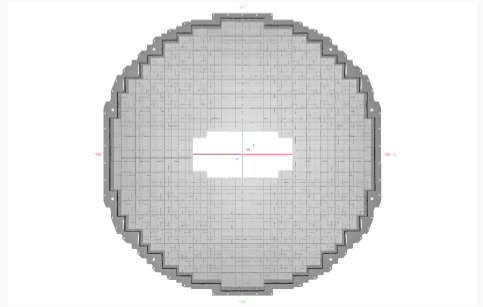


EMC Forward Endcap software developments in Bonn

Ben William Salisbury

March 10, 2020

HISKP University Bonn



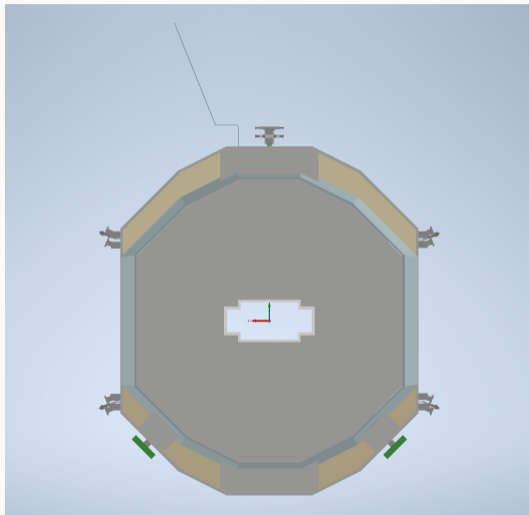
Forward endcap geometry

EMC code restructuring

Determination of Cluster-entering MCTracks

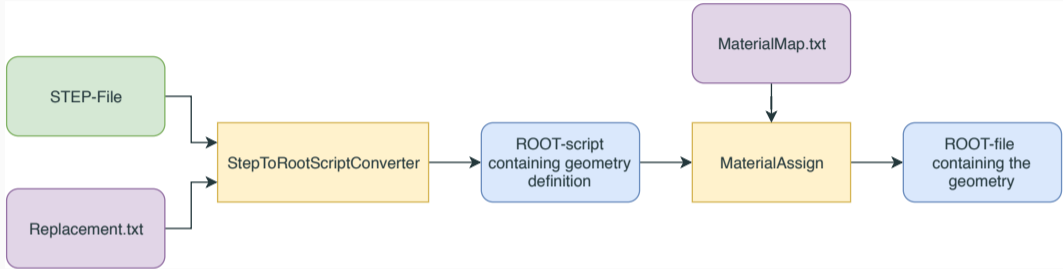
Forward endcap CAD model

Use CAD model to
create new ROOT
geometry for Forward
endcap



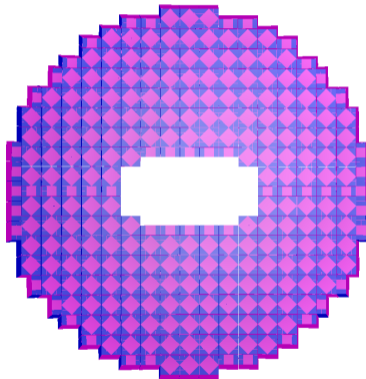
- Complex CAD-parts not easily convertible
- We developed TGeoArbN
- Any triangle mesh now simulatable

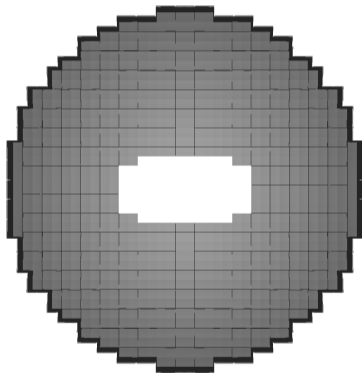
Our version of T.Stockmanns' CADToROOTConverter



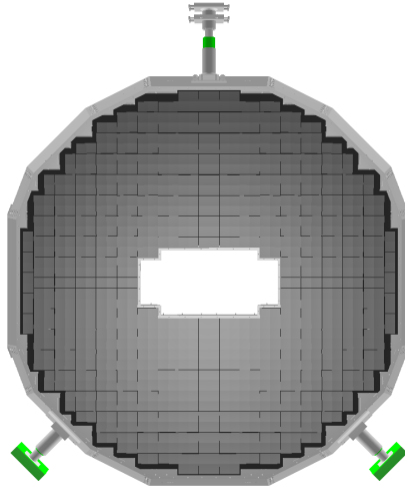
- python instead of c++ (easier access to relevant libs)
- only creates ROOT-scripts as output (list of volumes and definition of transformation matrices)
- material assignment is done in a separate ROOT-script

Forward endcap

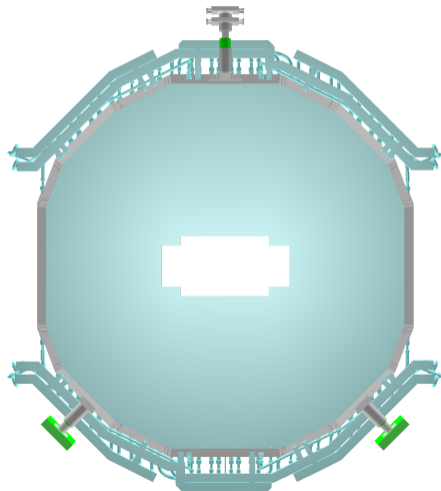




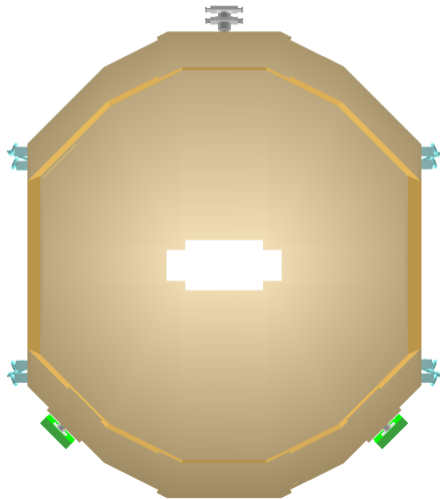
Forward endcap



Forward endcap

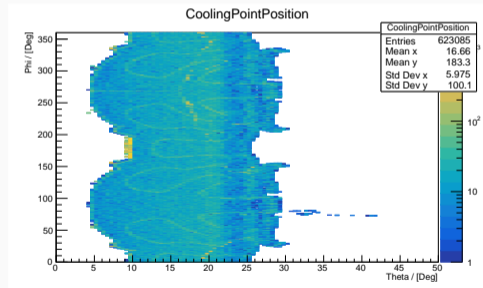
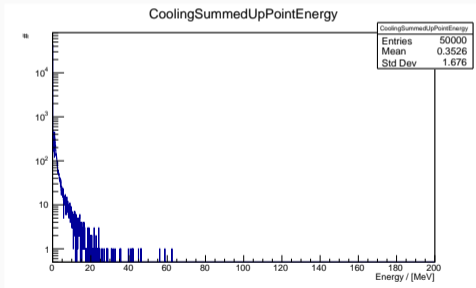


Forward endcap



New forward endcap: A quick glimpse at the cooling structure

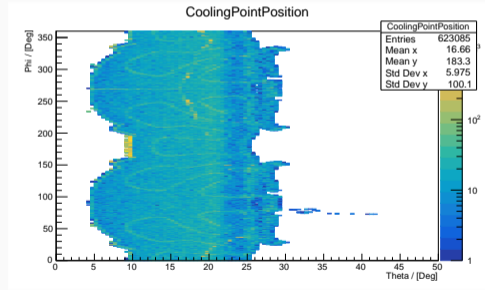
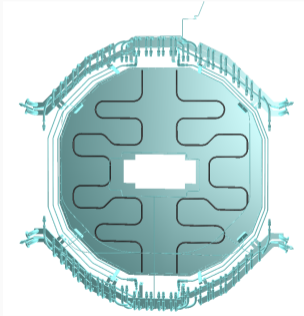
Looking at the cooling structure after shooting 50000 2 GeV photons between $\theta = 5^\circ$ and $\theta = 35^\circ$



Hit map

New forward endcap: A quick glimpse at the cooling structure

Looking at the cooling structure after shooting 50000 2 GeV photons between $\theta = 5^\circ$ and $\theta = 35^\circ$

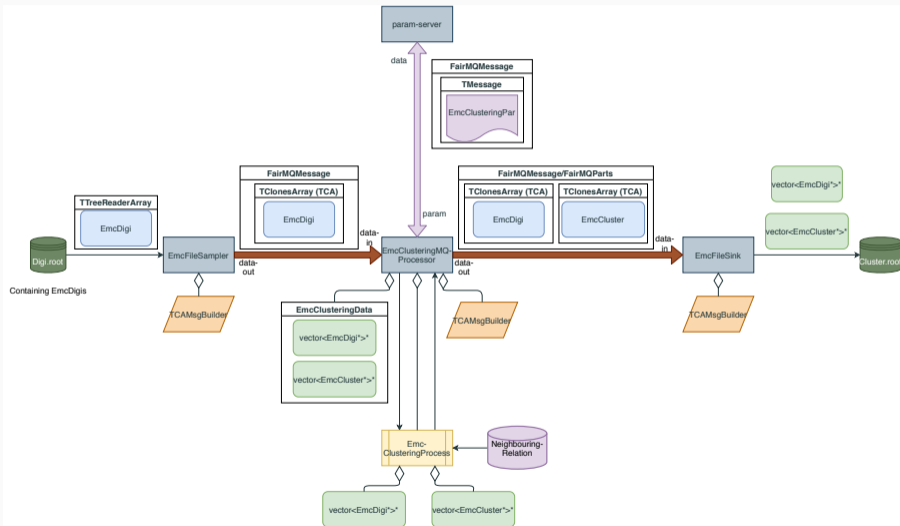


Hit map

We are still working on refactoring the EMC code

- Parameter passing to Processes: Processes (algorithm implementation classes) need more than one parameter set
- Eliminating singleton usage where parameters should have been used
- Changing TClonesArray to `std::vector`

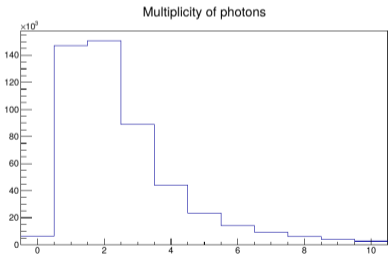
Restructuring efforts: Using our offline Processes in an online-like “setup”



Multiplicity - First glimpses

- In the past we saw a large number of reconstructed bumps for a single generated photon

High Photon Multiplicity



Picture taken from Kevin Luckas

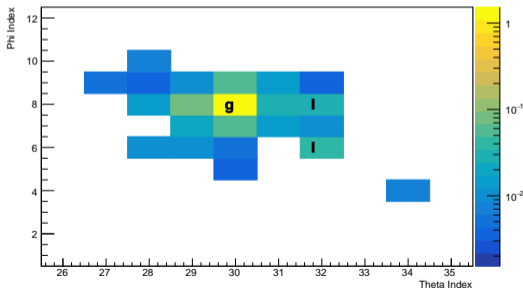
- Some reasons for this high multiplicity are/might be:
 1. Barrel/FwEndcap overlap at $\theta \sim 22^\circ$.
 2. The old clustering algorithm (have not looked into that)
 3. The new clustering algorithm
 4. Split-offs

Split-offs

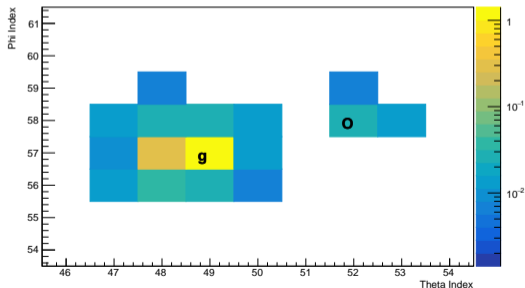
Split-Offs

Additional maxima in a cluster due to statistical fluctuation of the energy deposition in crystals

In-cluster:
Event_30



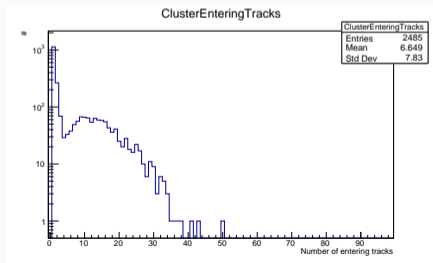
Out-of-cluster:
Event_422



Monte-Carlo Truth propagation for the EMC

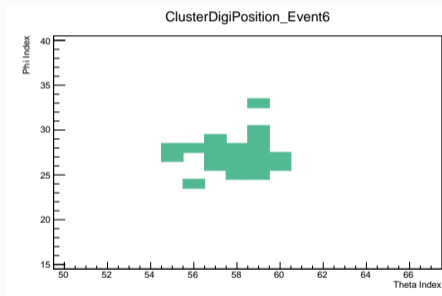
- We want to be able to determine the “source” of a cluster
- We know which track enters and exits a crystal
- Tobias has written a algorithm to determine tracks that enter or exits a cluster, the essence of which is:

A track enters/exits a cluster, if it enters/exists each crystal that the track touched

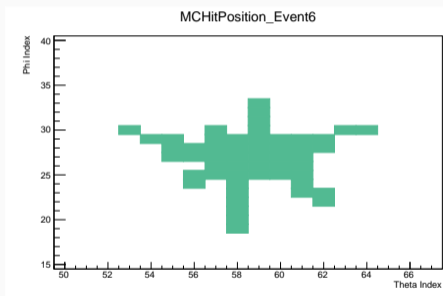


Monte-Carlo Truth propagation for the EMC

- Too many entering tracks because of using PndEmcDigis fragmenting the simulated shower



Shower representation using Digis

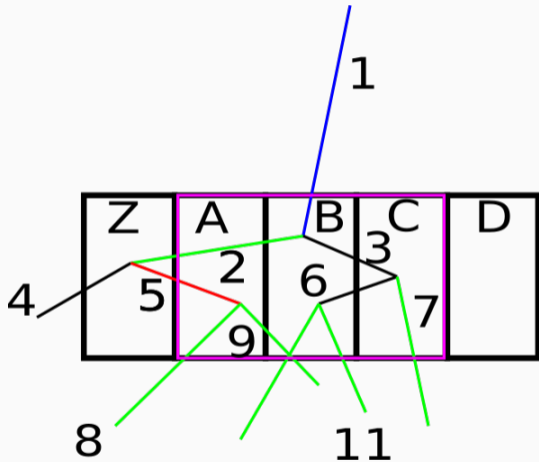


Same Shower using MCHits

- some shower-internal PndMCTracks falsely labeled as entering tracks

Monte-Carlo Truth propagation for the EMC: Cluster made of Digis

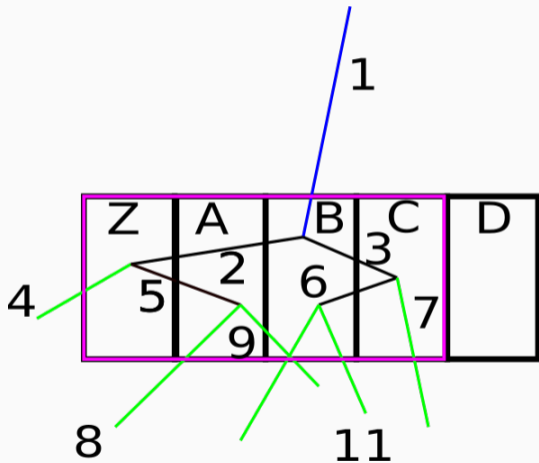
- Crystals Z, A, B and C are hit by the shower
- Crystals A, B and C are part of the cluster (violet enclosure) (Z below our threshold of 3 MeV)
- I only want to get track 1 to be classified as entering but I believe I also get tracks such as track 5



tracks: blue - entering, green - exiting, red - unwanted, black - not interesting

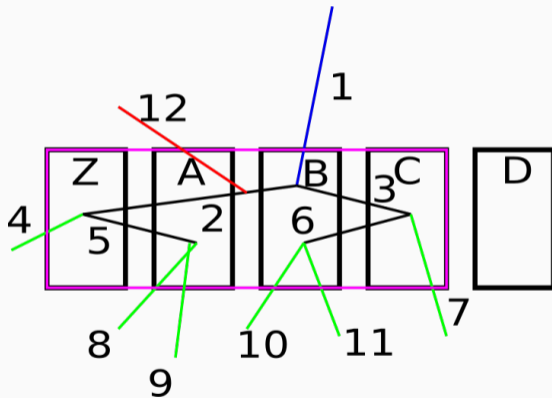
Monte-Carlo Truth propagation for the EMC: Cluster made of MCHits

- we slightly decrease the number of entering tracks
- but we still get a lot more tracks than expected :-)
- our picture is too simplistic

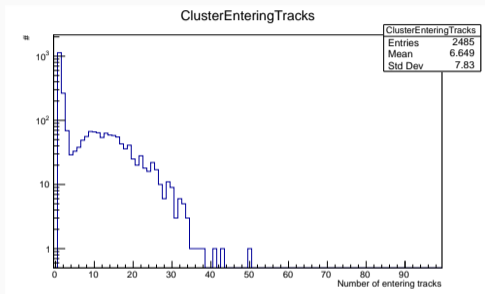


Monte-Carlo Truth propagation for the EMC

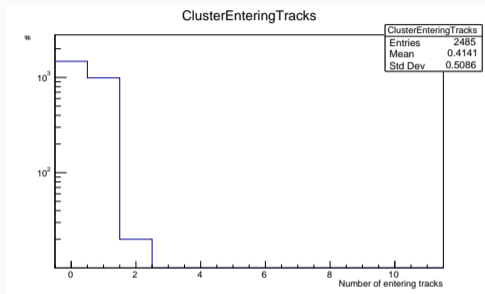
- having a closer look at the remaining tracks:
 - we still have a lot of tracks entering
 - the ancestors of most of these already entered the cluster
 - tracks (I believe Bremsstrahlphotons?) are occasionally radiated off in passive material between our crystals (such as track 12)
- I throw away entering tracks whose ancestors already entered the cluster



Comparison



Old



New using MCHits to determine entering
Tracks and passing those to the Digi
Cluster

Single 2 GeV photon

Maxima and Cluster level PndMCTrack matching: 2 photon events

500 2 2 GeV photon events simulated and shot at $\theta = 13 - 17^\circ$ and $\phi = 93 - 97^\circ$

805 Maxima matched to:

- 568 photons
- 207 multi hits
- 26 split offs
- 2 electrons
- 2 positrons

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We can “expand” the Maxima info to classify our 1499 seen digi cluster:

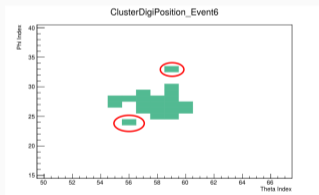
- 996 without a maximum
- 253 with two photon maxima
- 188 with one multi hit maximum
- 24 with one single photon maximum
- 13 with two photon plus one split off maxima
- ...

Maxima and Cluster level PndMCTrack matching: 2 photon events

500 2 2 GeV photon events simulated and shot at $\theta = 13 - 17^\circ$ and $\phi = 93 - 97^\circ$

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- ...

Event level PndMCTrack matching: 2 photon events

500 2 2 GeV photon events simulated and shot at $\theta = 13 - 17^\circ$ and $\phi = 93 - 97^\circ$

- 252 double photon events
- 188 one multi maximum events
- 13 single cluster with two photon and one split off maxima events
- 22 single photon events?
- 25 other events

The majority of determined event types do seem plausible, besides a few events only registering a single gamma.

Summary

- new geometry on a good way
- restructuring ongoing
- narrowed down PndMCTrack-Cluster assignment for selection of interesting events

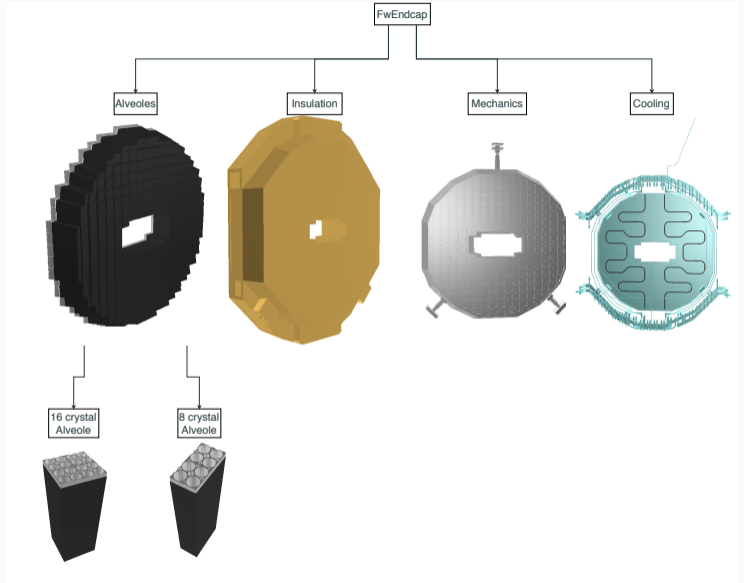
Outlook

- finalize the debugging of the geometry
- move EMC restructuring on to be able to push it
- want to start with having a closer look at and play around with split-offs

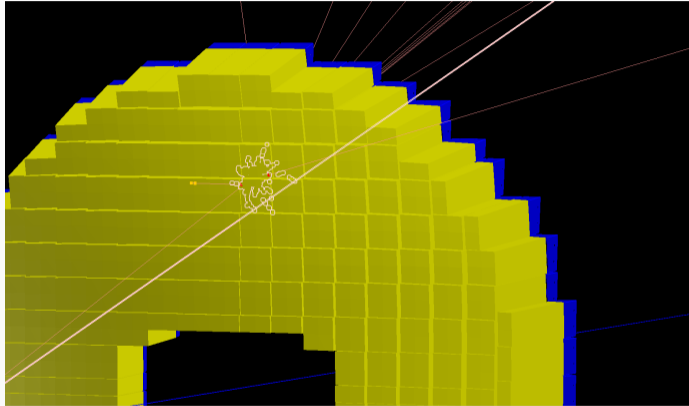
Appendix

Structuring the geometry definition by including scripts in scripts:

- easy to replace, ex- or include specific parts
- debugging easier
- easy to make stand-alone geometries out of a script



“Single” photon event in 2 photon simulation



One photon seems to travel mainly between two Alveoles, hardly touching a crystal. In the ϕ range of $93 - 97^\circ$ this seems to be rather “common”.