Trigger setup development for phase-3 commissioning

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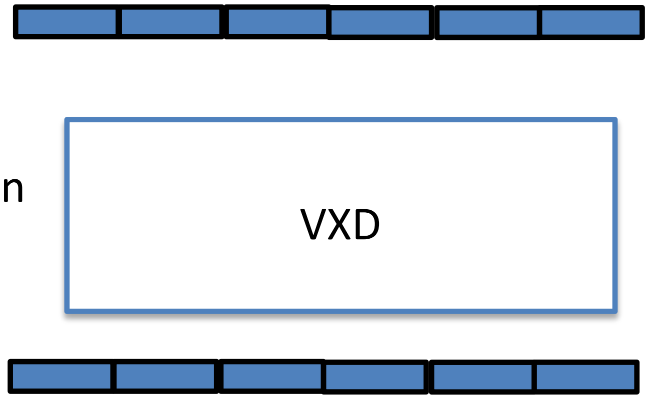
DEPFET Workshop, Ringberg 8-11 April, 2018

VXD trigger system Construction Status

Design



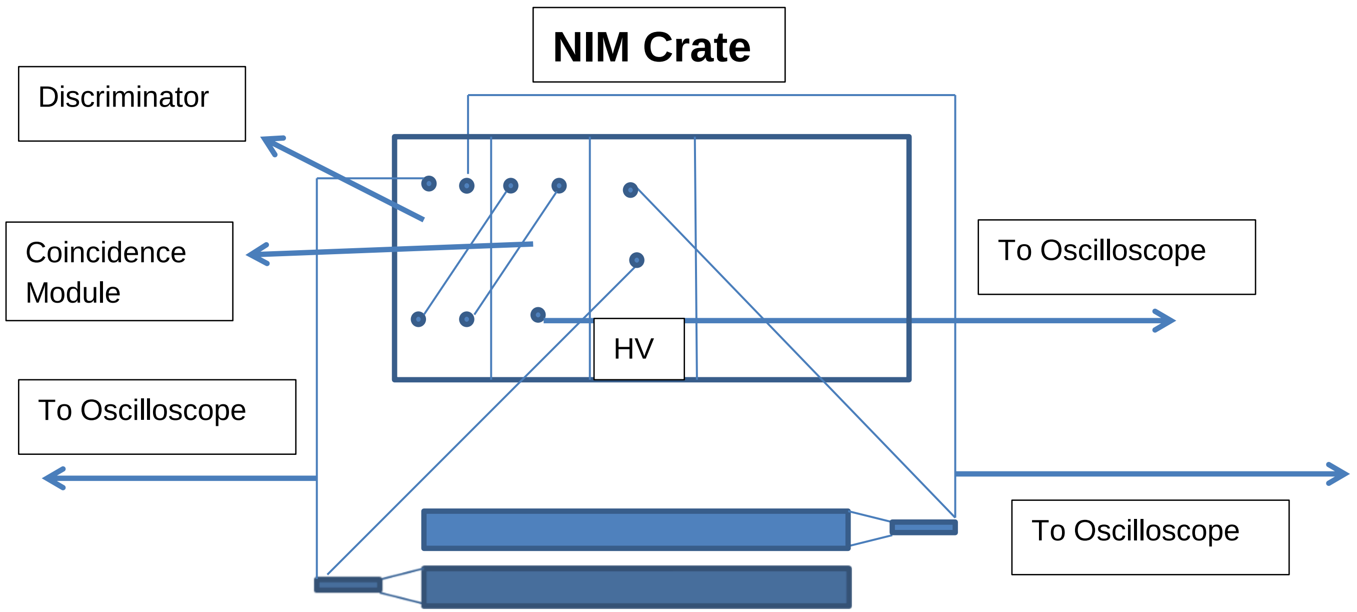
Scintillator: 10cmx30cm + 1cm tick

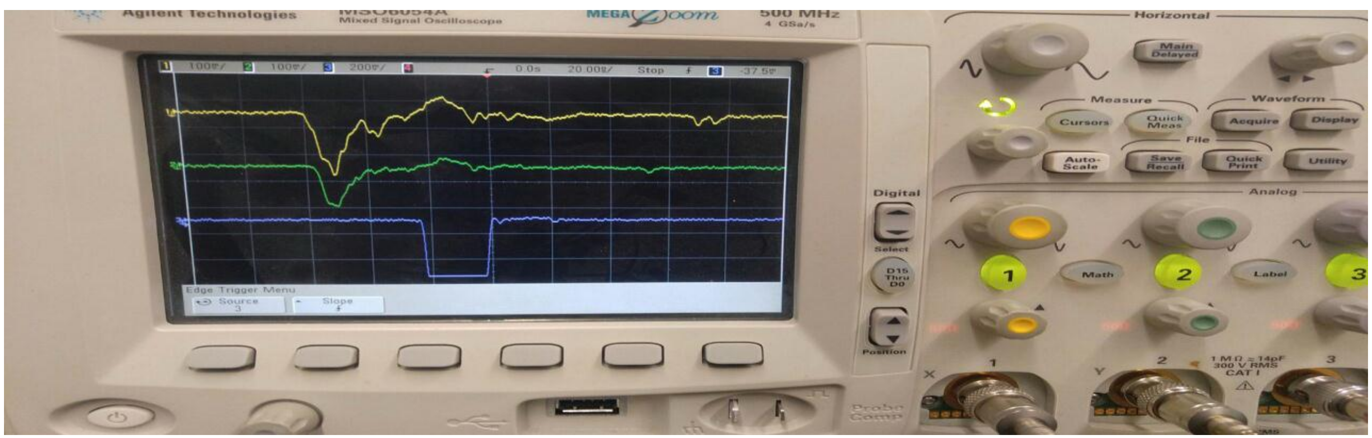
All 12 scintillators are in the Frame

Rear View: All scintillators with PMs

1) All PMs tested in pairs (that are top on each others in the frame)
2) All Plateaus were found with cosmic coincidences in pairs
3) Coincidence rates dependence on angle studied
4) Global cosmic trigger rate estimated
5) Plan for DESY test with PXD and KEK tests with VXD set

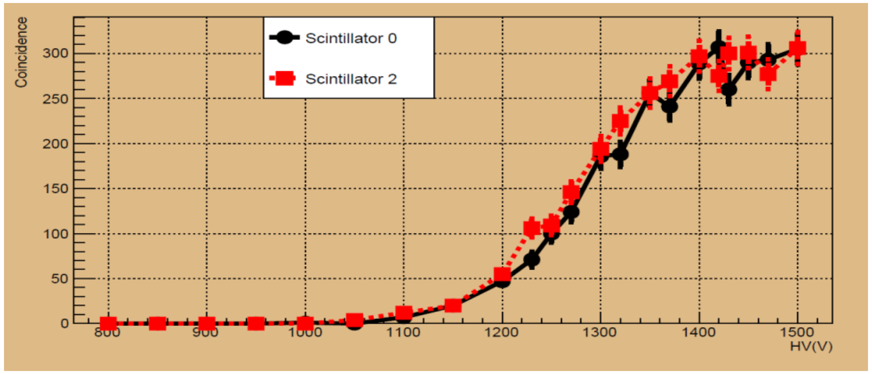
Experimental Setup to test scintillators in pairs with cosmic coincidences

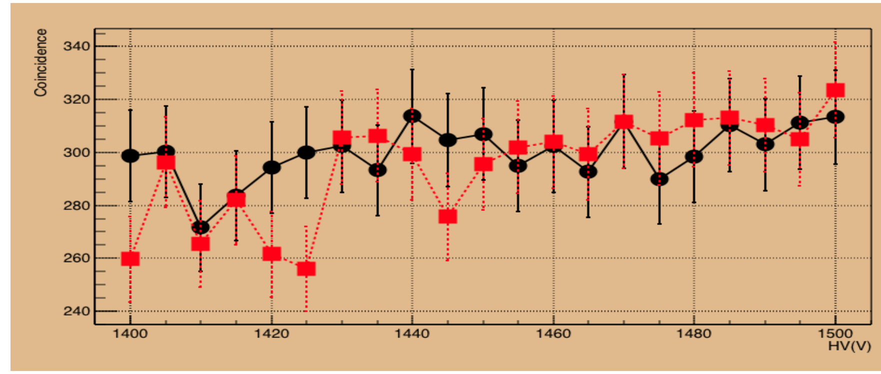


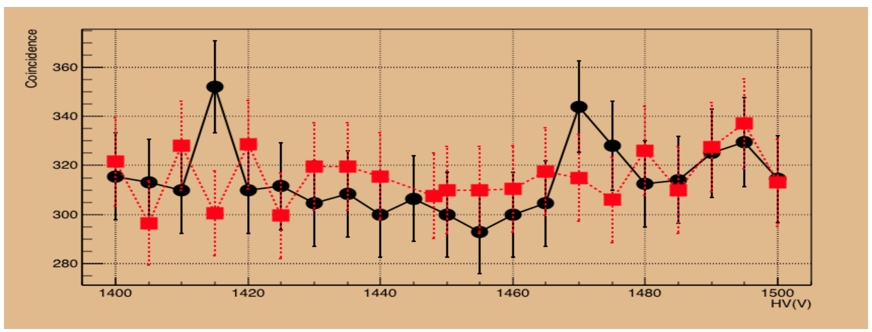


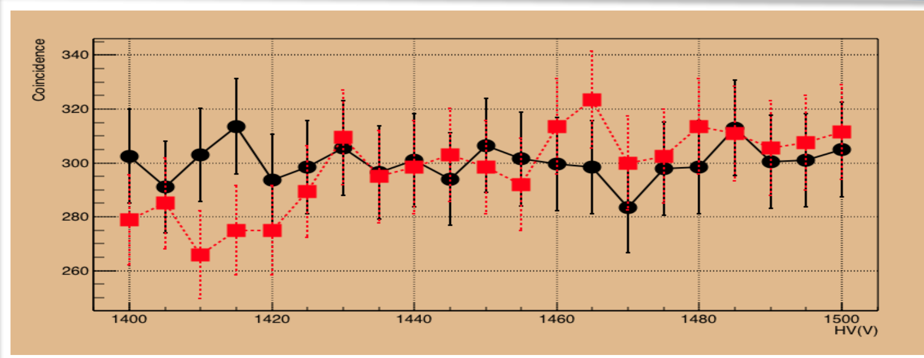
Coincidence NIM signal (Blue) and scintillators signals (yellow and Green)

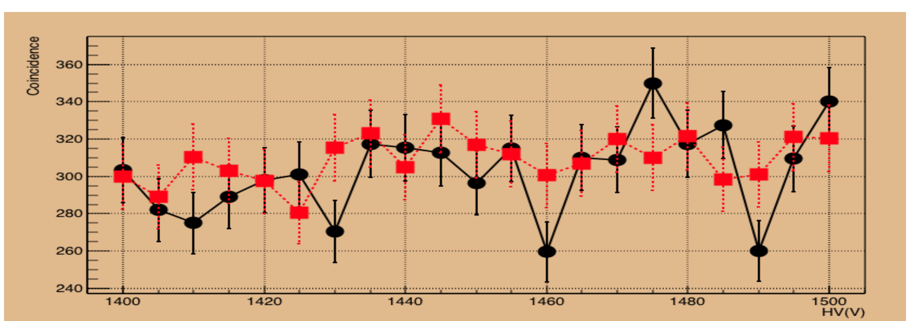
All Plataus Found in pairs

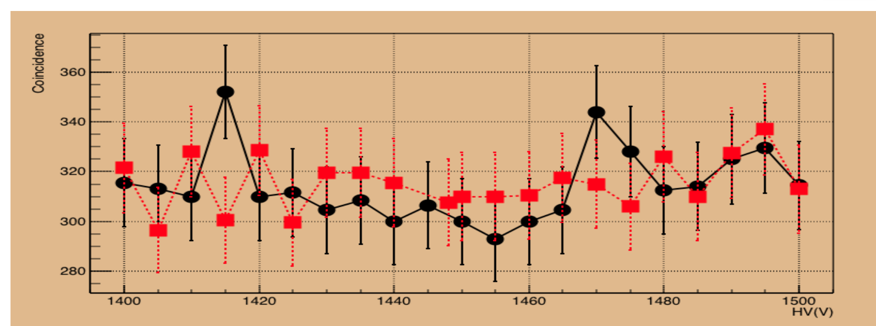




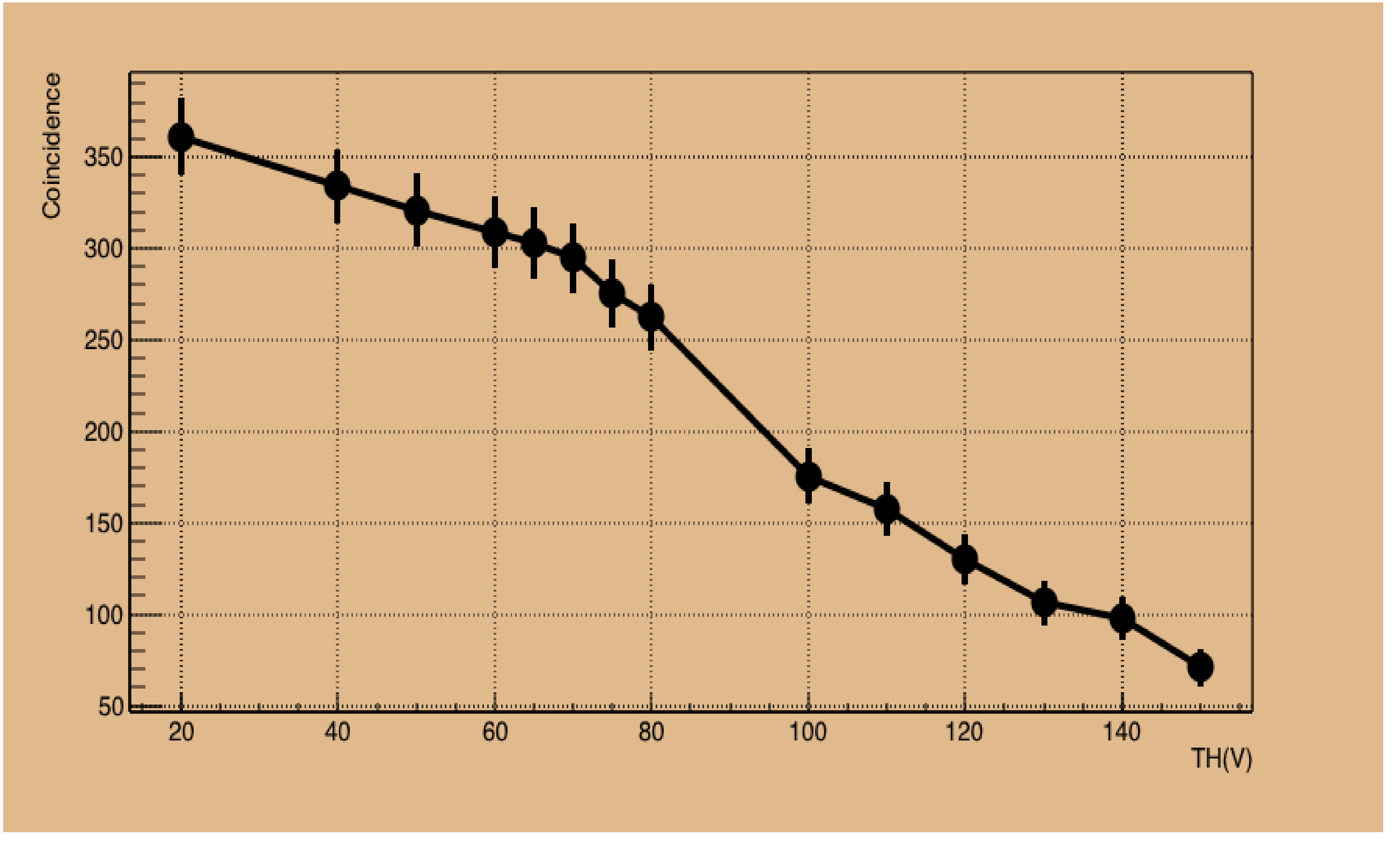




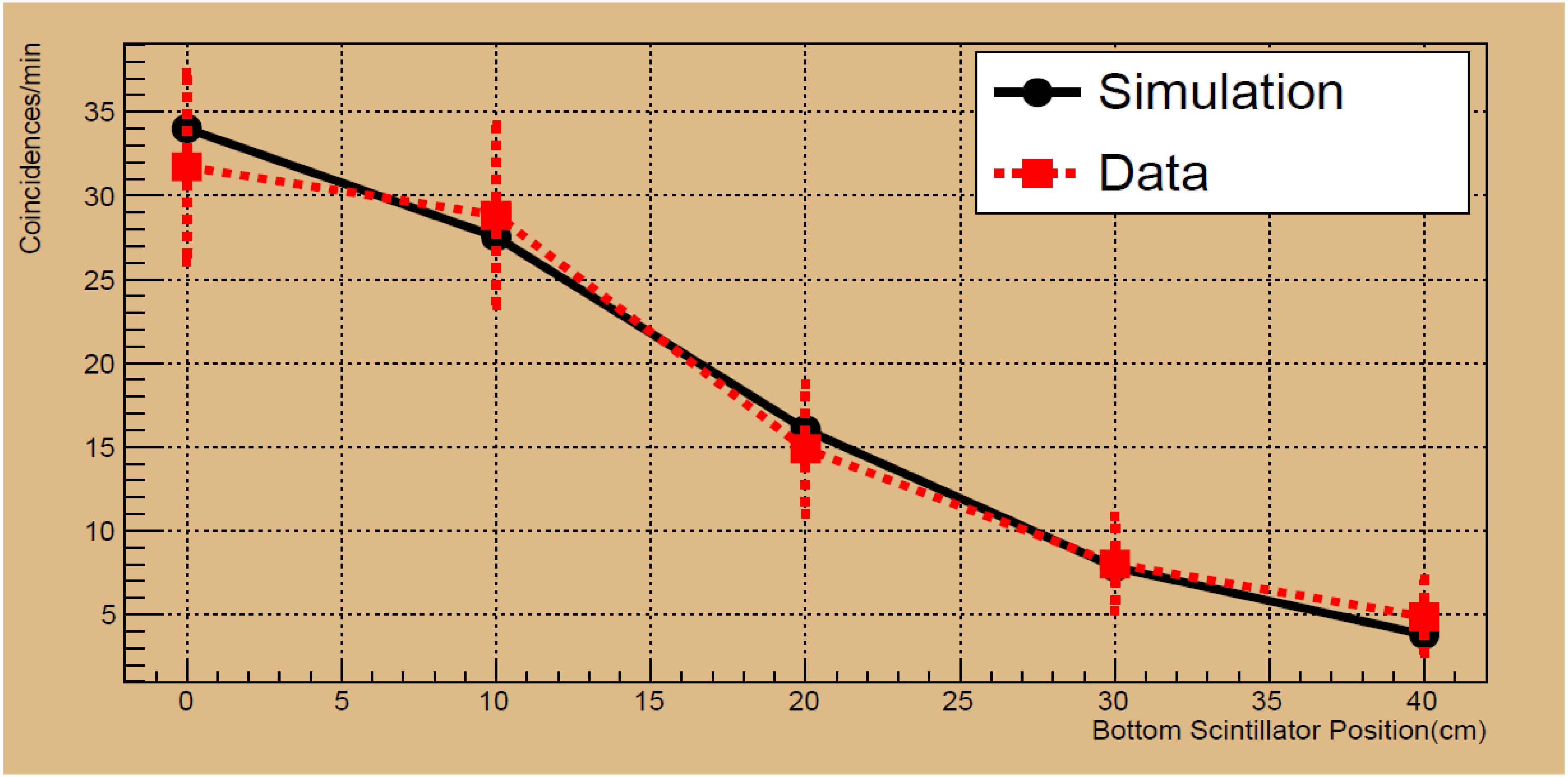




Thresholds are set, in pairs, to the value giving a cosmic coincidence rates found in Plateaus



Cosmic Rate vs Bottom Scintillator Position using a hit and miss simulation program



The distance between Top and Bottom scintillators rows is 30 cm.

With such rates the cosmic trigger system will produce about 470 cosmic per minutes so about 8 cosmic per second

Status of hardware from last talk

Got New Modules

Four new Coincidence Modules (4 channels) Plus 3 form before so 7 NIM modules so 21 Channels

CAEN SY127 HV supply with 12 channels all functional

Hope these weeks the setup will be complete and will have a global Cosmic trigger and restricted trigger logic ready by end of April when The trigger system will be shipped to DESY for PXD cosmic tests

Conclusion

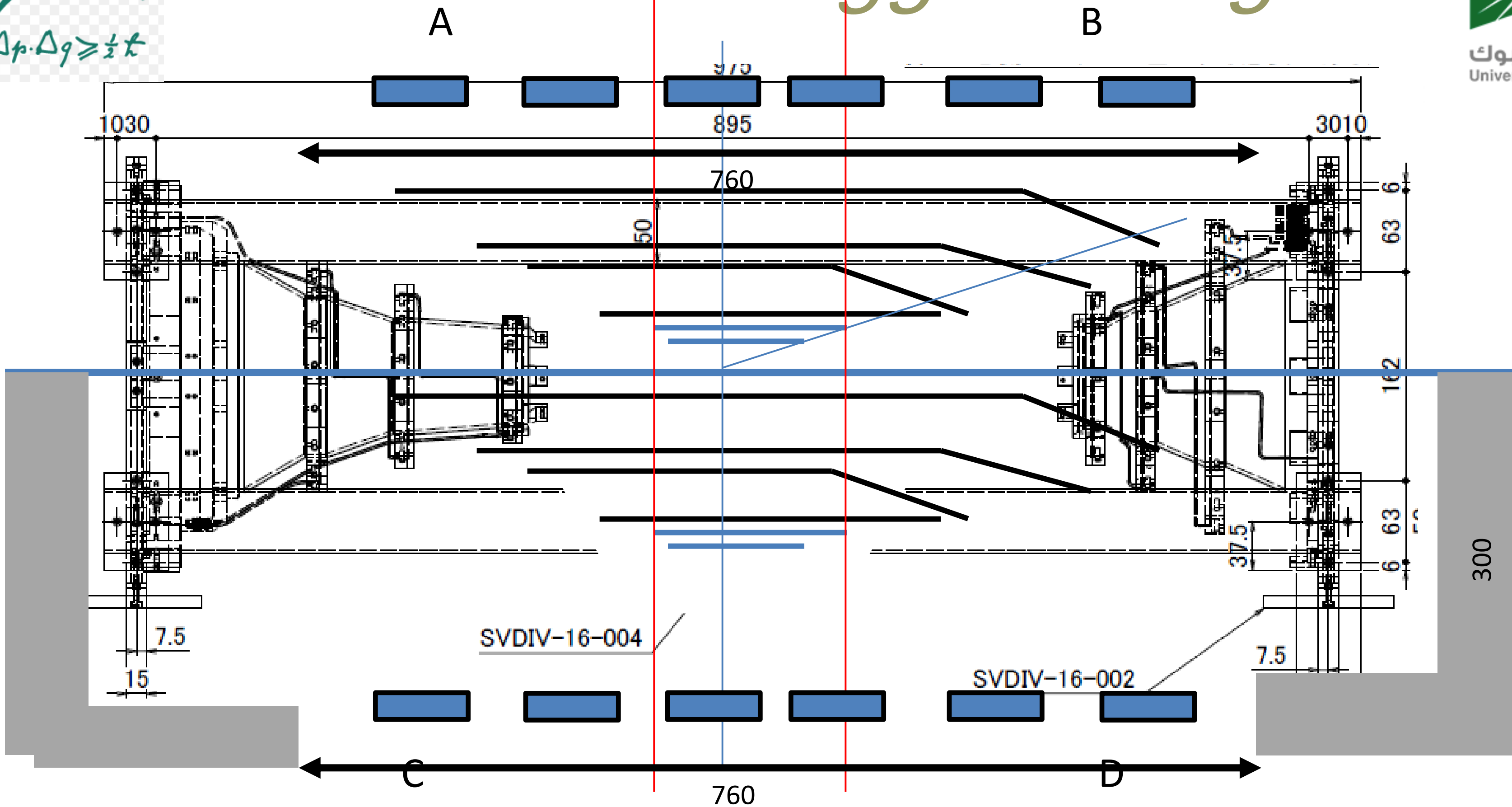
1. The VXD cosmic trigger system will be fully tested at MPP and ready to be shipped To DESY by April to first tests of PXD with cosmic Rays

2. We should discuss here if the trigger system will be return to MPP for further test of the DAQ system to include coincidences rates in data, or shipped from DESY to KEK. The first option is also good as the trigger system should be at KEK by August as per last B2GM discussion.

3. Work on VXD cosmic tracks analysis in basf2.

Backing Slides

VXD cosmic trigger Design



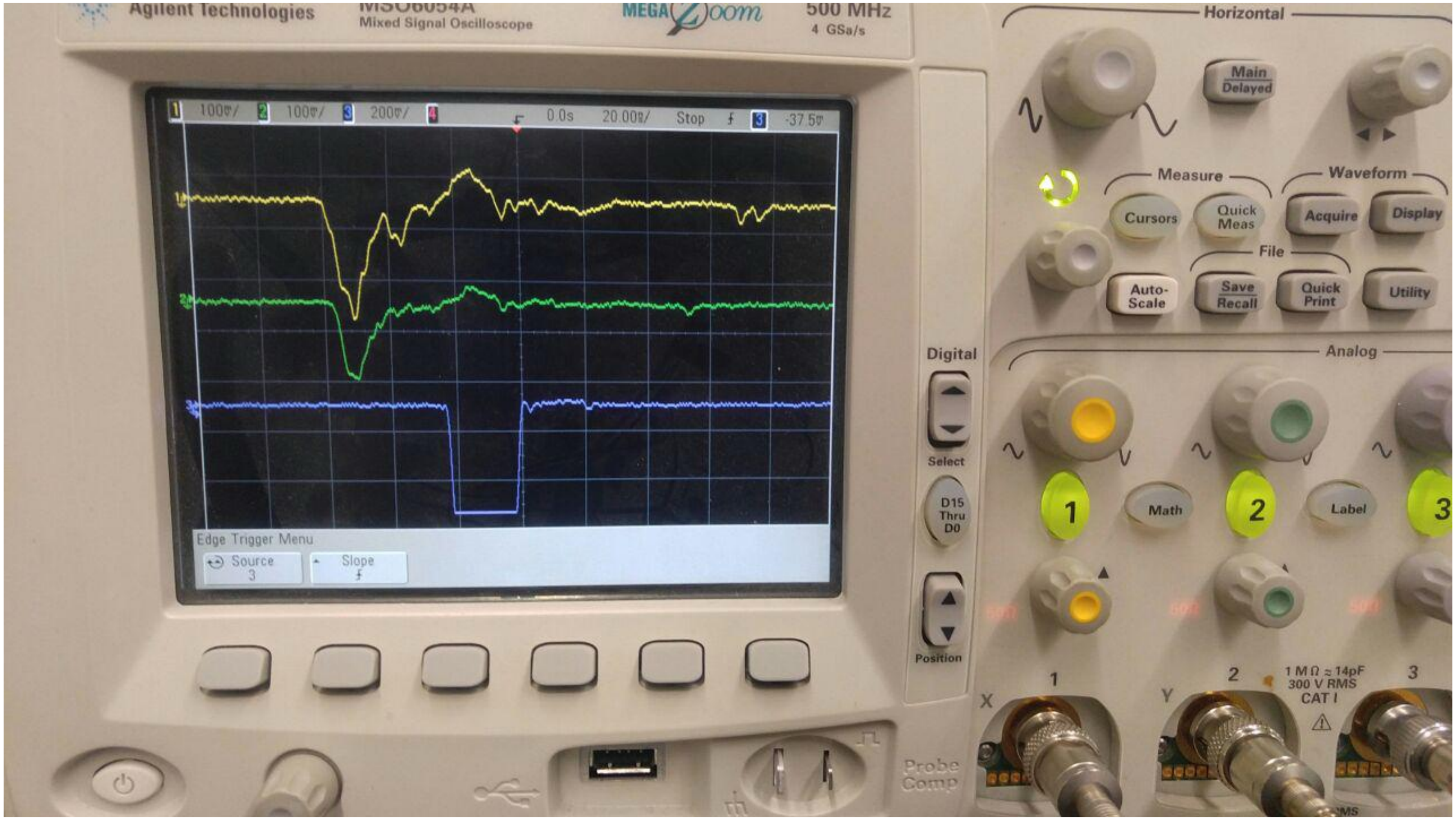
As you know from previous B2GM talks Now at MPP 12 scintillators (One spare) with 10cm width(x), 30cm long (z), and 1cm thick. As seen above will place 6 top and 6 on the bottom of VXD.

13 Scintillators produced at MPP as shown in the next slide.

Scintillators already produced

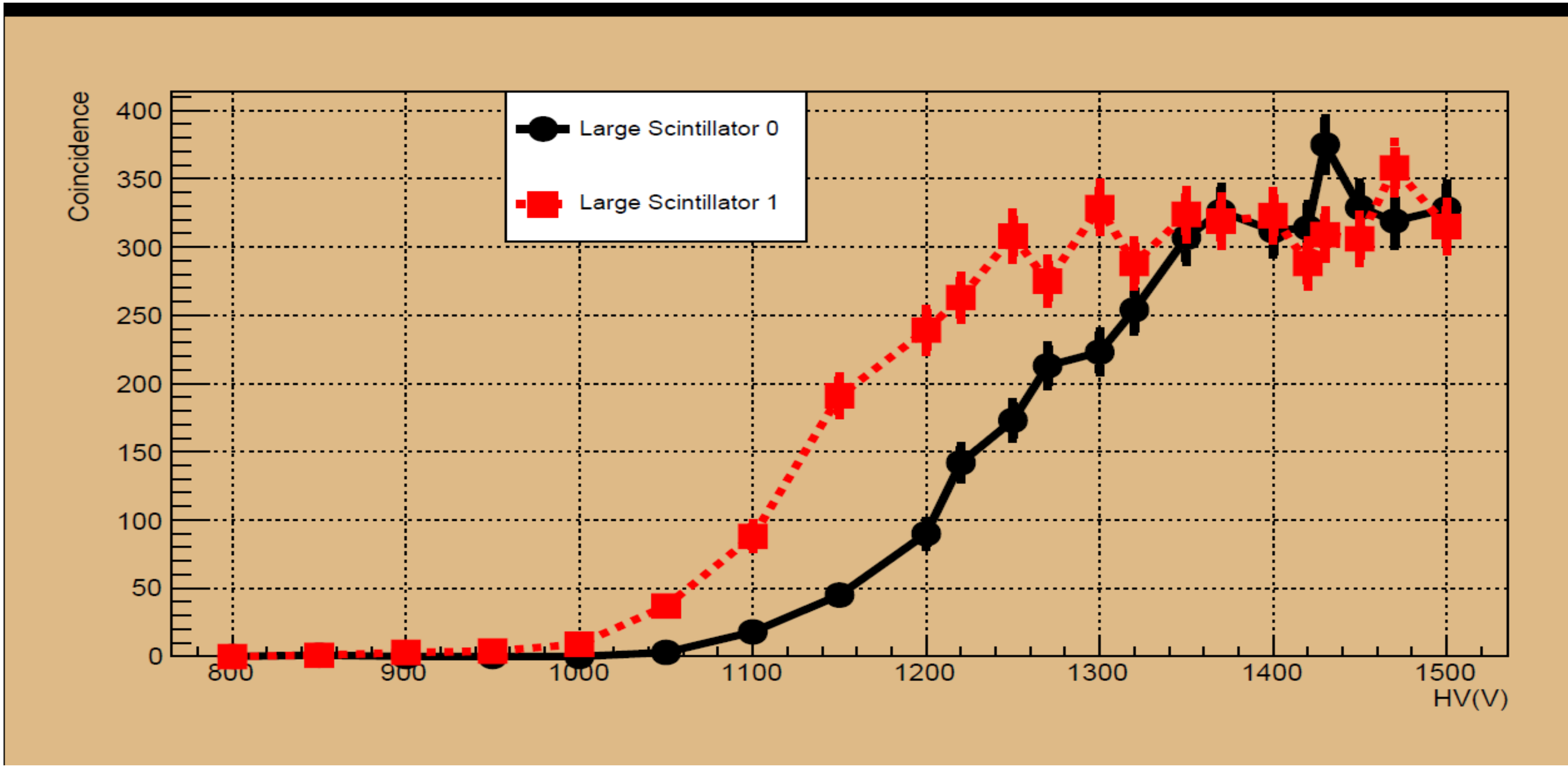
13 PMs just arrived at MPP so we concentrate here on showing tests just two scintillators.

Coincidence



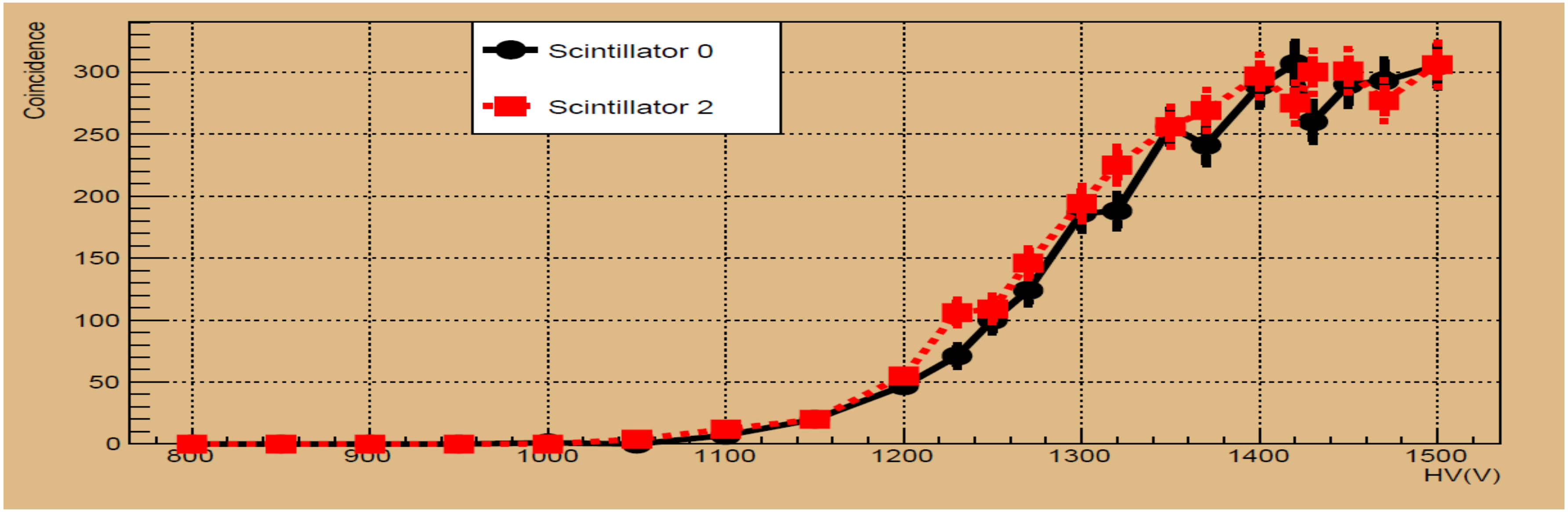
Coincidence of the two scintillators on top of each other. The blue signal is the NIM coincidence NIM signal .

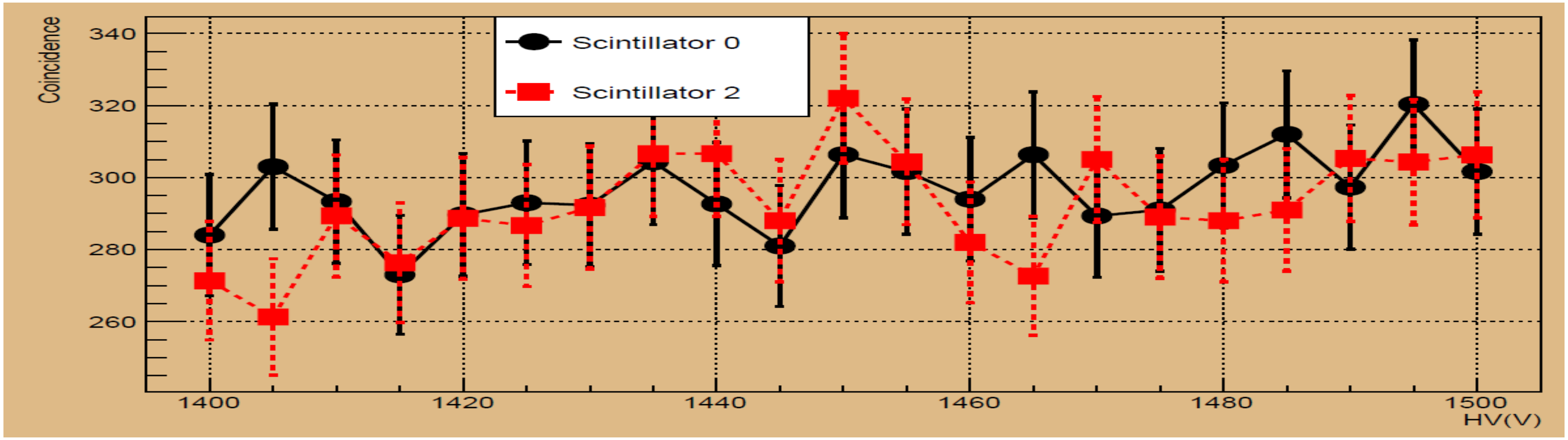
PMs Plateaus I
PMs 0 and 1



Operational HV:
Scintillator 0 (Black): 1400V
Scintillator 1 (Red): 1300V
Also the coincidence counting rate is matching the rough 1 cosmic/cm^2.minute for a Surface of 10x30cm^2 when the scintillator are on top of each other with maximum stereo angle.

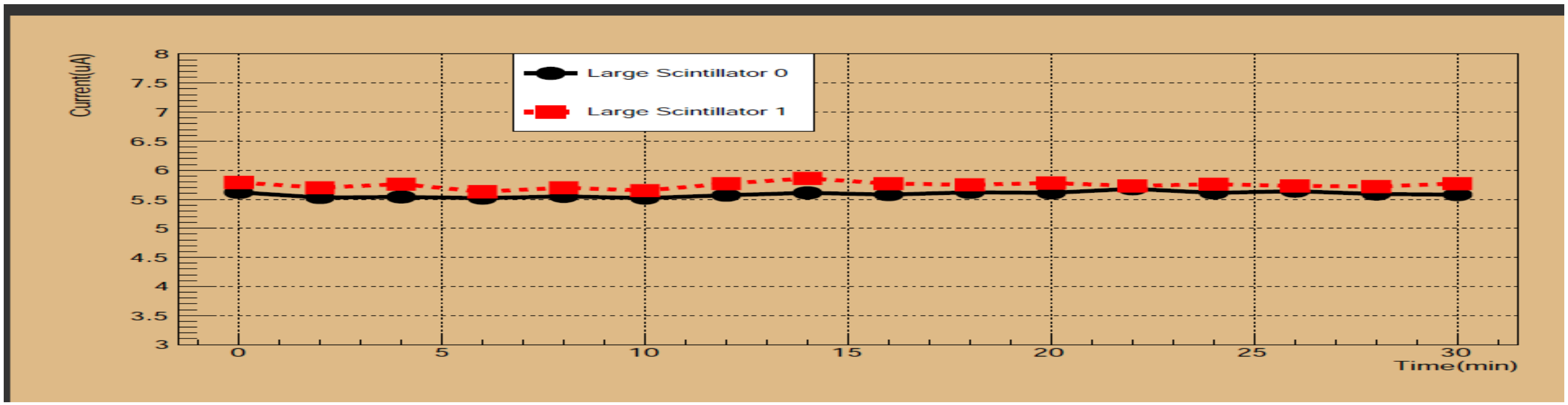
PMs plateau II (PMs 0 and 2)



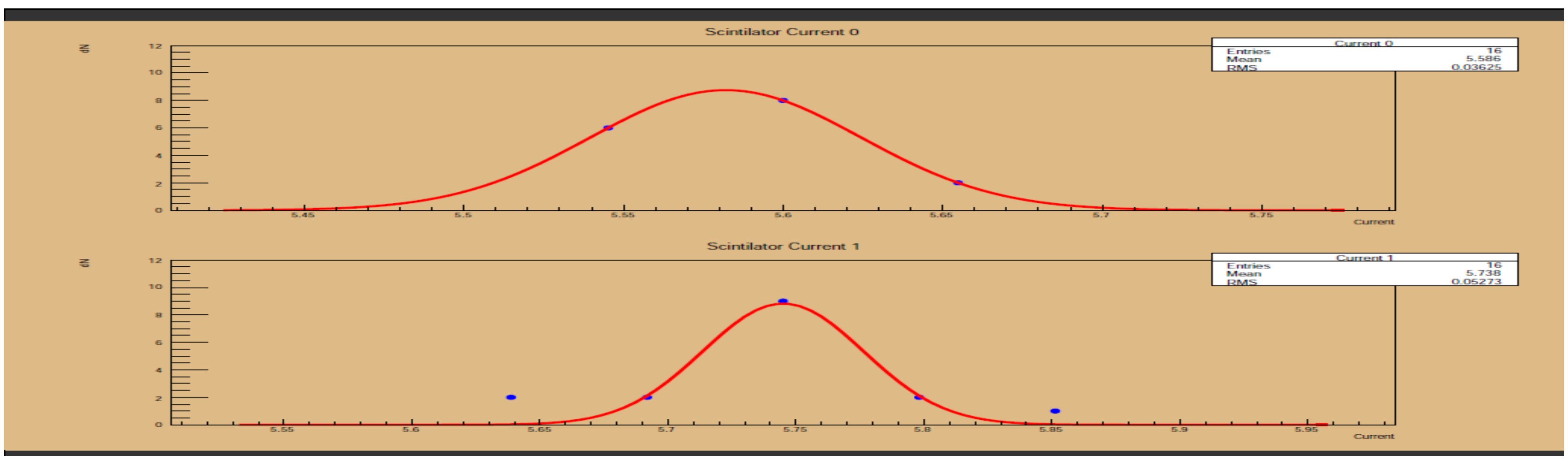


Zoom into the plateau region with small HV step (5V)

Currents were monitored



Both current scintillators are stable with time



Good Gaussian distribution with 0.036 and 0.053 μA spread

VXD cosmic trigger Frame II

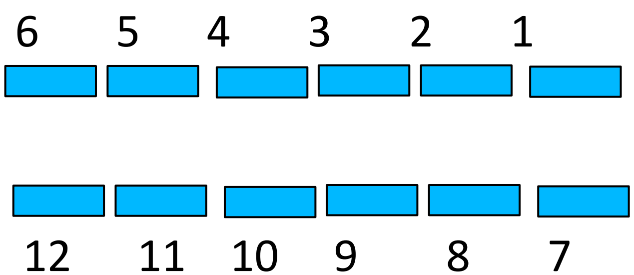
Bottom PMTs fixation

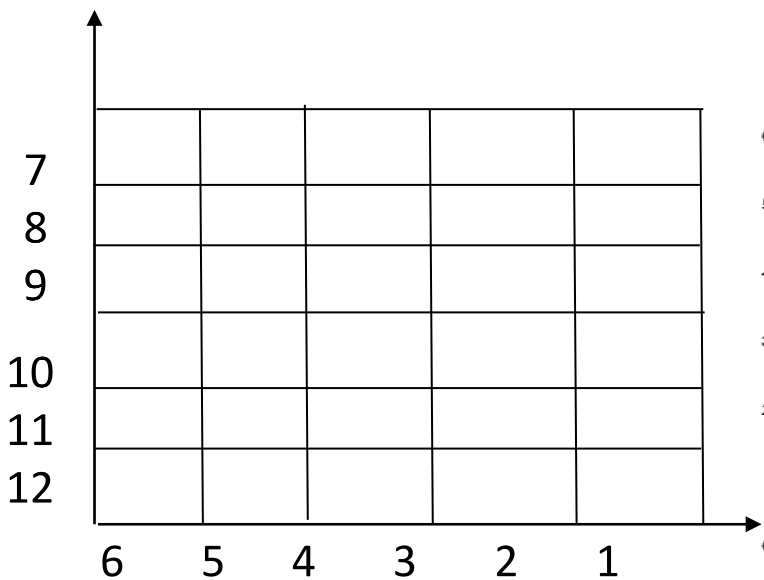
Top PMTs fixation

Frame as designed in slide 2, is ready, PMTs will be installed through adjustable fixation

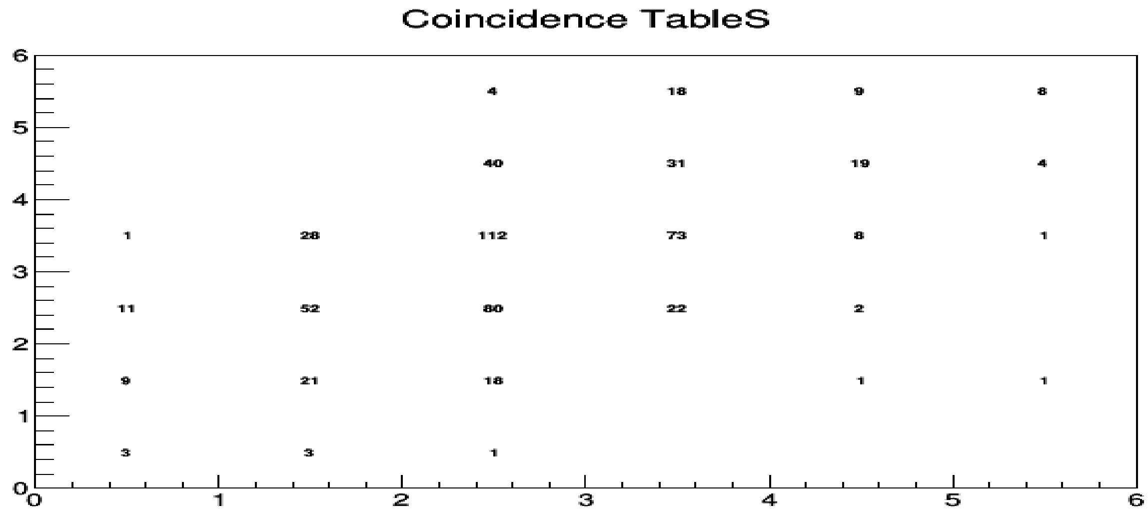
Trigger coincidences study (basf2 200k cosmic's generated with cosmic generator program CRY)

Belle II Analysis Software framework (basf2)

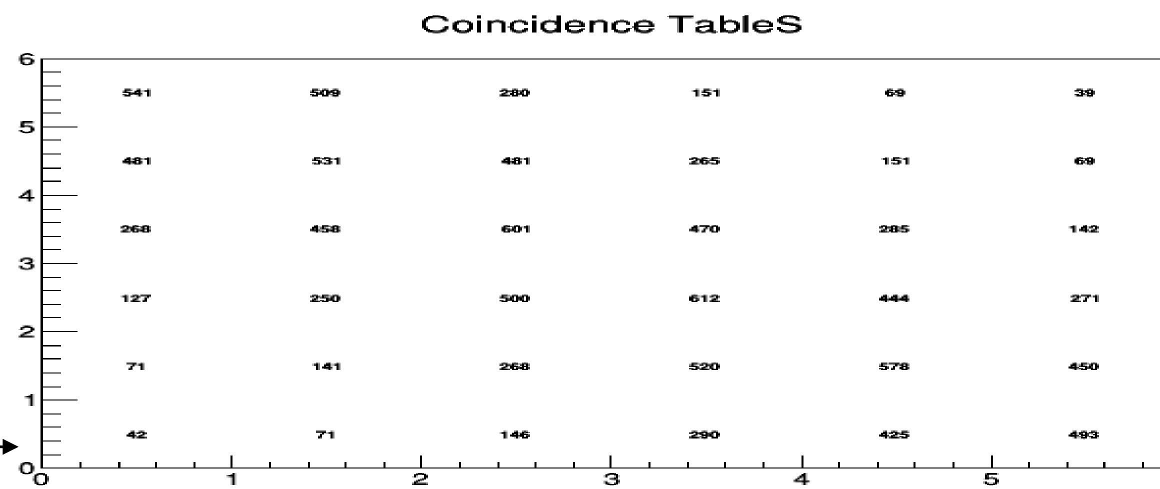




Coincidence Table: At least one hit in PXD

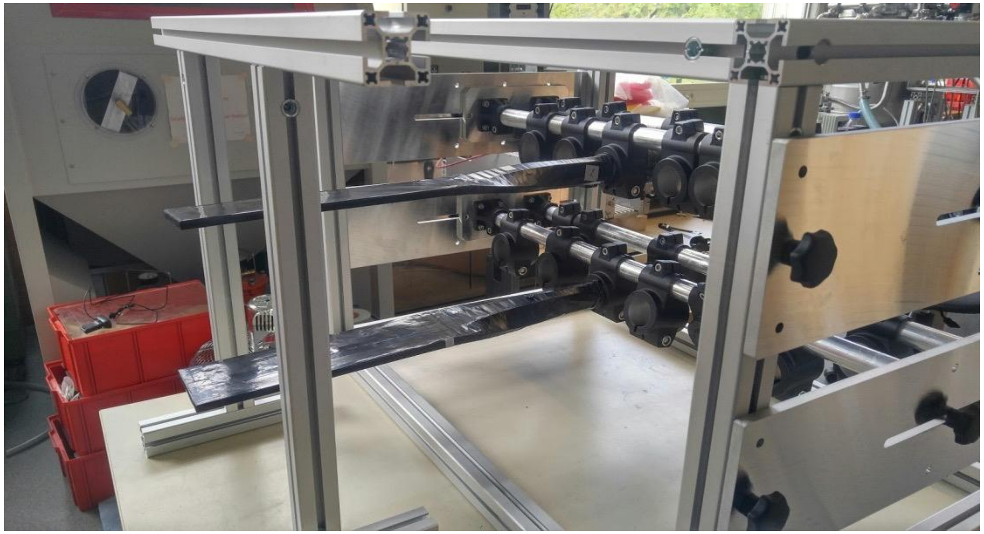


Coincidence Table: At least one hit in SVD

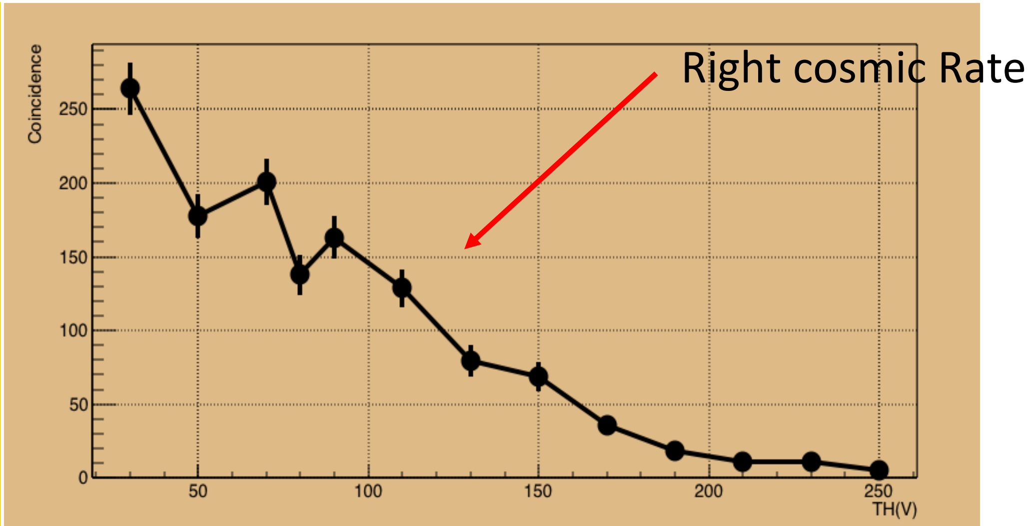


First tests of two scintillators in the frame

Two scintillators on the frame one in
bottom layer and the second just on
top of the first one on the top layer .

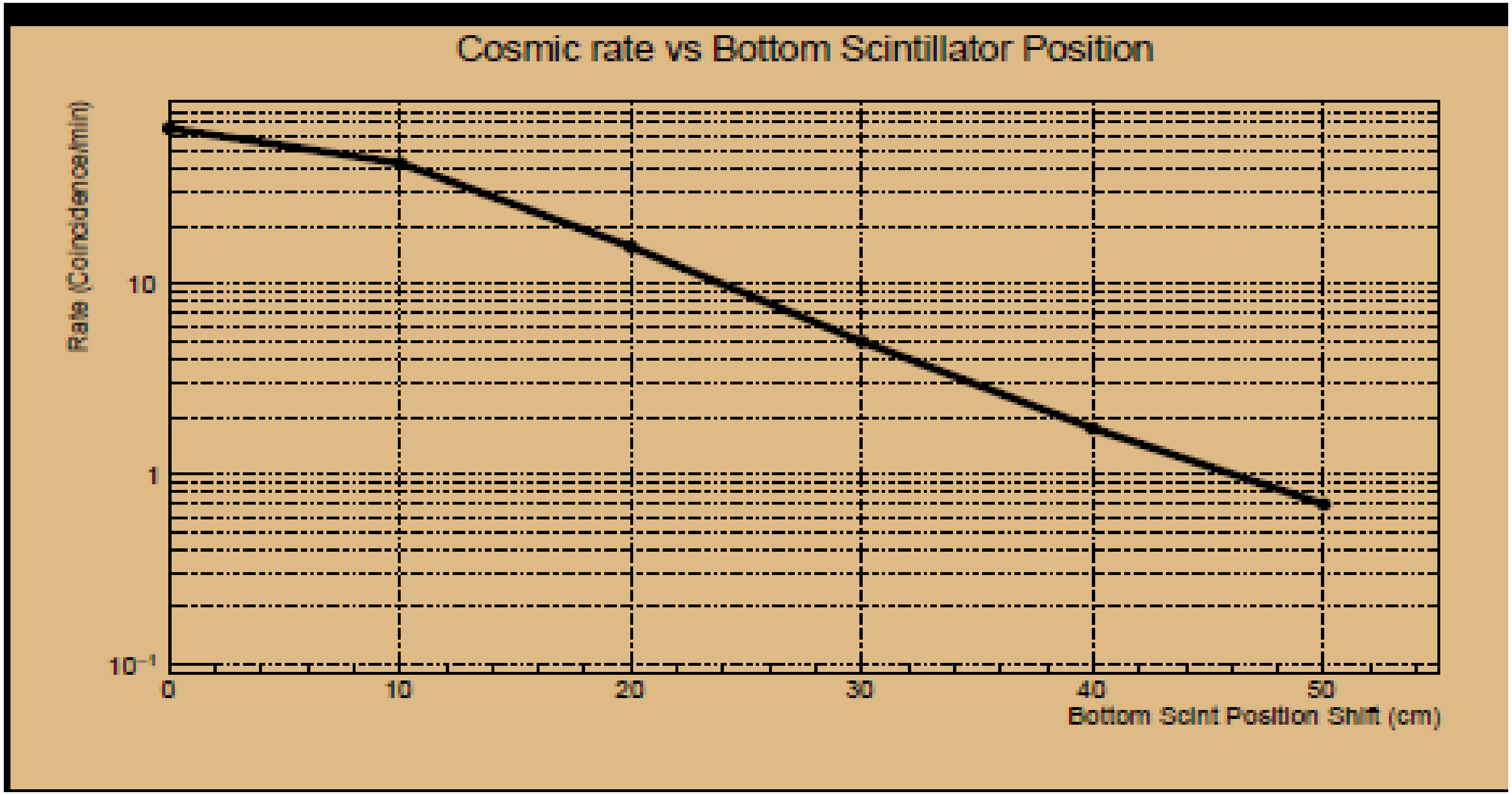


Scintillator dimensions are: 10cmx30cm with a vertical separation of 19.3cm. Giving such inputs to a hit and miss program to estimate cosmic ray rate we found that the rate of about 65/s which is matches the rate found with scitillators Coincidence, right plot, with 2 minutes counting time .



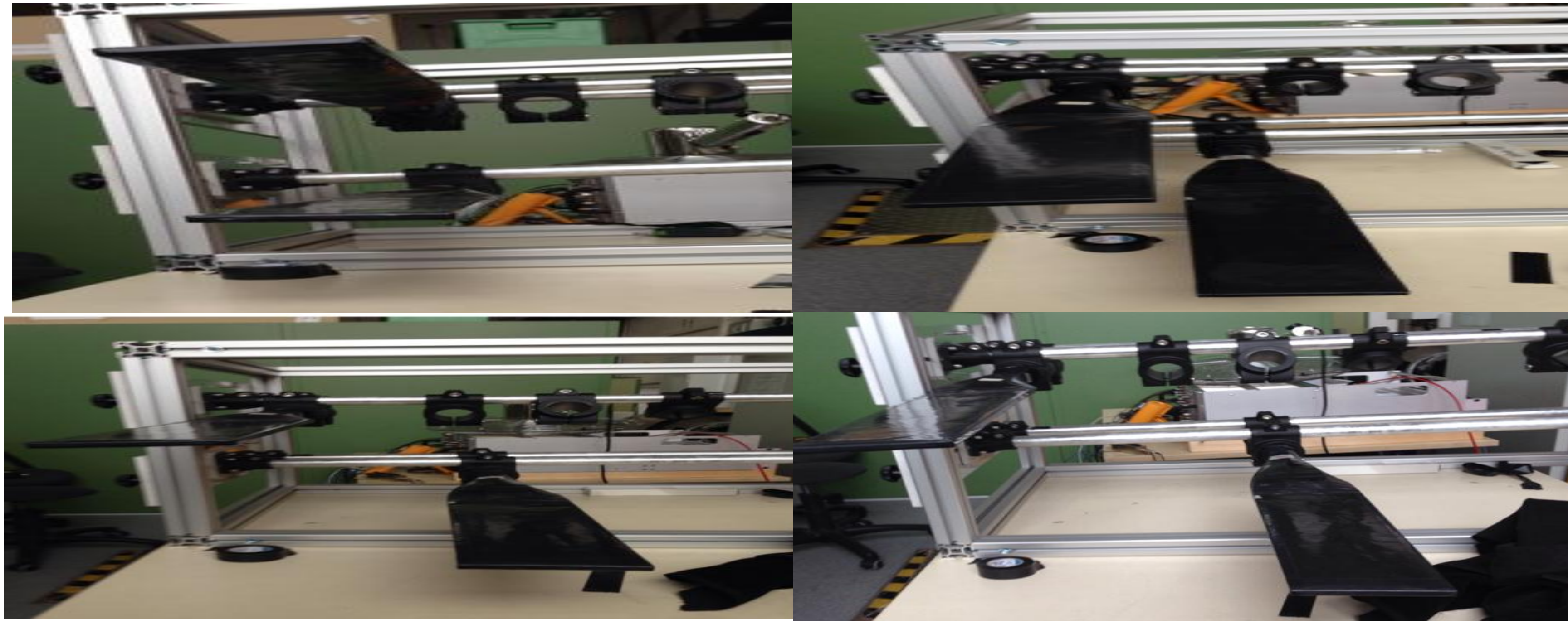
Threshold (mV)

Cosmic Rate vs Bottom Scintillator Position using a hit and miss program



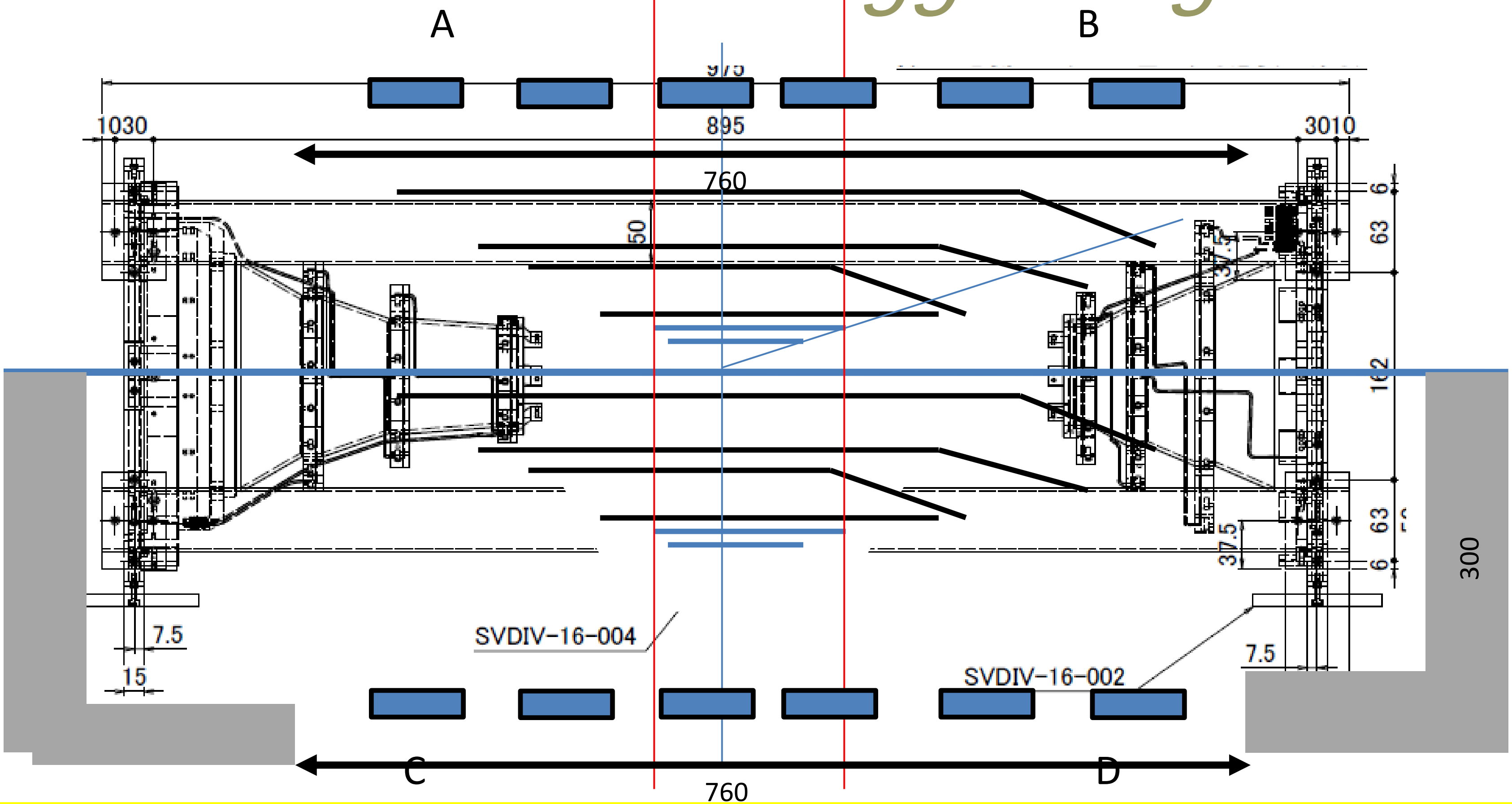
We will move bottom scintillator to measure cosmic rate versus bottom scintillator Position shit. The rate at 0 shift (scintillators are on top of each other) were checked to be about 65/min.

Bottom Scintillator Scan Position at 0 , 10 , 20 ,30 cm
To compare data cosmic rates with simulation in Previous slide



We found problems to move smoothly the PMT support. The
Mechanical System will be reworked then mount all scintillators in the frame and start global Tests.
Now to not mount all Scintullators with the current mechanics and remove it later we will just Fix a top scintillator and scan the bottom scintillator in different six positions and reporduce simulation results previous slide.

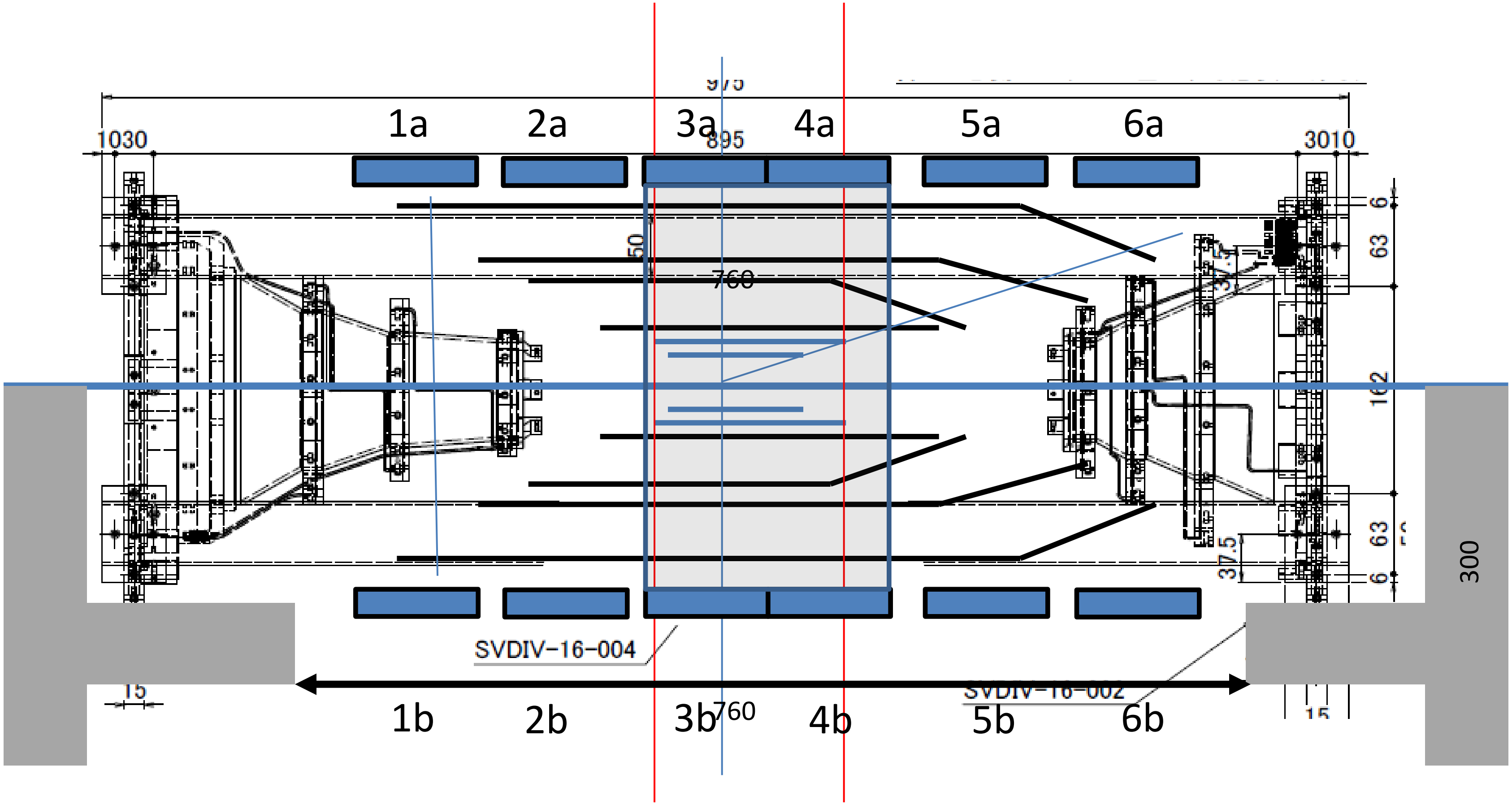
VXD cosmic trigger Logic



We need to use segments of scintillators to have special triggers logic to trig on special PXD tracks and SVD tracks like depending on cosmic track incidence angle.

Some of this triggers logic are listed below

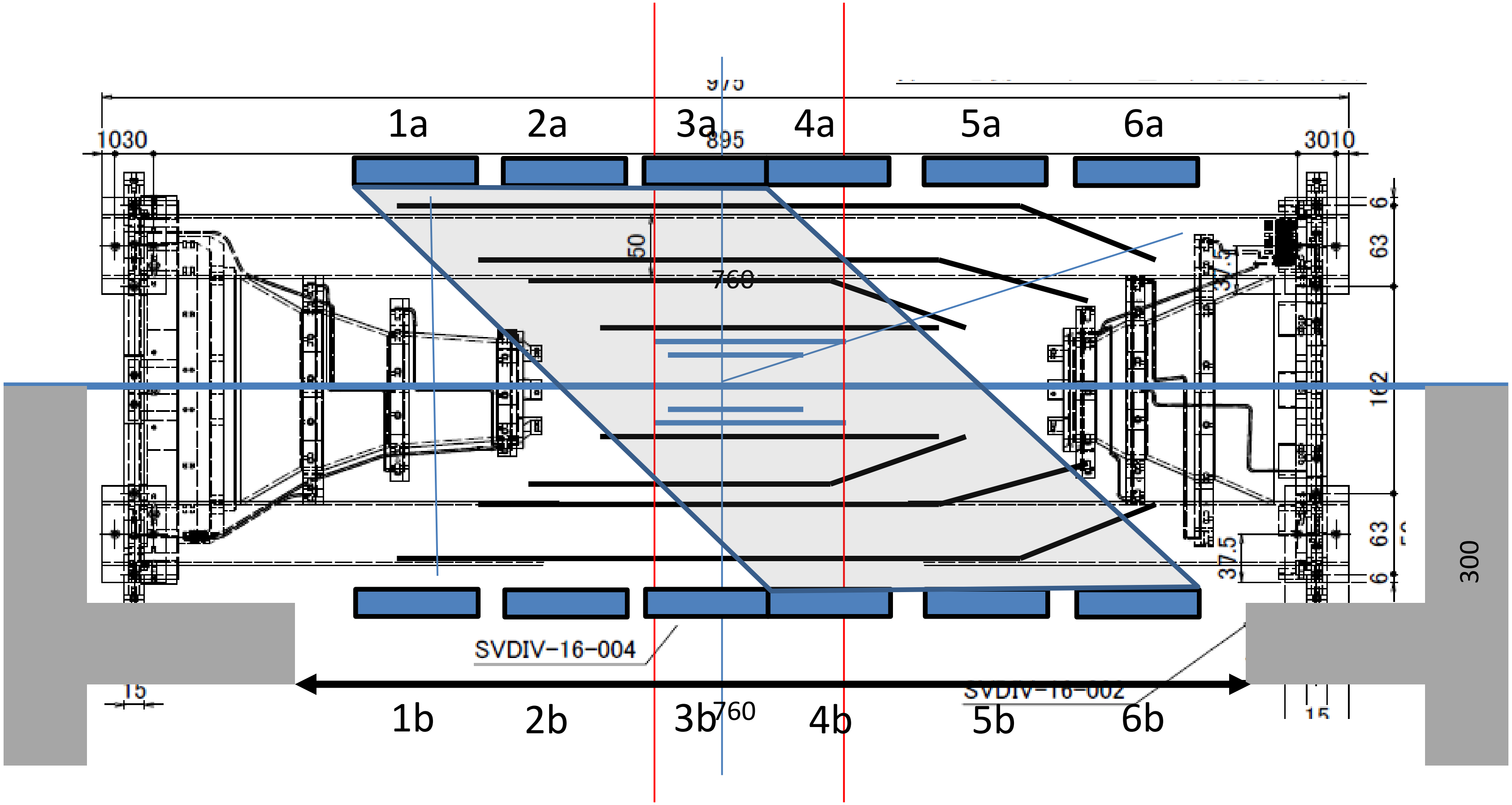
Trigger Logic III



Trig on PXD with mostly vertical tracks

(3a v 4a) ^ (3b v 4b)

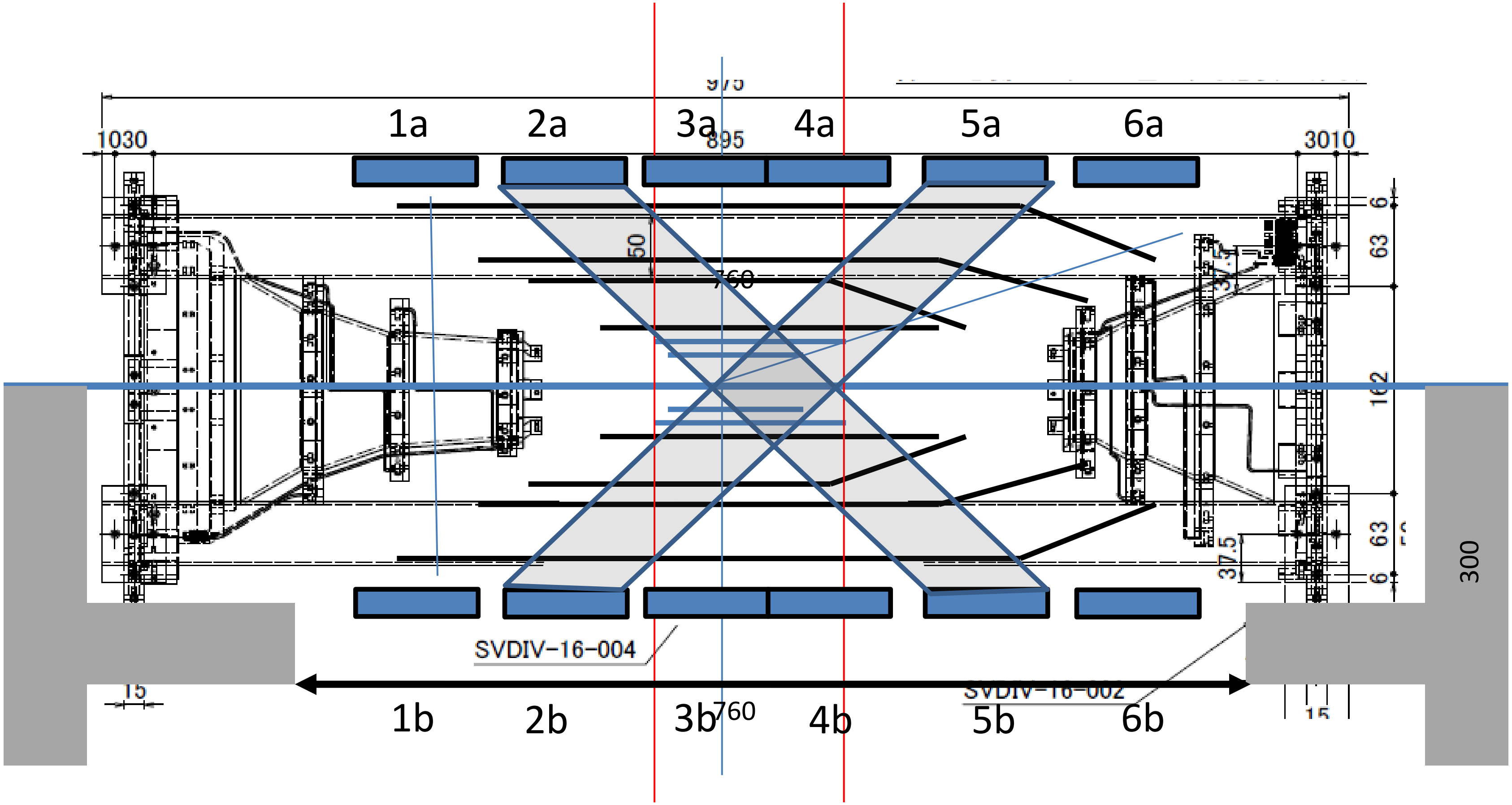
Trigger Logic IV



Trig on PXD with mixed vertical and tilted tracks (r-z)

(1a v 2a v 3a) ^ (4b v 5b v 6b)

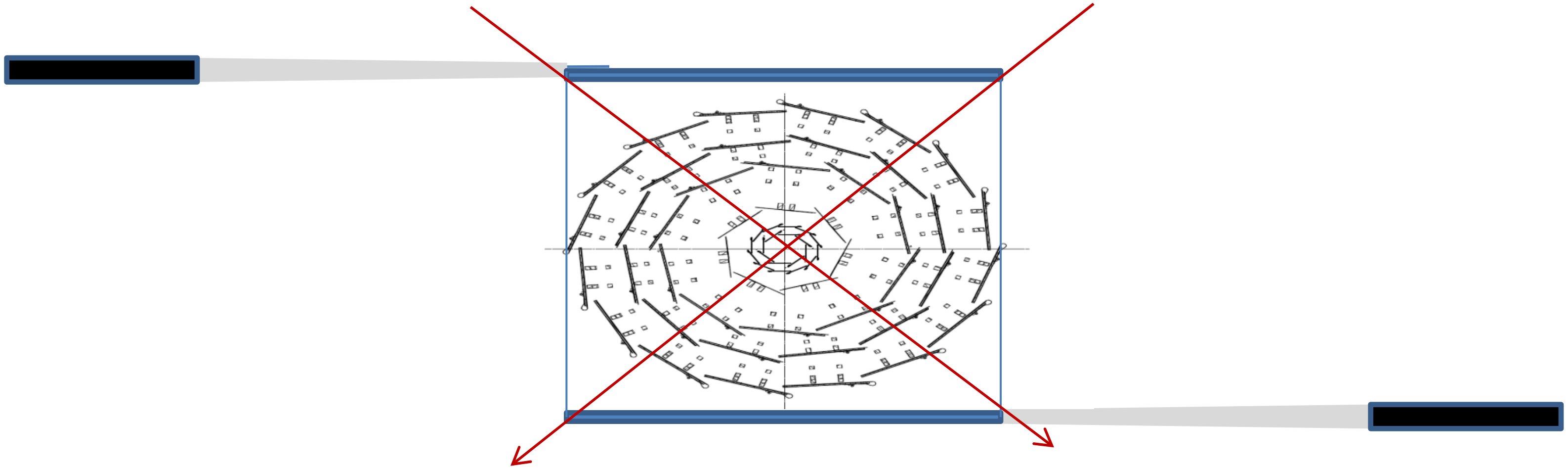
Trigger Logic V

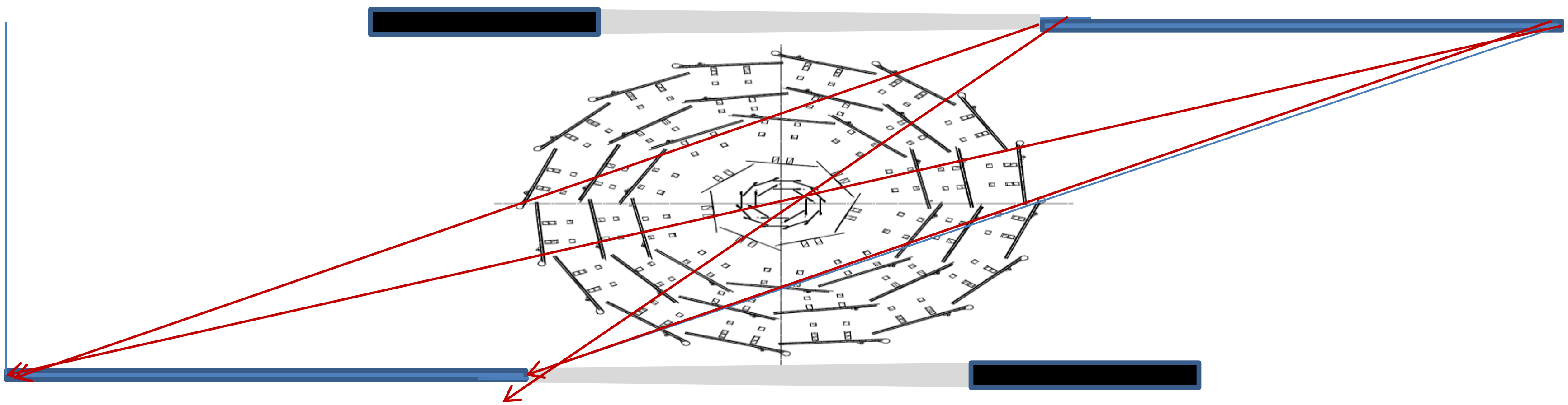


Pointing on PXD tilted tracks (r-z)

(2a ^ 5b) v (5a ^ 2b)

Trigger Logic VI (Scintillators can be moved in x to cover tilted tracks in r-phi





Better pointing tracks can be selected

(1) (1a v 2a v 3a) ^ (4b v 5b v 6b)

(2) (4a v 5a v 6a) ^ (1b v 2b v 3b)

(3) (3a v 4a) ^ (3b v 4b)

(4) (2a v 5b) ^ (5a v 2b)

(1) and (2) are mainly for SVD, (3) and (4) for PXD. There is a partial overlap of (3) with (1) and (2) and a full overlap of (4) with (1) and (2). These triggers serve especially for PXD enriched subsets of data to speed up selection.
If this can be done offline (4) is obsolete and (3) could be replaced by (3a ^ 3b) v (4a ^4b).

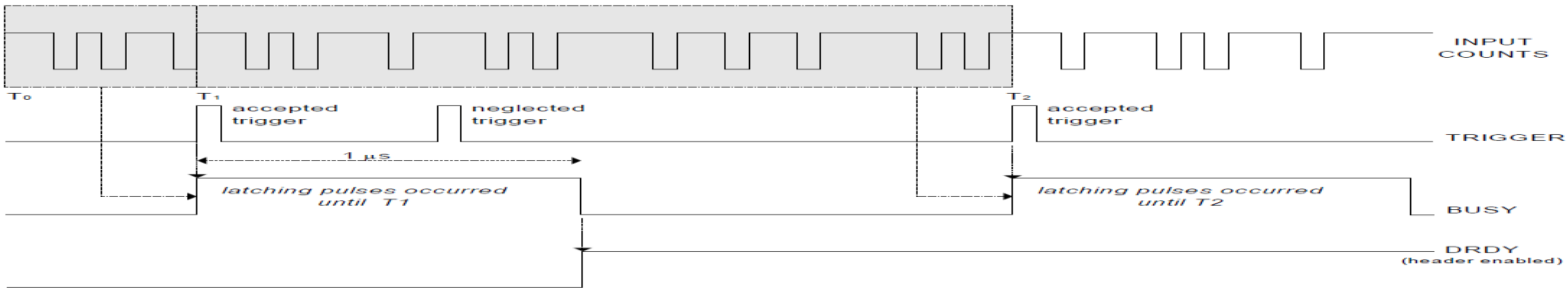
Maximally one would need 5 AND coincidences and 8 OR coincidences (with max 4 inputs in one OR, or 5 AND and 7 OR with 5 inputs in one OR). In the second case 4 AND and 5 OR are needed.

Storing latched triggers register

We have a CAEN VME V830 scaler card that can be used as latching triggers (from CAEN Support service).
It is a 32Channels card.
We used this card as scalers purpose so
We have experience to program it from a Linux box

We have also a VME crate (from CAEN)
No need to order it.

How it works with the VXD DAQ



Channels scalers are latched once a trigger is received (front card input), then stored and Clear registers.

Our Standalone VXD cosmic Trigger system reading Cosmic triggers register

Synchronization

Standalone VXD cosmic Trigger system reading Cosmic triggers register

Send Triggers Register To be stored in VXD data files

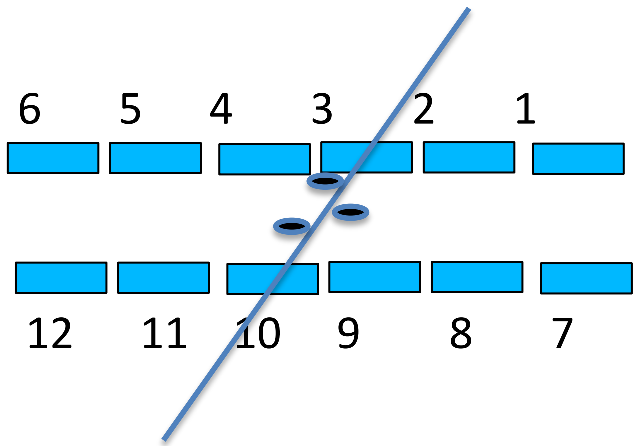
Ethernet (Sockets)

OR

Just we run our standalone process to read latched trigger register and merge these data later with VXD cosmic Data using event (trigger) number.

Trigger Readout (finish)

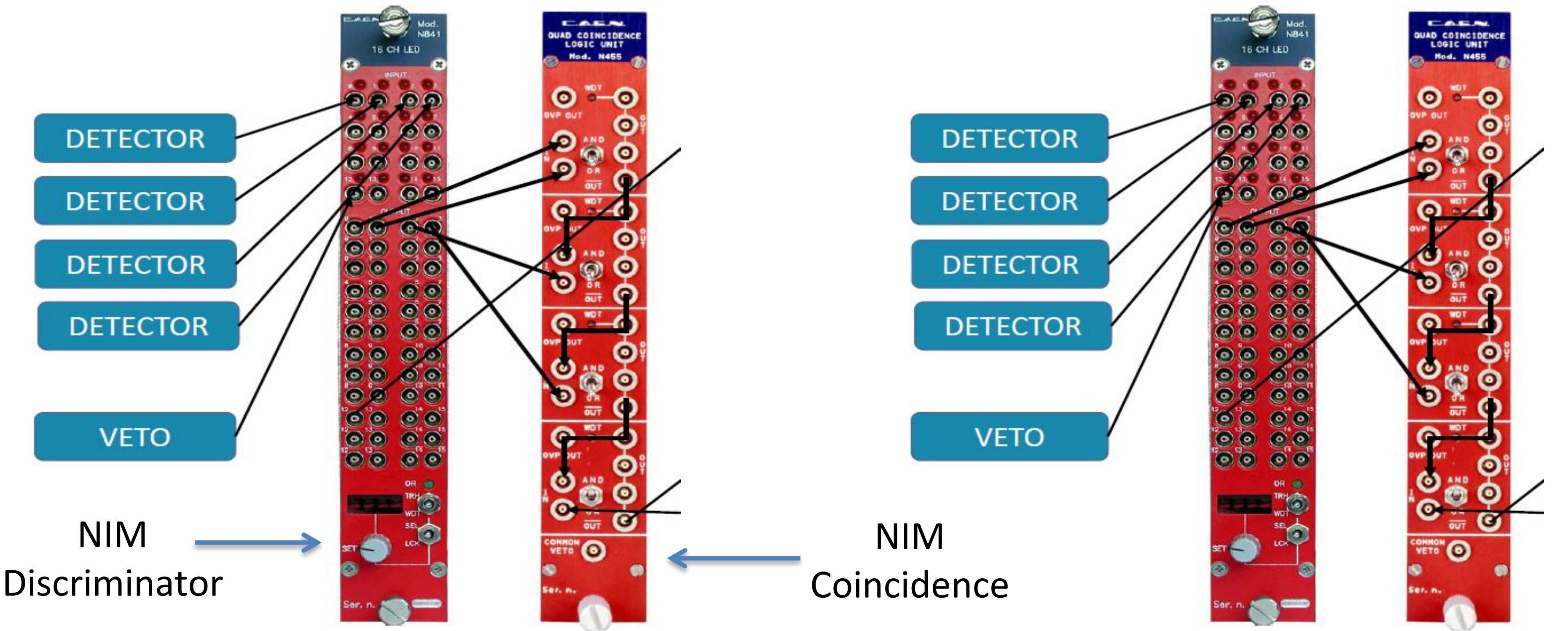
Maybe to not work on synchronizing with VXD DAQ we do not use the CAEN V830 trigger card means we will not run from our side but just using the trigger logic pattern mentioned starting from slide 14 but just deliver a cosmic trigger to VXD DAQ, then reconstruct the triggered Scintillator by extrapoling the reconstructed track, in VXD, to scintillator positions.



VXD reconstructed track extrapolated to find triggered scintillators.
Here hardware global trigger, to VXD, only matters.

Also using special runs, for specific trigger logic, will separate data on special runs with Specific trigger logic which is good for analyzers.

Global trigger (we have such NIM discriminator and coincidence modules)

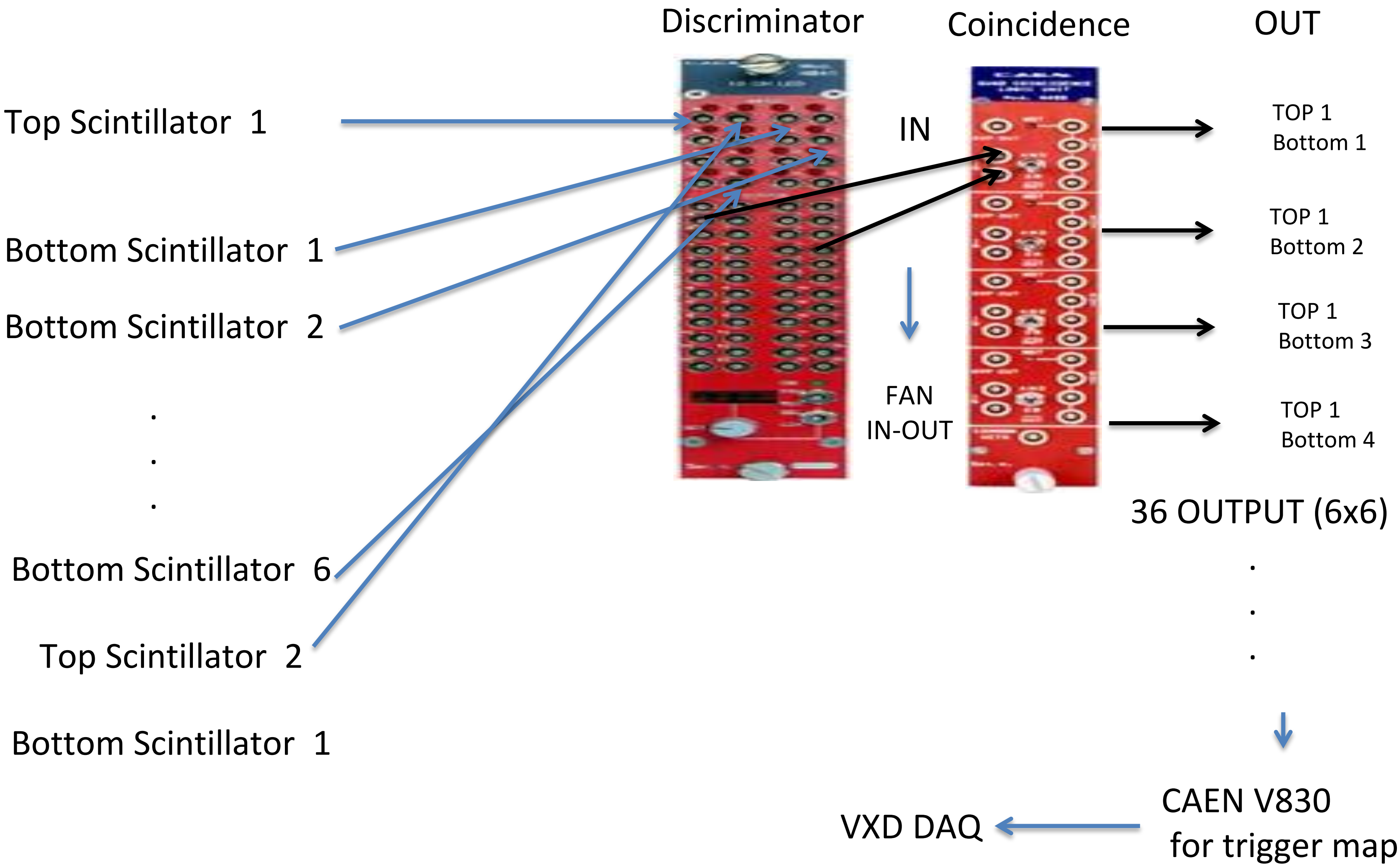


Or between all top scintillators

Or between all bottom scintillators

Coincidence
Global trigger
(Cosmic)

Trigger Coincidence map



Or Use Modules doing Coincidence Logic of large number of inputs

Like the CAEN VME V2495 card (Needs VHDL coding)

But there is the scaler version FW2495SC

Within this card all the trigger logic coincidence is done
Inside the card, we need just enter the 12 discriminators signals

Conclusion

1. Three scintillators with their PMs of the VXD trigger system had been well tested

2. Cosmic Rate of a two 10x30cm^2 scintillators on top of each others at a vertical distance of 19.3 cm had been estimated by a simple hit and miss MC program to be about 65 cosmic/min and compared to measurement at the same value about 120/(2 minutes).

3. Next step to fix a TOP scintillator and scan the bottom scintillator in six positions and compare rates with simulation (page 12).

4 All scintillators arrived at MPP!!!! , so we will mount them in the scintillators, fix them in the frame (after making some mechanical work on the frame) and test the full system. This will take about a week and be ready for KEK test starting from September 2018.

5. The trigger geometry is already in basf2 and cosmic rates were estimated but we will start soon an analysis study in basf2 to study cosmic tracks: residuals of SVD into PXD, cluster size versus track angle, SVD and PXD alignment, cosmic trigger efficiency versus scintillator, and also estimate track resolution.

Thank you

(1) (1a v 2a v 3a) ^ (4b v 5b v 6b)

(2) (4a v 5a v 6a) ^ (1b v 2b v 3b)

(3) (3a v 4a) ^ (3b v 4b)

(4) (2a v 5b) ^ (5a v 2b)

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