Status of MSD subsystem

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FOOT Collaboration Meeting – 3/4 giugno – La Biodola

Hardware

→ Sensor type choice: LGAD or Standard

A) LGAD: Recently (last week) we got news from N. Cartiglia.
Most likely an extended R&S program is needed (at least one year) before a suitable microstrip ladder could be available.

→ LGAD NO longer an option for FOOT.

We will monitor the progress of the R&D on LGAD, but from now on we will work on the assumption of standard sensors with no internal amplification.

Hardware

→ Sensor type choice → Standard : double-sided or single-sided ?

A) double-sided silicon detector (DSSD): 150 μm thickness, 95x95 mm^2

We are discussing with Hamamatsu about their willingness to produce such detectors.

Pro: reduced thickness

→ less fragmentation on detector

→ less multiple scattering

→ no saturation of readout channels (see poster at FDFP 2018)

→ easier mechanical construction (no x-y perpendicular misalignment)

Hardware

→ Sensor type choice → Standard : double-sided or single-sided ?

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We are discussing with Hamamatsu about their willingness to produce such detectors.

Cons: → more complex assembly
→ not yet sure they will be there

Cost: estimated: ~ 60-65 k€ + IVA for 10 planes

Hardware

→ Sensor type choice → Standard : double-sided or single-sided ?

B) single-sided Silicon Strip Detector (SSD): 150 μm thickness, 95x95 mm^2

Pros: → already existing both at Hamamatsu and Micron UK;
→ no saturation of readout channels (see poster at FDFP 2018);
→ easier assembly of readout chip;
→ more silicon → better dE/dx measurement

Cons: → more complex mechanical assembly (x-y perpendicular misalignment)
→ more thickness (300 μm)→ multiple scattering & fragmentation

Cost: estimated: ~ 60-65 k€ + IVA for 20 planes

Hardware

→ Readout Chip : VA140 (Ideas) or TIGER-Si (Torino) ?

A) VA140 from Ideas:

Pros: → already existing and tested both for DAMPE than in the teast beams of the last years (LNS and Trento , see poster at FDFP 2018)

→ hybrid already designed and used;

→ readout system for test already existing;

Cons: → the cost… The production has to start because they do not have anymore chips already produced (already known).

Price list now is 200 k€ for 300-500 pieces. We have found a partner for 30 k€. If FOOT could put 70 k€ (100 chips) we could then ask to chinese groups to put 100 k€.(Giovanni is discussing about)

Hardware

→ Readout Chip : VA140 (Ideas) or TIGER-Si (Torino) ?

B) TIGER-Si from INFN Torino (Micorelectronic Group – A. Rivetti):

Modify an existing chip for GEM detectors in order to satisfy Si strip detectors. Feasible on short time scale (few months) from Microelectronic Group. They are willing to do this work without entering FOOT.

Pros:
- → the cost: should be significantly smaller (30-50 k€);
- → hybrid already designed and used;
- → readout system for GEM test already existing;
- → same sample should be shortly available to be attached to silicon;

Cons:
- → they are not yet existing in the form we need.
- → final readout system to be derived from the actual one. Torino is willing to assist us in this task.

Hardware

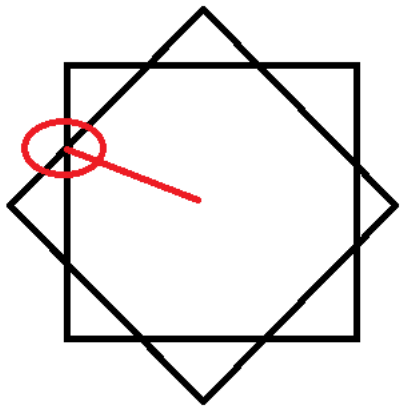
→ x-y Planes Acceptance :

Due to magnet length and field strenght definition a possible request for increased area coverage (11x11-12x12 cm^2 instead than 9x9 cm^2) has been put forward.

One not HW disruptive possibility is to have 2x2 x-y planes.
This way:

→ at least 2 x-y points guaranteed up to 5.3 cm from center, i.e. 10.6 cm diameter.

→ 4 points up to 4.5 cm from center, i.e. 9 cm diameter.

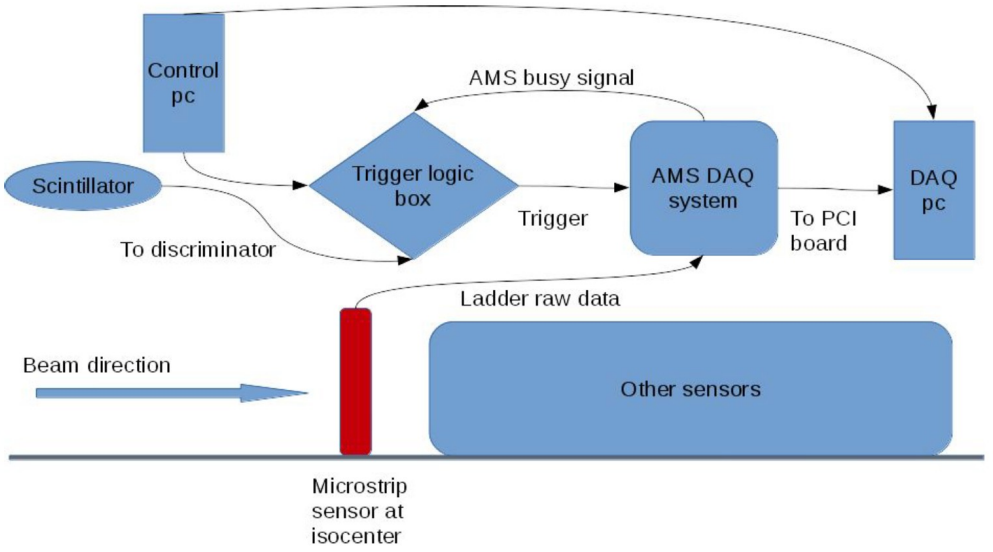


Is this enough?

Readout chain

→ Current readout chain :

We have built an interface
(connectors + cables) to read
Raw data from sensor → VA140
→ Hybrid to AMS DAQ .
Tested and working.



→ increased readout speed. 300 Hz of RAW data (3-4 sensors)
→ up to 2 kHz for 24 sensors read in compressed mode (zero suppression).

Plan to setup a stable and easily movable configuration.

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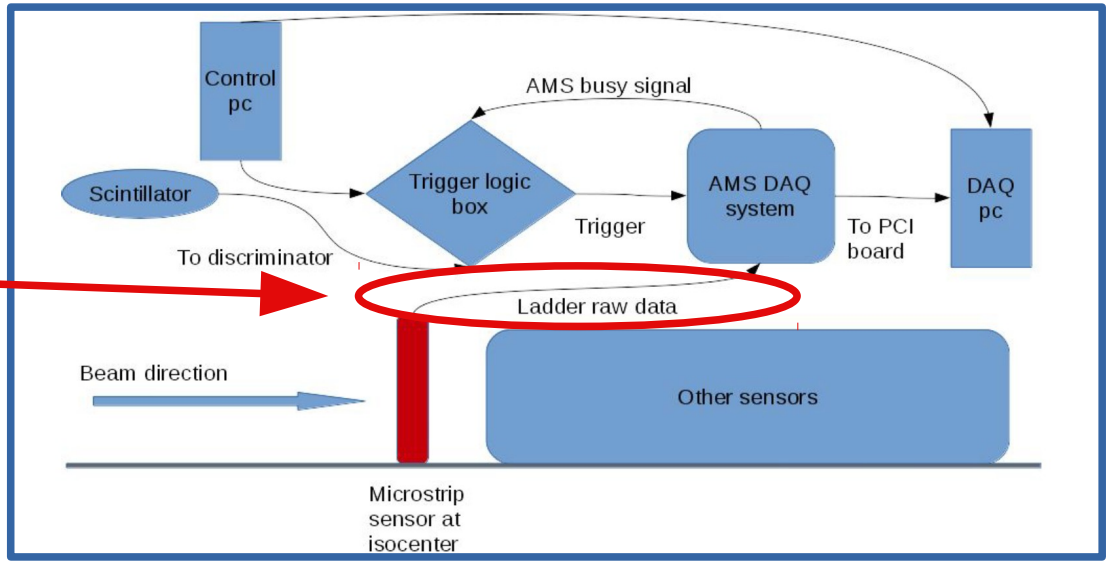

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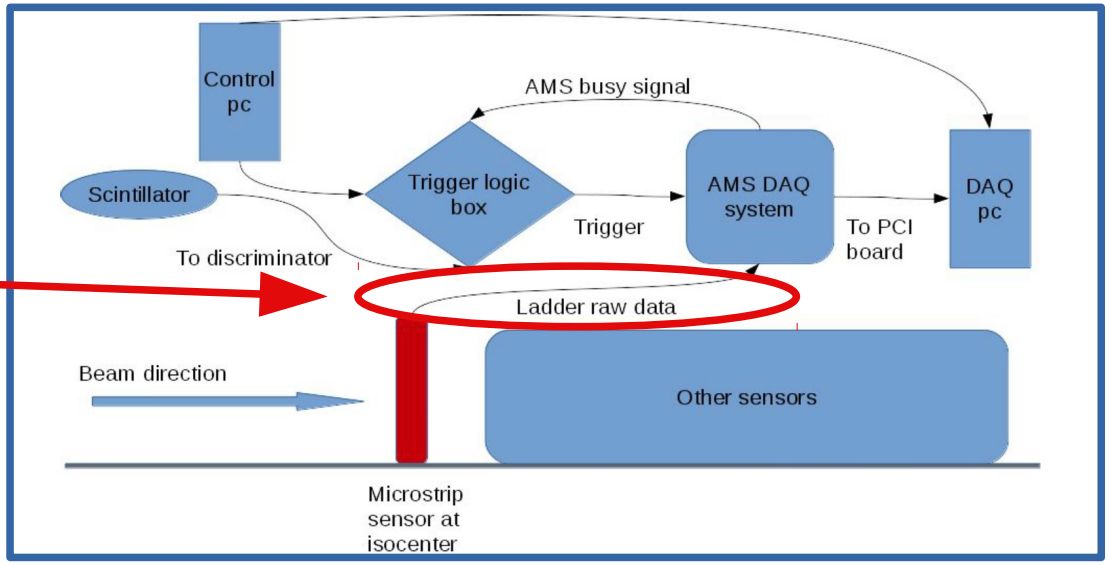
Combined Test Beam

→ Material to be provided :

2 x-y planes read out by AMS DAQ chain (300 Hz).

→ need external trigger to work.

Open point: synchronization with remaining DAQ.



Future Test Beams

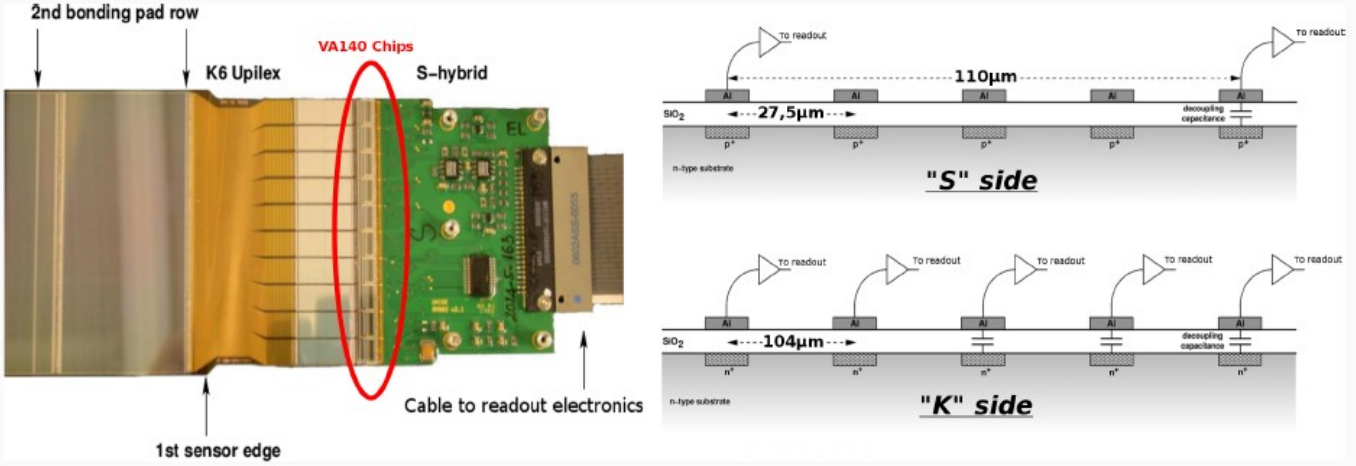
→ **Before August:** test with carbon ions at CNAO (?) of 150 μm single-sided Sensor (Micron UK), 120 μm strip pitch, equipped with VA140 chips to check about charge division among strips and confirm non saturation.

→ **September:** Partecipation in combined test to calibrate Beam Monitor chamber. Bring two x-y plans at 300 Hz readout speed. Also some LGAD strip detectors to complete the test programme (secondary priority)

→ **Sometime 2018:** Possible further test at Trento to complete measurements done last december (conditioned by completing the analysis of data already existing)

Test at Trento 12-2018

Poster at FDFP2018



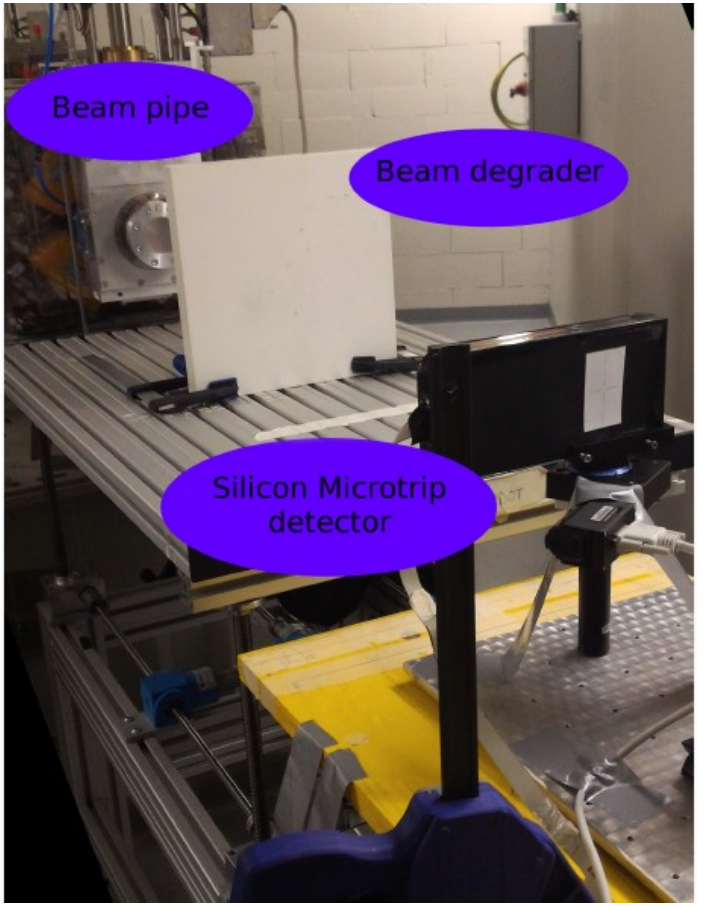
- Silicon sensor dimensions: approx. 4x7 cm^2
- Thickness: approx. 300 μm
- Number of strips on "S" side: 2568, of which 640 are read-out (1 in 4)
- Implantation pitch on "S" side: 27.5 μm, readout pitch of 110μm
- Number of strips on "K" side: 384, all read-out
- Implantation pitch on "K" side: 104μm

Test at Trento
12-2018

Protons @ 50, 70, 80, 112, 159, 200, 228 MeV.

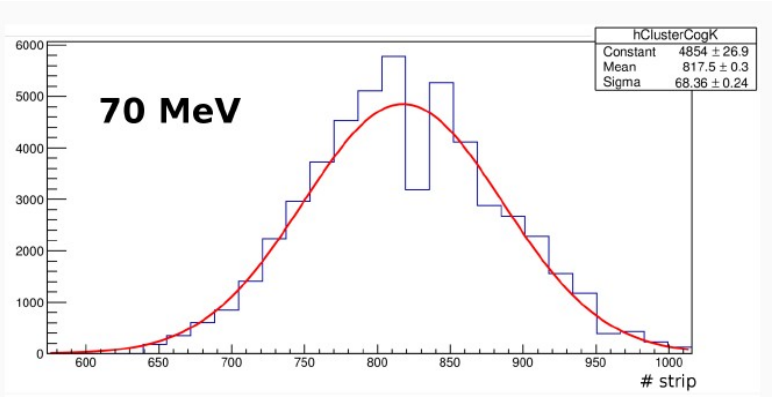
Perpendicular to sensor surface. (analyzed)

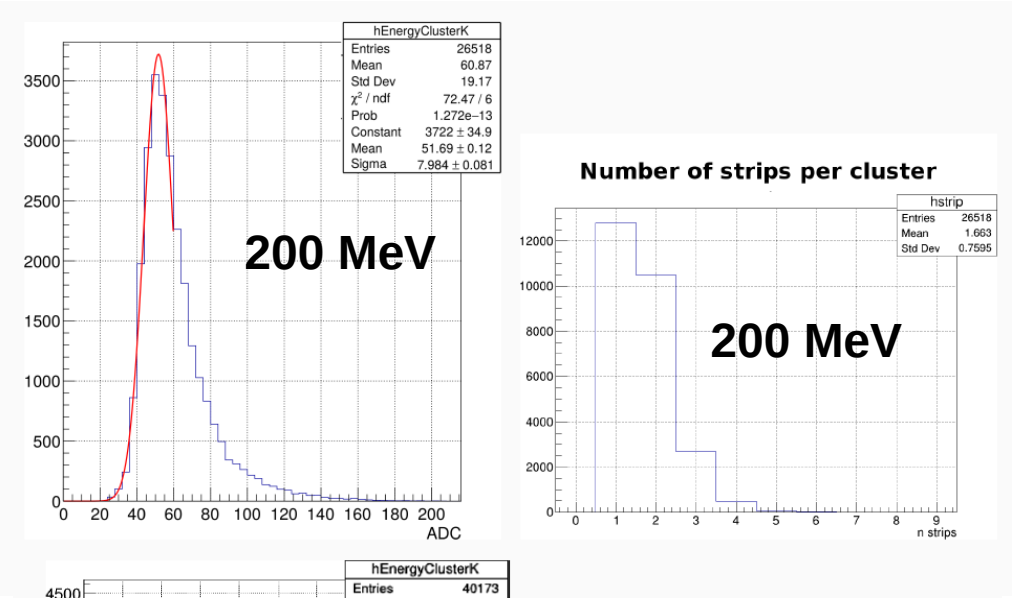
Variable angle with respect to sensor surface
(to be analyzed)



Test at Trento 12-2018

Quality plots:





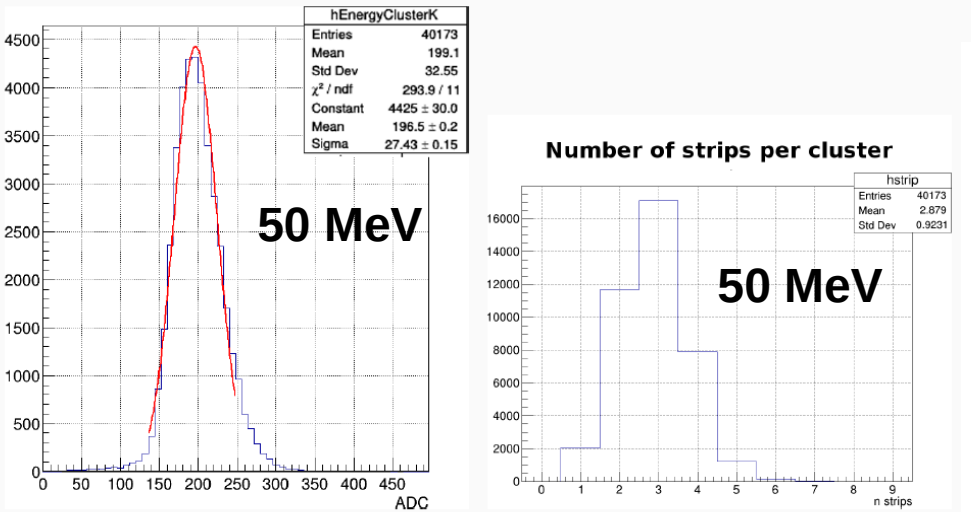
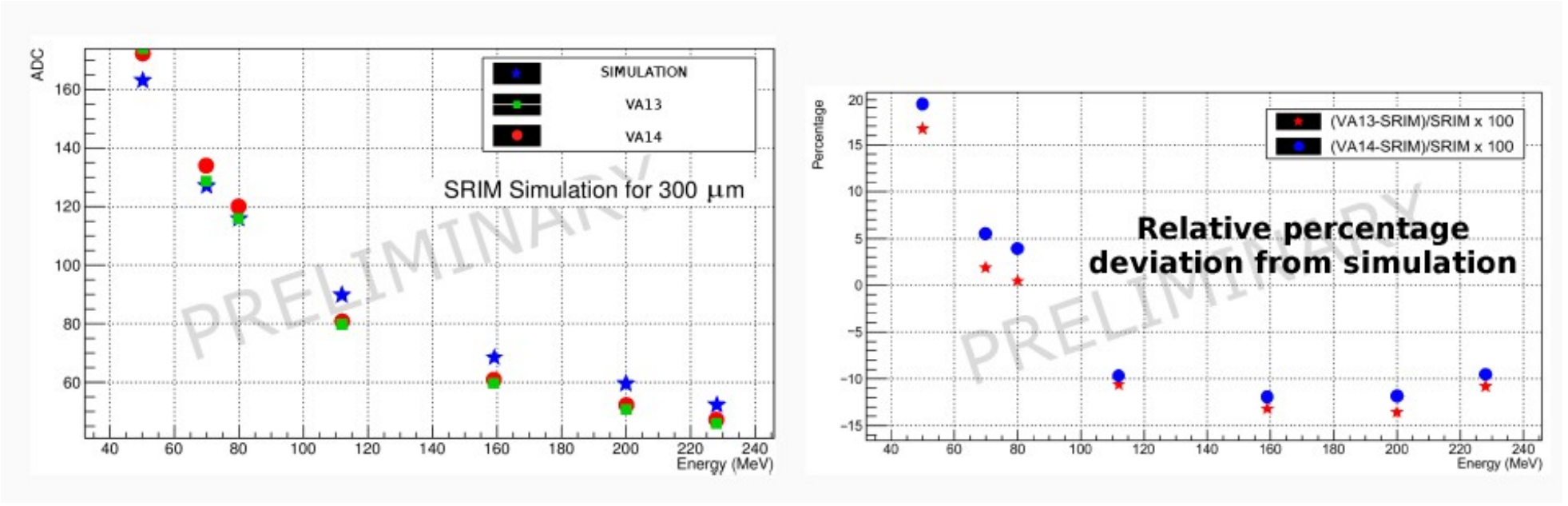


Figura 2: Example: data for 50MeV beam

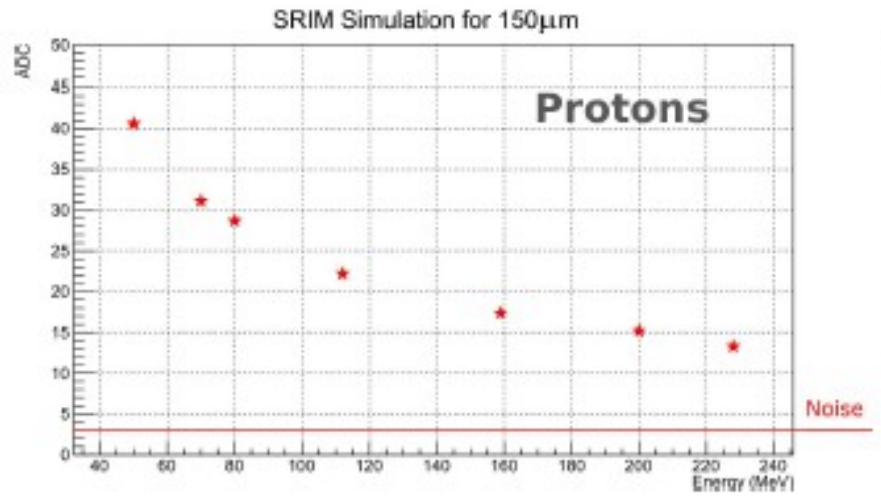
Test at Trento 12-2018

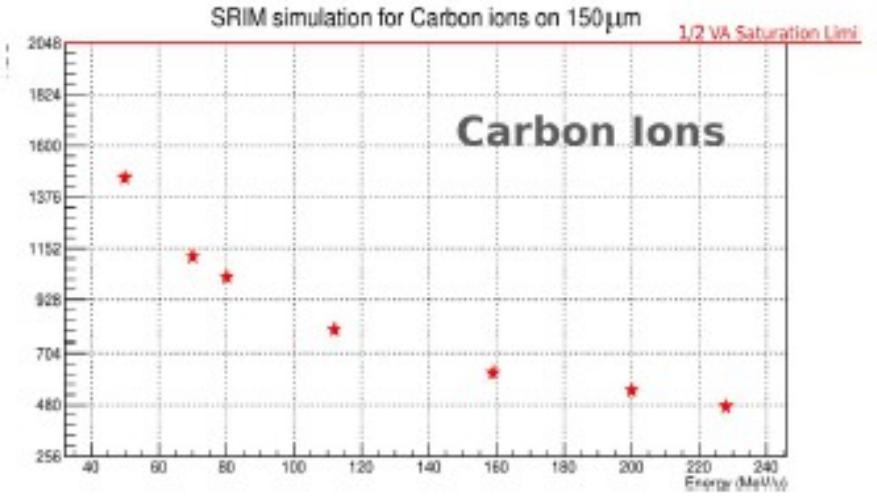
Dependence from beam energy and comparison with SRIM simulation



Test at Trento 12-2018

Simulations:





→ For carbon ions on 150µm thick silicon we do not predict saturation of the single channels of readout chips.
Given the typical pedestal value of about 600ADC we predict an effective dynamic range of about ±160fC for the readout chip.

Papers and Conferences

→ Poster at FDFP2018 : Full Collaboration paper. Proceedings to be written.
Performance of standard microstrip + VA140 chip on ion beams.

→ LGAD paper: Technical paper concerning LGAD performances on ion beams.
Most likely submitted before end of summer)

→ Paper with more Trento Test beam results on standard microstrip.
Full collaboration paper. Data to be analyzed in the next months. Target: autumn submission.

→ Submission for oral talk at Vienna Conference in Instrumentation (2019)