

# **eRD110 FY24 Progress Report**

**Alexander Kiselev (BNL) on behalf of the eRD110 Consortium**

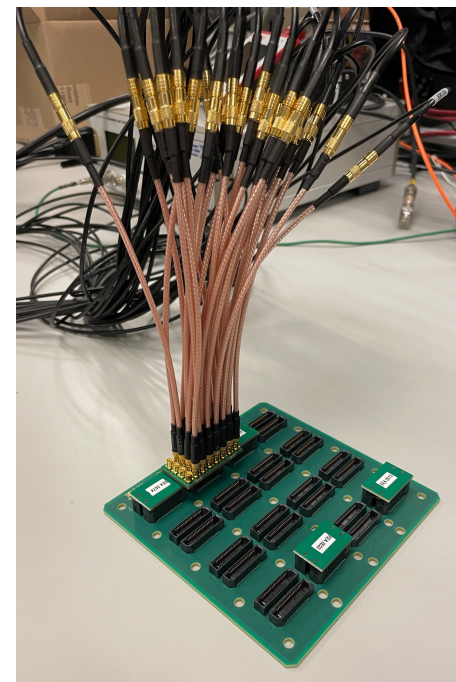
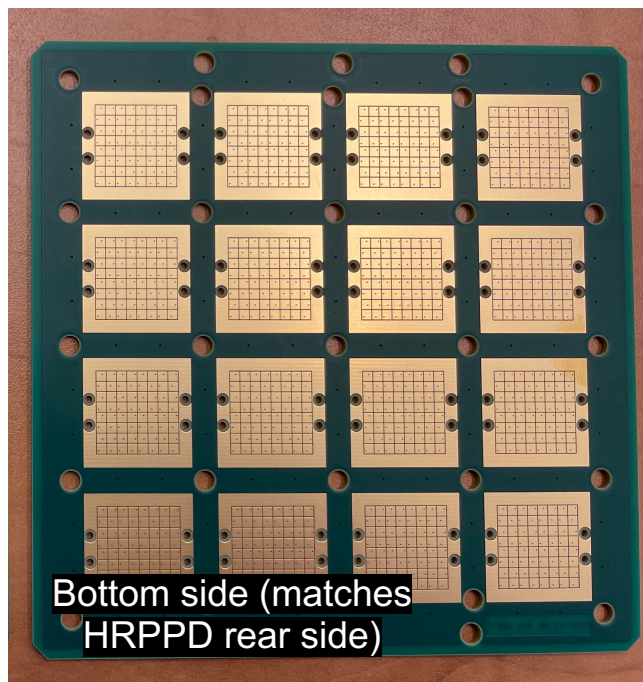
**ePIC / EIC Project Detector R&D Day, March 25, 2024**

# HRPPD / MCP-PMT evaluation activities & funding

eRD110 proposal topics as of August 2023	Actual funding	Status & plans
Samtec interposers purchase	Not funded	Ordered using FY23 carryover money
HRPPD passive interface	Not funded	Built using FY23 carryover money
HRPPD ASIC backplane	Not funded	PED funding request coming
B field studies at Argonne	MCP-PMT evaluation only	Planned for summer 2024
B field studies at INFN	Not funded	
Beam tests at Fermilab	Cancelled	Focus on lab studies in 2024
HRPPD ageing studies at INFN	FY24 funding granted	Planned for summer 2024
HRPPD QE evaluation at Argonne	Not funded	
HRPPD PDE evaluation at BNL	Not funded	
Timing upgrade at BNL	FY24 funding granted	Pretty much completed
MCP-PMT evaluation at Glasgow	FY24 funding granted	Setup upgrade work in progress

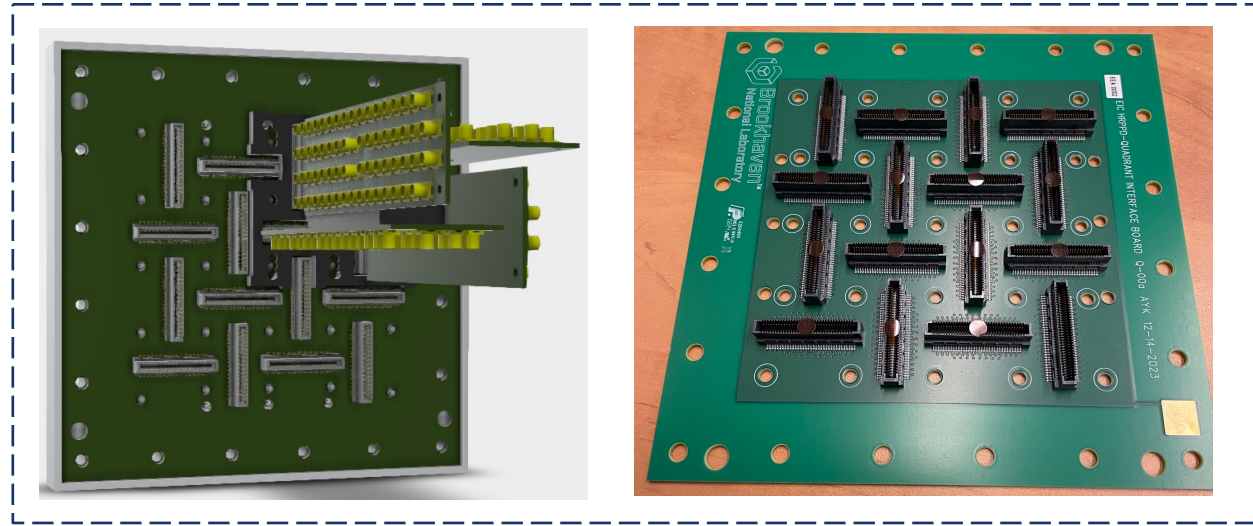
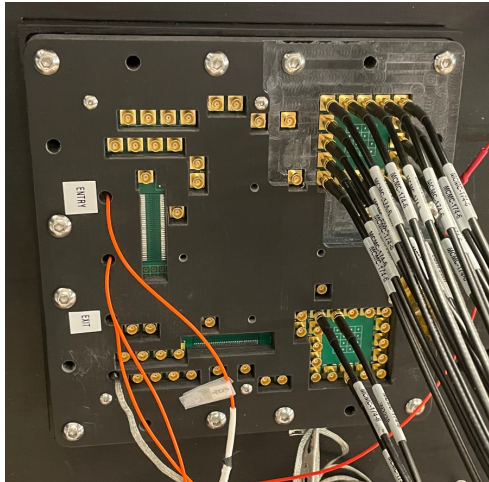
**None of the “HRPPD evaluation” items was approved**

# HRPPD passive interface #1



- For installations with a low electronics channel count
- Samtec -> MMCX adapter; MMCX -> MCX pigtail cables, grounding caps
- Four sets assembled by now (one @ JLab, one @ Incom)

# HRPPD passive interface #2



- Interface to the existing 64-channel edge-to-MCX adapter cards
- Allows one to scan a full HRPPD quadrant at once (256 channels)
- Two sets assembled (one @ Incom & one @ BNL)



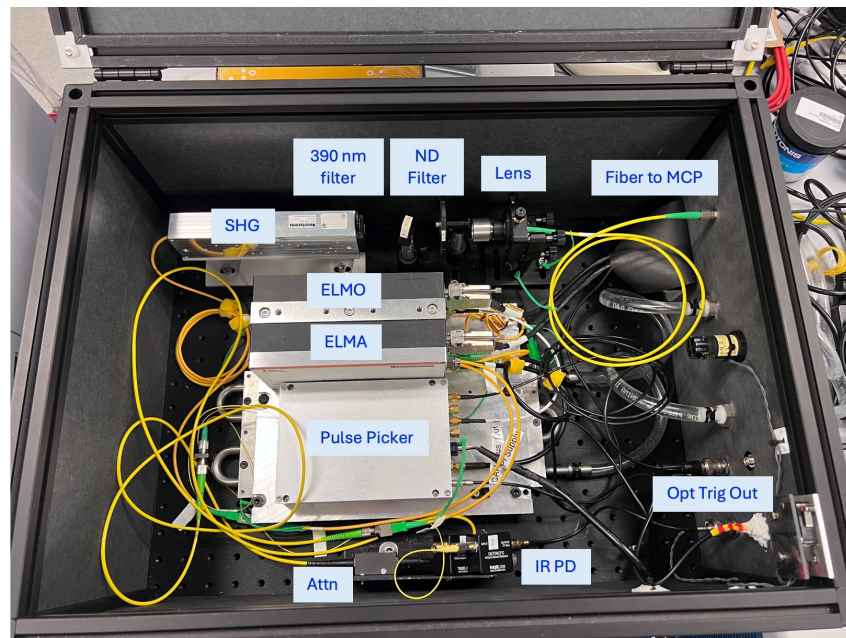
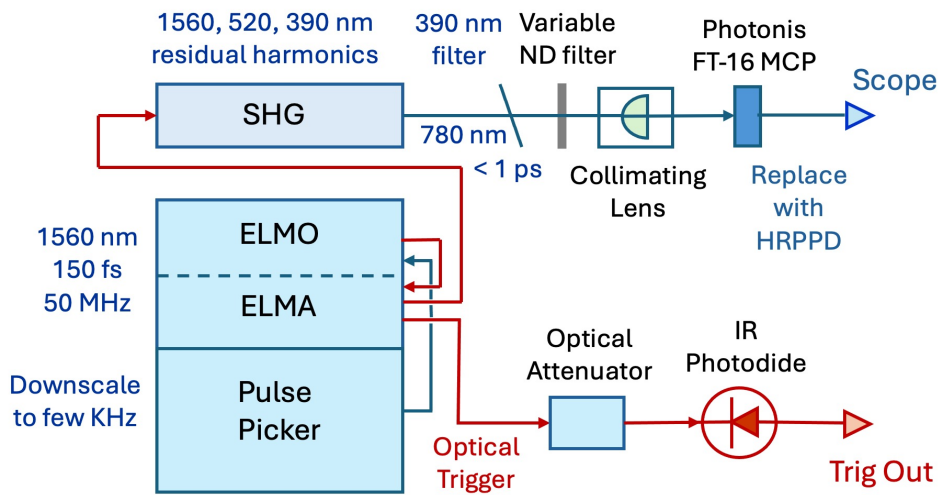
# Femtosecond laser calibration system

Menlo Systems Elmo 780 Erbium Fiber Femtosecond Laser

ELMO = Primary Laser Oscillator

ELMA = Optical Amplifier

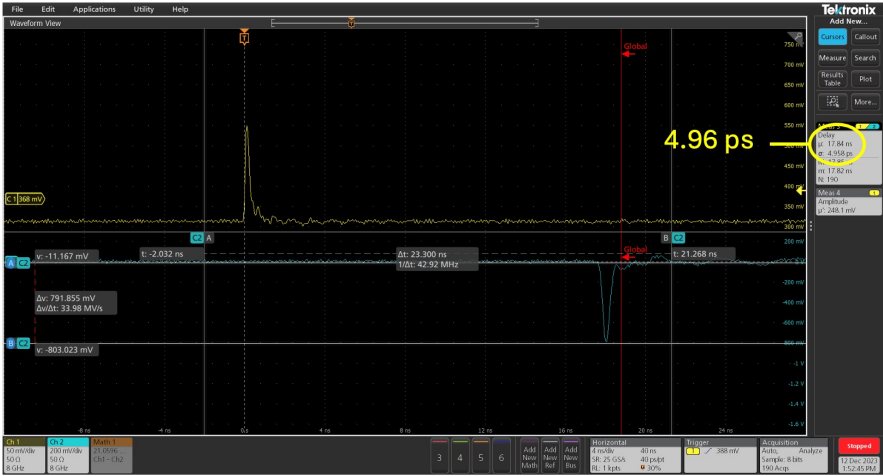
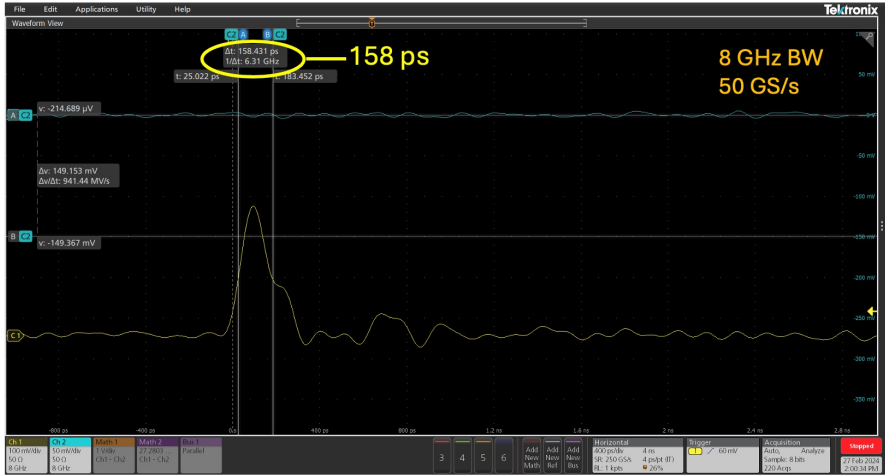
SHG = 2<sup>nd</sup> Harmonic Generator



# Measurements with Photonis MCP-PMT

IR Photodiode Pulse  
Rise Time ~ 70 ps  
Pulse Width < 160 ps

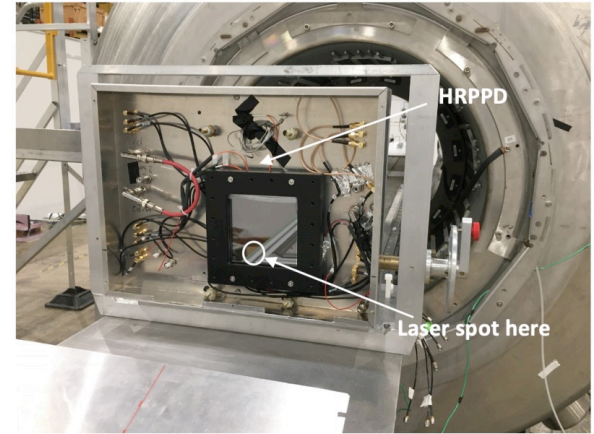
Time Jitter between Photodiode Trigger  
and MCP < 5 ps



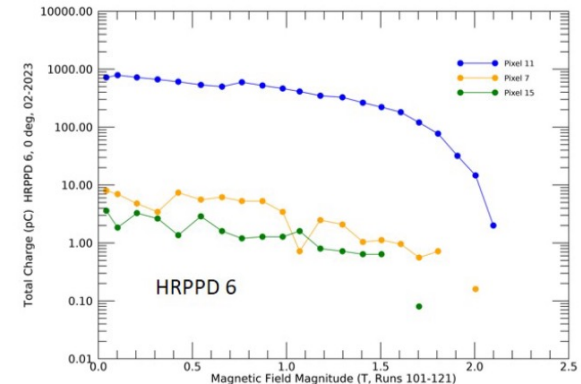
**Conclusion: we should be able to make timing measurements with a resolution < 10 ps**

# Photosensor performance in a B-field

- Generic LAPPDs and first available HRPPD were tested at the Argonne g-2 magnet in 2022-2023
  - Gain decreases as the magnetic field strength increases
  - Gain can be recovered by increasing the bias voltage of the MCPs and the photocathode
  - Conclusion: HRPPDs would work for hpDIRC and pfRICH, not suitable for dRICH due to the sensor plane orientation
- FY24: Photek MCP-PMT testing planned

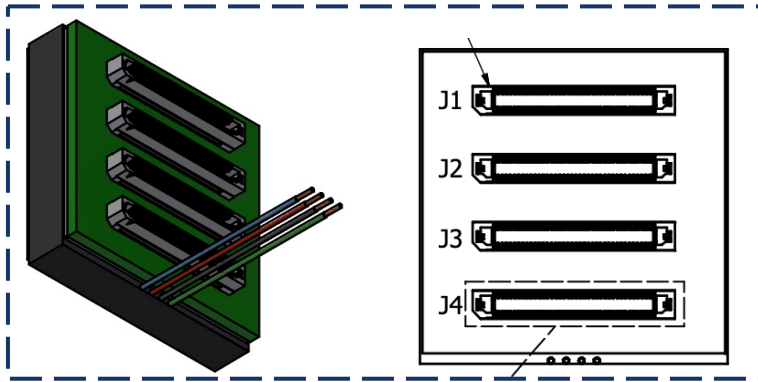


HRPPD #6 (with 10  $\mu\text{m}$  pores)  
operational up to  $\sim 1.8$  T

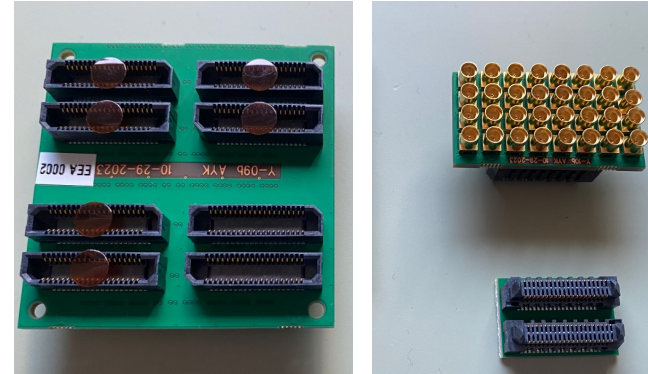


Tasks	Timeline
Magnetic field test facility at Argonne ready for 2" MCP-PMTs	June 2024
Receive MCP-PMTs, ready for fitting and test	July 2024
Magnetic field test of received MCP-PMTs	Aug 2024
Magnetic field tolerance report	Dec 2024

# Photek & Photonis MCP-PMT evaluation



Photek Auratek stock configuration



HRPPD world

- Photek Auratek MAPMT253 16x16 pixel Multi-anode MCP-PMT ordered by JLab in Dec 2023
  - Planned to be shipped to Glasgow mid April 2024
- Adapter boards available
- A 32-channel V1742 digitizer and a PCI card by CAEN ordered via USC
  - Arriving to Glasgow end of April 2024
  - Meanwhile can use a 16-channel desktop CAEN digitizer

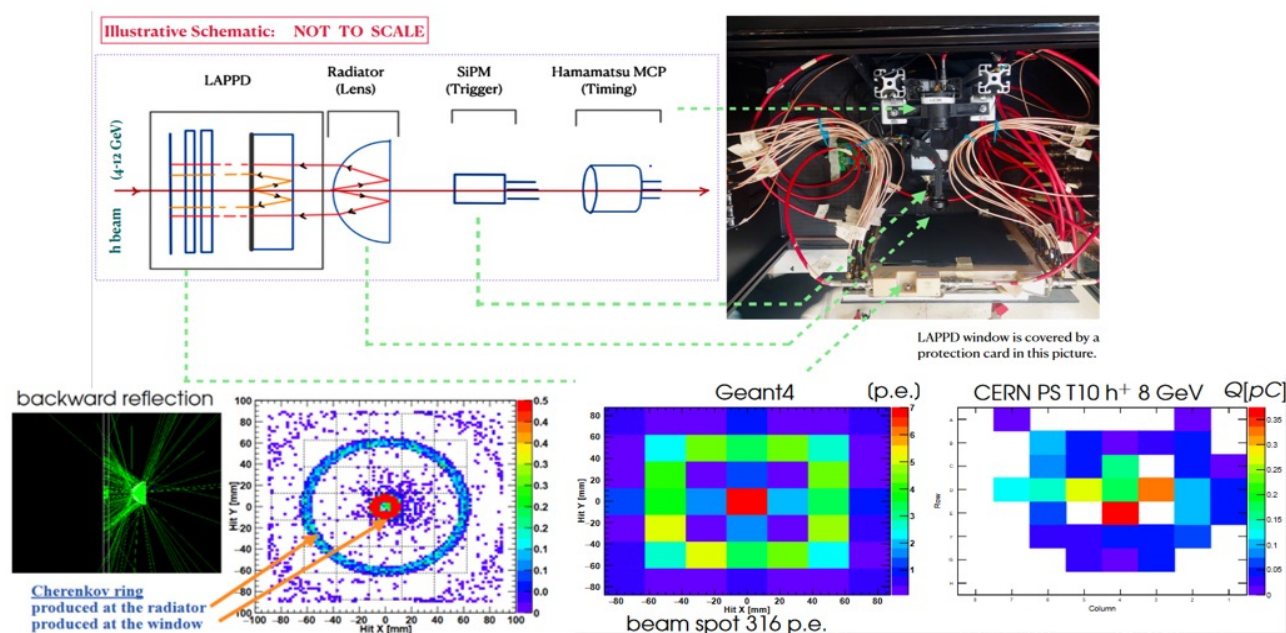


# Photek & Photonis MCP-PMT evaluation

- SoW Agreement between JLab and UoG still being set up by finance / legal teams
  - Waiting for budget in place so that pieces for upgrade of test stand can be ordered
  
- Currently arranging loan paperwork to borrow PANDA Planacon MCP-PMT from GSI
  - This is the one which was thoroughly tested at Erlangen by A. Lehmann
  - Will be on loan until Dec 2024 and used as a reference tube for UoG setup

# 2022 LAPPD beam test data analysis

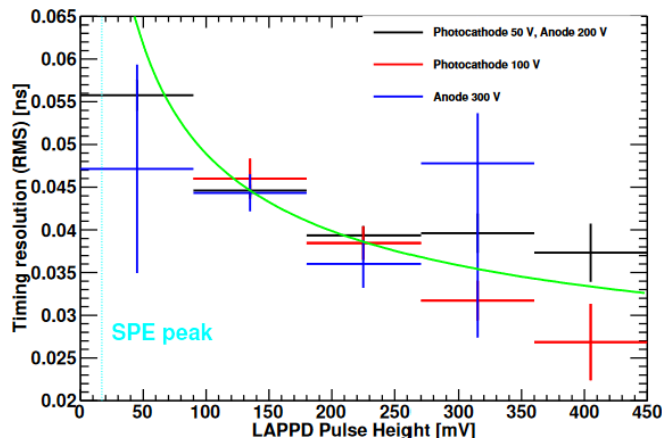
INFN groups: Trieste, Genova



- CERN PS beam line, 20  $\mu$ m pore Gen II LAPPD (capacitively coupled)
- Focus: timing performance characterization with a particle beam

# 2022 LAPPD beam test data analysis

INFN groups: Trieste, Genova



$$\sigma_t = p_0 + \frac{p_1}{\sqrt{V_{peak}/1V}}$$

**Single photon time resolution: 75 ps**  
**Asymptotic limit for large amplitude (multiple detected photons) : 18 ps**

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Full Length Article

Characterization of LAPPD timing at CERN PS testbeam

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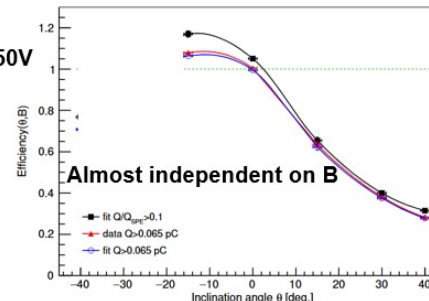
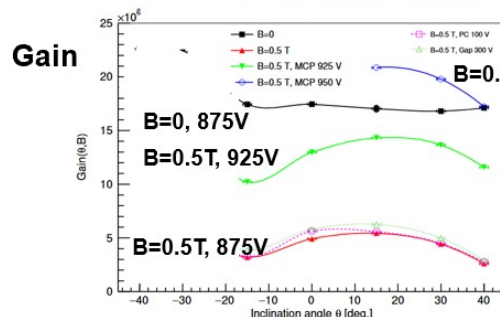
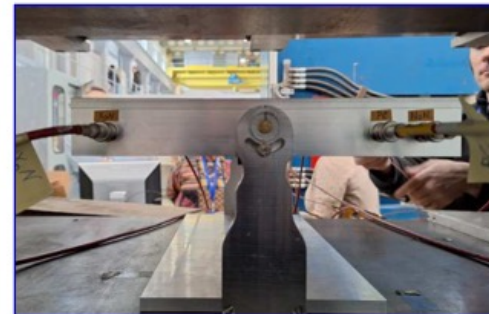
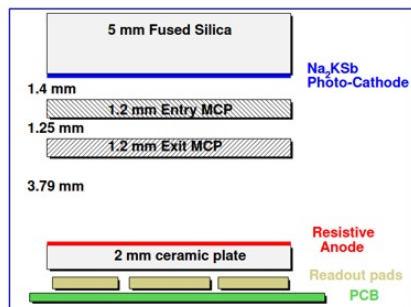
➤ Analysis finalized and a NIM paper published in 2024

# LAPPD B-field and ageing studies

INFN groups: Trieste, Genova

Essentially a carryover of the approved FY23 program

- First campaign with field up to **0.5 T** (November 2023)



Efficiency

[Slides](#)

- Second campaign with field up to **1.5 T** (March 2024, ongoing these days)
- Preparation for HRPPD photocathode ageing studies ongoing



# Summary

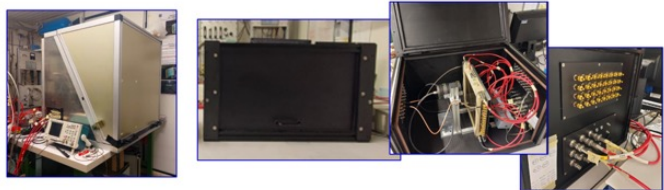
- Activities in FY24 are ongoing, within the limits of a provided funding
- We should be able to meet the milestones
  
- The whole effort is migrating into the PED world
  - HRPPD evaluation
  - Auratek & Planacon evaluation beyond FY24
  - ASIC backplane design
  - Integration into detector prototypes (pfRICH)

*Backup*

# LAPPD studies by INFN groups - HIGHLIGHTS

## ➤ INFN groups: Trieste, Genova

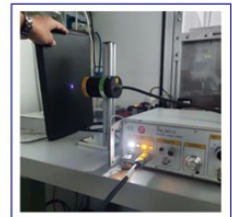
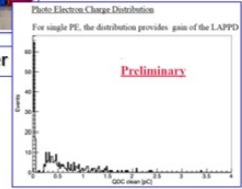
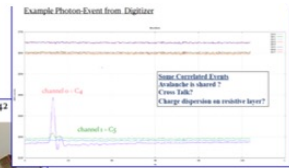
## ➤ FY2022: Completion of the lab equipment for LAPPD characterization at INFN



Initial dark-box; then, optimized dark-box modified to improve light-tightness and operative needs

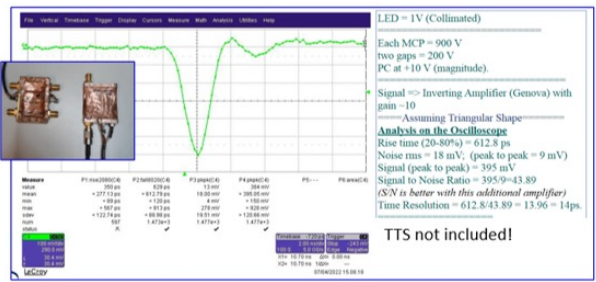


First exercises with the digitizer

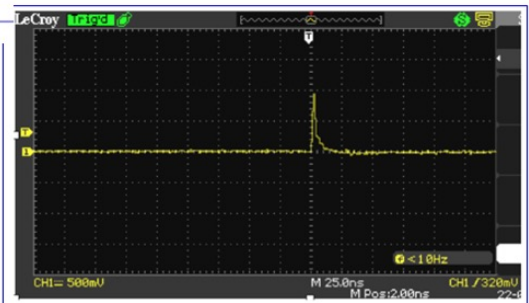


The LASER as we received is working fine

Getting familiar with the new head (405 nm) of the PICOQUANT pulsed laser source

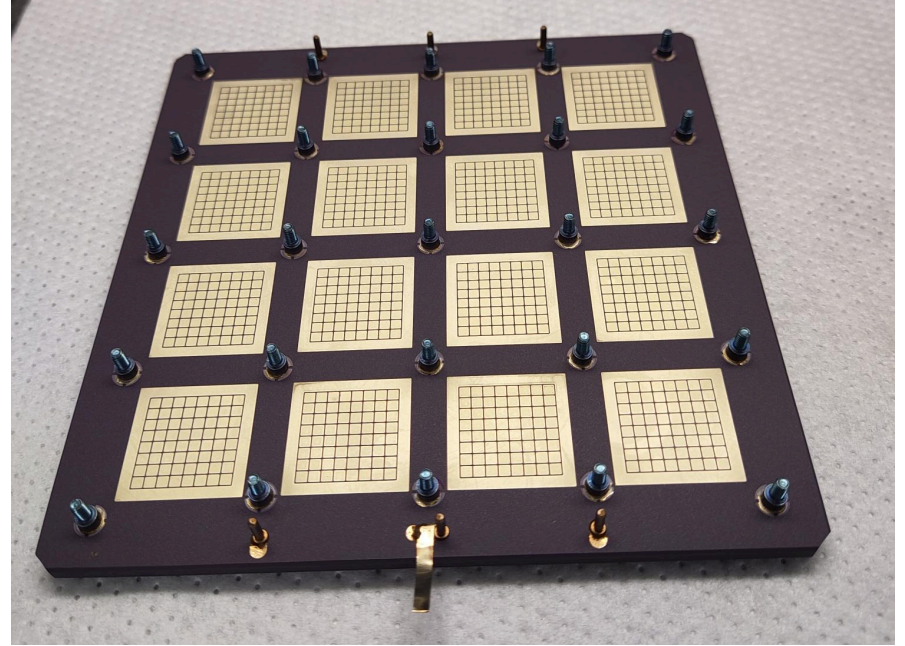
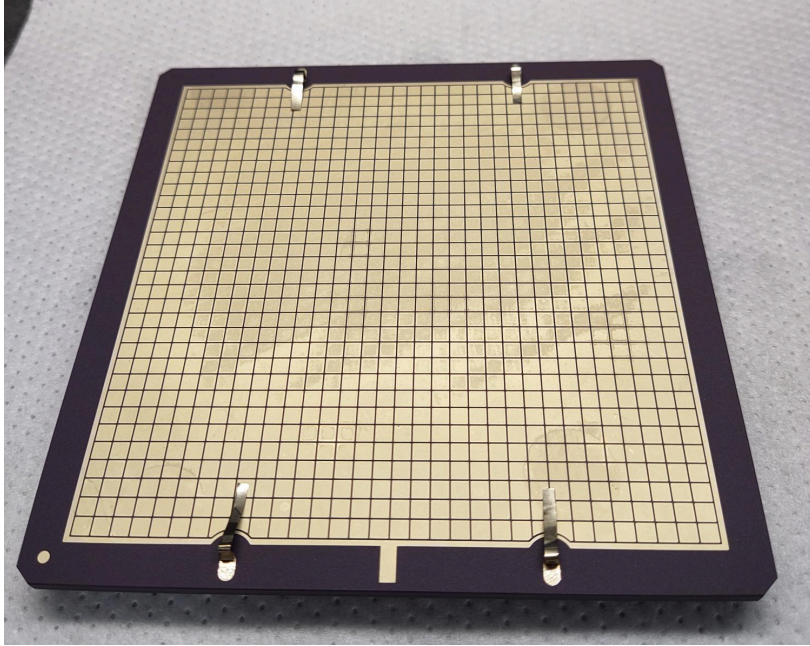


Using the pre-amplifier: signal analysis at the scope



A pulse from the LAPPD with the LASER incident on it

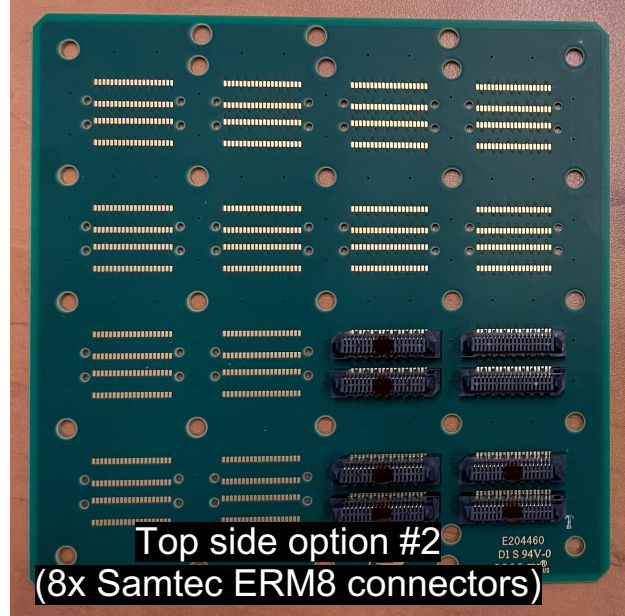
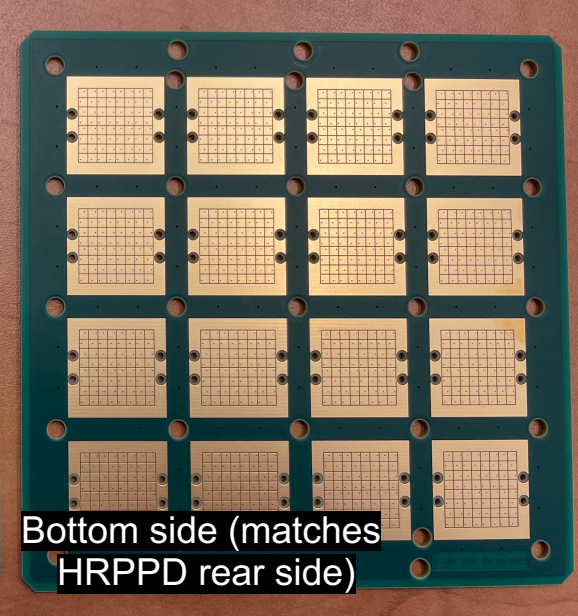
# HRPPD #16 (EIC HRPPD #2)



- A number of production bugs fixed, as compared to #15
- If everything goes well, will be ready for shipment next week

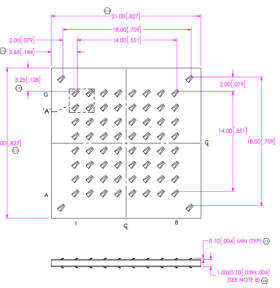


# Passive interface

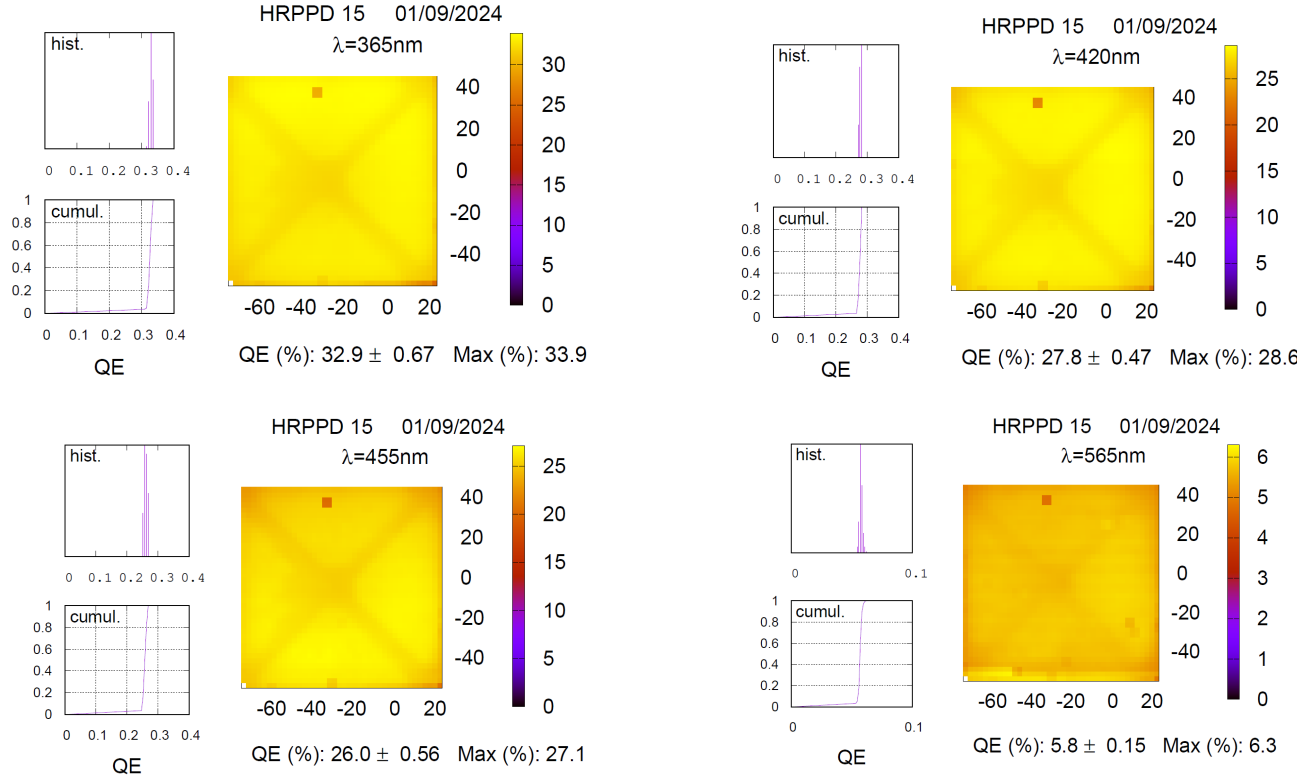


Enables ASIC interface to MCP-PMTs

- Connectivity for any of the sixteen 8x8 pad fields:
- A set of [2x Samtec ERM8 -> MMCX] adapters, 32ch (4x8) connected at a time
- A set of ERM8-based grounding caps for all other 8x8 fields

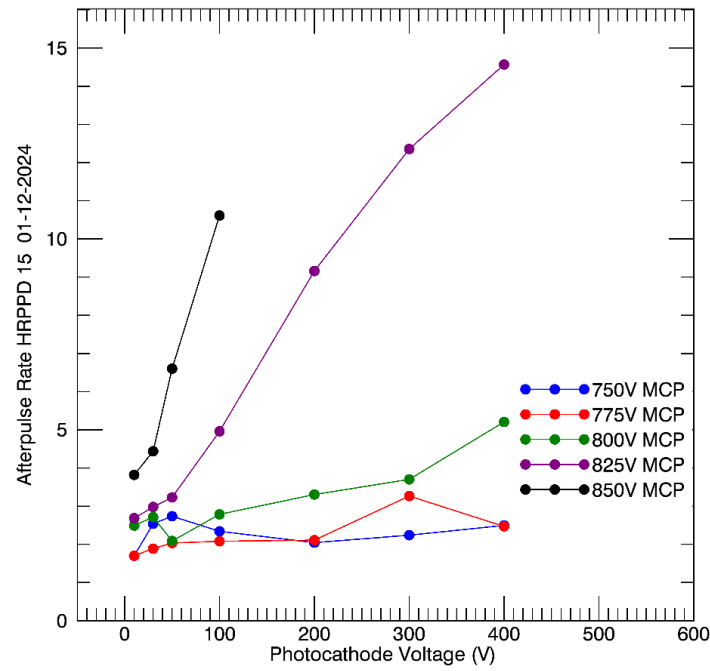
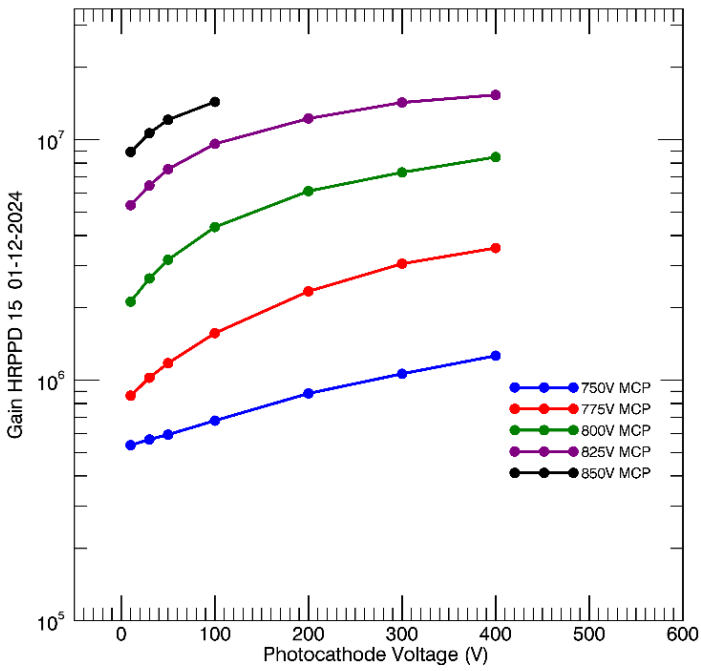


# HRPPD #15 (EIC HRPPD #1)



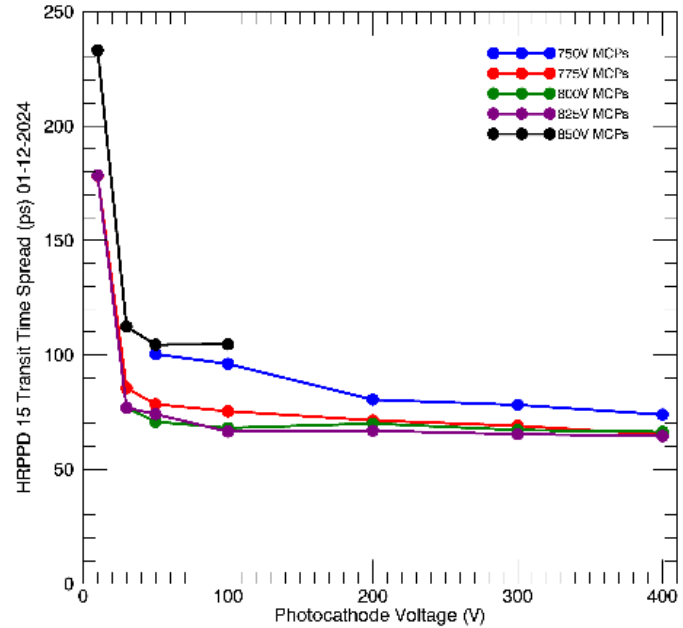
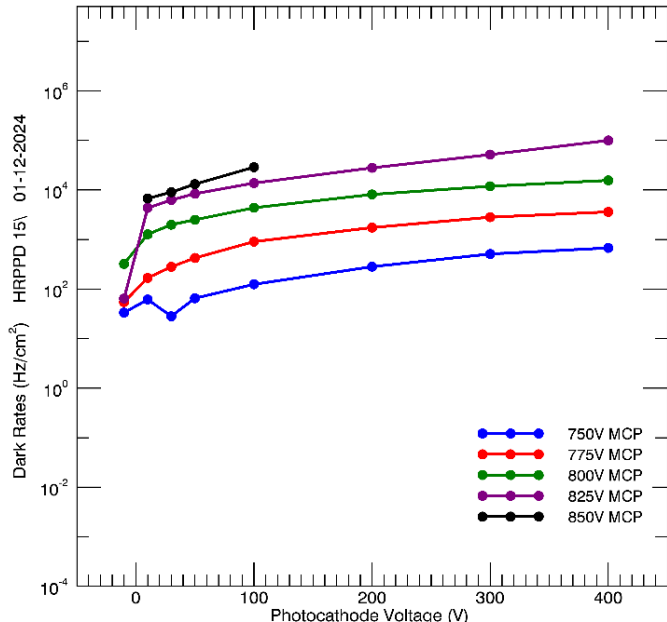
The QE scan looks very promising: ~33% @ 365nm

# HRPPD #15 (EIC HRPPD #1)



Gain few times  $10^6$ ; afterpulsing seems to be small

# HRPPD #15 (EIC HRPPD #1)



DCR few kHz/cm<sup>2</sup>; SPE timing ~60ps