LIDAL (Light Ion Detector for ALTEA) detector: a compact system for Time of Flight measurement onboard the International Space Station

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Università di Roma
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Content

HSERLab
Human Space Exploration Radiation Lab

- LIDAL motivation
- Upgrade strategy
- Final design
- Prototype
- Perspectives and simulations

Objectives

LIDAL (Light Ion Detector for the ALTEA detector system): an upgrade of **ALTEA**

- enhanced triggering capability (extension of **ALTEA** energy acceptance for protons and He nuclei)

- Time of flight measurements (direct measurement of velocity, enhanced particle discrimination)

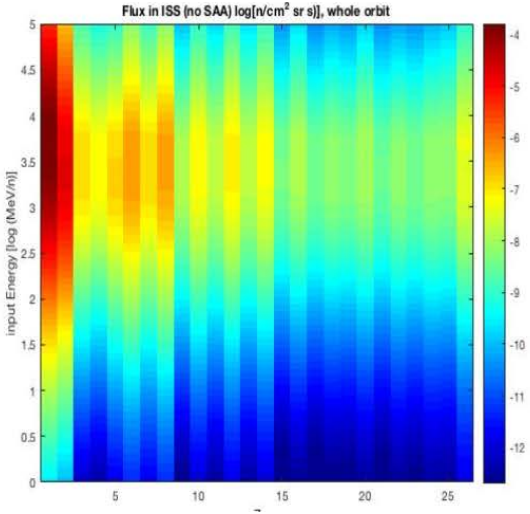
  - *Design and project by the Department of Physics – University of Rome Tor Vergata*
  - *Final development and integration by Kayser Italia*
  - *Beam Tests at TIFPA (IT) & GSI (GE)*

ASI 2016 contract, to be launched with the Luca Parmitano Mission in 2019

Enhanced trigger

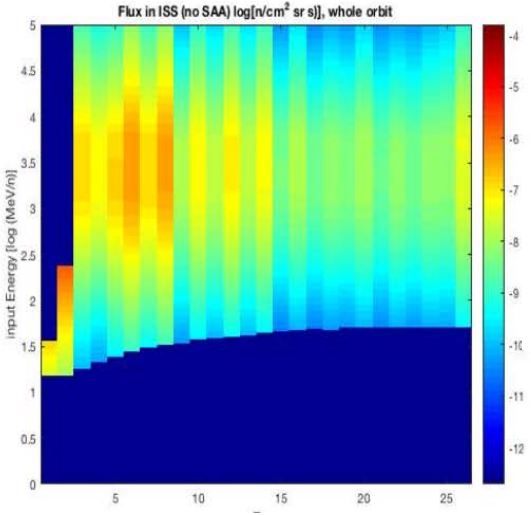
‘Real’

Flux in ISS (GCR, CREME96)



ALTEA

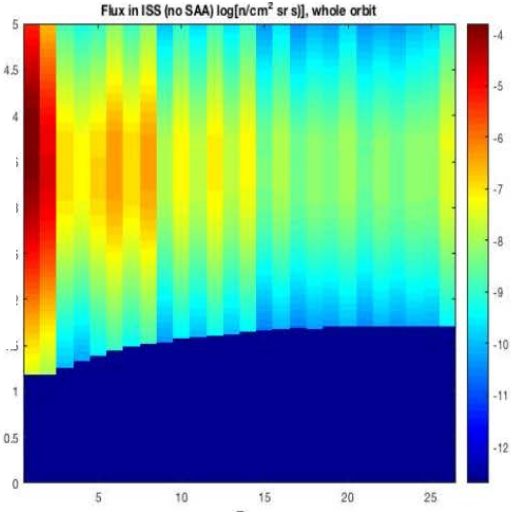
Flux in ISS measured by ALTEA



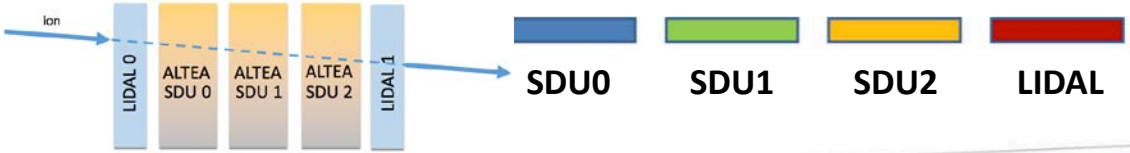
The blue regions are not measured

LIDAL-ALTEA

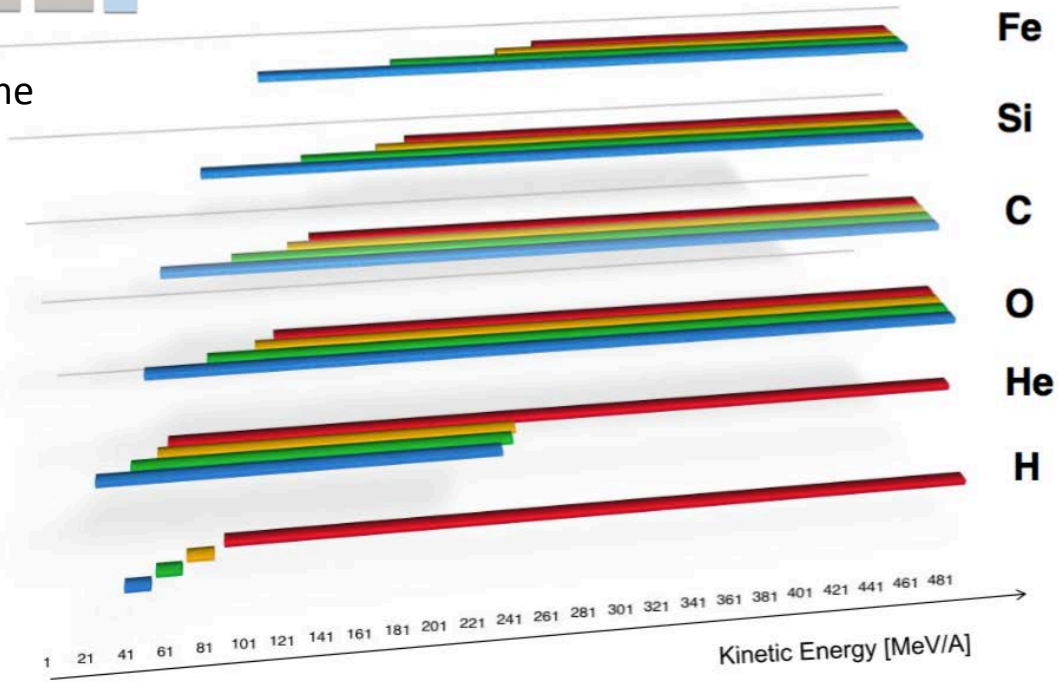
Flux in ISS measured by LIDAL-ALTEA

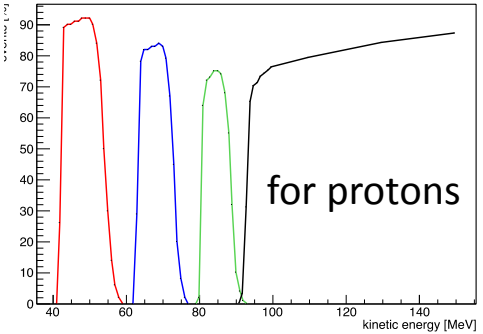


Triggering



Triggering of the different detectors in LIDAL-ALTEA





Strategy

- plastic scintillators for fast timing applications read by Photo-Multiplier-Tubes (PMTs)

- custom Front End Electronics (FEE) [final time resolutions (scintillators + FEE) less than 100 ps for protons)

- Prototype for scintillators designed and built at the University of Rome Tor Vergata
  to test:
  - the scintillators timing performance,
  - the PMTs,
  - the FEE

- Prototype tests at the proton beam line in TIFPA - Trento, Italy

- Results very encouraging ($\sigma_{ToF} < 100$ ps)

- The consequent Particle Identification (PID) capability shows a significant improvement.

Strategy

- test on the Engineering model at TIFPA &/or GSI
- test on the Flight model at GSI or TIFPA
- delivery to NASA in February – March 2019 TBC
- Upload to ISS in July 2019 TBC

LIDAL has been awarded for a CORA-IBER grant to perform beam tests at TIFPA

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for Investigating the Biological Effects of Space Radiation

CORA-IBER

LIDAL-ALTEA – exploded view

LIDAL
Detector Unit (LDU)
8 fast scintillator bars
Kinetic Energy

fast scintillators

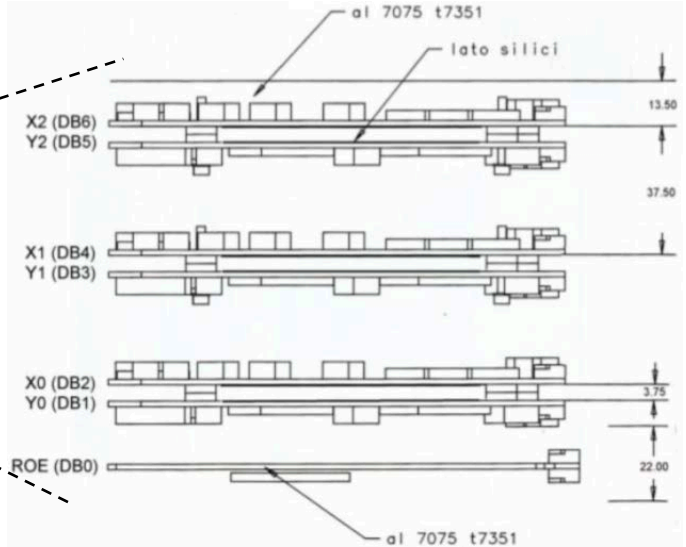
ALTEA SDU
6 stripped silicon planes
dE/dx

ALTEA SDU
6 stripped silicon planes
dE/dx

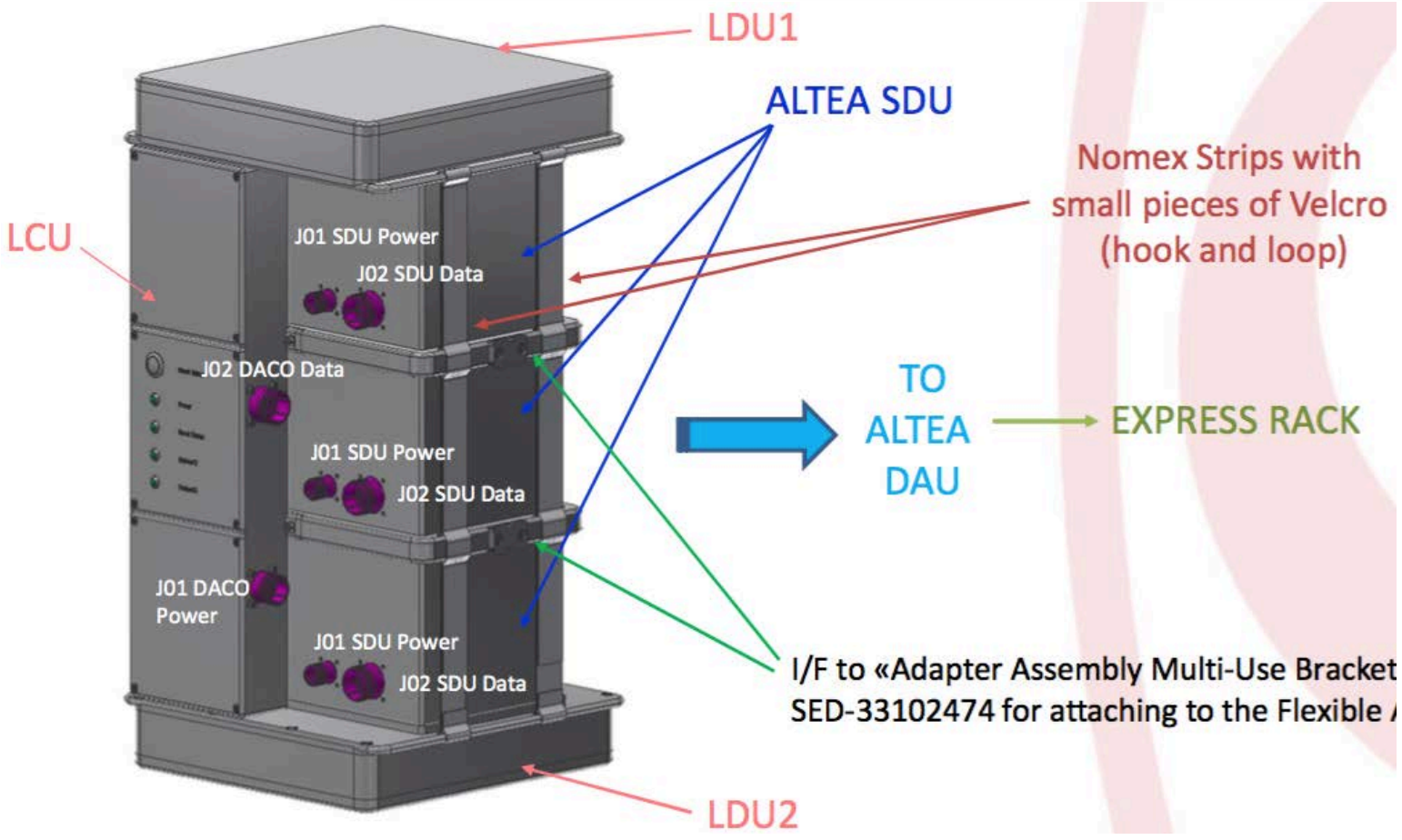
ALTEA SDU
6 stripped silicon planes
dE/dx

LIDAL
Collector Unit (LCU)
data collection and
protocol with ALTEA

LIDAL
Detector Unit (LDU)
8 fast scintillator bars
Kinetic Energy

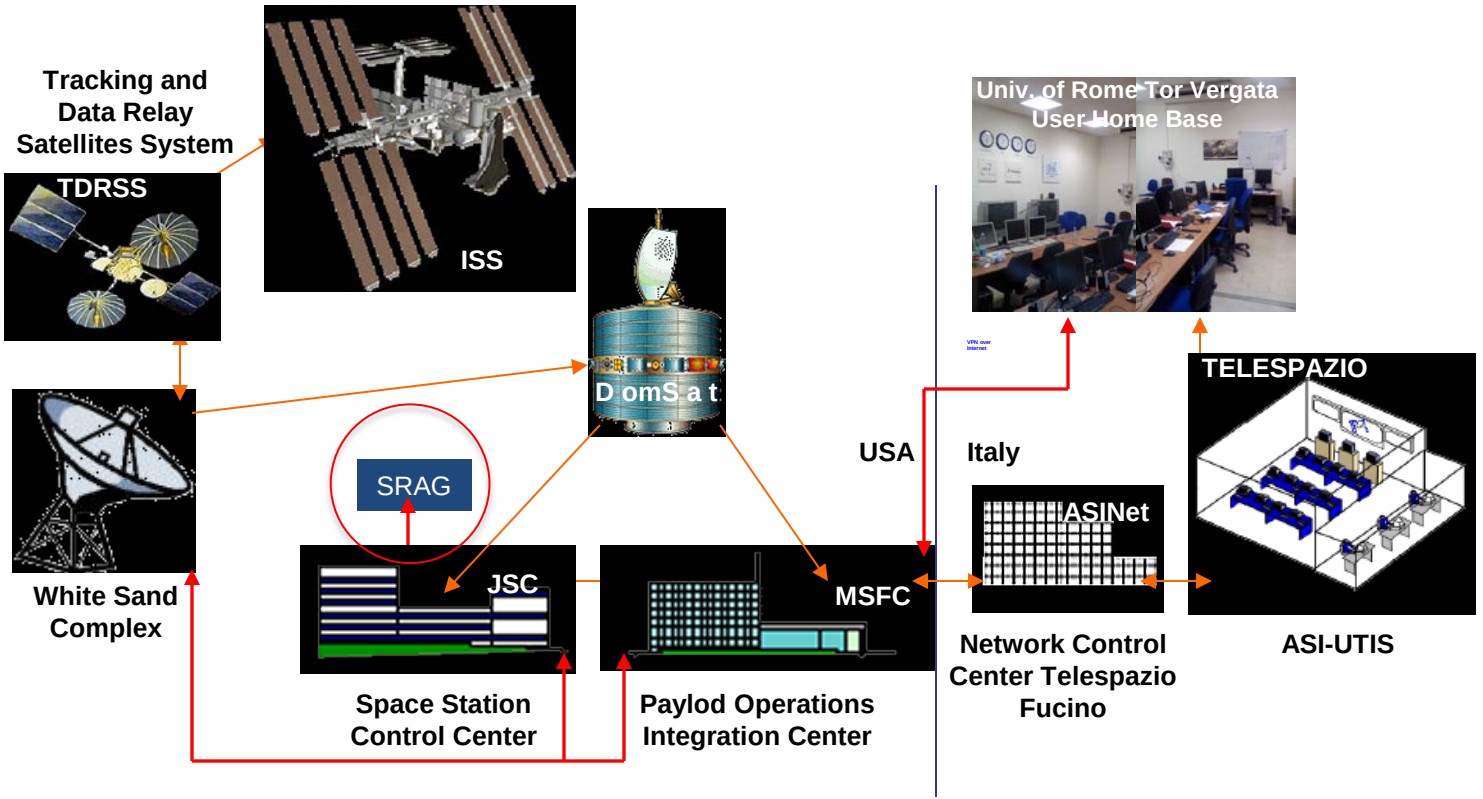


LIDAL-ALTEA


LDU1
ALTEA SDU
Nomex Strips with small pieces of Velcro (hook and loop)
LCU
J01 SDU Power
J02 SDU Data
J02 DACO Data
J01 SDU Power
J02 SDU Data
J01 DACO Power
J01 SDU Power
J02 SDU Data
TO ALTEA DAU
EXPRESS RACK
I/F to «Adapter Assembly Multi-Use Bracket
SED-33102474 for attaching to the Flexible
LDU2

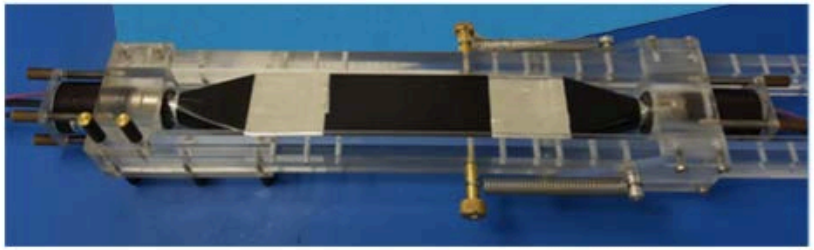
LIDAL-ALTEA data downlink

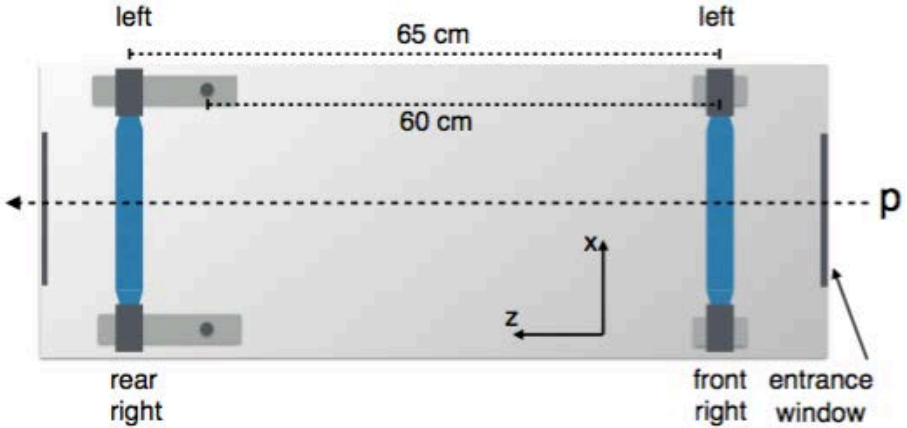
The foreseen data downlink route



LIDAL scintillators prototype

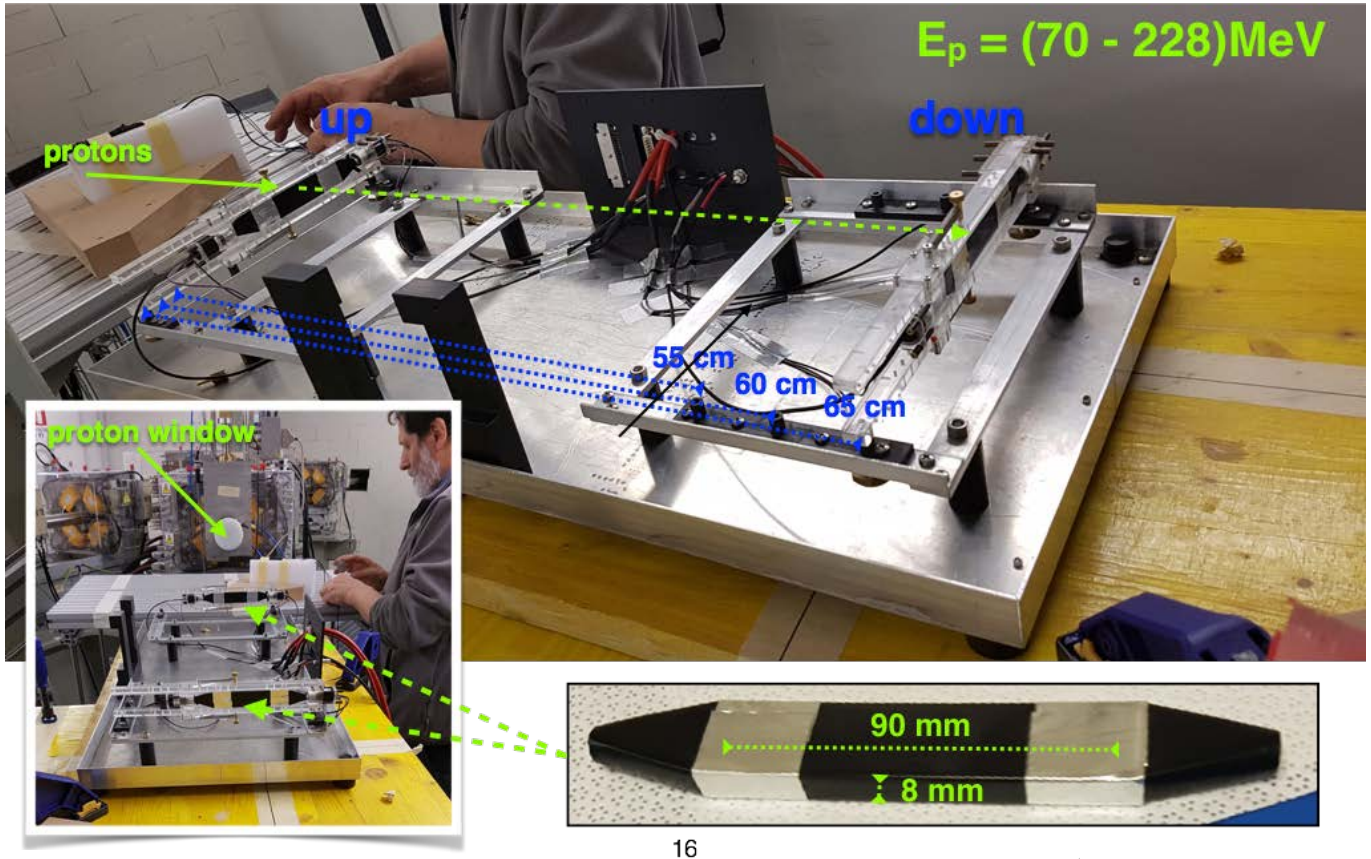
Scintillators: EJ-230 (Eljen Technology) - Rise time 500 ps.





The prototype at TIFPA proton beam

Prototype at TIFPA

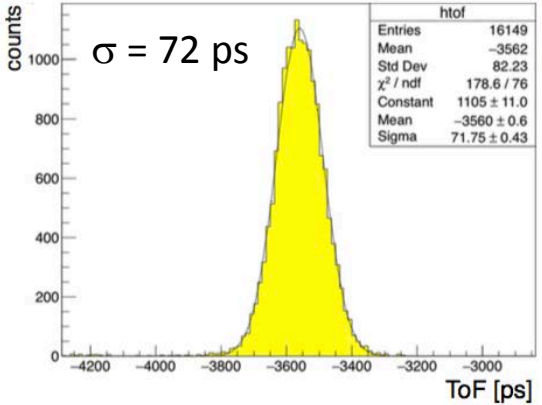


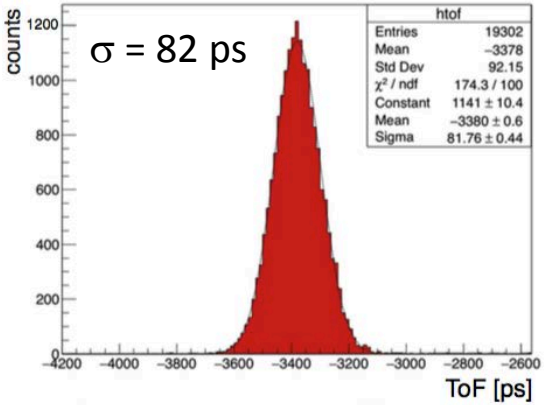
Time of Flight performances

65 cm

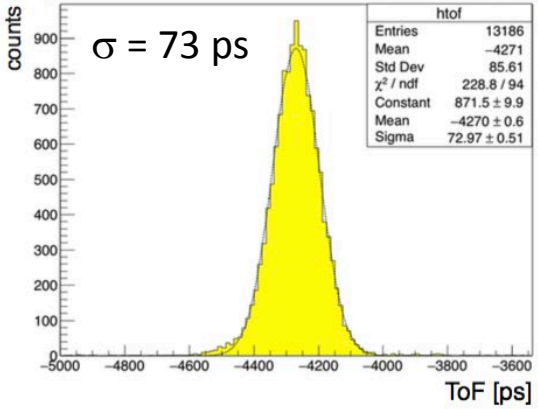
60 cm

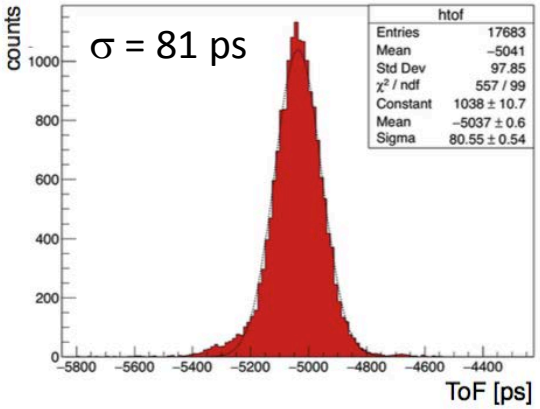
228 MeV





100MeV





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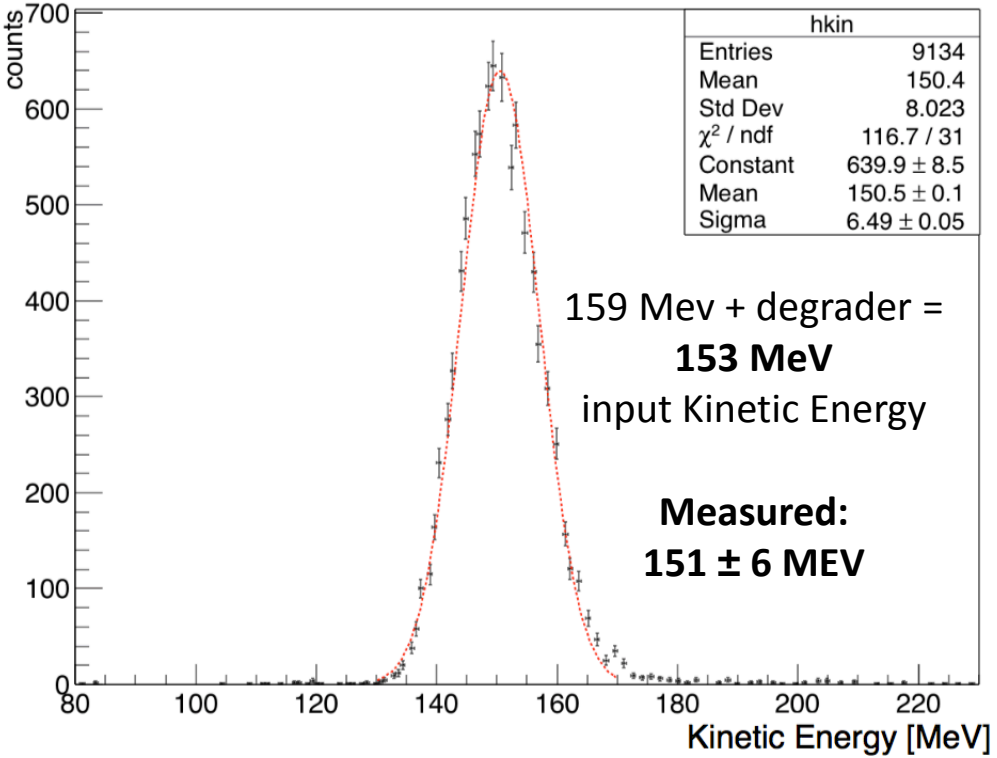
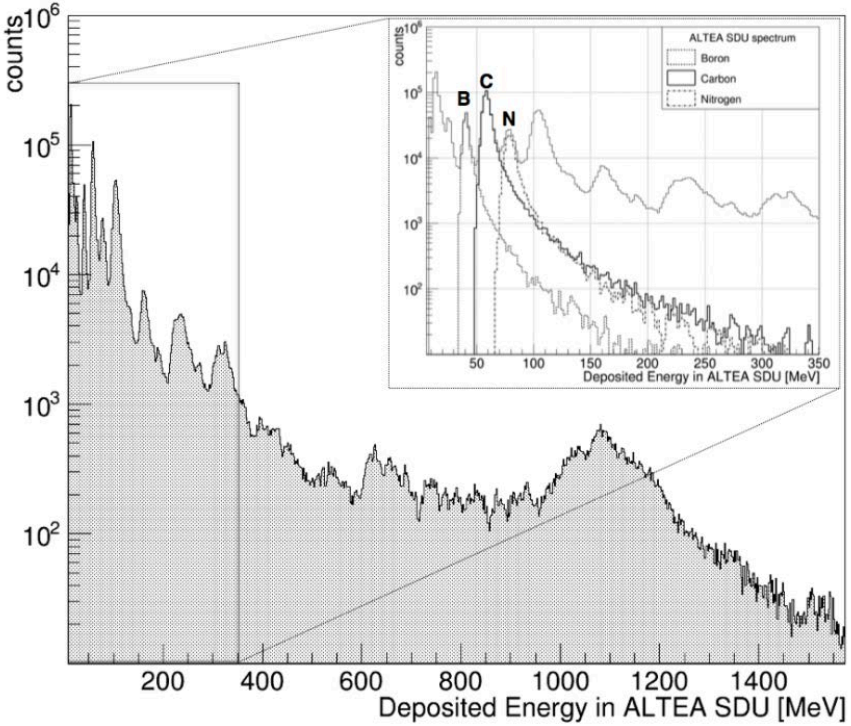
Check of the beam kinetic energy



Nuclear discrimination as it was



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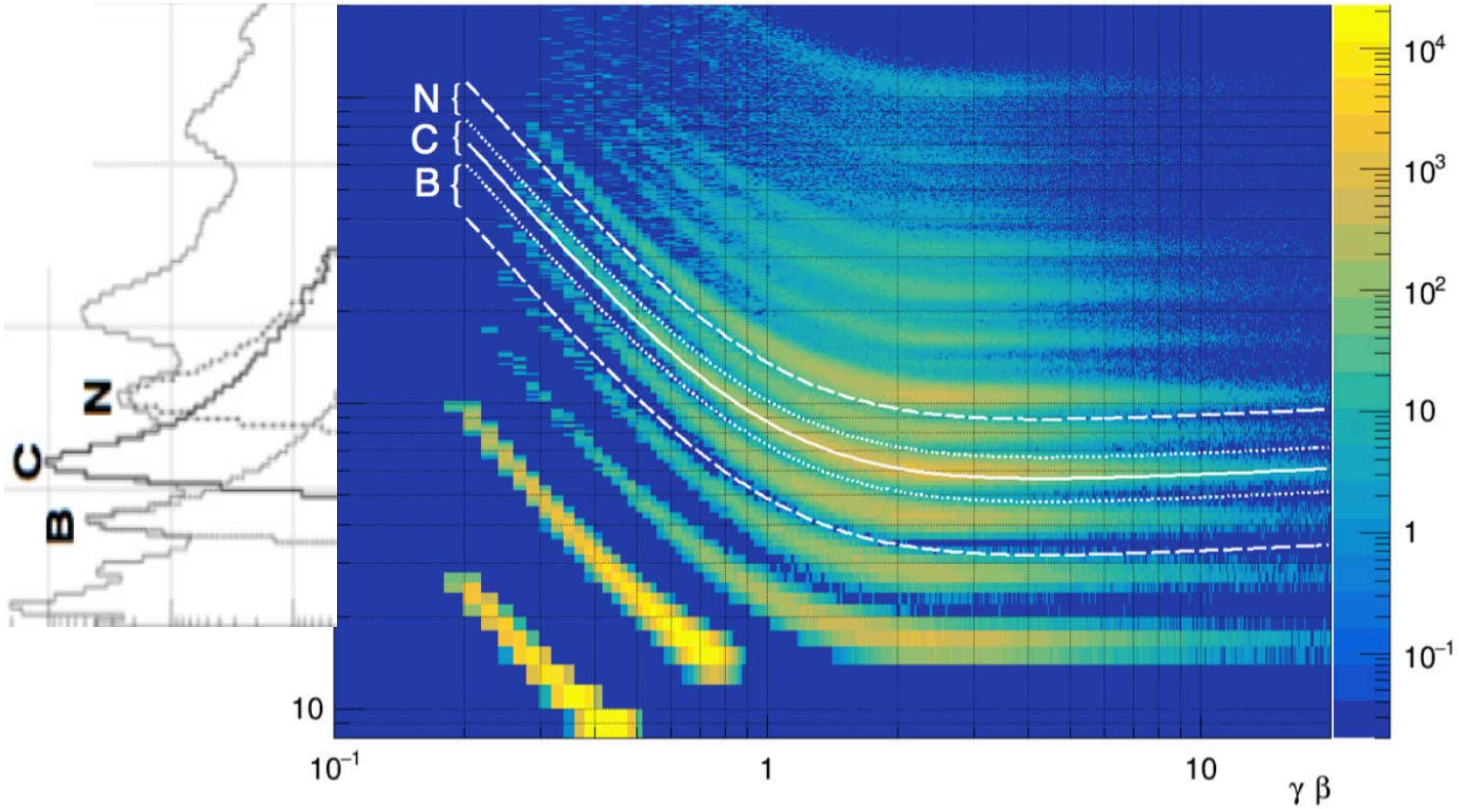
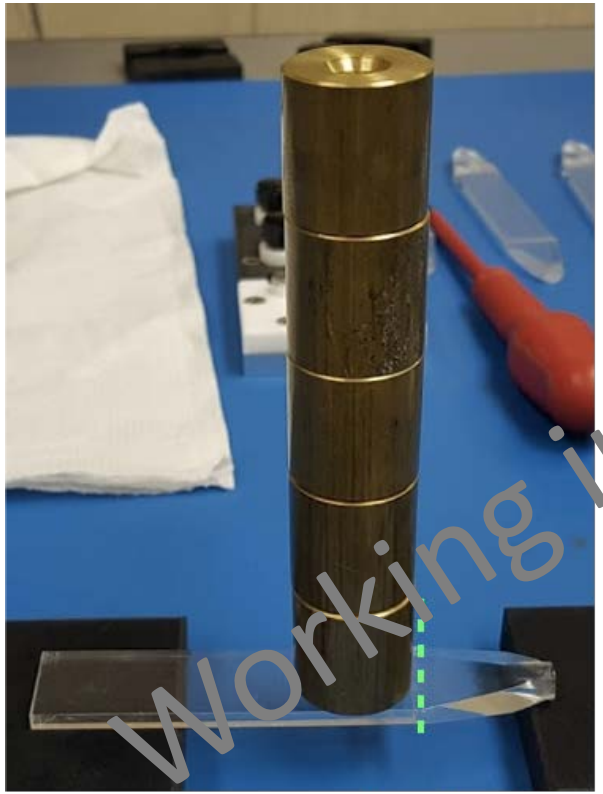
… and as it will be



In principle a significant improvement of nuclear identification

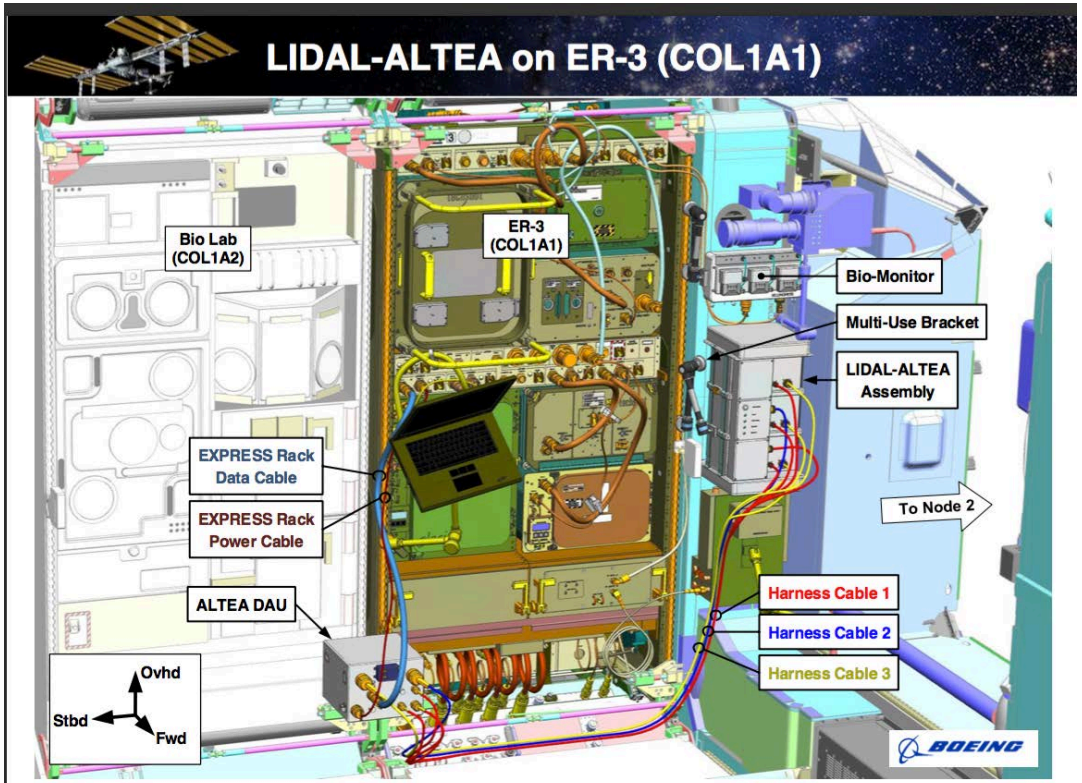
The final scintillators



glued surface

Timeline

LIDAL	Increment 59	SpaceX-18 (05-07-2019)



Conclusions

- LIDAL-ALTEA will be able to measure all ions
- The nuclear discrimination capability appear quite promising
- 6 to 18 (48) months of measurements foreseen
- Medipix cross calibration: agreement in development
- DOSTEL/RAD cross calibration?

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Thank you for your attention

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