# The μ-RWELL detector

## in High Energy Physics & beyond

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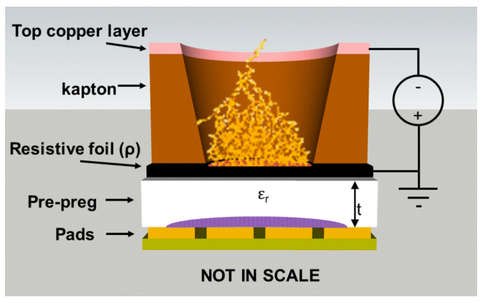
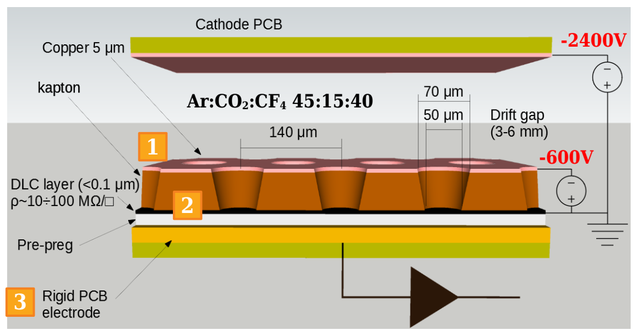
The **μ-RWELL** is a mature technology developed in order to satisfy the requests for **compactness**, **construction** and **assembly simplicity** as well as radiation hardness of HEP experiments. The **resistive stage** protects the detector, reducing the amplitude of potential sparks. The μ-RWELL is a versatile technology suitable for many different applications, mainly inside High Energy Physics. Thanks to the simplicity of the detector the **technology transfer** with the industry is ongoing, allowing a cost effective mass production.

## Principle of Operation

The μ-RWELL is a Micro Pattern Gaseous Detector (MPGD) composed of only two elements: the μ-RWELL_PCB and the cathode. **The core is the μ-RWELL_PCB**, realized by coupling three different elements:

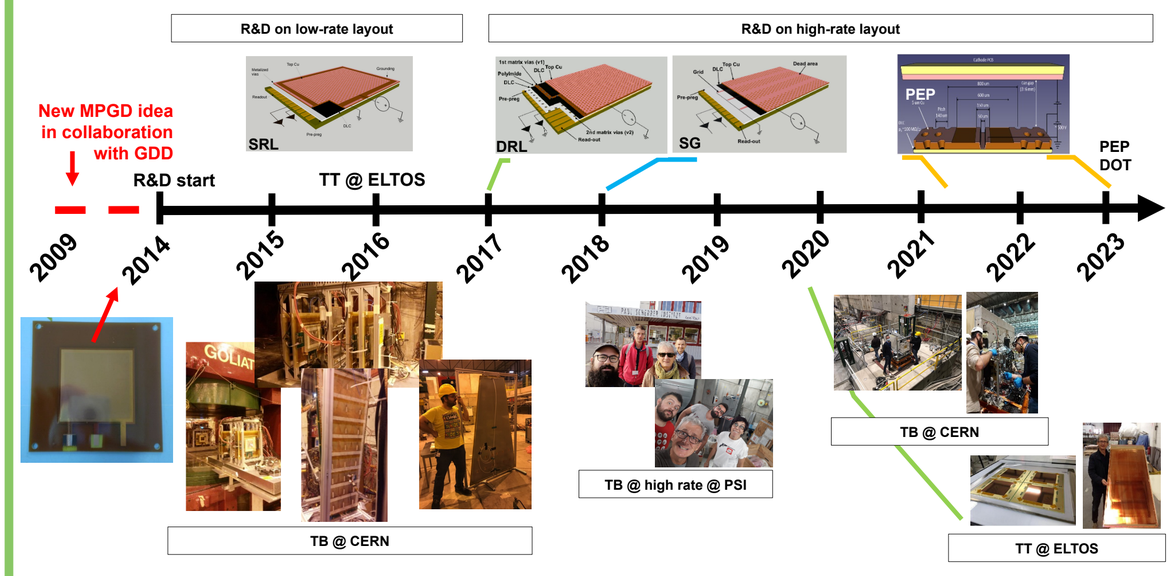



Applying a suitable voltage between the **top Cu-layer and the DLC** the WELL acts as a **multiplication channel for the ionization** produced in the conversion/drift gas gap.

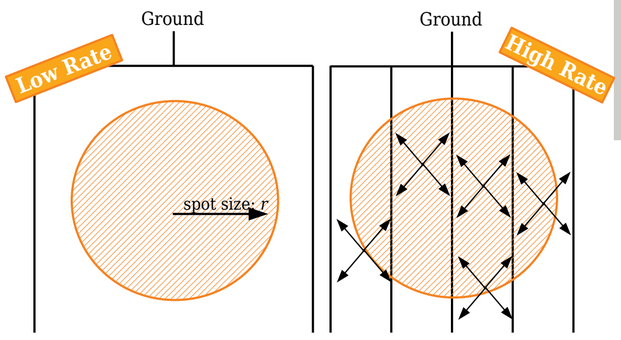



1. **a WELL** patterned kapton foil acting as **amplification stage** (GEM-like)
2. a **resistive DLC layer (Diamond-Like-Carbon)** for discharge suppression with surface resistivity ~ 50÷100 MΩ/□
3. a standard readout PCB

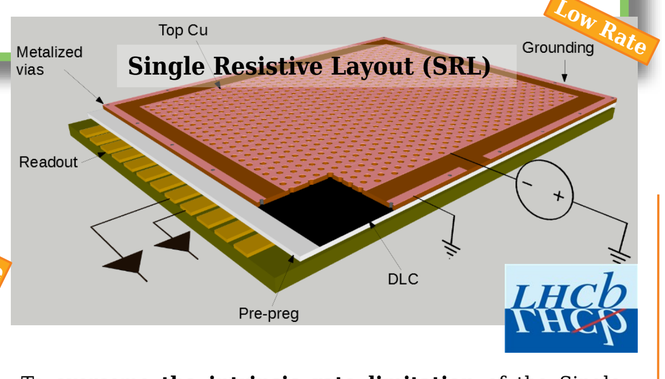
## INFN-LNF DDG μ-RWELL R&D – a summary



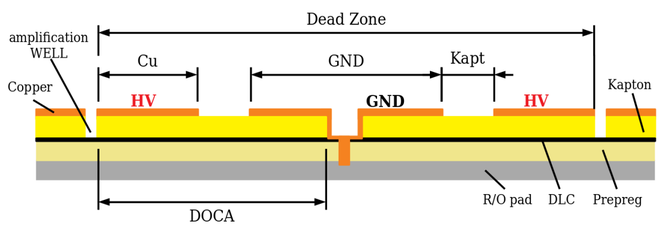

## The High Rate quest

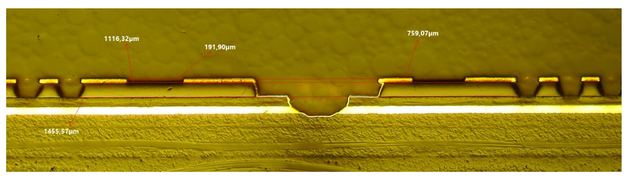


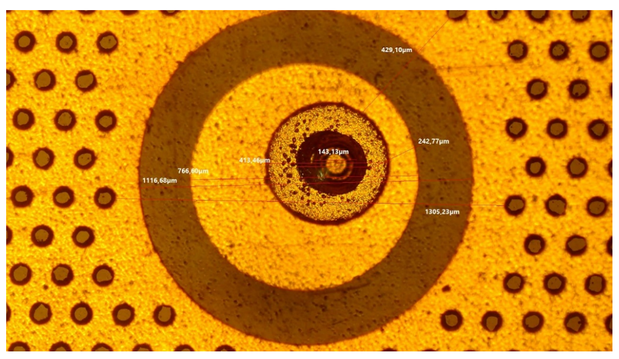

A sort of tiling with smaller low rate schemes.

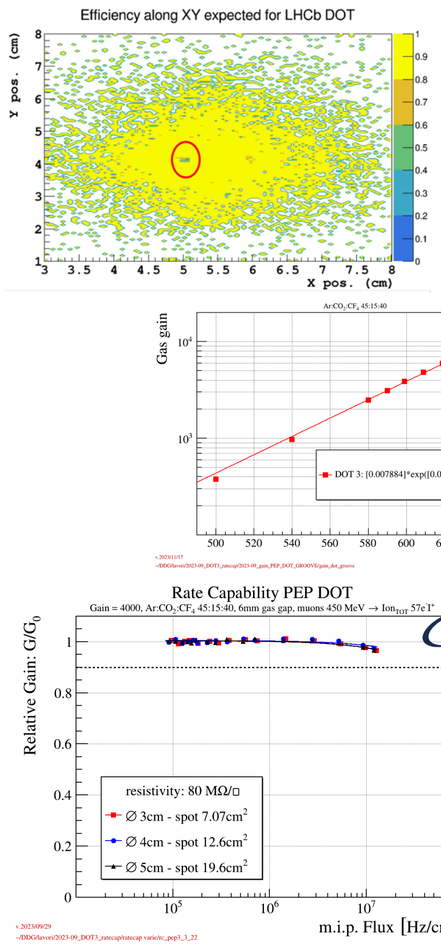



To overcome **the intrinsic rate limitation** of the Single Resistive layout with edge grounding, the solution is to reduce as much as possible the paths towards the ground connection introducing a **high density "grounding network"** on the resistive stage of the detector.





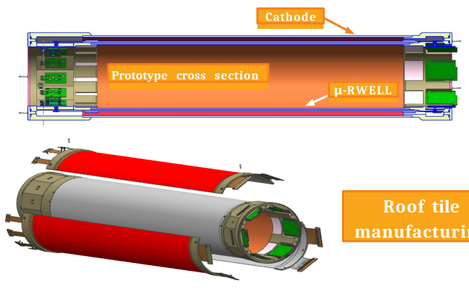





## Tracking: Low $X_0$ cylindrical μ-RWELL

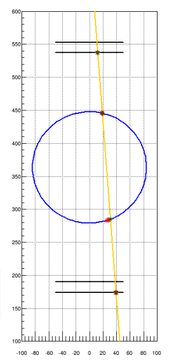
eurizon
European network for developing new horizons for RIs

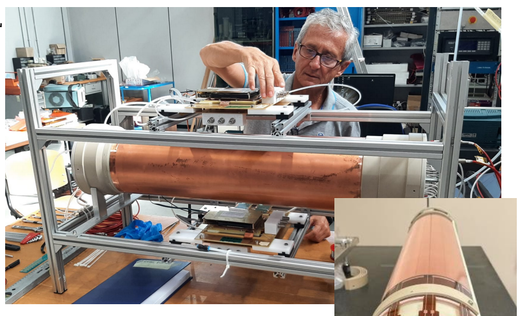
Development of an ultra-light modular **cylindrical μ-RWELL** as **inner tracker** for the Super Charm Tau factory (EURIZON project). The B2B layout (a double radial TPC) is designed to have a **very low material budget** (0.86÷0.96% X0) and **modular roof-tile shaped components**: in case of failure/damage of the part, the structure could be opened And the damaged module replaced.

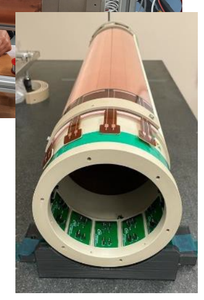





Roof tile manufacturing







**The first fully cylindrical low mass μ-RWELL**

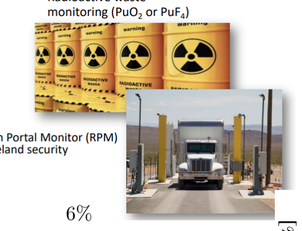
Thanks to the INFN-LNF,Fe Eurizon collaboration.

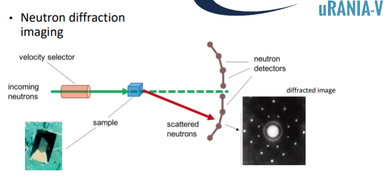
## uRANIA-V: μ-RWELL for thermal neutron detection

INFN uRANIA-V

**WHY**

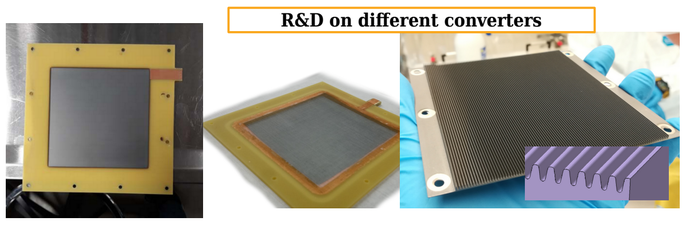
- **Probing heavy structure in motion**
- High penetration power
- **Radioactive waste monitoring**
- **Radiation Portal Monitor** (homeland security)
- **Neutron tomography**

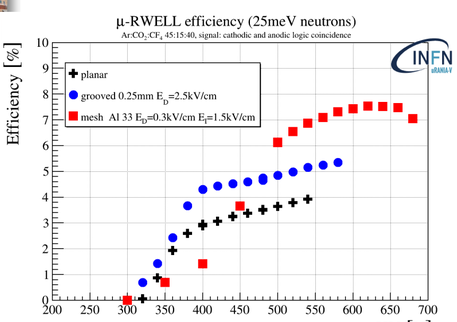



$$n + {}^{10}_{5}B \begin{cases} {}^{7}_{3}Li(1.02MeV) + \alpha(1.78MeV) & 6\% \\ {}^{7}_{3}Li(0.84MeV) + \alpha(1.47MeV) + \gamma(0.48MeV) & 94\% \end{cases}$$

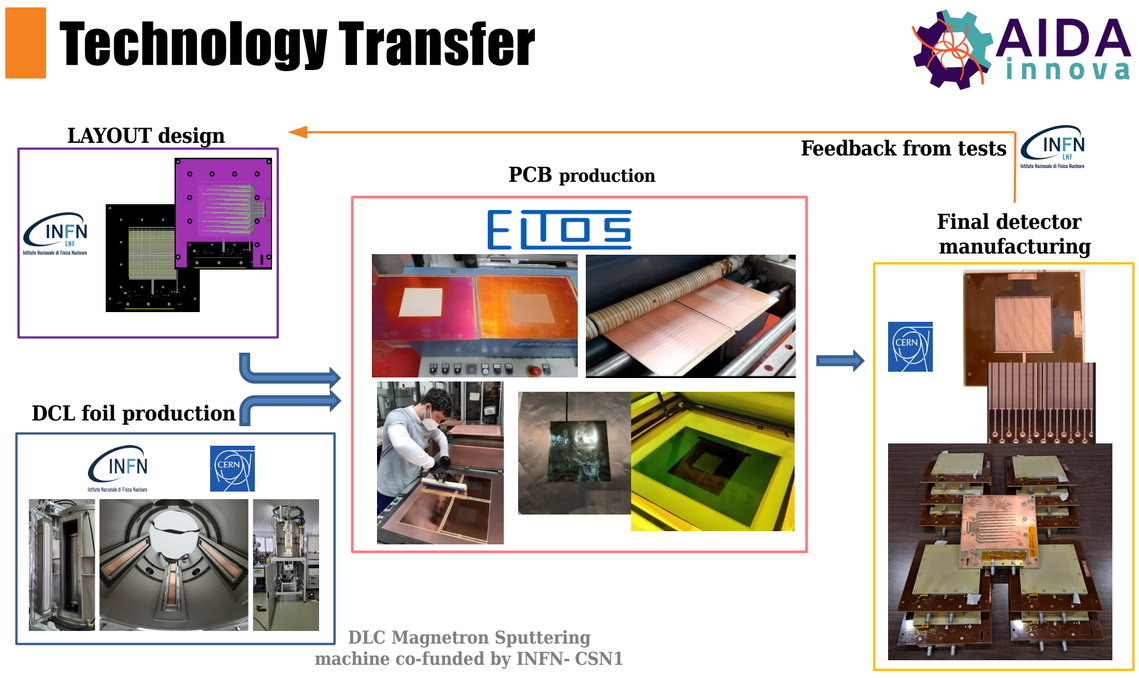
**R&D on different converters**






## Technology Transfer

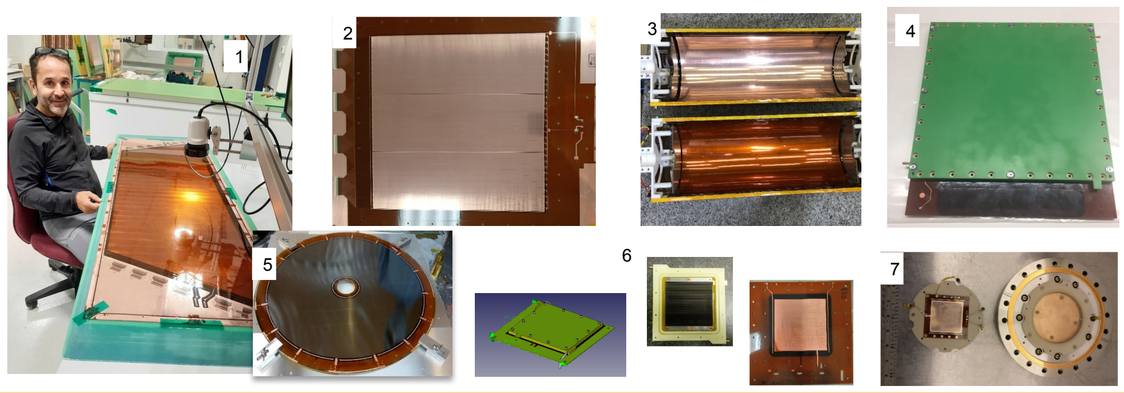
AIDA innova




## μ-RWELL technology spread

The μ-RWELLs are proposed in

1. **CLAS12 @ JLAB:** the upgrade of the muon spectrometer
2. **X17 @ n_TOF EAR2**: for the amplification stage of a TPC dedicated to the detection of the X17 boson
3. **TACTIC @ YORK Univ.:** radial TPC for detection of nuclear reactions with astrophysical significnace
4. **Muon collider:** hadron calorimeter
5. **CMD3:** uRWELL Disk for the upgrade of the tracking system
6. **URANIA-V**: a project funded by INFN-CSN5 for neutron detection,
7. **UKRI:** neutron detection with pressurized $^3$He-based gas mixtures




**Pubblications**

[1] G. Bencivenni et al., *The micro-Resistive WELL detector: a compact spark-protected single amplification-stage MPGD*, 2015 *JINST* **10** P02008

**1st RD51 Micro Pattern Gaseous Detectors School, 27 Nov. 2023**

**CERN, Geneva, Switzerland**