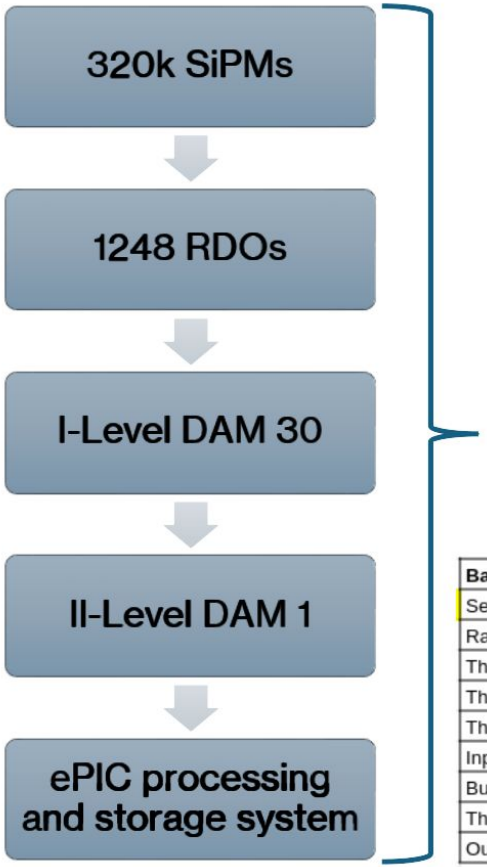
dRICH Interaction Tagger status

29/01/2025

Marco Battaglieri, Mikhail Osipenko, Vallarino Simone
INFN GENOVA

The high data throughput issue



dRICH DAQ parameters	
RDO boards	1248
ALCOR64 x RDO	4
dRICH channels (total)	319488
Number of DAM L1	27
Input link in DAM L1	47
Output links in DAM L1	1
Number of DAM L2	1
Input link to DAM L2	27
Link bandwidth [Gb/s] (assumes VTRX+)	10
Interaction tagger reduction factor	1
Interaction tagger latency [s]	2,00E-03
EIC parameters	
EIC Clock [MHz]	98,522
Orbit efficiency (takes into account gap)	0,92

Bandwidth analysis		Limit
Sensor rate per channel [kHz]	300,00	4.000,00
Rate post-shutter [kHz]	55,20	800,00
Throughput to serializer [Mb/s]	34,50	788,16
Throughput from ALCOR64 [Mb/s]	276,00	
Throughput from RDO [Gb/s]	1,08	10,00
Input at each DAM I [Gbps]	50,67	470,00
Buffering capacity at DAM I [MB]	12,97	
Throughput from DAM I to DAM II [Gbps]	50,67	10,00
Output to each DAM II [Gbps]	1.368,14	270,00

Sensors Dark Count Rate

3 - 300 kHz (increasing with radiation damage → with experiment lifetime).

Detector throughput

14 - 1400 Gbps.

EIC bunch crossing

There is one bunch-crossing every 10 ns → bunch crossing rate of 100 MHz.

Interaction of physical interest

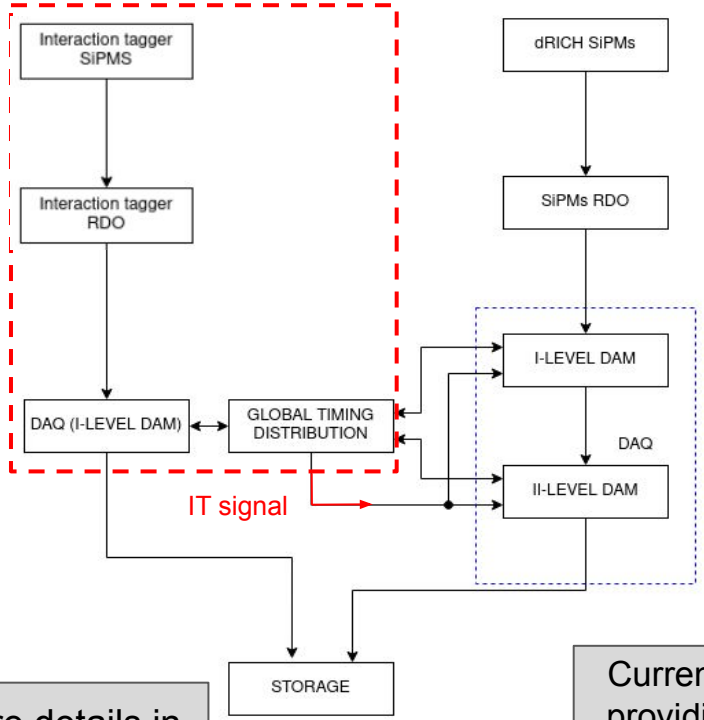
One every ~ 200 bunch crossing → interaction rate of 500 kHz.

A system tagging the interacting bunches can solve the throughput issue.

The ML guided data reduction system being developed by INFN RM1 is a complementary option to solve the issue.

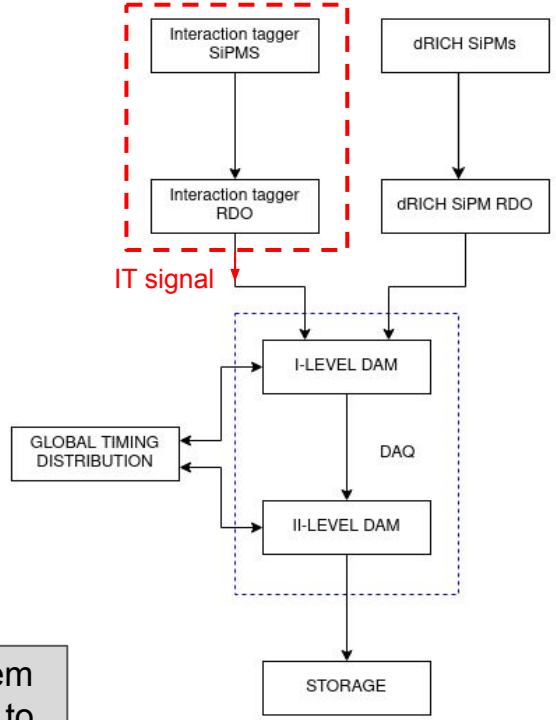
The dIT in the dRICH data stream

The dIT as global trigger of dRICH



More details in the next talk

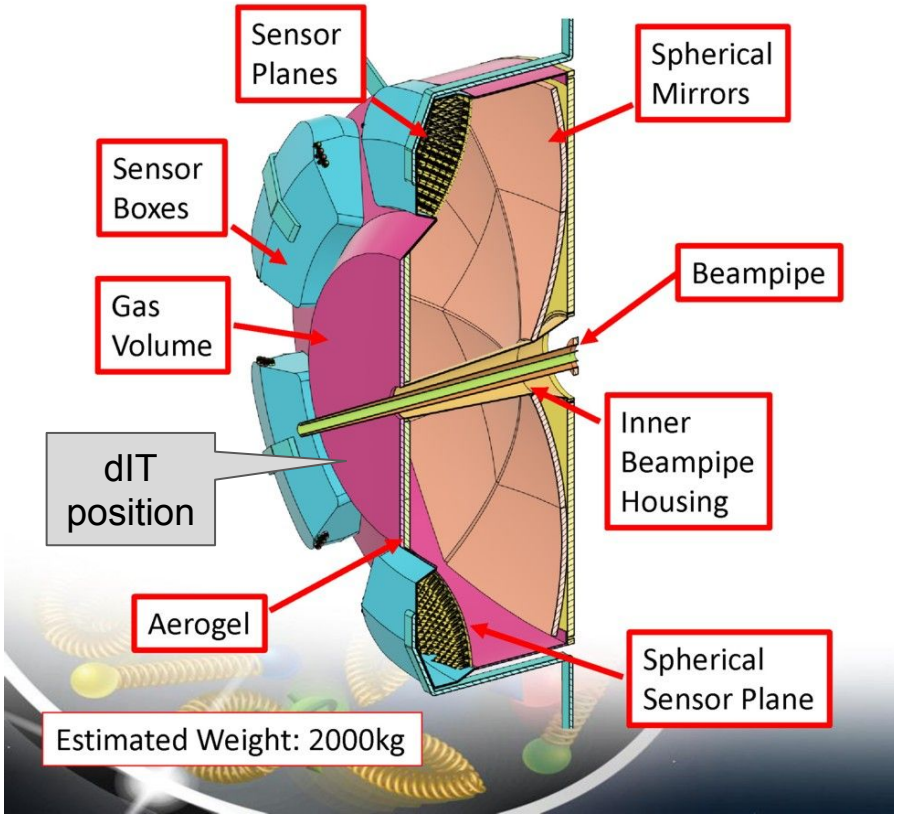
The dIT as an additive signal to dRICH DAQ



Current idea: to design a system providing both the possibilities to increase the detector redundancy

The dIT design hypothesis

dIT in dRICH overview



The dRICH Interaction Tagger (dIT) will be a scintillating detector-based component of the dRICH, designed to tag events in which at least one charged particle with sufficient energy passes through.

Requirements:

- High efficiency (no false negative)
- Good timing ~1 ns
- Reduction factor > 10

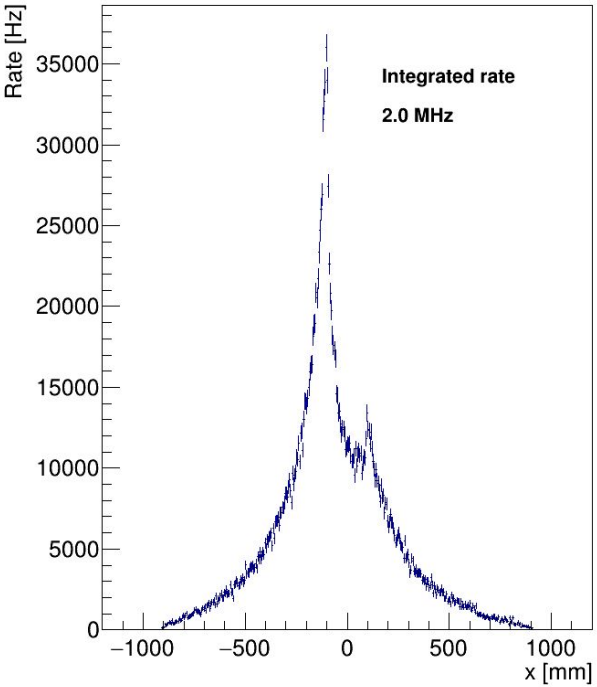
Two different options are being evaluated, based on Scintillating Fibers (SciFi) and plastic scintillator tiles.

Signal and BG rates on SciFi fibers

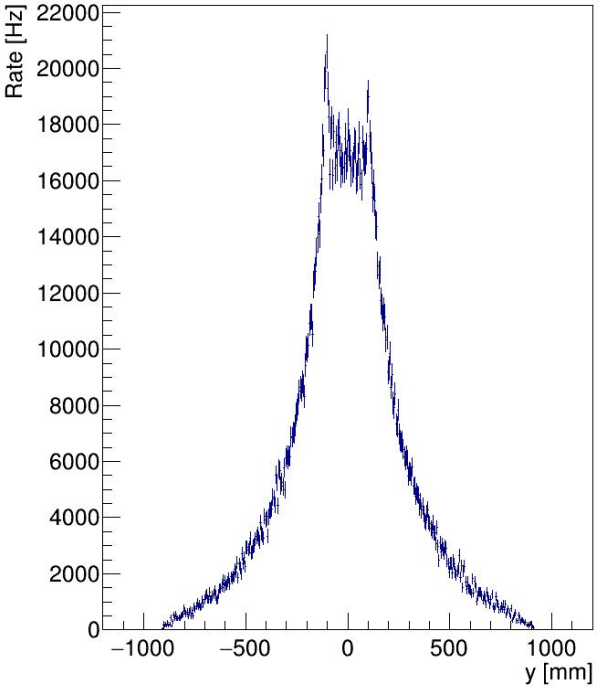
Based on July simulation

Signal rate (SIDIS events) on 5-mm diameter fibers. Maximum: ~36 kHz

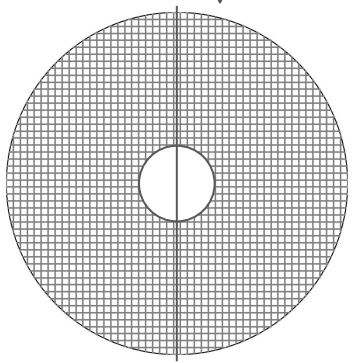
Vertical fibers - max 36 kHz



Horizontal fibers - max 21 kHz

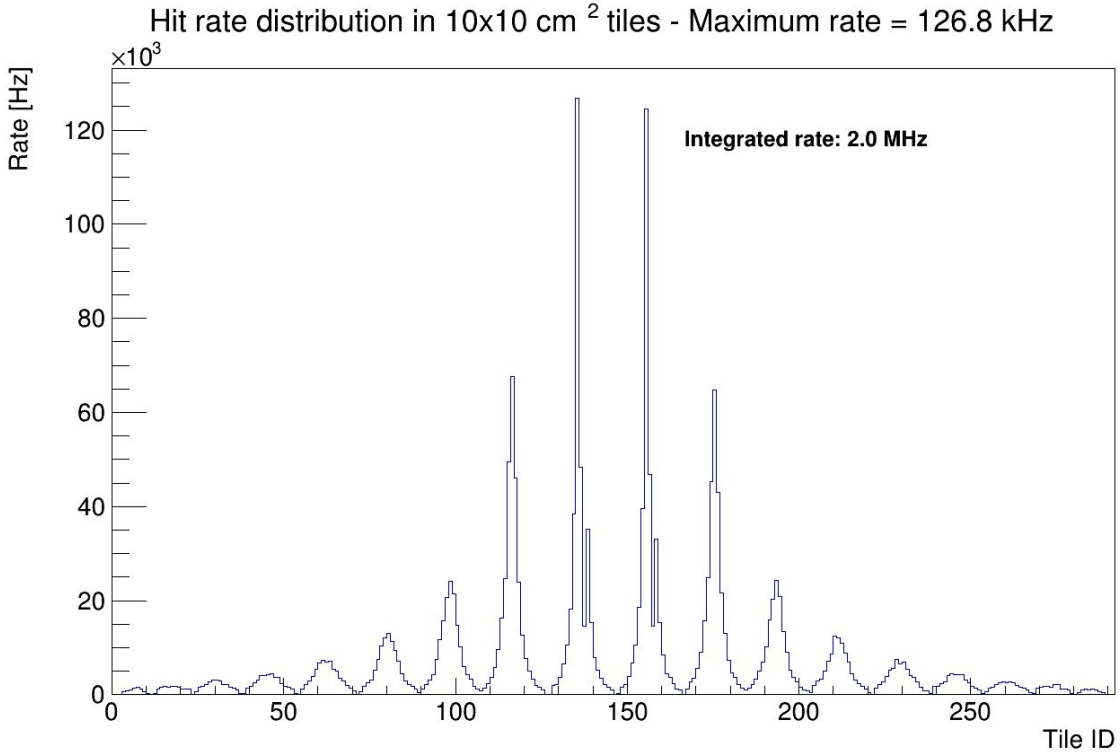


The 90° grid tessellation is considered

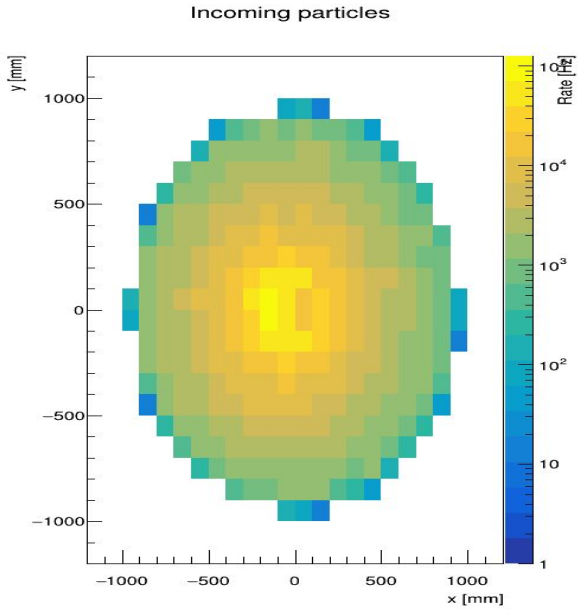


Signal and BG rates on tiles

Based on July simulation

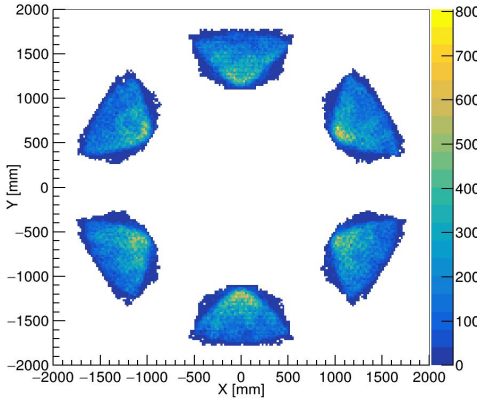


- Signal rates on 10x10 cm^2 tiles;
- Maximum rate = 127 kHz;
- Number of channels < 300;
- Position accuracy limited.

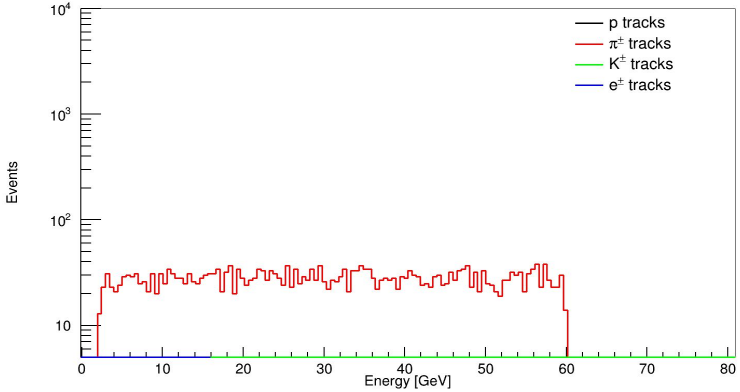


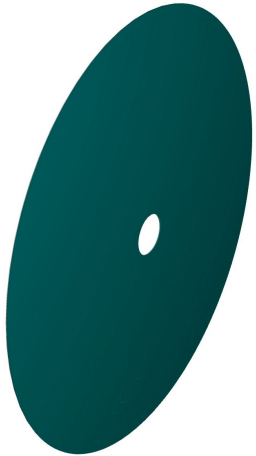
INFN Genova ongoing activities

dIT simulation



- dIT simulation has been implemented in DD4HEP (based on SciFi hypothesis);
- Recently some issues was solved;
- We are preparing a preliminary efficiency study.





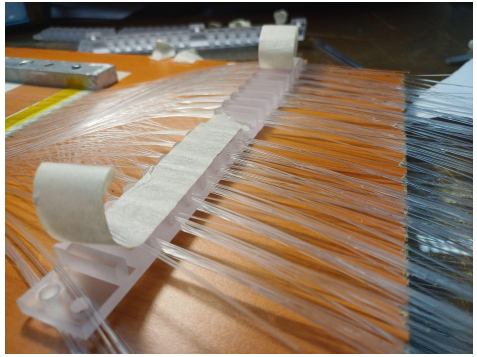
dIT geometrical efficiency

We evaluated the expected geometrical efficiency assuming the use of scintillating fibers.

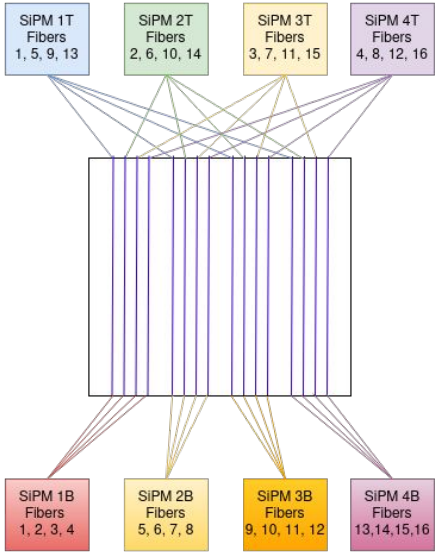
Hypothesis: Kuraray fiber, ⌀ 2 mm, cladding thickness 2%, glue layer 25 μm.

- Single fiber layer: ~95% efficiency for particles with trajectories normal to the surface.
- Double fiber layers (90° rotation): ~99% efficiency for particles with trajectories normal to the surface.
- Double fiber layers (0° rotation, 1 mm translation): 100% efficiency, but with partial loss of position resolution.

SciFi tracker prototype

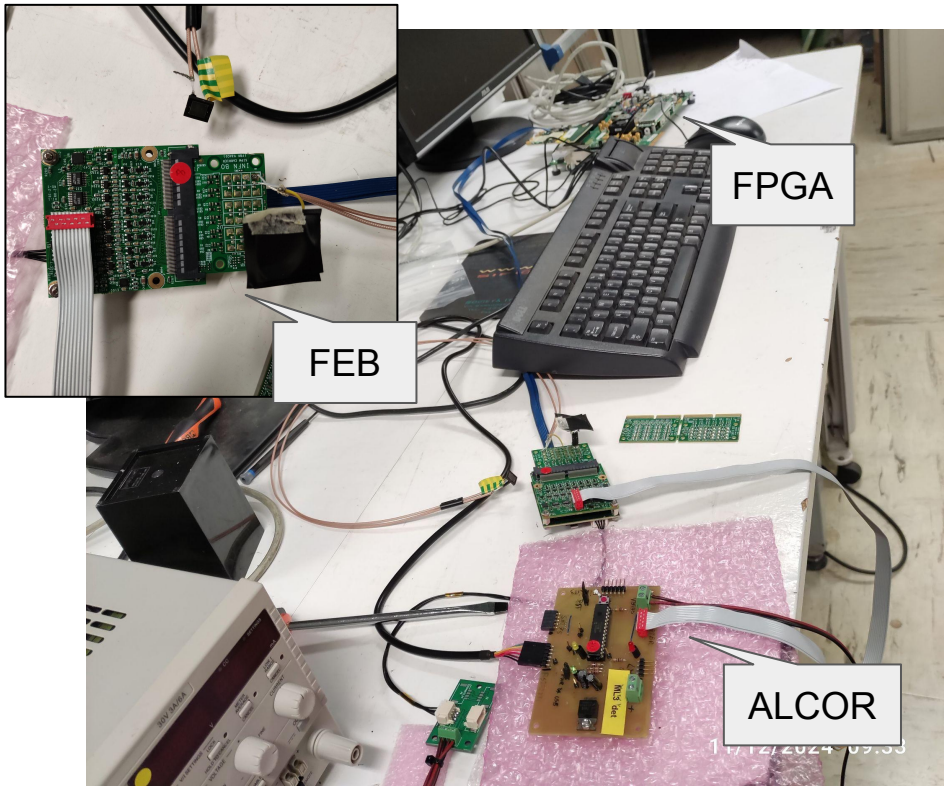


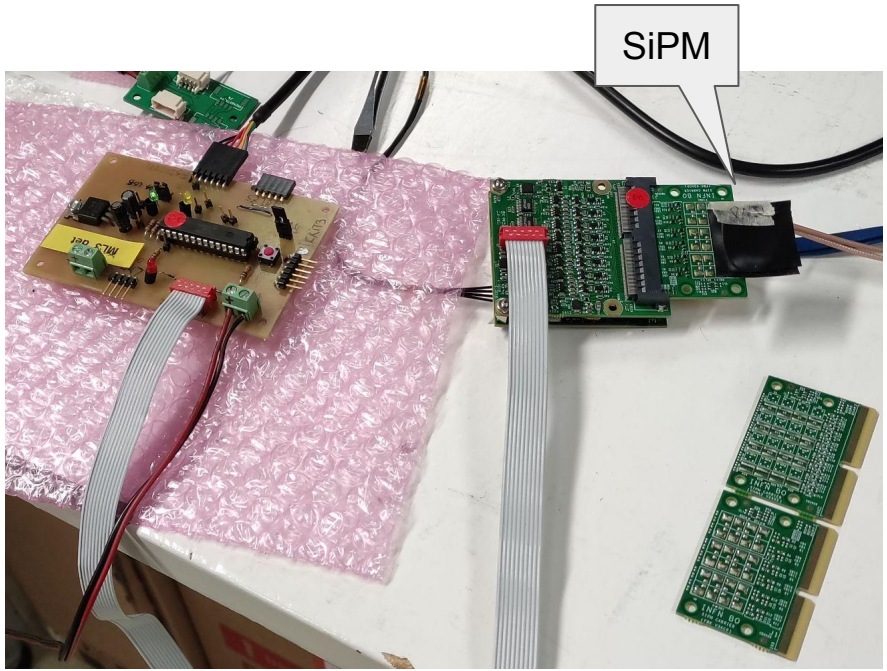
- 1 layer of tracker prototype based on 0.5 mm ⌀ SciFi;
- 10 cm →200 fibers.
- 32 channels;
- Designed to identify the exact fiber that fired.
- New 2 mm ⌀ fiber was ordered from Luxium. It will be used to measure the performance of this large-diameter fiber.



ALCOR DAQ chain

An ALCOR-based DAQ chain has been implemented in Genova, thanks to Roberto P. and Nicola R.

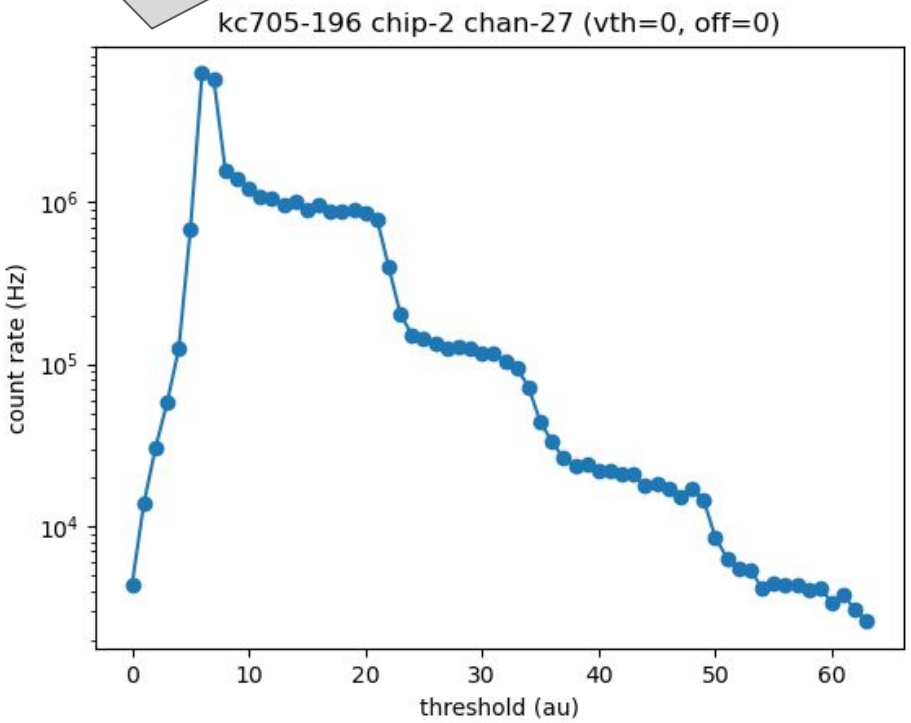




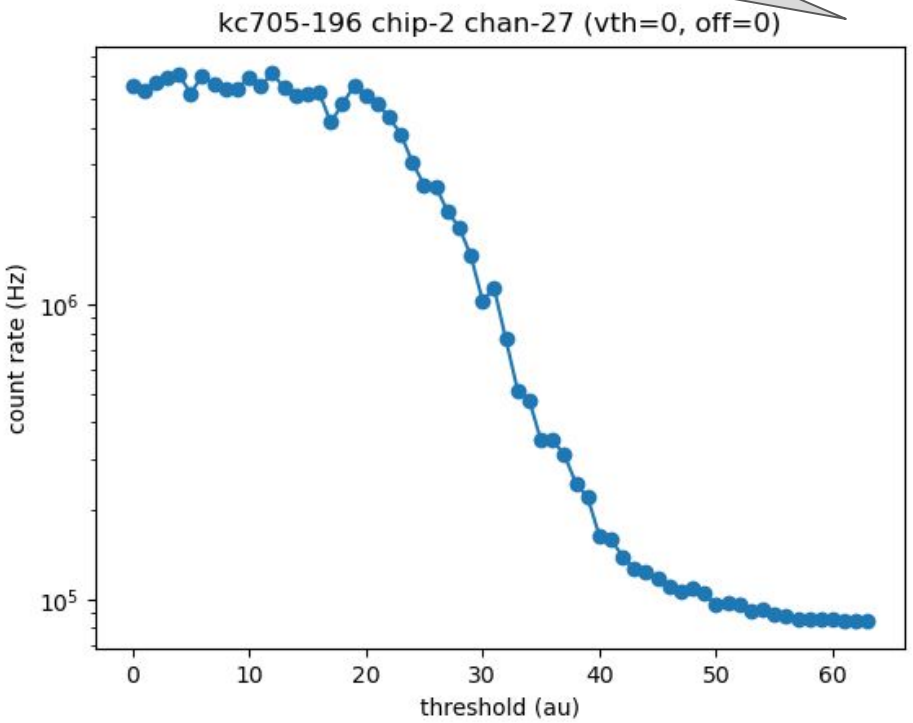
Connecting SiPM with our ALCOR DAQ

Ongoing studies aim to optimize its integration with our spatially distributed SiPMs.

Directly connected SiPM



45 cm cable connected SiPM



Conclusion and outlook

- The dIT is an effective solution for the dRICH data throughput issue.
- It can operate as stand-alone system or in combination with the ML algorithm being developed for the dRICH event selection.
- According to ePIC simulation, the dIT will enable a reduction factor ~ 50.
- Completing the dIT simulation will allow us to estimate the efficiency.
- Using the dIT simulation it is possible evaluate the geometrical resolution helpful for the dRICH data stream.
- The new 2 mm ⌀ SciFi from Luxium is coming and will be used to study its performance.
- The implementation of the ALCOR-based DAQ to read the SciFi SiPMs is ongoing.