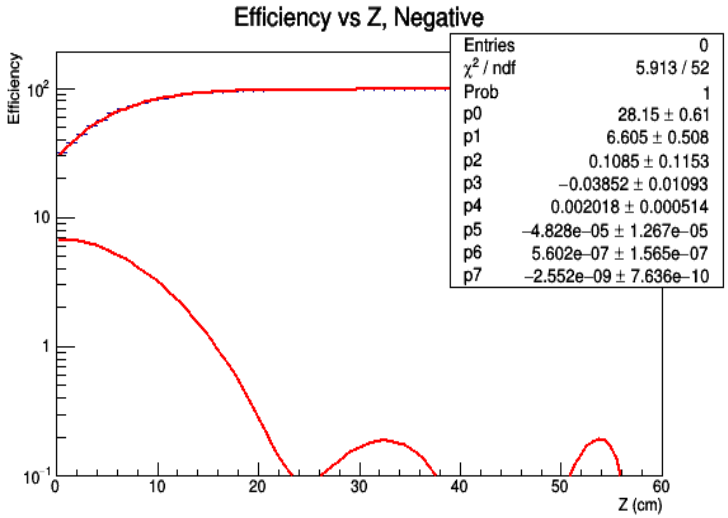


Fits 2

- Same fits in log scale
- y-axis in %

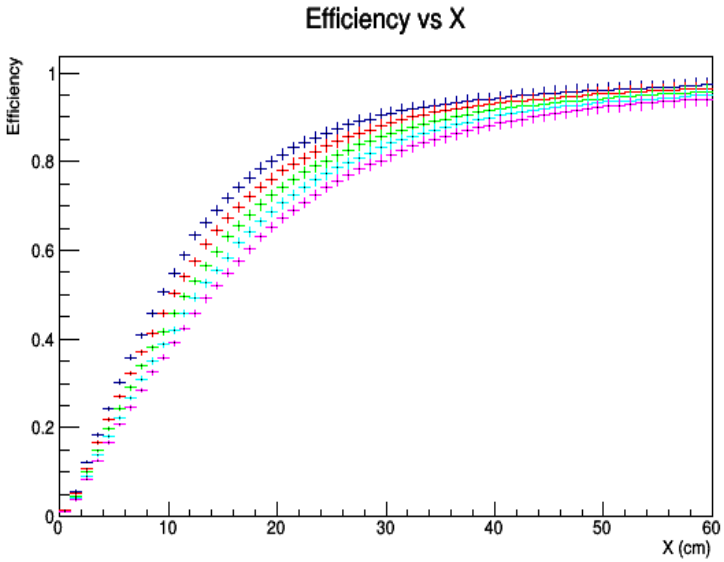


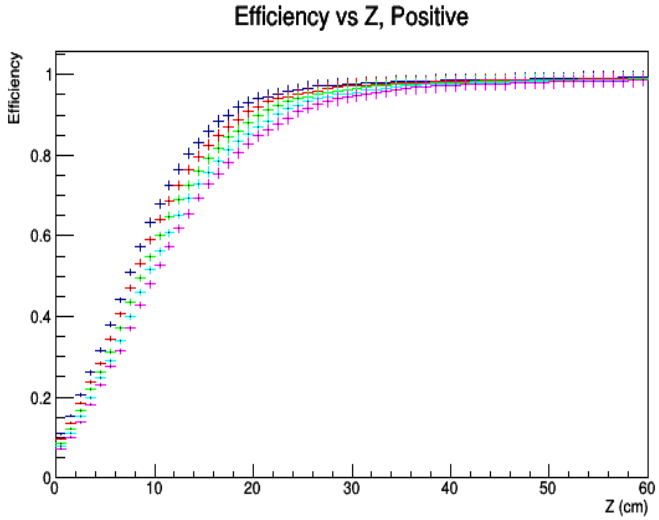


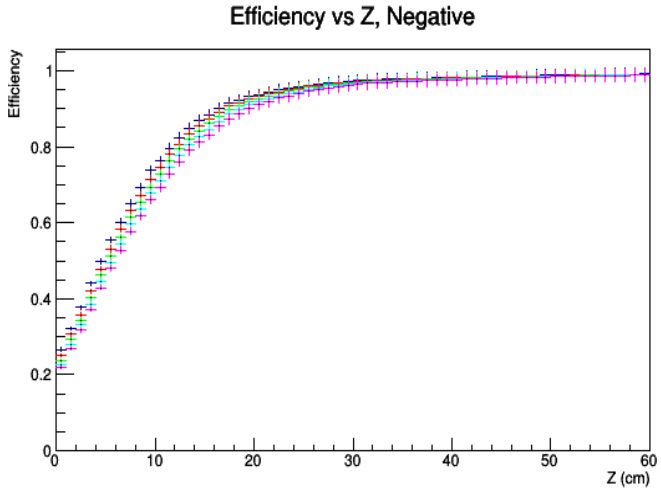


Dependence on inst. “height”

- Efficiency for y = 16, 18, 20, 22 and 24 cm respectively
- For “reasonable” scint. size most sensible is x-coordinate







PXD Numbers

- Slow rise in x, 90% at 30 cm (60 width), 95% at 44 cm (88 width!!)
- z rise is fast, +z (|-z|) 23 (19) cm > 95%, asymmetry as expected

Half-width (x)

```
Width: 25 cm, yeld: 0.863354
Width: 26 cm, yeld: 0.873936
Width: 27 cm, yeld: 0.882678
Width: 28 cm, yeld: 0.890039
Width: 29 cm, yeld: 0.89625
Width: 30 cm, yeld: 0.904302
Width: 31 cm, yeld: 0.909823
Width: 32 cm, yeld: 0.915344
Width: 33 cm, yeld: 0.919025
Width: 34 cm, yeld: 0.923856
Width: 35 cm, yeld: 0.925926
Width: 36 cm, yeld: 0.930757
Width: 37 cm, yeld: 0.934207
Width: 38 cm, yeld: 0.936278
Width: 39 cm, yeld: 0.938348
Width: 40 cm, yeld: 0.940189
Width: 41 cm, yeld: 0.943409
Width: 42 cm, yeld: 0.94617
Width: 43 cm, yeld: 0.9487
Width: 44 cm, yeld: 0.951001
Width: 45 cm, yeld: 0.953531
Width: 46 cm, yeld: 0.954911
Width: 47 cm, yeld: 0.955832
Width: 48 cm, yeld: 0.958362
Width: 49 cm, yeld: 0.960202
Width: 50 cm, yeld: 0.961583
Width: 51 cm, yeld: 0.962273
Width: 52 cm, yeld: 0.963653
Width: 53 cm, yeld: 0.965263
Width: 54 cm, yeld: 0.965723
Width: 55 cm, yeld: 0.966874
Width: 56 cm, yeld: 0.967794
Width: 57 cm, yeld: 0.968944
Width: 58 cm, yeld: 0.970094
Width: 59 cm, yeld: 0.972165
Width: 60 cm, yeld: 0.973085
```

+z

```
Length +: 11 cm, yeld: 0.680699
Length +: 12 cm, yeld: 0.726478
Length +: 13 cm, yeld: 0.765355
Length +: 14 cm, yeld: 0.803773
Length +: 15 cm, yeld: 0.830688
Length +: 16 cm, yeld: 0.859903
Length +: 17 cm, yeld: 0.883598
Length +: 18 cm, yeld: 0.899701
Length +: 19 cm, yeld: 0.918334
Length +: 20 cm, yeld: 0.930067
Length +: 21 cm, yeld: 0.939268
Length +: 22 cm, yeld: 0.94617
Length +: 23 cm, yeld: 0.952611
Length +: 24 cm, yeld: 0.957672
Length +: 25 cm, yeld: 0.963193
Length +: 26 cm, yeld: 0.967334
Length +: 27 cm, yeld: 0.971245
Length +: 28 cm, yeld: 0.973775
Length +: 29 cm, yeld: 0.974235
Length +: 30 cm, yeld: 0.975385
Length +: 31 cm, yeld: 0.977226
Length +: 32 cm, yeld: 0.978836
Length +: 33 cm, yeld: 0.979756
Length +: 34 cm, yeld: 0.980906
Length +: 35 cm, yeld: 0.982747
Length +: 36 cm, yeld: 0.983207
Length +: 37 cm, yeld: 0.983667
Length +: 38 cm, yeld: 0.984357
Length +: 39 cm, yeld: 0.985047
Length +: 40 cm, yeld: 0.985507
Length +: 41 cm, yeld: 0.985507
Length +: 42 cm, yeld: 0.985737
Length +: 43 cm, yeld: 0.986197
Length +: 44 cm, yeld: 0.986197
Length +: 45 cm, yeld: 0.986888
Length +: 46 cm, yeld: 0.987348
Length +: 47 cm, yeld: 0.988498
Length +: 48 cm, yeld: 0.988728
Length +: 49 cm, yeld: 0.989418
Length +: 50 cm, yeld: 0.990108
```

-z

```
Length -: 8 cm, yeld: 0.733379
Length -: 9 cm, yeld: 0.771797
Length -: 10 cm, yeld: 0.810674
Length -: 11 cm, yeld: 0.837819
Length -: 12 cm, yeld: 0.865194
Length -: 13 cm, yeld: 0.887049
Length -: 14 cm, yeld: 0.907752
Length -: 15 cm, yeld: 0.922475
Length -: 16 cm, yeld: 0.933057
Length -: 17 cm, yeld: 0.942719
Length -: 18 cm, yeld: 0.94939
Length -: 19 cm, yeld: 0.954221
Length -: 20 cm, yeld: 0.960202
Length -: 21 cm, yeld: 0.964573
Length -: 22 cm, yeld: 0.967794
Length -: 23 cm, yeld: 0.969864
Length -: 24 cm, yeld: 0.971705
Length -: 25 cm, yeld: 0.973315
Length -: 26 cm, yeld: 0.974695
Length -: 27 cm, yeld: 0.975615
Length -: 28 cm, yeld: 0.977686
Length -: 29 cm, yeld: 0.979296
Length -: 30 cm, yeld: 0.979986
Length -: 31 cm, yeld: 0.980446
Length -: 32 cm, yeld: 0.981827
Length -: 33 cm, yeld: 0.984127
Length -: 34 cm, yeld: 0.984817
Length -: 35 cm, yeld: 0.985507
Length -: 36 cm, yeld: 0.986197
Length -: 37 cm, yeld: 0.986657
Length -: 38 cm, yeld: 0.987118
Length -: 39 cm, yeld: 0.987348
Length -: 40 cm, yeld: 0.988038
Length -: 41 cm, yeld: 0.988498
Length -: 42 cm, yeld: 0.989188
Length -: 43 cm, yeld: 0.989188
Length -: 44 cm, yeld: 0.989418
Length -: 45 cm, yeld: 0.990108
Length -: 46 cm, yeld: 0.990338
```

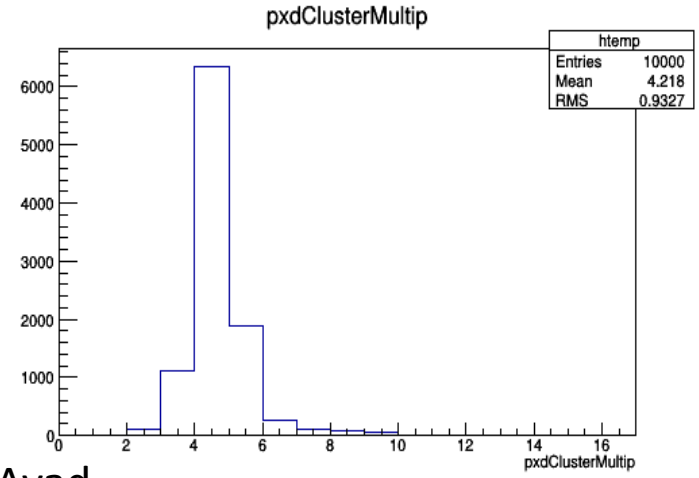
PXD Numbers 2

- Tentative (naive) calculations:
- $(0.9)^{1/3} = 0.965 \rightarrow$ x=53 cm... (z+=26 cm, z-=22 cm) (106 x 48 cm)
- Lets say we want eff > 90%
  - Fix max x size $\rightarrow$ 40 cm $\rightarrow$ $eff_X = 0.94$
  - $eff_{z+} x eff_{z-} = 0.957 \rightarrow eff_{z+} = eff_{z-} = 0.978$
  - z+ = 32 , z- = 28
  - Total scintillator size 80x60 cm (x, z)
- Which width is “reasonable”?

Cross-check

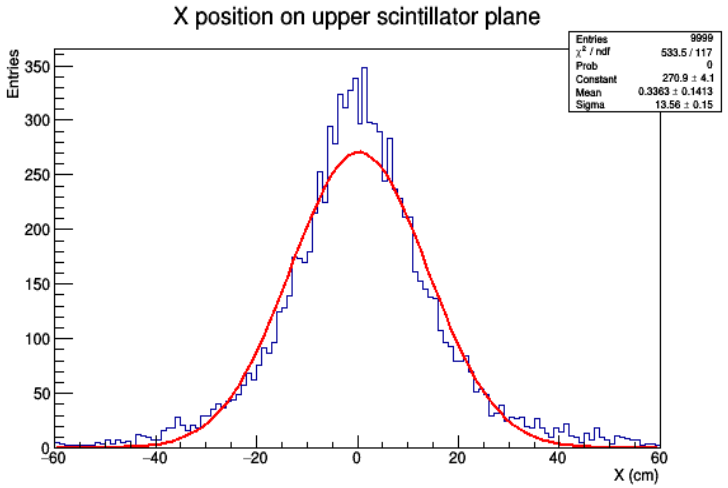
- The fact that we have used the available track finder (i.e. not designed for cosmics) may introduce some bias
- To have some independent result (in particular for x dimension) we made a 2nd calculation constraining the cosmic generator (10K evts)
- We require r < 1.4 cm (distance from IP in xy plane) and |z| < 3 cm from IP along beam axis → cosmics are forced to pass all 2 PXD layers
- (Unfortunately +z and -z cannot be set independently with current cosmic generator)

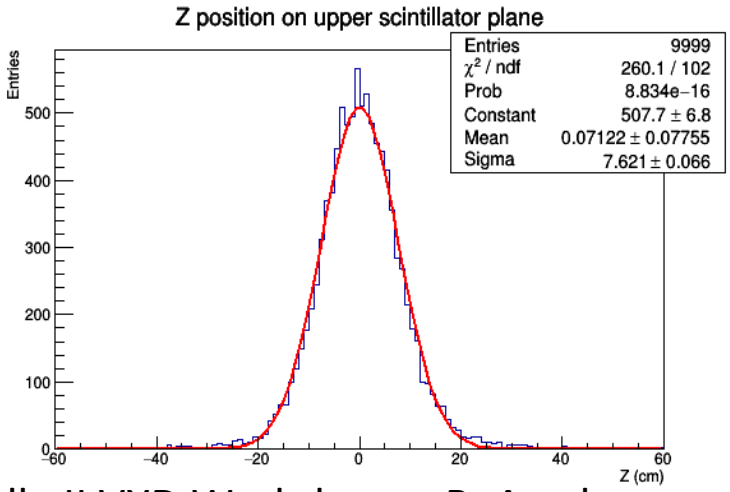
- We expect no (x) or small (z-) change for 2 coordinates and symmetric results along beam axis (z- , z+)

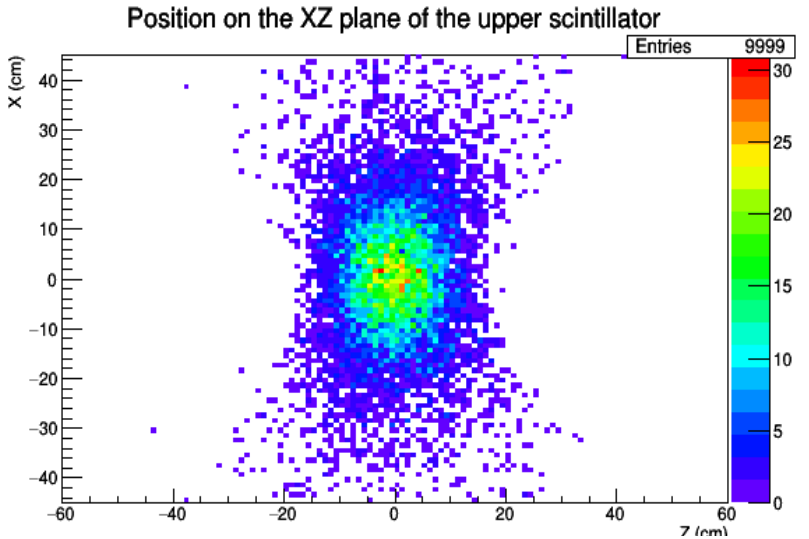


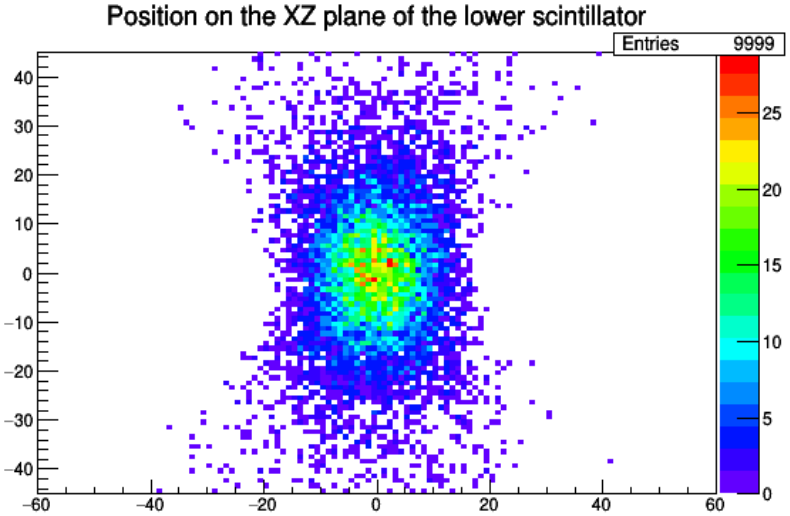
Cross-check 2

- The x and z- distributions are compatible as expected
- z+ and z- are now symmetric



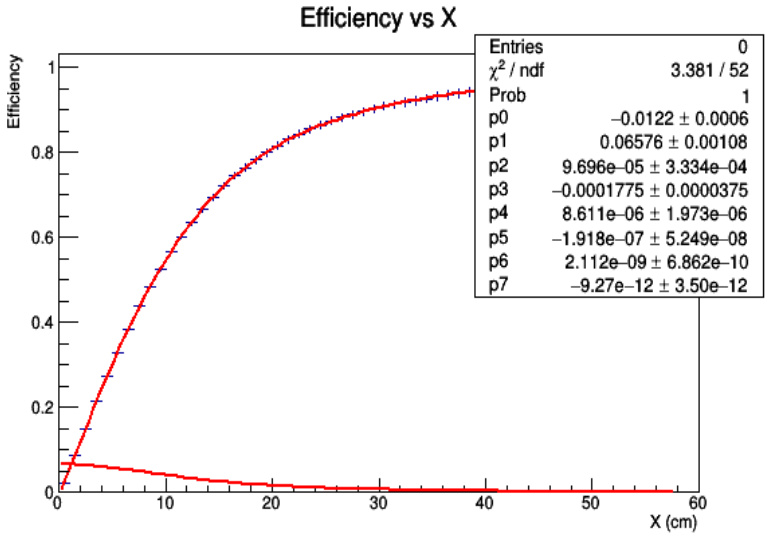


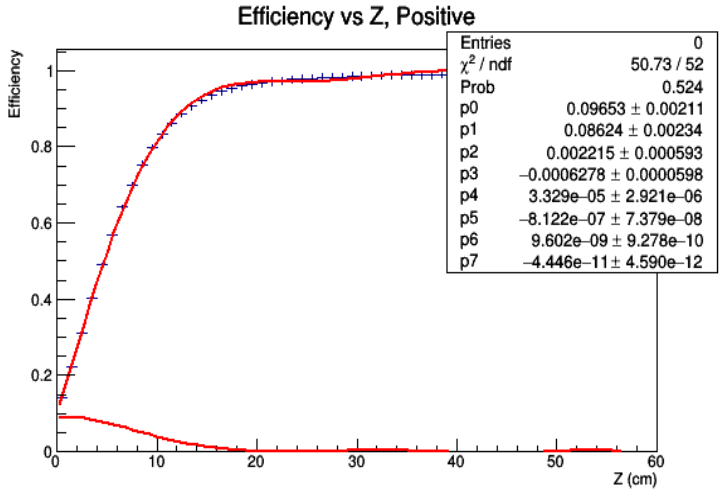


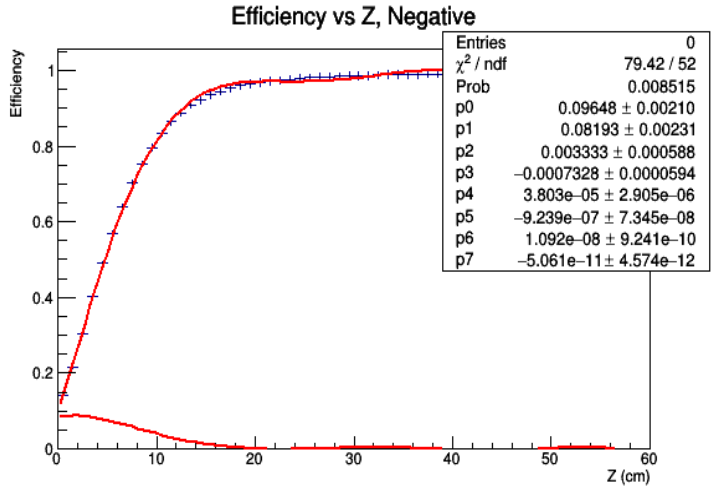


Cross-check results

- Fit results are compatible where expected







Cross-check Numbers

- Using the same requests as in the previous calculation and imposing +z = -z

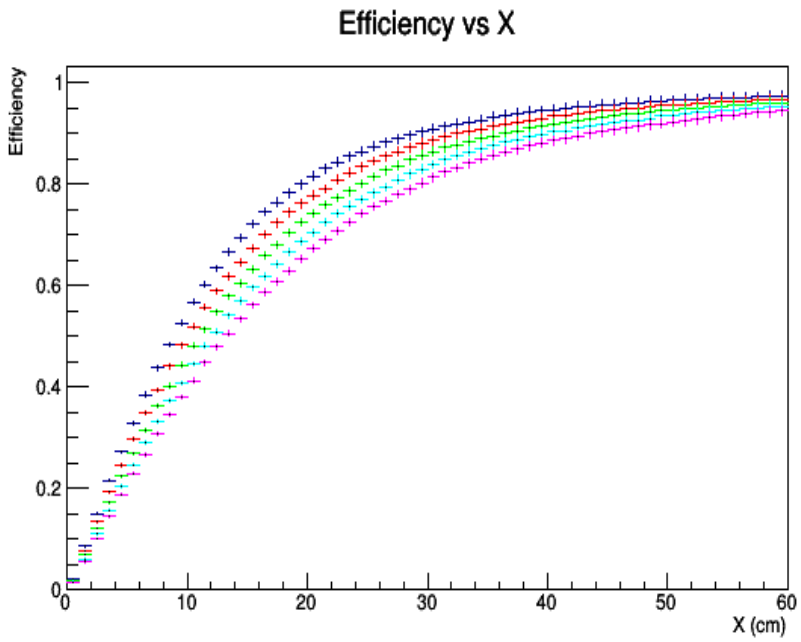
- eff 90%, x = 40 cm → eff_z = 0.974 → z+ = 24 cm, z- = 24 cm → OK!

Half-width (x)

```
Width: 27 cm, yeld: 0.882588
Width: 28 cm, yeld: 0.889689
Width: 29 cm, yeld: 0.89739
Width: 30 cm, yeld: 0.90399
Width: 31 cm, yeld: 0.908791
Width: 32 cm, yeld: 0.913891
Width: 33 cm, yeld: 0.918792
Width: 34 cm, yeld: 0.922092
Width: 35 cm, yeld: 0.926593
Width: 36 cm, yeld: 0.931793
Width: 37 cm, yeld: 0.936394
Width: 38 cm, yeld: 0.939594
Width: 39 cm, yeld: 0.942294
Width: 40 cm, yeld: 0.944894
Width: 41 cm, yeld: 0.946995
Width: 42 cm, yeld: 0.949795
Width: 43 cm, yeld: 0.952595
Width: 44 cm, yeld: 0.954295
Width: 45 cm, yeld: 0.955896
Width: 46 cm, yeld: 0.957696
Width: 47 cm, yeld: 0.958996
Width: 48 cm, yeld: 0.960996
Width: 49 cm, yeld: 0.962796
Width: 50 cm, yeld: 0.964096
Width: 51 cm, yeld: 0.965197
Width: 52 cm, yeld: 0.966597
Width: 53 cm, yeld: 0.968197
Width: 54 cm, yeld: 0.969097
Width: 55 cm, yeld: 0.970197
Width: 56 cm, yeld: 0.971197
Width: 57 cm, yeld: 0.971697
```

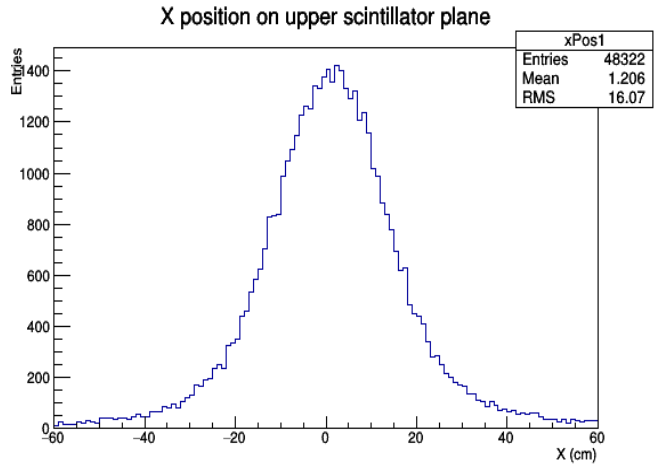
+z

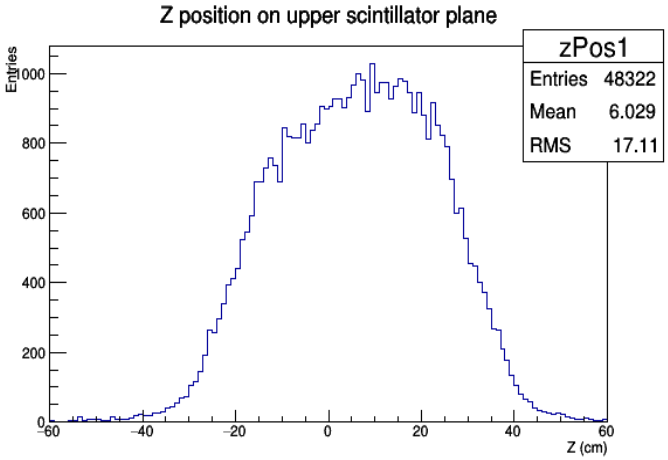
```
Length +: 14 cm, yeld: 0.906791
Length +: 15 cm, yeld: 0.922192
Length +: 16 cm, yeld: 0.935094
Length +: 17 cm, yeld: 0.946395
Length +: 18 cm, yeld: 0.953895
Length +: 19 cm, yeld: 0.959496
Length +: 20 cm, yeld: 0.964196
Length +: 21 cm, yeld: 0.966697
Length +: 22 cm, yeld: 0.970497
Length +: 23 cm, yeld: 0.973397
Length +: 24 cm, yeld: 0.976798
Length +: 25 cm, yeld: 0.978298
Length +: 26 cm, yeld: 0.979998
Length +: 27 cm, yeld: 0.981498
Length +: 28 cm, yeld: 0.983198
Length +: 29 cm, yeld: 0.983498
Length +: 30 cm, yeld: 0.984498
Length +: 31 cm, yeld: 0.985599
Length +: 32 cm, yeld: 0.986799
Length +: 33 cm, yeld: 0.987699
Length +: 34 cm, yeld: 0.988299
Length +: 35 cm, yeld: 0.988999
Length +: 36 cm, yeld: 0.989299
Length +: 37 cm, yeld: 0.989599
Length +: 38 cm, yeld: 0.989899
Length +: 39 cm, yeld: 0.990499
Length +: 40 cm, yeld: 0.991199
Length +: 41 cm, yeld: 0.991899
Length +: 42 cm, yeld: 0.992099
Length +: 43 cm, yeld: 0.992299
```

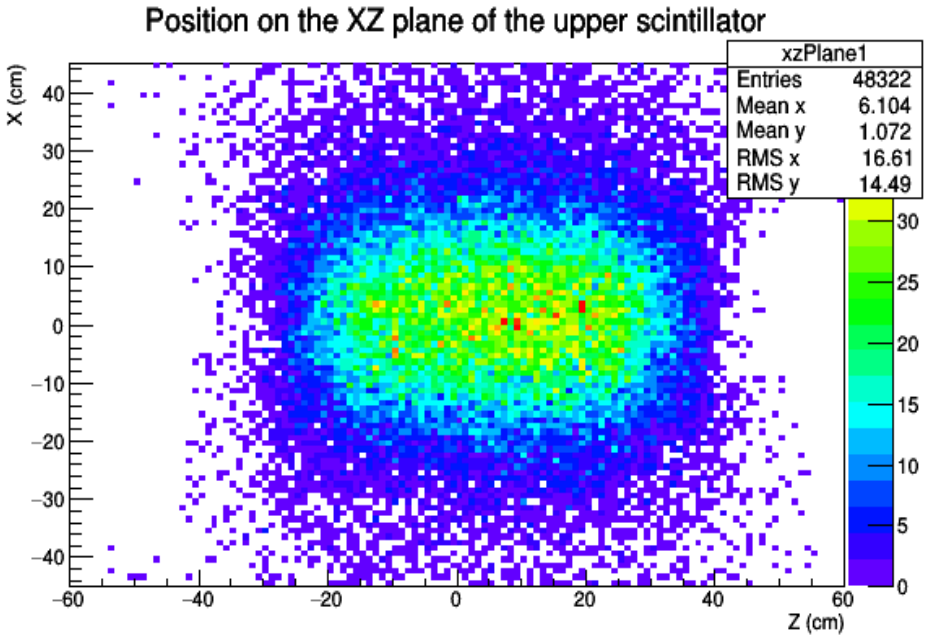


Optimization for whole VXD

- In this case we require just a track in the VXD

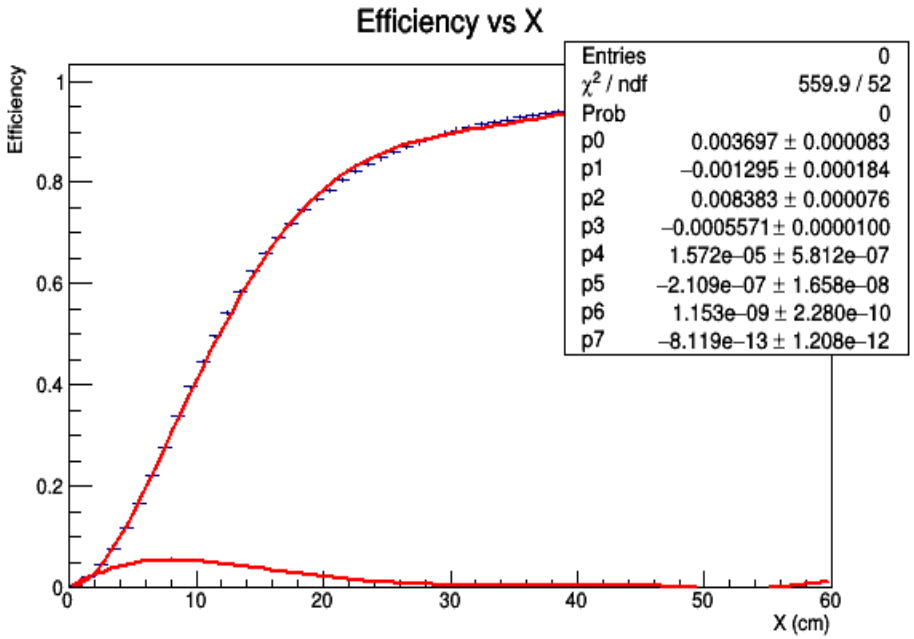


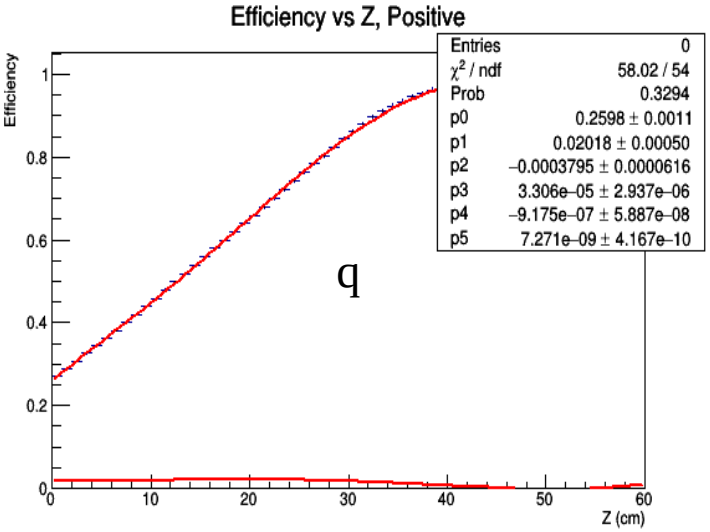


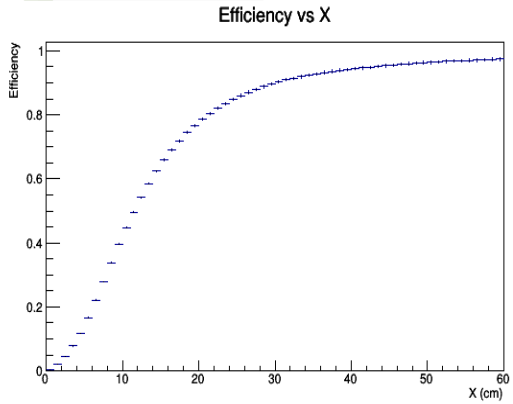


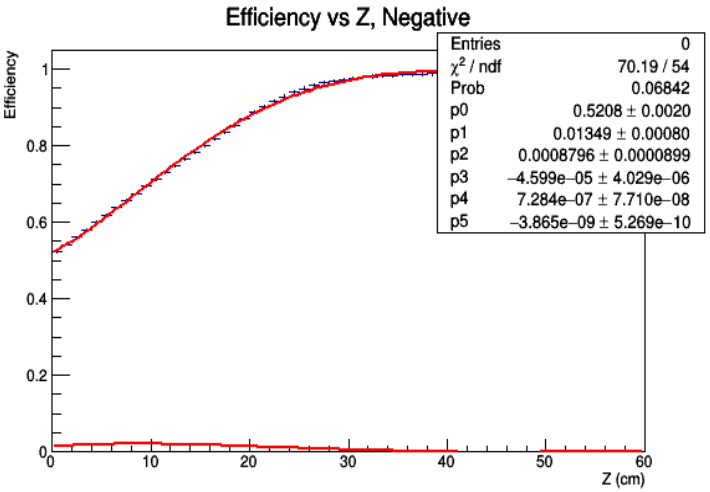
VXD Fits

- pol7 for x, pol5 for z



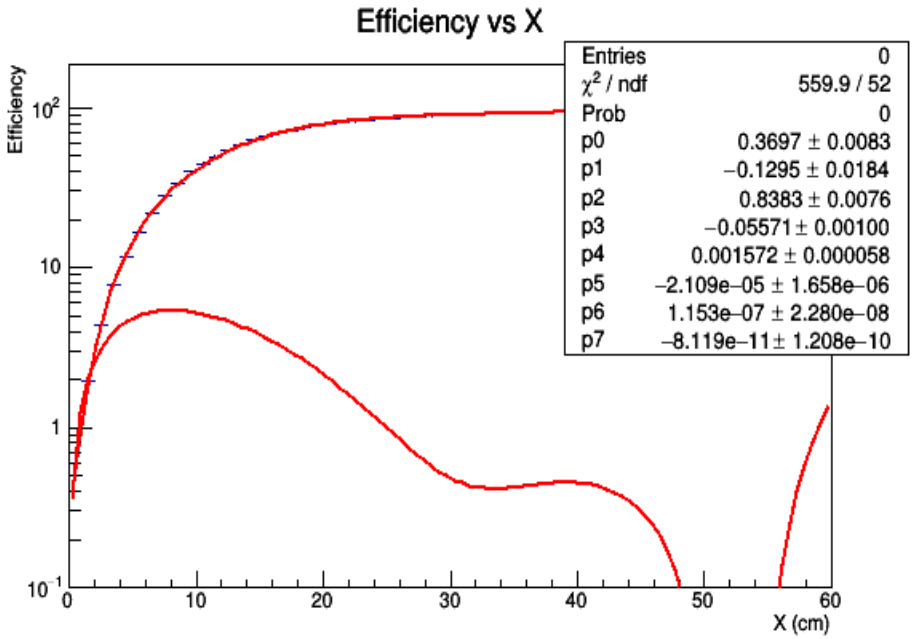


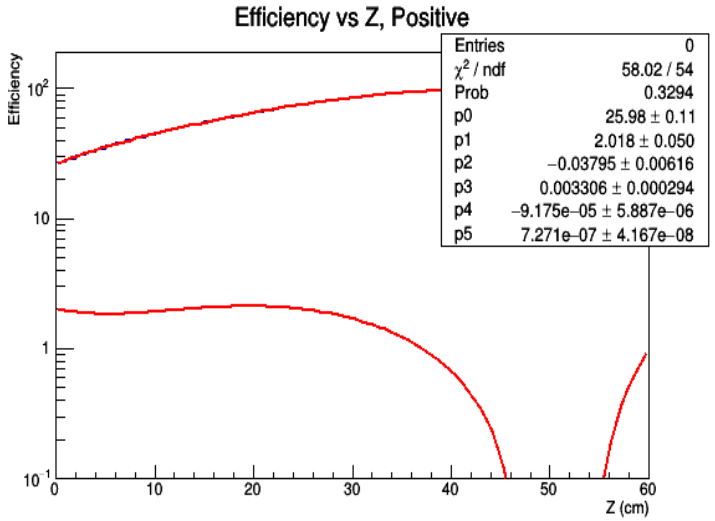


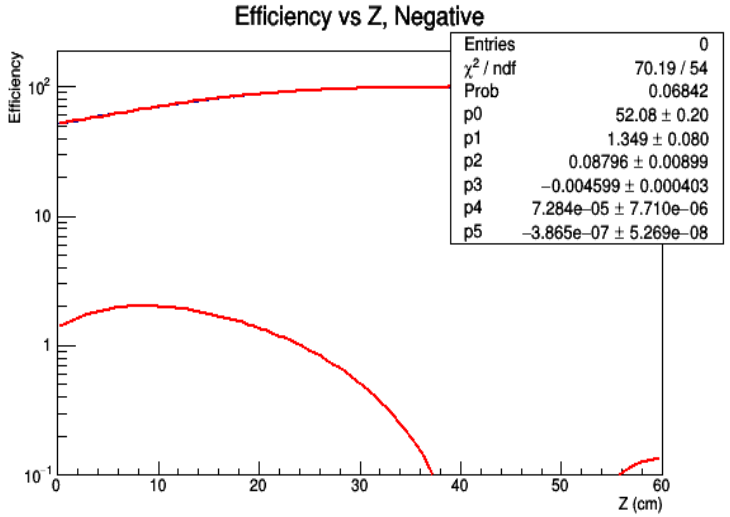


VXD Fits Log

- y-axis in %

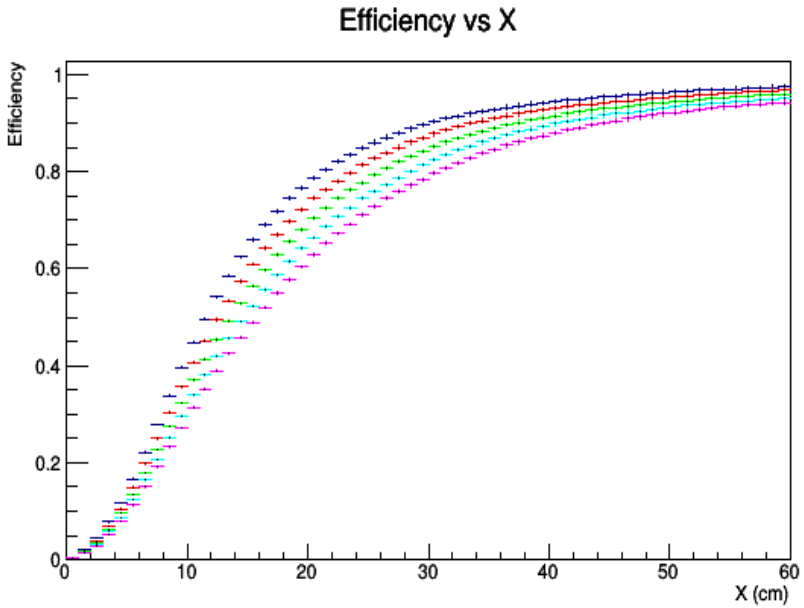


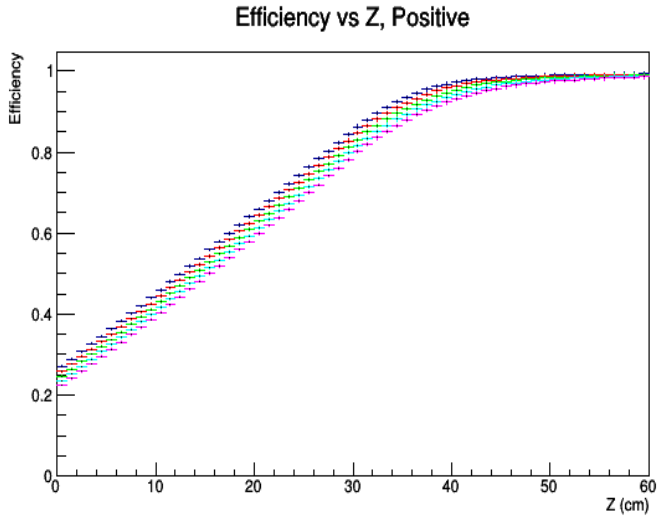


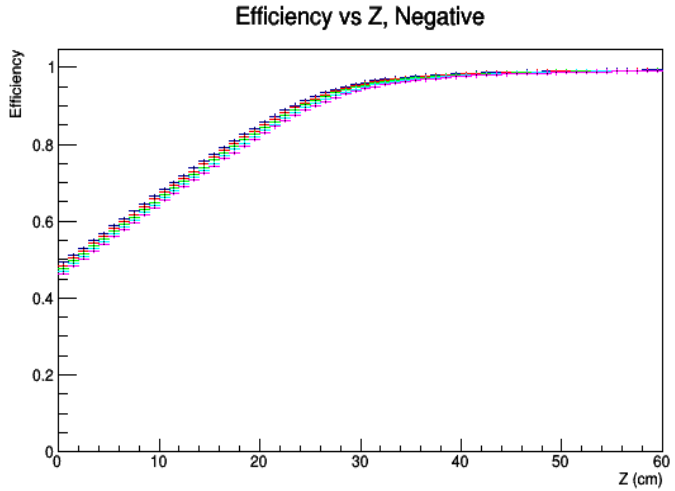


VXD Installation Height

- Efficiency for y = 16, 18, 20, 22 and 24 cm respectively







VXD Numbers

- Quite similar in x
- Same eff. → approximately 10 cm increase in (both) longitudinal coordinates

Half-width (x)

```
Width: 30 cm, yeld: 0.8963
Width: 31 cm, yeld: 0.903212
Width: 32 cm, yeld: 0.909462
Width: 33 cm, yeld: 0.914449
Width: 34 cm, yeld: 0.919747
Width: 35 cm, yeld: 0.924134
Width: 36 cm, yeld: 0.928149
Width: 37 cm, yeld: 0.932122
Width: 38 cm, yeld: 0.936075
Width: 39 cm, yeld: 0.938868
Width: 40 cm, yeld: 0.9416
Width: 41 cm, yeld: 0.944083
Width: 42 cm, yeld: 0.946546
Width: 43 cm, yeld: 0.948885
Width: 44 cm, yeld: 0.951306
Width: 45 cm, yeld: 0.953499
Width: 46 cm, yeld: 0.955569
Width: 47 cm, yeld: 0.957742
Width: 48 cm, yeld: 0.959791
Width: 49 cm, yeld: 0.961488
Width: 50 cm, yeld: 0.962978
Width: 51 cm, yeld: 0.964405
Width: 52 cm, yeld: 0.965626
Width: 53 cm, yeld: 0.967158
Width: 54 cm, yeld: 0.968172
Width: 55 cm, yeld: 0.969289
Width: 56 cm, yeld: 0.970221
Width: 57 cm, yeld: 0.971131
Width: 58 cm, yeld: 0.972083
Width: 59 cm, yeld: 0.973242
Width: 60 cm, yeld: 0.974194
```

+z

```
Length +: 23 cm, yeld: 0.701502
Length +: 24 cm, yeld: 0.720893
Length +: 25 cm, yeld: 0.741401
Length +: 26 cm, yeld: 0.762882
Length +: 27 cm, yeld: 0.783804
Length +: 28 cm, yeld: 0.803464
Length +: 29 cm, yeld: 0.824179
Length +: 30 cm, yeld: 0.844605
Length +: 31 cm, yeld: 0.863106
Length +: 32 cm, yeld: 0.880096
Length +: 33 cm, yeld: 0.896093
Length +: 34 cm, yeld: 0.910869
Length +: 35 cm, yeld: 0.923948
Length +: 36 cm, yeld: 0.93473
Length +: 37 cm, yeld: 0.945491
Length +: 38 cm, yeld: 0.954576
Length +: 39 cm, yeld: 0.962253
Length +: 40 cm, yeld: 0.967924
Length +: 41 cm, yeld: 0.972766
Length +: 42 cm, yeld: 0.976056
Length +: 43 cm, yeld: 0.979016
Length +: 44 cm, yeld: 0.981354
Length +: 45 cm, yeld: 0.983237
Length +: 46 cm, yeld: 0.984727
Length +: 47 cm, yeld: 0.985907
Length +: 48 cm, yeld: 0.987004
Length +: 49 cm, yeld: 0.987832
Length +: 50 cm, yeld: 0.988721
Length +: 51 cm, yeld: 0.989529
Length +: 52 cm, yeld: 0.99017
Length +: 53 cm, yeld: 0.990687
Length +: 54 cm, yeld: 0.991101
Length +: 55 cm, yeld: 0.991432
Length +: 56 cm, yeld: 0.991826
Length +: 57 cm, yeld: 0.992157
Length +: 58 cm, yeld: 0.992426
Length +: 59 cm, yeld: 0.992736
Length +: 60 cm, yeld: 0.993088
```

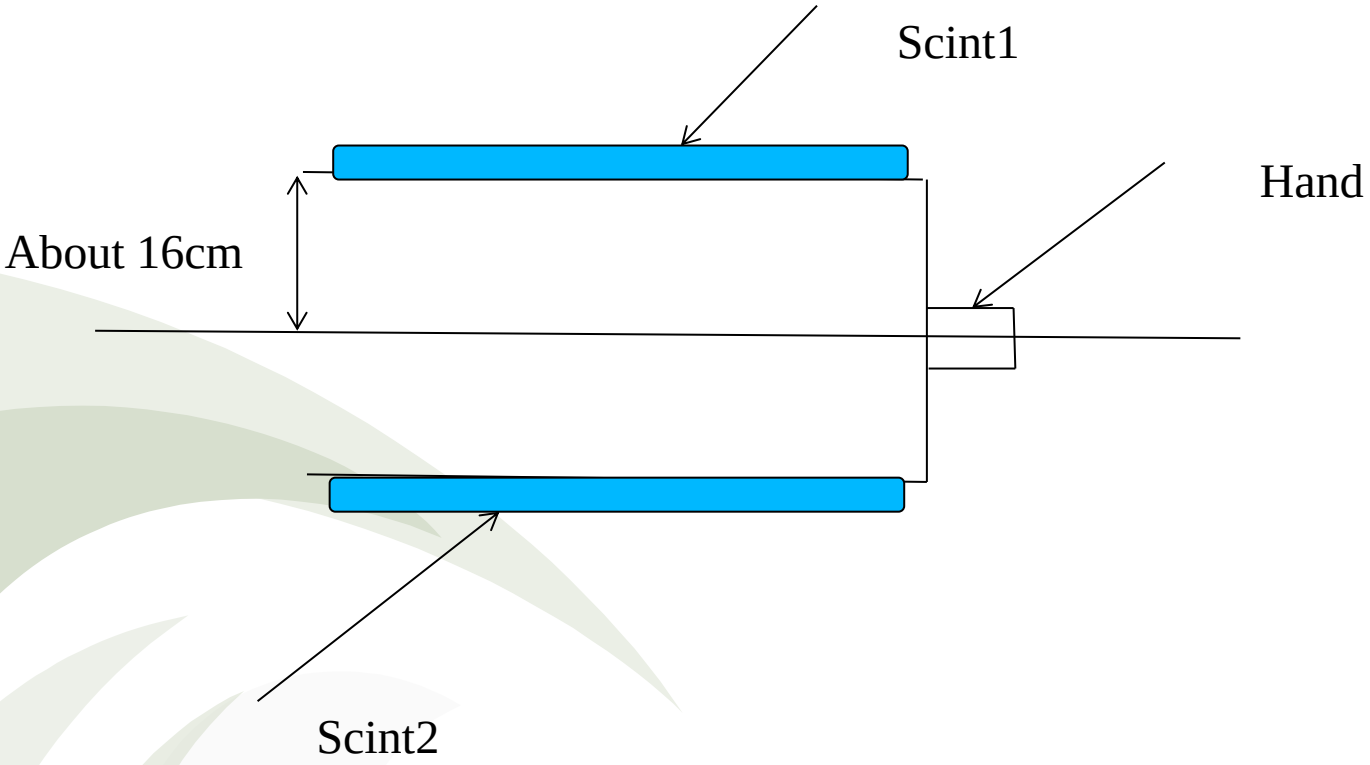
-z

```
Length -: 20 cm, yeld: 0.870287
Length -: 21 cm, yeld: 0.886987
Length -: 22 cm, yeld: 0.902363
Length -: 23 cm, yeld: 0.916146
Length -: 24 cm, yeld: 0.92819
Length -: 25 cm, yeld: 0.939096
Length -: 26 cm, yeld: 0.949567
Length -: 27 cm, yeld: 0.957825
Length -: 28 cm, yeld: 0.963764
Length -: 29 cm, yeld: 0.968793
Length -: 30 cm, yeld: 0.972807
Length -: 31 cm, yeld: 0.975953
Length -: 32 cm, yeld: 0.979036
Length -: 33 cm, yeld: 0.981065
Length -: 34 cm, yeld: 0.982948
Length -: 35 cm, yeld: 0.984645
Length -: 36 cm, yeld: 0.985907
Length -: 37 cm, yeld: 0.986983
Length -: 38 cm, yeld: 0.987873
Length -: 39 cm, yeld: 0.988618
Length -: 40 cm, yeld: 0.989301
Length -: 41 cm, yeld: 0.990067
Length -: 42 cm, yeld: 0.99077
Length -: 43 cm, yeld: 0.991205
Length -: 44 cm, yeld: 0.991536
Length -: 45 cm, yeld: 0.991971
Length -: 46 cm, yeld: 0.992302
Length -: 47 cm, yeld: 0.992695
Length -: 48 cm, yeld: 0.993047
Length -: 49 cm, yeld: 0.993254
Length -: 50 cm, yeld: 0.993419
Length -: 51 cm, yeld: 0.993771
Length -: 52 cm, yeld: 0.994081
Length -: 53 cm, yeld: 0.994268
Length -: 54 cm, yeld: 0.994661
Length -: 55 cm, yeld: 0.994785
Length -: 56 cm, yeld: 0.995033
Length -: 57 cm, yeld: 0.995075
Length -: 58 cm, yeld: 0.995137
Length -: 59 cm, yeld: 0.995261
Length -: 60 cm, yeld: 0.995406
```

VXD Numbers 2

- With similar calculations as done before
- Lets say we want eff > 90%
  - Fix max x size → 40 cm → $eff_X = 0.94$
  - $Sqrt(eff_{z+}\ eff_{z-}) = 0.957 \rightarrow eff_{z+} = eff_{z-} = 0.978$
  - z+ = 43 cm, z- = 32 cm
- Compare to PXD numbers → 40 cm (x), 32 cm (z+), 28 cm (z-)
- 15 cm increase in longitudinal direction with respect to PXD only case could give a trigger with 90% efficiency for whole VXD

Building the scintillator trigger system (frame)



The frame should be slit underneath and up to the VXD piece (discussed with Charlie)

Cosmic Setup at Tabuk (Final Setup)

Shelf to mount Scintillator 1

Shelf to mount Alibava Tracker Plane 1

Shelf to mount the PXD module

Shelf to mount Alibava Tracker Plane 2

Shelf to mount Scintillator 2

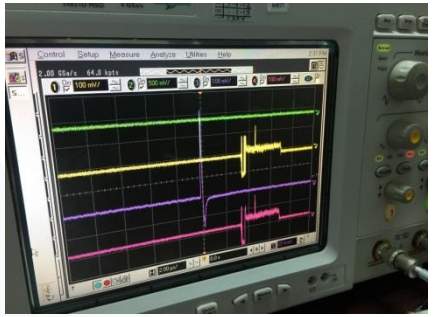
Shelf to mount Alibava Trigger Card (TC)

Trigger: Two scintillators

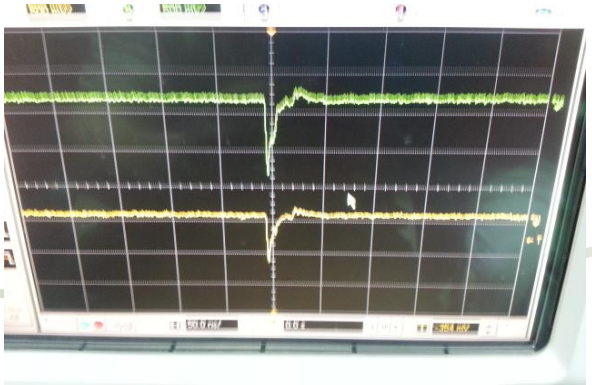
A 10cmx1cmx0.5cm scintillator two crossed scints so a 1cm^2 cross section to match the Alibava Tracker sensible area

A shelf with Alibava Plane detector installed

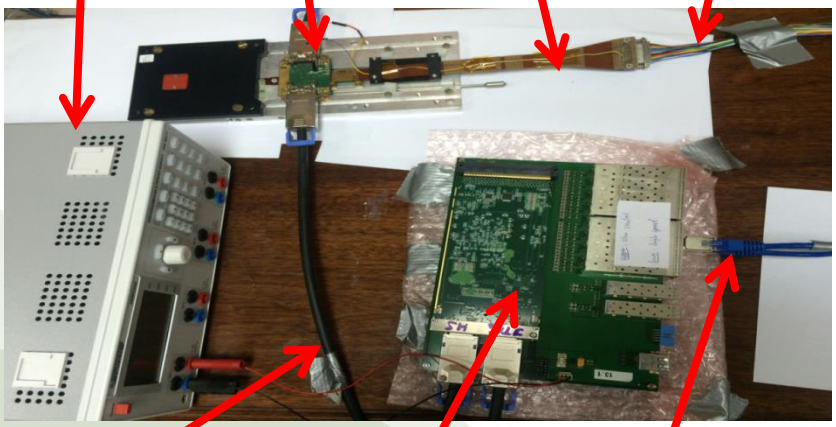
Coincidence on two Alibava Planes with Beta source

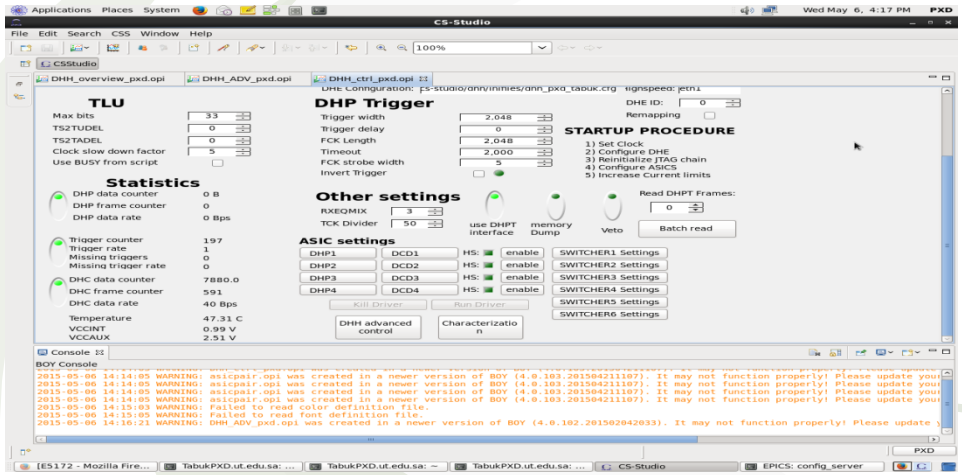


Scintillators coincidence: Muon



PXD setup and Software

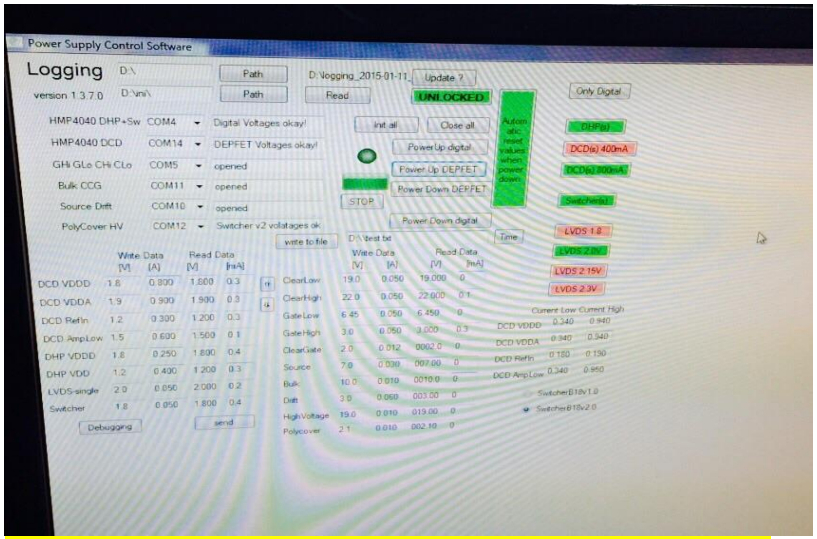




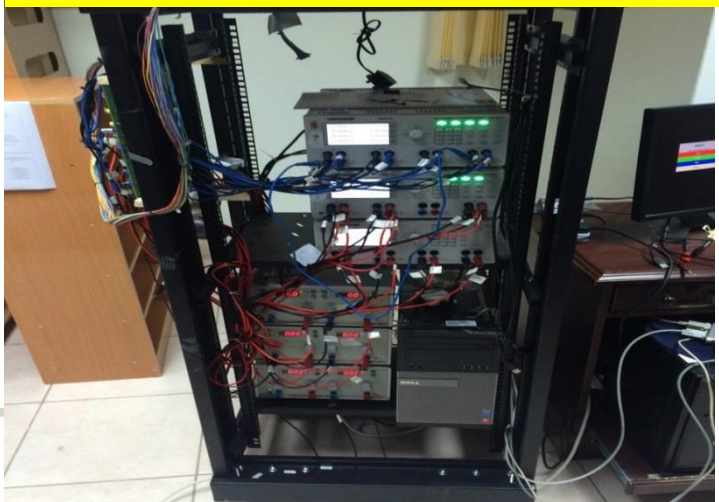
PXD testing setup available

Slow Control powering ASICs and DEPFET

SC (PSs) program works fine and stab



All items in the Rack including the PC



Conclusion and outlook

- Scintillators size simulated and have sizes for mechanical frame

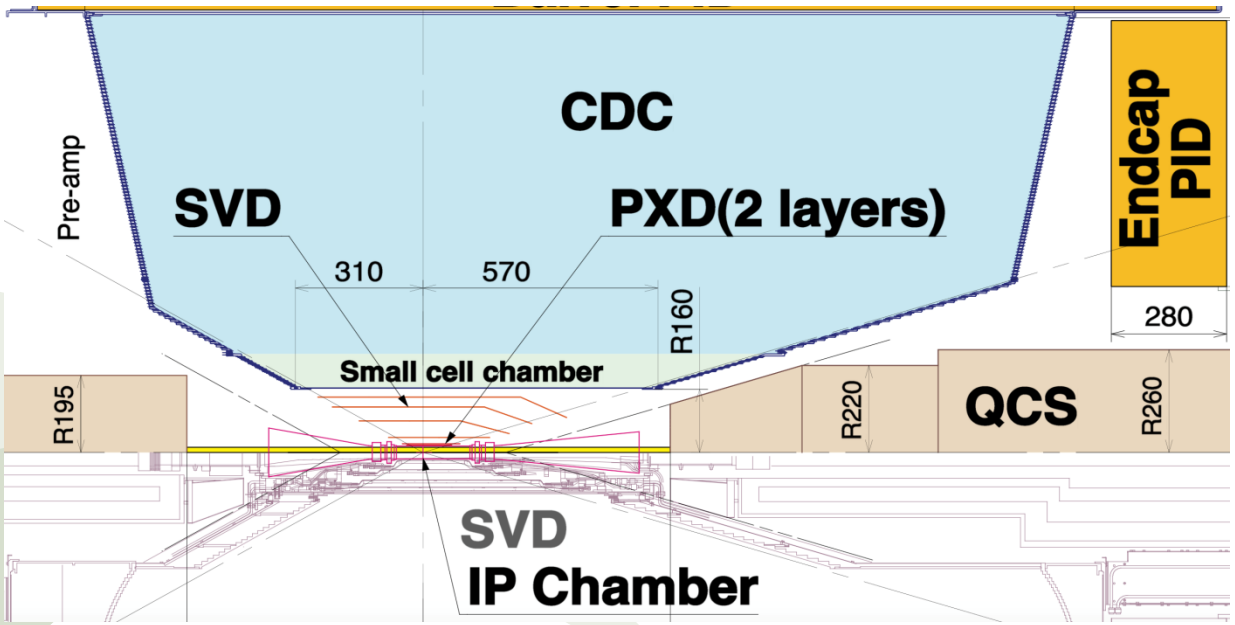
- Now we are starting a cosmic track finder in VXD (for now just working on a MC cosmic track finder

- We are starting:
  - Producing PXD(VXD) cosmic trigger
  - Look first at PMs (HAMAMATSU) to choose the PMs window size so that we build PM guide light size accordingly.
  - The scintillators will be built at MPP
  - Test the system at Tabuk before shipping it to KEK or other testing facility

- A cosmic setup is set at Tabuk with tracking system to test PXD modules.

Backups

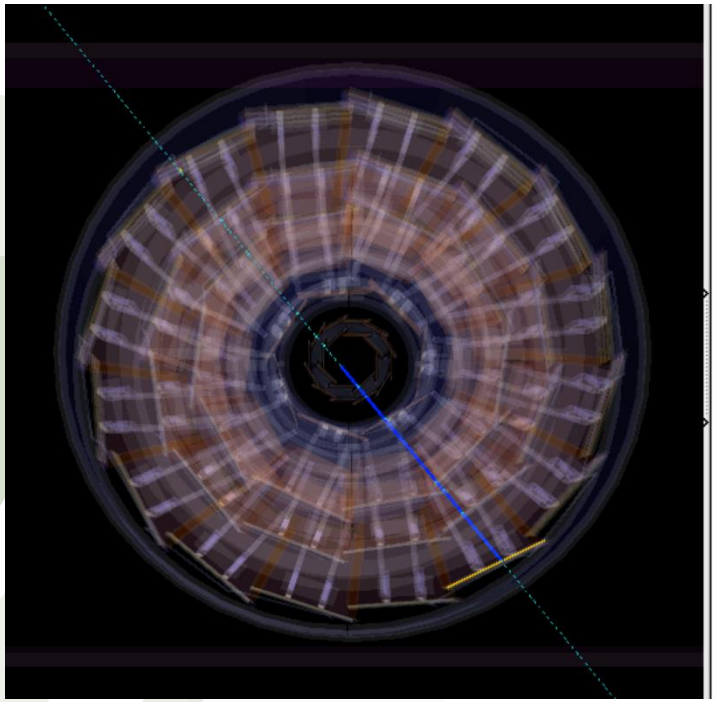
Geometry


CDC
Pre-amp
SVD
PXD(2 layers)
310
570
R160
Endcap PID
280
Small cell chamber
R195
R220
QCS
R260
SVD
IP Chamber


r
160
140
120
100
80
60
40
20
0
SVD
PXD
-z
-200
-100
0
100
200
300
+z
IP

Cosmic tracks

- Currently no (ad hoc) cosmic track finder for VXD exists in basf2
- Nevertheless existing (MC) track finder fits at least half track



DataStore /

Arrays

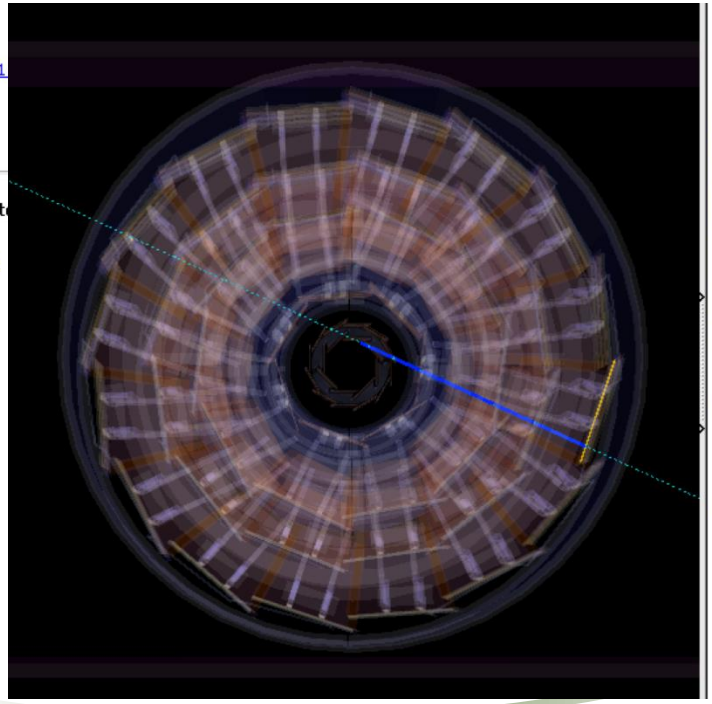
DedxLikelihoods (1)
GF2Tracks (1)
MCParticles (1)
PXDClusters (4)
PXDDigits (263)
PXDSimHits (5)
PXDTrueHits (5)
SVDClusters (18)
SVDDigits (5784)
SVDSimHits (9)
SVDTrueHits (9)
TrackCands (1)
TrackFitResults (1
Tracks (1)

Objects

EventMetaData

Objects (c_Persist

FileMetaData
ProcessStatistics



DataStore /

Arrays

DedxLikelihoods (1)
GF2Tracks (1)
MCParticles (1)
PXDClusters (3)
PXDDigits (259)
PXDSimHits (3)
PXDTrueHits (3)
SVDClusters (16)
SVDDigits (6078)
SVDSimHits (8)
SVDTrueHits (8)
TrackCands (1)
TrackFitResults (1)
Tracks (1)

Objects

EventMetaData

Objects (c_Persistent)

FileMetaData
ProcessStatistics