T-SDHCAL

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For the SDHCAL groups

Outline:

- ❑ Limitation of the high granularity for PFA

- ❑ Timing
  - ✓ Neutron cleaning
  - ✓ Showers counting and separation

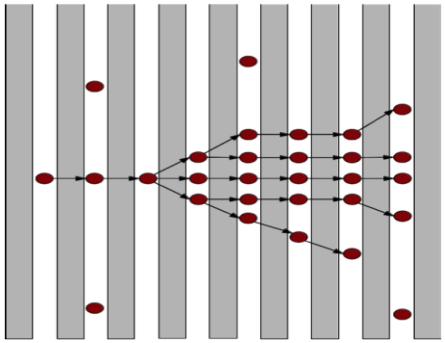
- ❑ MRPC performance
- ❑ MRPC for SDHCAL
- ❑ Readout electronics for T-SDHCAL

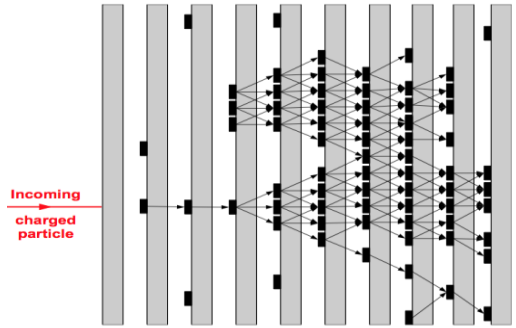
SDHCAL high granularity is essential feature of PFA

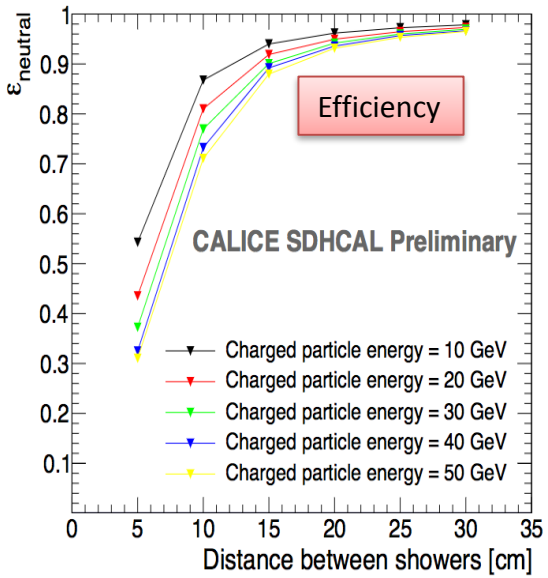
It helps to optimize the connection of hits belonging to the same shower by using first the topology and then the energy information

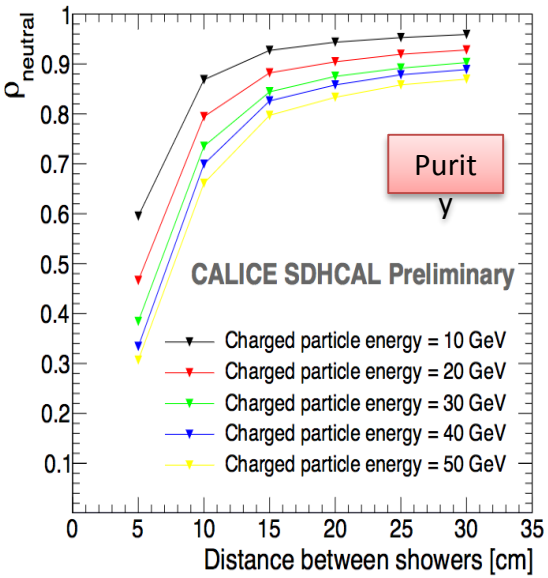
ArborPFA algorithm*:

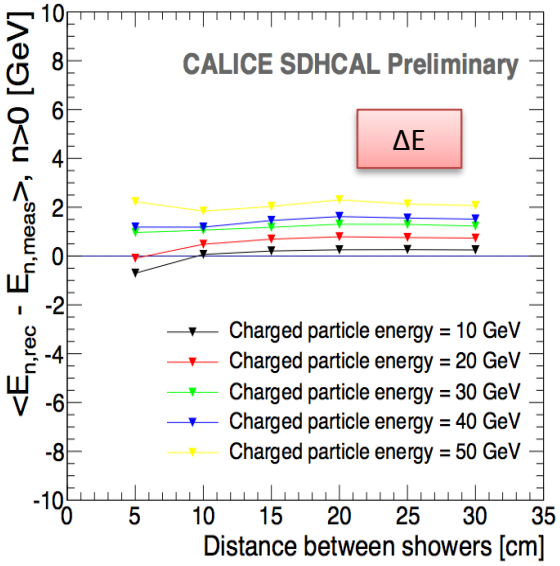
It connect first hits and then their clusters using distance and orientation information then correct using tracker information (momentum)







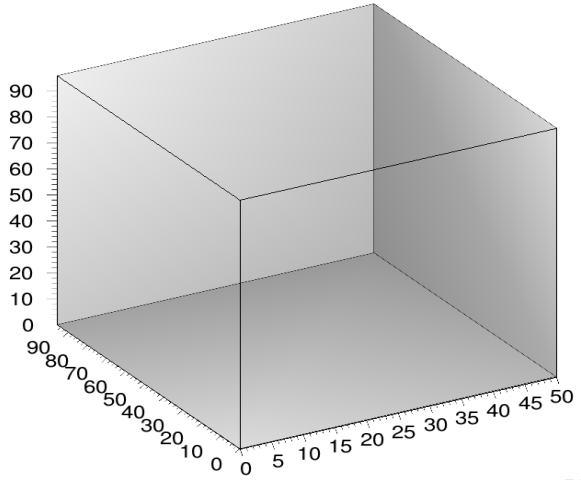


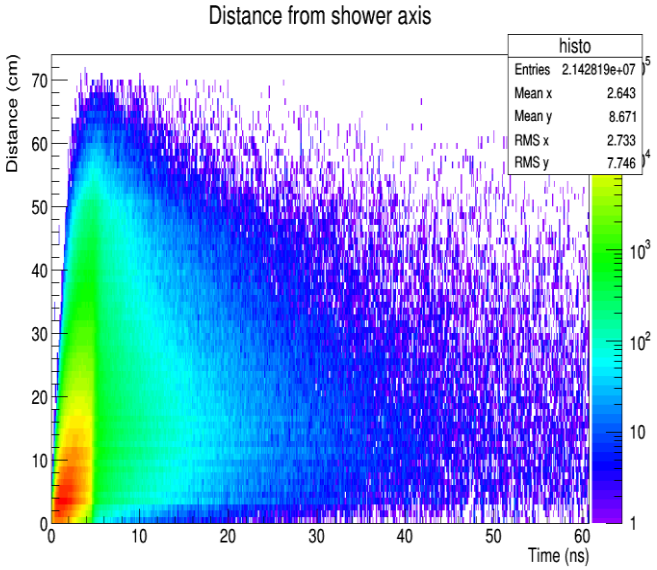


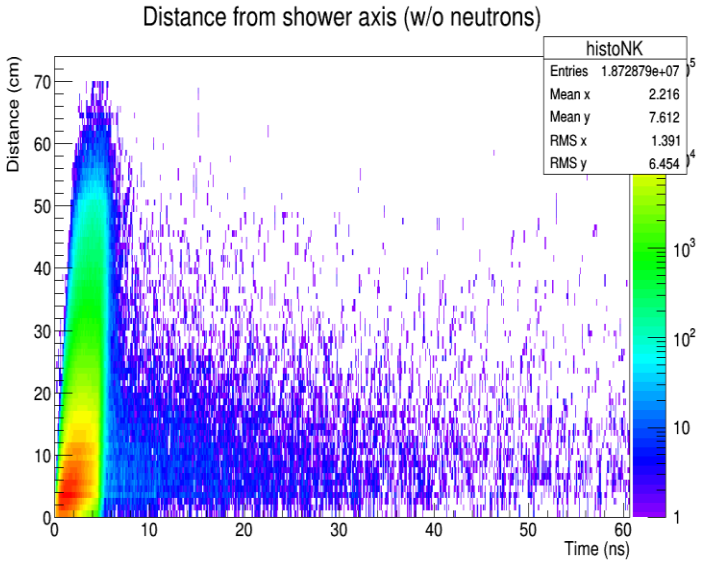
CALICE note CAN054

Timing

Timing could be an important factor to identify delayed neutrons and **better reconstruct their energy**

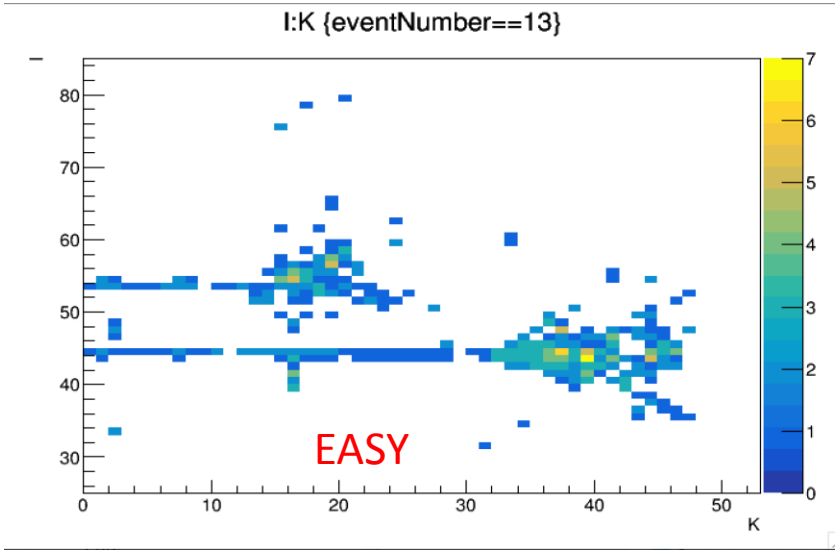


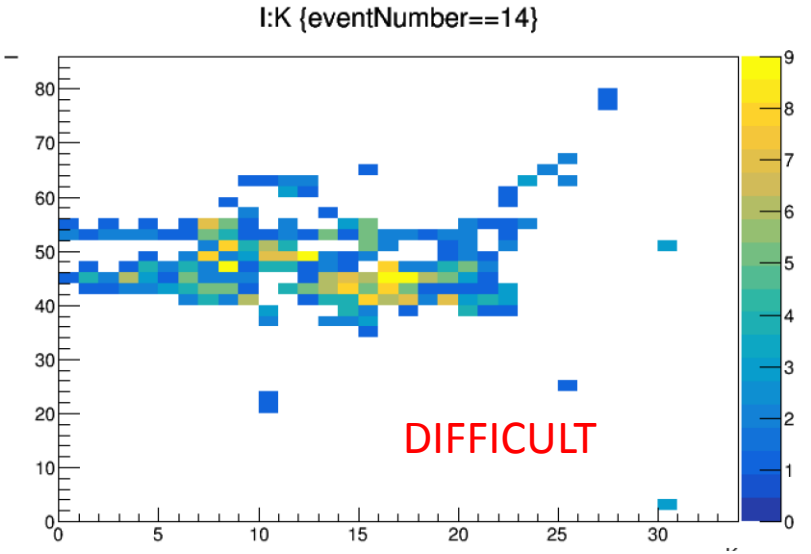


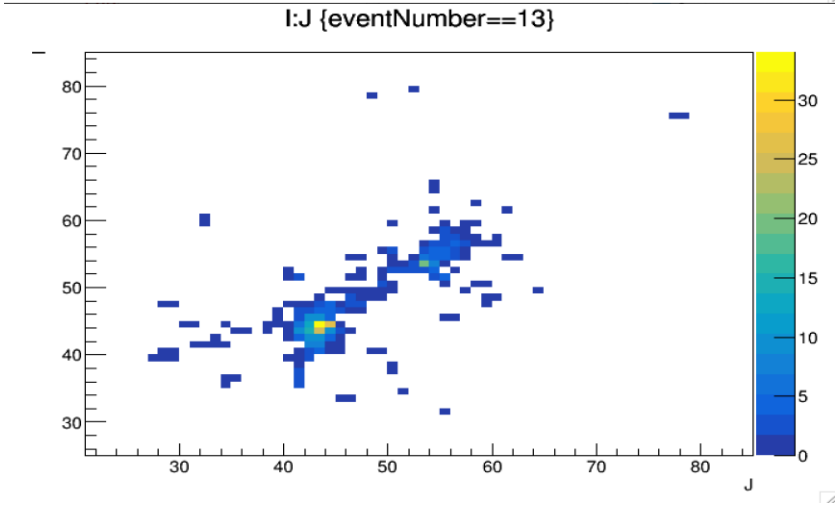


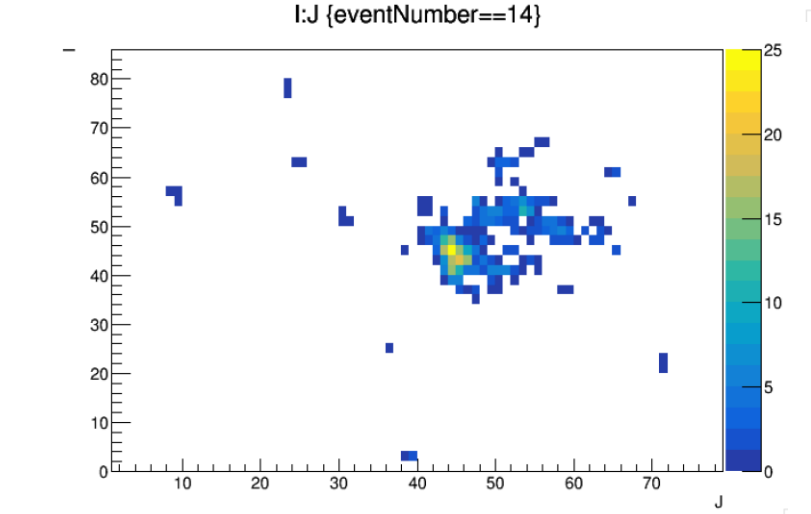
Timing

Time information can help to separate close by showers and reduce the confusion for a better PFA application. Example: pi-(20 GeV), K-(10 GeV) separated by 15 cm.

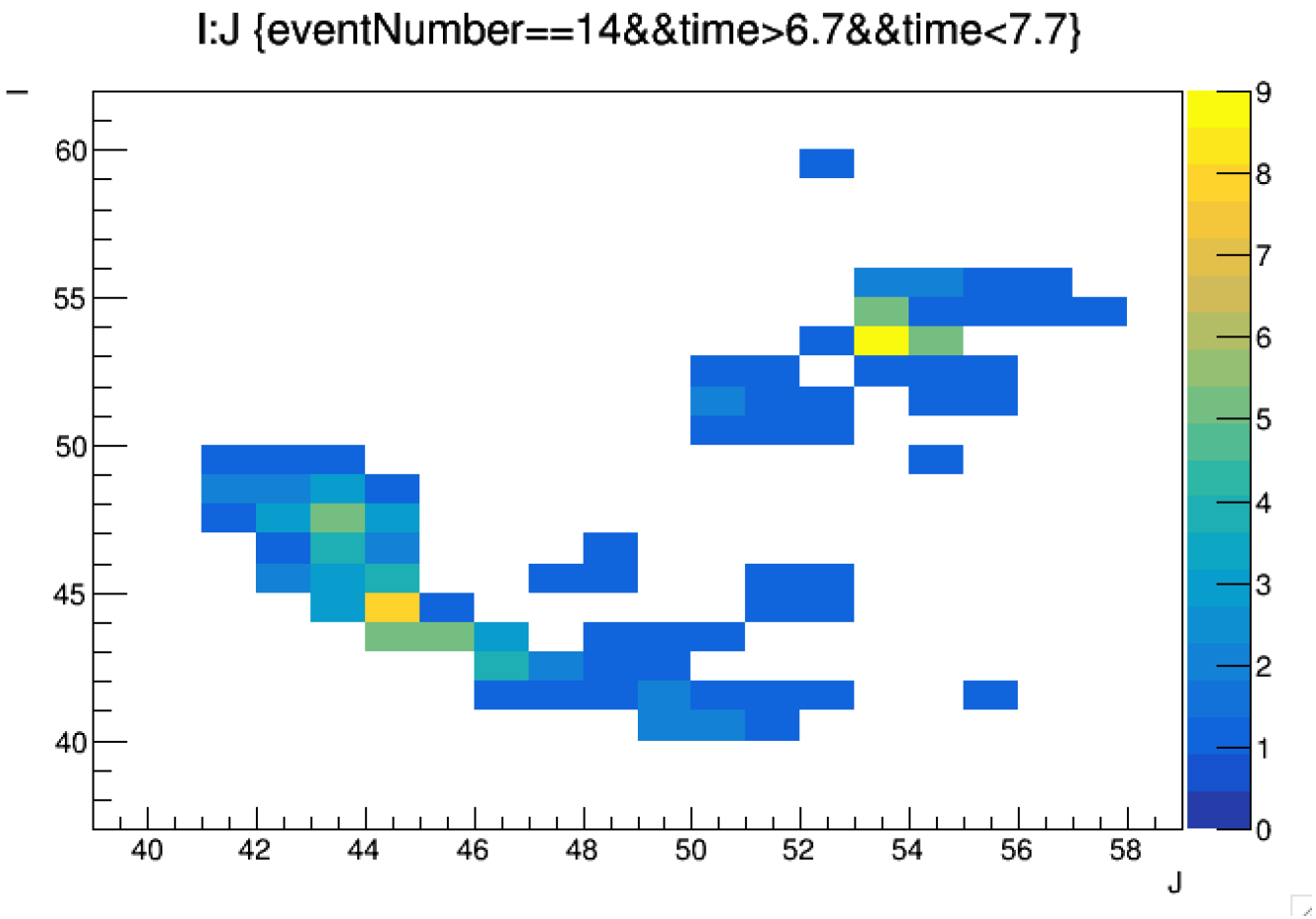




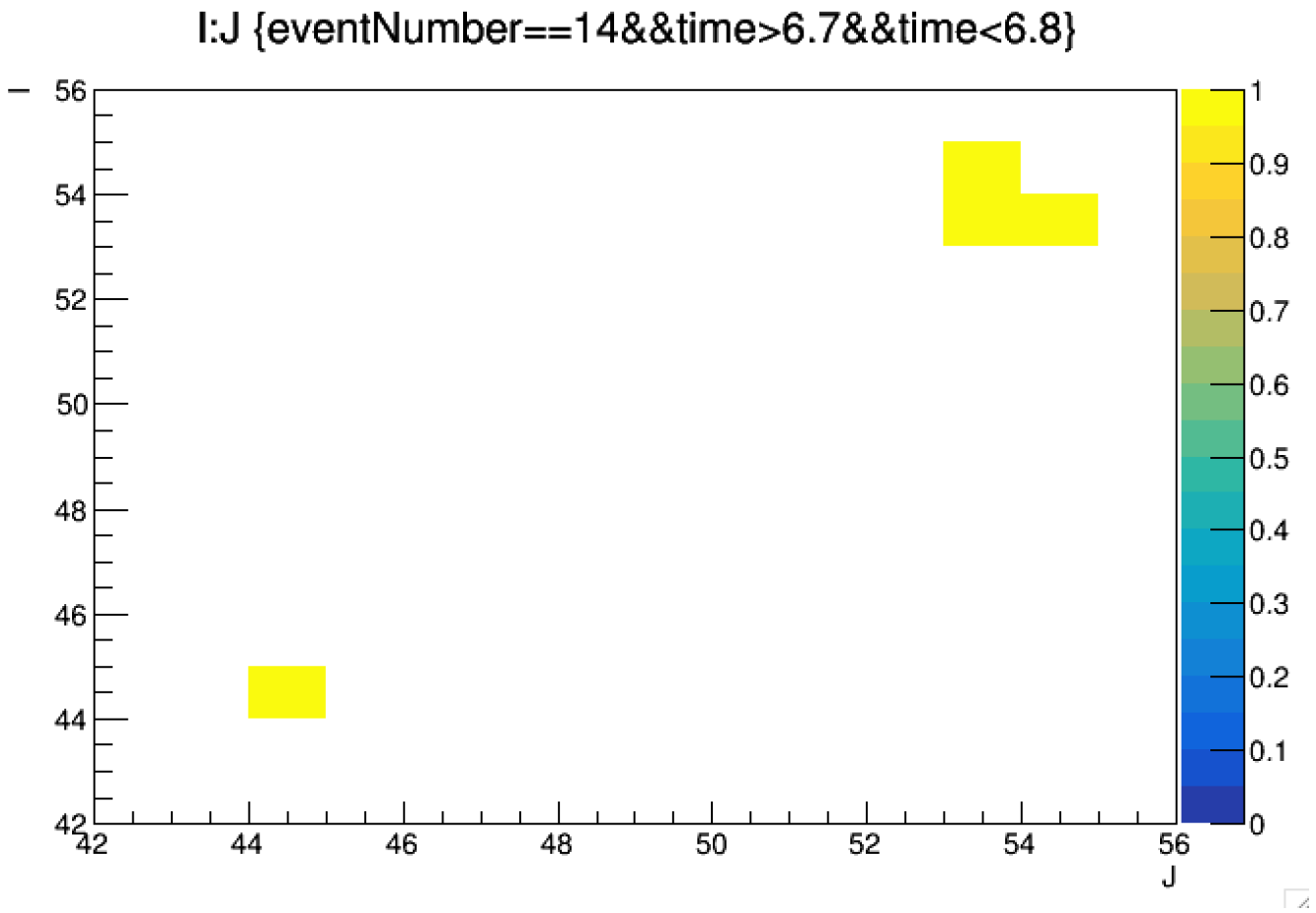




If we have 1 ns resolution



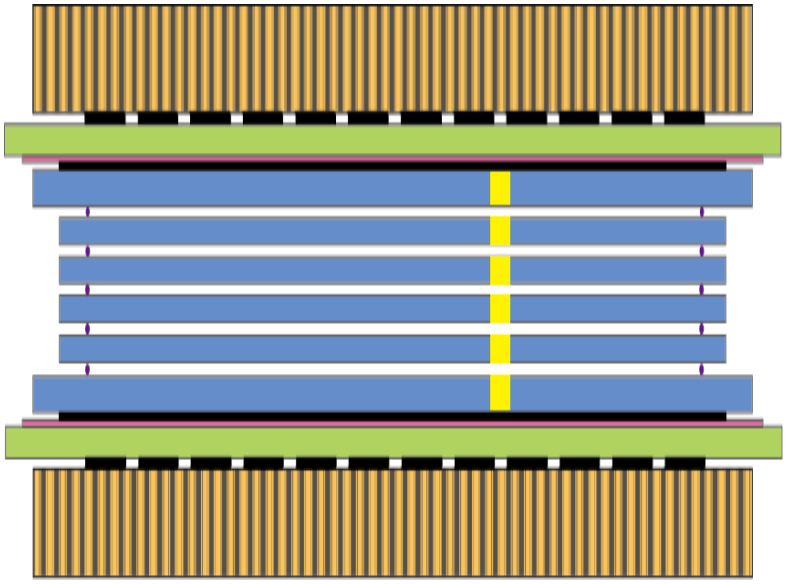
If we have 100 ps resolution

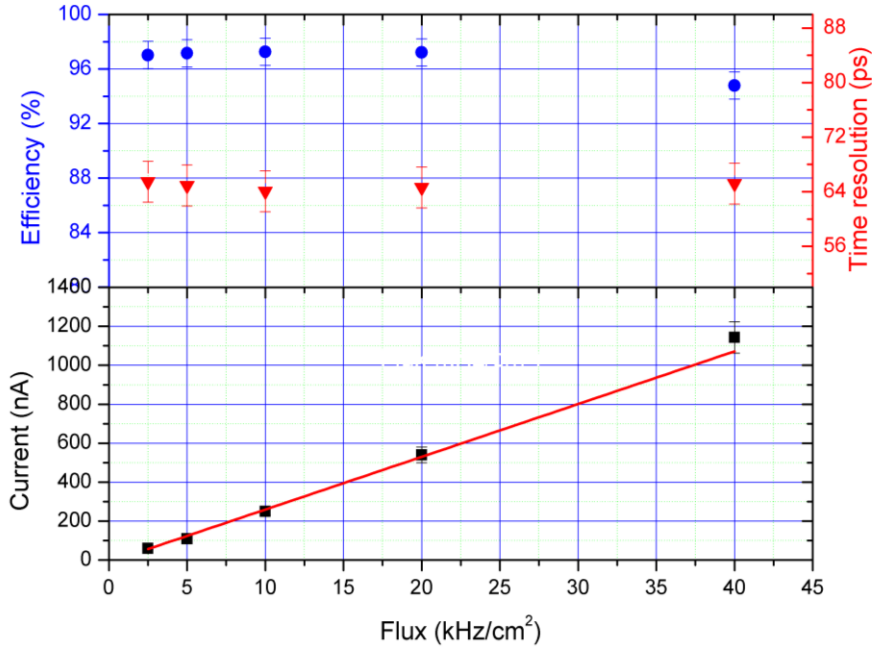


How to achieve an excellent time resolution:

- Multi-gap RPC are excellent fast timing detectors

Time resolution of better than 100 ps was obtained with 5-gap RPC by Tsinghua group





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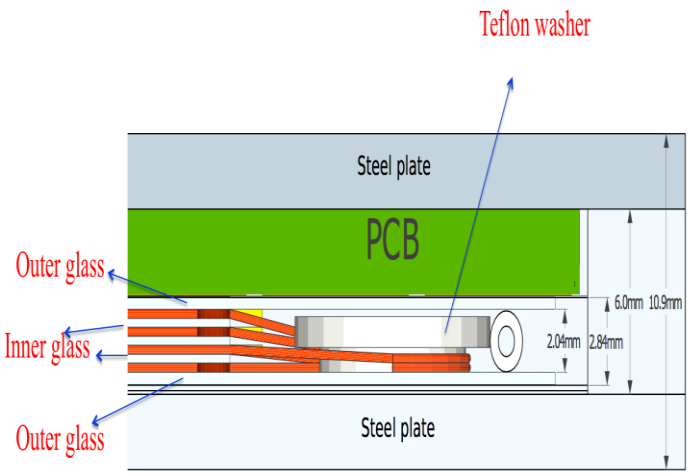
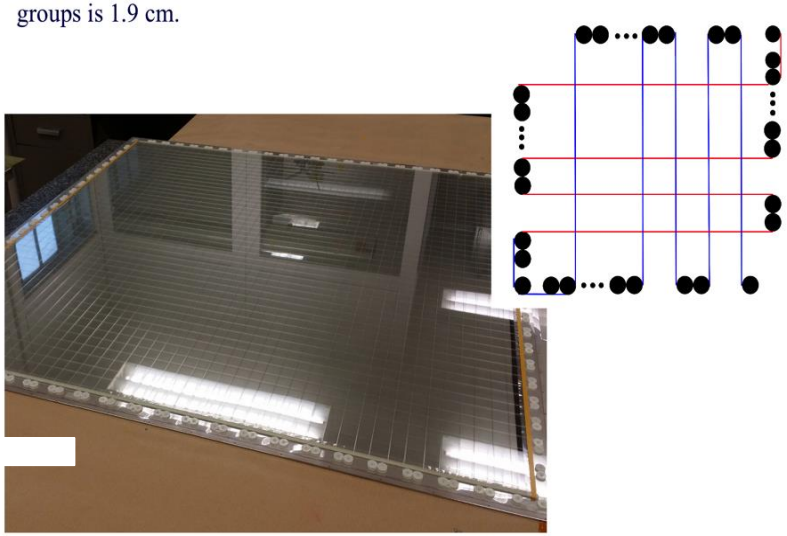
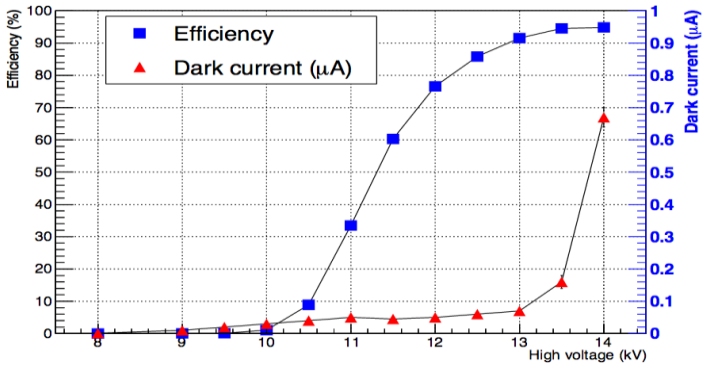


groups is 1.9 cm.





Threshold sets at 114 fC

NIMA, volume 871,
November 2017,113-117

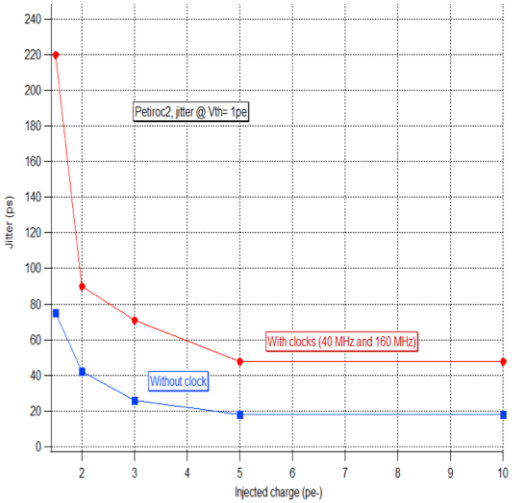
How to achieve an excellent time resolution:

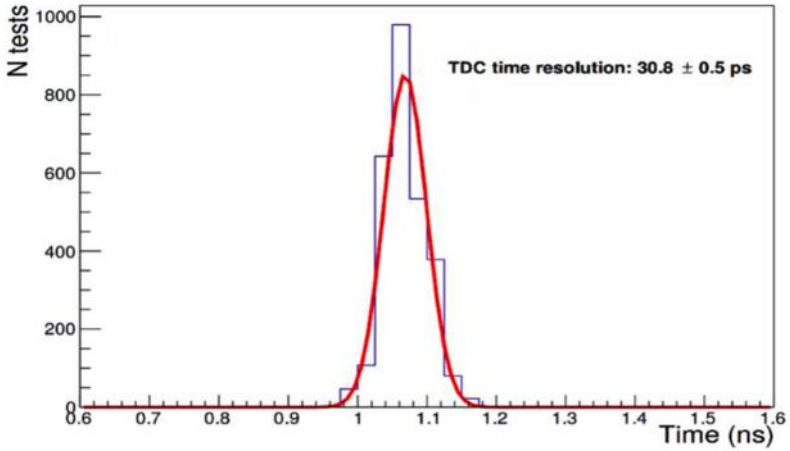
- An ASIC with a fast preamplifier, precise discriminator and excellent TDC

→PETIROC 32-channel, high bandwidth preamp (GBWP> 10 GHz), < mW/ch, dual time and charge measurement (Q>50 fC)

jitter < 20 ps rms @ Q>0.3 pC

→ TDC (delay-line, Vernier,..etc)





Strategy to follow in the coming years

- Develop large MRPC (1 m x 1 m) with excellent time resolution
  (IP2I- GWNU)
- Develop large pickup pads PCB hosting both the PETIROC with TDC.
  Later use ToT if possible for "analog" readout (or still using several thresholds).
  (IP2I-SJT-OMEGA)
- Develop DIF boards
  (IP2I-CIEMAT)

→ Build several detectors and several electronics board to equip them
(GWNU-SJTU-GENT)

→ Develop a DAQ system allowing to read out both SDHCAL electronics (HR2) and the new ones that use PETIROC
(IP2I)

→ Replace some of the SDHCAL layers with the timing ones and check the G4 model validity for what concerns time information
(LPC-IP2I)

→ Replace all of the SDHCAL layers with timing ones (if funding)

Conclusion

- Timing is not just a nice toy. It is the 4th dimension and could be a powerful tool for PFA
- T-SDHCAL is a realistic project with several already tested components
- There is still much to do on the hardware side but also on the software
  For instance T-PFA→ longitudinal granularity could be reduced?

New comers (but also old ones) are welcome to join this new challenging adventure