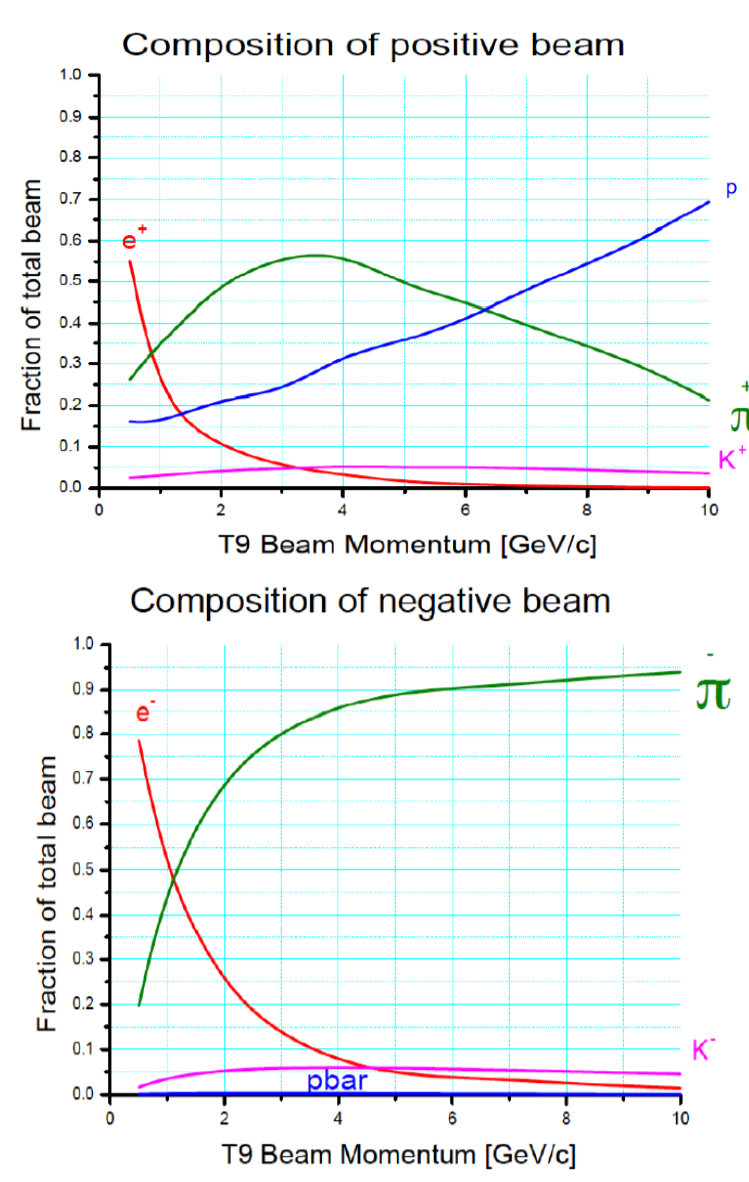


The T9 experimental area

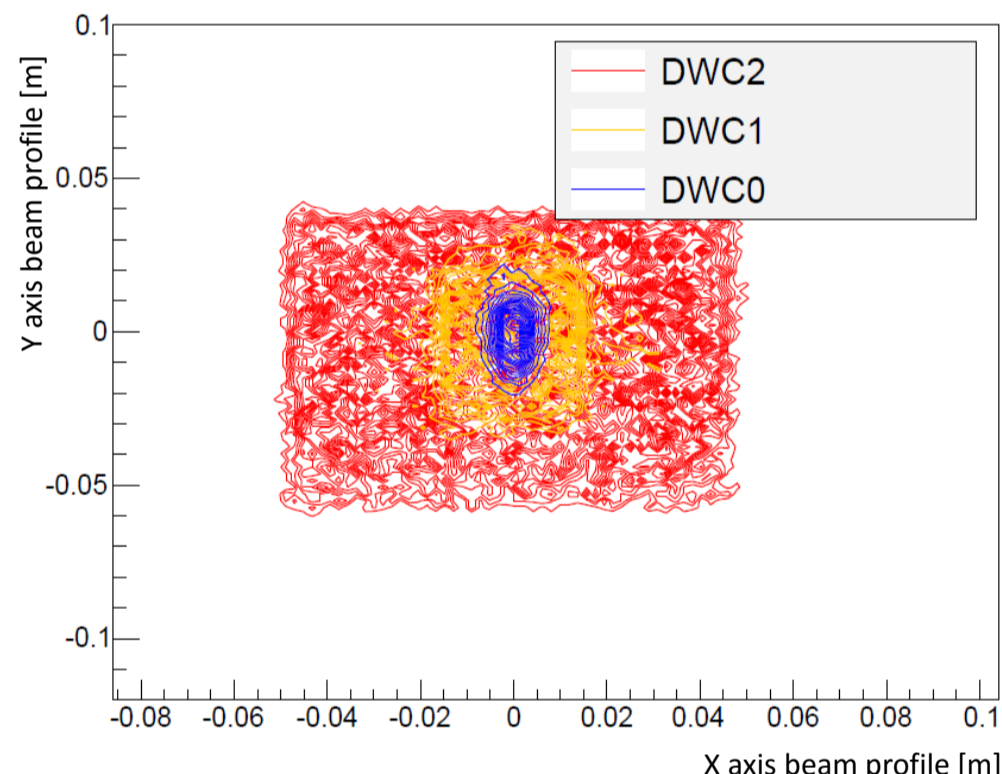


The Beamline for Schools (BL4S) [1] experiments take place in a beam line (called T9) at CERN's Proton Synchrotron. The beam contains either positively or negatively charged particles with a well-defined momentum. T9 is a space of about 5 m by 12 m, containing a number of detectors, which are fixed, along with the available equipment and detectors which can be laid out according to the needs of the winning experiments.

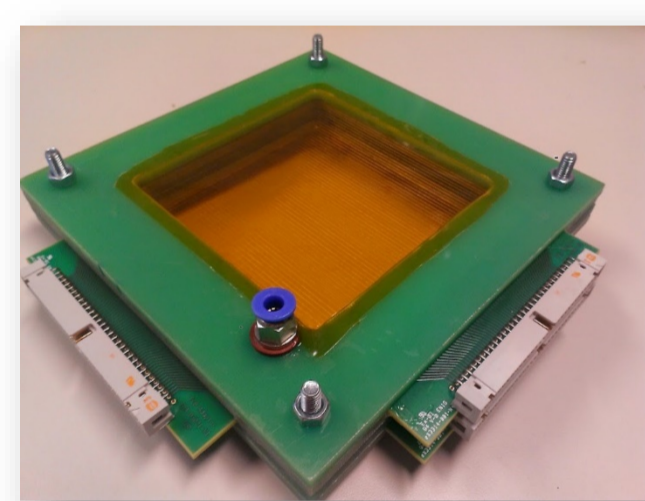
Delay Wire Chambers

The Delay Wire Chambers (DWC) [2] are multi-wire gaseous chambers. They use an array of wires at high voltage connected to a delay line.

- The DWCs of BL4S have an active area of 10x10 cm².
- Space resolution of few hundred μm can be achieved.
- One DWC is part of the fixed setup of the beamline. Two additional DWCs are available for the experiment.

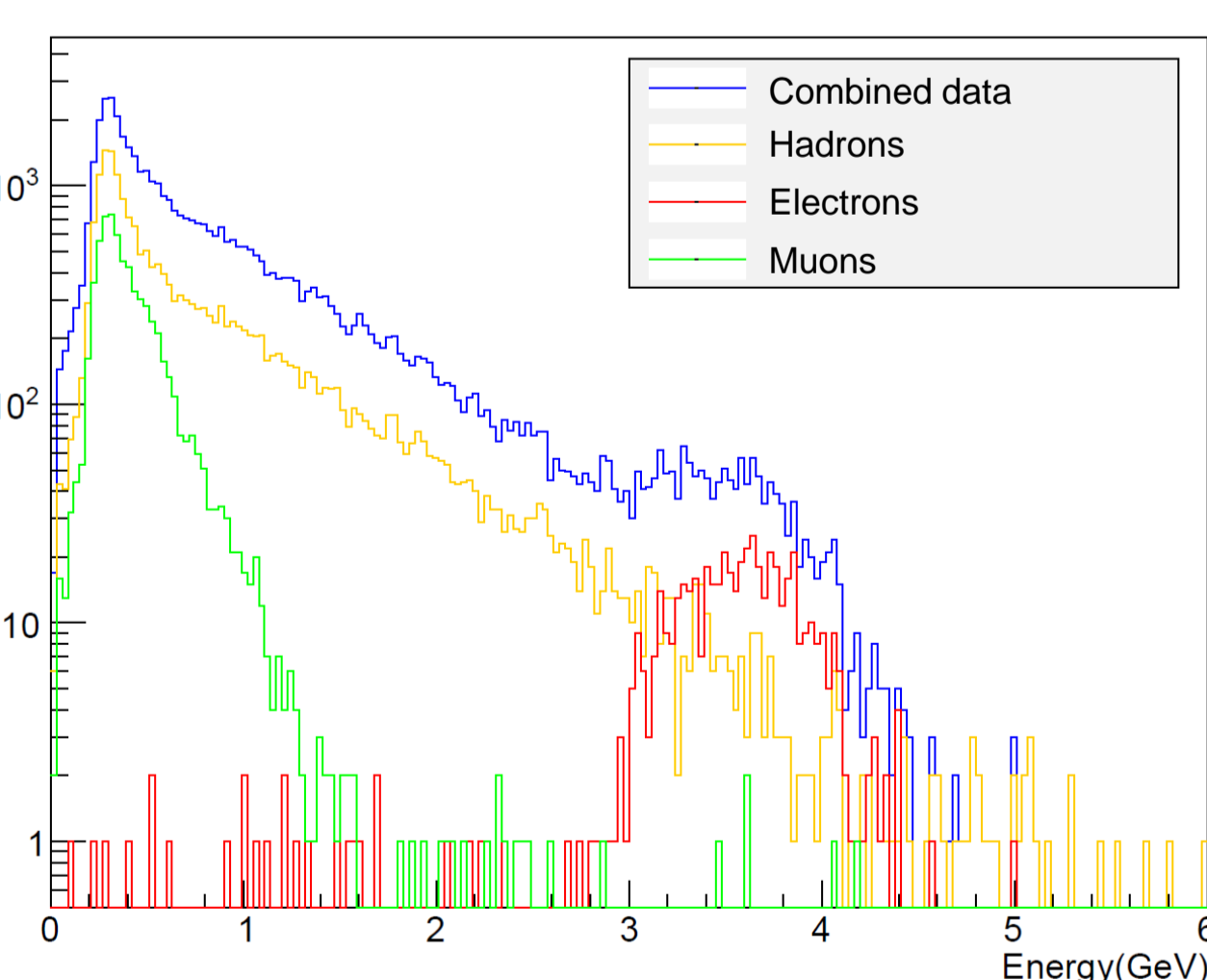


Left: The beam profile as recorded by 3 DWC positioned with approximately 3 m between them in T9 during the Beamline for Schools experiments in 2014. The beam was focused on the first detector (DWC0).

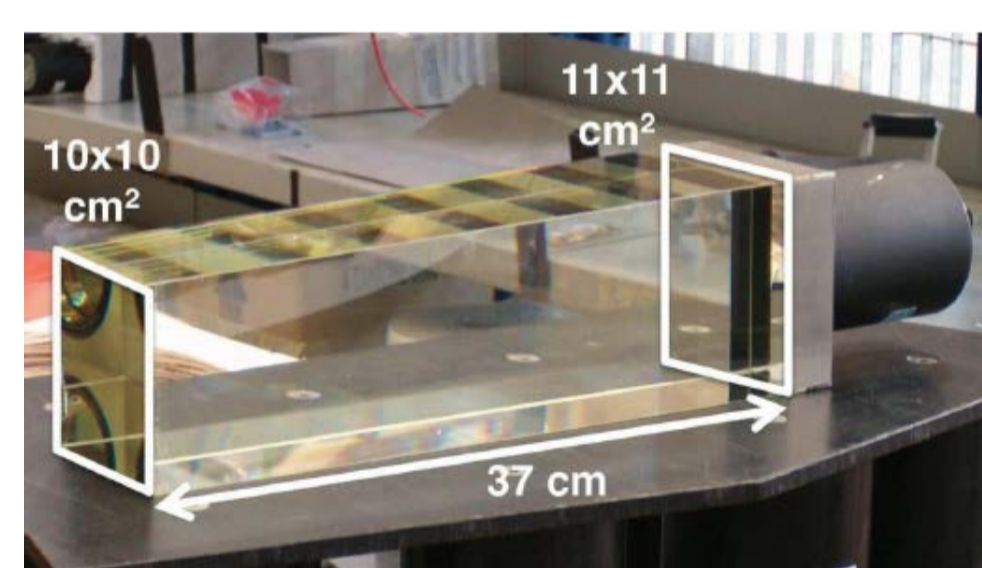


Right: A prototype DWC has been built at CERN for the Bogazici University [3] with the support of BL4S.

Lead glass calorimeters



Heavy particles produce a signal in the lead glass calorimeters but the energy deposition is smaller than that of electrons. By measuring the deposited energy, signals induced by electrons can be distinguished from those induced by muons and hadrons. The plot shows data from BL4S 2014 for a 4 GeV/c beam.



BL4S has 16 calorimeters available with dimensions 10x10x37 cm³ [5].

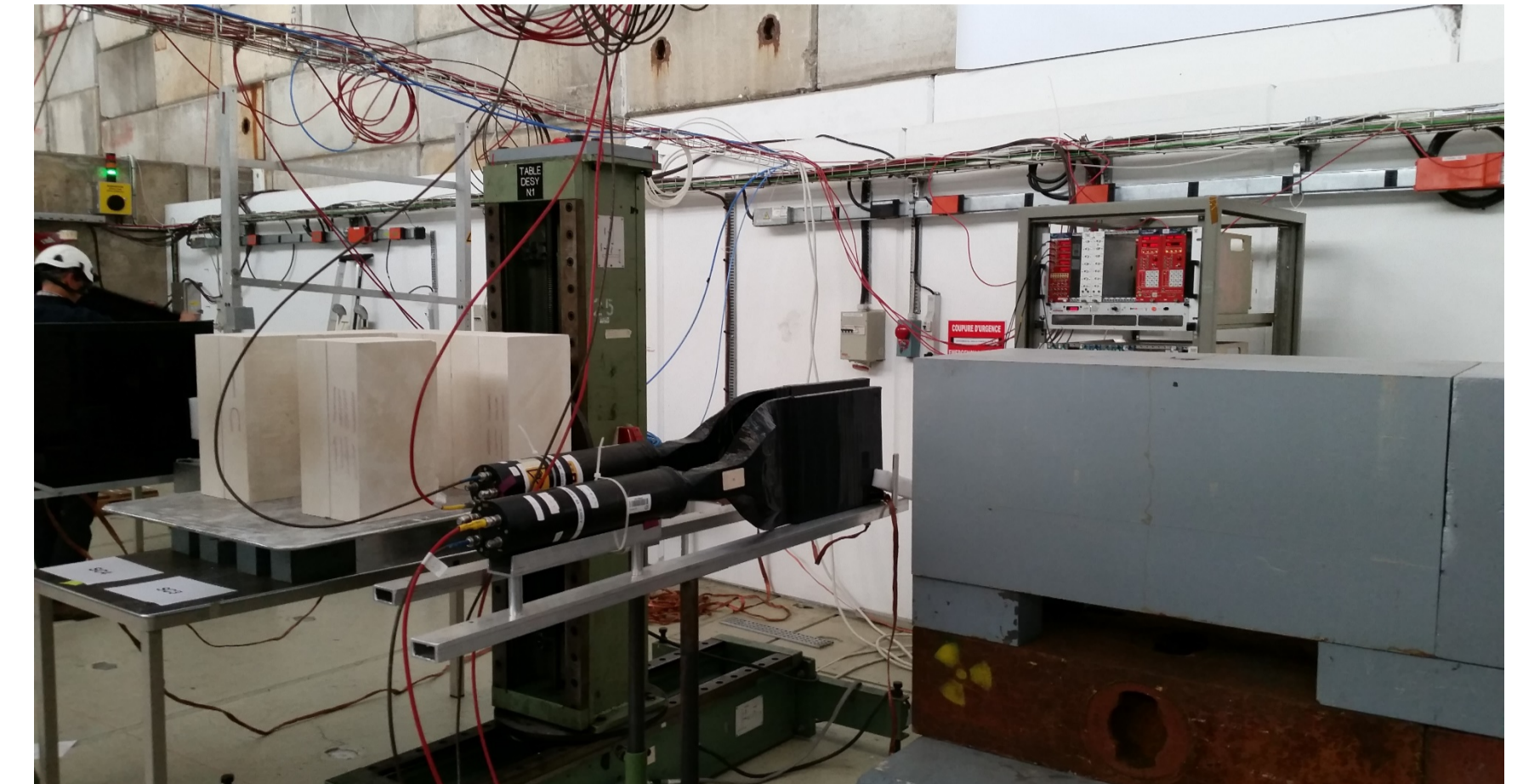
Scintillation counters

One scintillation counter is part of the fixed setup of the beam line. BL4S has a plethora of scintillation counters of various shapes and sizes that are available for installation in the experiment. Depending on the needs of the winning experiments new scintillators can be made at CERN*.



They can be used for:

- counting particles,
- tracking,
- time of flight,
- trigger,
- veto.

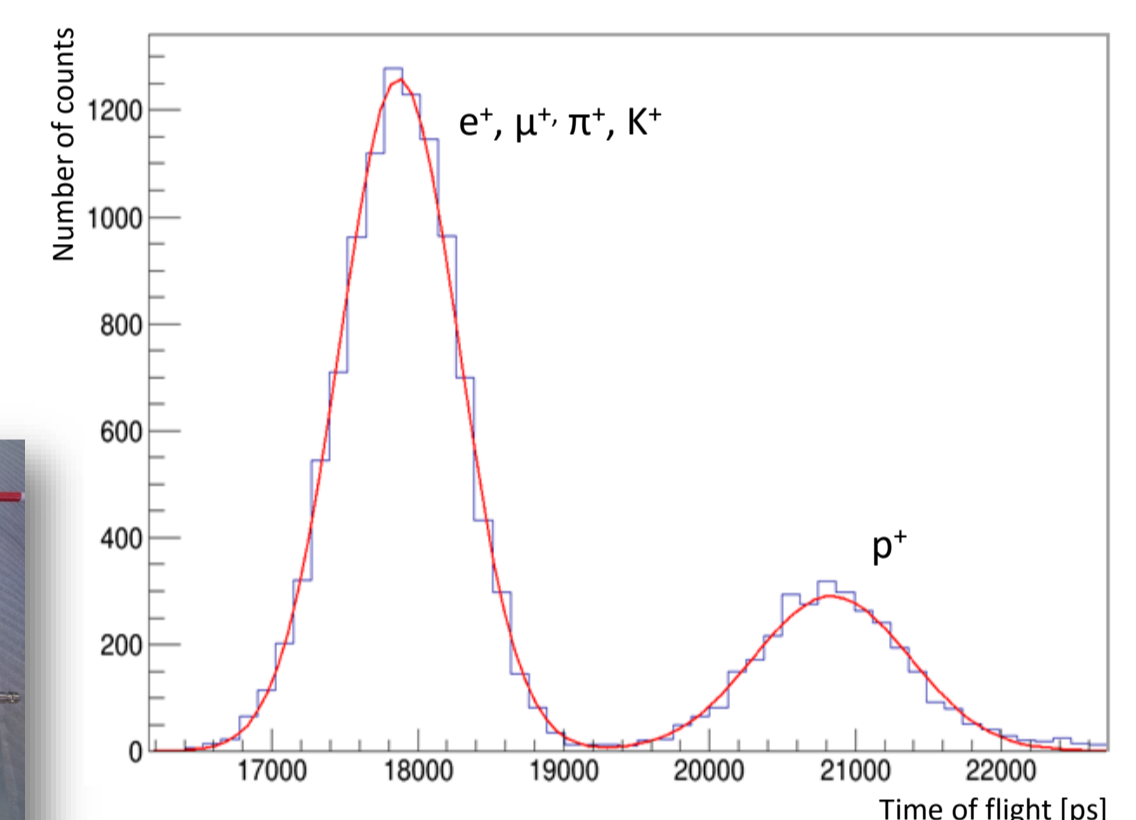
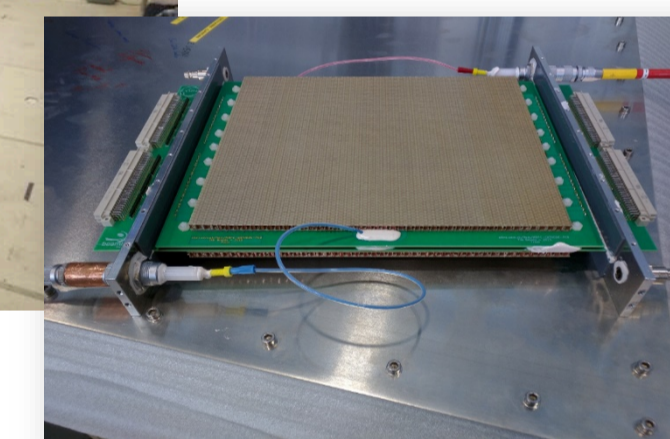
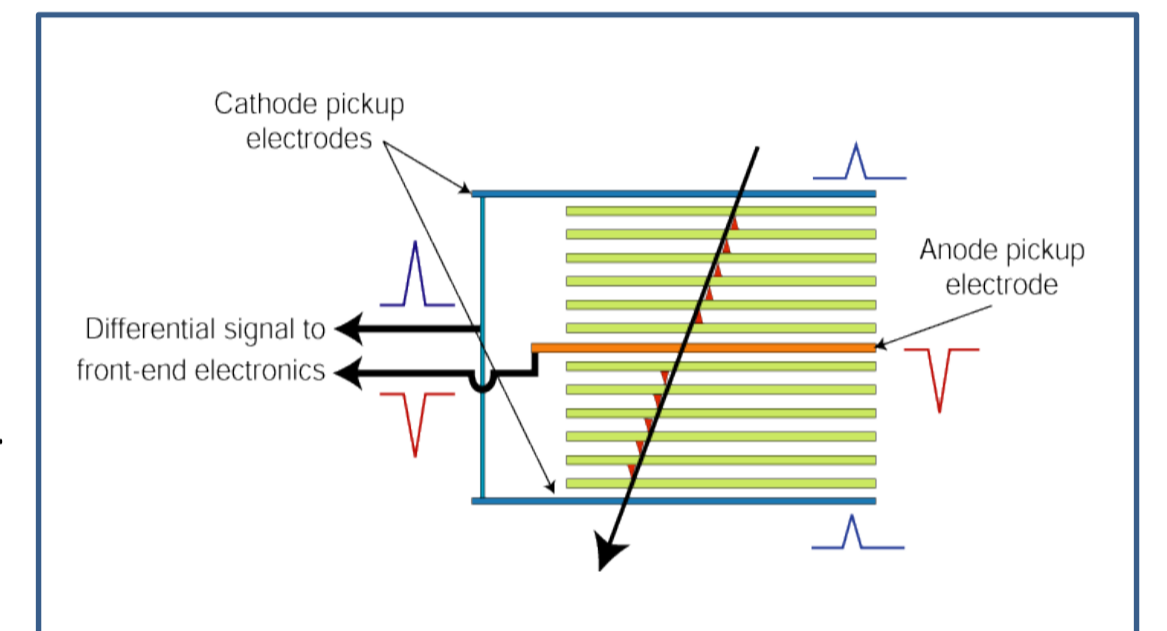


Scintillation counters in coincidence, counting muons for one of the winning experiments of BL4S 2016.

Multi Resistive Plate Chambers

The Multi-gap Resistive Plate Chambers (MRPC) [4] are gaseous detectors with a stack of resistive plates.

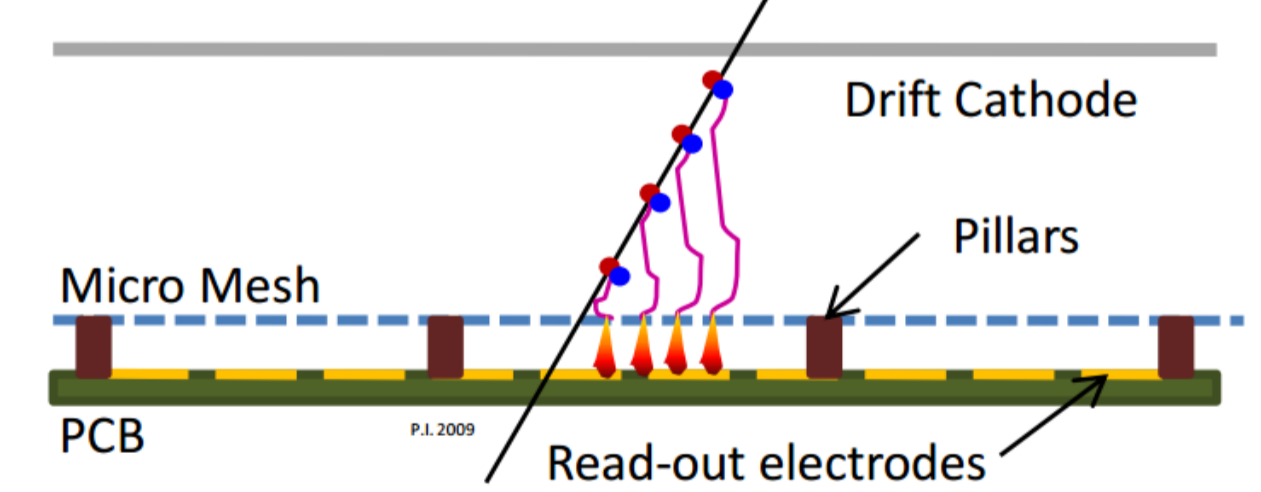
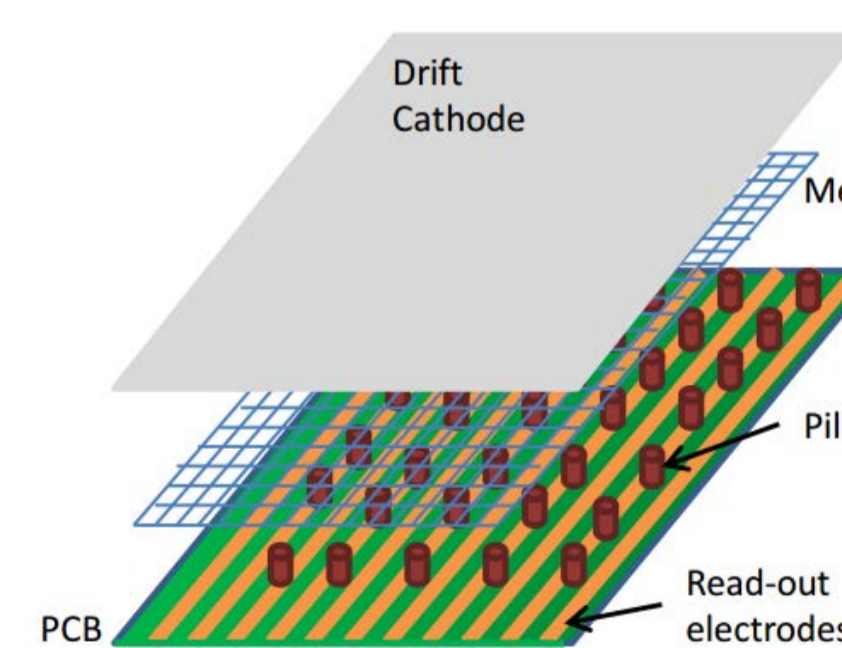
- Very accurate time information for the passage of a particle \rightarrow suitable for time-of-flight measurements.
- Course grained tracking capability.



Our three MRPCs** have a surface area of 30x30 cm². In the BL4S 2016 we measured the time of flight of protons and the rest of the particles of the beam with a resolution of around 400-500 ps. The plot shows the time of flight of 1.5 GeV/c particles in T9 for an effective distance of flight of 5.36 m.

New for 2017

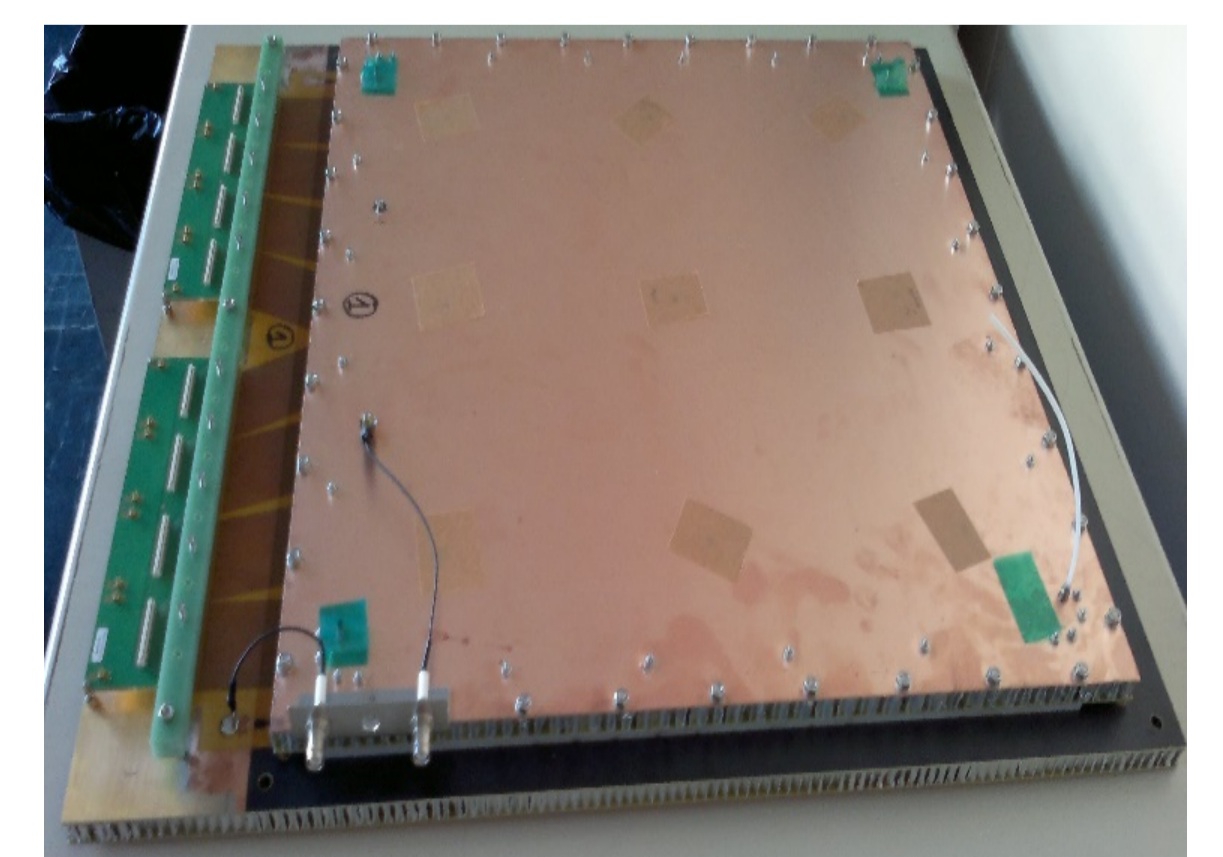
Micromegas detectors



Micromegas are gaseous detectors with a drift electrode, a drift region, and a thin metallic mesh [6].

BL4S has 4 Micromegas 1-D detectors***.

- 5 mm drift / 128 μm amplification gap.
- Spatial resolution of about 200 μm .
- Active area of 40 x 40 cm².
- Excellent tracking capabilities.
- Currently read out via RD51 electronics and planning to switch to MMFE8 once available.



[1] http://beamline-for-schools.web.cern.ch/sites/beamline-for-schools.web.cern.ch/files/BL4S-Beam-and-detectors_2018.pdf
 [2] Delay wire chambers: A user's guide, <http://cds.cern.ch/record/702443/files/sl-note-98-023.pdf>
 [3] S. Gurbuz, G. Unel, S. Erhan, A wire chamber for educational purposes arxiv.org/abs/1409.0523
 [4] ALICE - Technical Proposal for A Large Ion Collider Experiment at the CERN LHC, CERN/LHCC/95-71, December 1995.
 [5] F. Ambrosino *et al.*, The large-angle photon veto system for the NA62 experiment at the CERN SPS, Journal of Physics: Conference Series, Volume 404, conference 1.
 [6] ATLAS collaboration, New Small Wheel Technical Design Report, [CERN-LHCC-2013-006](https://cds.cern.ch/record/1306067/files/CERN-LHCC-2013-006) (2013).

*The scintillators of BL4S are either kind contributions or produced specifically for the needs of winning experiments at CERN by R. Dumps.
 **The MRPC detectors were manufactured and tested at CERN by the BL4S team under the guidance of the team of C. Williams. The PCBs of the chambers were designed by the PCB design office of CERN.
 ***The Micromegas detectors were manufactured at CERN by R. de Oliveira, O. Pizzirusso and the BL4S team, based on designs by G. Sekhniaidze.

