12th ALICE ITS Upgrade, MFT, and O2 Asian Workshop

November 19 to 21 2018, Incheon, South Korea

Status of the MFT software in the ALICE O2 framework

Rafael P. Pezzi
(on behalf of MFT WP9)

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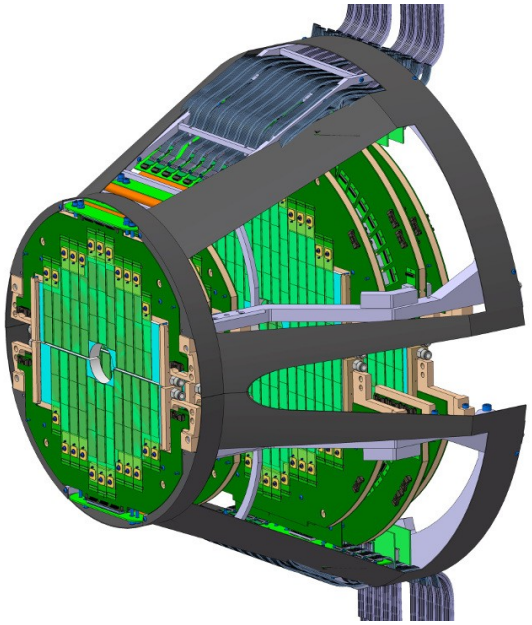
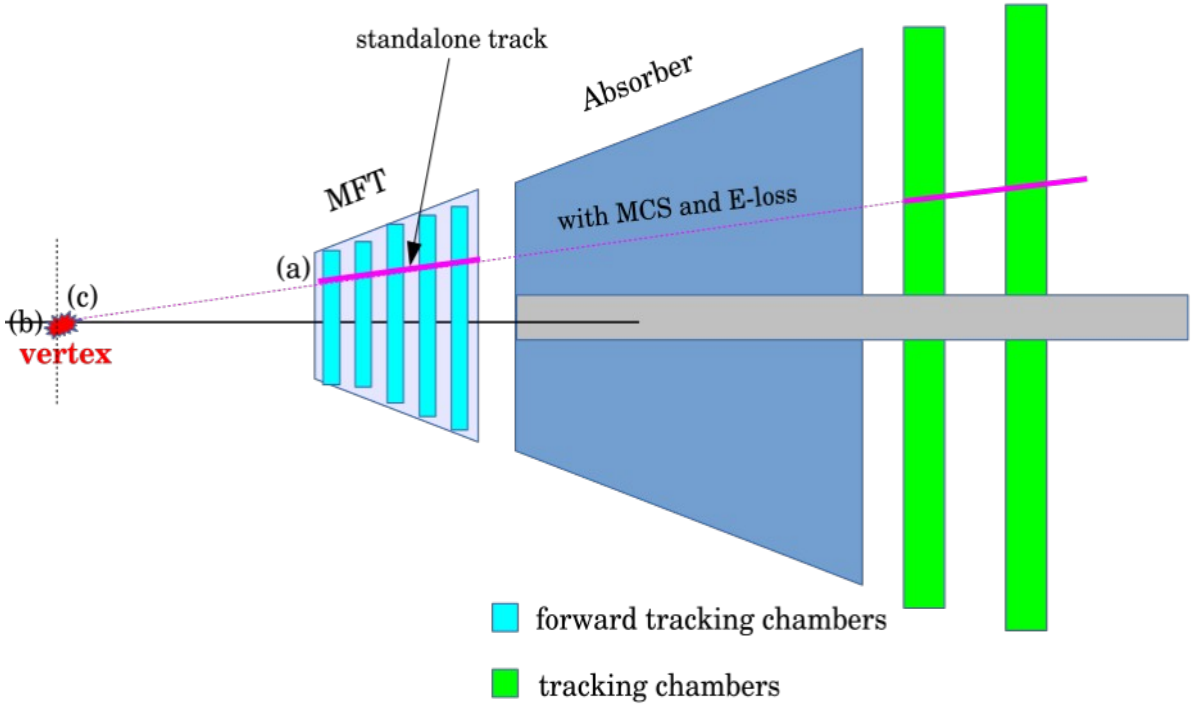
Porto Alegre – Brazil

Summary

- Brief introduction to MFT
  - Comparison: ITS & MFT
  - Readout electronics
- MFT Geometry
- Data reconstruction

Brief MFT introduction





- Standalone track (MFT) + muon tracks (MCH) = global tracks
- MFT + MCH matching to enable physics
  - global track with Pt and vertex information

Standalone tracking using cellular automaton algorithm

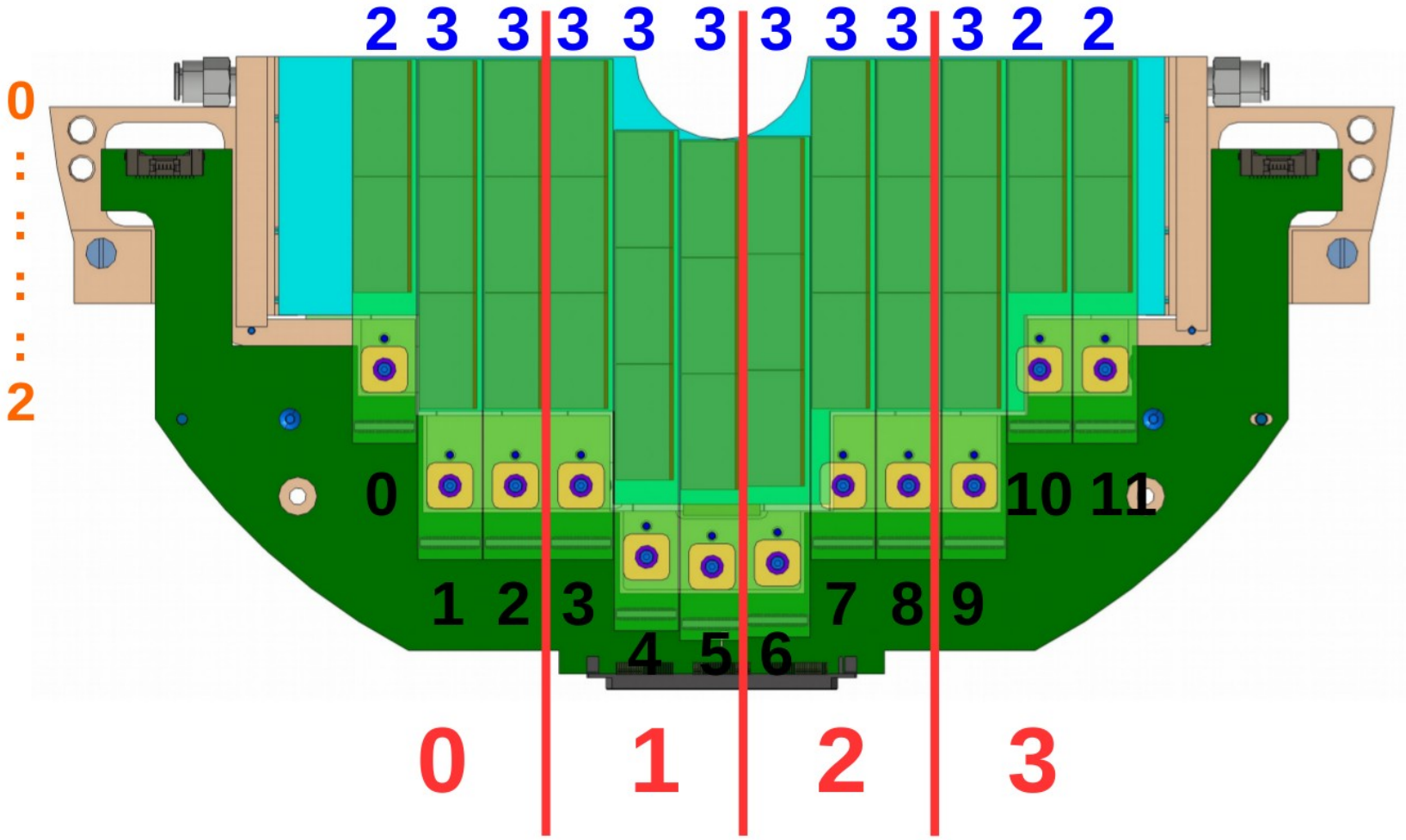
ALICE Collaboration, Technical Design Report for the Muon Forward Tracker
http://cds.cern.ch/record/1981898

Comparison: ITS & MFT

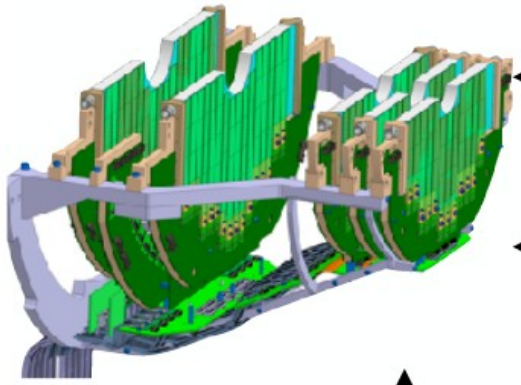
- Differences:
  - Readout electronics
  - Number of chips and its positioning symmetry
    - More difficult to sort clusters for track matching
  - ChipMapping
    - Geometry.xml
- Similarities:
  - Same ALPIDE Chip
  - Data reconstruction up to clusterization commont to ITS/MFT
  - Raw data and Data processing layer imported from ITS

Readout zones

- 8 zones per disk. One RU per zone.



Readout Scheme for half-MFT



Massimiliano Marchisone (Universite Claude Bernard Lyon I (FR))

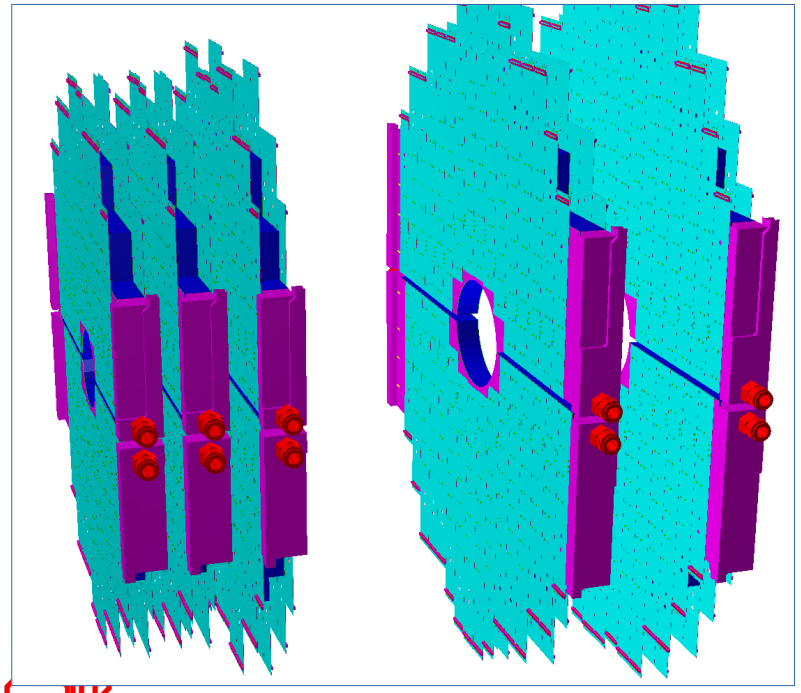
https://indico.cern.ch/event/671531/contributions/2746817/attachments/1535804/2405852/05Oct2017_MFT-WP9.pdf

MFT Geometry

- MFT Acceptance
  - Heat Exchanger, Flex, Sensors, electronic components
- TPC Acceptance
  - Barrel & services
- Passive elements: out of acceptance
  - Supports, structure, PSU
- Integration
- Alignment & Calibration

MFT Geometry

MFT Acceptance

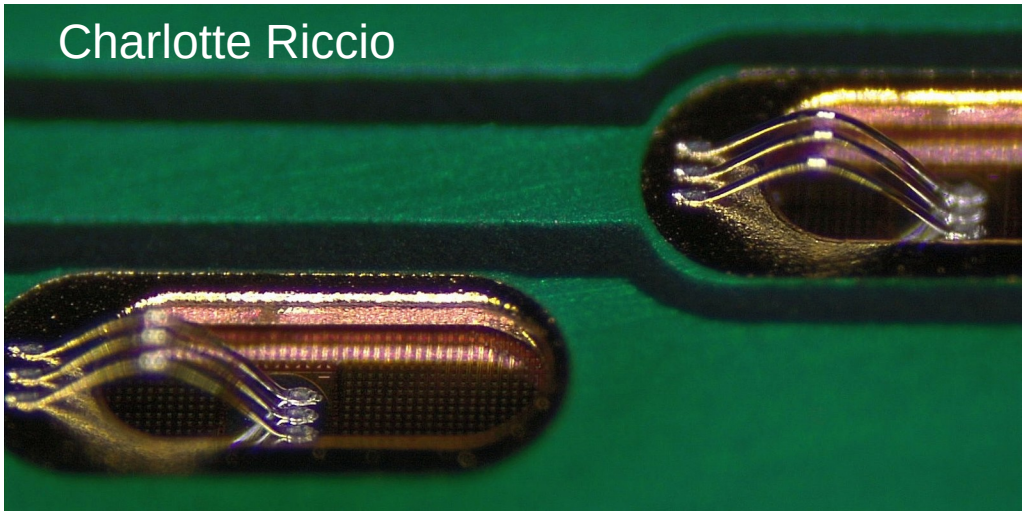


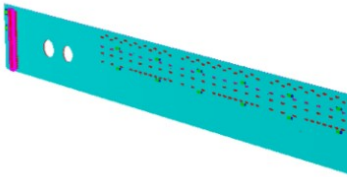
- Sensors
- Flex circuits (FPC) & connectors
- Heat ExchangerS

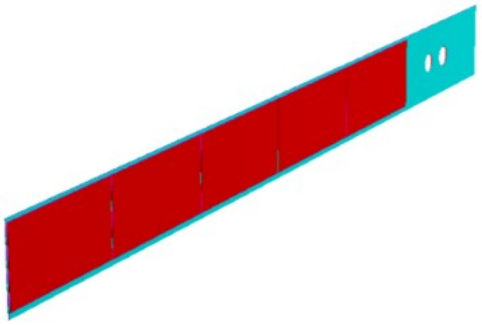
- Relevant volumes within MFT acceptance are implemented with fine details

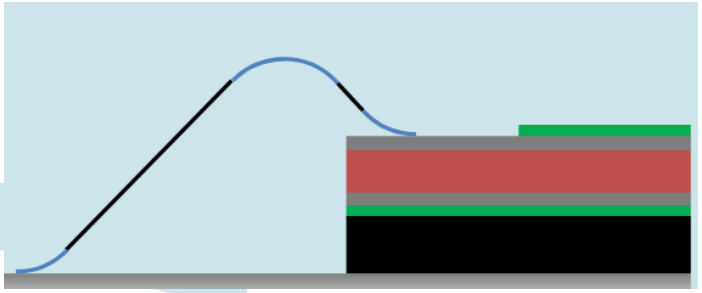
FPC details

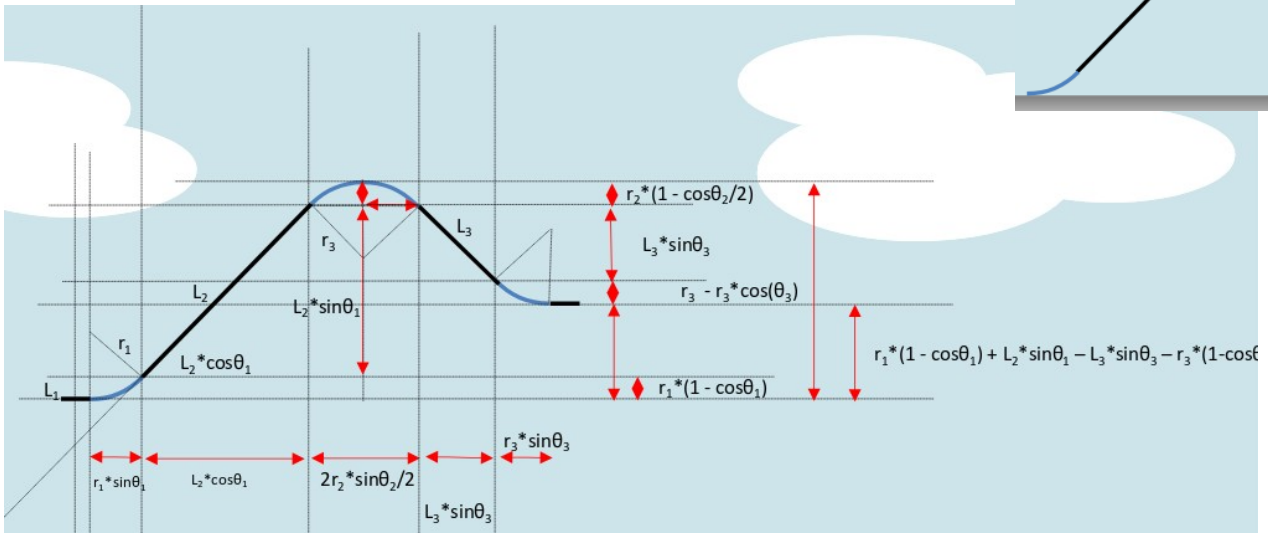
Satoshi Yano (IRFU, CEA)

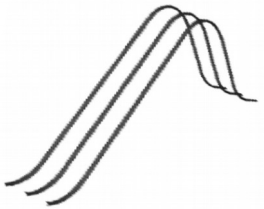








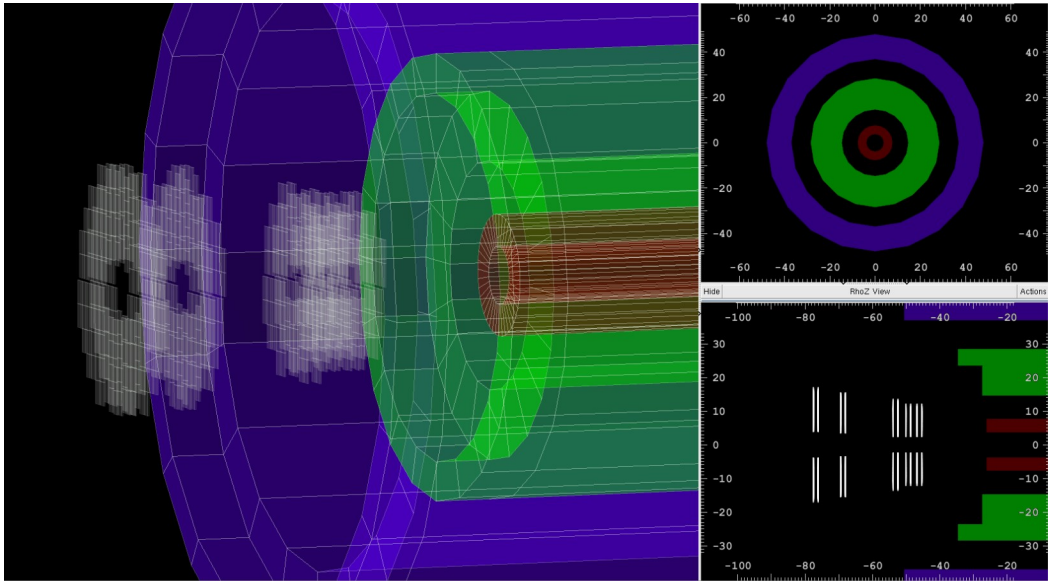


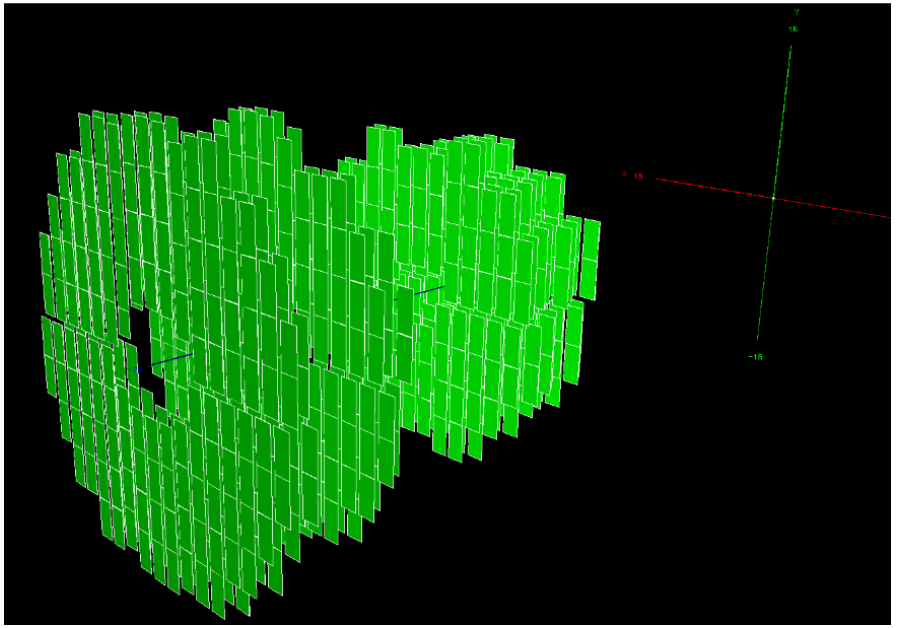


https://indico.cern.ch/event/749678/contributions/3101718/attachments/1699373/2736223/0809_syano_WP.pdf

Light version for status display

- Simplified volumes for sensors' active volume
- One box per sensor
- 936 boxes





MFT Segmentation

Rafael Pezzi (UFRGS) & Javier Castillho Castellanos (IRFU)

Detectors/ITSMFT/MFT/data/Geometry.xml

Geometry.xml

```
<?xml version="1.0"?>
<MFT>
  <half top="0"  ndisk="5" xpos="0" ypos="0" zpos="-46.">
    <disk   idisk="0" nladder="24" xpos="0." ypos="0." zpos="0."    phi="0" theta="0" psi="0">
        <ladder iladder="0"  nsensor="2"  xpos="-7.945"  ypos="-0.16"  zpos="0.7165"  phi="0" theta="180" psi="90">
            <chip ichip="0" xpos="0.04"  ypos="0.105"   zpos="0.0165" phi="0" theta="0" psi="0"/>
            <chip ichip="1" xpos="3.055" ypos="0.105"   zpos="0.0165" phi="0" theta="0" psi="0"/>
          </ladder>
        <ladder iladder="1"  nsensor="3"  xpos="-6.245"  ypos="-0.16"  zpos="0.7165"  phi="0" theta="180" psi="90">
            <chip ichip="0" xpos="0.04"   ypos="0.105"   zpos="0.0165" phi="0" theta="0" psi="0"/>
            <chip ichip="1" xpos="3.055"  ypos="0.105"   zpos="0.0165" phi="0" theta="0" psi="0"/>
            <chip ichip="2" xpos="6.07"   ypos="0.105"   zpos="0.0165" phi="0" theta="0" psi="0"/>
          </ladder>
        <ladder iladder="2"  nsensor="3"  xpos="-4.545"  ypos="-0.16"  zpos="0.7165"  phi="0" theta="180" psi="90">
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          </ladder>
```
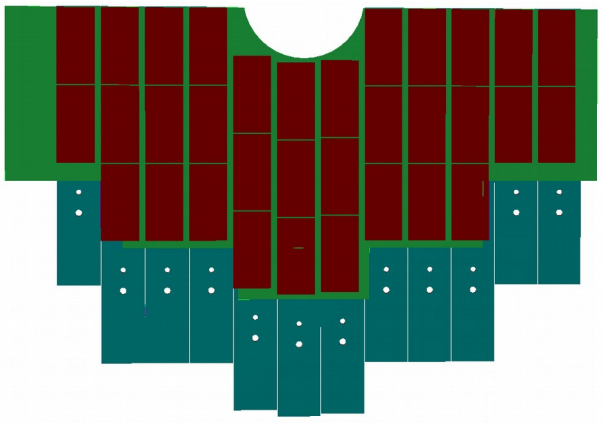
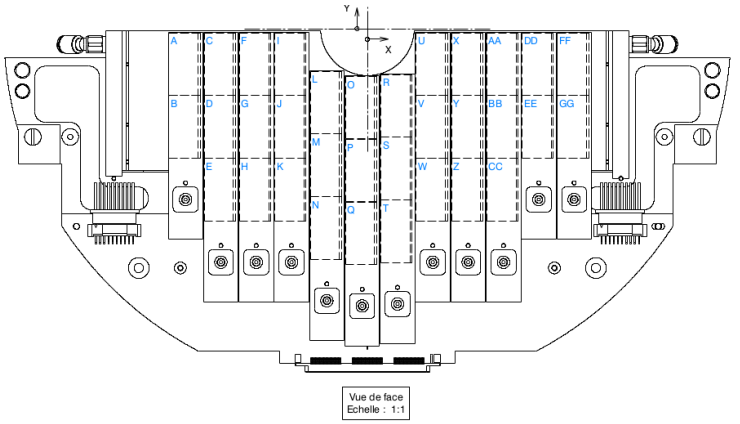
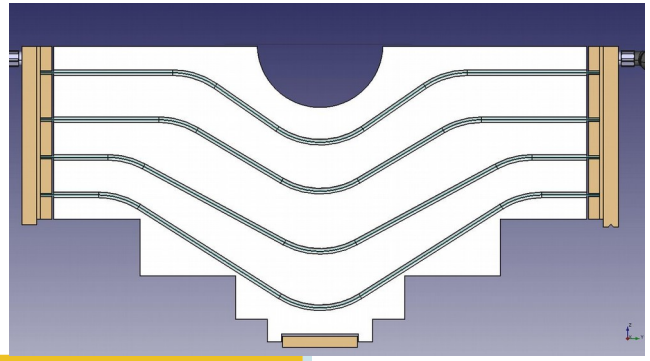
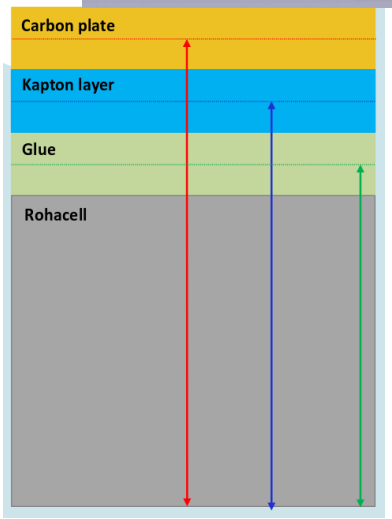



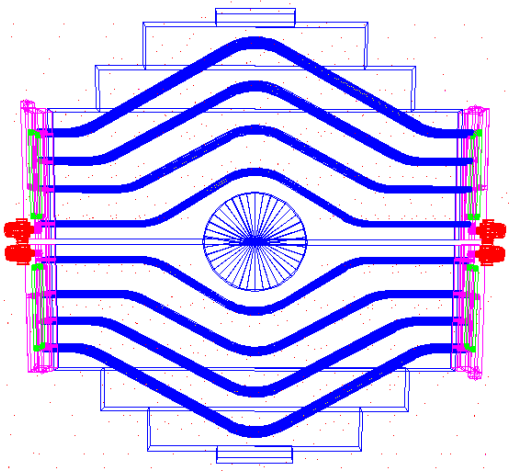


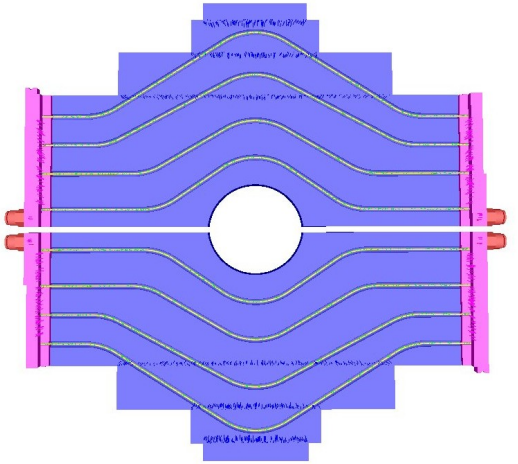
Heat Exchanger

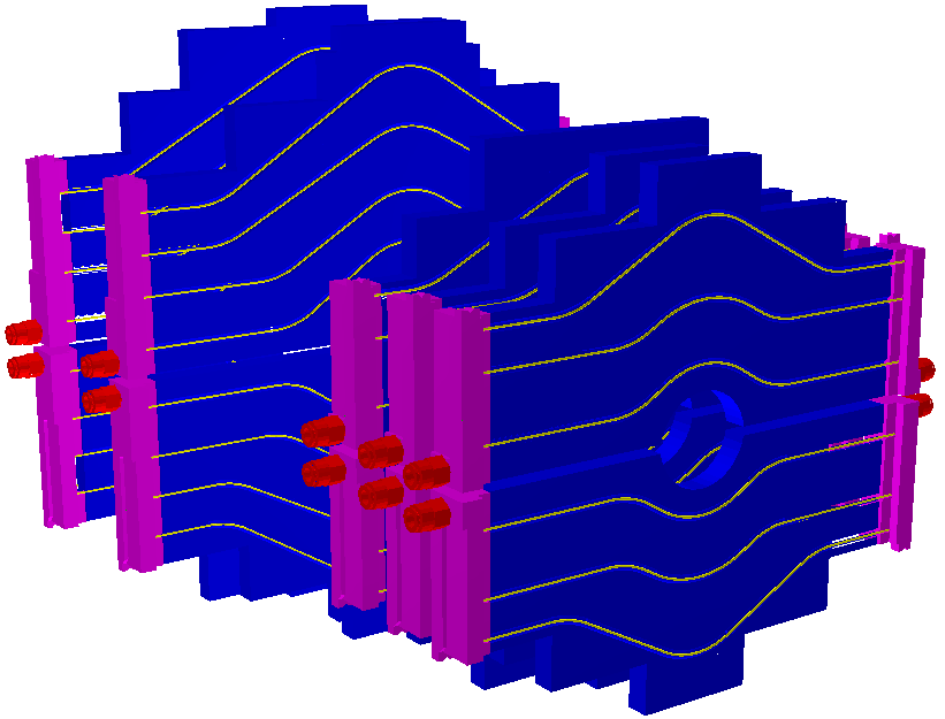
Franck Manso (LPC)











Satoshi Yano (IRFU, CEA)

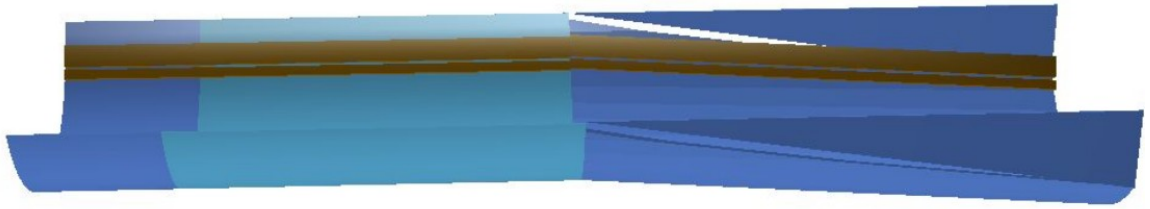
MFT Geometry

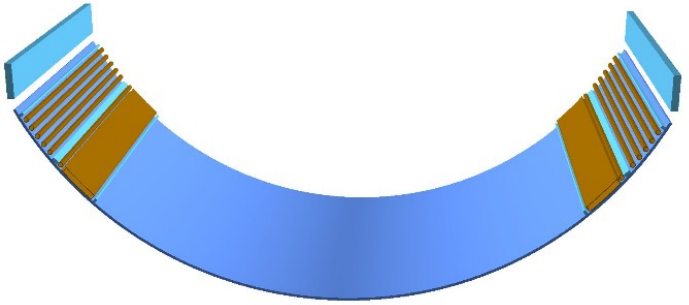
TPC Acceptance

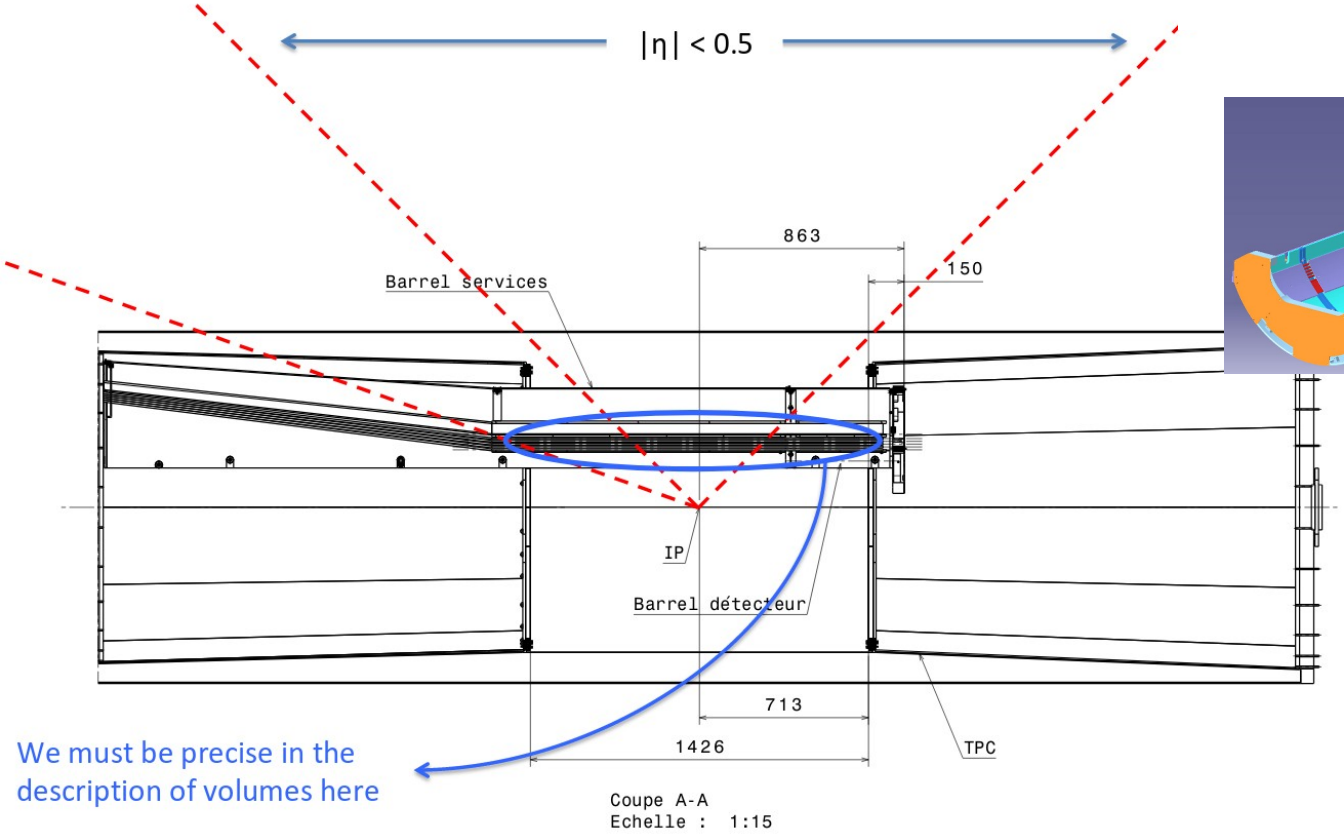
Barrel Services

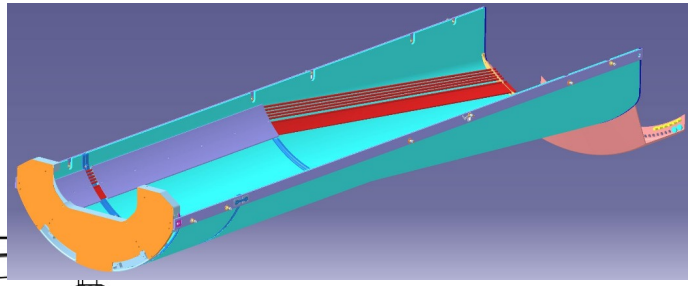
Rodrigo A. Helaconde

- Half barrel with services









Work in progress
Preliminary geometry implemented

We must be precise in the description of volumes here

MFT impact on TCP acceptance (Antonio Uras)

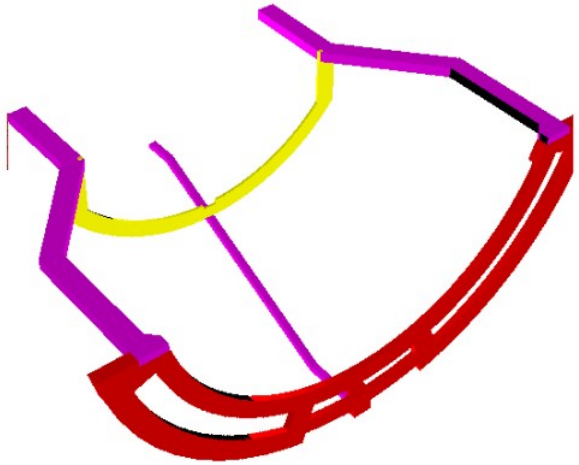
MFT Geometry

Out of acceptance elements

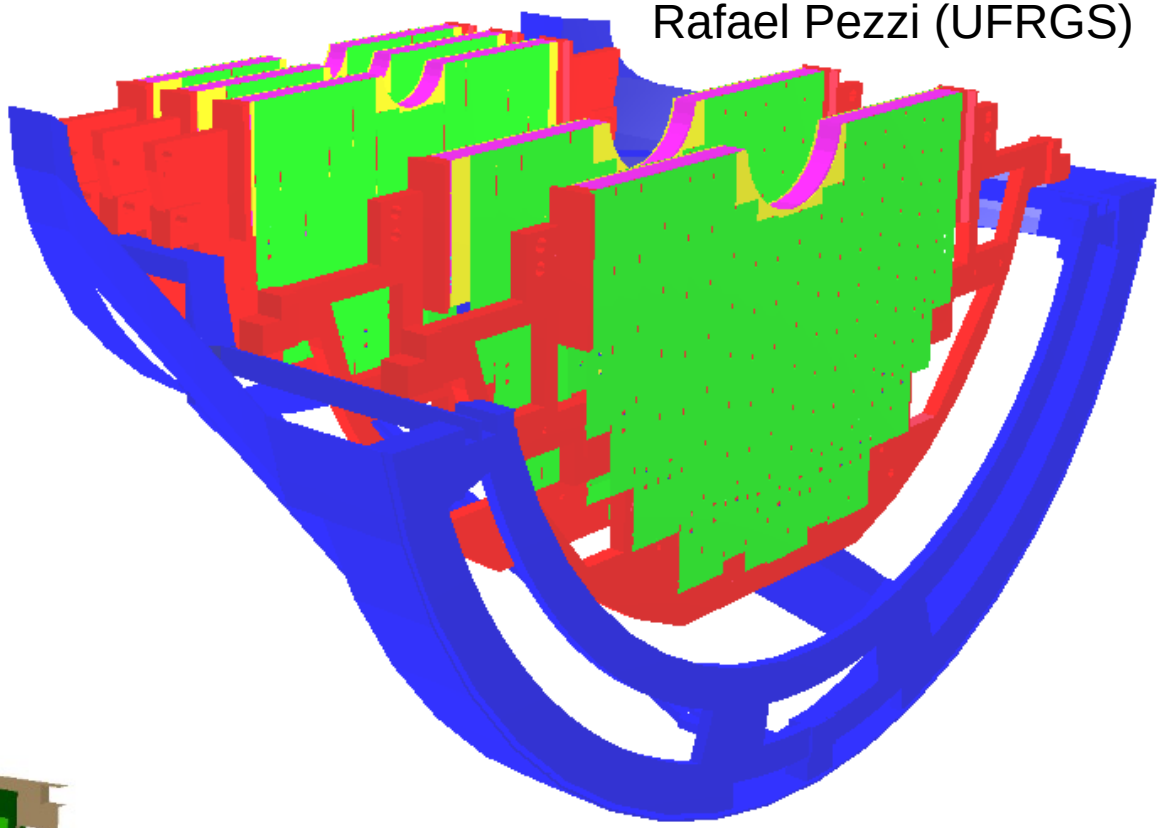
- PCB + Supports
- Services. Manyfold
- Power Supply Unit

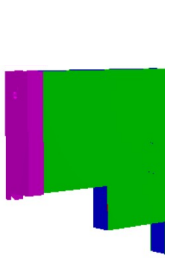
Supports and PCBs

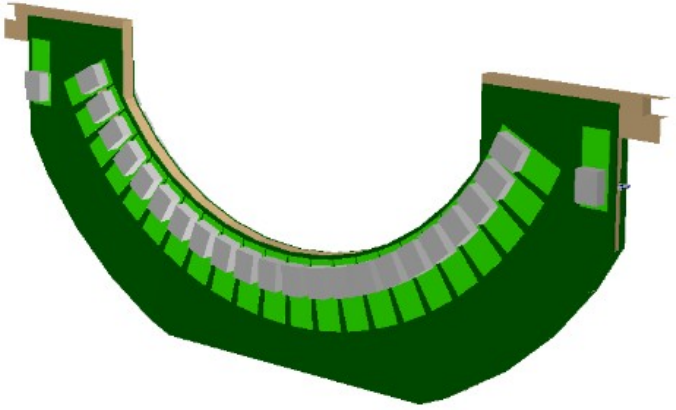
Carlos Soncco (PUCP)

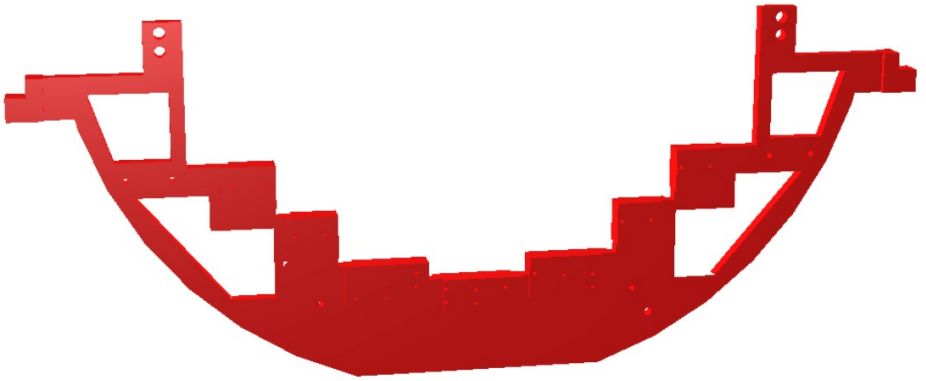


Rafael Pezzi (UFRGS)









Satoshi Yano (IRFU, CEA)

Summary (MFT Geometry)

- Detailed MFT Geometry description in progress
  - suitable only for detailed simulations: secondary particles production, back scattering, material budget close to reality
  - A simpler geometry suitable for high performance reconstruction needs to be implemented
- Design of some parts have changed since implemented in O2. Needs revision.

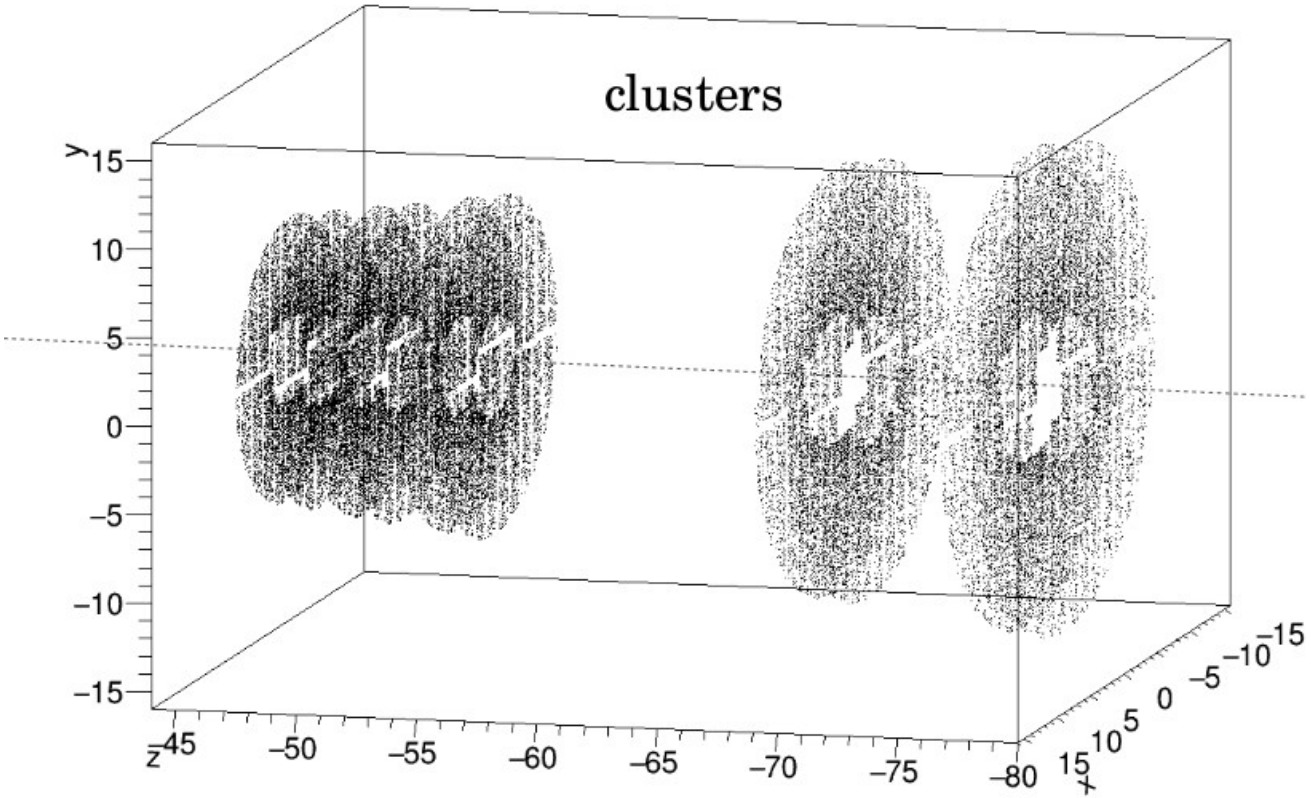
Reconstruction
(Bogdan Vulpescu)

- Cluster combinations for the track finder
  - Optimization strategy

- Integration of data flow devices into the Data Processing Layer: up to now we have the common ITS/MFT digitizer

- DPL Training planned for early 2019.

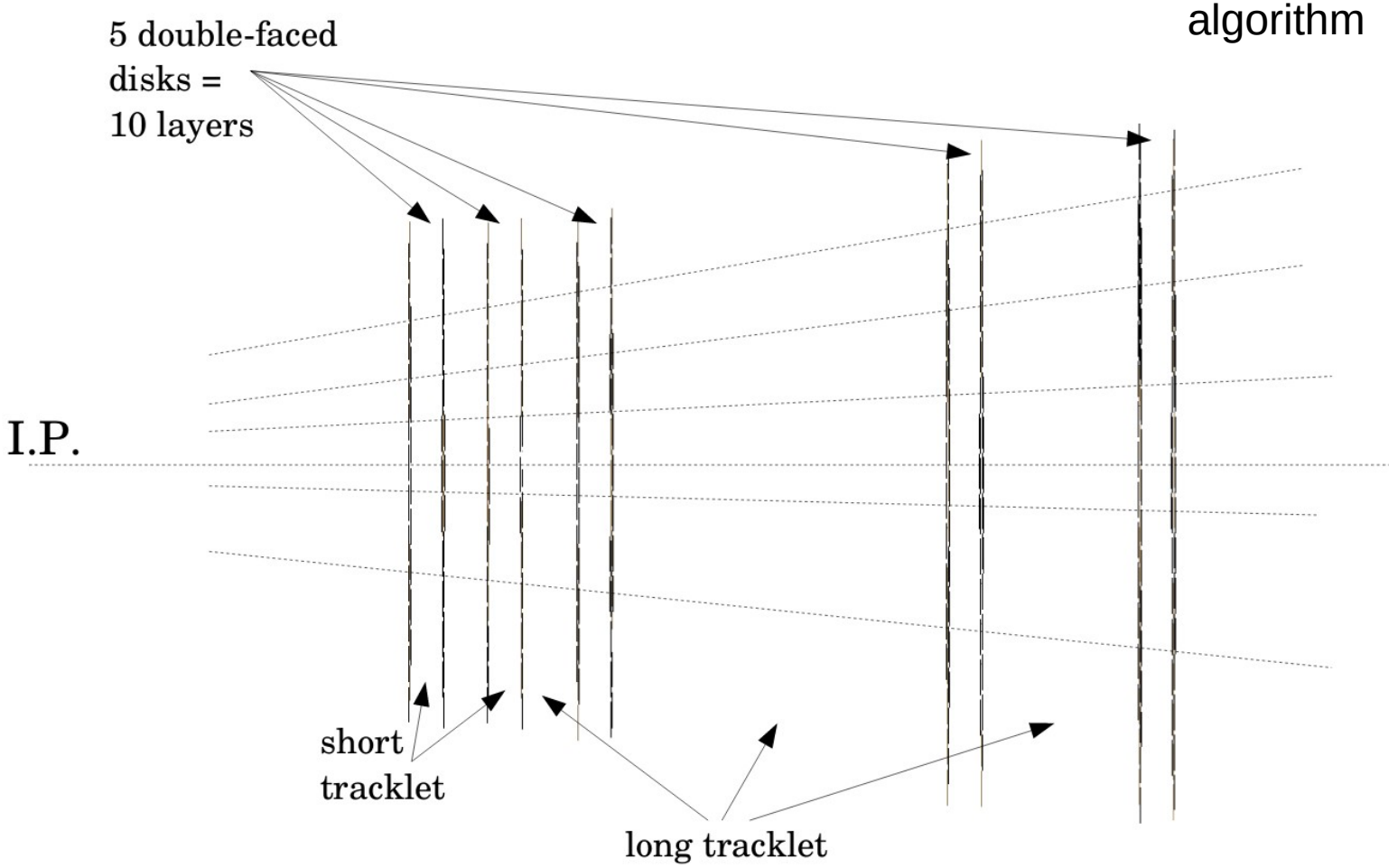
Simulation



How to find tracks?

Track finder from cluster groups

Standalone tracking using cellular automaton algorithm



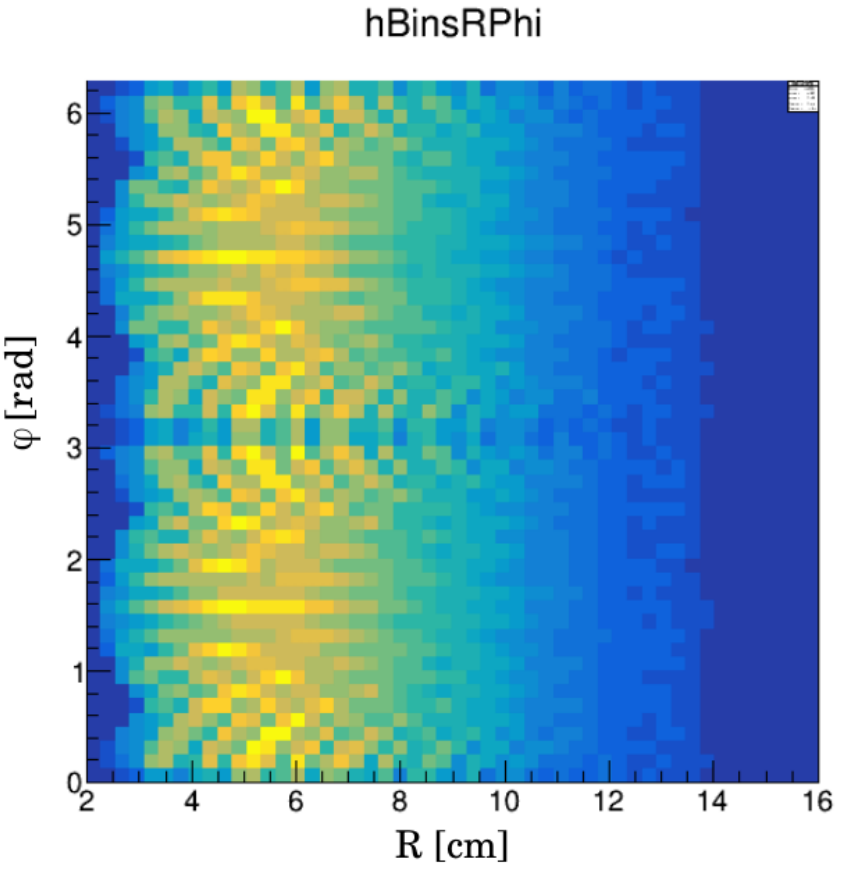
How to optimize standalone tracking?

Group and sort clusters in R-Phi (x-y plane)

The R-Phi histogram

- 50 x 50 bins in the range:
  - 2 cm < R < 16 cm
  - 0 < φ < 2π

    (contains all clusters in all layers)
- Each cluster has attached two indices $\mathfrak{I}_R$ and $\mathfrak{I}_\varphi$ and a combined index:
- $\mathfrak{I} = \mathfrak{I}\varphi \cdot \text{Nbins}(R) + \mathfrak{I}_R$
- The clusters are sorted according to the combined index (increasing order) in each of the 10 layers



Standalone tracking optimization

How many R-Phi bins should be scanned in order to take into account the multiple diffusion from one layer to the next?

1) consider a track which produces clusters in layers “i” and “i+1”

2) from the cluster in layer “i” follow a linear propagation to the layer “i+1” and find the R-Phi bin corresponding to the impact point

3) from the cluster in layer “i+1” find the corresponding R-Phi bin

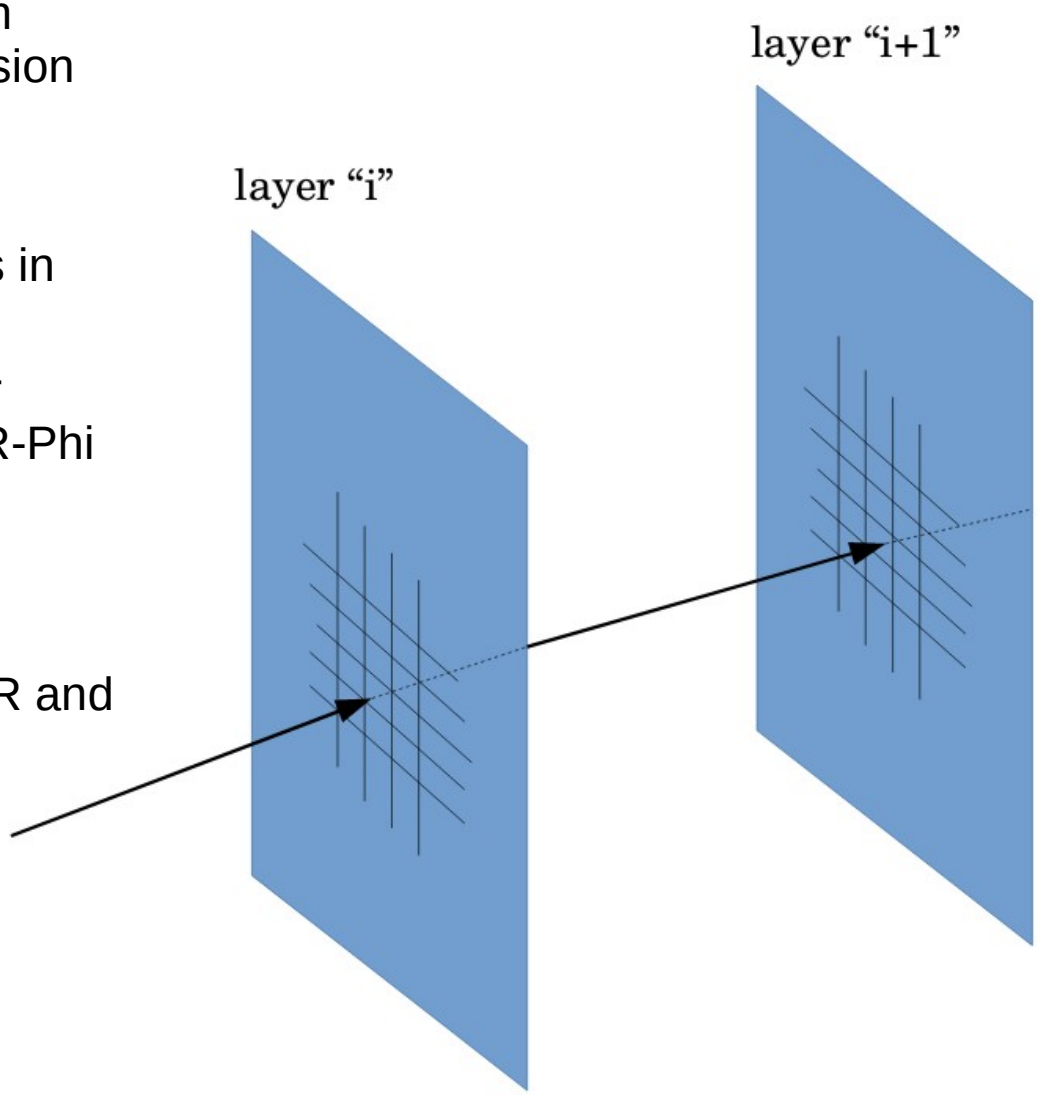
4) build histograms of the bin difference in R and Phi

5) must include several effects:

- low energy

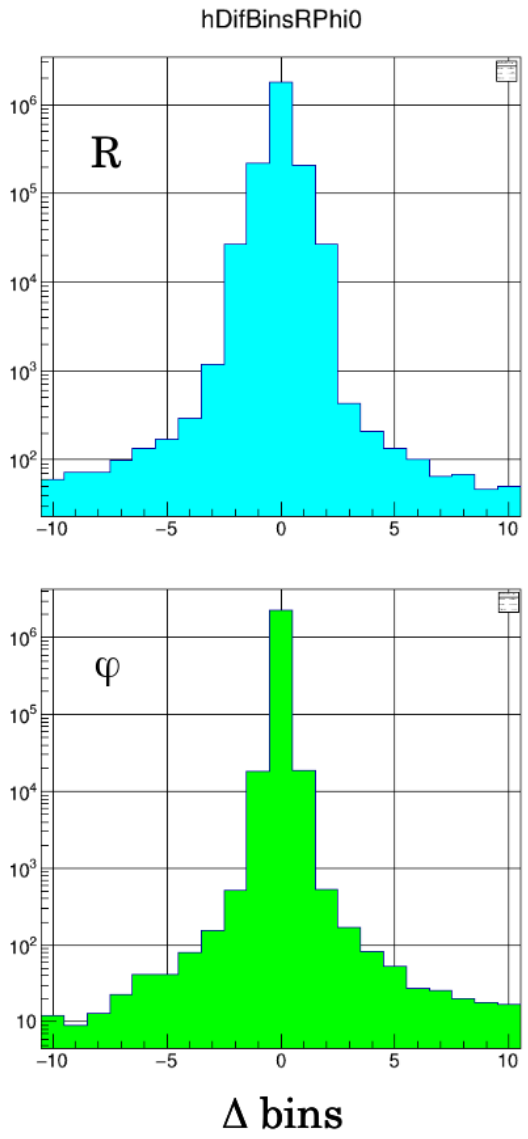
- magnetic field

- z-vertex distribution

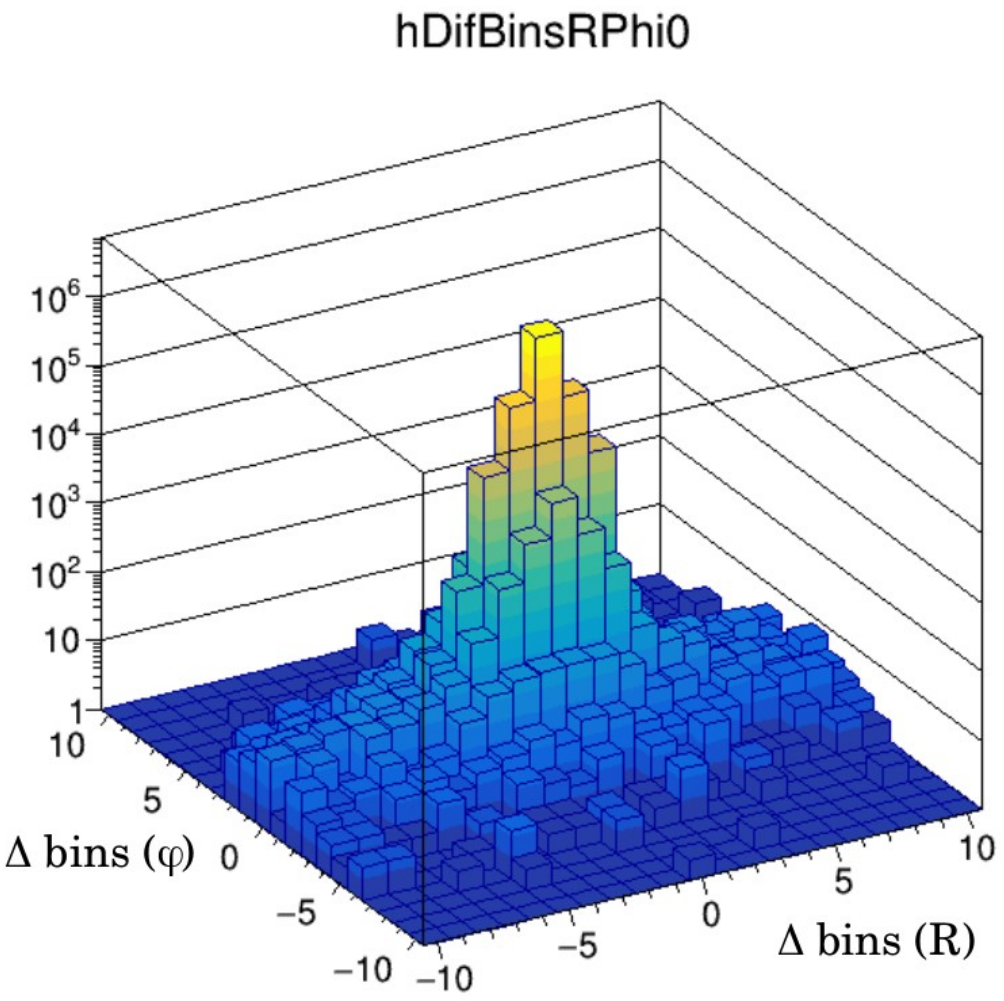


Diffusion on R & φ

Projections



Histogram of R-Phi bin difference



Cluster matching optimization

Note: within one R-Phi bin the (sorted) clusters are identified by the min/max index range from the cluster list of the full layer;

this is stored as a

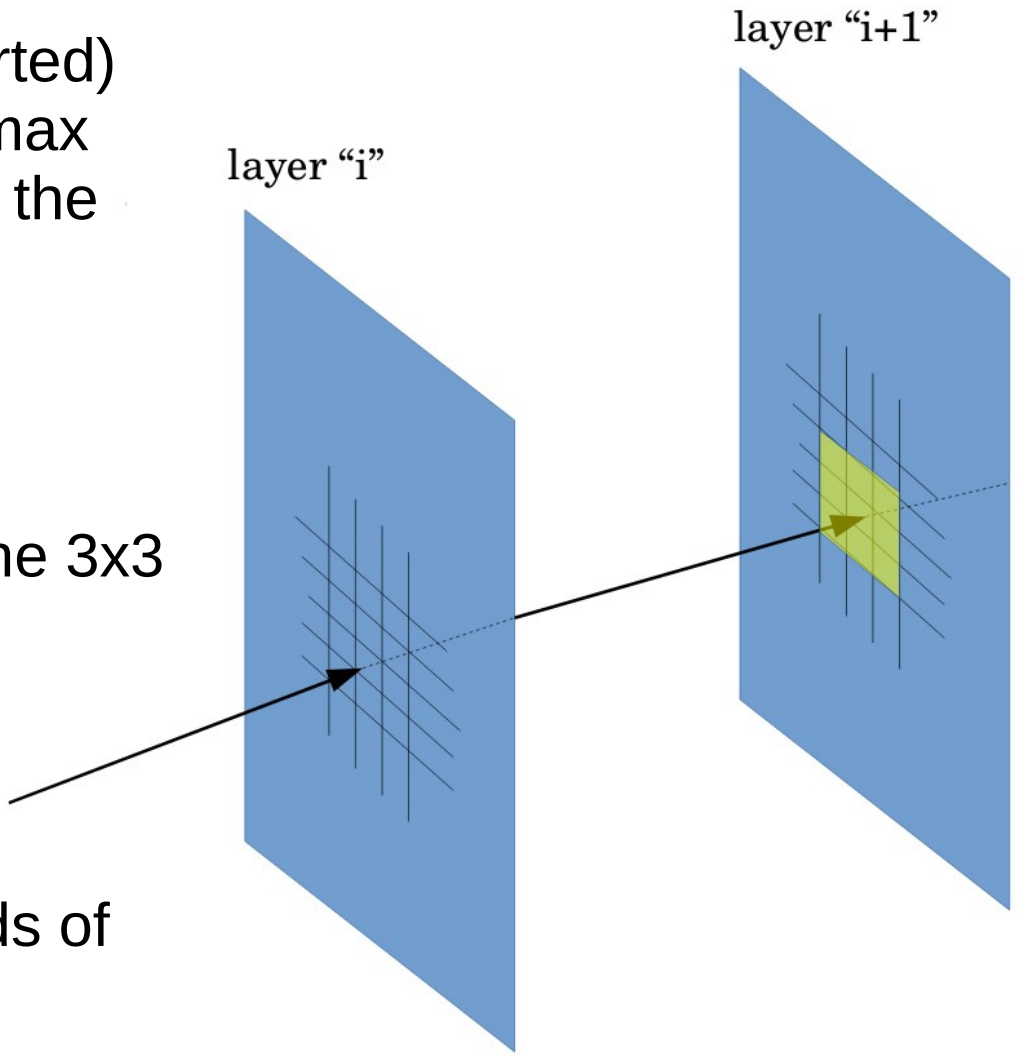
look-up-table for each layer

the yellow range corresponds to the 3x3 bins in layer “i+1”:

$\mathfrak{I}_R - 1, \mathfrak{I}_R, \mathfrak{I}_R + 1$

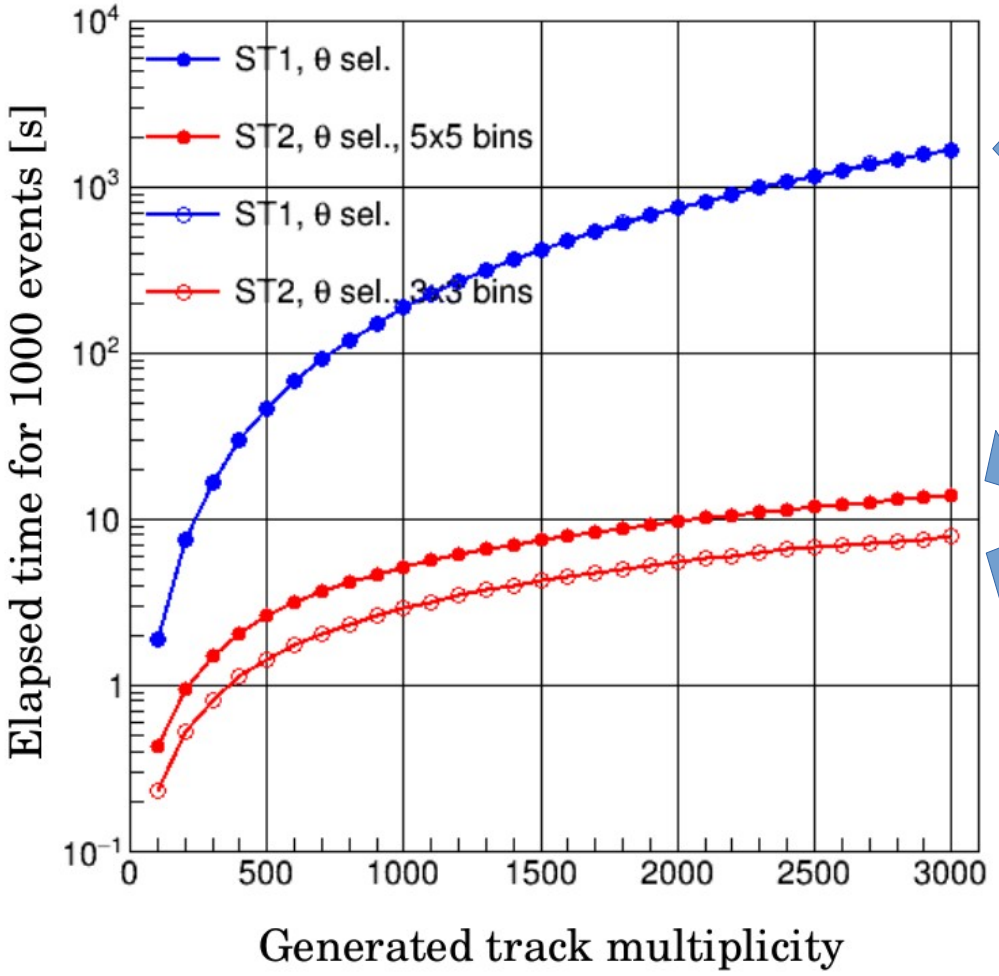
$\mathfrak{I}_\varphi - 1, \mathfrak{I}_\varphi, \mathfrak{I}_\varphi + 1$

In another version we explore fields of 5x5 bins in layer “i+1”.



Not final: room for optimization on the shape and size of lookup window

Testing the time spent in the cluster loops



Loop over all clusters

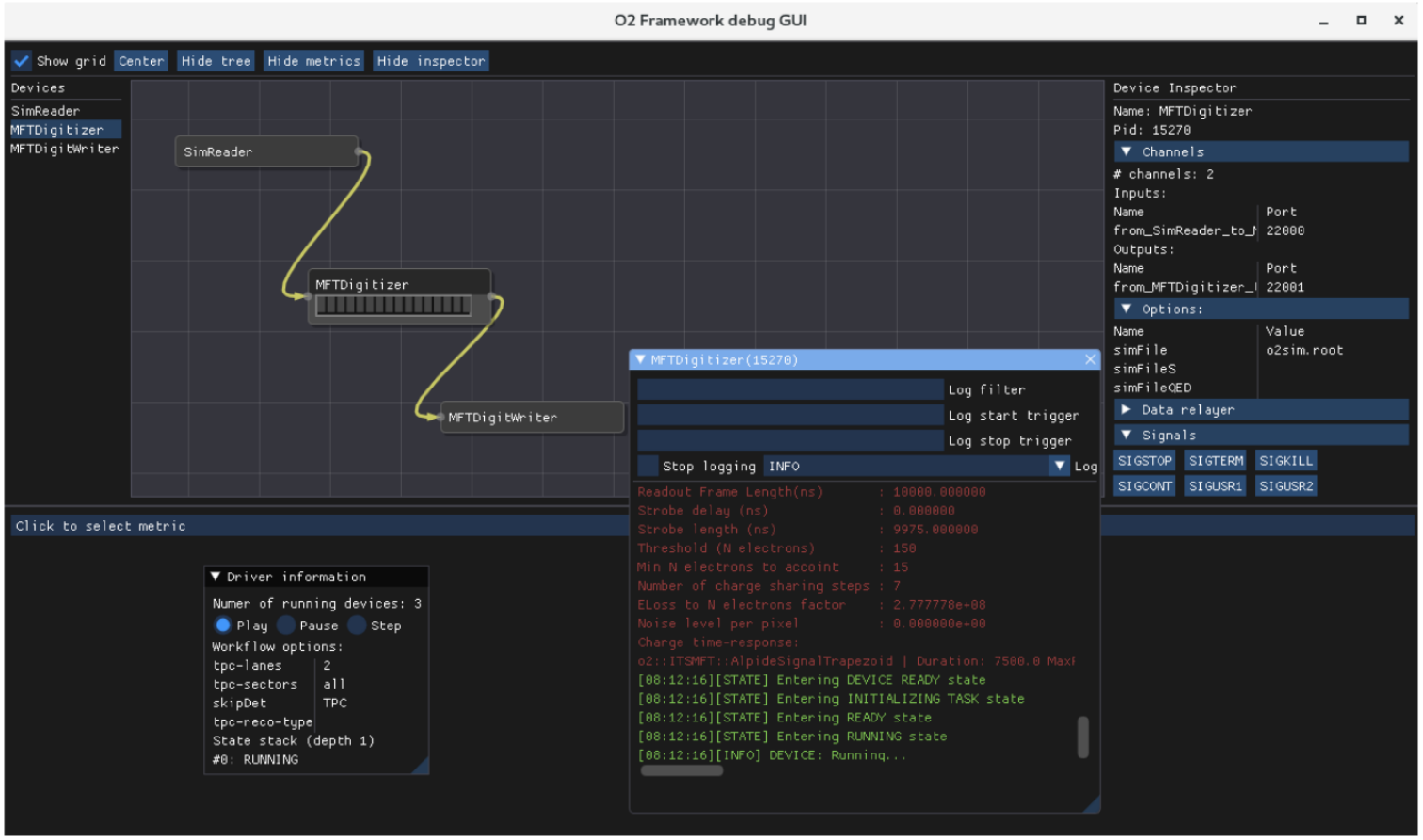
Search 5x5 bins on layer i+1

Search 3x3 bins on layer i+1

MFT Data Processing Layer

Digits → Clusters → Tracks

- MFT Digitizer implemented in Data Processing Layer
- Adapted from ITS digitizer (Sandro Wenzel)




```
> digitizer-workflow -b --mft-digit-outfile    <name>.root --simFile <name>.root
                        mftdigits.root                    o2sim.root
```

DPL Training planned for early 2019.

12th ALICE ITS Upgrade, MFT, and O2 Asian Workshop

November 19 to 21 2018, Incheon, South Korea

Thanks

Rafael P. Pezzi
Instituto de Física / UFRGS
Porto Alegre – Brazil

on behalf of MFT WP9
Antonio Uras, Bogdan Vulpescu, Carlos Soncco, Franck Manso, Javier Castillho Castellanos, Rafael Pezzi, Rodrigo A. Helaconde, Satoshi Yano