Aging & discharge studies of μ-RWELL technology

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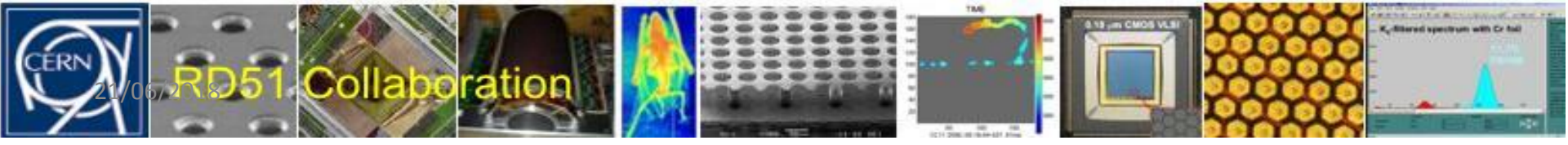
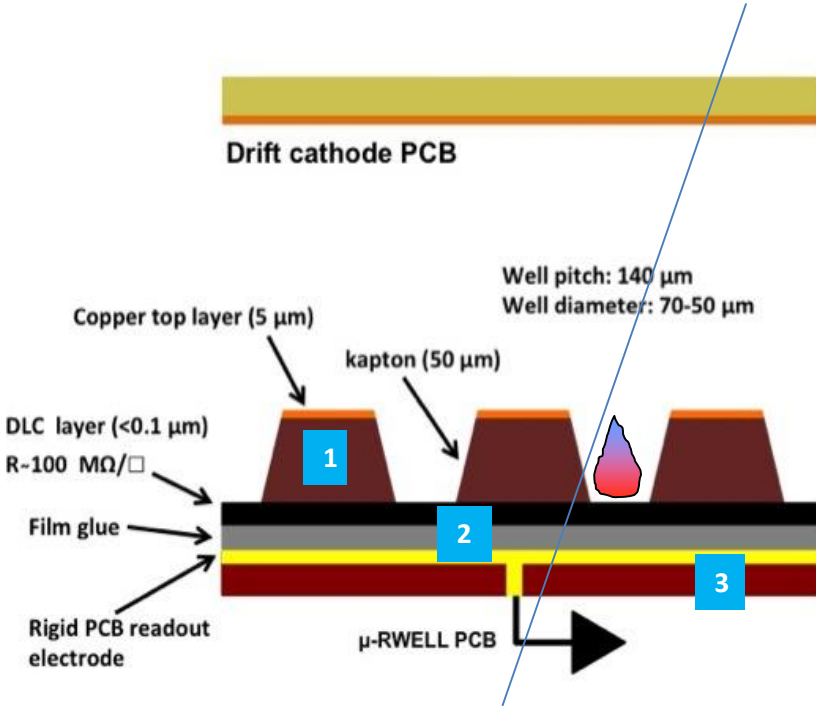


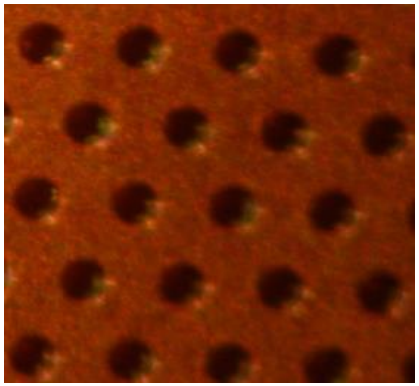
The μ-RWELL: the detector architecture

The μ-RWELL is composed of only two elements:
the **μ-RWELL_PCB** and the **cathode**

The **μ-RWELL_PCB, the core of the detector,** is realized by **coupling:**

1. a **WELL patterned kapton foil** as **amplification stage**
2. a **resistive layer (*)** for discharge suppression & current evacuation:
   i. **Single resistive layer (SRL) <100 kHz/cm²:** surface resistivity ~100 MΩ/□ (SHiP, CepC, Novosisbirsk, EIC, HIEPA)
   ii. **Double resistive layer (DRL) >1 MHz/cm²** (for LHCb-Muon upgrade & future colliders - CepC, Fcc-ee/hh)
3. a **standard readout PCB**





(*) DLC = Diamond Like Carbon
highly mechanical & chemical resistant

DLC aging/discharge

wrt to a GEM detector the only new component in the μ-RWELL is the DLC, so that we think that aging/discharge studies for μ-RWELL should mainly be focussed on DLC behaviour under irradiation and current drawing

DLC Ageing/Discharge tests

To do list within the framework of the RD51-CP (USTC, Kobe, CERN and LNF :

- Ageing effects of the **DLC** due to **current flow** inducing a **high current density:**
  - **GIF++ : current up 10 nA/cm^2** **TEST ON GOING**
  - **5.9 keV X-ray: current up to 30 nA/cm^2**
  - **current drawn by DLC (no radiation) in a gas-tight box with controlled humidity: current up to 1μA** **IN PREPARATION**

- **Discharge tests of DLC embedded on detectors** irradiated with different radiation source:
  - **localized 5.9 keV X-rays (spot 4x4 cm2)**
  - **gamma source (660 keV from ^{137}Cs – spot 10x10 cm^2)** **ON GOING**
  - **alpha particles (5.4 MeV from ^{241}Am)** **ON GOING**
  - **thermal neutrons**

Summary

The μ-RWELL is a new technology suitable for **large area planar tracking devices** as well as **high space resolution Cylindrical Inner Trackers:**

- **gas gain > 10^4**
- **rate capability > 1 MHz/cm²** *(w/HR layouts)*
- **space resolution < 100μm** *(over a large incidence angle of tracks)*
- **time resolution ~ 5.7 ns**

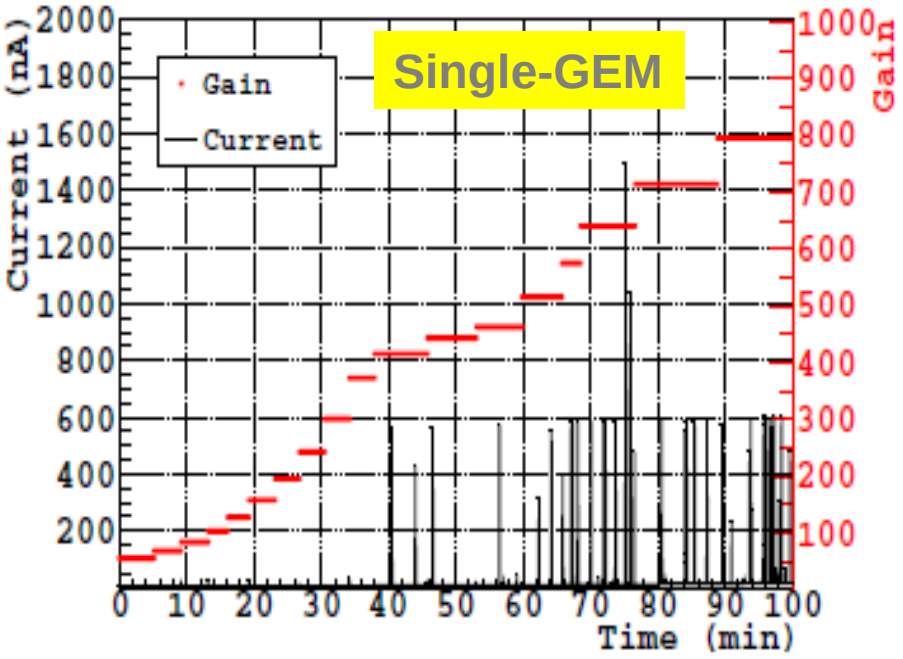
<u>Status of the R&D/engineering:</u>

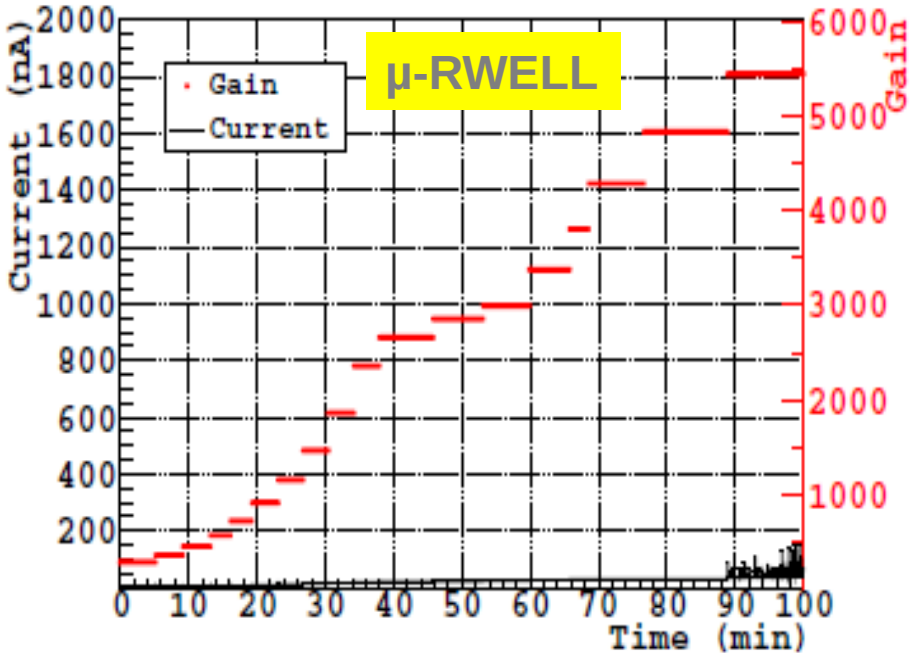
- **Low rate (<100kHz/cm²) :**
  - **small and large area prototypes built and extensively tested**
  - **Technology Transfer to industry (@ ELTOS) well advanced**
- **High rate (>1 MHz/cm²):**
  - **several layouts under study showing very promising performance**
  - **the engineering and the TT to industry will be started in 2019**
- **R&D on DLC manufacturing processes, study of stability under irradiation and current flow strongly required by the *Resistive-Community***

Every suggestion & help are welcome

SPARES SLIDES

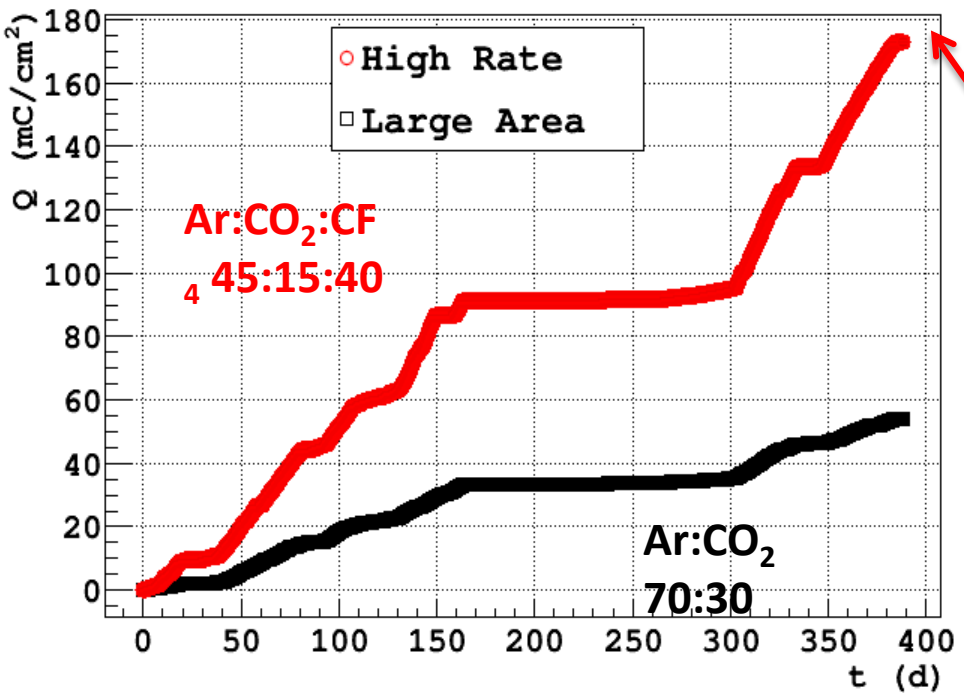
Preliminary study: μ-RWELL vs GEM





- discharges for μ-RWELL are of the order of few tens of nA (<100 nA @ high gain)
- for GEM discharges the order of 1μA are observed at high gas gain

Ageing test at GIF^{++} (I)



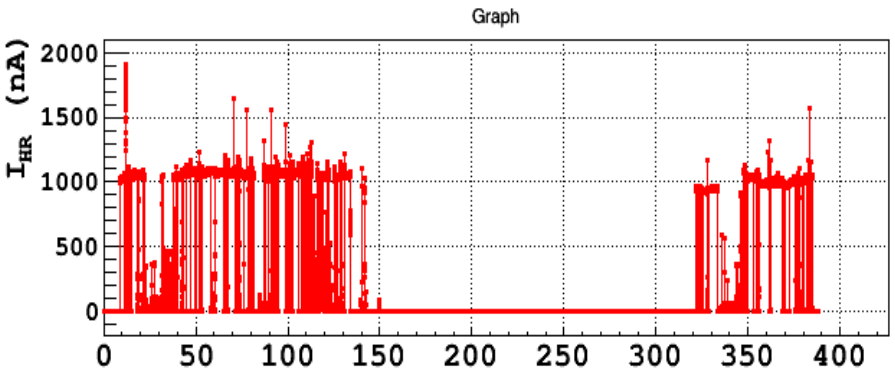
m.i.p. equivalent rate ~200 kHz/cm²

The ageing effects on DLC is under study at the GIF++ by irradiating different μ-RWELL prototypes operated at a gain of ~4000 .

On the most irradiated detector (~200 kHz/cm² m.ip. equivalent) a charge of about 180 mC/cm² has been integrated (in about 240 days up-time of the source).
No effects have been observed till now. Detectors will be opened by the end of the 2018.

Ageing test at GIF^{++} (II)

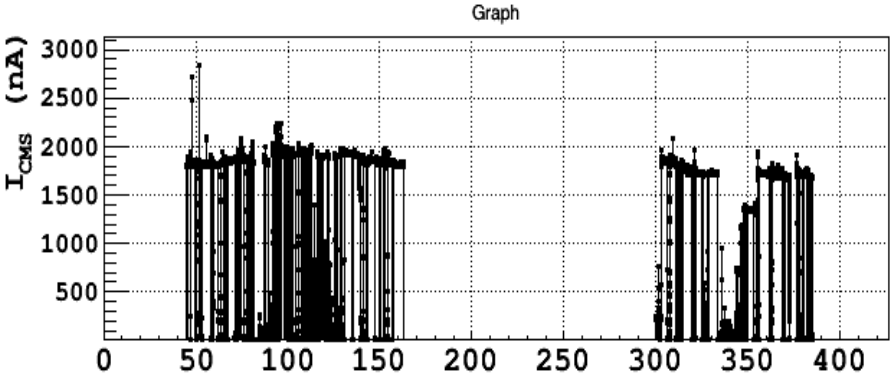
Very Preliminary



HR:

- $Ar/CO_2/CF_4$= 45/15/40
- ρ_s ~ 12 MΩ/□
- 100 cm^2
- 200 kHz/cm^2 mip equivalent
- Up-time ~ 1,6x10^7 sec
- N_{spark} ~ 32

P_{spark} ~ 1x10^{-13}



LR:

- Ar/CO_2 = 90/10
- ρ_s ~ 70 MΩ/□
- 380 cm^2
- 130 kHz/cm^2 mip equivalent
- Up-time ~ 1,7x10^7 sec
- N_{spark} ~ 19

P_{spark} ~ 2x10^{-14}

sampling time 1 ms / acquisition rate every 2 seconds