Corryvreckan Framework Integration for µ-RWELL Tracking Detectors

Thanks to the LNF, Ferrara, Bologna & Torino INFN groups

Corryvreckan

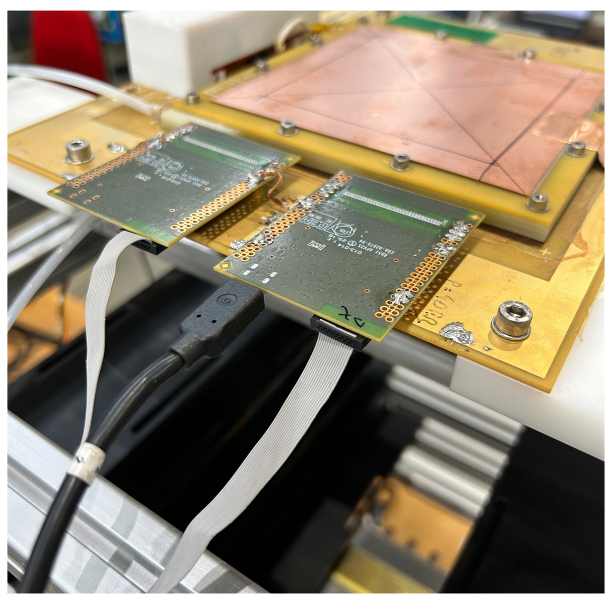
The Maelstrom for Your Test Beam Data

A versatile platform designed for the reconstruction and analysis of test beam data.

Corryvreckan's **modular approach** simplifies the process of adapting it to various types of detectors and enhances the efficiency of data analysis by providing a streamlined, **user-friendly** interface [1].

- Reconstruct and analyse data from **pixel R/O**
- Modular structure
- Highly flexible and configurable

... also **strips**, combining X and Y



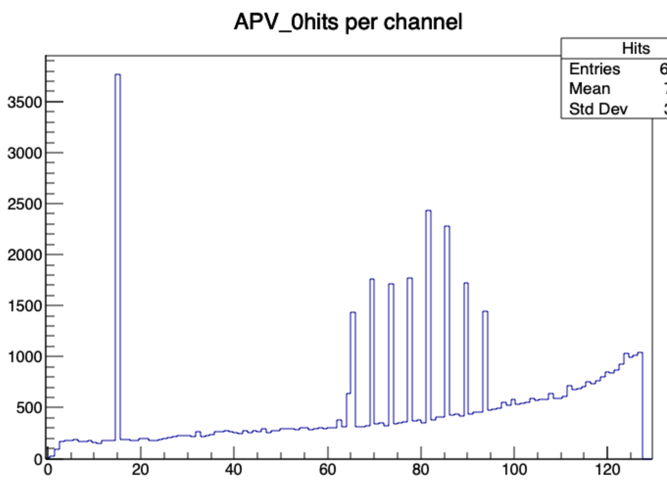
Integrating an interface for the **Scalable Readout System** (SRS)+**APV25** → initial stages of a very popular readout chain for acquiring and processing MPGD signals.

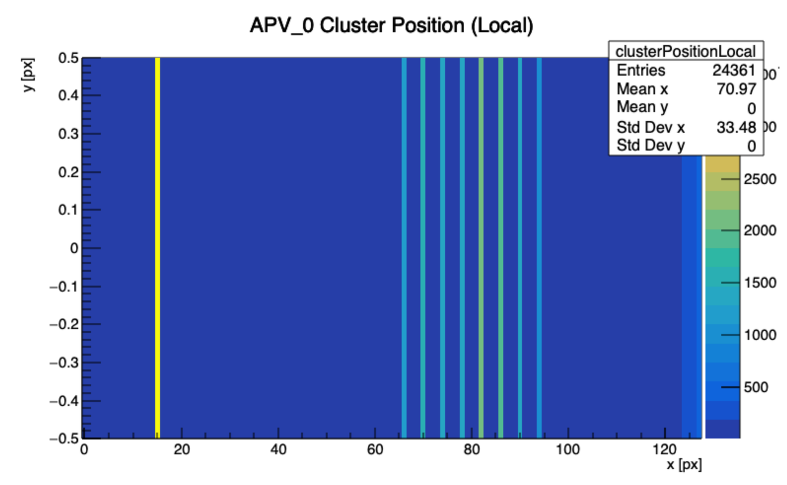
```
[APV1Dto2D]
input_directory = "/Users/elena/Desktop/corry/corry_TB/run/raw/"

[APVReader2D]
input_directory = "/Users/elena/Desktop/corry/corry_TB/run/raw/"
```

New Analysis modules:

APVReader – reads the APVs as they are, useful for debugging





APVReader2D – reads 2D chambers

APV1Dto2D – reads two 1D chambers transforming them in 2D virtual detectors

New Geometry features:

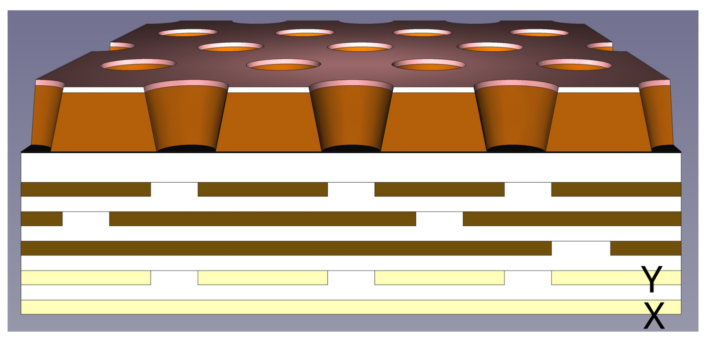
apv_1 and apv_2 – (geometry file) the apv number corresponding to the detector readout which will be read by the APVReader modules

TB analysis due tomorrow?

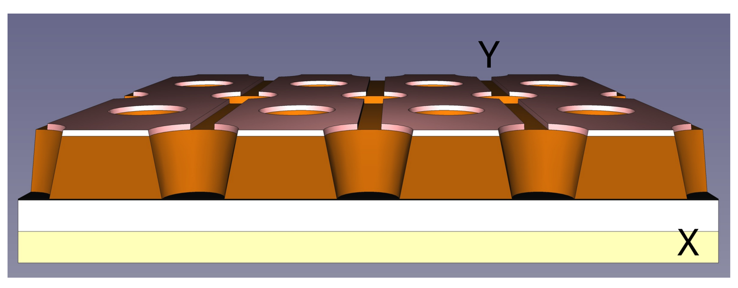
The μ-RWELL

A resistive single amplification stage MPGD [2]:

– a WELL patterned kapton foil (w/Cu-layer on top) acting as amplification stage
– a resistive DLC layer w/ ρ~50÷100 MΩ/☐
– a standard readout PCB with pad/strip segmentation



2D protos



u-RWELL - Charge Sharing R/O [4]

- Active area= 100x100 mm2
- Strip pitch= 1.2 mm, x width = 1.1 mm, y width = 0.3 mm
- Stack of layers of pad
- Reduce the number of FEE channels
- The charge is divided between X and Y (higher gas gain required w.r.t. 1D, common characteristic of R/O *a la COMPASS*)

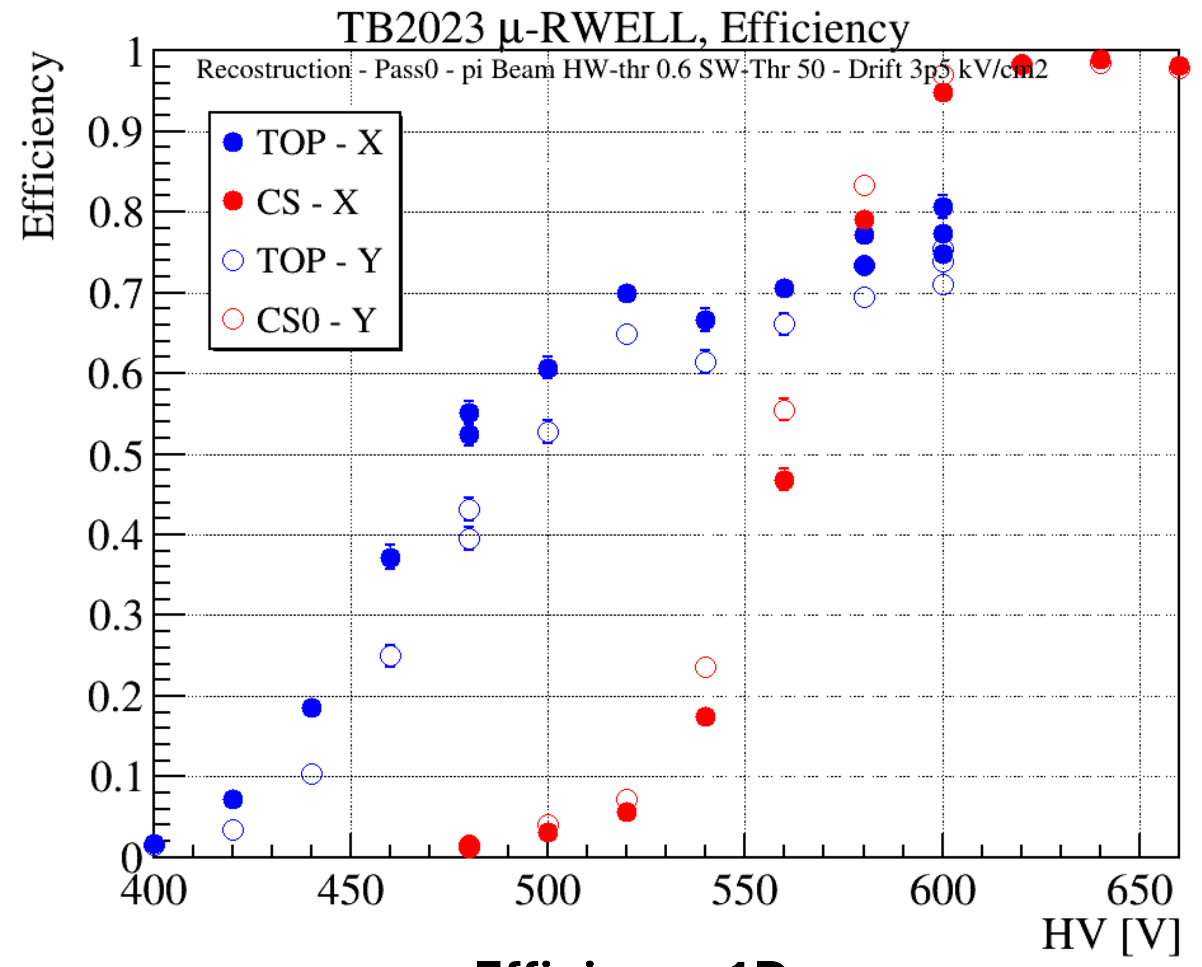
u-RWELL TOP R/O

- Active area= 100x100 mm2
- Strip pitch= 0.8 mm, width = 0.7 mm
- Pre-preg thickness= 70 um
- Charge is collected on both X and Y (lower gas gain required w.r.t. *COMPASS* R/O)
- The "TOP" segmentation introduces a dead zone ~ 15%

Check G. Morello's poster "*The u-RWELL technology for tracking apparatus in High Energy Physics*" in this session for more

Check G. Bencivenni's talk "*The u-RWELL for future HEP challenges*"

Test Beam - June 2023
collaboration of RD_FCC, LHCb and CLAS12
- GRAAL analysis -



Efficiency 1D

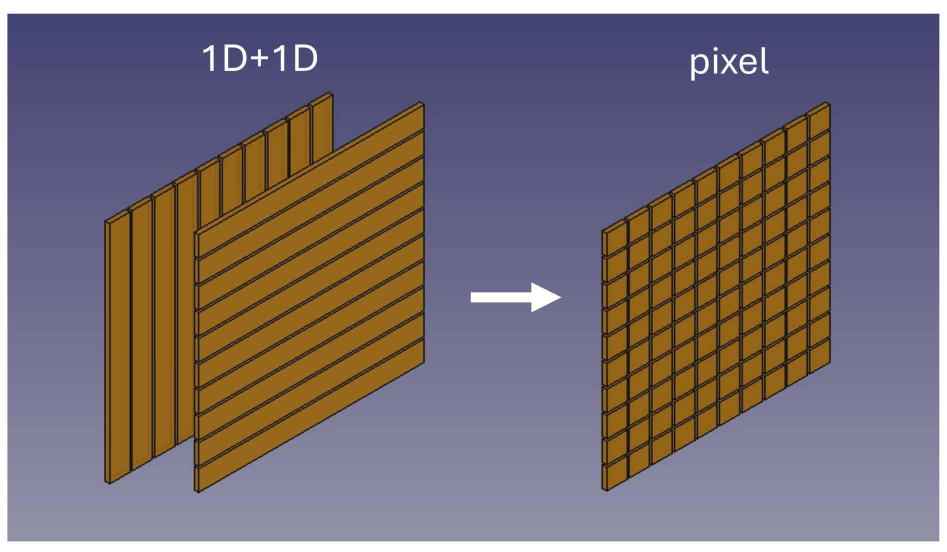
Previous results from the standard analysis framework GRAAL [3], used as benchmark.

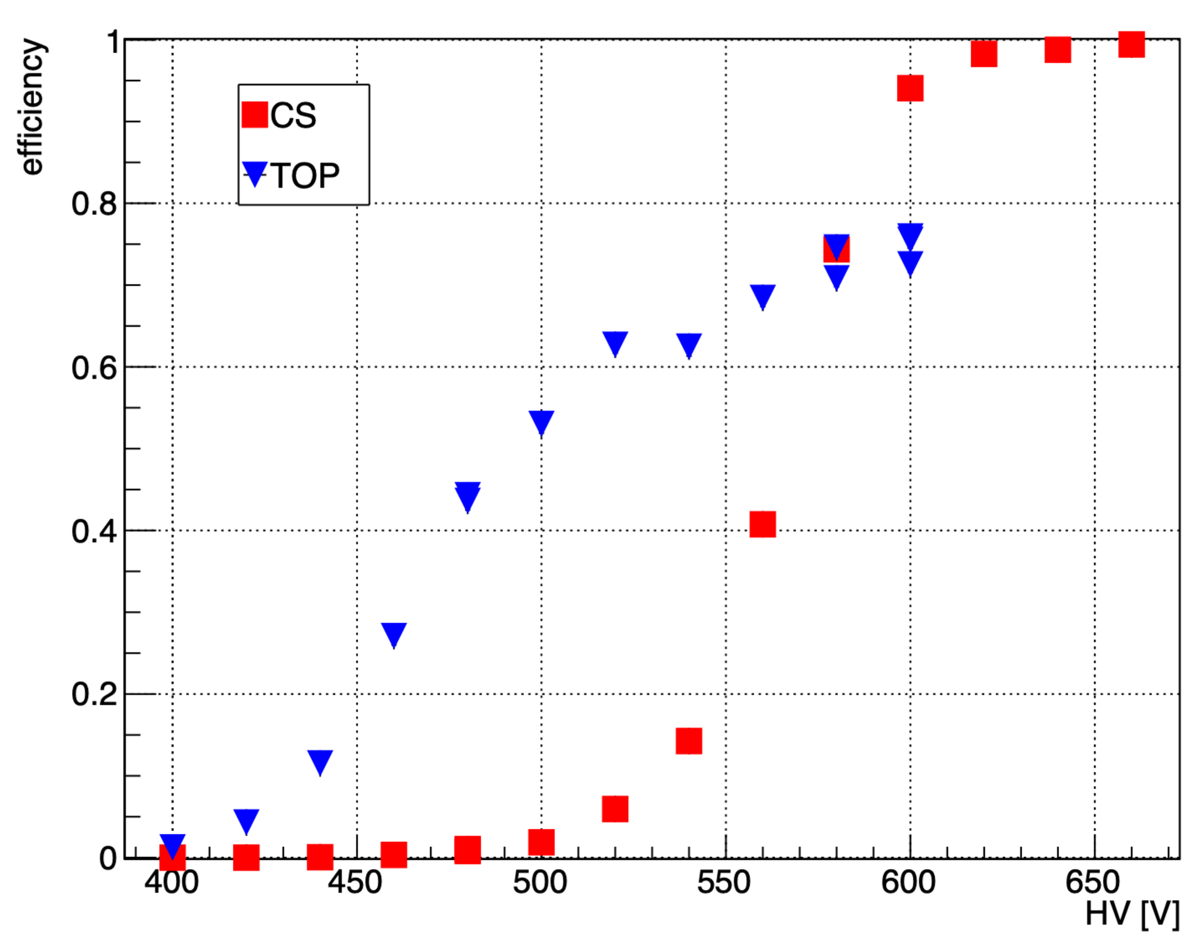
APVReader

1D+1D = VIRTUAL 2D DETECTOR

The module APV1Dto2D creates a **Virtual detector** between the X and Y ones.

- The column of the detector is defined by the strips along the "x" direction
- The row of the detector is defined by the strips along the "y" direction
- The charge of the pixel is the average of q_x and q_y
- The pixels cluster size will be the product of the number of the contiguous hits along X and Y
- (!!) this is not a native pixel R/O, ghost hits may occur

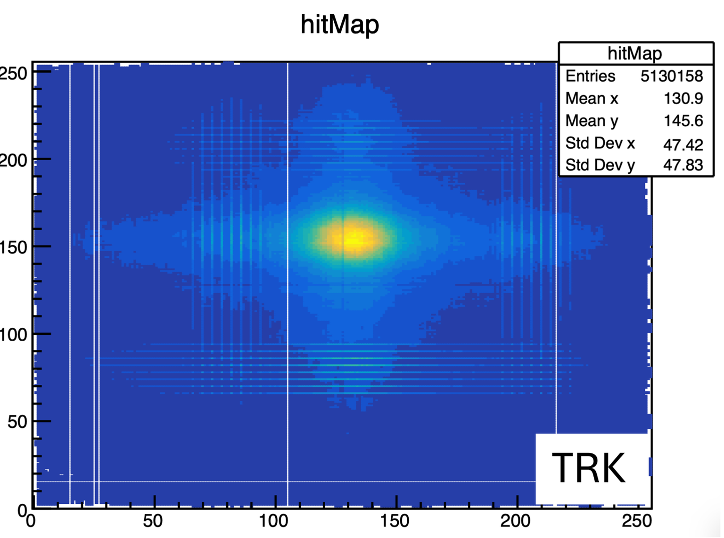


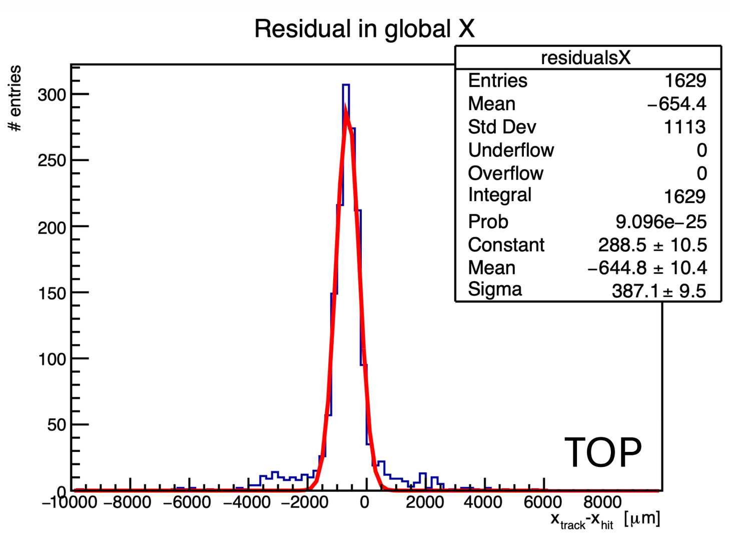


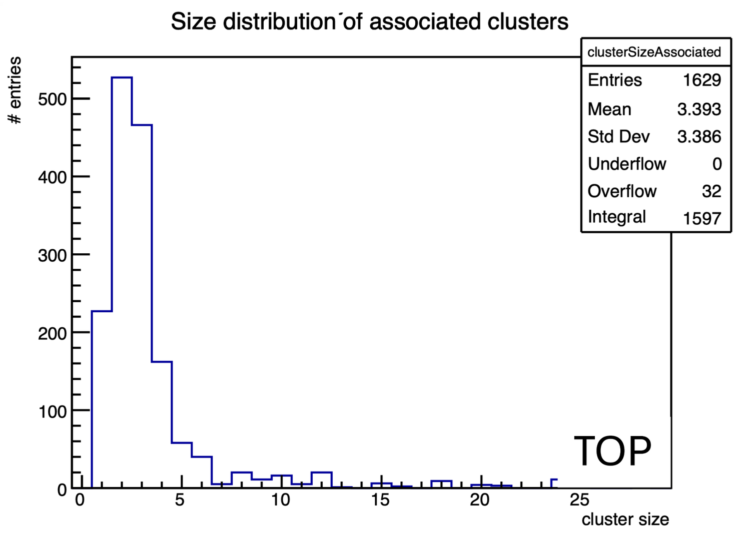
Efficiency 2D

$$\frac{\#\ tracks\ with\ associated\ cluster\ on\ the\ DUT}{\#\ tracks\ passing\ trougth\ the\ DUT}$$

ANALYSIS OUTPUT: Corryvreckan performs clustering, tracking, Detector Under Test (DUT) association, alignment, and it also provides efficiency and resolution of the signal.







Next steps: implementation of the μ**TPC** algorithm for inclined tracks

- [1] D. Dannheim et al., "Corryvreckan: a modular 4D track reconstruction and analysis software for test beam data", J. Instr. 16 (2021) P03008, doi:10.1088/1748-0221/16/03/P03008
- [2] G. Bencivenni et al., The micro-Resistive WELL detector: a compact spark-protected single amplifiction-stage MPGD, 2015 JINST 10 P02008
- [3] R. Farinelli et al., GRAAL: Gem Reconstruction And Analysis Library, DOI: 10.1088/1742- 6596/1525/1/012116, J.Phys.Conf.Ser. 1525 (2020) 1, 012116
- [4] K. Gnanvo et al., NIM A 1047 (2023) 167782