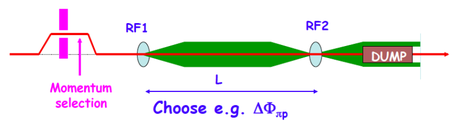
Development of a Micromegas prototype for the AMBER experiment at CERN

M. Alexeev on behalf of the working group

AMBER Collaboration:
> 200 members,
41 participating institute, 14 countries.

AMBER
Apparatus for Meson and Baryon Experimental Research



$\Delta\Phi = 2\pi\ (L\ f\ /\ c)\ (\beta_1^{-1} - \beta_2^{-1})$ with $\beta_1^{-1} - \beta_2^{-1} = (m_1^2 - m_2^2)/2p^2$

Conventional muon/hadron M2 beams

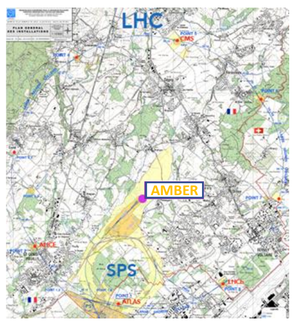
Run 3 → Run 4

Phase-1 ✓

Proton Radius Measurement
Antimatter production cross section
Pion structure (PDFs) via DY and charmonia

Phase-2

Kaon and pion structure (PDFs and PDAs)
High precision strange-meson spectrum
Kaon and pion charge radius
Kaon induced Primakoff reaction

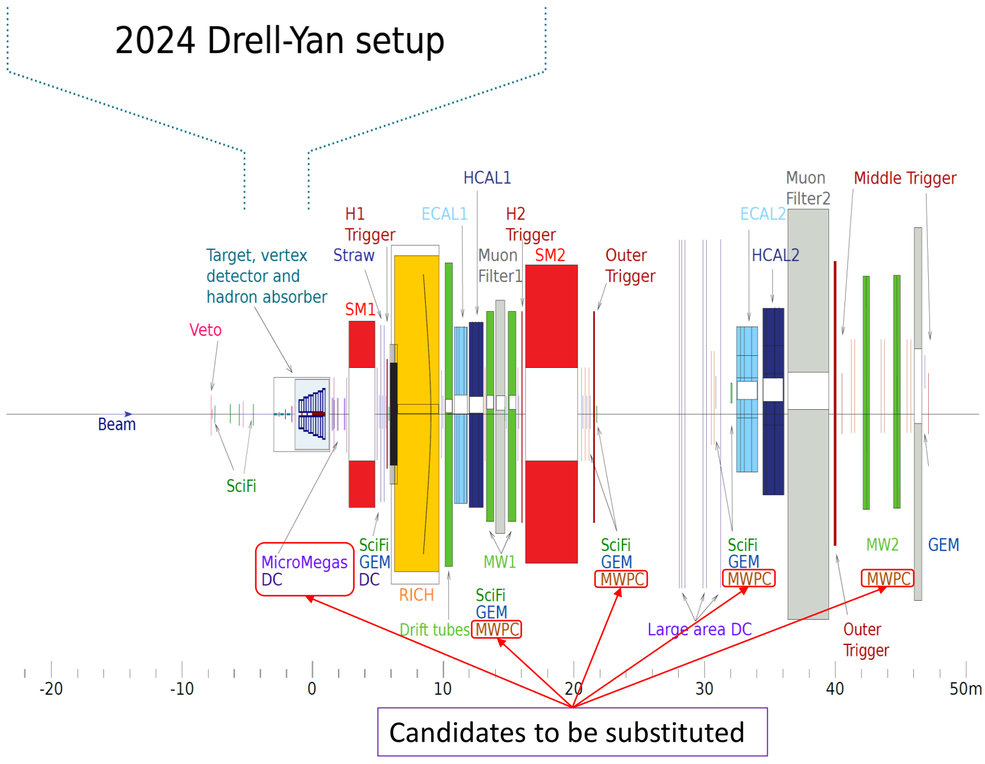


Located at CERN

Phase-1: Proposal approved by RB on 02/12/2020

Phase-2 Proposal submission in the beginning of 2022

2024 Drell-Yan setup

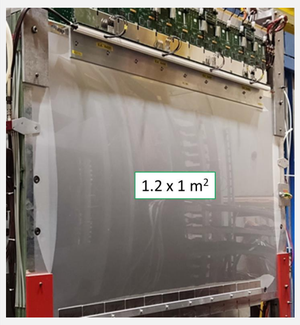


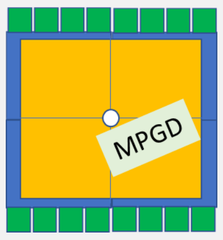
Candidates to be substituted

An MPGD detector with a new trigger less RO could find its first application starting the Drell-Yan measurement, presently scheduled for 2024

The development of the prototypes

We need to substitute detectors with specific requirements



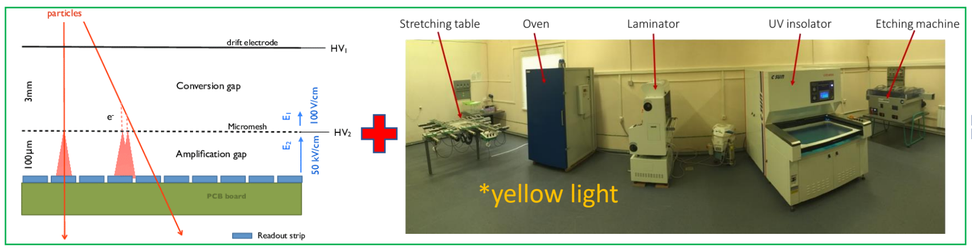


- ❑ Active area – up to 180x150 mm²
- ❑ Rates - ~150kHz/mm² (centre), 1-2 kHz/mm² (periphery)
- ❑ Thickness – 0.3-0.5 %/plane
- ❑ Possibly, proven design

To achieve that we would like to rely on a proven technology, a group with expertise and possibly a production site

Micromegas

JINR group involved in the ATLAS NSM project with a production site

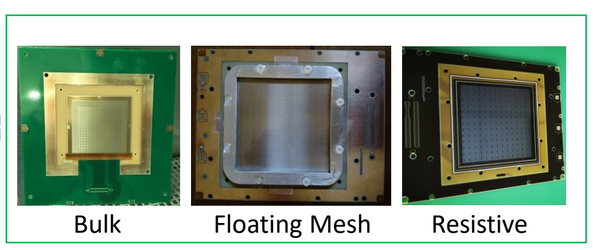


Possible prototyping timeline

2022
- 8x8 cm²
- TIGER ASIC
- New TIGER FE

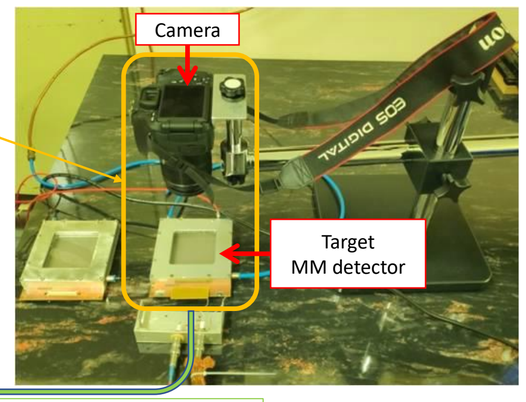
2022-23
- 50x60cm²
- TIGER ASIC
- New MM ASIC

2023-24
- 4x50x60cm²
- New MM ASIC



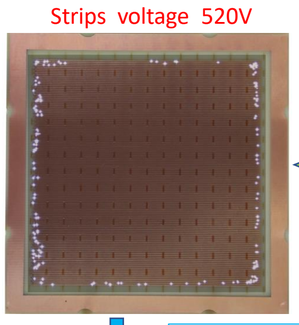
Quality check of the production

An optical system to analyse the anode defects has been implemented

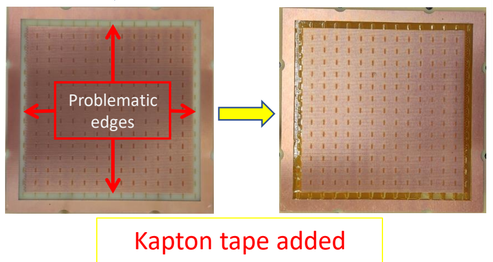


The camera accumulate the discharges picture

Strips voltage 520V

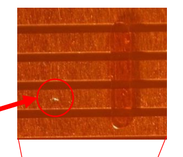


We can address the problematic areas

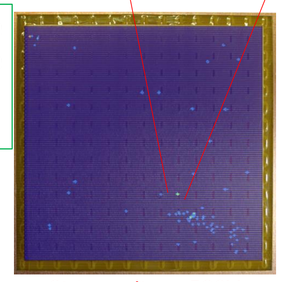


Kapton tape added

Local defects of the Cu on the strips



We have removed the problematic areas

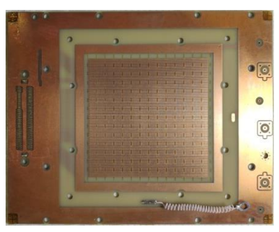


Strips voltage 590V

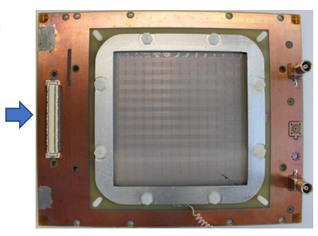
Our prototype: non-resistive floating mesh MM

- Active area: 6,8 x 6,8 cm²
- Amplification gap: 128 μm
- Conversion gap: ~ 5 mm
- Strips width: 400 μm
- Pitch: 550 μm
- Holes: 45 x 45 μm²
- Wires diameter: 18 μm

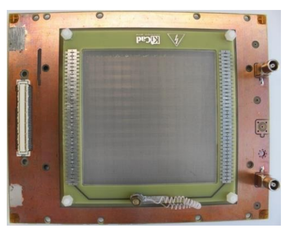
Anode PCB



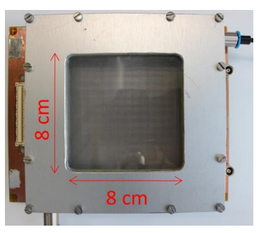
Mesh frame



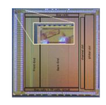
Drift electrode



Gas volume

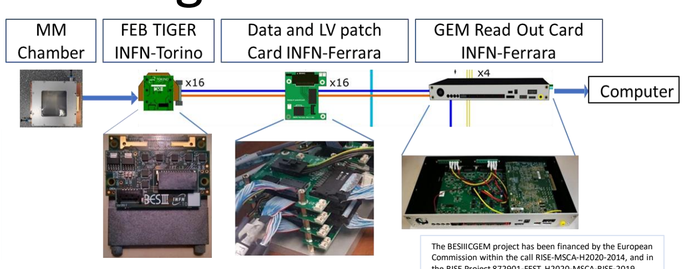


Initial digital RO chain

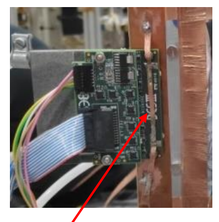


TIGER ASIC
(Torino Integrated Gem Electronics for Read-out)

The ASIC speicification:
-> 64 channels with up to 60kHz/ch rates
->12 mW/ch power evelop
-> Analog charge measurement up to 50fC
-> ENC noise below 2000 e⁻ rms for strip capacity < 100pF
-> Time-over-Threshold charge measurement possibility
-> 4 TAC on T and Q branch of every channel
-> SEU tolerant digital part



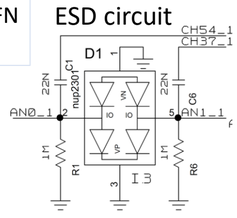
The BESIIICGEM project has been financed by the European Commission within the call RISE-MSCA-H2020-2014, and in the RISE Project 872901-FEST, H2020-MSCA-RISE-2019



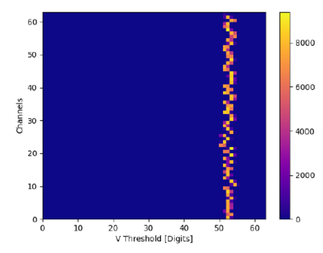
We use the versatile test DAQ system developed within the CGEM project by INFN To and INFN Ferrara

Two issues were identified:
- The grounding could be tricky
- The discharge protection circuit is not sufficient in our configuration

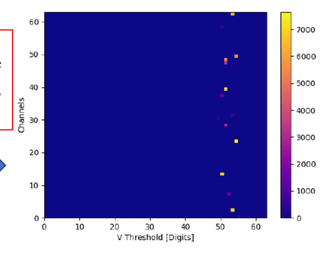
ESD circuit



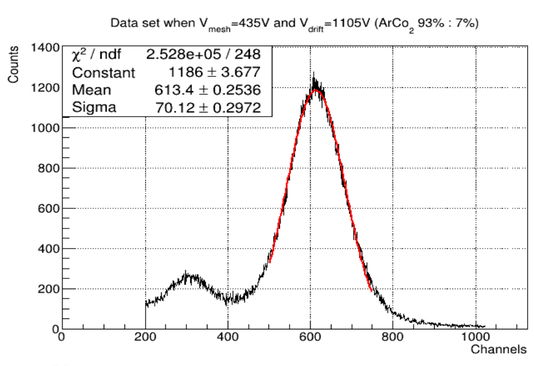
The GND is provided by soldering a trace, not through the connector



After 1 day on beam, most of the channels are gone

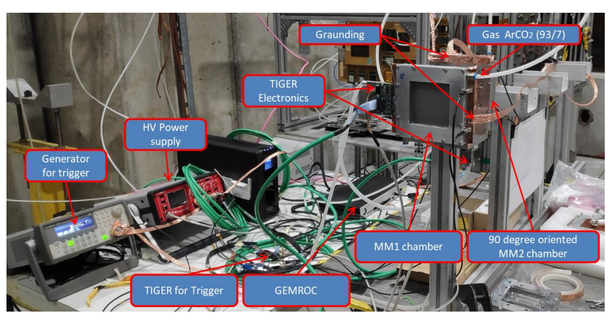


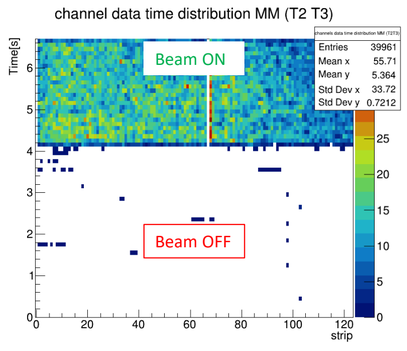
Initial laboratory tests



^{55}Fe source is used for quality checks

Operation at the RD51 TB

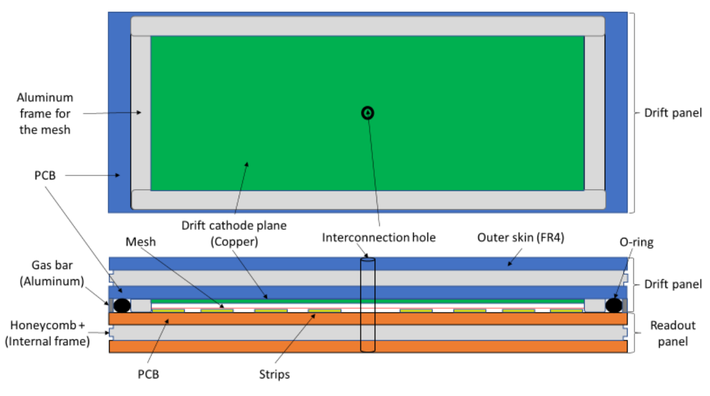


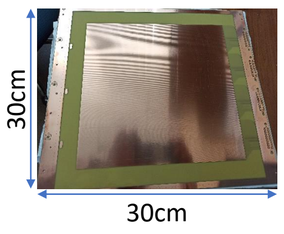


We collected a limited sample of data, the analysis is presently ongoing

Next steps

Mechanical challenges





1) Study of the bigger surface behaviour during the production

2) Mechanical structure adapted for bigger prototype size

FE challenges

A **new specialised ASIC** is being developed

The new FE card has been delivered in 05.22