Simulations concerning the Forward Endcap calibration at COSY

Cosmic based gain check and a brief look at π^0 peaks

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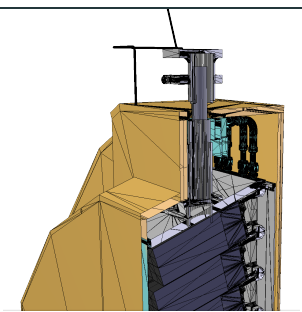
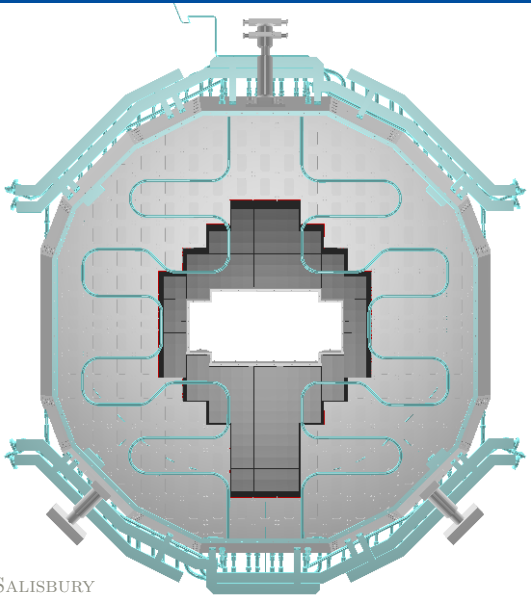
HISKP – University Bonn



Cosmic based gain check

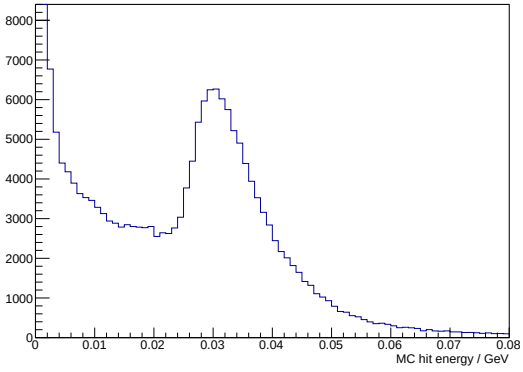
- In the past we wanted to do a gain check for the assembled crystal before the actual beamtime. Sadly, that will not be possible.
- Idea was: Approximate ADC to energy conversion value by using Cosmic minimal ionizing peak
  - Simulate Cosmic data to create crystal specific energy distribution
  - Fit these crystal distributions (energy domain) to the measured “ADC” data

New Simulation geometry



- Created a new FwEndcap simulation geometry specific for the COSY setup
- Passive material (mechanics, cooling and insulation (not shown)) as well as the currently assembled Alveoles

Cosmics - Energy Spectra



- Use the CRY-library to sample realistic cosmic primary particles
- Collect energy deposits within individual crystals to create crystal specific energy spectrum
- Clear, identifiable minimal ionizing peak at around 30 MeV

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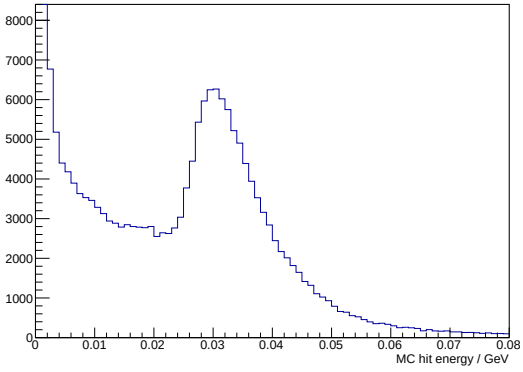

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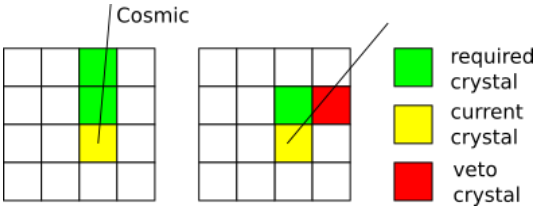
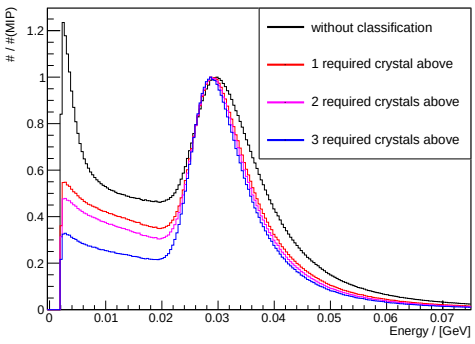
- Clear, identifiable minimal ionizing peak at around 30 MeV
- During a Bachelorthesis: Can we reduce background?

Cosmics - Track classification

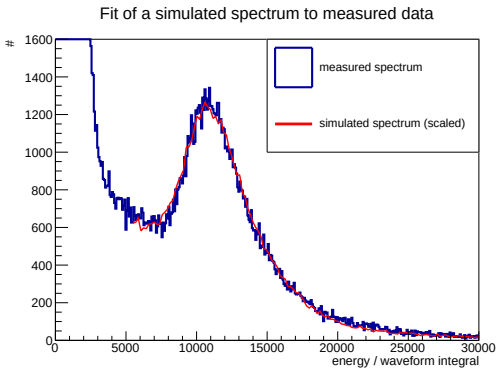


- Use energy depositions only, if track went straight through crystals

Cosmics - Track classification



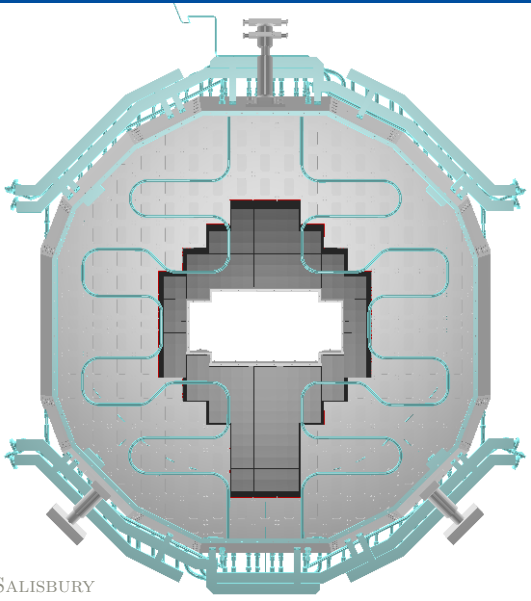
- Use energy depositions only, if track went straight through crystals
- Increases signal to background ratio (costing us statistic)
- Peak moves slightly to lower energies
- Nice to have, not really necessary though



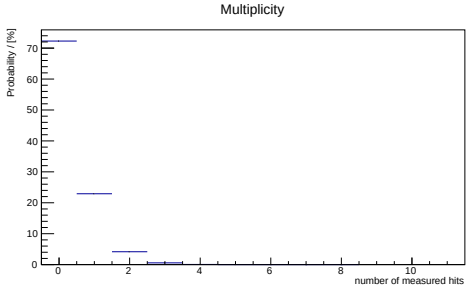
- Fitting the simulated spectra to the measured spectra then yield our conversion factor!
- Gathering enough statistics lies in the order of a couple of days (extrapolating from our teststation tests)
- Potential helpful addition for edge/corner crystals or for crystals later shielded by Barrel crystals where the π^0 may fail

π^0-calibration: Our actual goal

- With the significantly reduced FwEndcap: Will we see peaks?
- I only briefly looked at the π^0 peaks for the **reduced** FwEndcap
- I used Lukas Linzen's implementation of pp and $pn \rightarrow X$ channels for the Pluto generator to create realistic signal and background data.
- I only looked at a proton beam kinetic energy of 2.5 GeV as Lukas advises in his Masterthesis and COSY beam proposal.
- I simulated roughly 75 million pp as well as 75 million pn events and added those two event sets together

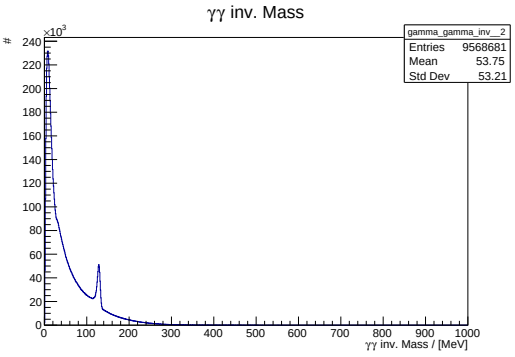


- due to severly limit angular coverage most of my $\sim 2 \cdot 75$ million events $pp/pn \to X$ miss the FwEndcap



- due to severly limit angular coverage most of my $\sim 2 \cdot 75$ million events $pp/pn \to X$ miss the FwEndcap
- nonetheless, when we see 2 or more particles, we can form the invariant mass of the combinations

π^0-calibration - pp/pn at kinetic energy of $\sim 2.5\,\mathrm{GeV}$



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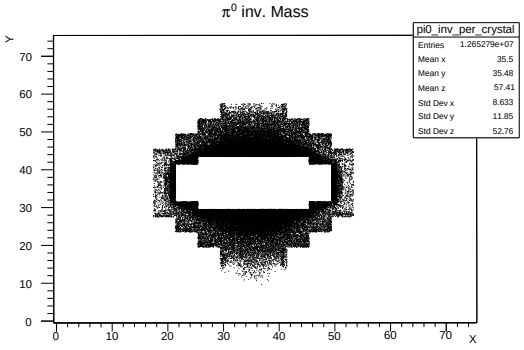
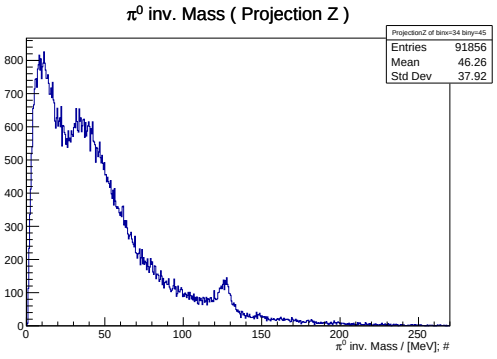


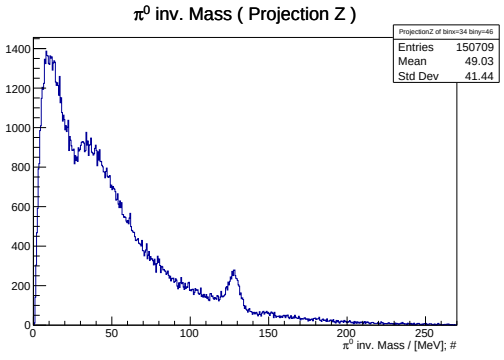
- due to severly limit angular coverage most of my $\sim 2 \cdot 75$ million events $pp/pn \to X$ miss the FwEndcap
- nonetheless, when we see 2 or more particles, we can form the invariant mass of the combinations
- and plot them for each individual crystal

π^0-calibration - VPTT crystals



- π^0 as seen by crystal X: 34 (middle), Y: 44 (at beampipe)

π^0-calibration - VPTT crystals



- π^0 as seen by crystal X: 34, Y: 46

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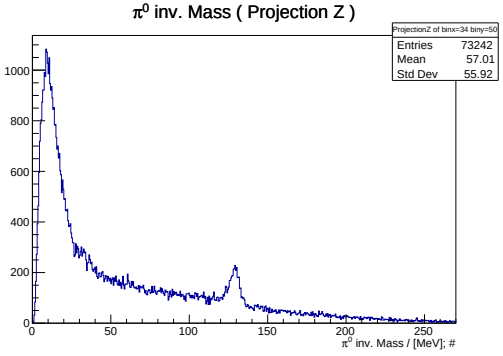

- π^0 as seen by crystal X: 34, Y: 50

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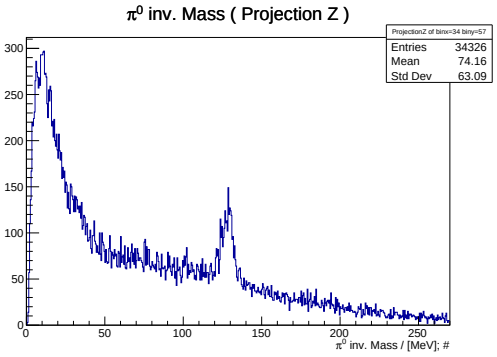
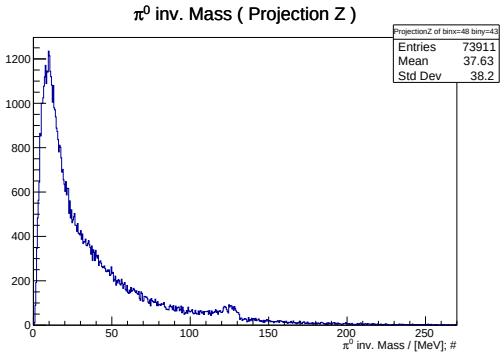


- π^0 as seen by crystal X: 34, Y: 57 (outer edge)

π^0-calibration - VPTT crystals



- π^0 as seen by inner beampipe corner crystal

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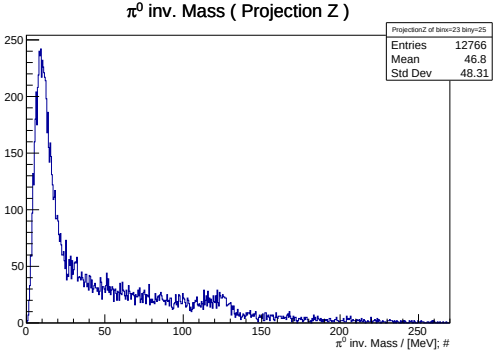
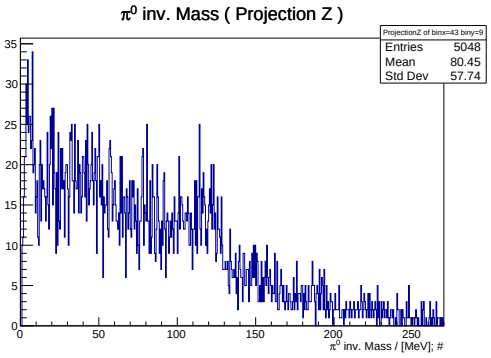


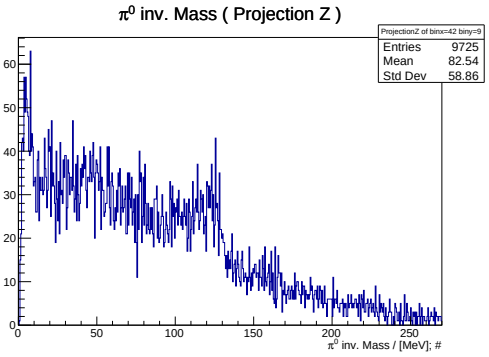
- π^0 as seen by outer corner crystal

- It may be difficult to calibrate the edge and corner VPTT crystals.
- However, the lowest row of additional APD crystals seems more problematic ...

π^0-calibration - APD crystals



- π^0 as seen by APD crystal (lowest row, left corner)



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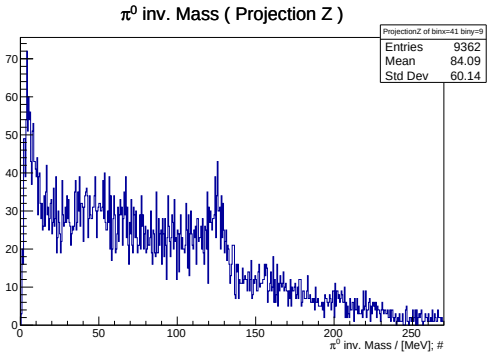
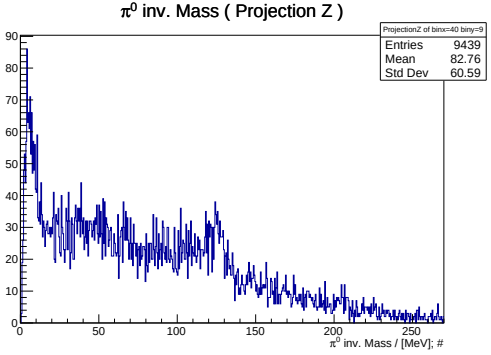


- π^0 as seen by APD crystal (lowest row, third from the left)

π^0-calibration - APD crystals



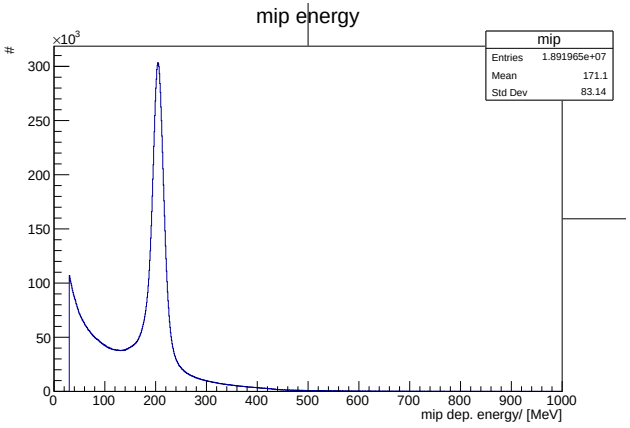
- π^0 as seen by APD crystal (lowest row, fourth from the left)

- Calibration here may still be possible: The hope is, that we can take a full week worth of data at a datarate of 1000 events per second, which would yield roughly 600 million events, a factor 4 more than I simulated

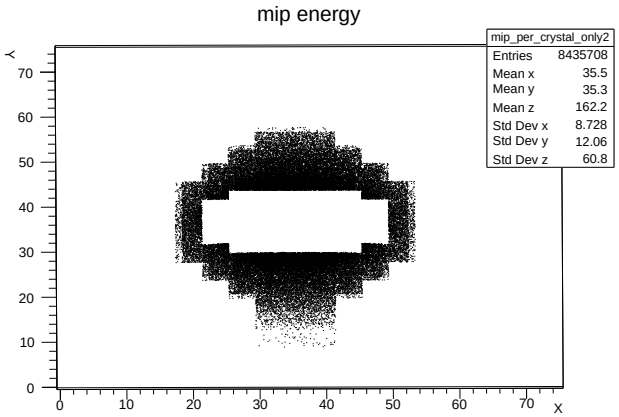
Nonetheless: Backup option?

- Minimal ionizing particles (mips) ($\pi^{+/-}$) may help to gain an additional calibration point for those crystals where a photon calibration may be unsuccessful.

minimal ionizing particles - *pp*/*pn* at kinetic energy of $\sim 2.5\,\mathrm{GeV}$



- Reconstructed hits with 1 or 2 crystals that have seen energy
- Clear peak structure at around 200 MeV
- Using 1 crystal cluster would form narrower peaks, but we would have problems for the lowest row of APD crystals (statistics and angle)



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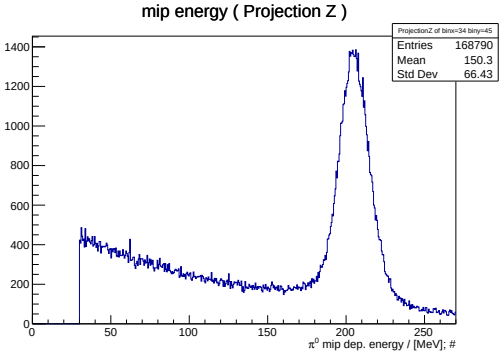

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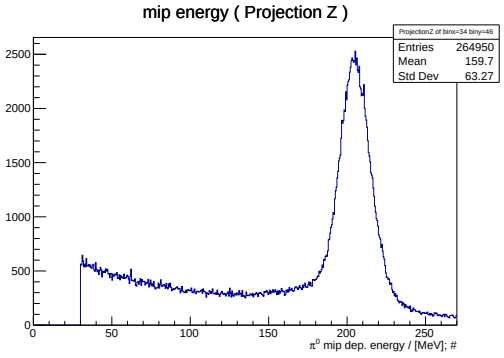
minimal ionizing particles - VPTT crystals



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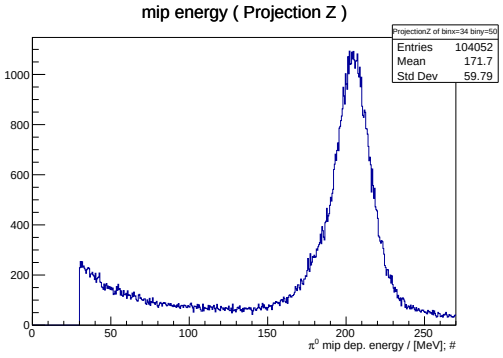

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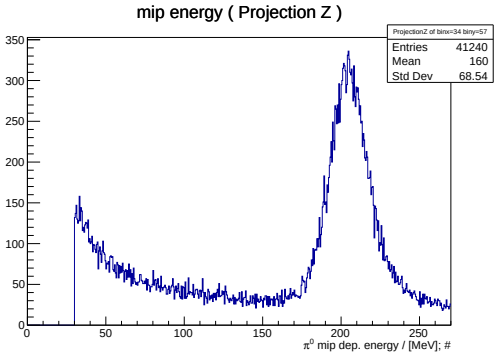

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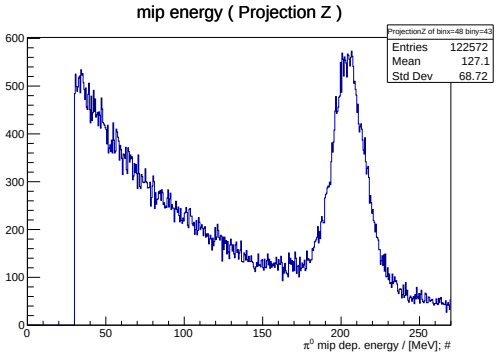

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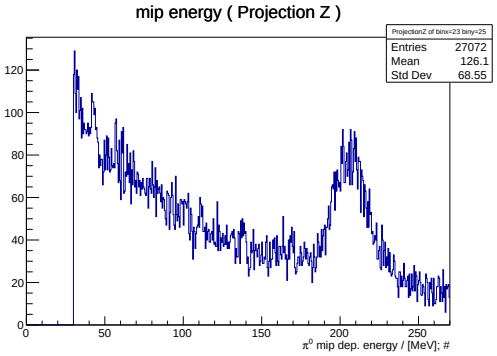
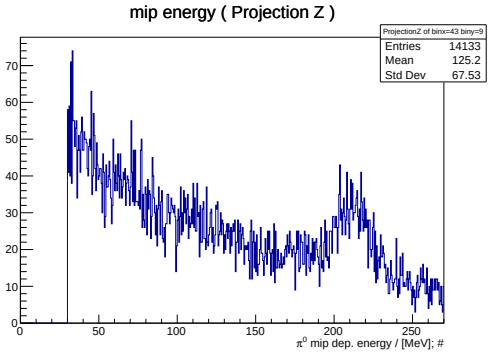
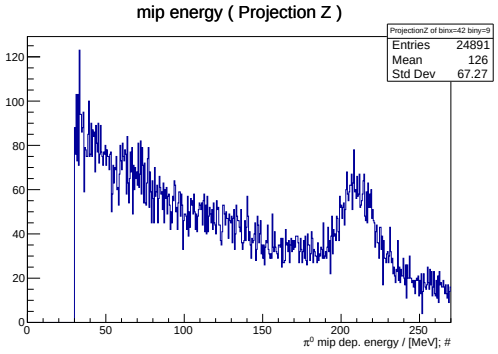


- mip as seen by outer corner crystal



- mip as seen by APD crystal (lowest row, left corner)

π^0-calibration - APD crystals



- mip as seen by APD crystal (lowest row, second from the left)

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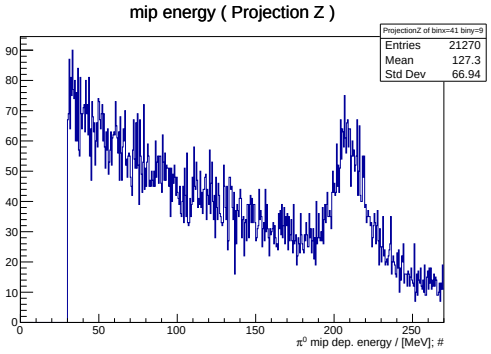

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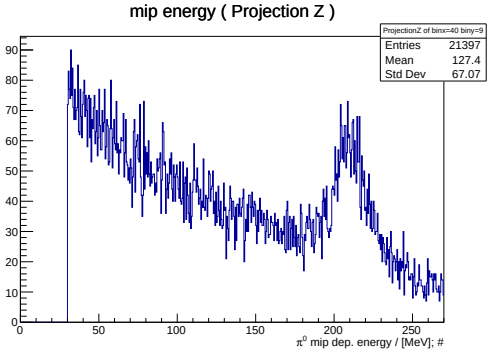

- mip as seen by APD crystal (lowest row, fourth from the left)

- mip clearly visible in all our crystals
- We can use the mip analog to the Cosmic peak just at an higher energy.

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Summary

- Cosmic peak is being investigated and is an easily accessible additional calibration point
- I would be carefully optimistic that we will see a π^0 peak (for individual crystals) and can do a test calibration

Important addition

- We are particularly interested in the additional information we can gain concerning realistic **waveforms** for the VPTT and APD crystals, especially since we will see photon induced signals as well as from $\pi^{+/-}$. These are **vital** for PandaROOT simulation and learning more about our Feature Extraction