dRICH prototype: test beam results and next steps

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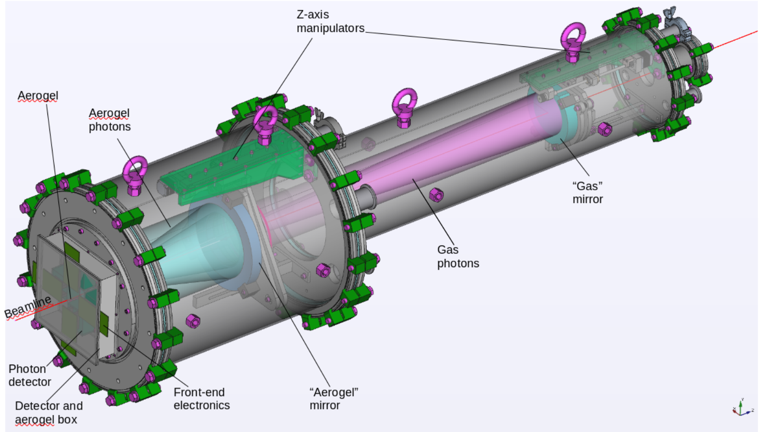
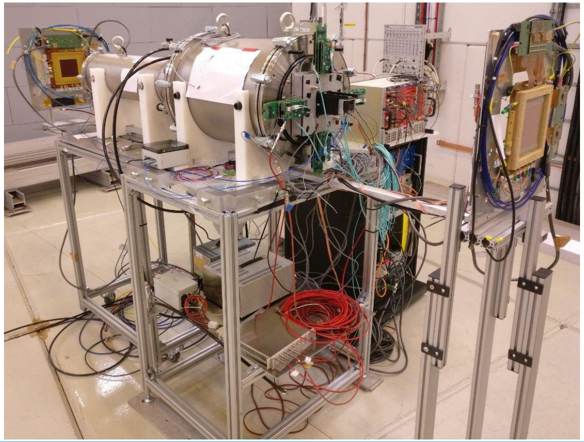
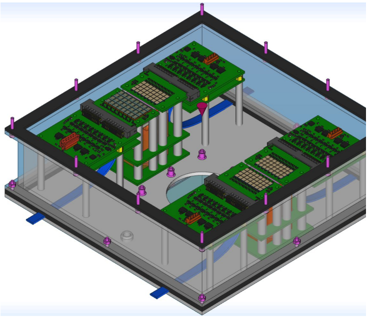
dRICH prototype



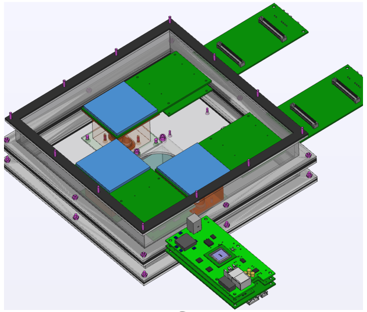
Test	Cherenkov medium	Nominal Energy [GeV]	Beam	Photon detector and DAQ
September at SPS	Aerogel	40÷120	π^+ π^-	SiPM and ALCOR
October parasitic run at SPS	Aerogel	120	μ^- π^-	MPPC and MAROC
October at PS	Aerogel and Gas (C_2F_6)	4÷12	p and π^+ π^-	MAPMT and MAROC

The dRICH setup at PS

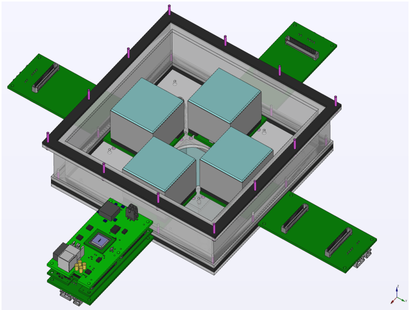




SiPM

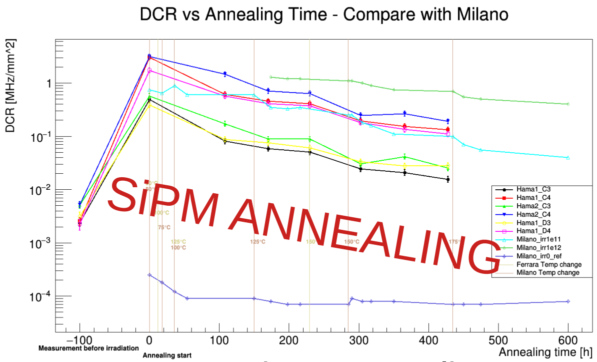


MPPC

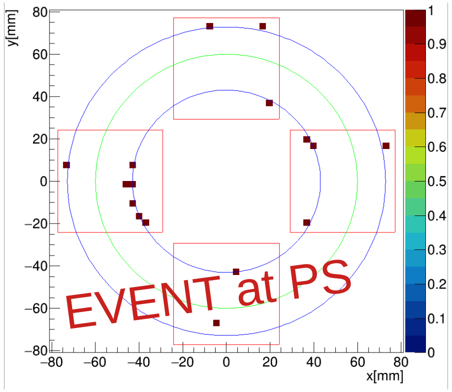


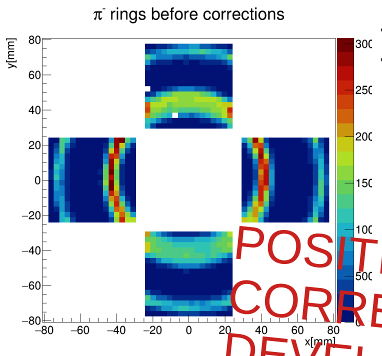
MAPMT

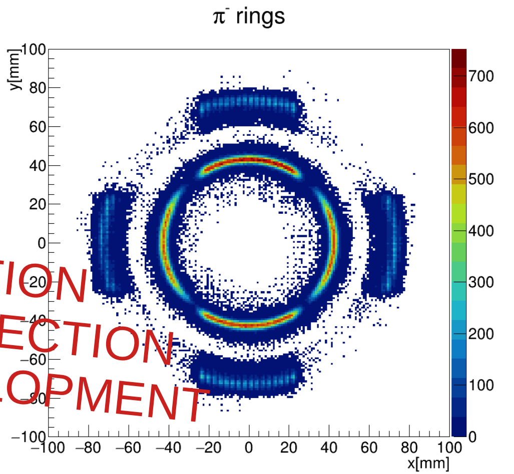
Older results quick review

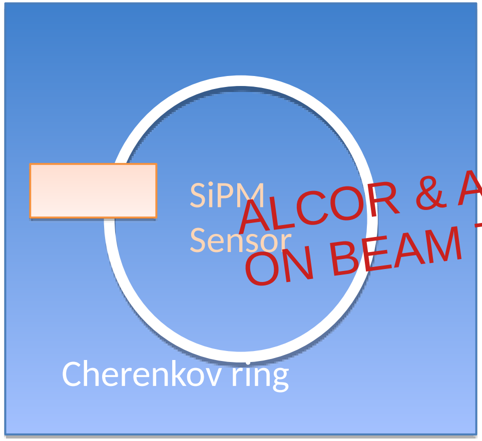


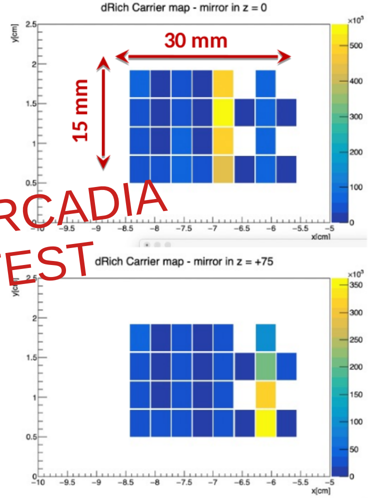
See next L. P. Rignanese talks

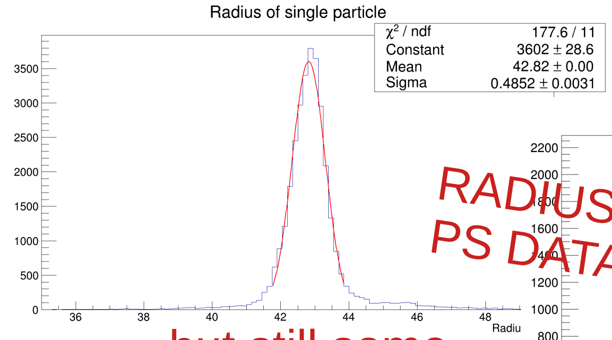


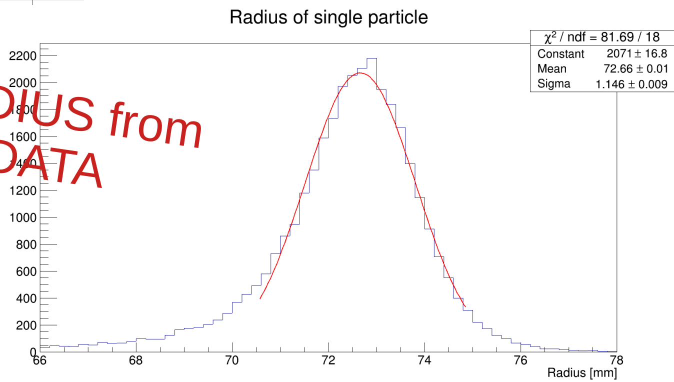






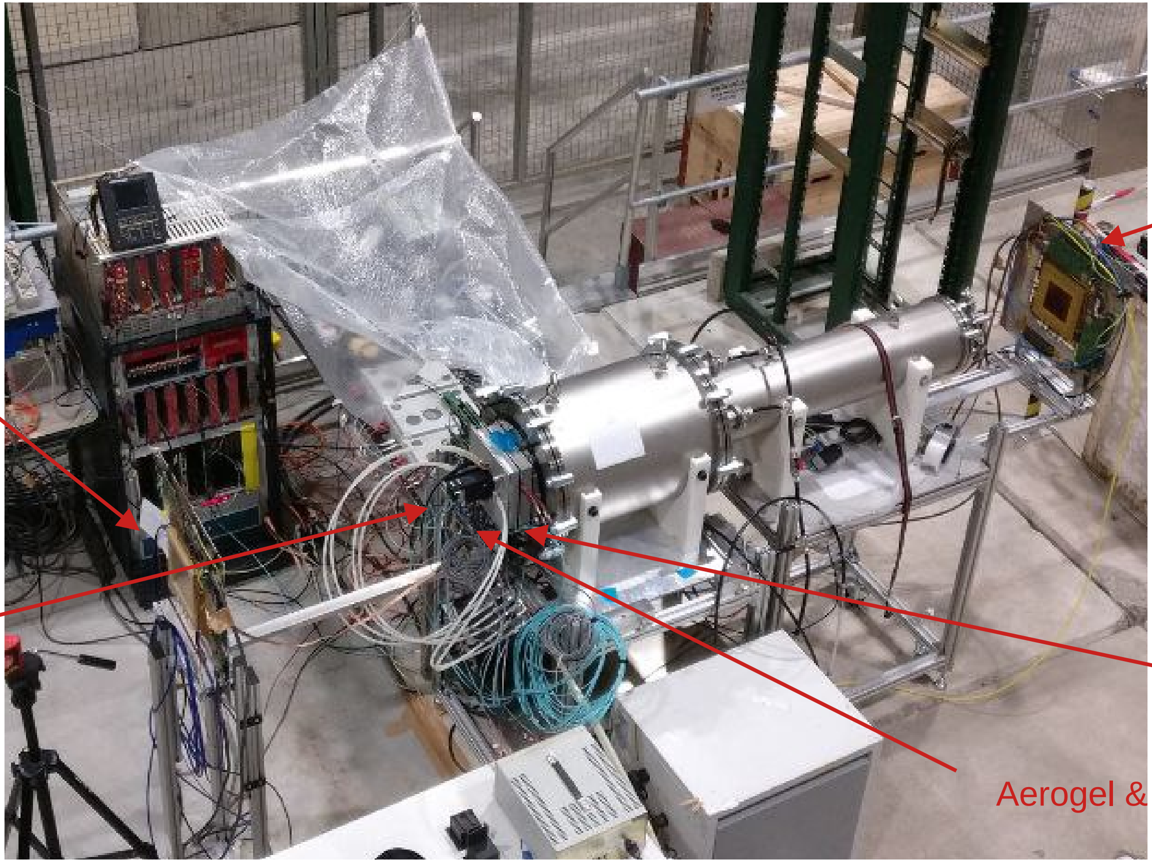


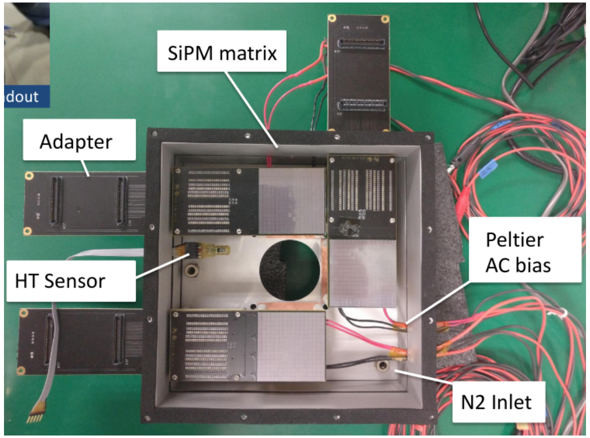




… but still some differences from simulation

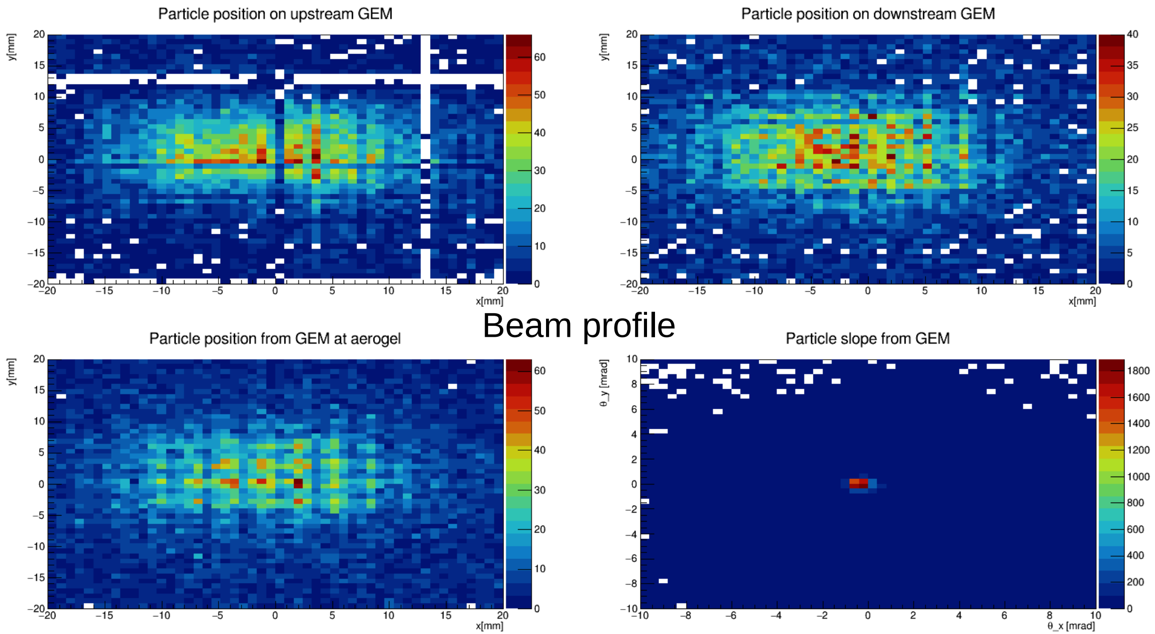
dRICH prototype at SPS

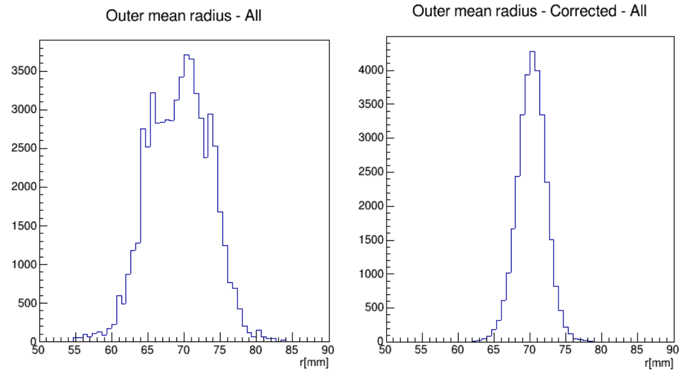


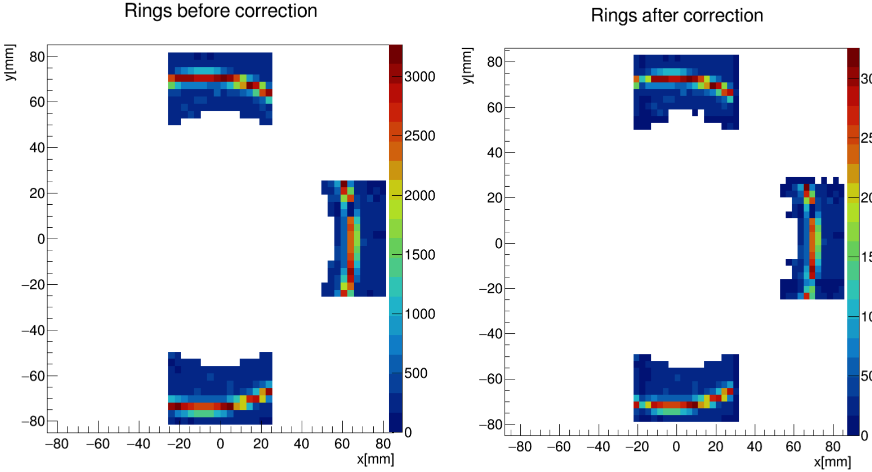


Radiator: aerogel

SPS parasitic run overview

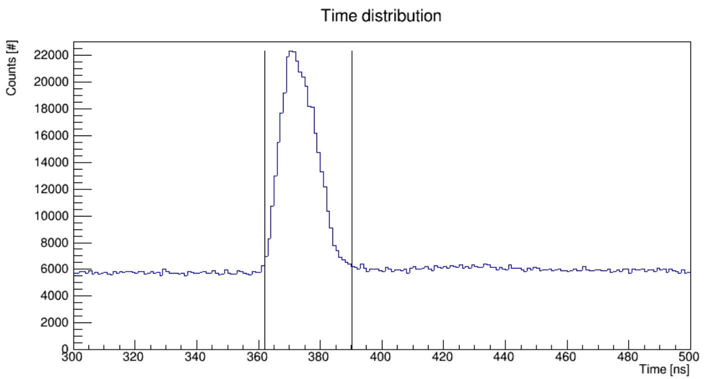




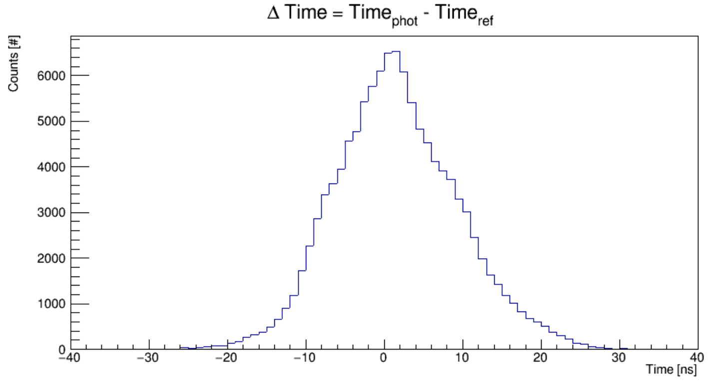


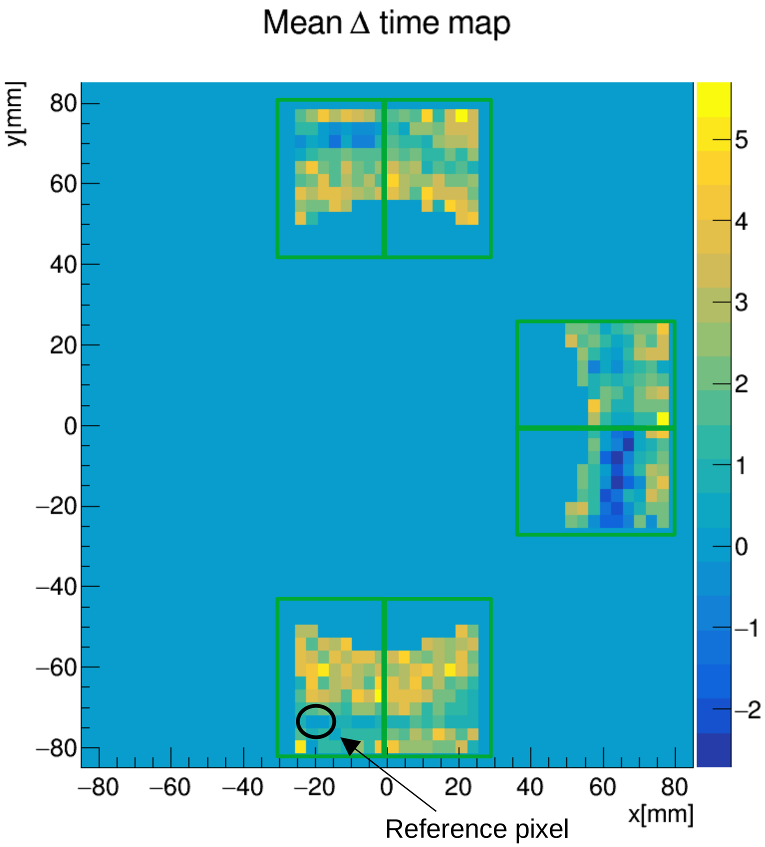
→ MPPC is an old and out-of-market photon detector based on semiconductor.
→ MPPC detector box: tests on SiPM-like detector.
→ π,μ 120 GeV beam.
→ Well aligned beam.
→ Only 3 detector: same correction for y-axis, new correction for x-axis.

SPS time study

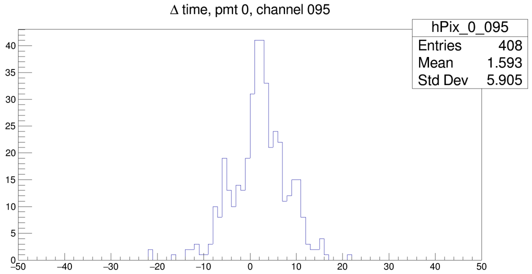


Large coincidence window (~20 ns) so a time calibration has to be developed to discriminate between aerogel and gas photons (expected Δt~5ns)

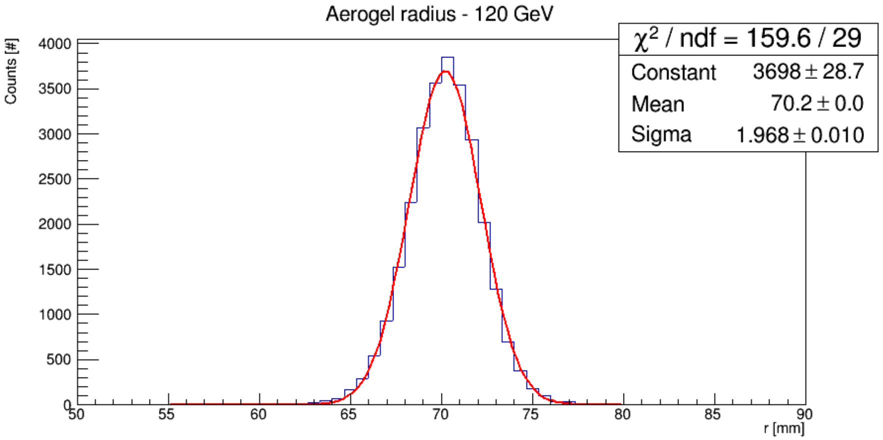


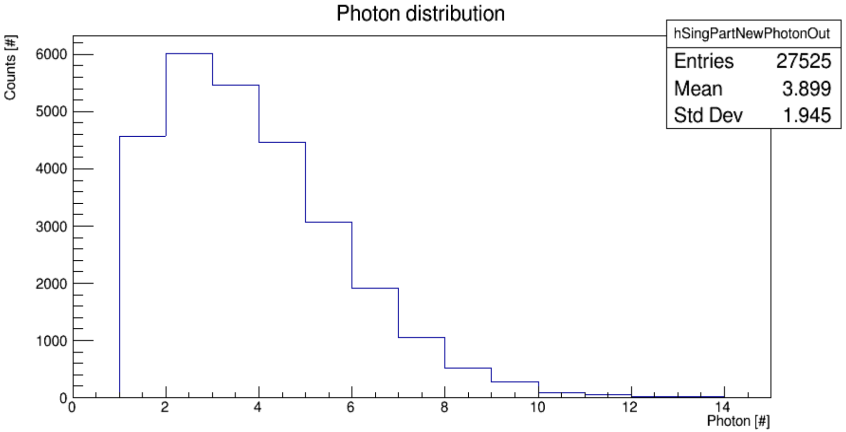


The map shows the mean of time difference between each pixel and the reference pixel (selected as one with higher rate).
There are differences between halves of the MPPCs, due to different DAQ path (different DAQ chip and optical fiber length).
The single channel correction is being developed, trying to shrink the coincidence window.



SPS parasitic runs results





On top left there is the single particle radius.

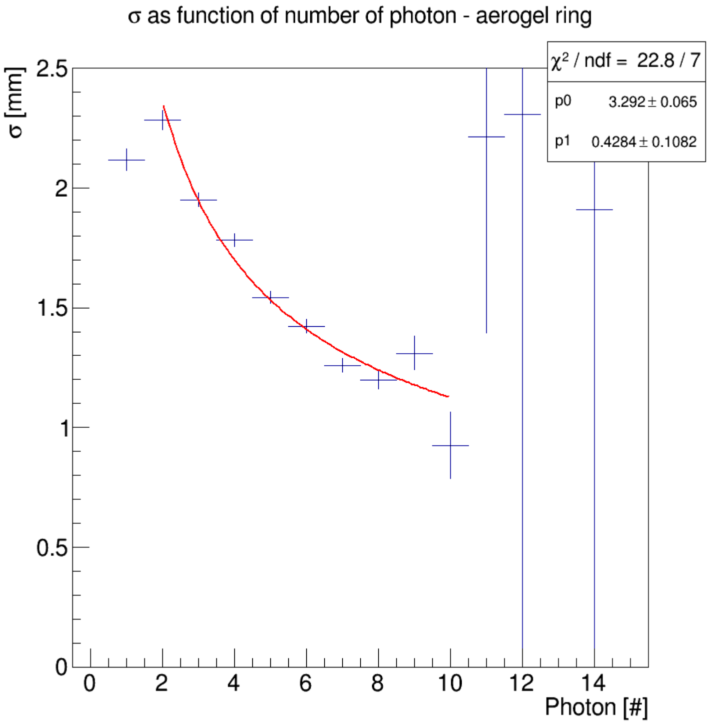
On bottom left there is the number of photon for event

On right there is the preliminary results on σ as function of photon number

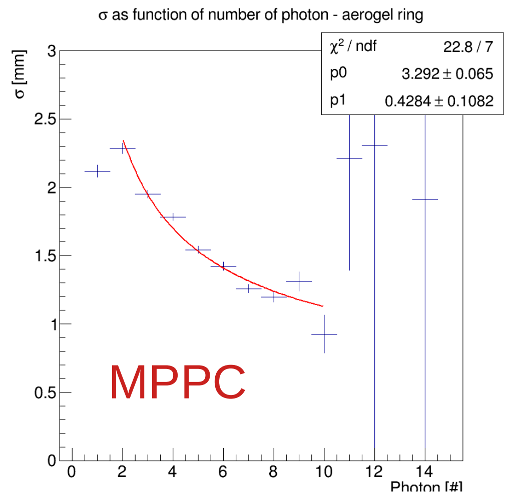
Fitting function:

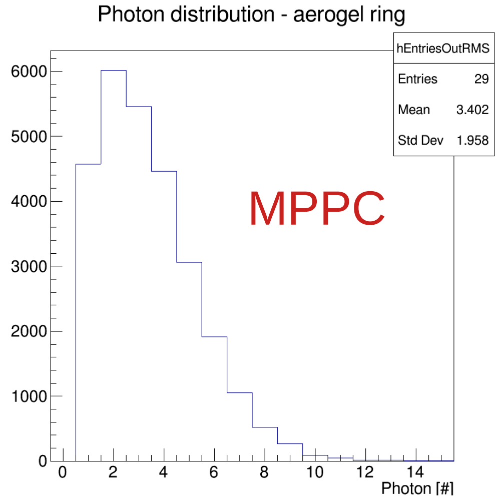
$$y=\sqrt{\frac{p_0^{\,2}}{x}+p_1^{\,2}}$$

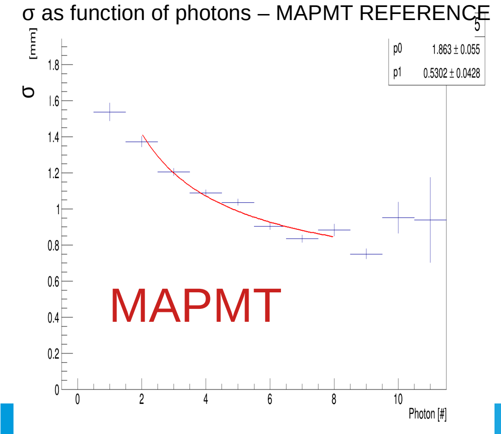
p_0 = single photon resolution
p_1 = single particle resolution constant term

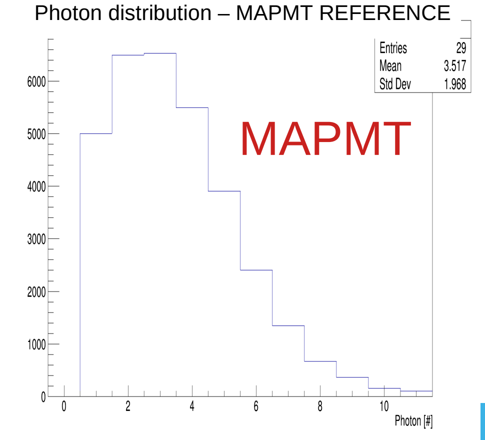


SPS and PS results compared







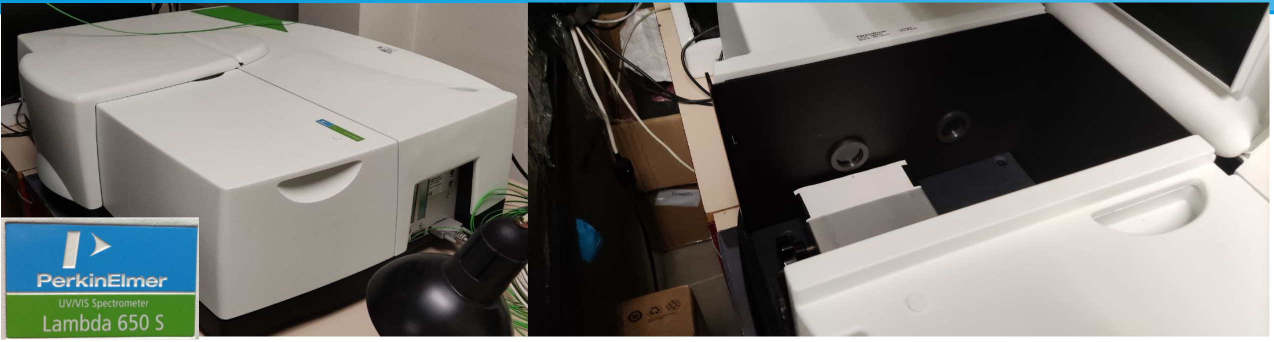


We can compare the results obtained by MPPCs with that were obtained by MAPMT reference detector used at PS.
We have to take account that they were obtained under quite different conditions:
→ 120 GeV pion beam at SPS Vs 12 (nominally, probably 8-9) GeV proton beam at PS;
→ well focused beam vs enlarged profile beam.

In any case, the results are pretty similar, in particular for the number of photon and constant term.

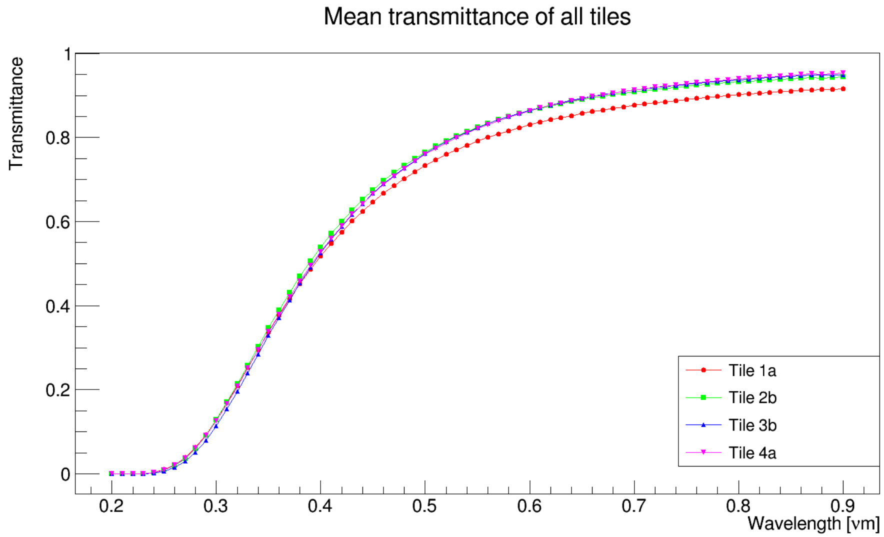
A discrepancy is present in the single-photon resolution term, probably it is due to the larger background of MPPC → a high background detector like SiPM needs a precise timing to discriminate between signal and noise.

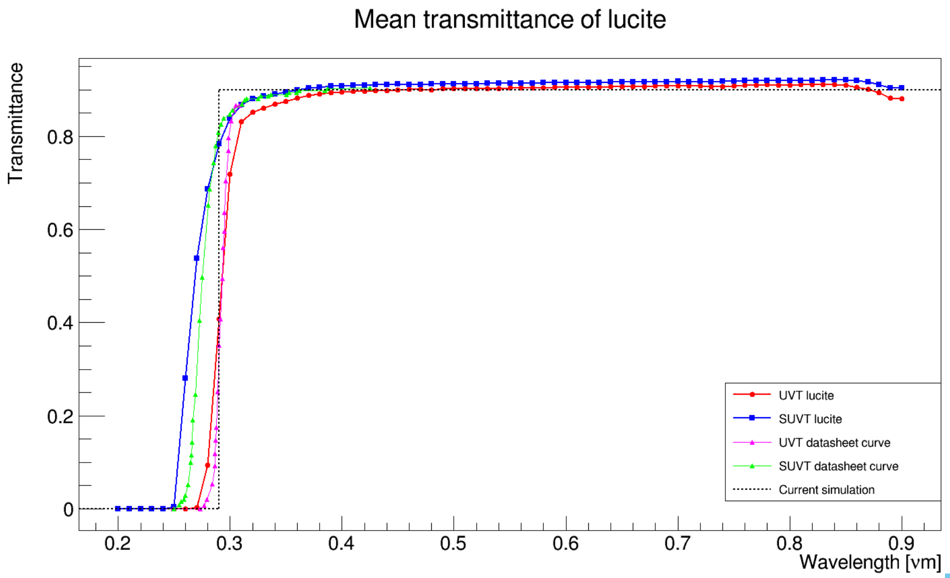
Optical component characterization



Spectrophotometer

→ Aerogel tiles characterization
→ Lucite characterization: there is a lucite window which divides the gas and the detector box (photon detector + aerogel support). The measured values are quite in agree with simulation, which inserts the lucite effect only in the analysis phase.





On going developments

Hardware:

- A new trigger system will improve the timing of the full system, allowing a better discrimination of aerogel and gas photons.

Reconstruction:

- Time calibration procedure for high background detectors

Simulation:

- A more sophisticated model of the dRICH prototype is being developed, it will include the presence of the lucite window and a more realistic geometry
- The measured values of aerogel and lucite transmittance will be used.

Analysis:

- A new version of analysis software is under development, it will allow to analyze every kind of data (SiPM, MPPC, reference MAPMT, simulation) with the same algorithm.
- An online monitor will be used during the next fall test beams at CERN, to obtain a quick evalutation of the acquired data

Next test beams outlook

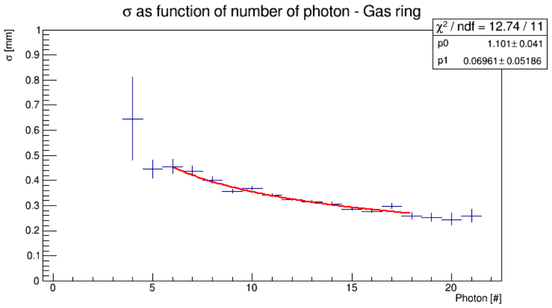
- Fall 2022 test beams: September at SPS and October at PS.
- After the commissioning achieved last year, we will be ready to operate the prototype in few day, allowing to acquire larger set of data.
- Being able to use more days to acquire data, we will can do systematic tests to evaluate the performance of the prototype.
- To acquire data using different kind of photon detectors (SiPM, MPPC and reference MAPMT) with the same beam.
- To acquire data with a more stable beam (in 2021 we was the first user after the hall renovation, the beam was not stable, not well set and not well aligned).
- To acquire data using an only one medium, to study the resolution of each one and improving the understanding of their background.

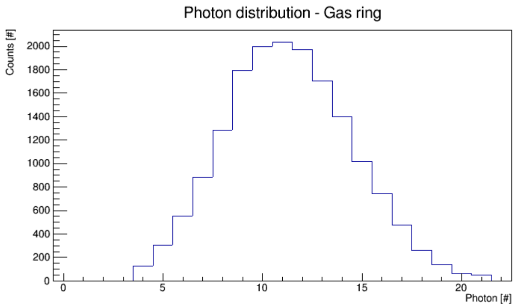
The end

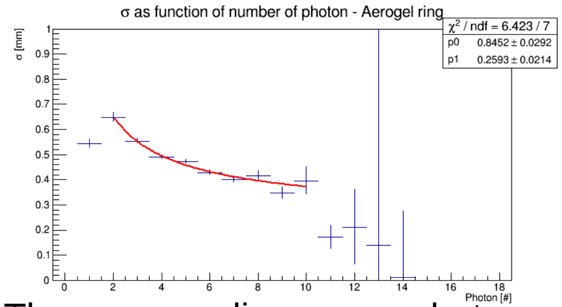
Thanks for your attention

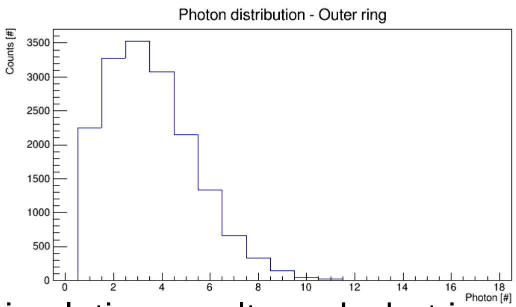
Backup slides

PS simulation check







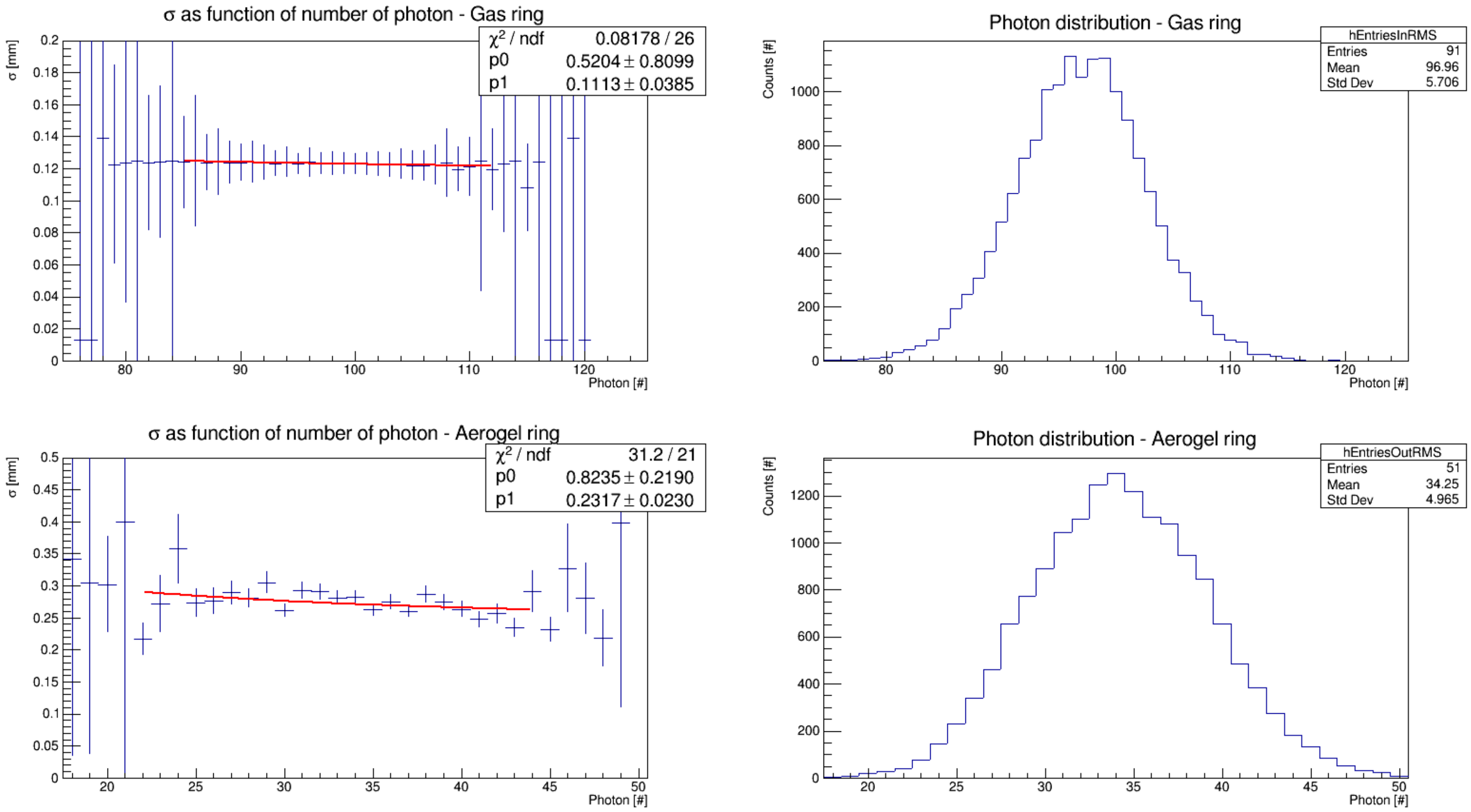


There was a discrepancy between simulation results and what is reasonable to expect: p_1 should be comparable to 0. For gas it is within 1.5σ, while for aerogel it’s not.
To check if it is due to the range of the fit, the quantum efficiency effect was removed in the simulation to increase the number of photons for ring.

Gas	Data	Simulation
p_0 [mm]	1.5	1.1
p_1 [mm]	0.22	0.07
Avg photon	12.8	11.3

Aerogel	Data	Simulation
p_0 [mm]	1.9	0.8
p_1 [mm]	0.53	0.26
Avg photon	3.5	3.5

PS simulation check



When effect of quantum efficiency was removed, that increases the photon number, allowing to study the constant term.
For gas rings, it is compatible with zero within 3σ.
For aerogel it is not compatible with 0.
This means that there is something that is not still understood, in the analysis or in the simulation → the next step will be to develop a more realistic simulation and to check the analysis algorithm, making it the same for all kinds of data (simulation and different type of photon detector).