

# Comparative study of resistive MPGD technologies

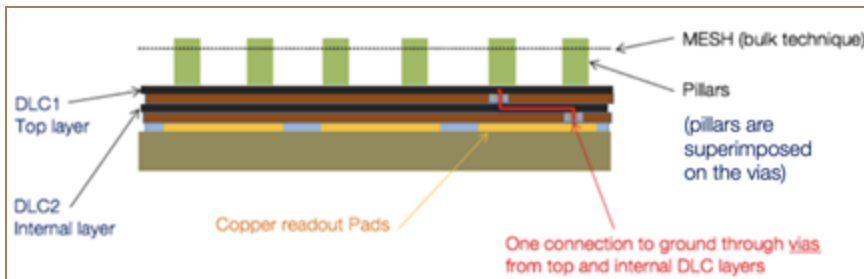
Darina

January 16, 2025

# Reminder

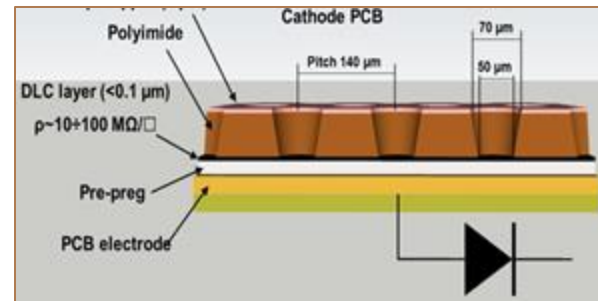
Motivation: to characterize three technologies in similar conditions systematically

## Micromegas, MM



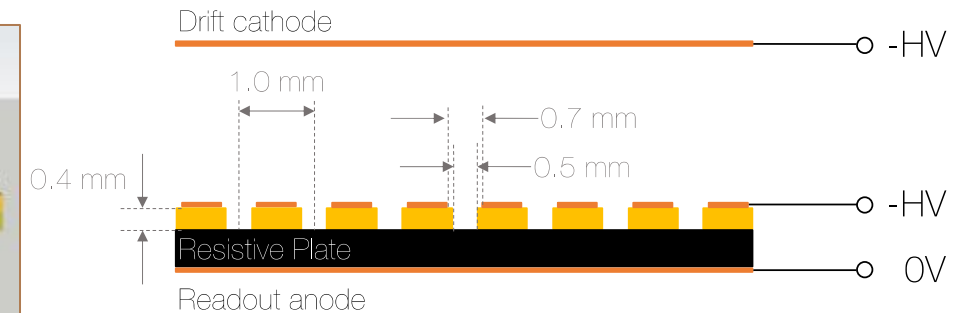
- Double DLC layer
- $\sim 50 \text{ M}\Omega/\square$
- Grounding points through vias under the pillars
- $\text{ArCO}_2\text{iC}_4\text{H}_{10}$  93:5:2

## uRWELL



- Single DLC layer
- $\sim 100 \text{ M}\Omega/\square$
- Grounding lines between GEM HV sectors
- $\text{ArCO}_2\text{iCF}_4$  45:15:40

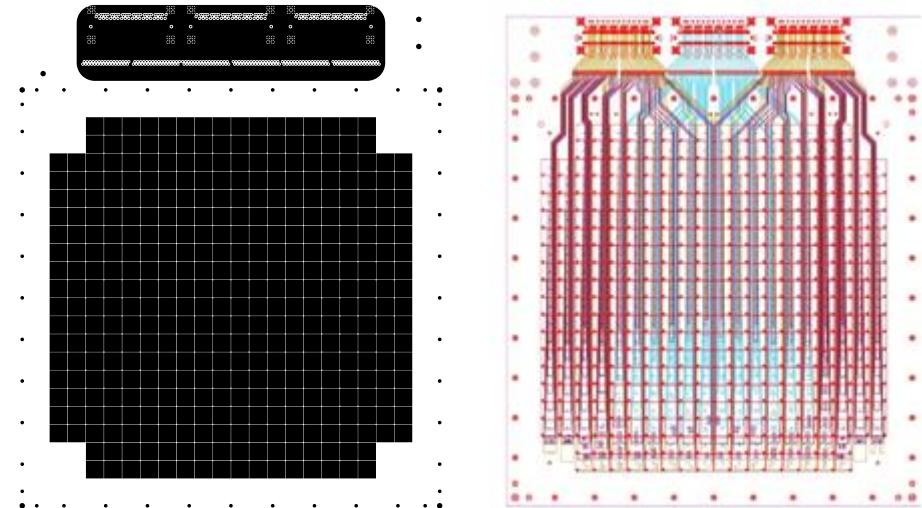
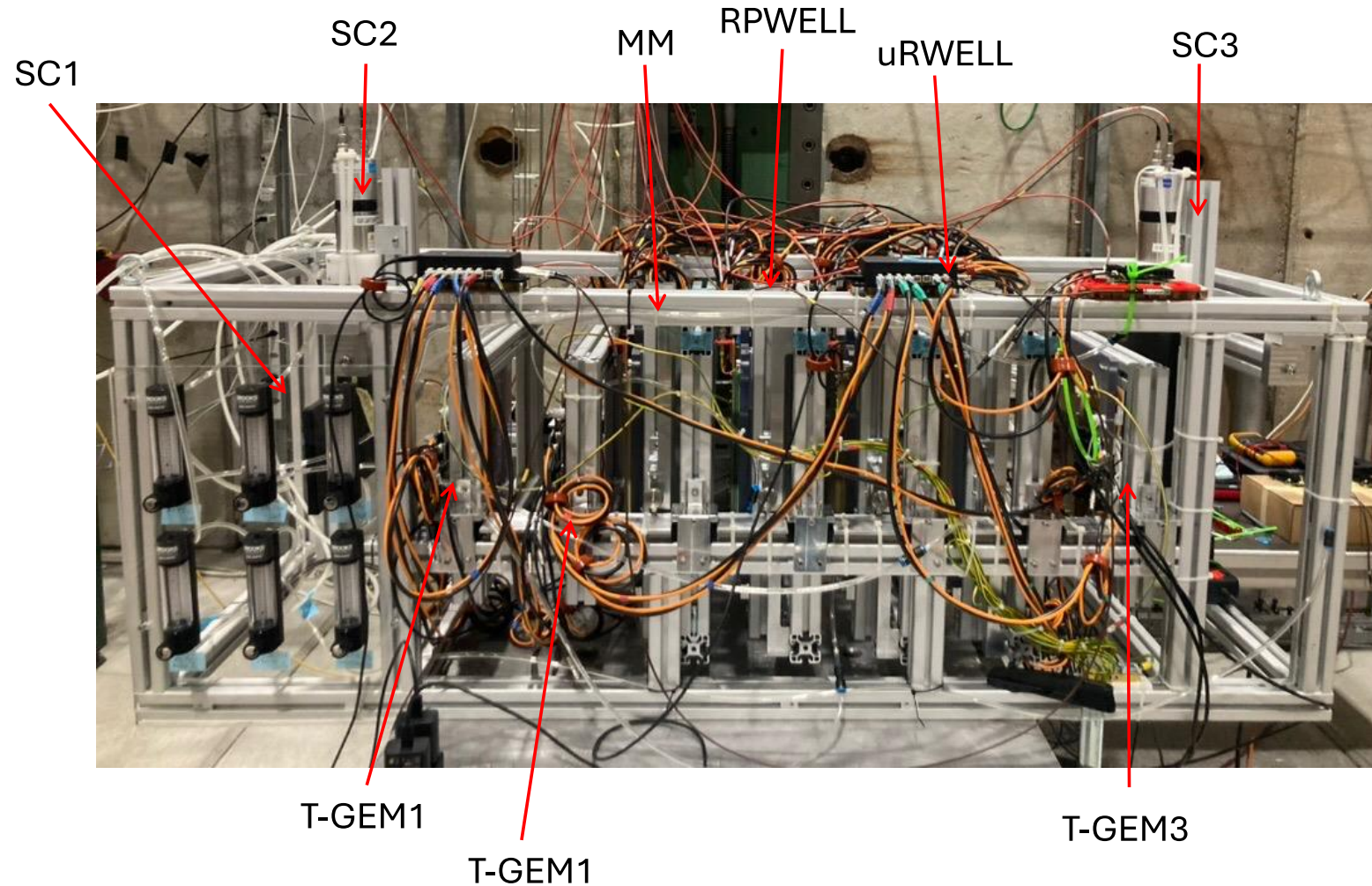
## RPWELL



- Fe-doped glass
- $2 \text{ G}\Omega\cdot\text{cm}$
- Grounding through pads with epoxy-graphite mixture
- $\text{ArCO}_2\text{iC}_4\text{H}_{10}$  93:5:2

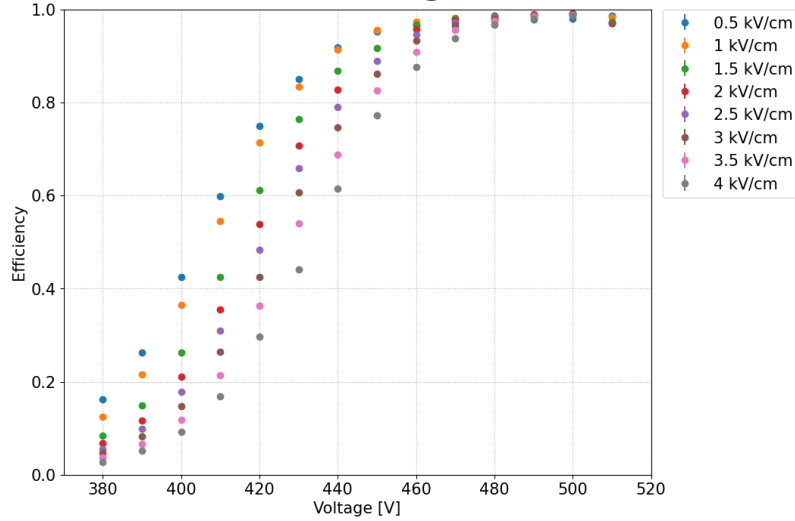
# Reminder

- Common readout scheme
- Common DAQ – VMM3a-based SRS
- Setup within a telescope
  
- Muon & pion beams at CERN SPS NA
  
- vmm-sdat cluster reconstruction
- Tracking based on Hough transform seeded with clusters
- Tracker efficiency ~70%
- Matching cluster to a track within 1cm

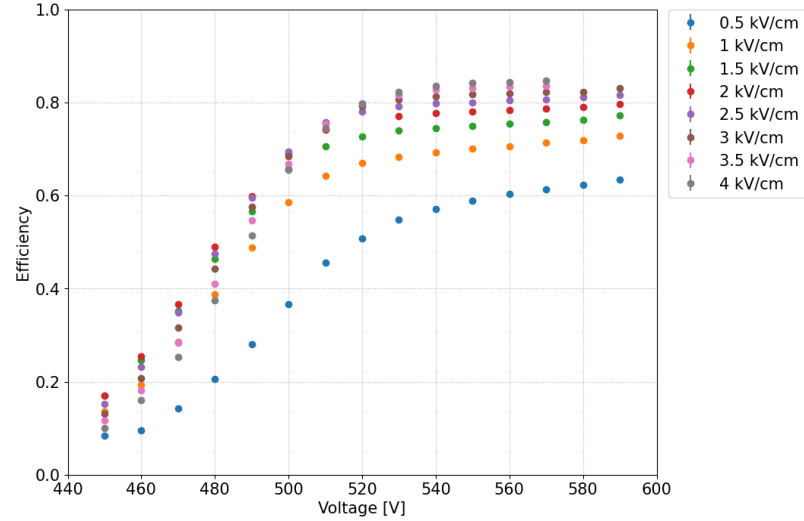


# Reminder - efficiency

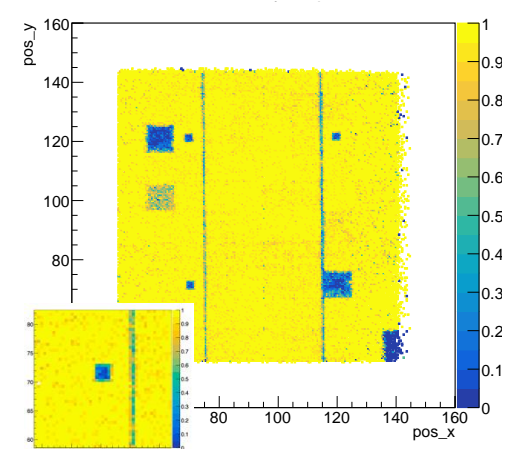
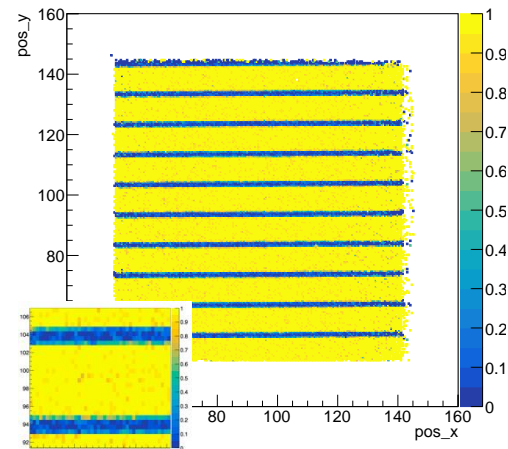
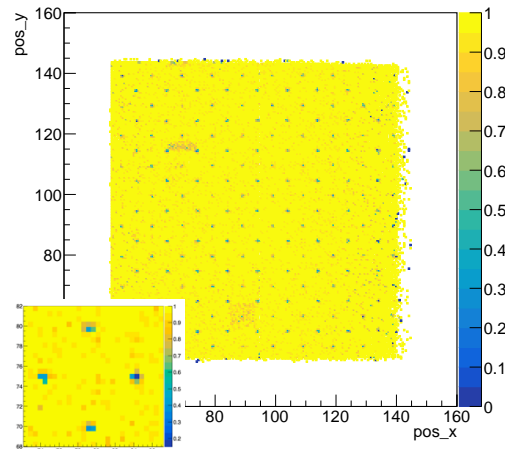
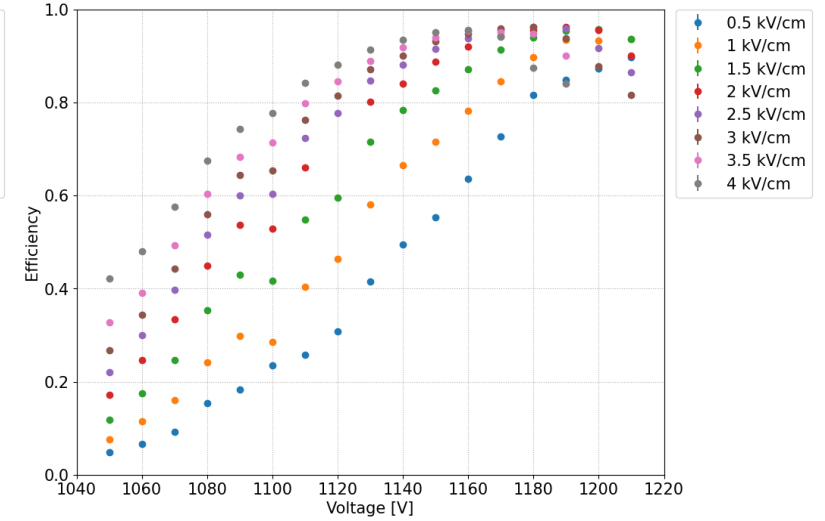
## Micromegas



## uRWELL



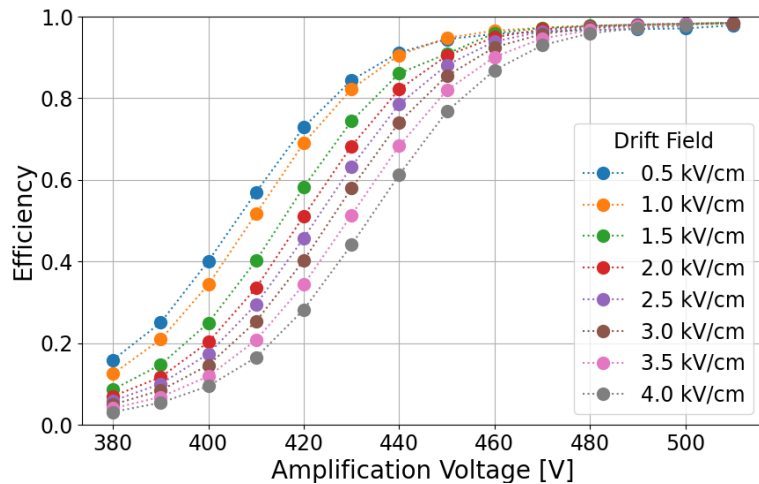
## RPWELL



# Efficiency excluding the dead areas

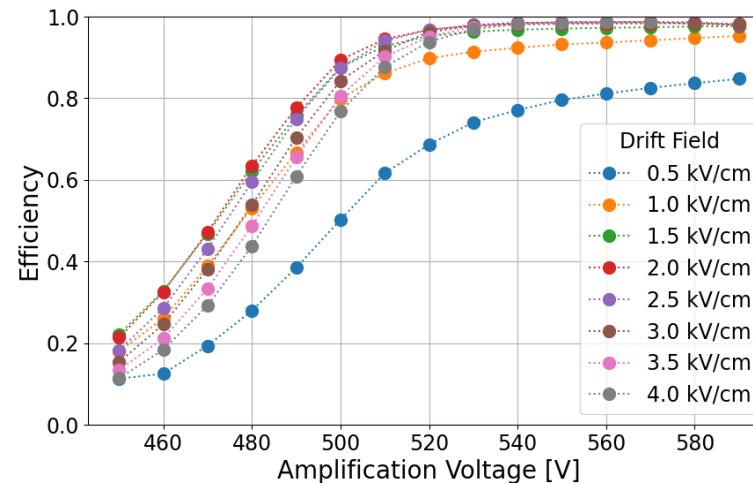
## Micromegas

- No dead areas
- Pillars are an integral part
- Plateau of 98% starts @470V



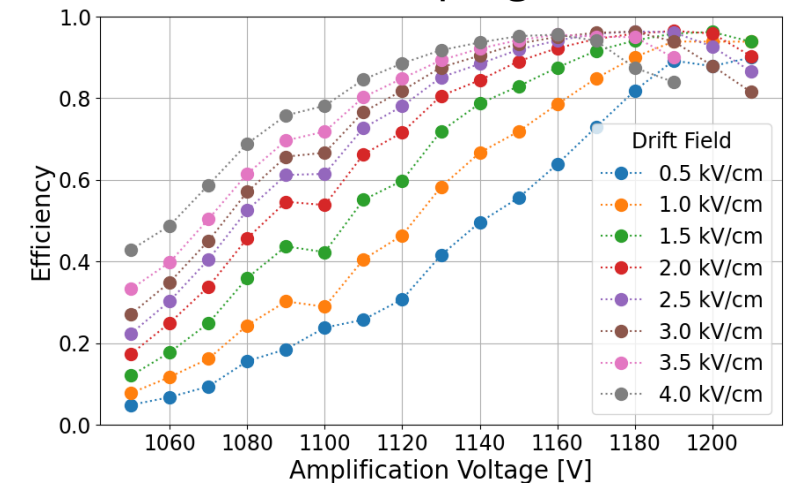
## uRWELL

- Excluding PEP lines – 3mm – 30% of the tested area
- Lines be replaced by PEP dots
- Plateau of 98% starts @540V



## RPWELL

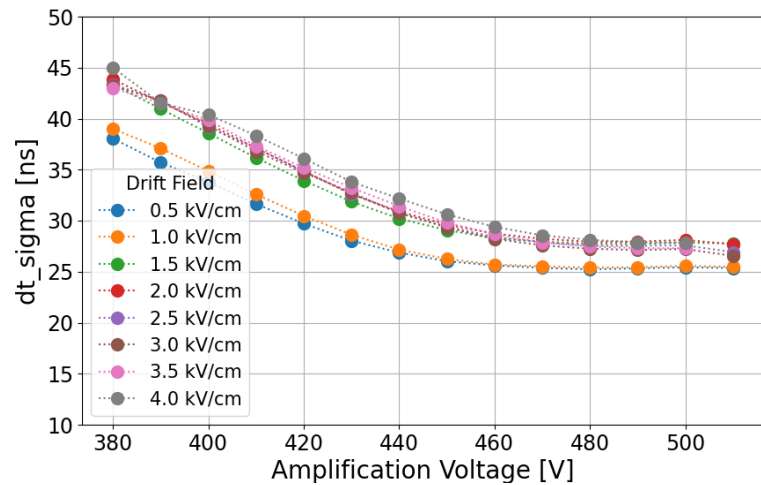
- Excluding dead channels
- Keeping the gluing points and HV sectors separating lines
- Plateau of 96% starts @1170V, dependent strongly on the drift – simulations in progress



# Timing – width of $dt = t_{\text{trigger}} - t_{\text{DUT}}$

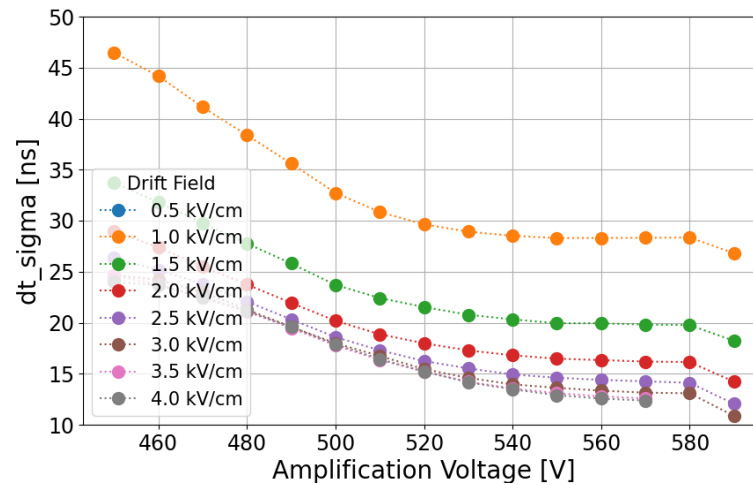
## Micromegas

- Optimal at 0.5 kV/cm



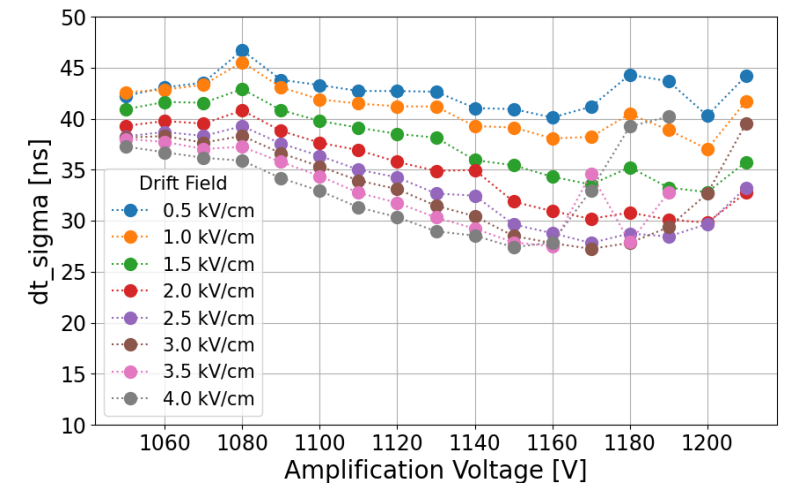
## uRWELL

- Better resolution with higher drift field – to be understood



## RPWELL

- Higher values due to the thicker amplification gap
- Better resolution with higher drift field – to be understood



# Charge

## Micromegas

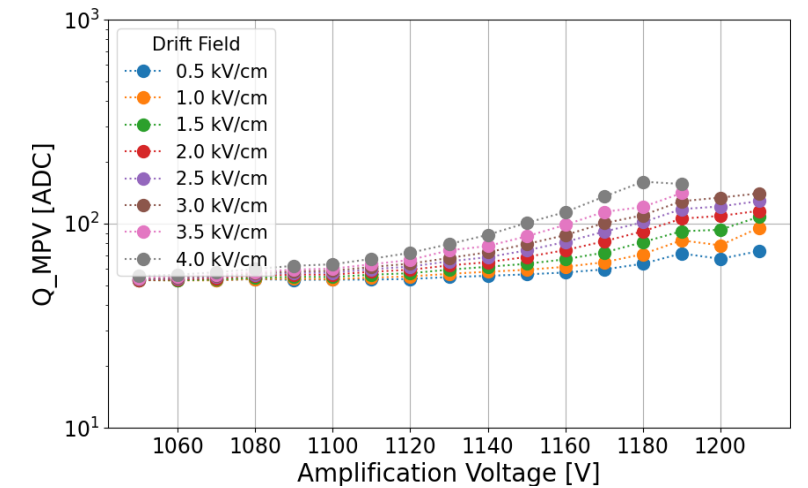
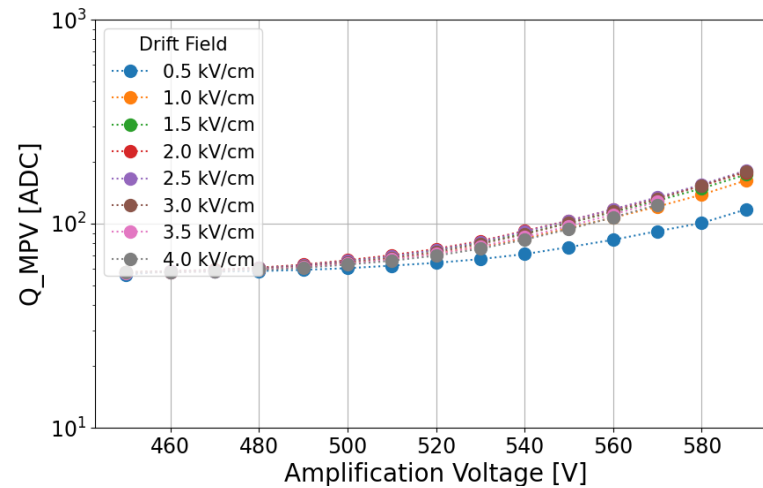
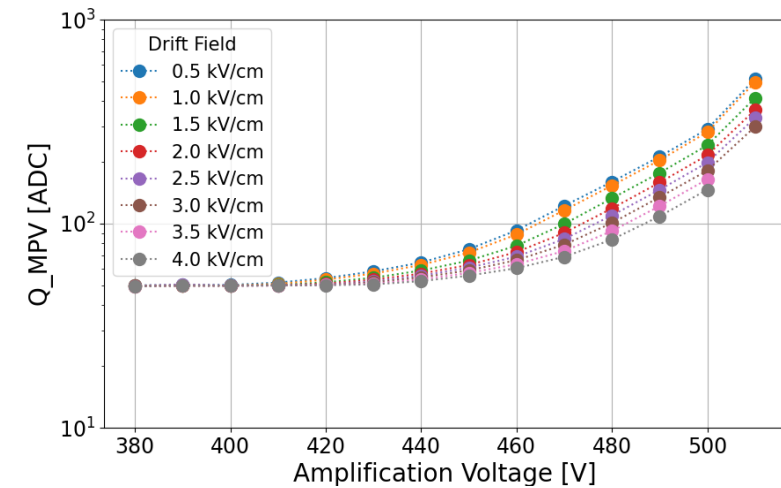
- Highest gain @0.5 kV/cm

## uRWELL

- Highest gain @2.0 kV/cm
- Overall lower gain than MM

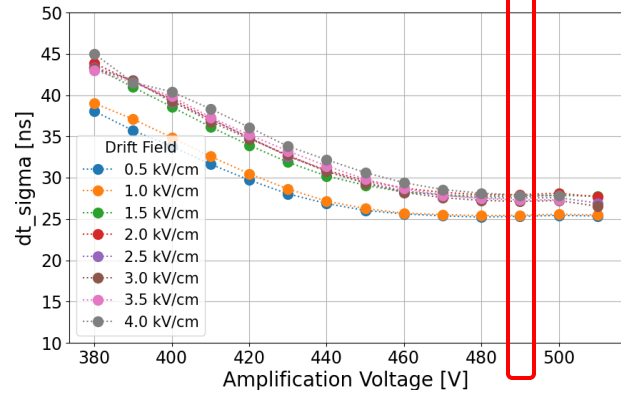
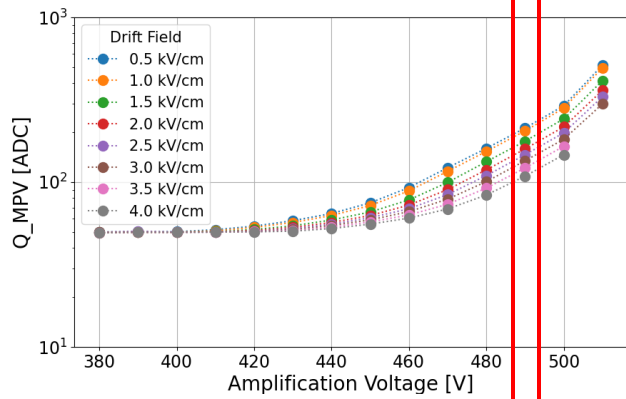
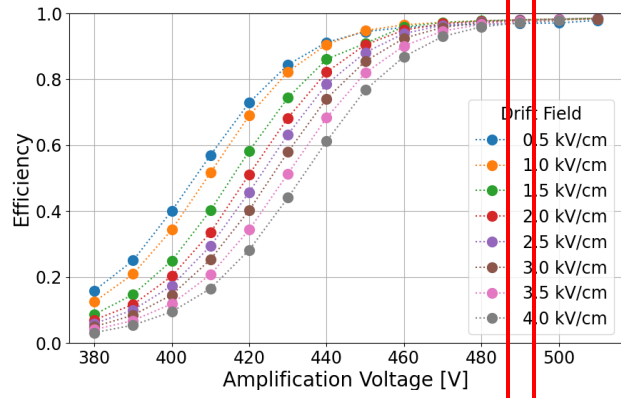
## RPWELL

- Higher charge with higher drift field
- Partial charge measurement

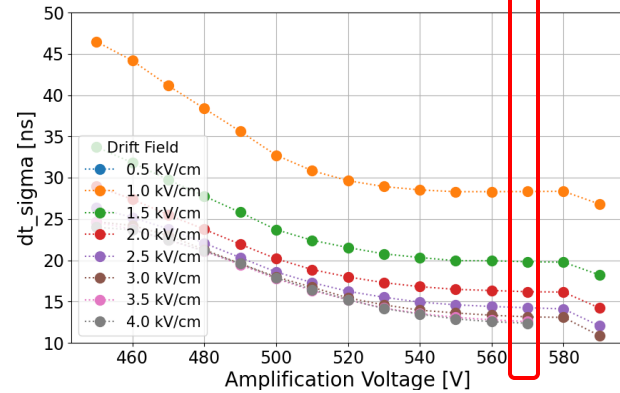
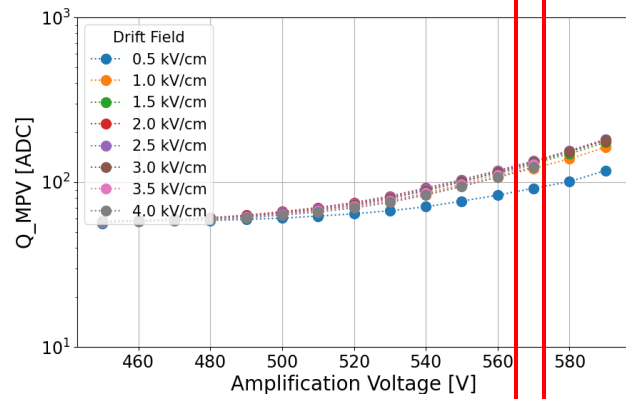
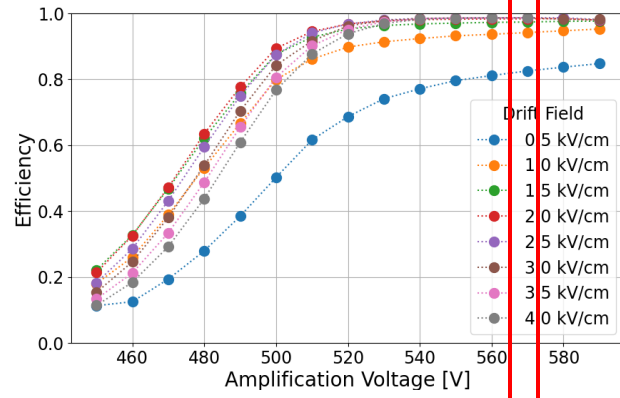


\*First points are not to believe – due to the threshold cutting the Q distribution - not a real gain of the detector

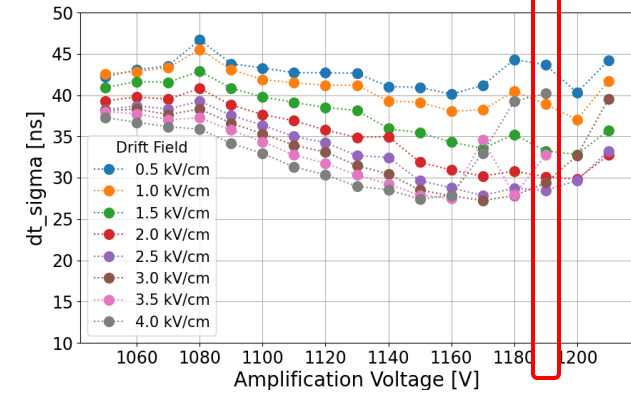
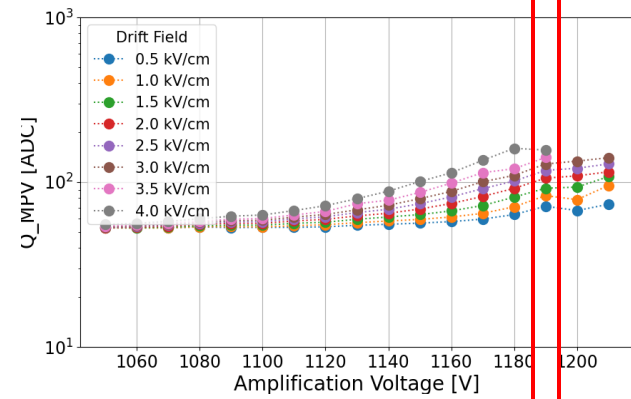
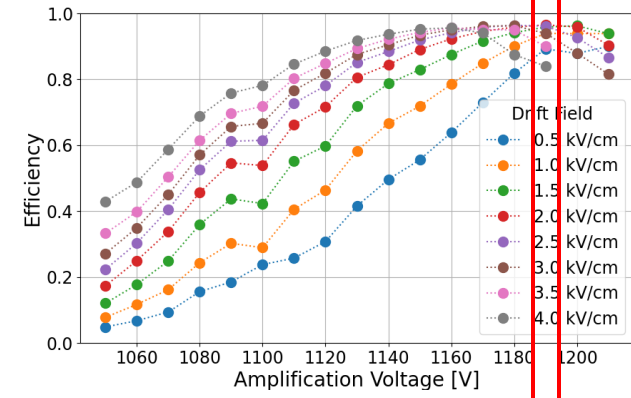
# Micromegas



# uRWELL

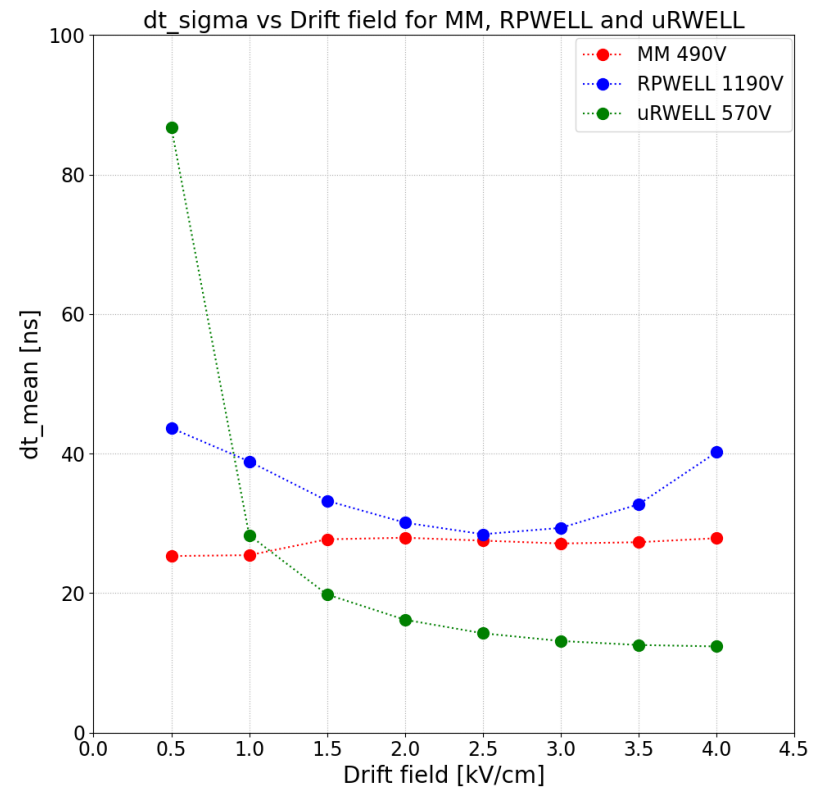
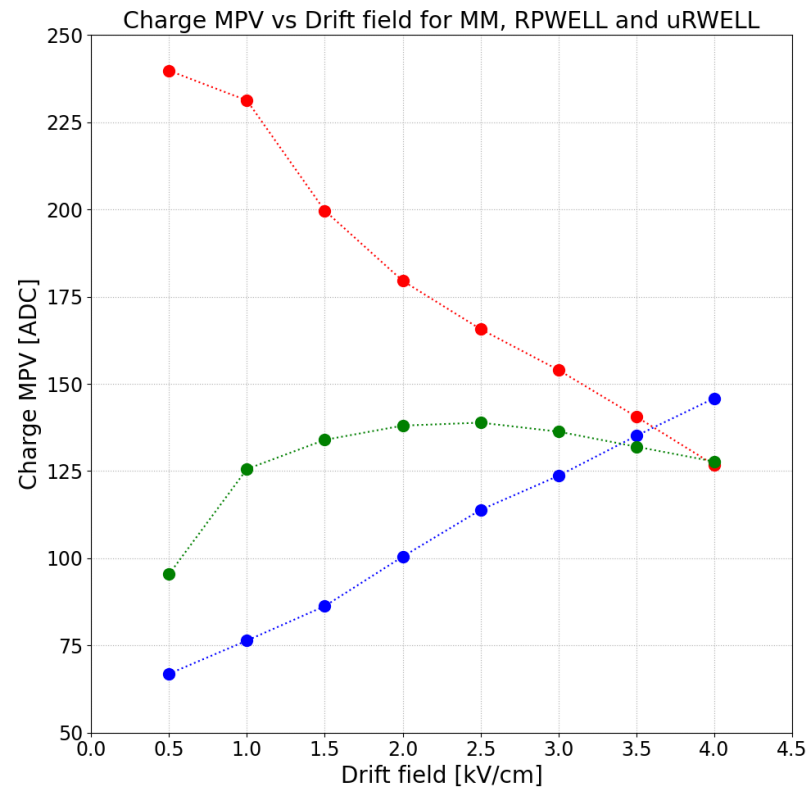
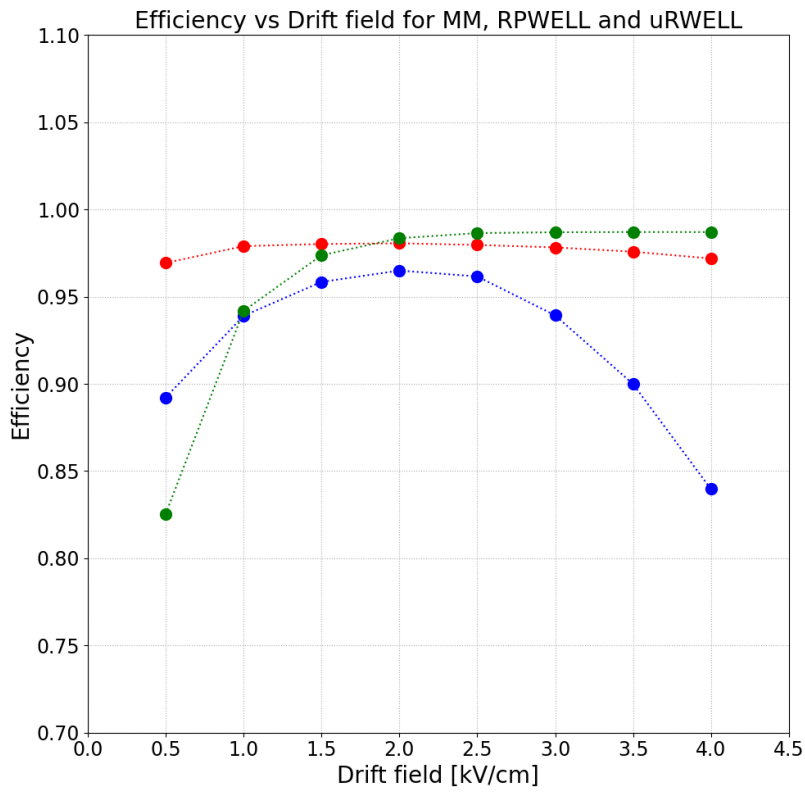


# RPWELL

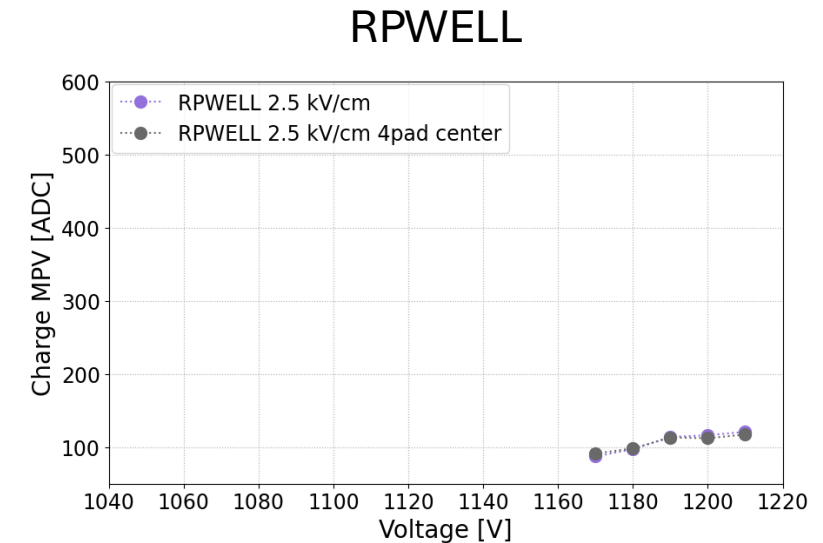
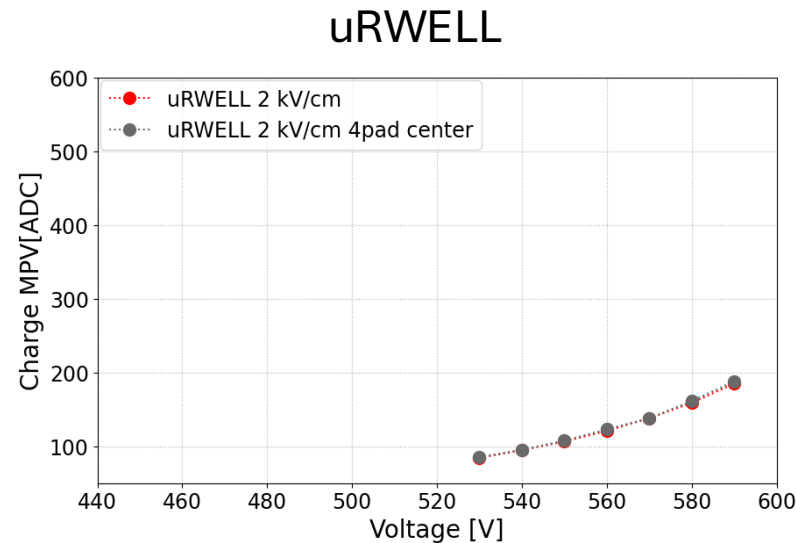
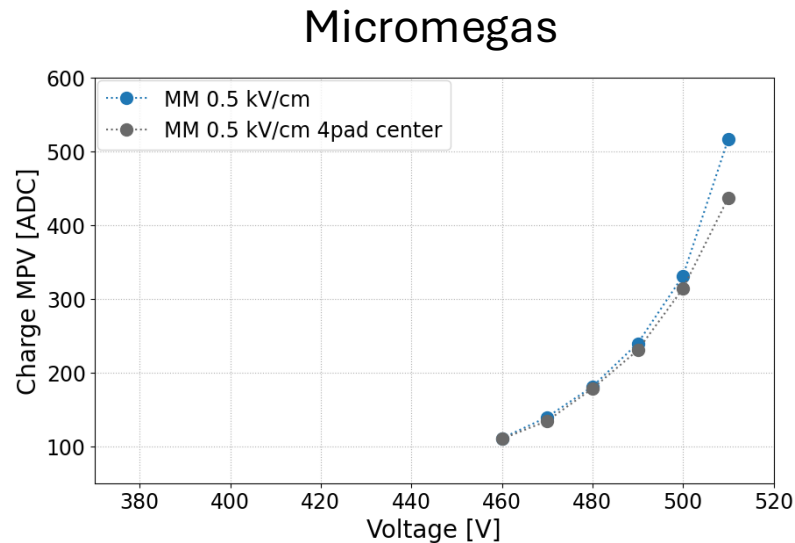




# Performance dependency on the drift field – to be understood



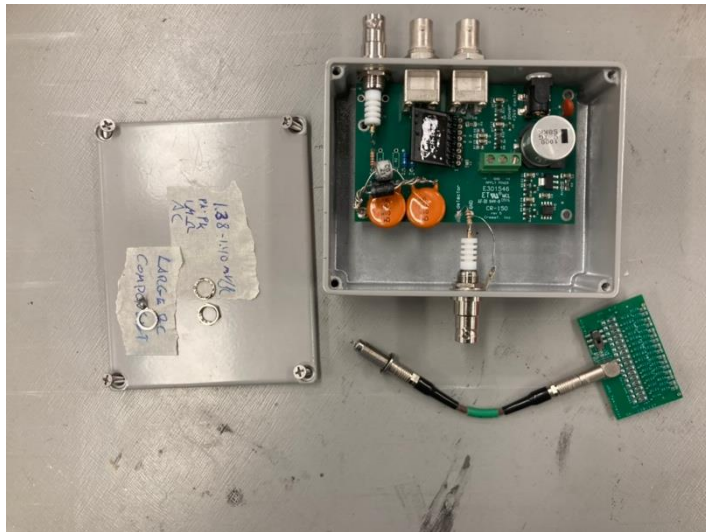
# Charge measurements – at the efficiency plateau, at optimal drift field



Main questions:

1. Why uRWELL gain is lower than MM?  
Gas mixture? 45% argon instead of 93? → Garfield simulations
2. How much of the total charge we measure with VMM3a 200ns shaping time?  
Signal is order of magnitude longer in RPWELL → Signal shape measurement

# Signal shape measurements



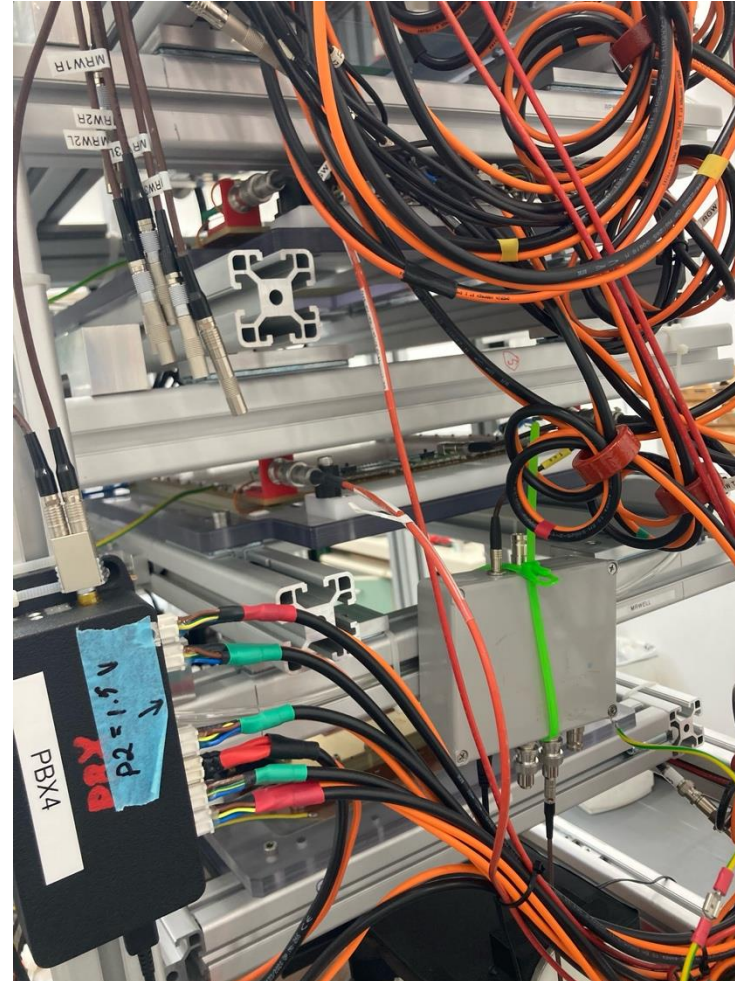
Cremat110 preamp:

- 1.4 V/pC
- 7 ns rise time with 0 input capacitance

HRS terminator

- Cluster of 8 channels

Triggering with cosmic muons

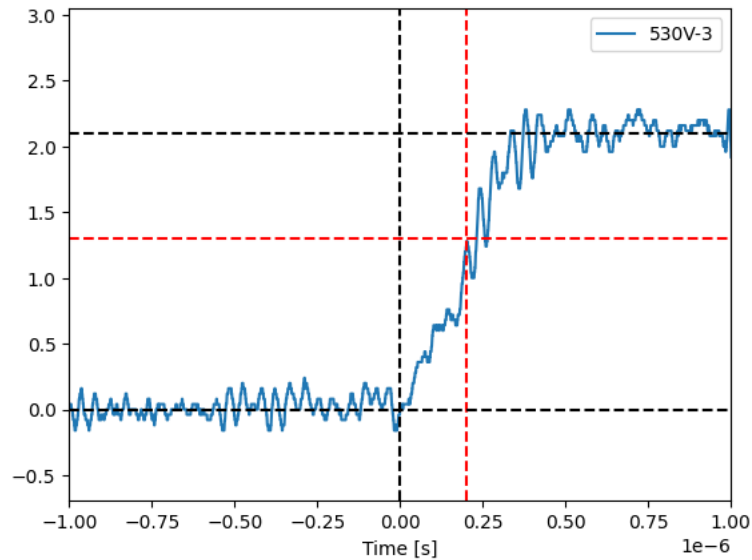


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# Signal shape in thee detectors

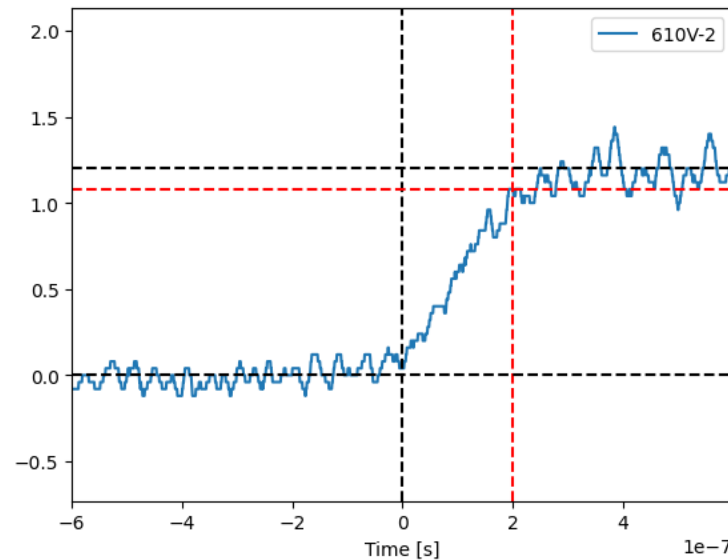
## Micromegas

- Rise time  $\sim 300\text{ns}$
- At 200 ns,  $63.6 \pm 1.3\%$  of the total amplitude is measured



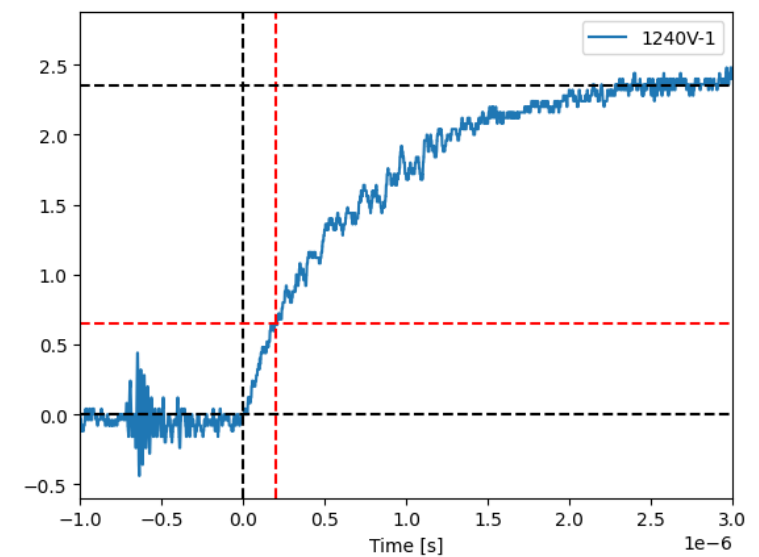
## uRWELL

- Rise time  $\sim 200\text{ns}$
- At 200 ns,  $89.9 \pm 1.1\%$  of the total amplitude is measured



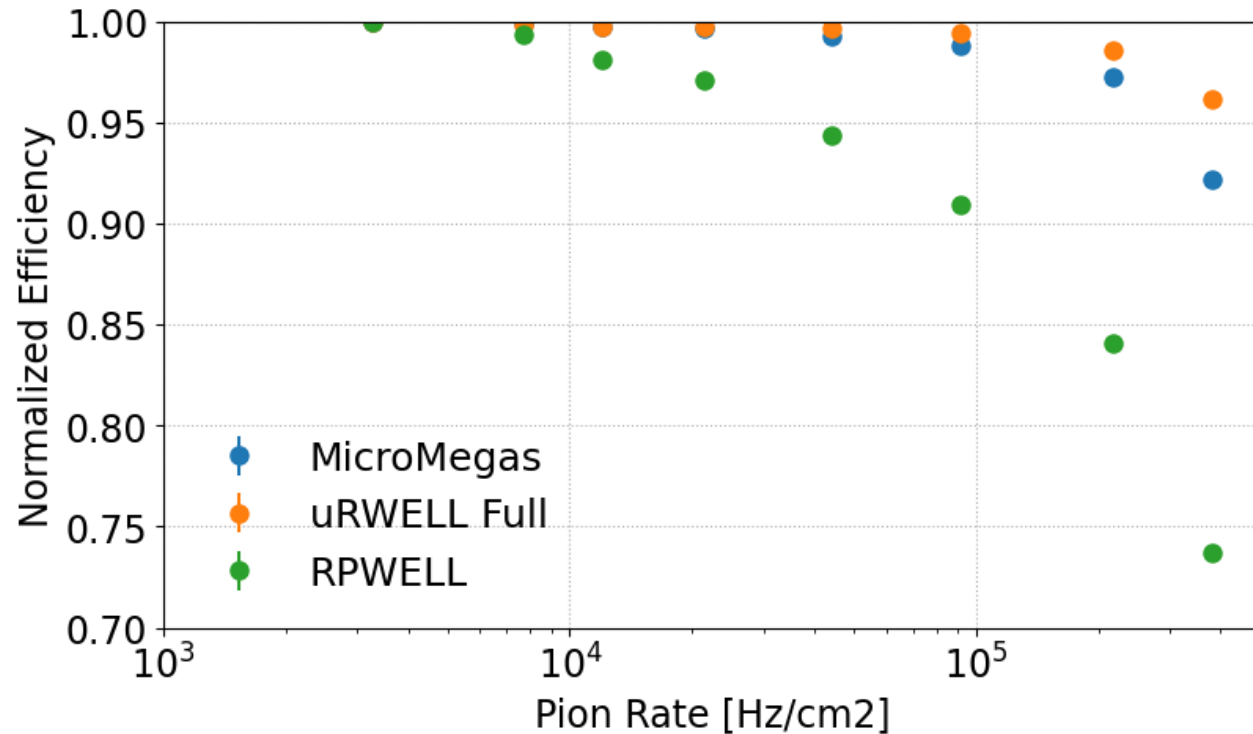
## RPWELL

- Rise time  $\sim 2000\text{ns}$
- At 200 ns,  $32.1 \pm 1.3\%$  of the total amplitude is measured



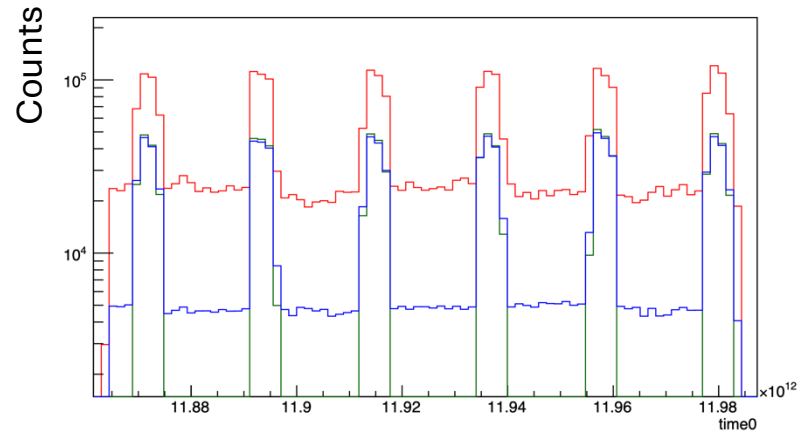
This has to be taken into account for gain estimation.

# Rate capability with pion beam

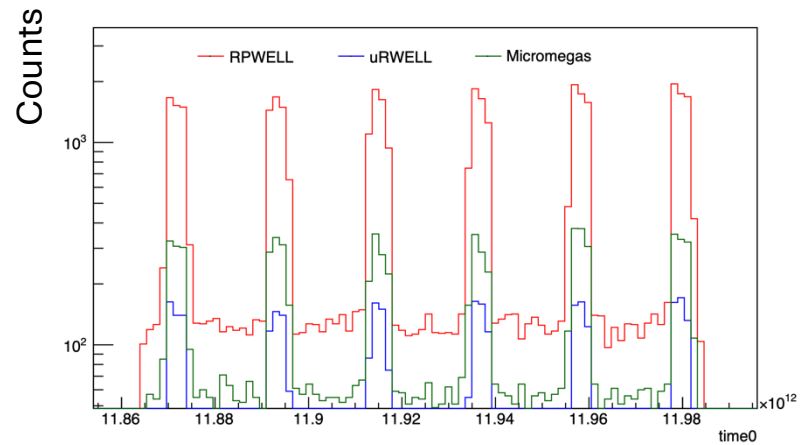


- Detectors operated at the efficiency plateau with  $\sim$ optimal drift field
- Efficiency normalized to the first point
- RPWELL drop  $\sim$ 26% due to higher resistivity
- MM and uRWELL drop by 8 and 4% respectively

# Off-beam activity – stability



← Reported in MPGD2024



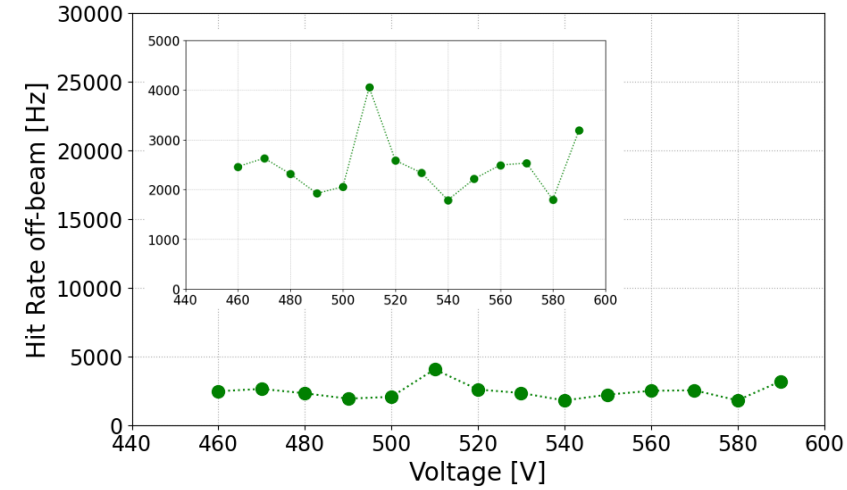
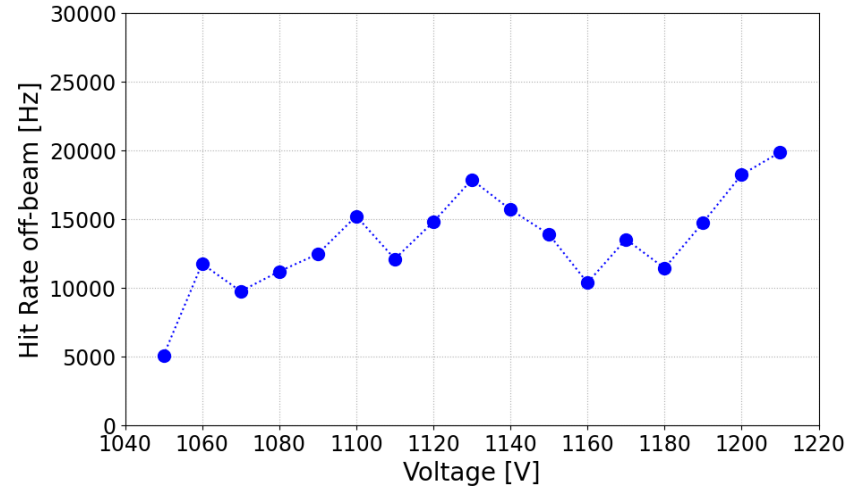
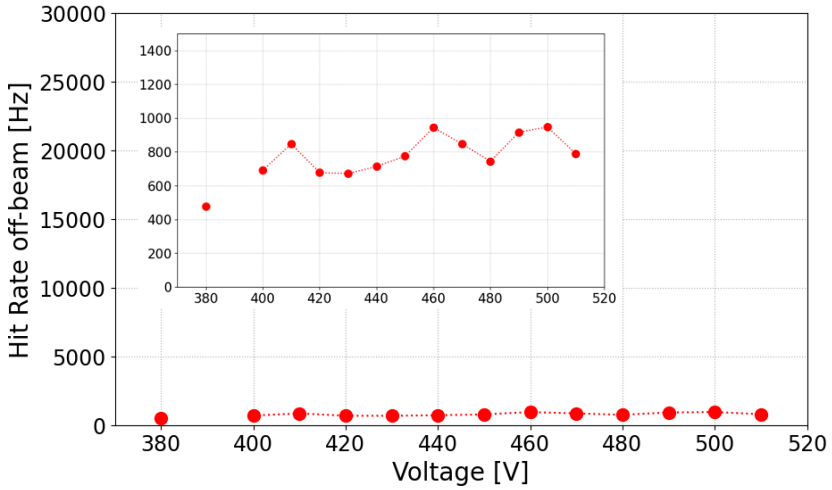
# Off-beam activity

Micromegas

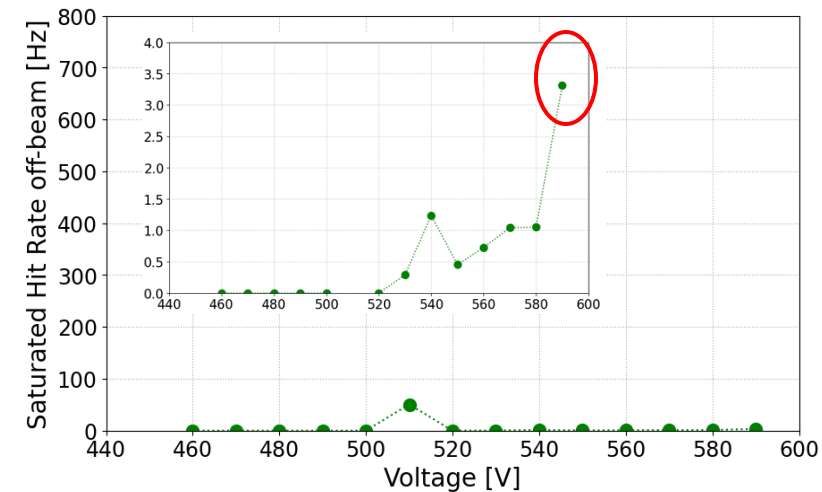
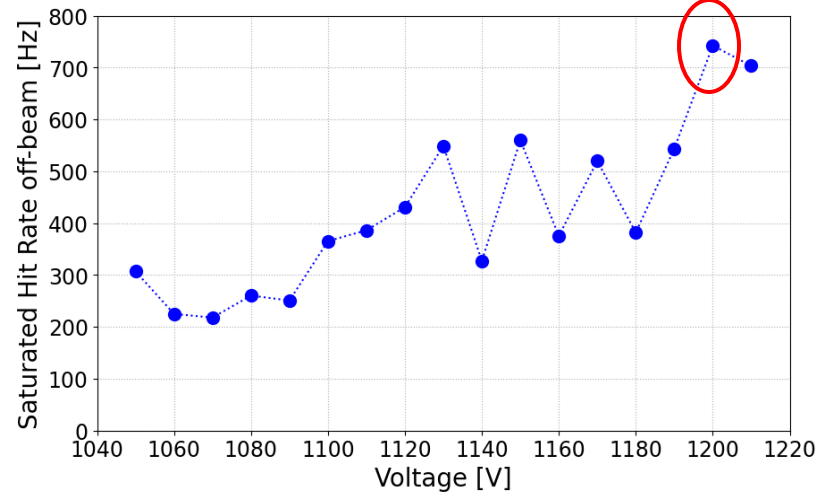
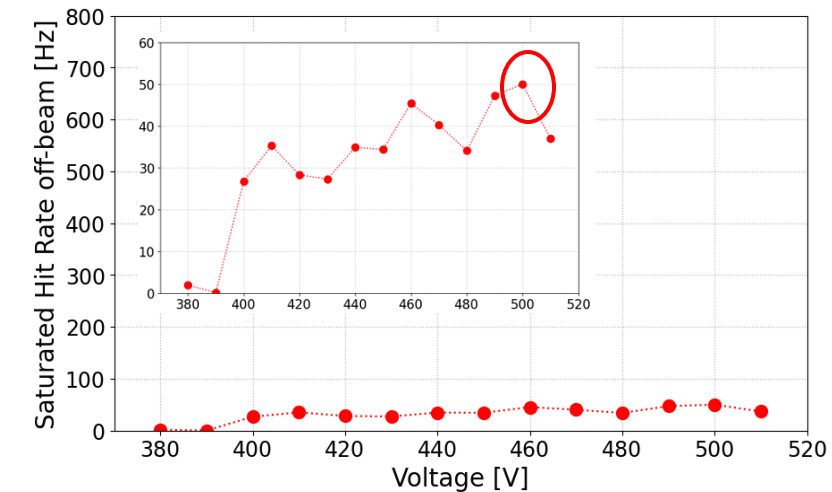
RPWELL

uRWELL

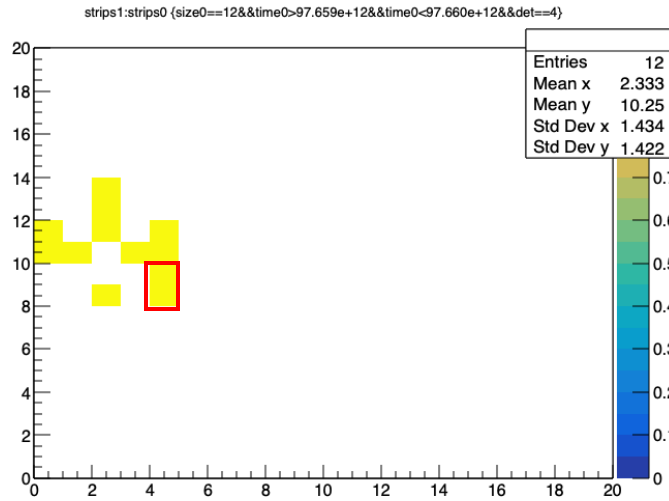
## 1. All hits rate in off-beam



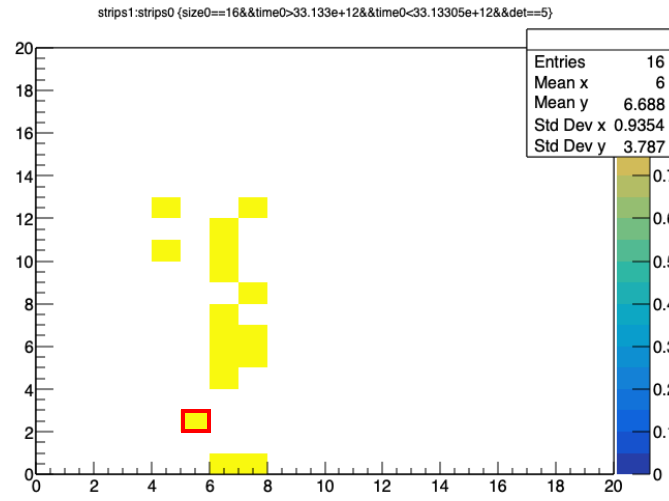
## 2. Saturated hits rate in off-beam



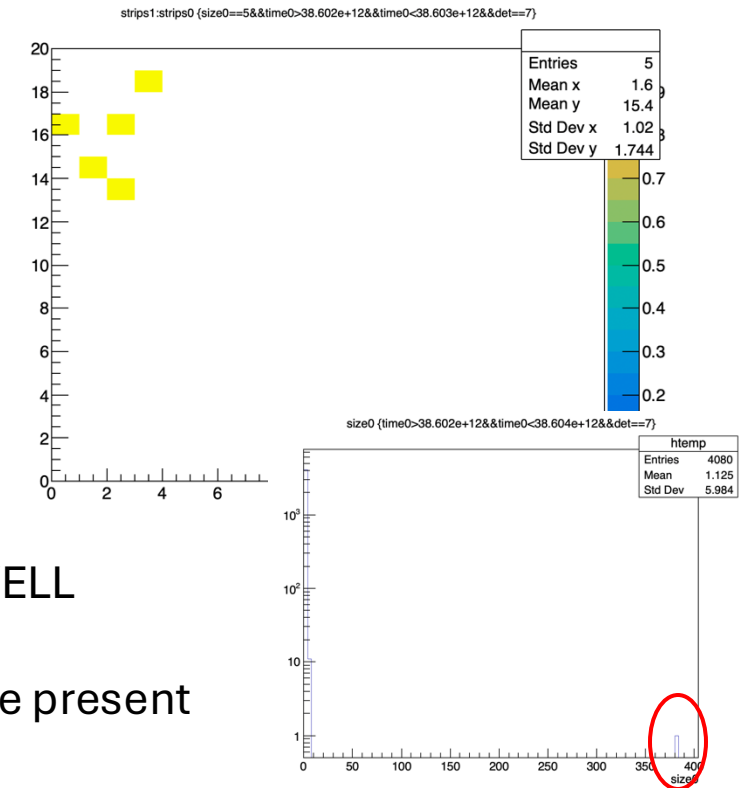
## Micromegas



## RPWELL



## uRWELL



1. Saturated clusters (with saturated single hits) are present in MM and RPWELL
  2. Size of saturated clusters in RPWELL is higher than in MM
  3. No saturated clusters in uRWELL, but huge size non-saturated clusters are present
- Further analysis needed and ongoing