Cygnus-TPC

The Large TPC for Directional Dark Matter Detection

Jan 9, 2016

Camille Couturier and Daniel Santos
MIMAC collaboration
LPSC(Grenoble)-IRFU(Saclay)-CPPM(Marseille)-
LMDN (Cadarche)-Tsinghua(Beijing)

More information about MIMAC status on CYGNUS2015 web site:
Daniel Santos' and Quentin Riffard's talks

Directional Detection

- The directionality gives the possibility to cope with neutron background… a big detector will have in any case such background as limitation !!

- The directionality may improve the limits by more than 1 order of magnitude, for a given detector mass.

- —> getting limits at high mass Wimps competitive to non-directional detectors is not where we should aim at.

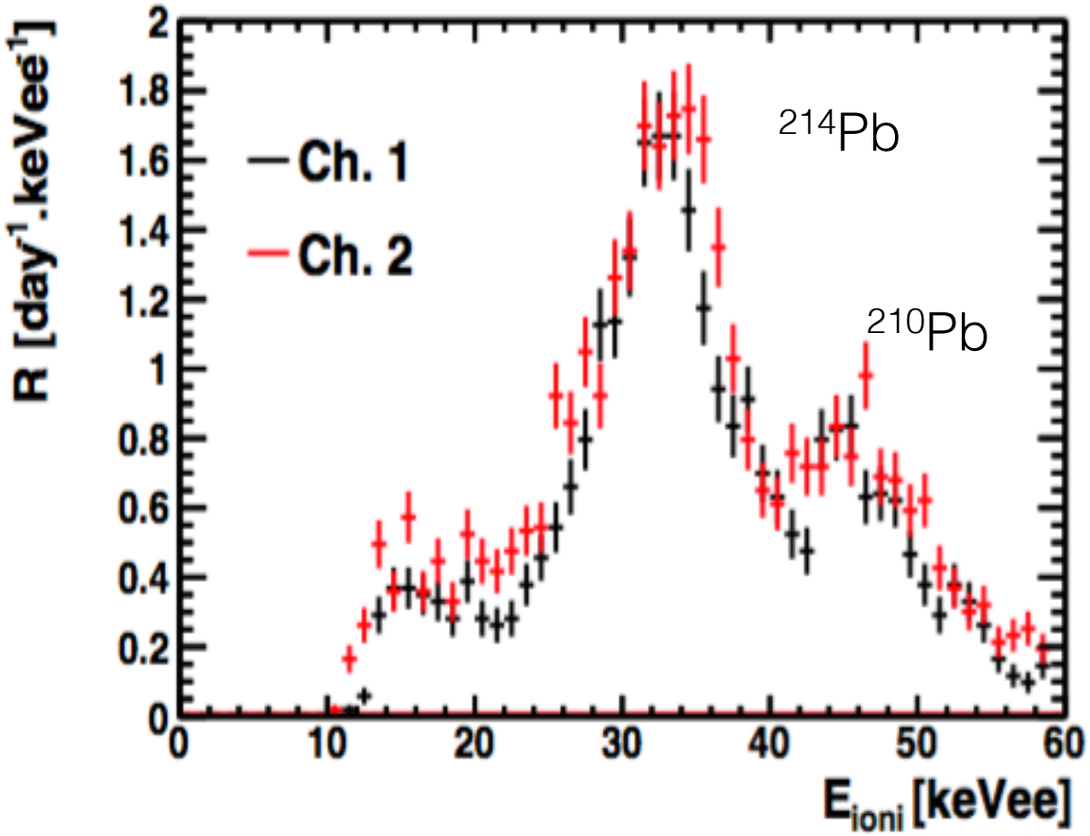
- Our specificity is to get a directional signature and to be able to explore the low mass WIMPs

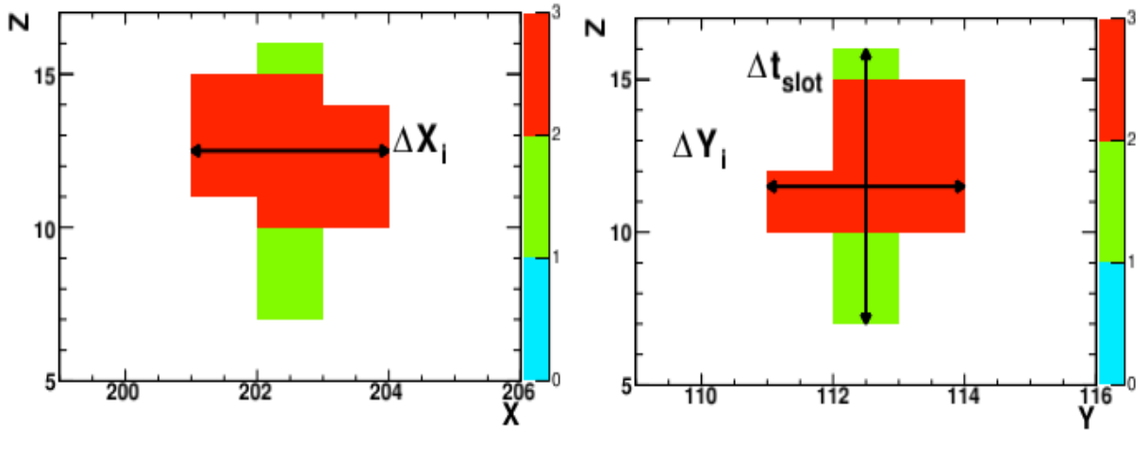
- We have to be able to adapt our TPC to confirm an eventual WIMP candidate as to be part of our Galactic Halo !!

- —> let's first show that we can indeed get as a good 3D reconstruction of the nuclear tracks (with criteria e.g. angular resolution <20°)

3D tracks of Radon progeny

- Are our detectors able to measure the 3D tracks of Rn progeny?
- These events are present in all our detectors.
- First Measurement of 3D tracks of Rn progeny @Modane
  Ionization released by the recoils of 214Pb and 210Pb

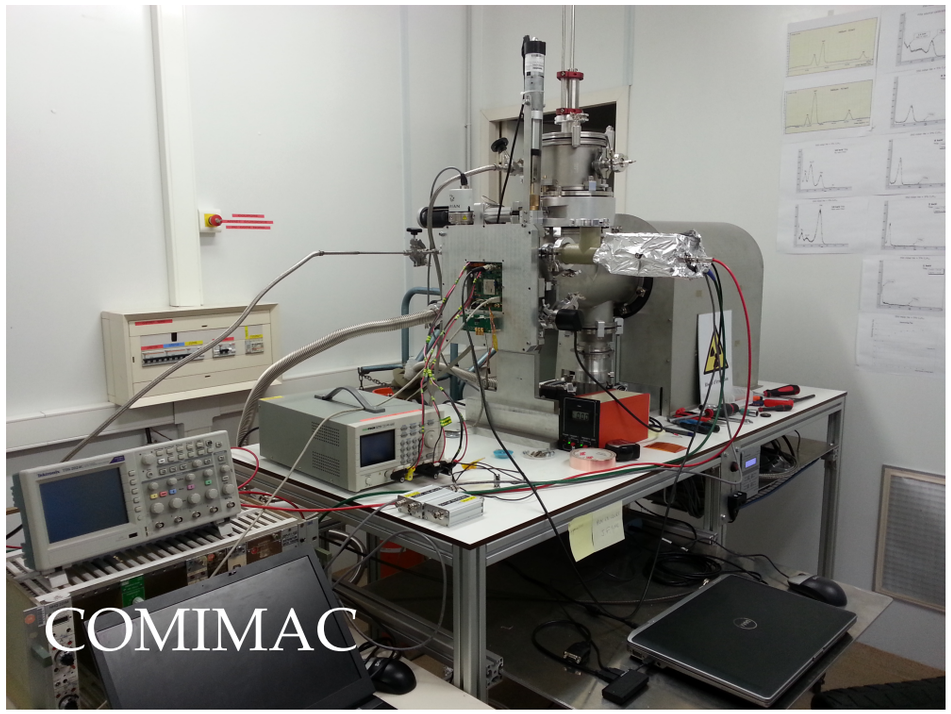




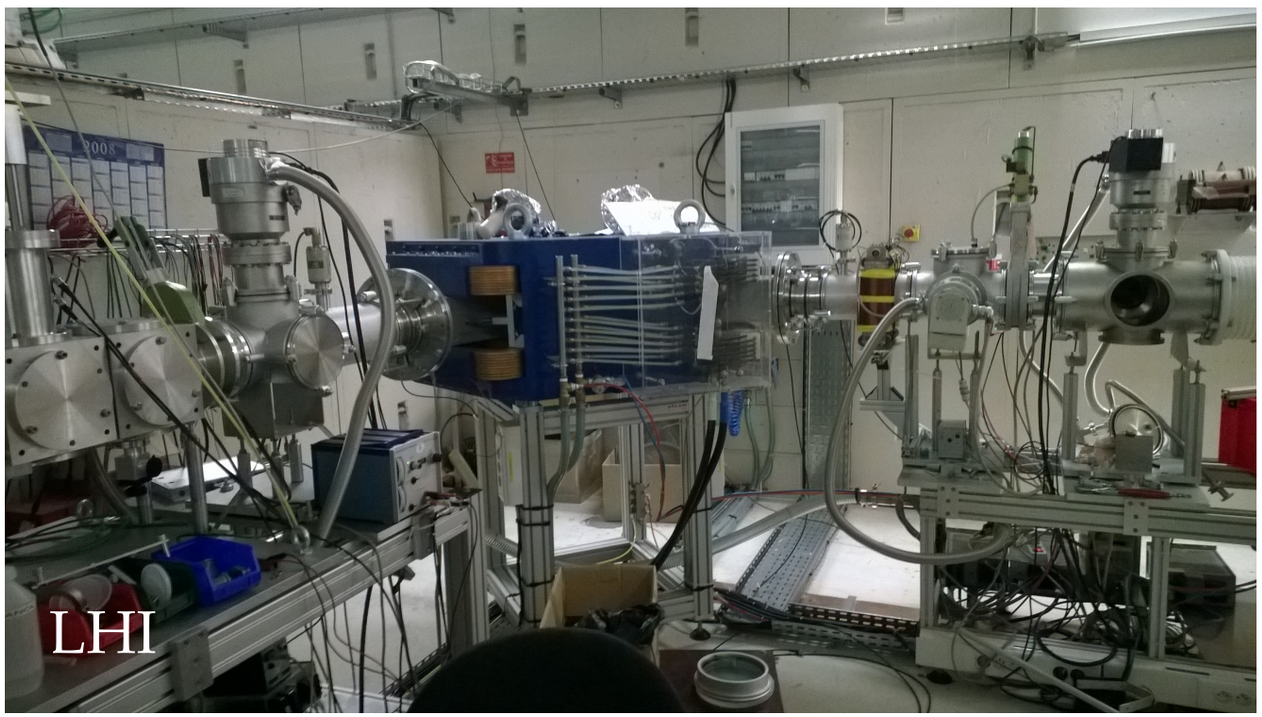
Riffard et al. arXiv:1504.05865.

Characterization of the directionality in 3D

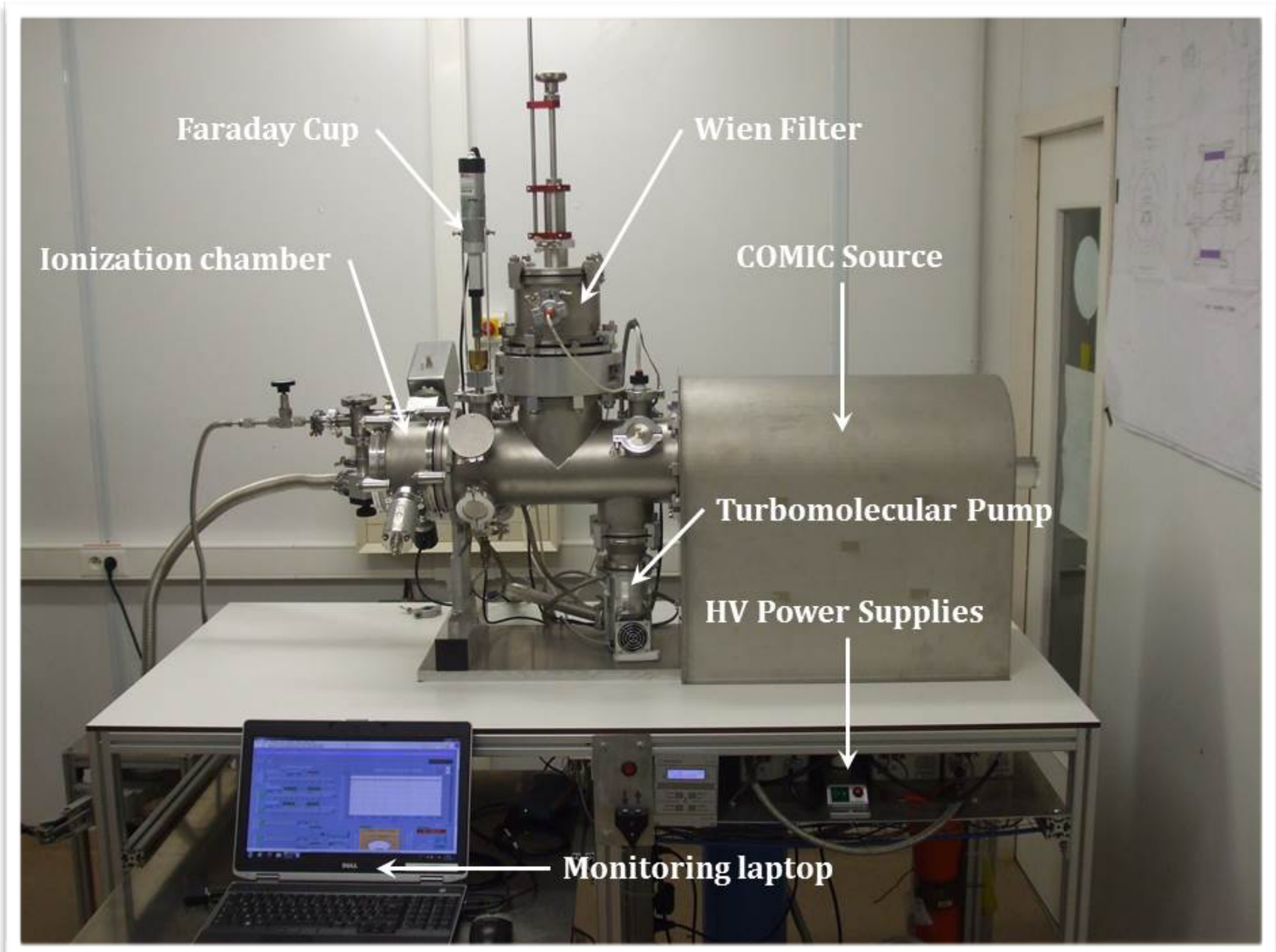
- Dedicated facility @Grenoble: combined Comimac ion/electron beam line with a pixelized anode from MIMAC



- It is also now possible to plug the MIMAC pixelated anode/ electronics to the LHI for measuring higher energies (up to 100 keV) and heavy nuclear recoils (Ne, Ar, Xe !!)



COMIMAC: a transportable beam line



JF Muraz

Primarily designed for

- the energy calibration of MIMAC up to ~50 keV
- the measure of the quenching factor of nuclei at low pressure

- Aim: characterize the 3D track reconstruction

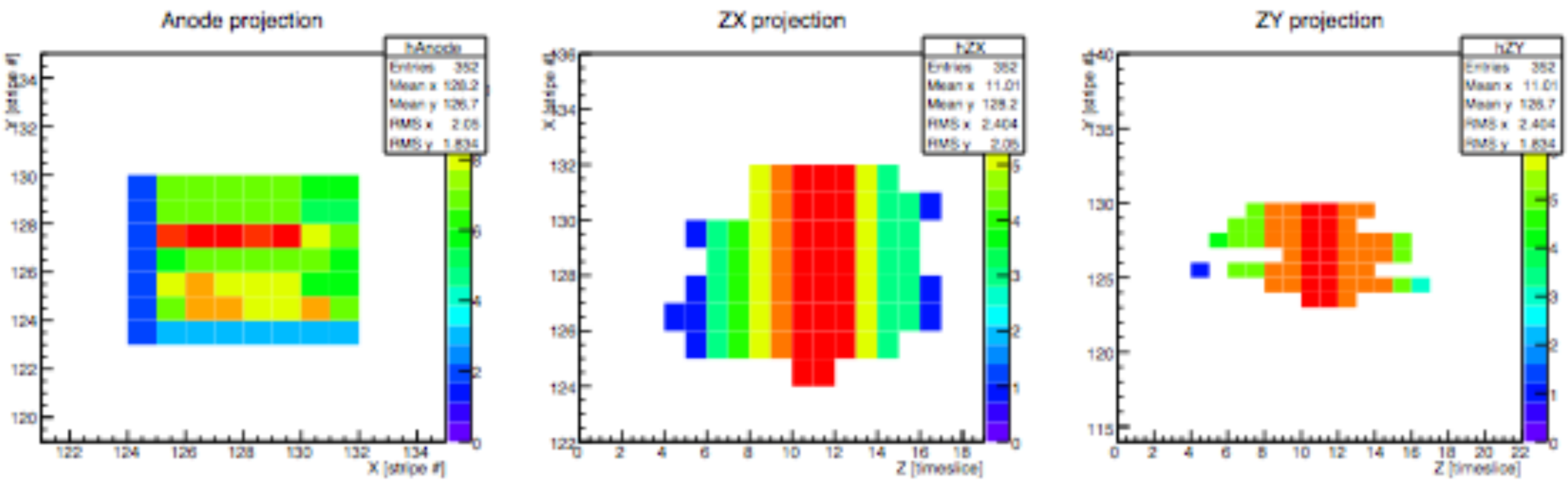
Angular distribution as a function of the energy for ^{19}F, ^{12}C and H recoils, other recoils are possible too !!

Asymmetric Flash-ADC and Head-Tail signatures

e- /recoil discrimination as a function of the kinetic energy and as a function of the drift

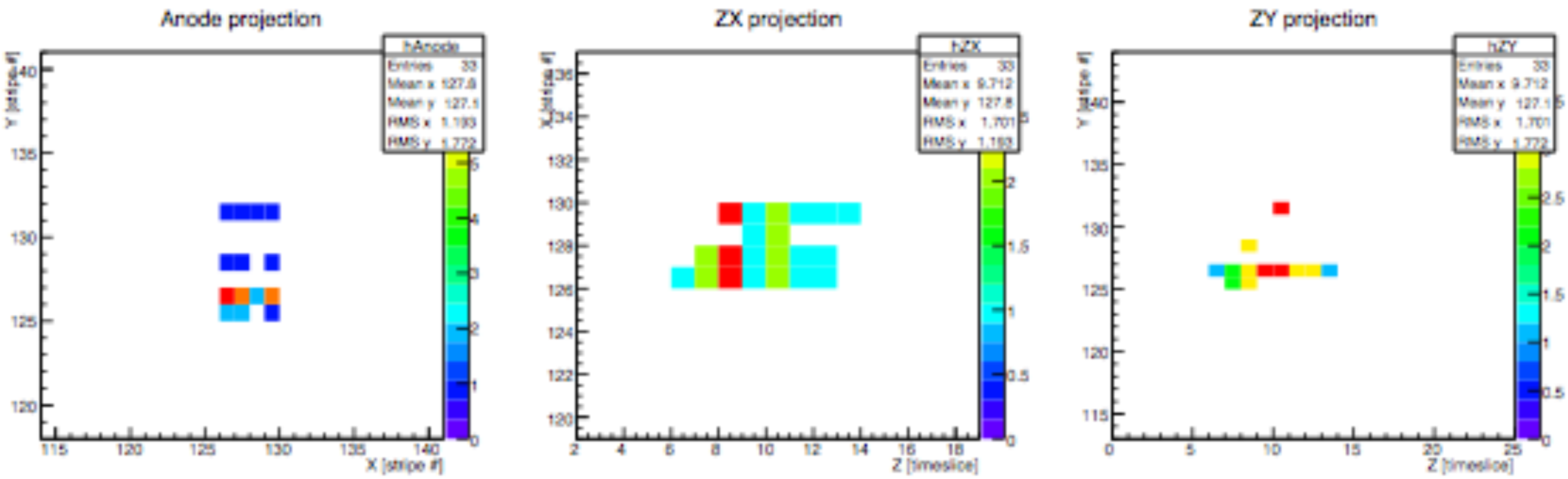
- First controlled tracks of ions in He + Isobutane mix

  Here, a 15 keV Helium



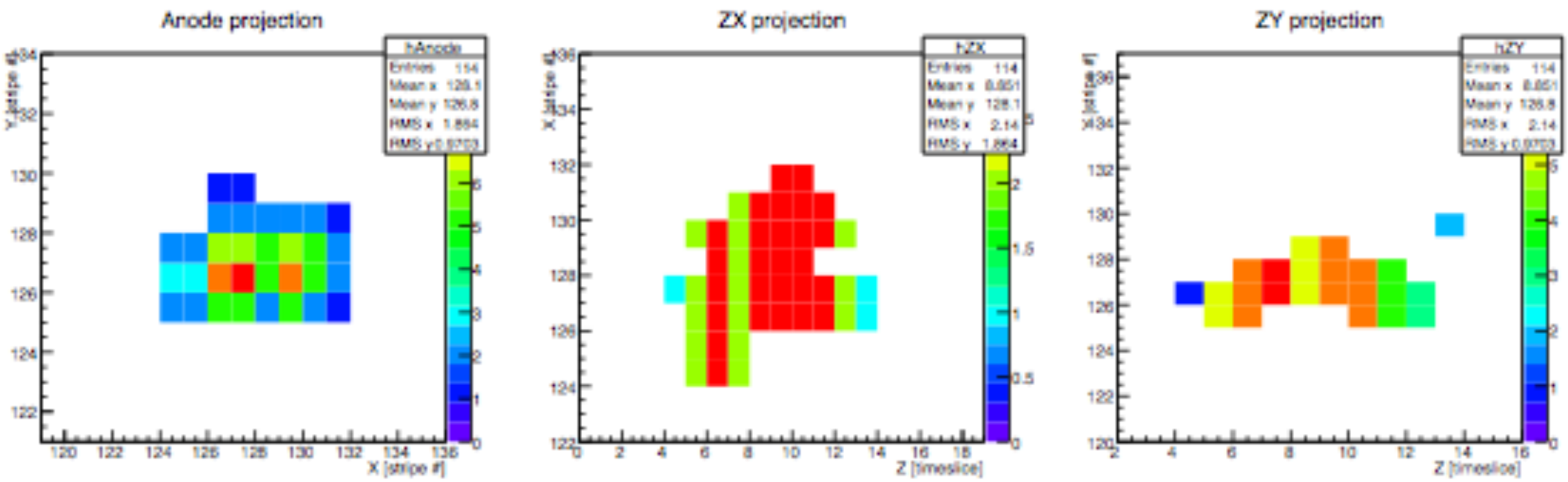
- First controlled tracks of ions in He + Isobutane mix

  Here, a 6 keV Helium



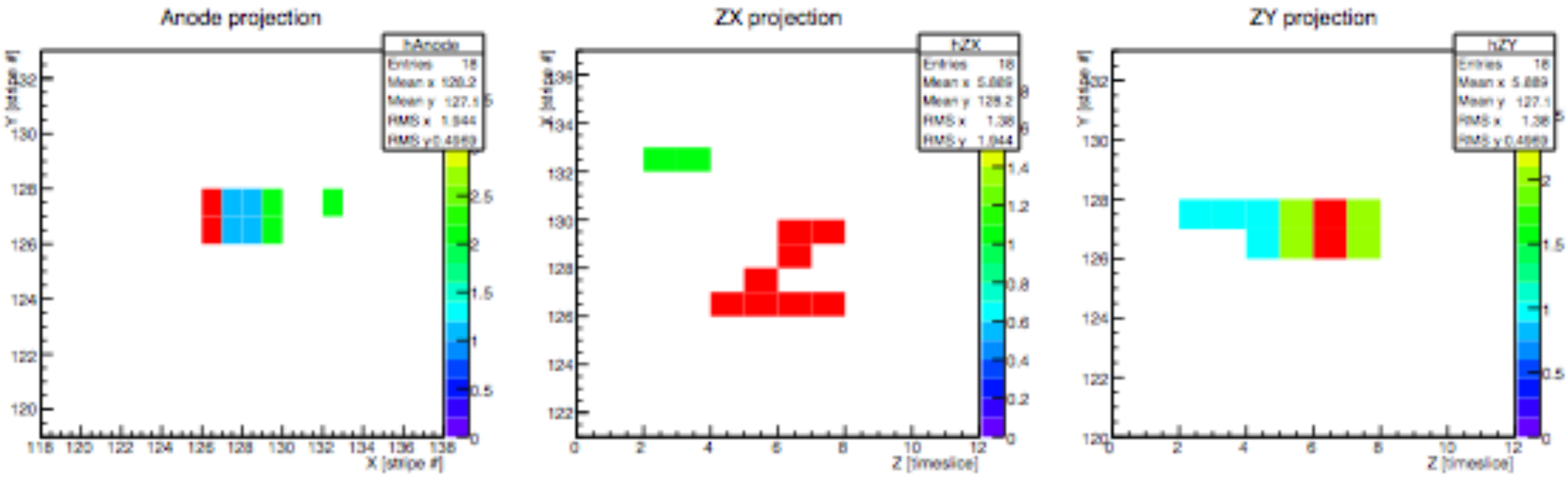
- First controlled tracks of ions in He + Isobutane mix

  Here, a 15 keV Fluorine



- First controlled tracks of ions in He + Isobutane mix

  Here, a 8 keV Fluorine



Proposed criteria for choosing the detector

- Instead of “building big, fast, and cheap”, we should agree on the detector that may fulfill the physics objectives detailed before.

- Proposed criteria and method:

  - Characterisation of the directionality/reconstruction of the 3D track (we’re building a “directional” detector, aren’t we?).

  - Fiducialization of the active volume

  - Benchmark : show the 3D tracks of the Radon progeny

  - Show that we can work with electron and negative ion charge collection to be able to adapt our target (He, F, Ne, Ar, Xe)

Next steps…

- MIMAC can measure the Negative Ion charge collection in SF_6 showing the tracks of nuclear recoils (^{19}F) of known kinetic energy !!

- Adaptation of the MIMAC read-out to cope with 1ms charge collection. The experiment will be performed end of January 2016.

- The MIMAC electronics of 1024 channels is working coupled to (20 cm x 20 cm) uMegas.

- The low background large detector is being developed for 1 m^3

Conclusions

- We think that MIMAC (MIcro-tpc Matrix of Chambers) detector can be adapted to different possible scenarios in the Direct Dark Matter Detection challenge in the near and far future.

- Improving the detector is always necessary to be adapted to the directional detection signature. (permanent R&D)

- You are all invited to join us… even if you are working on Drift, DMTPC, Newage or D3

- We have to work together if we agree on the main ideas here presented on the CYGNUS large TPC for Directional Dark Matter Detection.