

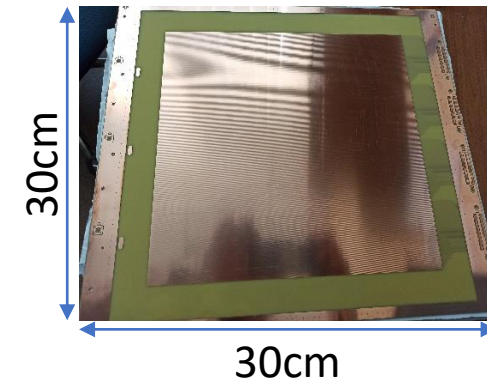
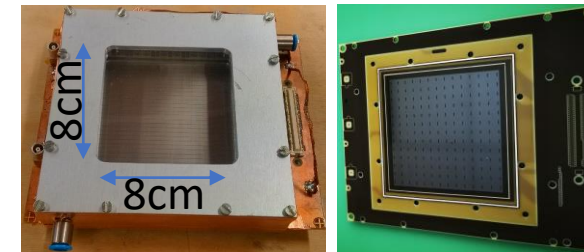
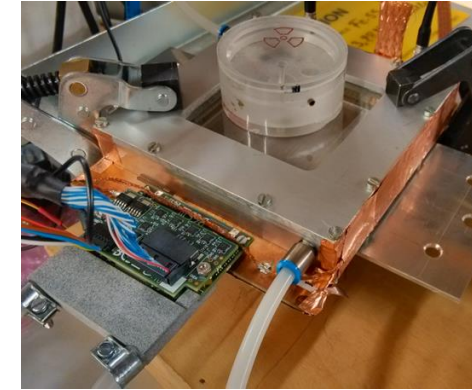
MM prototyping & COMPASS++/AMBER

M. Alexeev on behalf of the group
Università di Torino & INFN Torino



Motivation for the ongoing work

- For the running of the AMBER program, we evaluate the possibility to substitute a part of the MWPCs with MPGD based detectors
- The motivation is to substitute the structurally aged MWPC, to be able to optimize the acceptance coverage with a variable size detector. We would like to be able to cover both the high-rate central beam area and the external part of the aperture with a single detector taking advantage of the MPGDs anode design flexibility
- The new detectors should be ready for the new trigger less DAQ and one of the possible R/O options could be the TIGER ASIC that was developed specifically to be used with MPGD detectors. Several other options like the VMM ASIC must be investigated
- Presently small size prototypes are under test to validate the R/O and the production technics



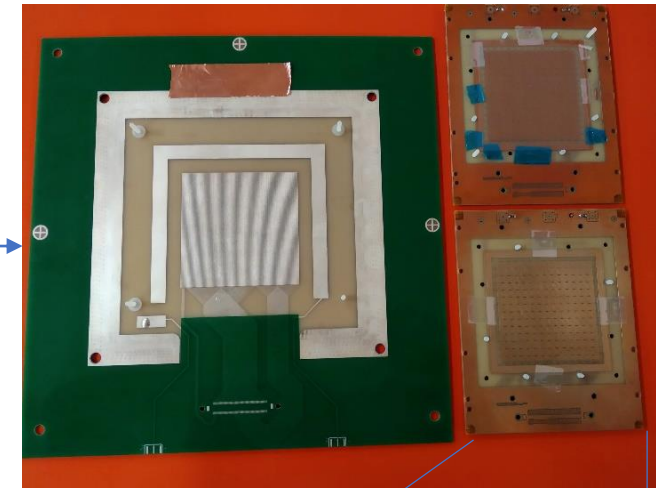
□ We would like to produce the first prototypes of a size $\sim 55 \times 55 \text{ cm}^2$ in 2022-2023

Motivation for the ongoing work



- The MWPC have a $\sim 20\text{cm}$ diam. passivated area around the beam
- The support structure and the GEM detector elements are visible in the reconstruction
- Would be nice to have a single detector at least in the upstream part of the spectrometer

Historical comment



JINR
production
facility

Torino Integrated Gem Electronics Readout (TIGER)

TIGER Design:

INFN-Torino
LIP-Lisboa
PETSYS-Lisboa
IHEP Beijing

Test responsible:

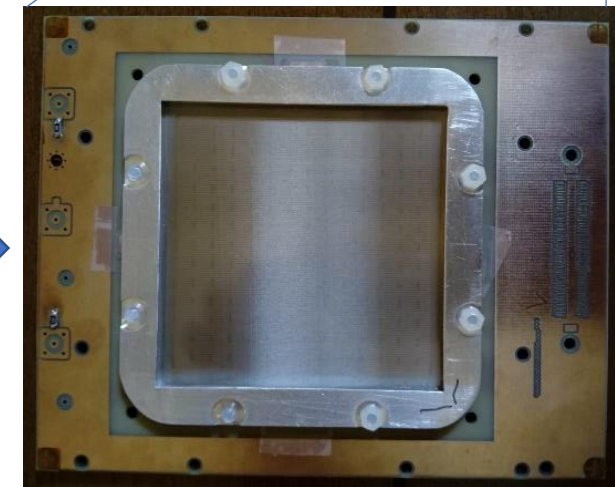
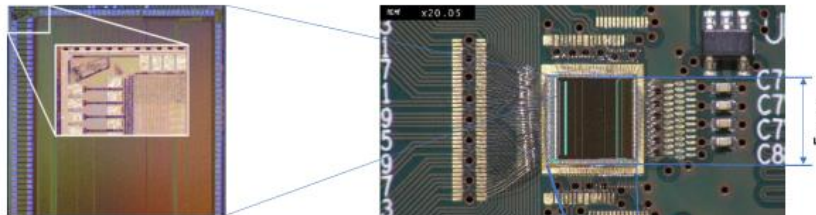
INFN-Torino

The TIGER ASIC has been developed within the BESIII/GEM Project, funded by European Commission within the call H2020 MSCARISE2014.



Ref.: A. Rivetti et al. "TIGER: A front-end ASIC for timing and energy measurements with radiation detectors" Nuclear Inst. and Methods in Physics Research, A 924 (2019), pp. 181-186.

14/10/2019



FE development
compatible with
trigger less DAQ

19/02/2021

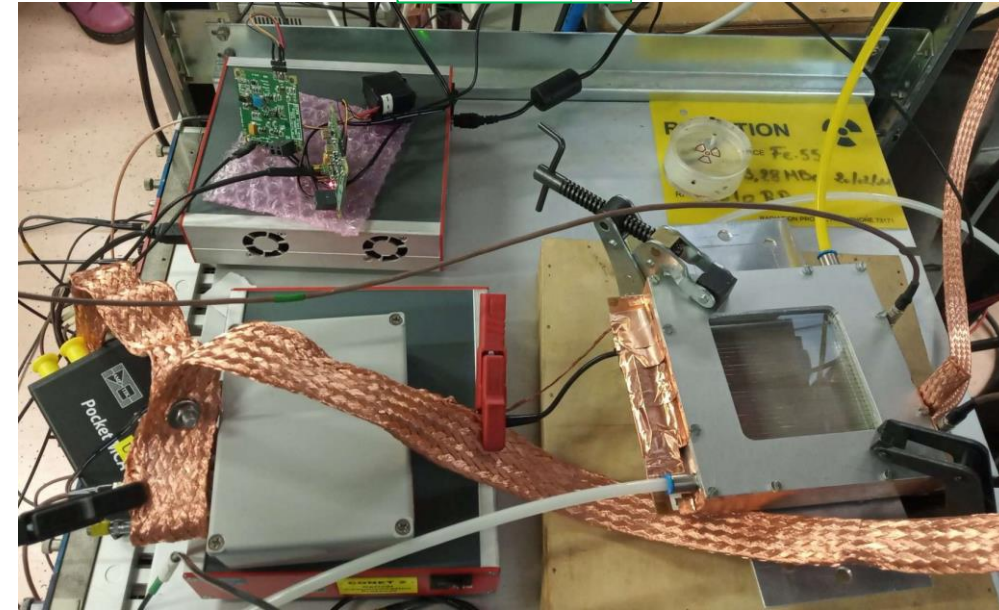
MM prototype setup at RD51 (11.2019)



~120 um pillars



Compensated for the PCB bending

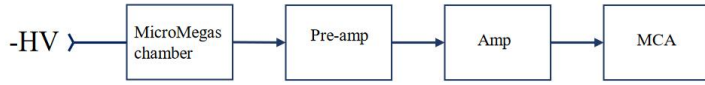


The setup

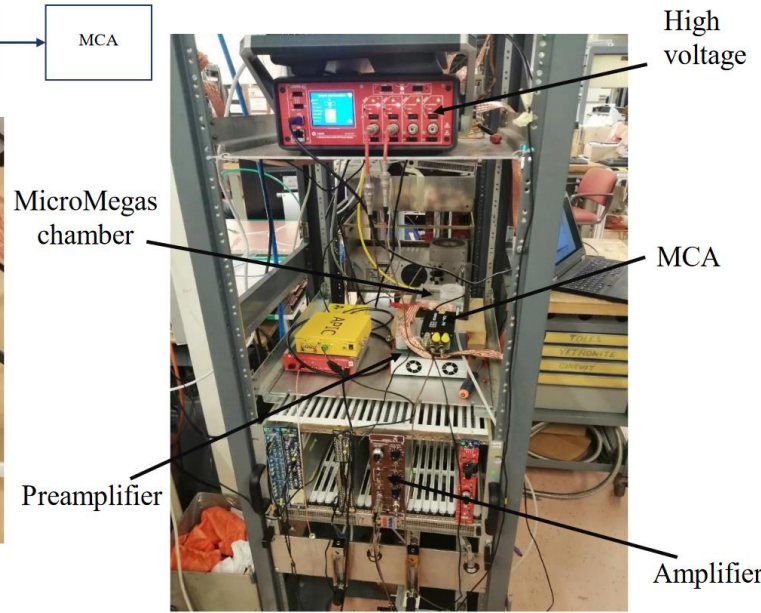
- ✓ The main goal of the test was to confirm that the present prototype is ready to be further studied with the digital R/O and during the foreseen test beams
- ✓ Using the RD51 infrastructure and support we have conducted the check of the mechanicals properties and prepared the detector for the tests with the source

Testing with the Fe55 and MCA

Testing scheme of MicroMegas chamber



MCA8000D Digital Multichannel Analyzer



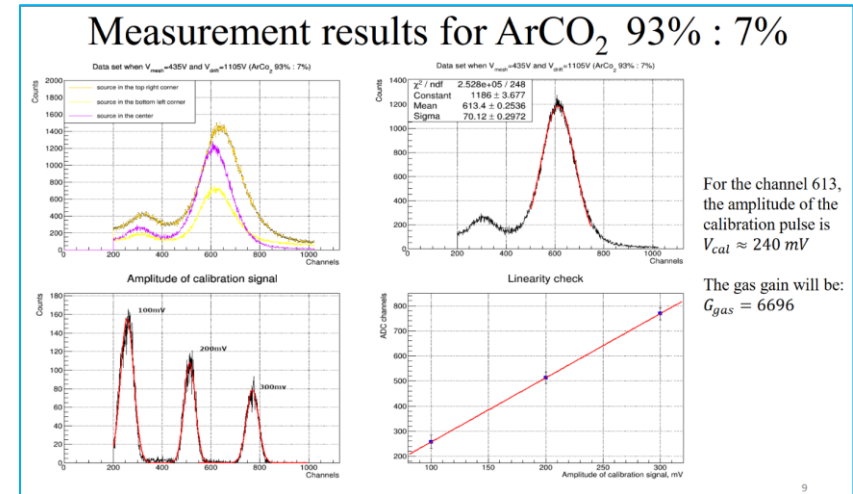
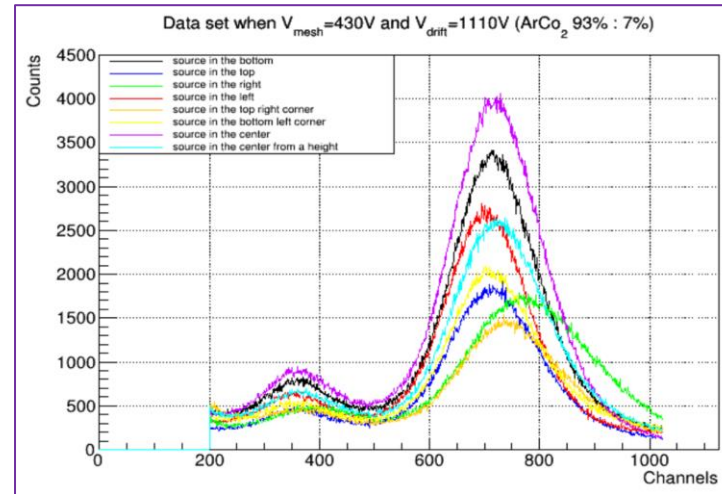
Fe₅₅ source location

Fe ₅₅ source in the center	Fe ₅₅ source in the bottom	Fe ₅₅ source in the top	Fe ₅₅ source in the left
Fe ₅₅ source in the right	Fe ₅₅ source in the bottom left corner	Fe ₅₅ source in the top right corner	

- The characteristics of the detector were checked using a source Fe₅₅ emitting an x-ray line with energy 5.9 keV
- Gas mixture used ArCO₂

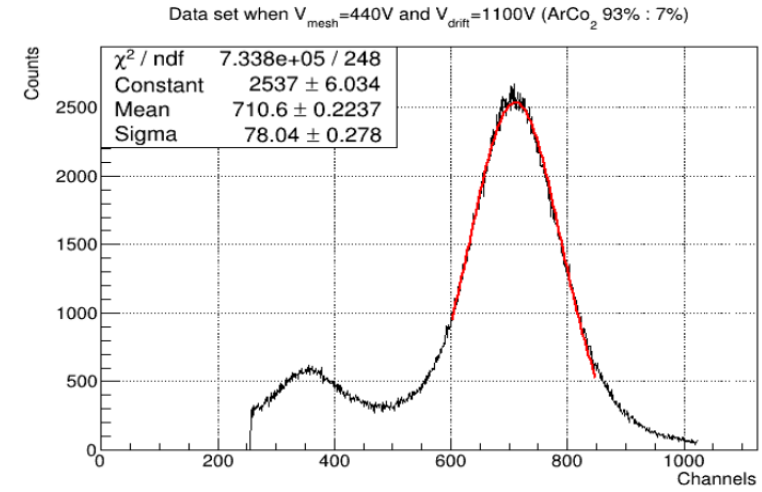
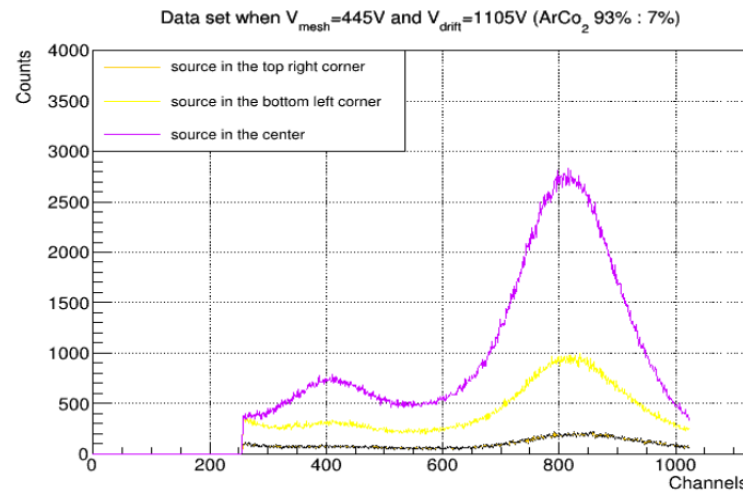
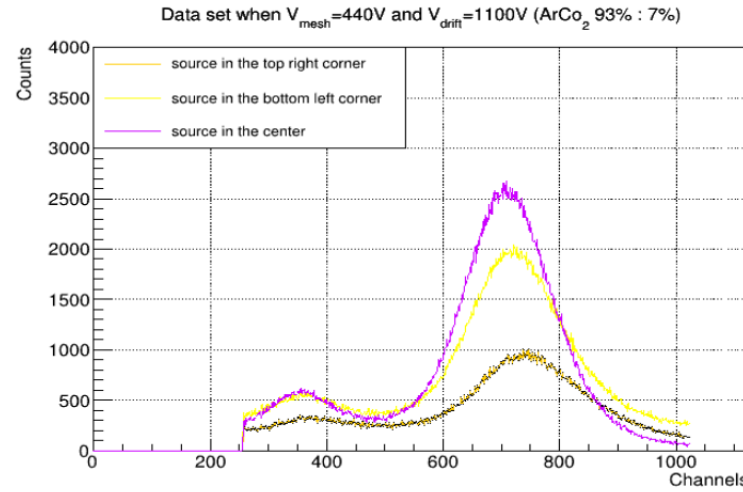
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- ✓ We have conducted a check of the uniformity of the detector's response
- ✓ A study of the achievable amplification and detector's stability were conducted



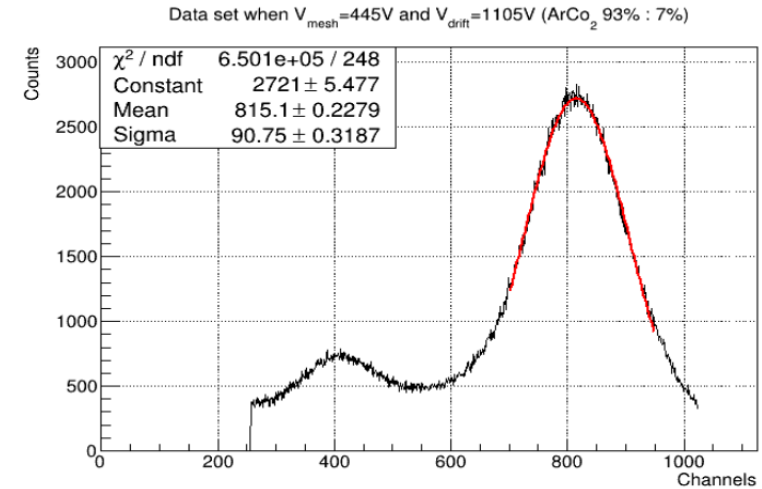
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Some results with the Fe55 and MCA



For the channel 710, the amplitude of the calibration pulse is $V_{\text{cal}} \approx 275 \text{ mV}$

The gas gain will be: $G_{\text{gas}} = 7673$



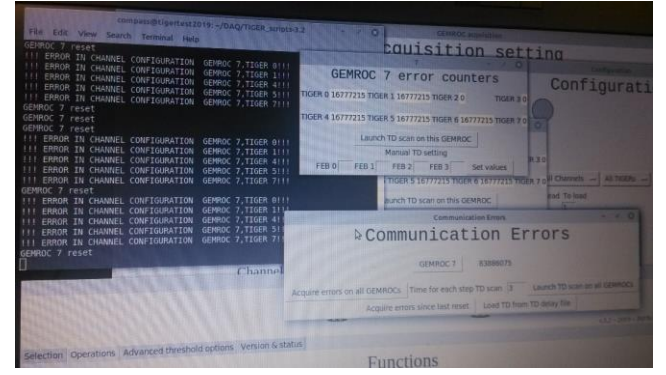
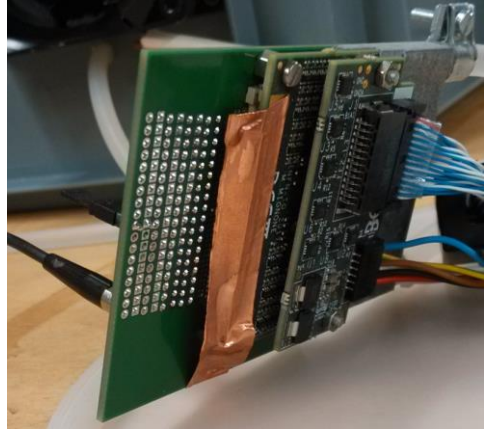
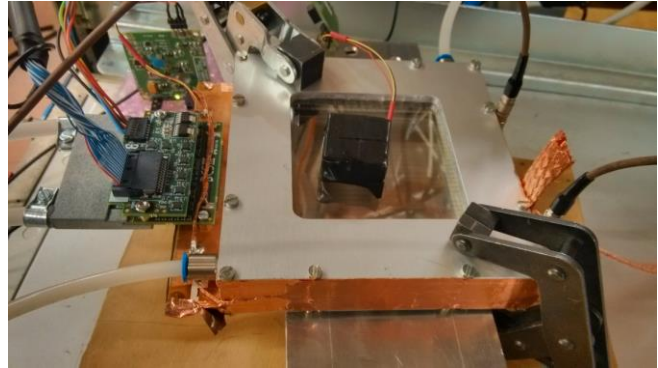
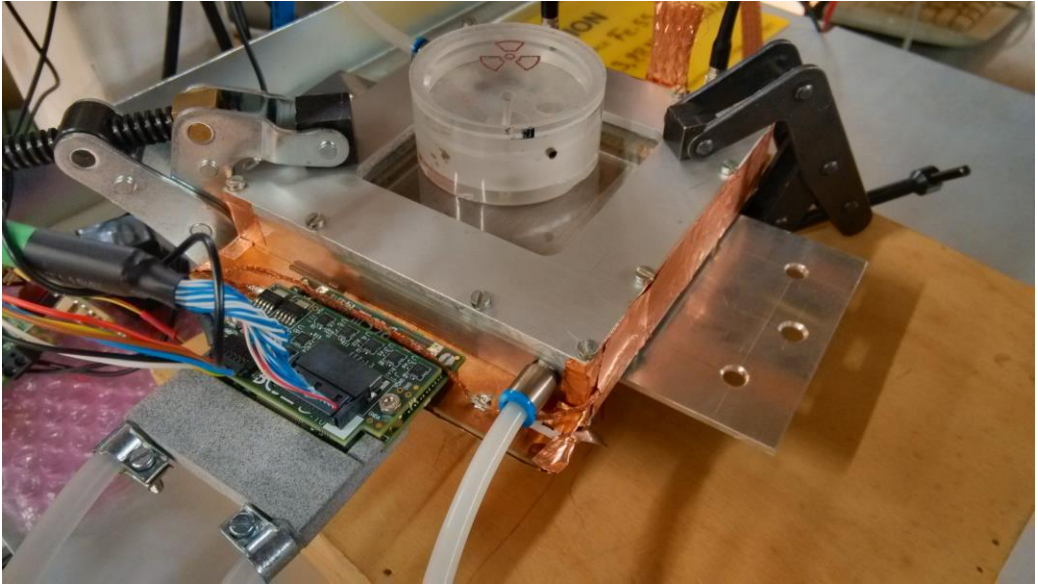
For the channel 815, the amplitude of the calibration pulse is $V_{\text{cal}} \approx 315 \text{ mV}$

The gas gain will be: $G_{\text{gas}} = 8789$

➤ We are satisfied with those initial results in ArCO₂ 93%:7%

➤ Further studies in ArCO₂ will be carried at end of the Covid (03.2020)

Testing with the TIGER ASIC and cooling



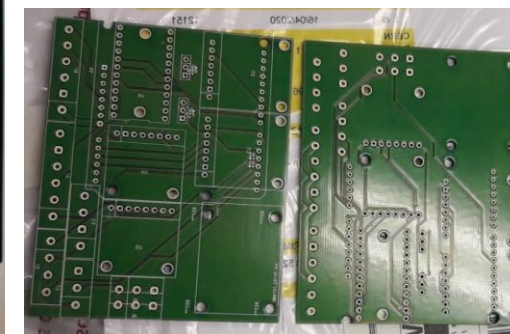
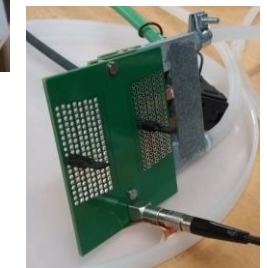
- We have managed to operate the whole DAQ chain
- Some data with the source has been taken
- We have tested the trigger system and the trigger pulse injection into the FE
- Unfortunately it was later found that all the FEs we had got the ASICs from an unfortunate batch with underperforming ADCs. During testing we did not realise it and spent too much time trying to solve the problem.

In March 2020, just before the lock-down, all the FEs were moved to be bond with new ASICs, we are waiting to restart the testing

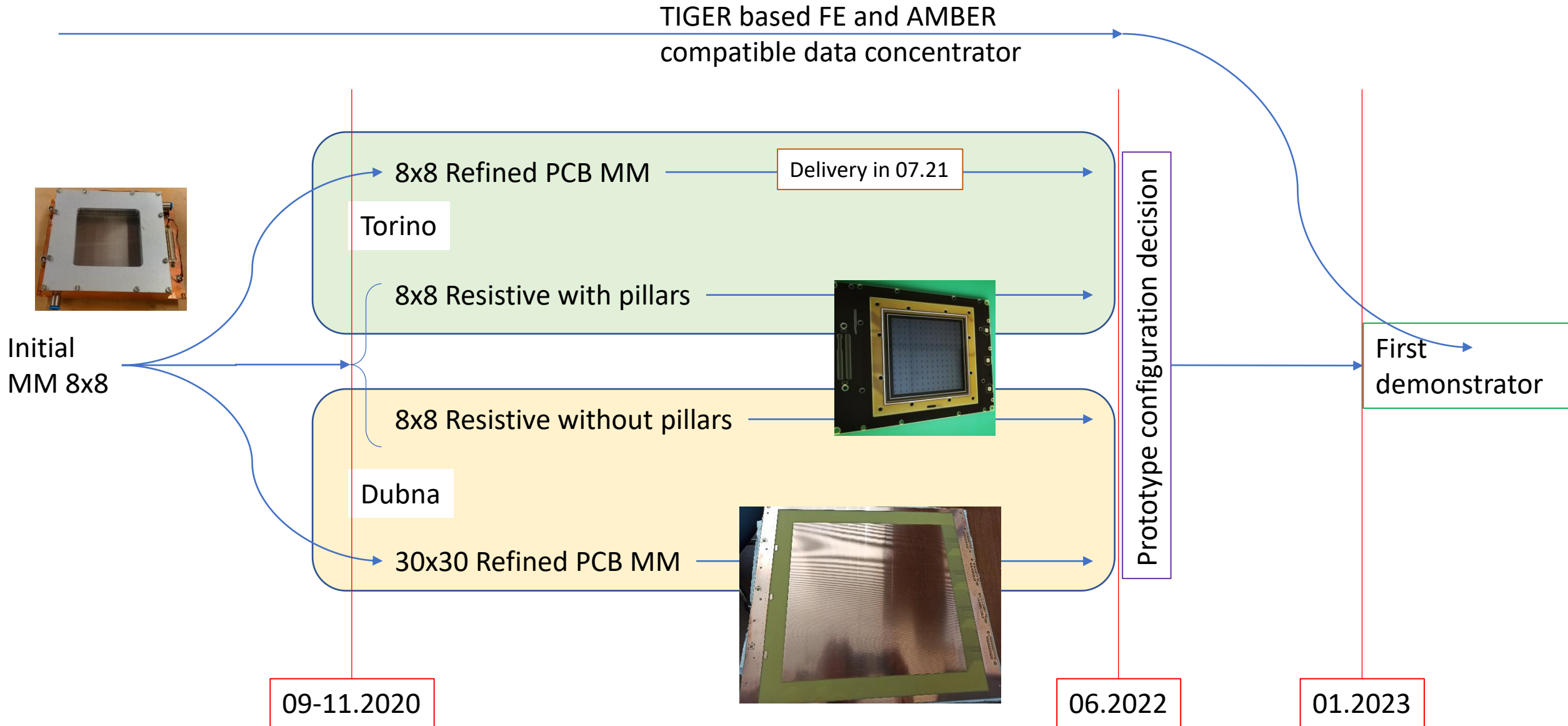
MM prototype at the COVID outbreak

Since the autumn o 2019 we completed the following goals:

- ✓ Finalized the testing of the prototype in laboratory and solved the HV instabilities
- ✓ Finalized, produced and validated the custom heat exchangers for the TIGER FE cards
- ✓ Prepared a “first prototype” cooling circuit that can be used during off-site testing
- ✓ Instrumented a DAQ system based on the BESIII acquisition modules designed and produced by INFN Ferrara
- ✓ Prepared and tested the small stand-alone trigger system
- ✓ Designed, produced, tested and used during tests the signal injection cards
- ✓ Tested the prototype with a Fe55 source at RD51
- ✓ Tested the R/O of the TIGER FE cards
- ✓ Designed and produced the PCBs for the portable cooling system



Present project organization



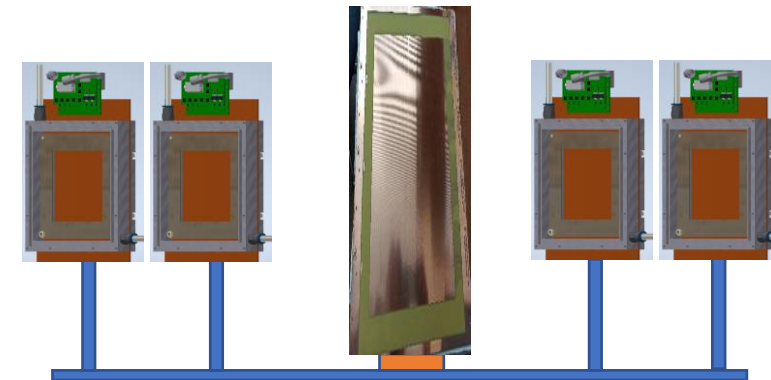
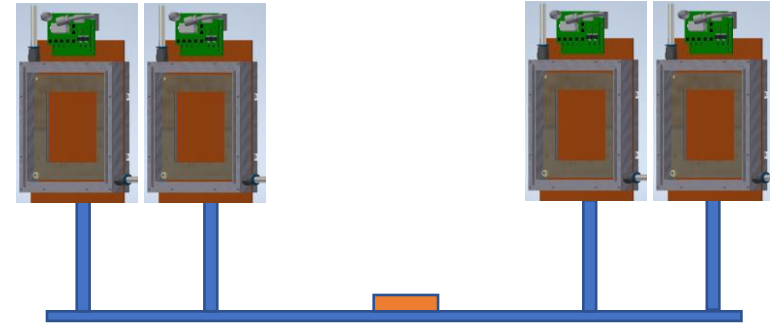
Input for the TBs

In July

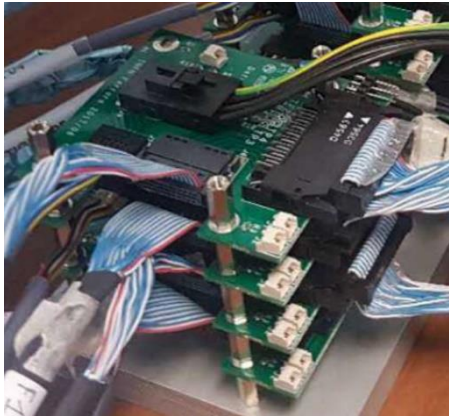
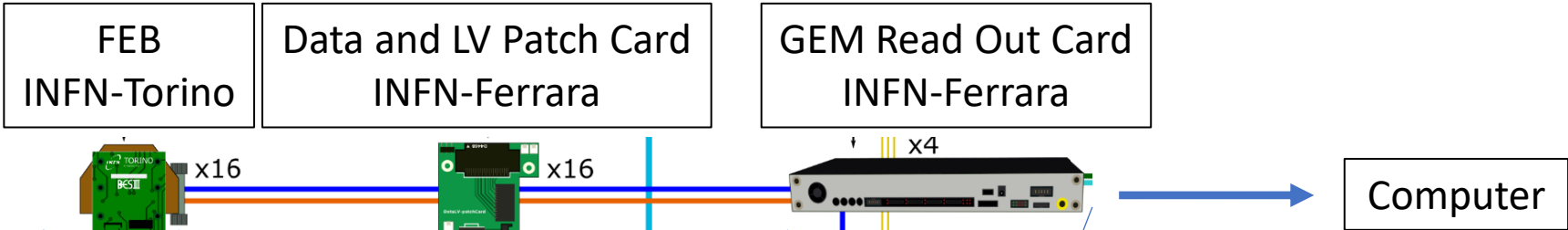
- We will use the “same” TIGER FEs with new chips
 - We would like to test the tracking with 2-4 small prototypes
 - We would like to test the trigger system
 - Data acquisition both in trigger less and triggered modes
 - We need the ArCO₂ mixture and the 220V infrastructure
 - We would use 30 - 60 cm along the beam, 2x“rack slots” and a PC
 - We would need 2-3 days including the installation and removal.
(If more is possible would be used)
- Beam: MIPS at rates ~1-100kHz with a ~1cm sigma

“Later”

- We would use the tested telescope with the modified prototypes as test samples
- We will have more R/O modules in synchronised operation
- Dedicated TIGER based FE will be used



R/O configuration



➤ Minimal laboratory equipment in trigger less mode

➤ The trigger matching can be added to the system

