

# CLICDP TIMEPIX3 TELESCOPE - IMPROVEMENTS AND MONITORING

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- Testing silicon detector technology demonstrators
  - Evaluation of interconnection yield of new bonding approach (CERN EP R&D - WPI.3)
  - Evaluation of new CMOS designs (CERN EP R&D - WPI.2)

What

- Requiring good **spatial** and **temporal precision**
  - Need to verify track reconstruction efficiencies per pixel
  - Need to evaluate in-pixel effects
  - Need to verify time of hit of different readout and sensor technologies
- All done at **very high rate**
  - Devices Under Test (DUT) ranging from 2 cm<sup>2</sup> down to 0.004 mm<sup>2</sup>

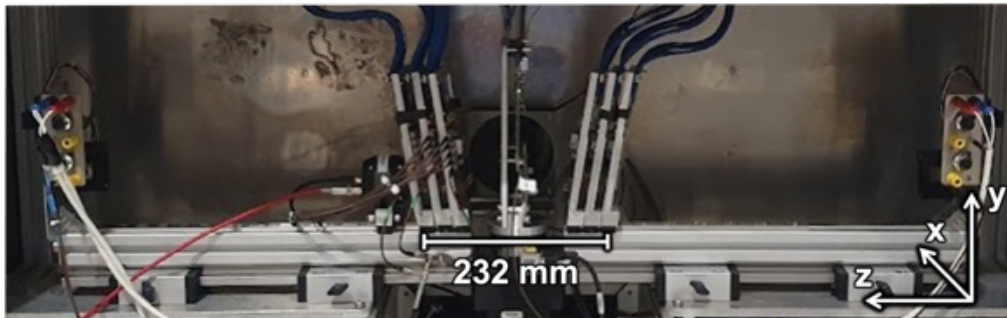
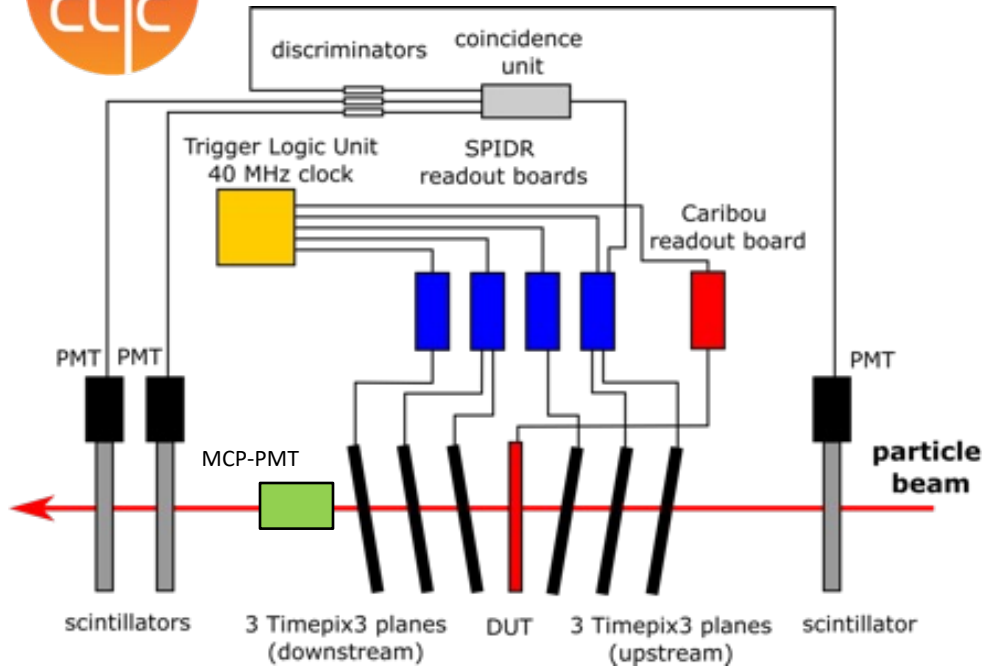
How

- Relying on integration of common readout tools for DUT – **Caribou**

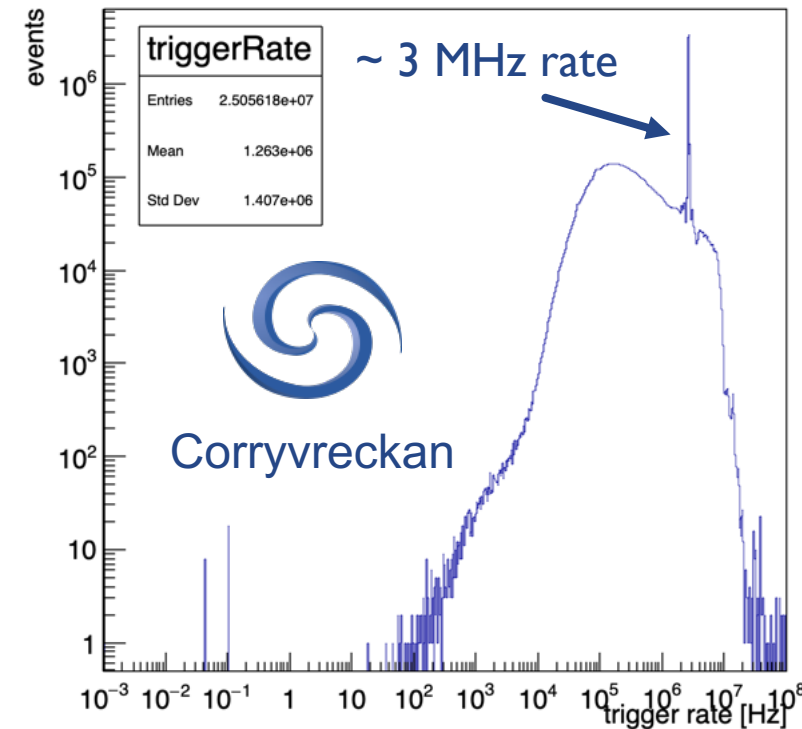
*(see poster by Younes)*



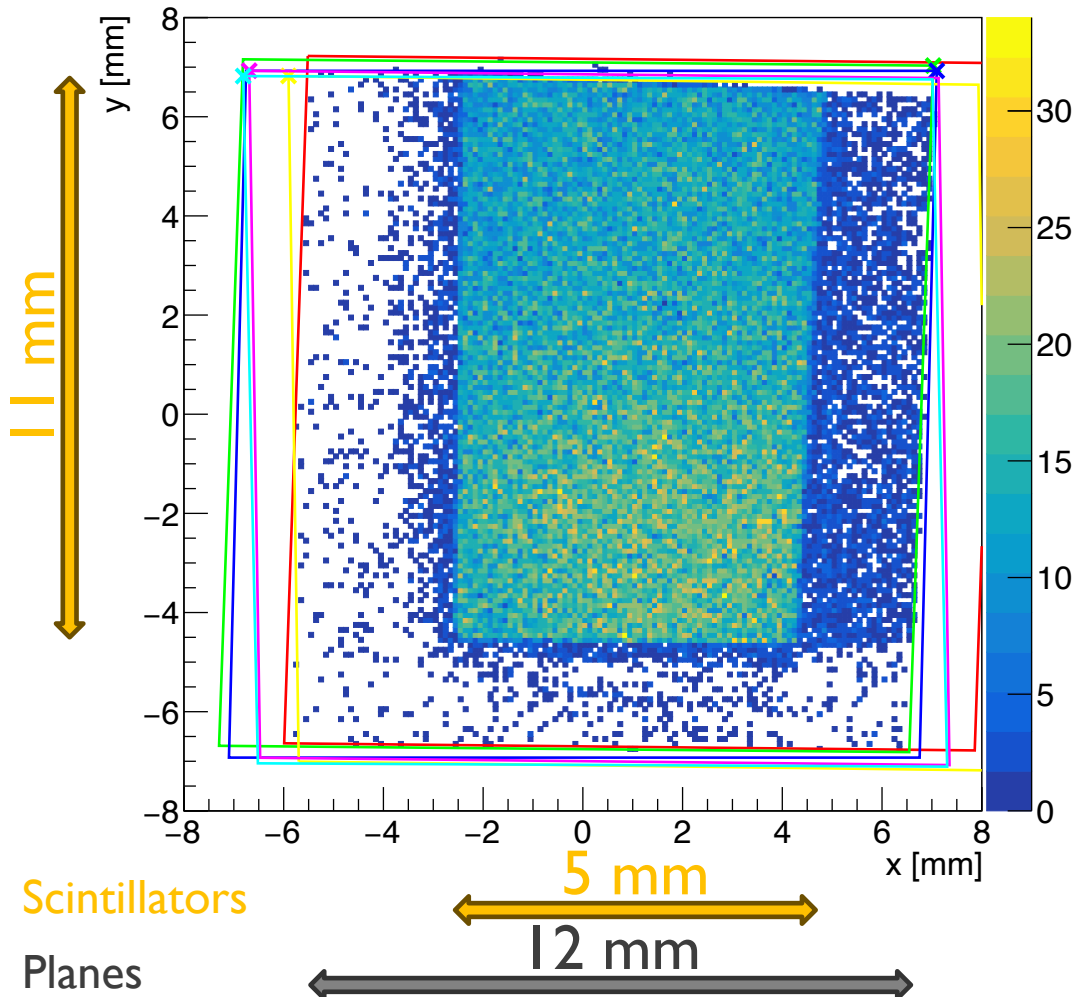
## CLICdp Timepix3 telescope



- End of **SPS H6-beamline at CERN North Area**
  - Usually 120 GeV/c pions
  - Timepix3 telescope, resolution at DUT about 1.5  $\mu\text{m}$
  - Scintillator coincidence recorded by SPIDR (at about 200 ps)

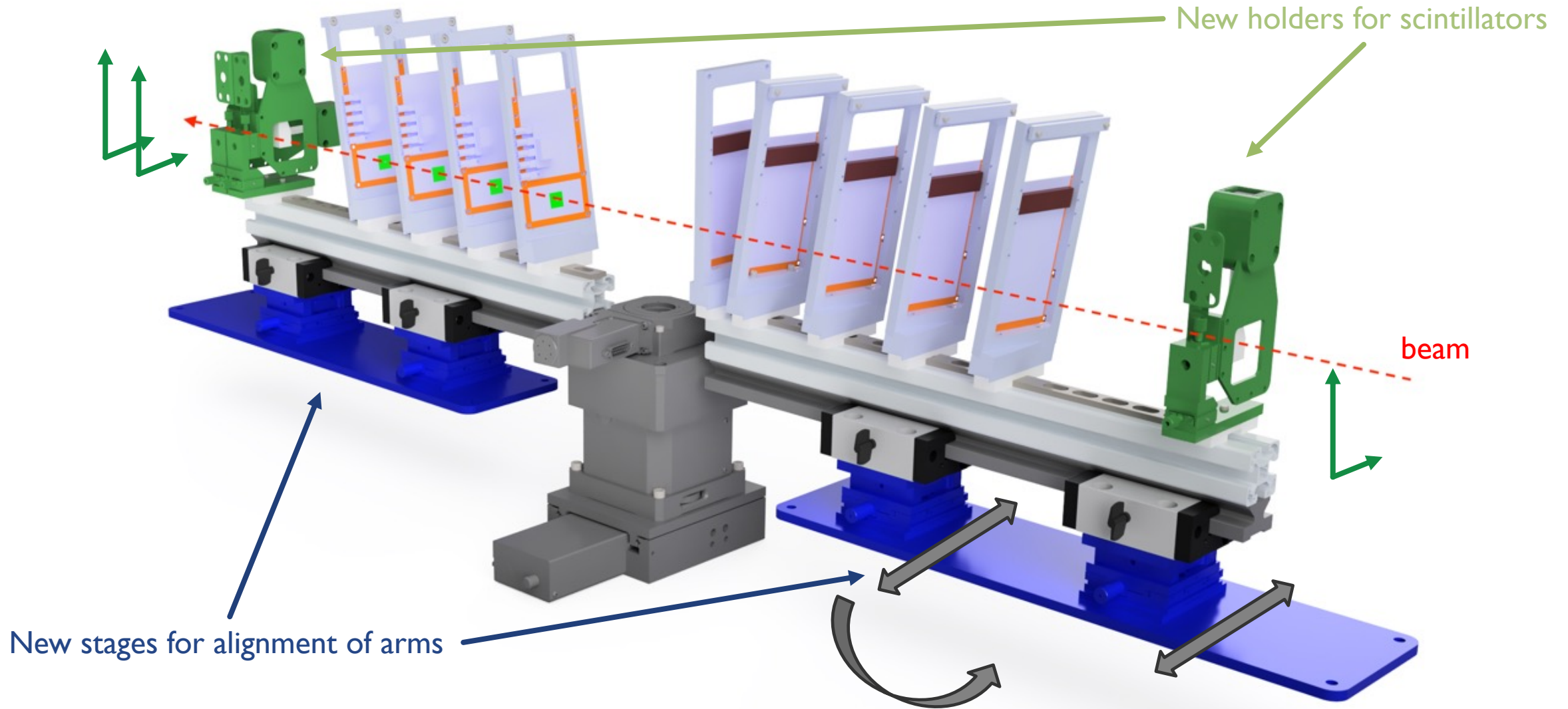


Before modifications  
Track intercept at  $z=0$  mm

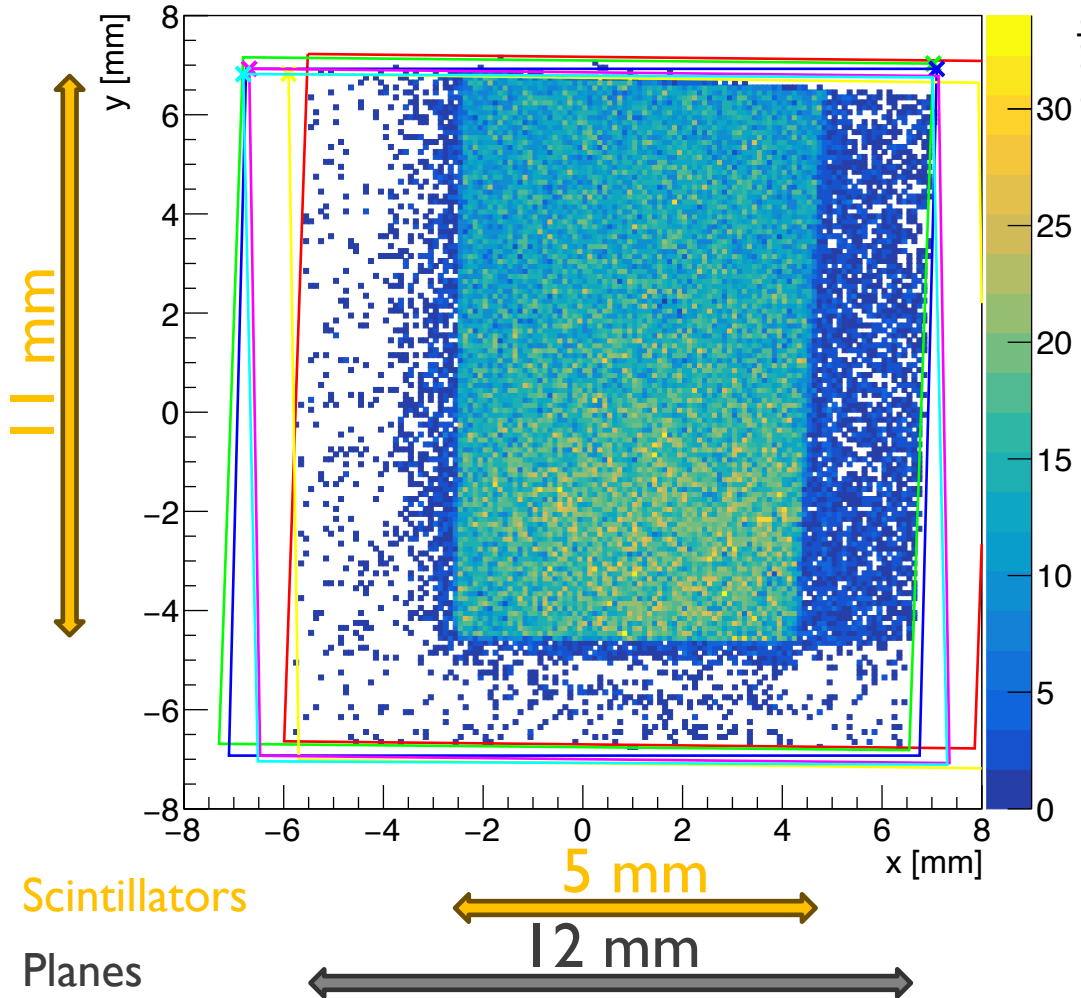


- Not utilising the full overlap of Timepix3 planes (max size approx.  $14 \times 14$  mm<sup>2</sup>)
  - Problem when measuring larger devices
- Scintillator coincidence only a small fraction of the acceptance
  - Problem when relying on timestamps with precision better than  $O(1$  ns)

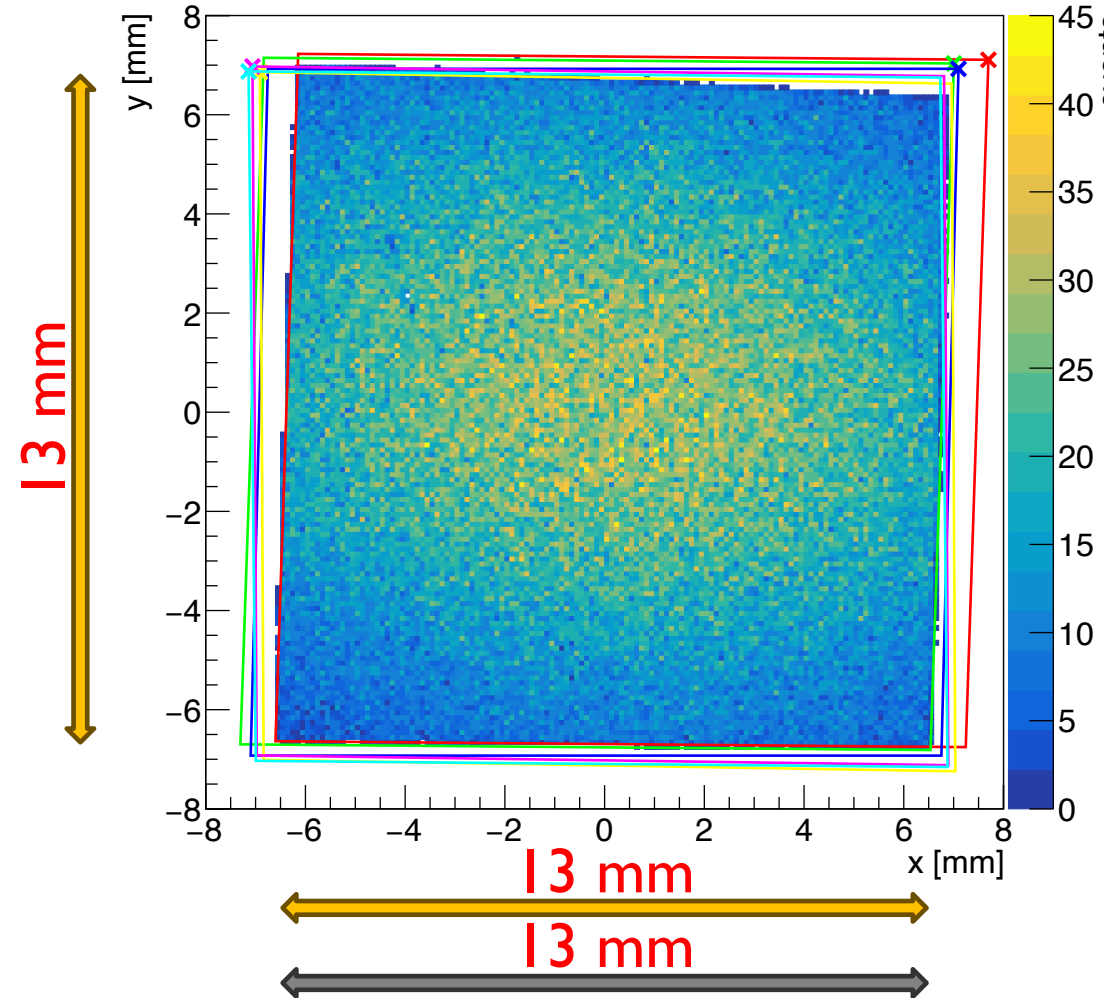
# MECHANICAL IMPROVEMENTS



Before modifications  
Track intercept at  $z=0$  mm



After modifications  
Track intercept at  $z=0$  mm



# ADDITION OF MCP-PMT



- Acceptance  $\sim 1 \text{ cm}^2$ , expected resolution below 10 ps
- Built-in amplifier and bias-T circuit ( $V_{\text{bias}} = 2.5 \text{ kV}$ )
- For now qualified with oscilloscope readout
  - performance achieved, but limiting readout speed
  - ongoing efforts to use Constant Fraction Discrimination and TDC units (get in touch if interested in data analysis)

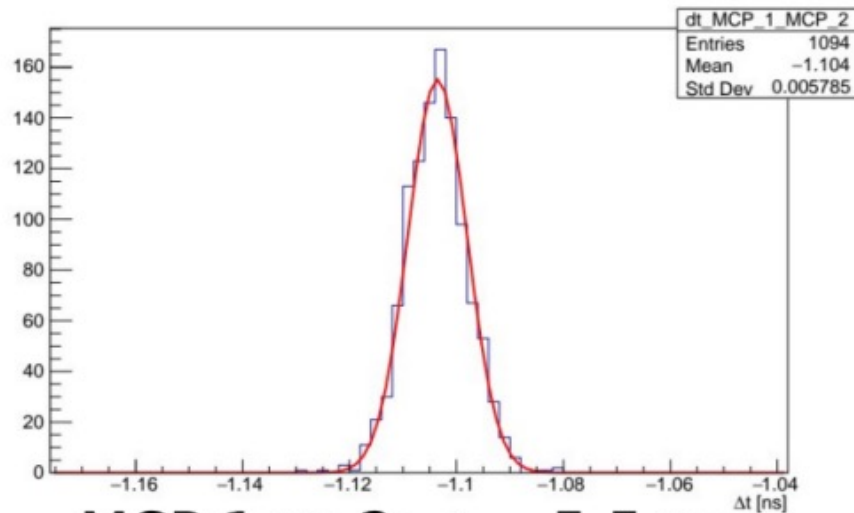
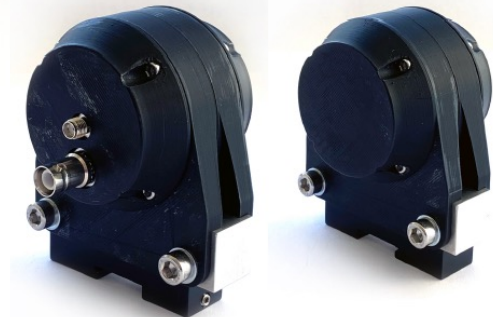
DOWNSTREAM

UPSTREAM

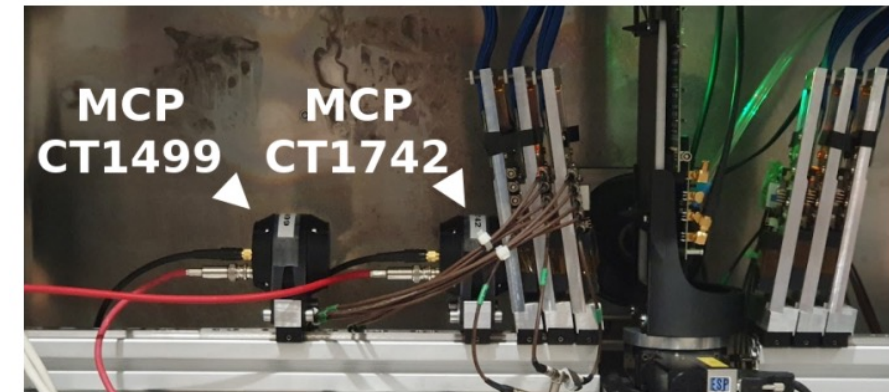


HAMAMATSU R3809U-50 CT1742

Custom 3D printed housing



MCP 1 vs 2:  $\sigma_{\text{fit}} = 5.5 \text{ ps}$



- The whole testbeam operation requires extensive environment monitoring
  - File sizes and DAQ information
  - Motion stage (telescope and DUT)
  - MCP-PMT high-voltage
  - ...

Data sources

- Simplified access required for late-night monitoring
  - Operation of telescope is 24/7 during beam time
  - Reachable out of local network
  - Phone / PC friendly

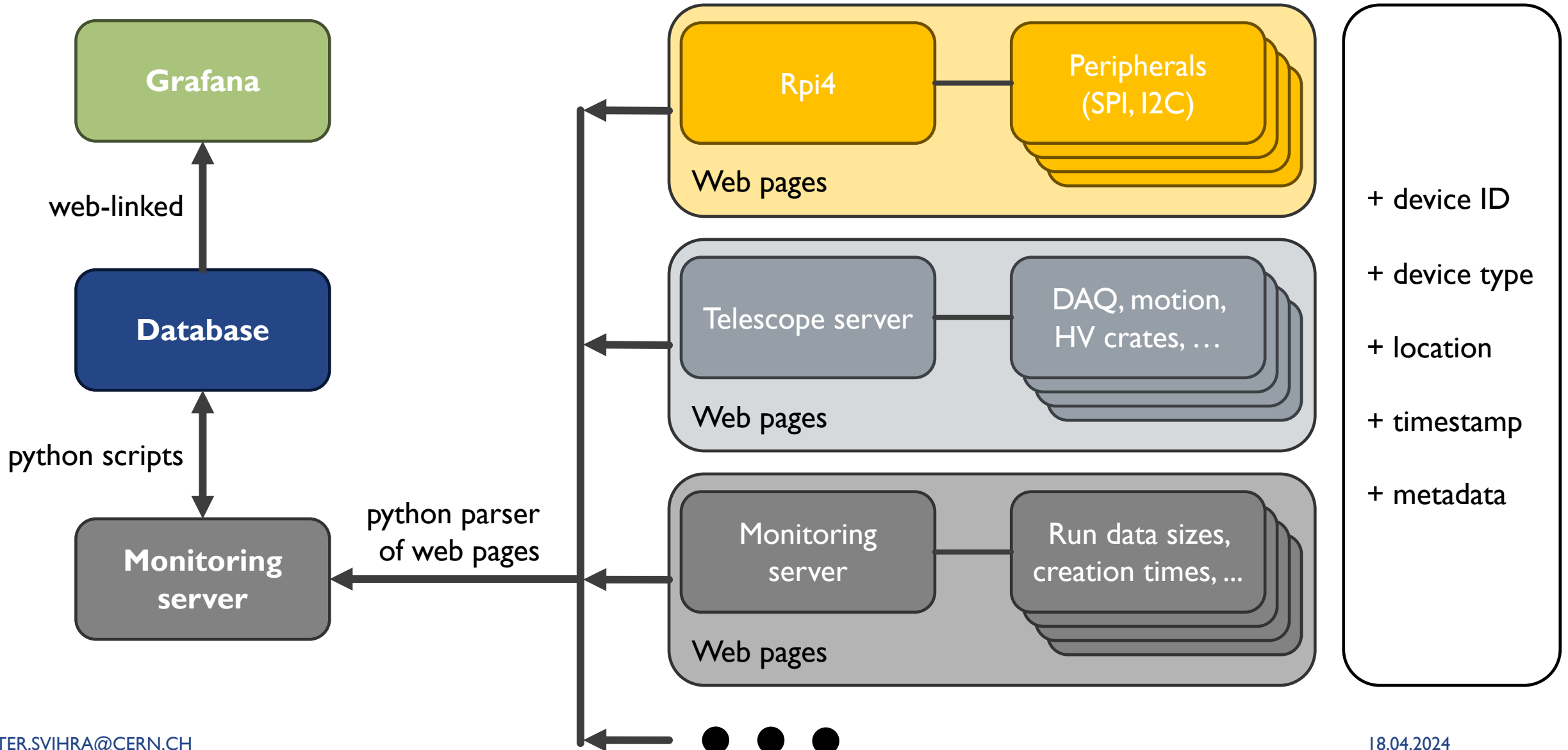
Monitoring requirements

- **Designed custom low-cost and scalable solution**
  - Using existing CERN infrastructure (Database on Demand, Grafana instance)
  - Still portable for other environments

Solution



# MONITORING – LAYOUT



Example of web page information, automatically pulled by the monitoring server

Last updated: 2024-02-27 14:54:21.012961

location	device_ID	sensor_ID	sensor_type	sensor_readout	sensor	quantity	value	timestamp
180/R-L15	10	0	CPUtemperature	digital	t_0	temperature	33.59	1709045661
180/R-L15	10	0	BME280	digital	t_0	temperature	22.83	1709045661
180/R-L15	10	0	BME280	digital	h_0	relative_humidity	27.29	1709045661
180/R-L15	10	0	BME280	digital	p_0	pressure	956.86	1709045661
180/R-L15	10	0	BME280	digital	alt_0	altitude	480.48	1709045661

**error messages**

Last updated: 2023-08-31 06:02:20

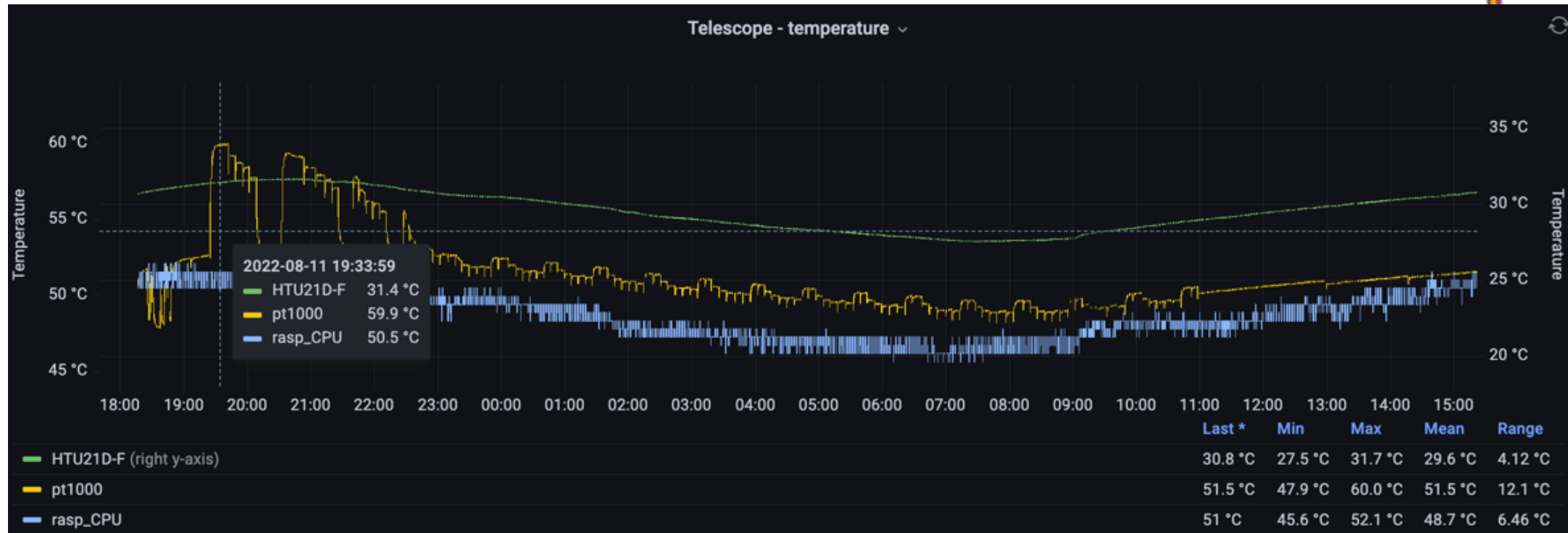
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SPS_H6B	2000	0	RunControl	run	run_0	run	131309	1693454540
SPS_H6B	2000	0	SPIDR	trig	trig_0	triggers	5237361	1693454540
SPS_H6B	2000	0	TPX3	temp	t_0	temperature	61.2	1693454540
SPS_H6B	2000	0	TPX3	data	data_0	data	346514216	1693454540
SPS_H6B	2000	1	TPX3	temp	t_0	temperature	63.9	1693454540
SPS_H6B	2000	1	TPX3	data	data_0	data	298275896	1693454540
SPS_H6B	2000	1	SPIDR	trig	trig_0	triggers	0	1693454540
SPS_H6B	2000	2	TPX3	temp	t_0	temperature	57.9	1693454540
SPS_H6B	2000	2	TPX3	data	data_0	data	274538568	1693454540

# MONITORING – RPI4

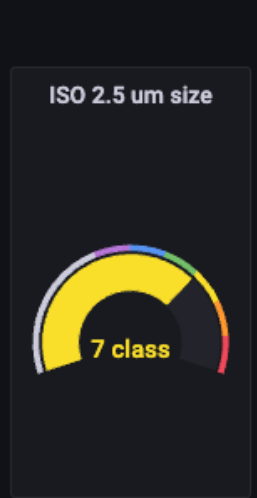
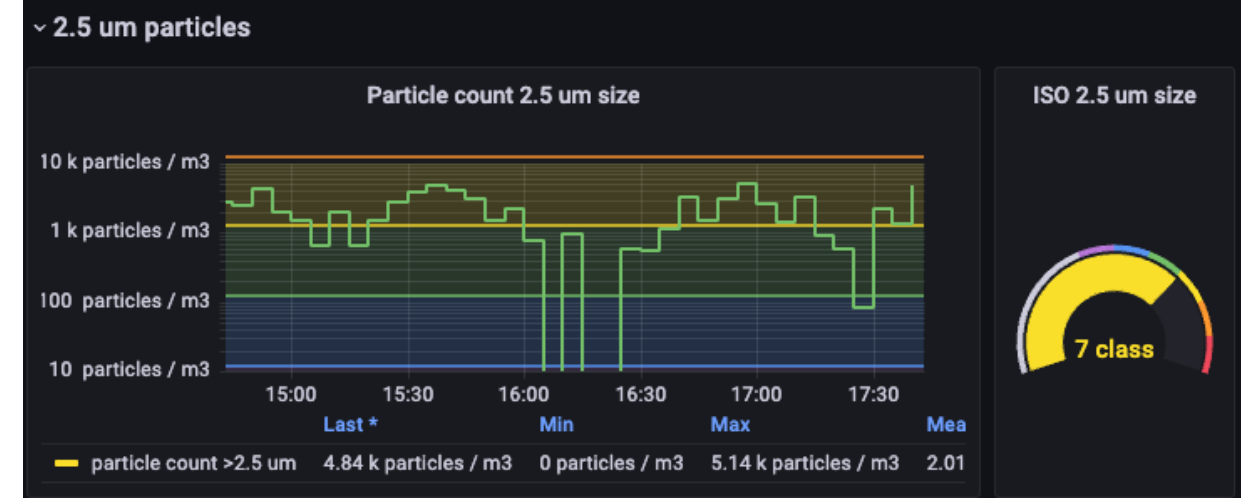
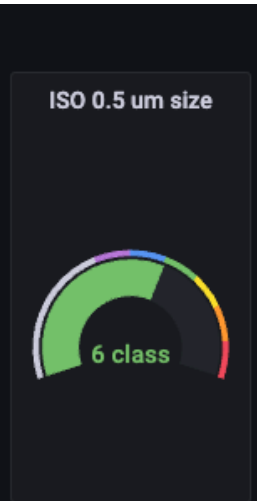
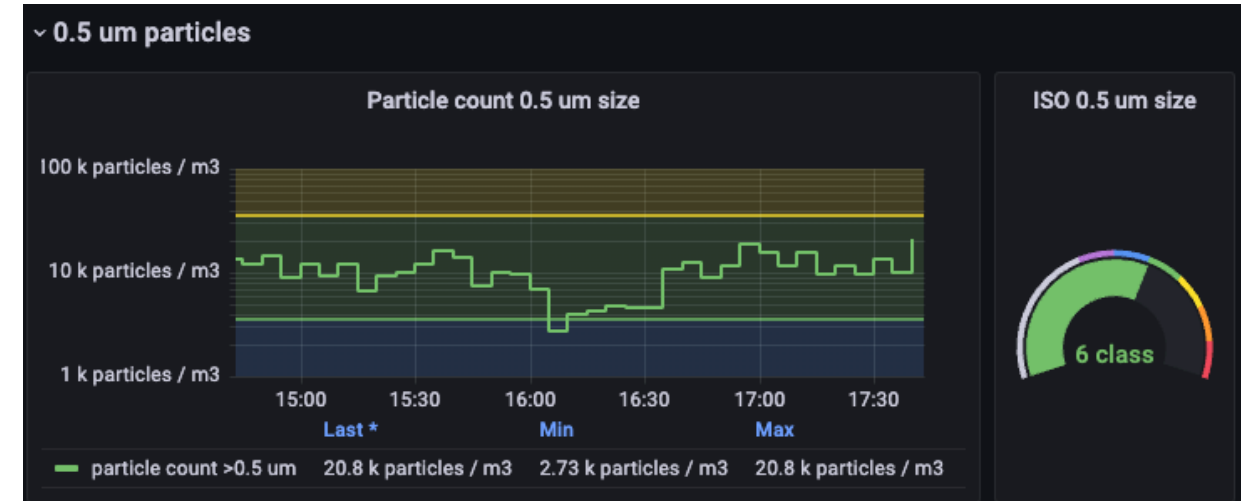
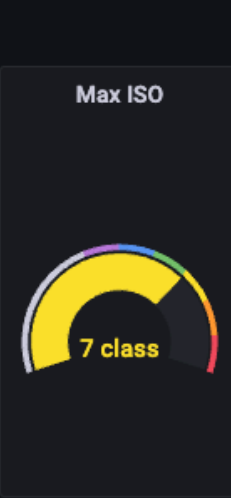
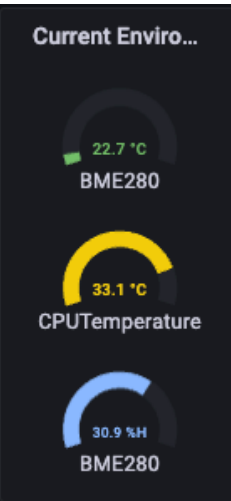
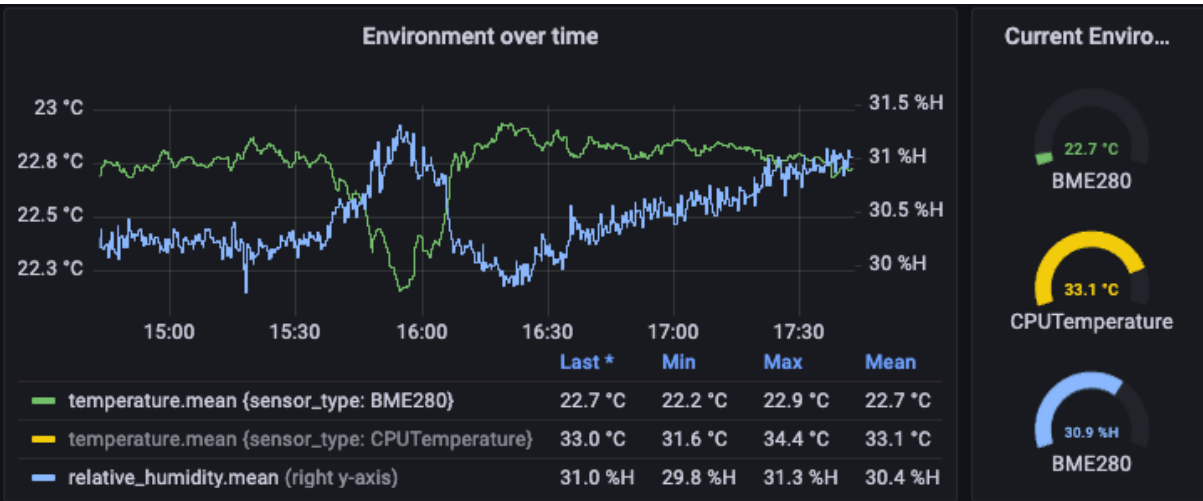


EP R&D

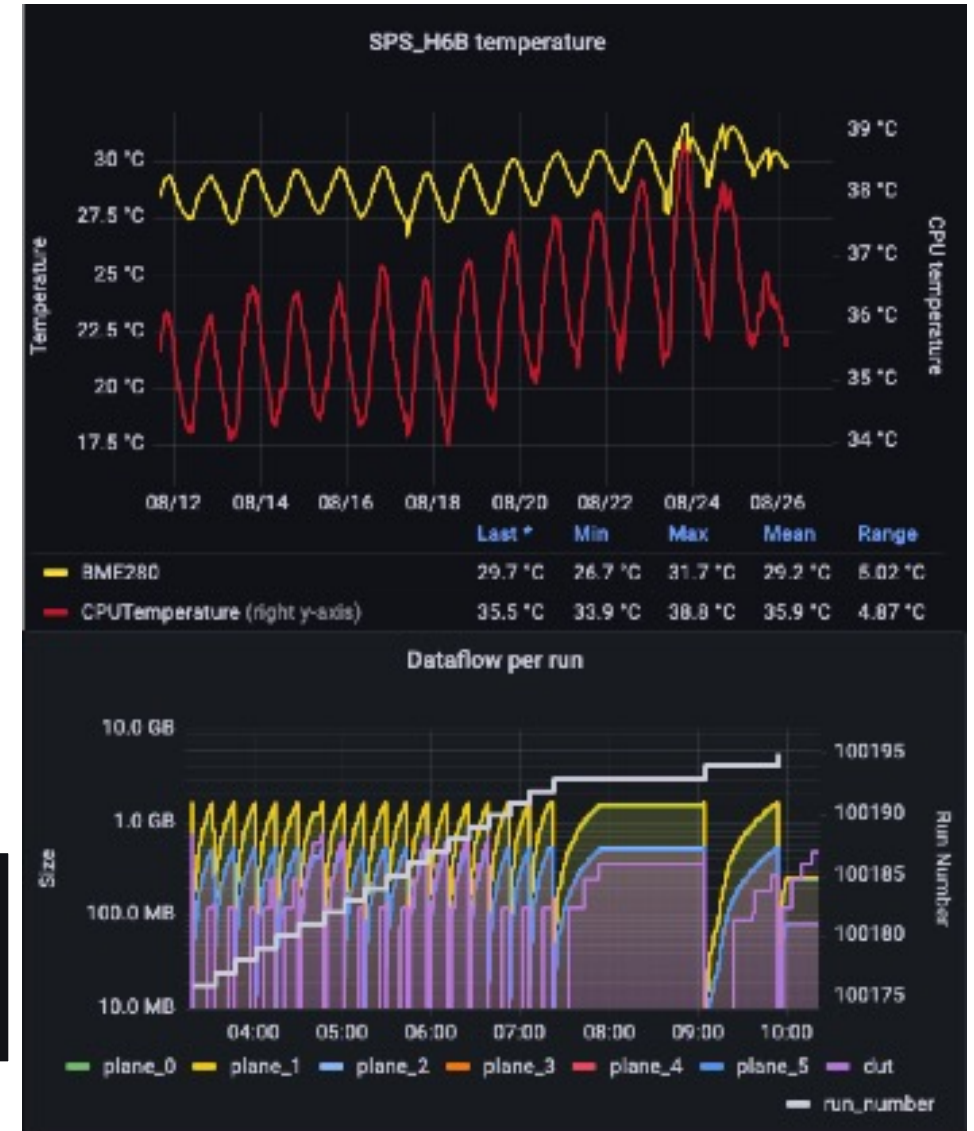
- Scalable system based on Raspberry Pi
  - Supports up to **8 Pt1000 with 4 wire readout**
  - and a **chain of I<sup>2</sup>C devices**
- Each RPI as an independent node



# MONITORING – CLEANROOM STATUS



- Monitoring PC pulling data from telescope server  
(**independently checking files**)
- DAQ monitoring
  - Planes and DUT setup
  - Runtime + data size
  - Temperature in telescope
  - Motion stage status, HV status, ...
  
- More details in [CERN-STUDENTS-Note-2022-218](#)



- Modified setup needed for mechanical alignments
  - Increased overlap of detector planes
  - Improved overlap of scintillators **by factor 3**
- Monitoring of environment and DAQ during testbeam operation
  - System of independent nodes with single server gathering data
  - Combined visualisation of everything in one place
- Ongoing efforts of improving time-stamping capabilities
  - Driven by the new detector designs

