Jefferson Lab

µRWELL-PICOSEC CERN 2024 test beam plans

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Radiation Detectors & Imaging Group (RD+I Group) - JLab

JLab PICOSEC Team:

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- Jack McKisson
- Brian Kross
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JLab plan for 2024 PICOSEC test beam campaigns

April test beam campaign

- **Akash and myself** will participate in the test beam; Akash will come 2 or 3 days before to familiarize with activities in GDD lab
  - When do we know the dates? We would need at JLab to know at least 10 weeks before hand
  - Will be great if test beam is scheduled happens **in early May** ➔ Single trip to continue to Pisa meeting (end of May).
- Focus on 8 new single-pad prototypes with different parameters: HV scans (cathode / µRWELL) to optimize timing and stability
- Interested only in CsI photocathode ➔ will send up to 6 MgF2 crystal ahead of time for CsI deposition
- Will provide a JLab PICOSEC telescope stand for 4 prototypes (similar to RD51 telescope) + GEM SRS and DAQ PC
- Will request one position scan run for 10 × 10 pad µRWELL-PICOSEC on CERN RD51 telescope ➔ JLab telescope not ready for large proto

July or September test beam campaign

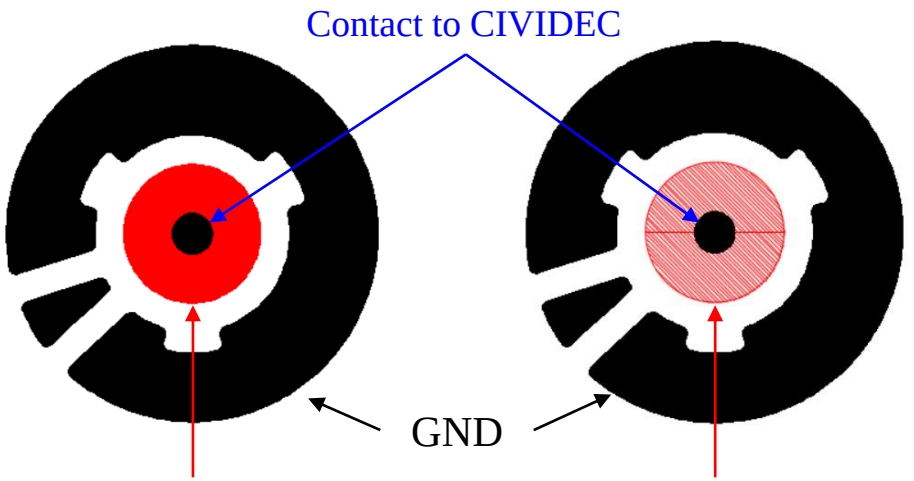
- We plan to participate in one of the other two other test beam ➔ probably the two of us
- This second test beam will focus on our two 10 × 10 large prototypes (our MM-PICOSEC for reference and µRWELL-PICOSEC
- We will use our telescope stand and multi-channel readout electronics (Marinko's preamps + SAMPIC digitizer and LMH6881 + picoTDC)
- We will still continue the test of small prototypes as needed (stand can accommodate 2 small + 2 large prototypes)
- Focus again on CsI photocathode but we will also try DLC if we have time

New single-pad µRWELL-PICOSEC prototypes

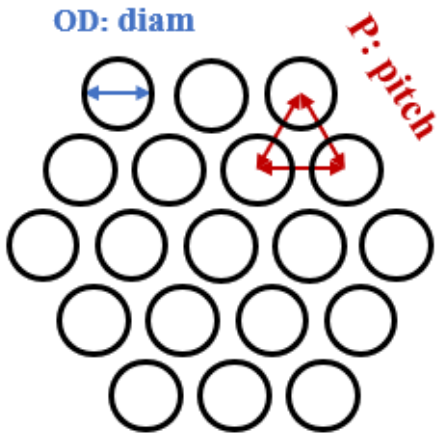
From lessons learned following the excellent 2023 test beam campaigns ➔ improvement of timing performance require:

- New mechanical housing of single-pad device ➔ Antonija's new design
- Minimization of detector capacitance by reducing pickup pad area
  - Plain solid pad vs. hash pattern pad
- New µRWELL hole geometries: 3 main approaches under investigation
  1. Minimize pitch to outer diameter ratio ➔ reduce e-field effect
  2. Increase hole density ➔ Increase gain capability
  3. Standard round holes vs. square holes ➔ mimic MM mesh pattern

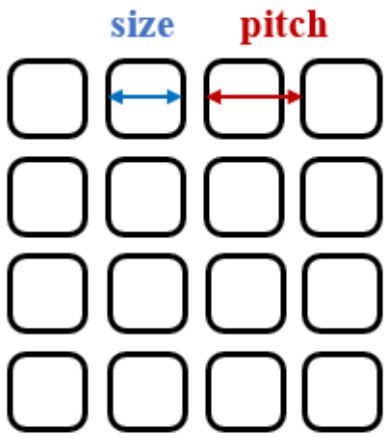
Pad readout geometry



New holes geometry for µRWELL amplification



Round holes (RD)



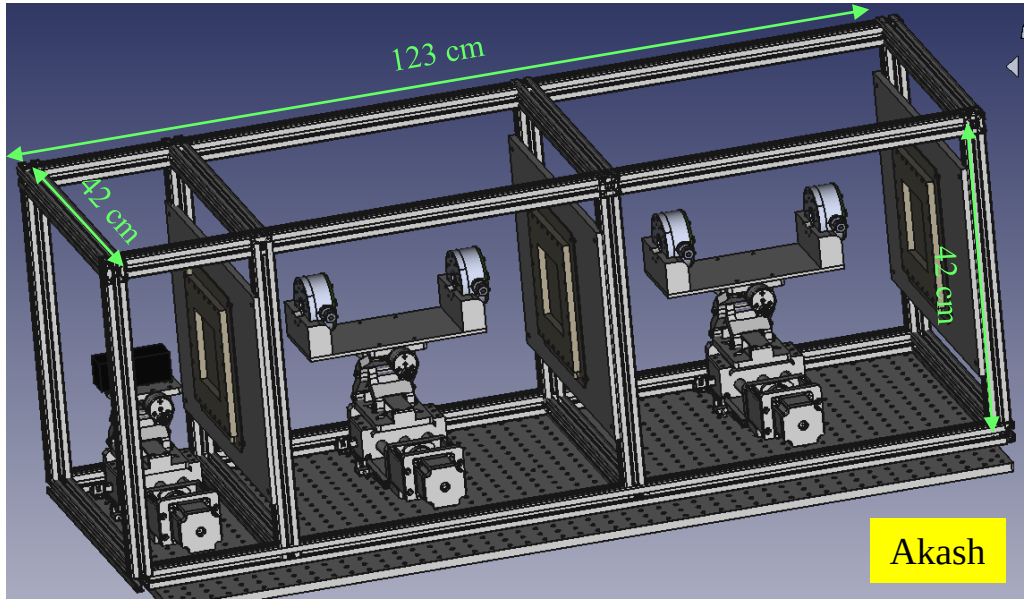
Square holes (SQ)

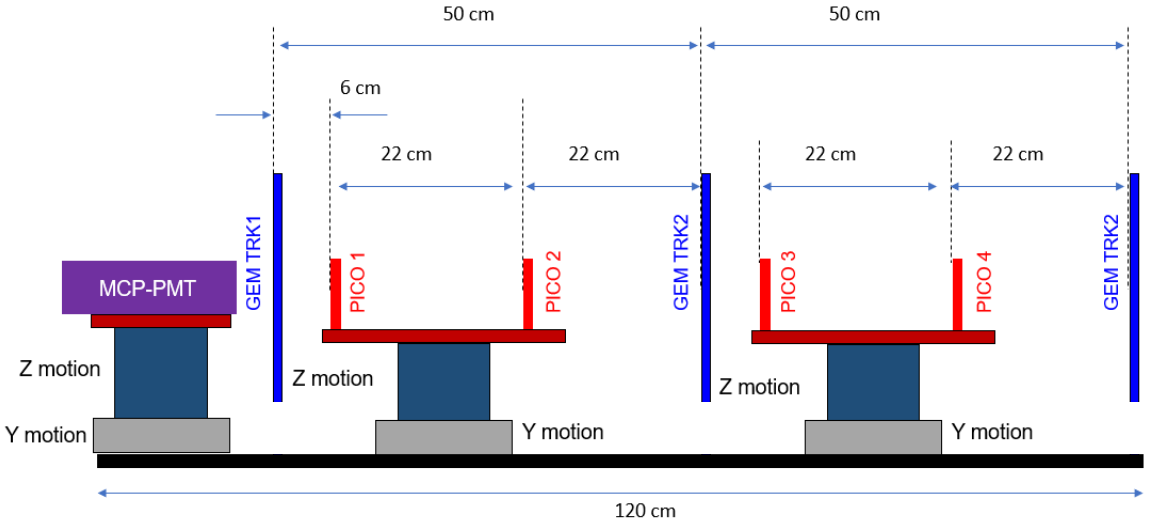
Prototype	Shape	P (µm)	OD (µm)	ID (µm)
1: RD-T150-P80-D60	round	80	60	40
2: RD-T150-P100-D80	round	100	80	60
3: RD-T150-P120-D100	round	120	100	80
4: SQ-T150-P120-D100	square	120	100	80

µRWELL-PICOSEC Telescope

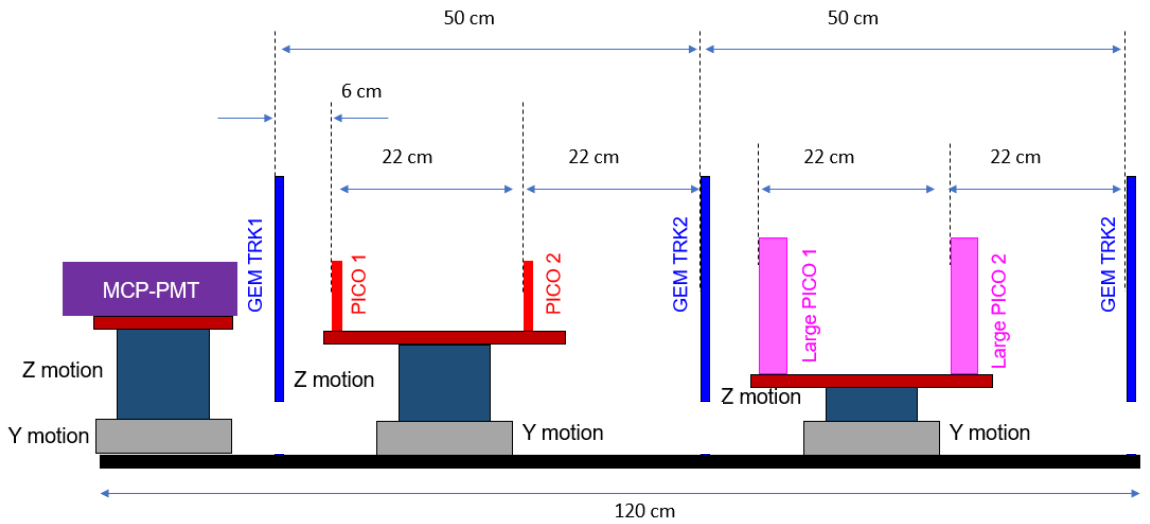
- Dedicated telescope for µRWELL-PICOSEC prototypes testing
- Include 3 GEMs for tracking and 1 MPC-PMT for trigger and timing
- 4 CIVIDEC preamps for the prototypes signal
- DAQ PC for the GEM trackers, HV and controls of the motion devices
- Test up to 4 single-channel prototypes in **setup#1** configuration or 2 single-channel and 2 10x10 pad prototypes in **setup#2** configuration
- **April test beam will focus only on single-channel setup#1 configuration**
- The CAD drawing is almost complete ➔ start procurement of the parts this week
- Can we borrow the spill container at CERN?

CAD design of the µRWELL-PICOSEC telescope stand





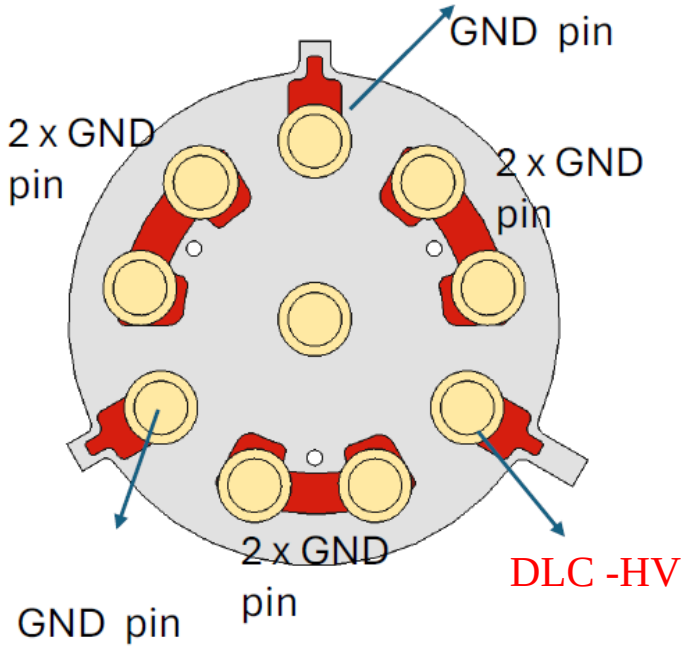
Setup#1: 4 single-channel prototypes **(April test beam)**



Setup#2: 2 single-channel and 2 10x10 prototypes **(July test beam)**

µRWELL-PICOSEC Prototypes: Parts

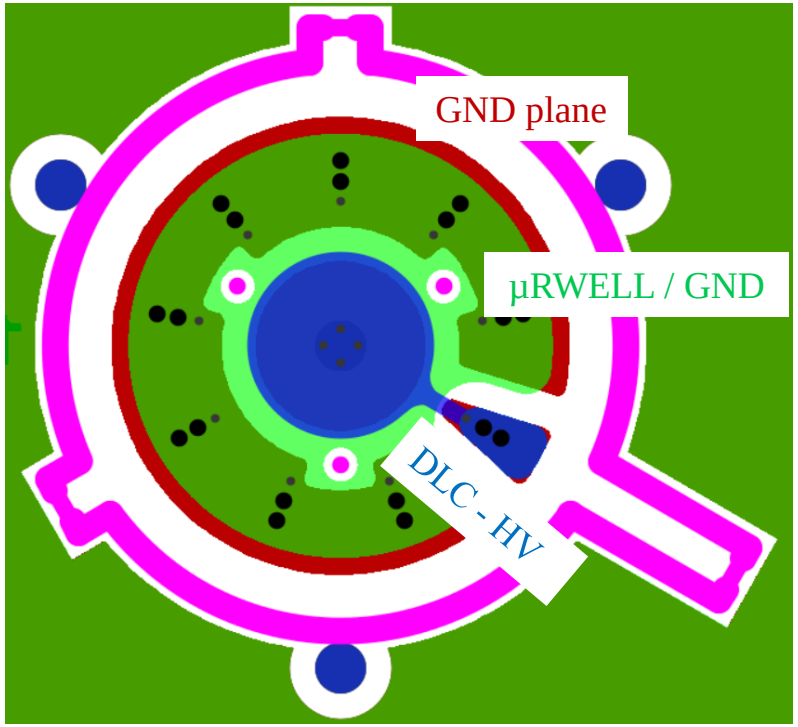
Outer HV and Signal PCB



based on Antonija's design

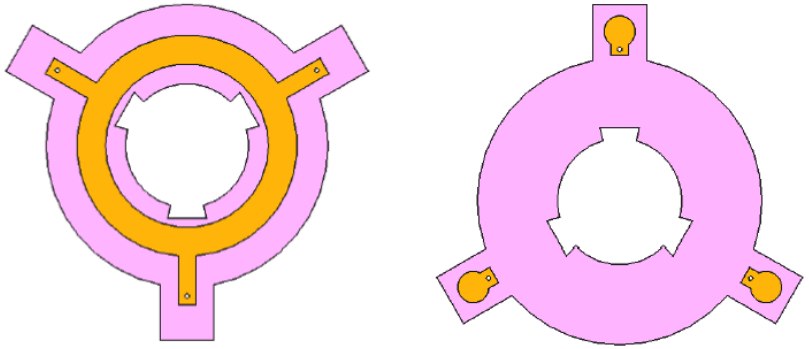
- Everything is checked out correctly ➔ no obvious conflict in the design between resistive MM and µRWELL
- Need to get the files from Antonija / Marinko and place the order ➔ this week

Gerber view of the µRWELL-PCB design



- The prototypes are ready for shipment to JLab
- I have MgF2 crystals in hand
- need at least 4 CsI photocathodes ➔ will have to ship crystals to CERN ahead of time for CsI deposition before beam test start
- **Fused silica entrance windows?**

Cathode ring and Kapton spacers



-1 panel of minimum 4 pieces (17um Cu + 100 um Kapton)
50um polyimide + 50um coverlay
-1 panel of minimum 4 pieces (17 um Cu + 150 um Kapton)
50um polyimide + 100um coverlay
-1 panel of minimum 4 pieces (17 um Cu + 200 um Kapton)
50um polyimide + 150um coverlay

based on Antonija's design

- PO in JLab bureaucratic pipeline
- Will get to Rui hopefully this week

Readout electronics and DAQ

Readout **for Single-channel** prototypes (ready for April test beam campaign)

- 4 CIVIDEC fast preamplifier in hand to be used at the April test beam
- Will borrow 2 fast oscilloscope at CERN electronics pool for the DAQ during the beam test

Readout for **10 × 10 pads** prototypes (Full system to be ready for July test beam campaign)

Two systems under consideration

- Marinko's preamps + SAMPIC digitizers
  - 70 channel preamp (7 x 10-ch PCBs) ➔ Order sent to Marinko *(delivery in April 2024)*
  - PO for 64-ch SAMPIC digitizer board + 5-slots crate + controllerV3 (4 FE) sent to D. Breton *(delivery end April)*
- LMH6881 fast amplifier + picoTDC
  - Development is ongoing with RD&I colleagues W. Xi and J. McKisson at JLab
  - Connectivity will be fully compatible with PICOSEC outer readout PCB
  - We expect to have the prototypes with multi-channel ready for test for the July test bea,
- Outer large 10 × 10 readout PCB
  - We got all the files and parts specifications from Antonija and Florian to start procurement

Back up