URANIA-V 2022: new resistive detectors

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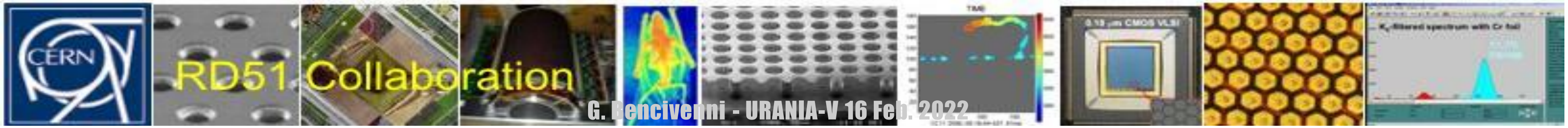
[1] LNF– INFN

LNF - DDG



micro-RWELL neutron – tile (I)

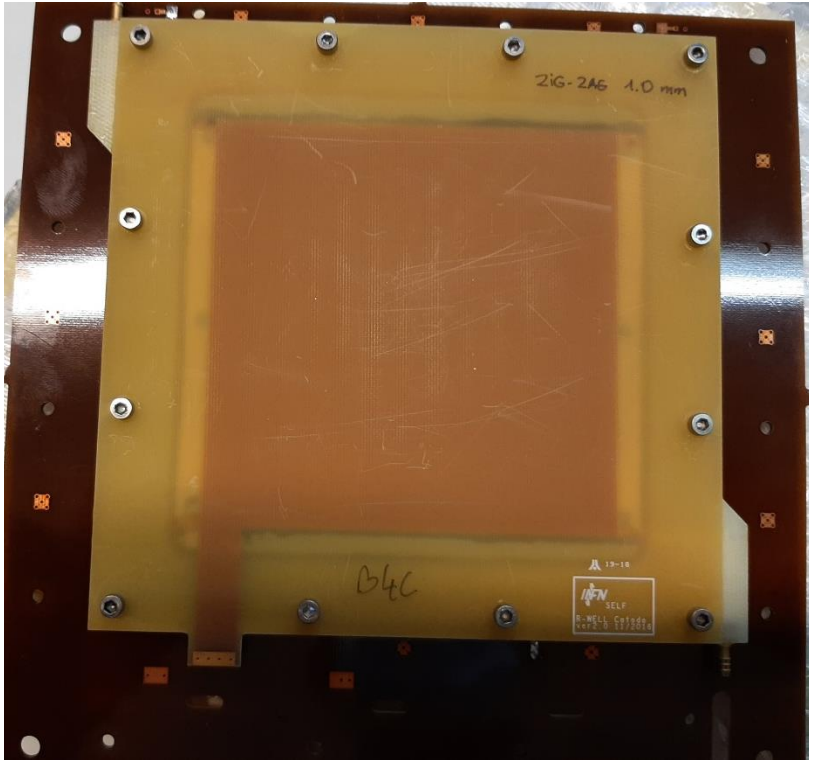
Detector features:

- single-pad detector 10x10 cm2 active area
- LR layout:
  - no HV TOP segmentation
  - no DLC segmentation with usual current evacuation grid
- 6 mm drift gap
- equipped with different cathode layouts:
  - N.2 2.5 um B4C coated flat cathode
  - N.3 ‘2.5 um’ B4C coated grooved (0.25-0.5-1.0 mm pitch) cathode
- instrumented with CREMAT 110:
  - new board w/two CREMAT for the readout of the TOP + PAD
  - HV double filter on board
  - integrated Faraday Cage

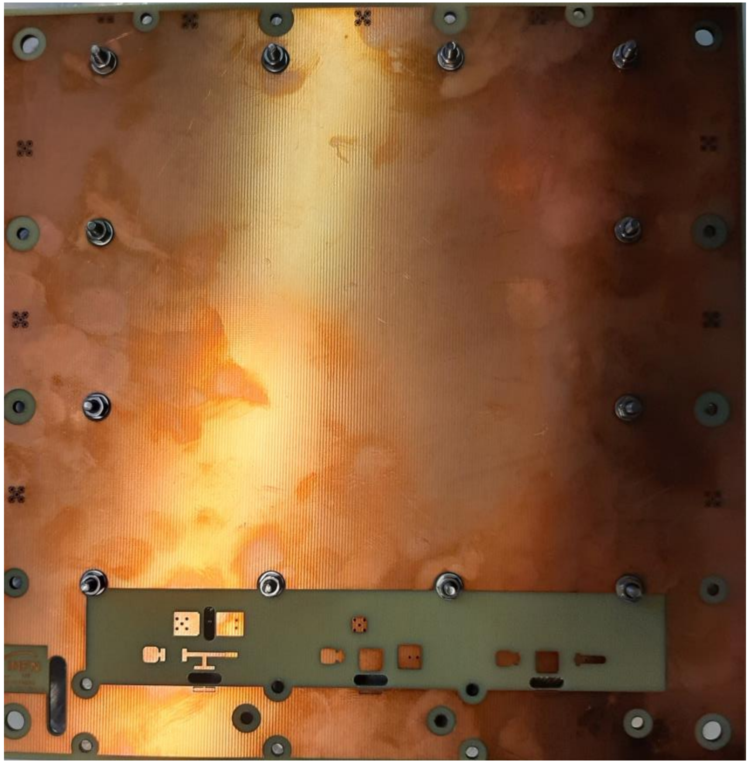
micro-RWELL neutron – tile [I.I]

Resistività Mohm/sq	HV test (@500V)	Cathode	B4C (micron)	O-ring
55	100G	Grooved 1 mm	2.5	2.62
56	100G	Planar	3.5	2.62
28	100G	Planar	3.5	3.54
34	100G	Grooved 0.5 mm	3.5 (?)	2.62
29	100G	Planar	2.5	2.62
51	100G	Planar	0	2.62
30	100G	Planar	0	2.62
58	100G	Planar	0	3.54
52	100G	Planar	0	3.54
52	100G	Planar	0	3.54
29	77M	Grooved 0.25 mm	2.5	2.62

micro-RWELL neutron – tile (I)

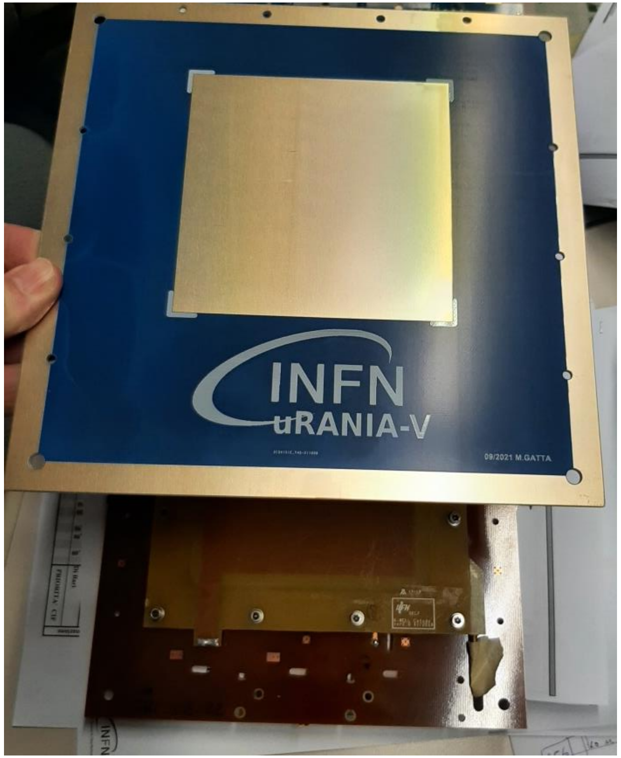


FRONT



BACK

micro-RWELL neutron – tile (II)



FRONT w/Faraday Cage

BACK w/FEE board

BACK w/FEE + Faraday Cage

sRPC vs RPC

- **Classical RPCs :**
  - **bulk resistivity electrodes** (bakelite or float-glass)
  - recovery time proportional to **volume resistivity** and **electrode thickness**
  - **low volume resistivity and thin electrodes,** together with the **reduction of the gas gain** is the standard **recipe to increase the detector rate capability**

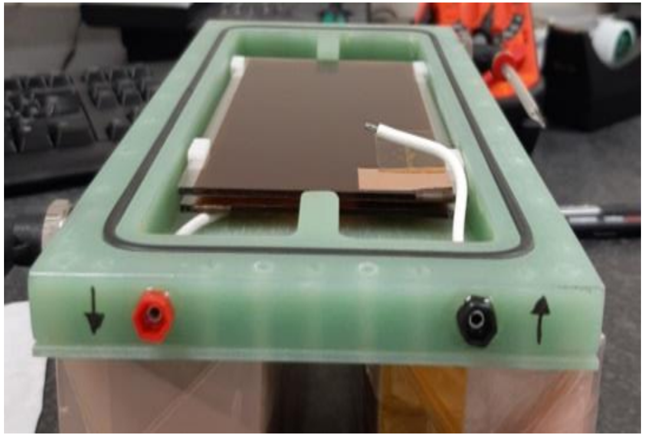
- **sRPC**:
  - **surface resistivity electrodes** manufactured with industrial sputtering techniques of **DLC on flexible supports**
  - the technology allows to realize electrodes with a surface resistivity in a **very wide range, 0.01 ÷ 10 GΩ/□**
  - **high density current evacuation schemes**, similar to the ones used for **resistive MPGD** (μ-RWELL), can be implemented **to increase the rate capability** of the detector

Prototype design

Two layouts

1) a **symmetric** one with **both electrodes made of patterned DLC** sputtered kapton foil glued on glass substrates
2) a **hybrid** version in which **one electrode is realized with DLC** kapton foil on glass and the second **one made of float-glass** powered by means a copper tape on the external side

The **2 mm gas gap** between the two electrodes is ensured by **E-shaped spacers made of Delrin**.
The electrodes stack is inserted in a **FR4 box that acts as gas volume container.**

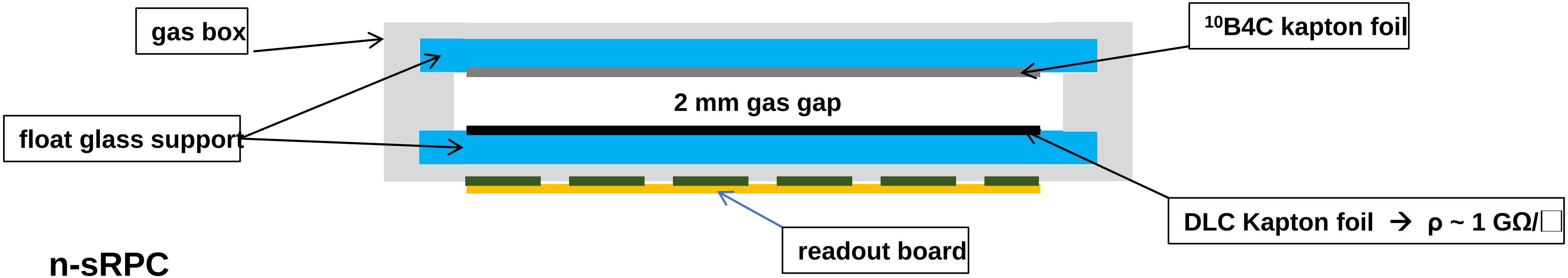


sRPC for thermal neutron detection

neutron detection with ^{10}B4C

- detecting **thermal neutrons** (E_k ~ 25meV) with **$^{10}B_4C$** deposition on one of the two detector electrodes
- **neutron converts** in ionizing particles: **α/^{7}Li** back to back
- **expected efficiency ~ 4% for single layer (2×HOTNES efficiency)**

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



n-sRPC

- the **anode**, with **DLC coated kapton foil**, acts as **"voltage-quencher"**, ensuring the correct operation of the detector
- the **cathode**, with low resistivity **^{10}B4C coated kapton foil,** acts as "**neutron-converter"**
- the **sRPC as neutron detector is operated at much lower voltages** than in mip detection mode

Milestones 2021

M1: realizzazione di convertitori a mesh e grooved-cathode e costruzione prototipi
M2: analisi dati del test beam di HOTNES con prototipi equipaggiati con converters a mesh e grooved-cathode instrumentati con elettronica commerciale

Milestones 2022

M3: costruzione e test di una detector tile head-on con grooved cathode/mesh converters ed elettronica counting integrata
M4: costruzione e test di prototipi basati su tecnologia sRPC