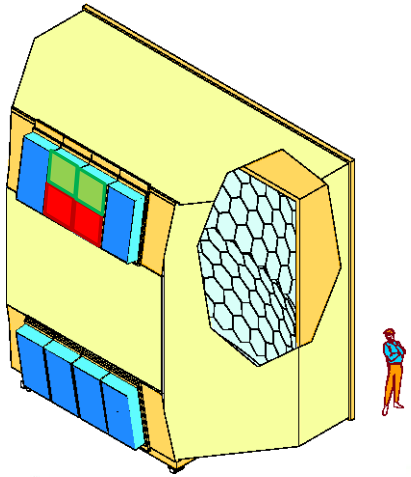
SINGLE PHOTON DETECTION WITH MPGDS

Daniele D'Ago on behalf of COMPASS RICH group

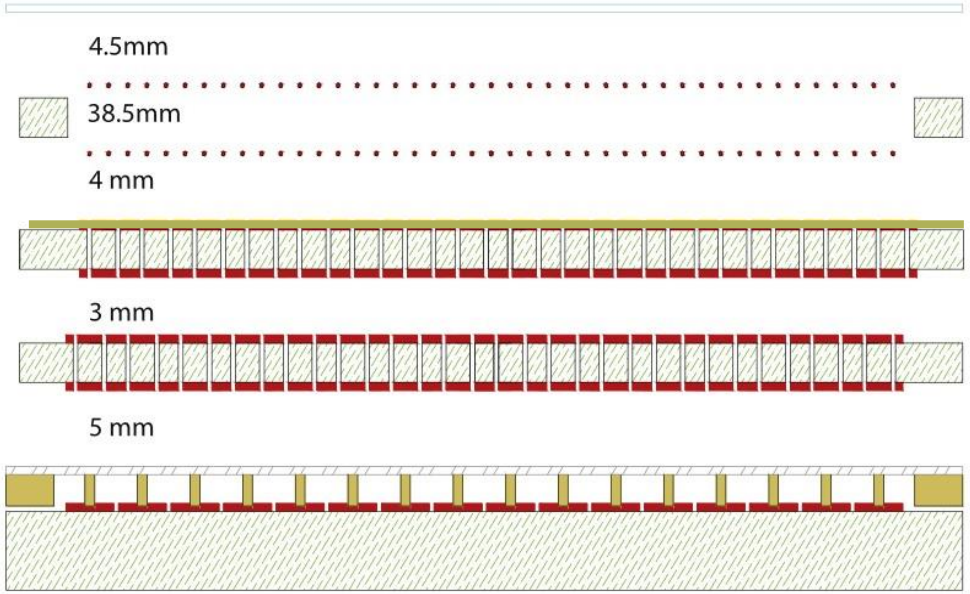


Cover large area with photon detectors in COMPASS RICH (~1.4 m^2)

Why MPGDs?

> Reduced ion and photon backflow to photocathode > reduced aging and improved electrical stability

> Faster signal development > higher rate capabilities



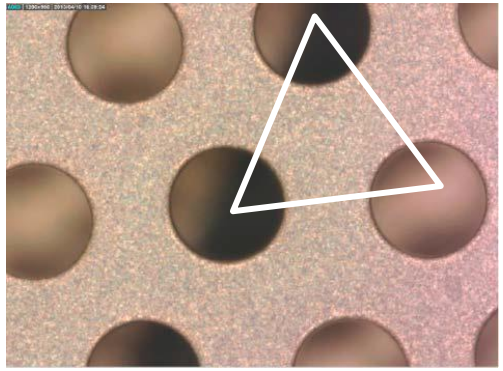
600x600 mm^2 Photon detectors composed of two equal segments

Fused silica window

2 layers of THGEM (staggered)
first THGEM coated with CsI
> reflective photocathode

1 Micromegas
Suppresses Ion backflow (3%)

Gas Mixture: $Ar: CH_4 = 50: 50$



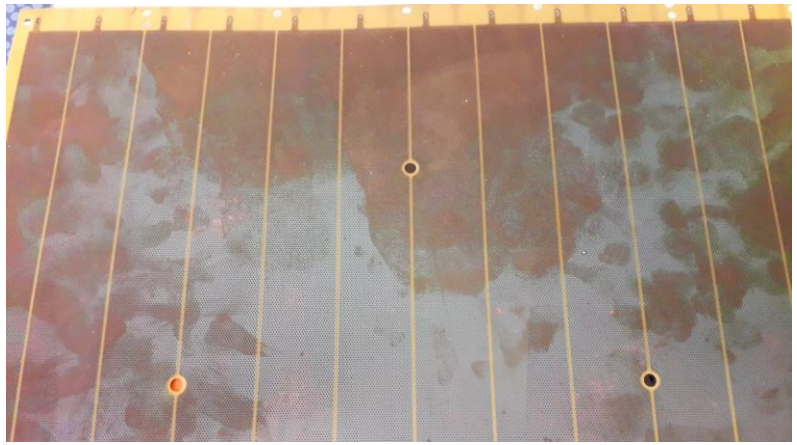
Dielectric Thickness: 400 µm
Hole Ø: 400 µm
Hole in triangular pattern
Hole pitch: 800 µm
No rim

Bulk Micromegas
Stainless steel, woven mesh
Anodic distance: 128 µm
Wire Ø: 18 µm
Wire pitch: 63 µm

POWERING AND READOUT

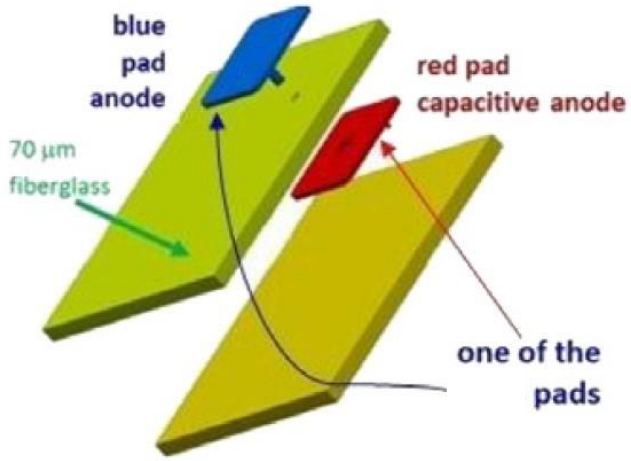
Electrode segmentation is essential. Each sector biased via 500 MΩ resistor.
> discharges affect single sector
> operating conditions restored in ~10 s

Voltages rescaled according to p and T fluctuations > stability of gain (~6%)

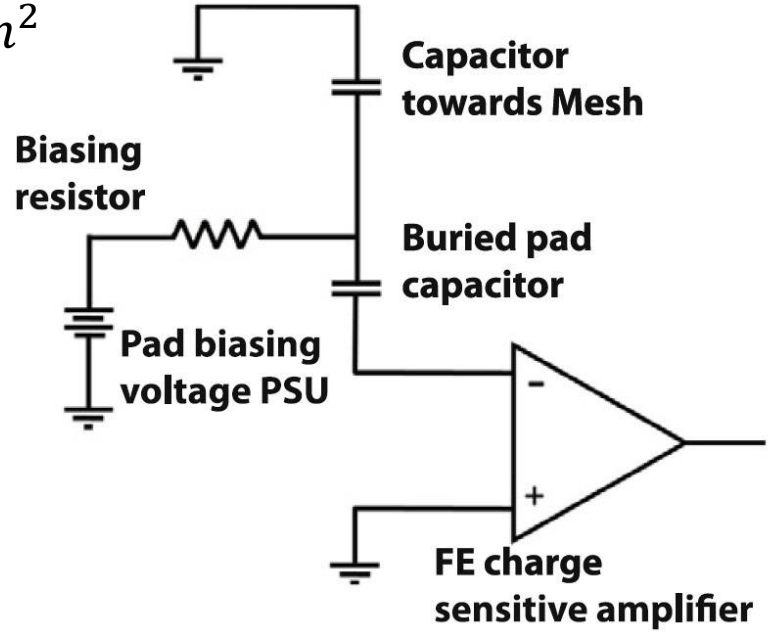


Large number of HV channels (~100) > compromise between cost and flexibility

Readout pad size: 7.5 x 7.5 mm^2
Readout pad pitch: 8 mm



"resistive" MM:
470 MΩ in series with each pad
Signal collected by buried pad and read with APV25 chip



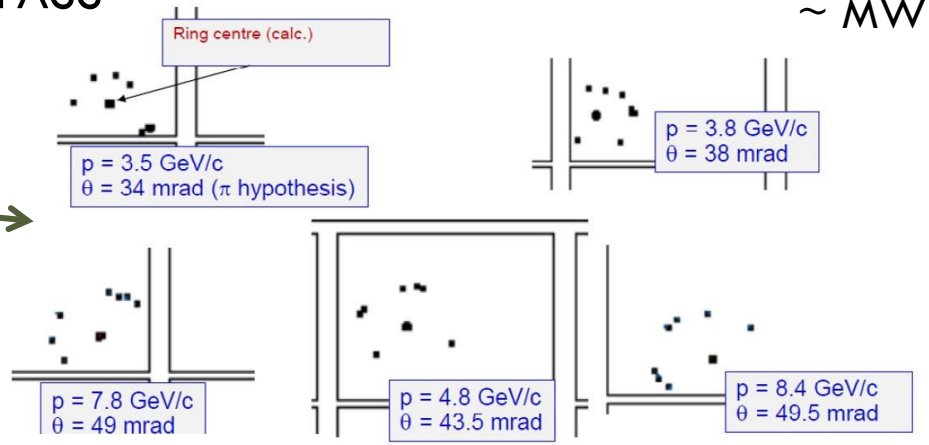
PERFORMANCE

MPGD-based PDs used during COMPASS runs 2016, 2017, 2021, 2022

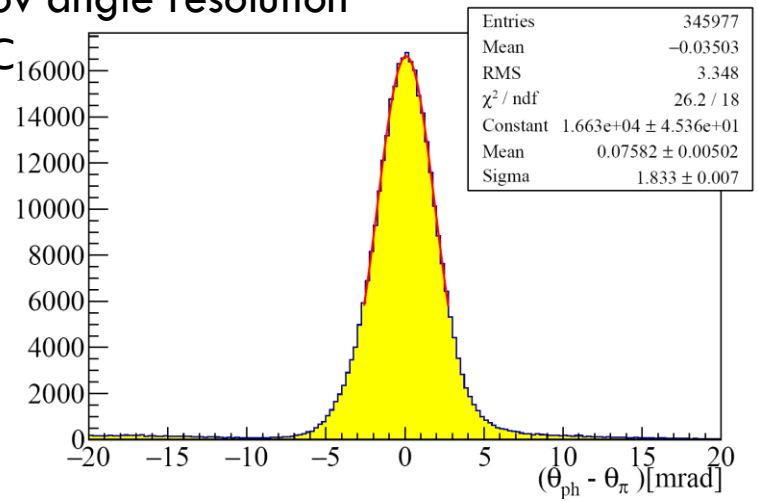
IBF: 3%

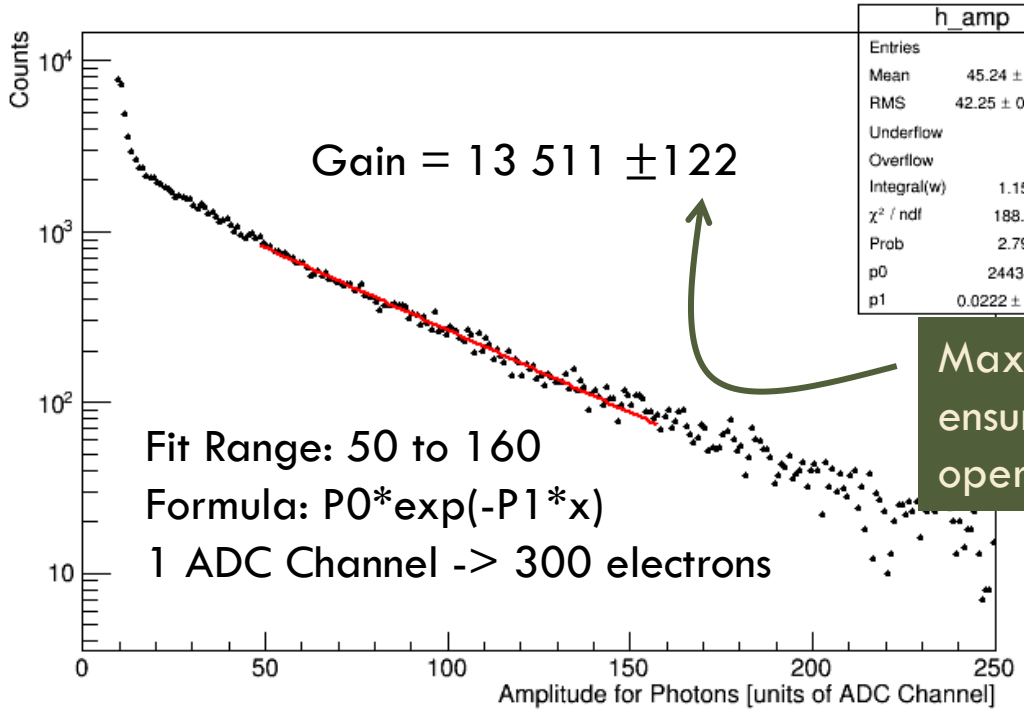
Electronic noise: 900ENC

Cherenkov rings in MPGD PDs
- no background subtraction



Cherenkov angle resolution
~ MWPC

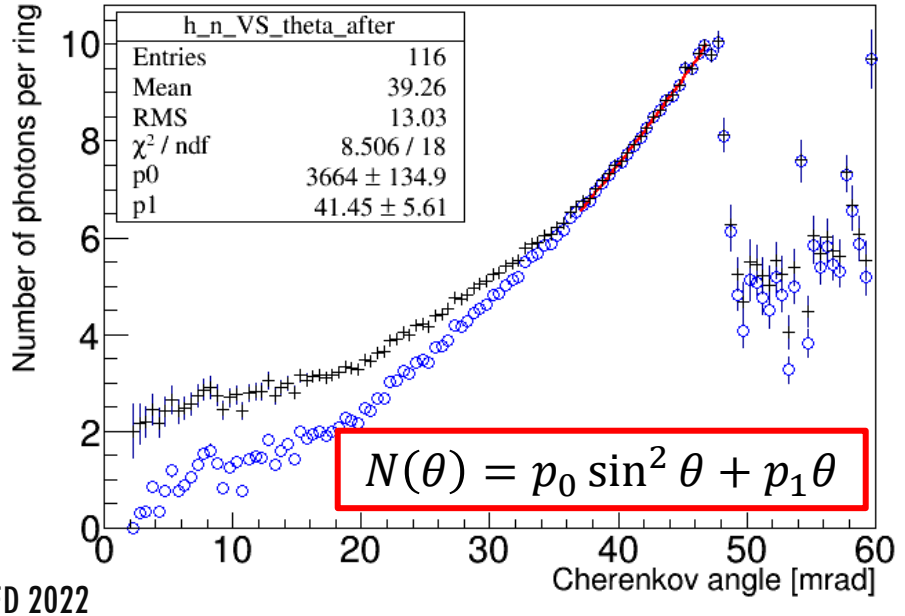




Gain = 13 511 ±122

Fit Range: 50 to 160
Formula: P0*exp(-P1*x)
1 ADC Channel -> 300 electrons

Max gain that ensures stable operation

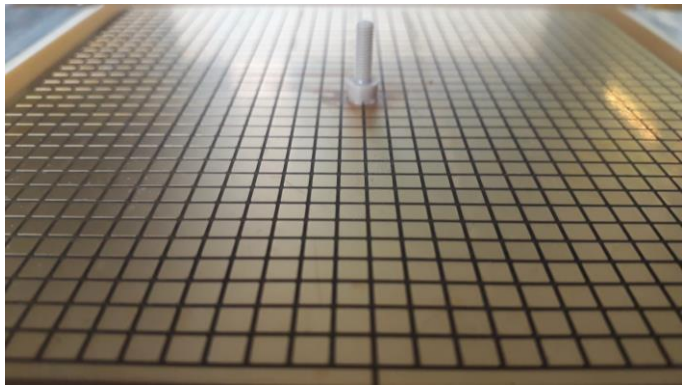


\+ data points
○ Poissonian correction

At saturation:
11 photons

A LOOK TO THE FUTURE

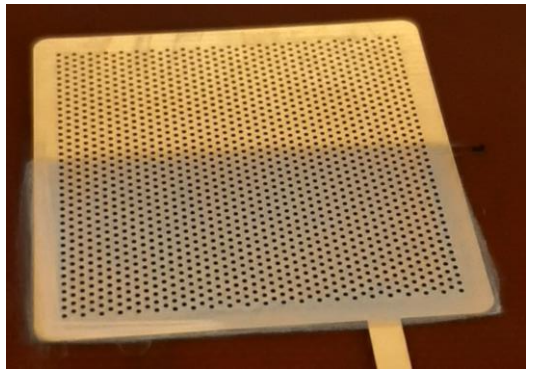
For exporting the technology to shorter radiator (e.g. collider experiment) >
Improve space resolution



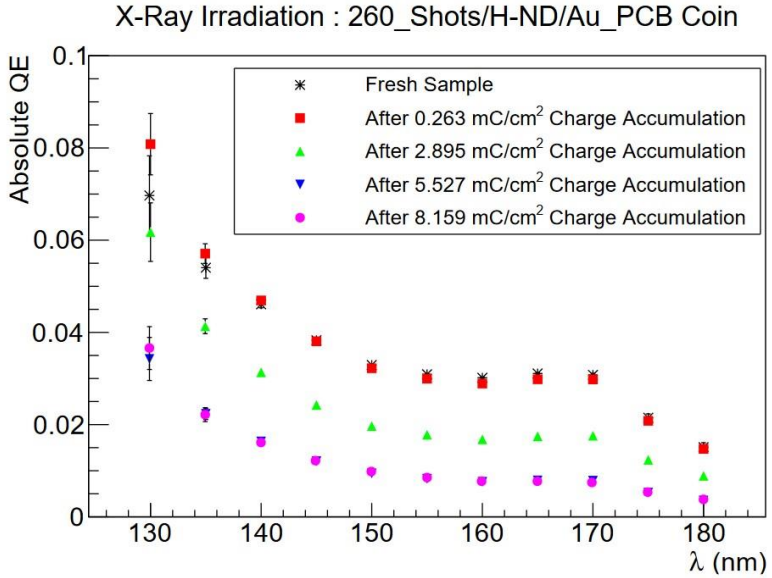
Reduced readout pad size (3x3 mm^2)

A prototype was produced and tested, promising results
> non uniformity among pads requires careful design of anode plane

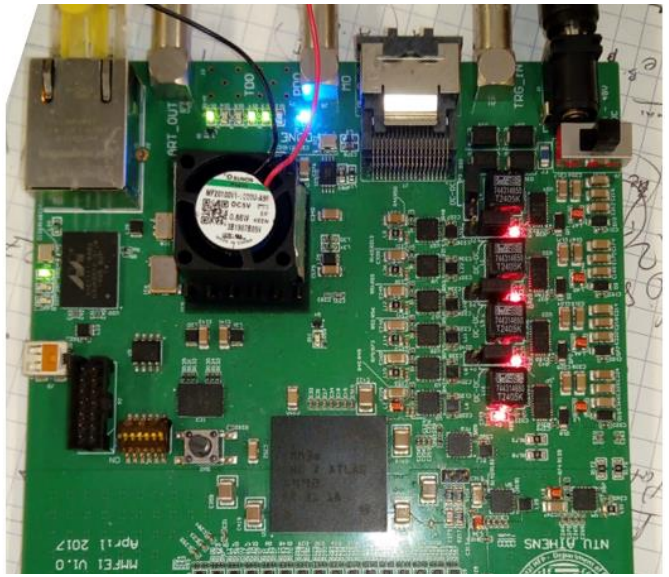
How low can we go in pad size?



Novel photocathode: hydrogenated nanodiamond powder
> Robust to ion bombardment
> Easier to handle compared to CsI
> QE comparable with CsI



A LOOK TO THE FUTURE



Single photon detection requires extremely low noise electronics

New Front-end electronics: VMM3a, designed for ATLAS NSW (MM and sTGC)

> Compatible with triggerless DAQ

> Each channel: CSA, Shaper, Discriminator, Digitizer

> Output fully digital (time stamp, amplitude, n of channel, …)

> First tests with UV photons ongoing in Trieste