

EUSO-TA

Y.Kawasaki (RIKEN)

共同利用課題

紫外線撮像望遠鏡によるTAサイトでの空気シャワー蛍光の観測

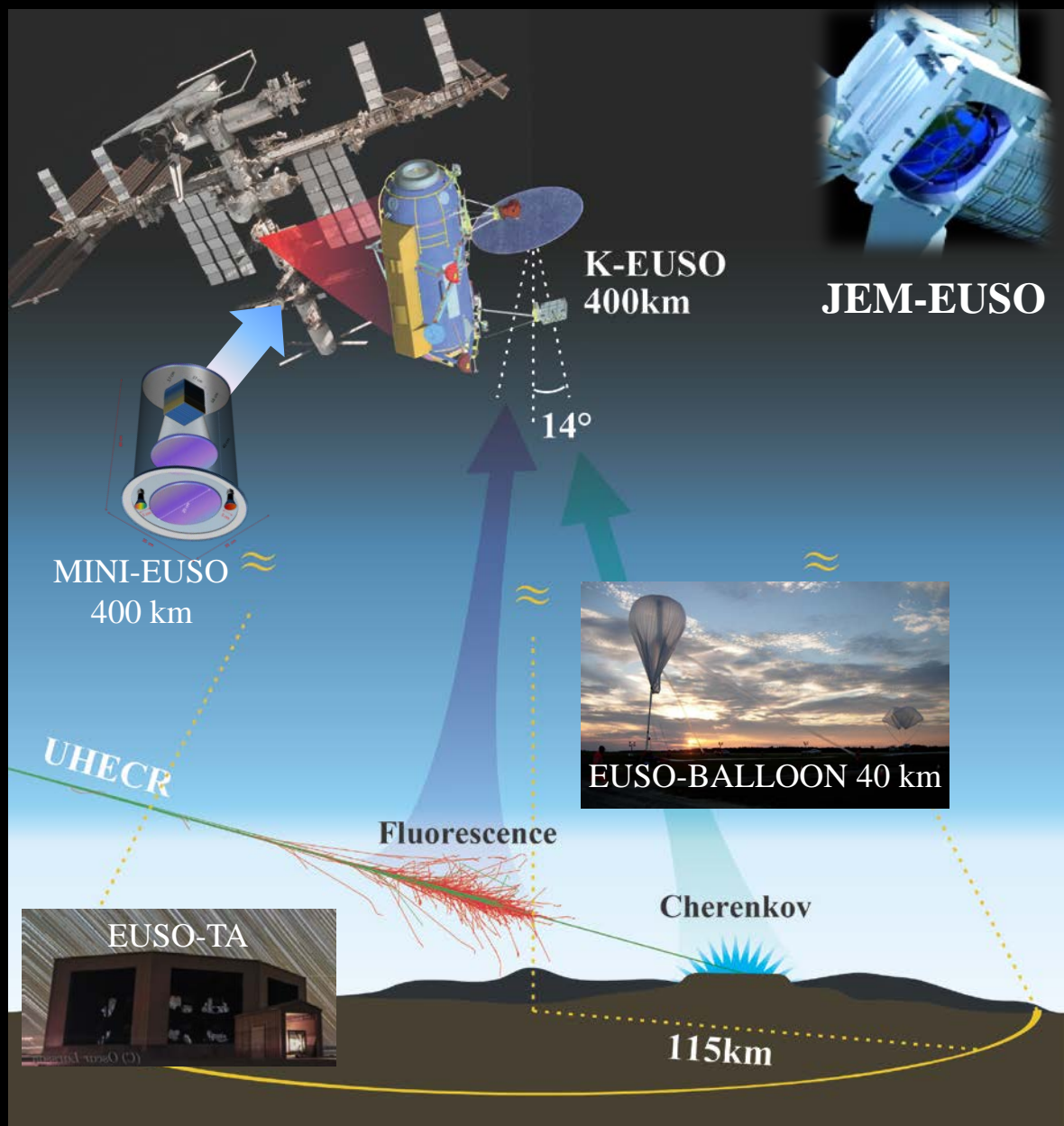
旅費 75万円

(C) Oscar Larsson

The EUSO program

*Ultra-High Energy
cosmic rays from space*

- EUSO-TA:** *Ground detector installed in 2013 at Telescope Array site: currently operational*
- EUSO-BALLOON:** *1st balloon flight from Timmins, CA (French Space Agency) Aug 2014; 2nd flight: 2016, NASA Ultra long duration flight: 2017*
- MINI-EUSO (2017):** *Precursor from International Space Station (ISS: 30kg 2017). Approved by Italian and Russian Space agencies*
- K-EUSO (2019 JFY):** *ISS Approved by Russian Space Agency*



JEM-EUSO collaboration

16 Countries, 93 Institutes, 351 people



EUSO-TA

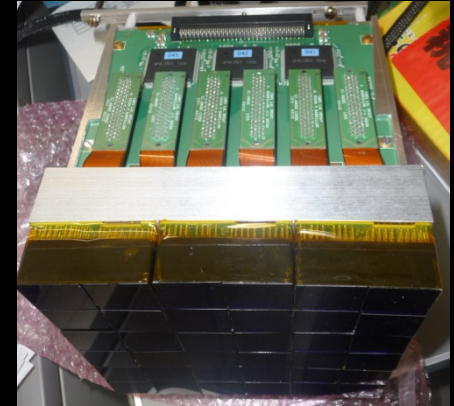
Installed in 2013

Used in 2014 for

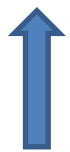
Auger/Fast tests

First data taking campaign
in March 2015

Subsequent: May, sept,
oct, nov



- Stars: 0.34 deg PSF
(work also with Moon)
- UV Background
- Laser:
 - Mobile, LED
 - CLF of TA
- Cosmic ray



Location of TA-EUSO

CLF
(21km)



Black Rock Mesa FD Station

2013年3月22日



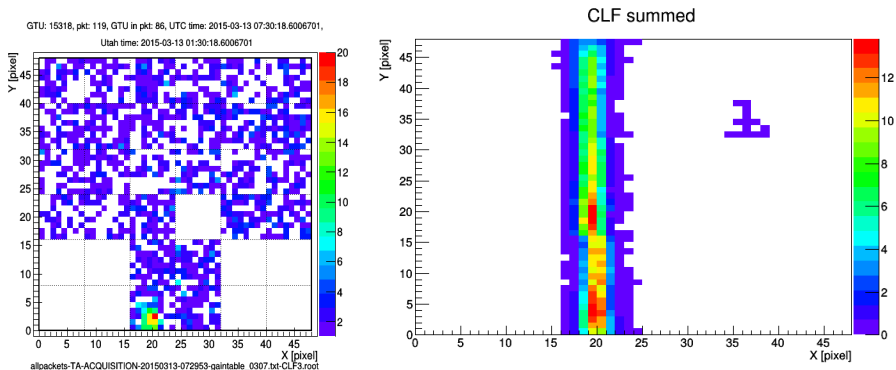
EUSO-TA campaigns

So far EUSO-TA had 5 observation campaigns:

- | | |
|---------------------|--|
| February/March 2015 | <ul style="list-style-type: none">• Detector installation• Focusing, initial calibration• Initial CLF and CSOM laser observations |
| May 2015 | <ul style="list-style-type: none">• Cosmic ray observations – one UHECR detected• CLF and CSOM laser observations• Flat screen and LED calibration |
| September 2015 | <ul style="list-style-type: none">• Cosmic ray observations – analysis ongoing• CLF and CSOM laser observations |
| October 2015 | <ul style="list-style-type: none">• Cosmic ray observations – analysis ongoing• Internal trigger tests on the balloon PDM board – successful triggering on laser• CLF and CSOM laser observations |
| November 2015 | <ul style="list-style-type: none">• Cosmic ray observations• CLF laser observations |

Central Laser Facility

- Distance from EUSO-TA: 21 km
- Energy: $\sim 3\text{-}7$ mJ (4 mJ $\simeq 10^{19.2}$ eV)

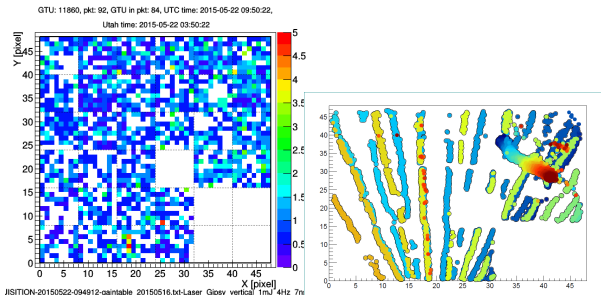


Empirical flat fielding applied – Z scale arbitrary

Laser tests

Preliminary Colorado School of Mines' laser results for three campaigns:

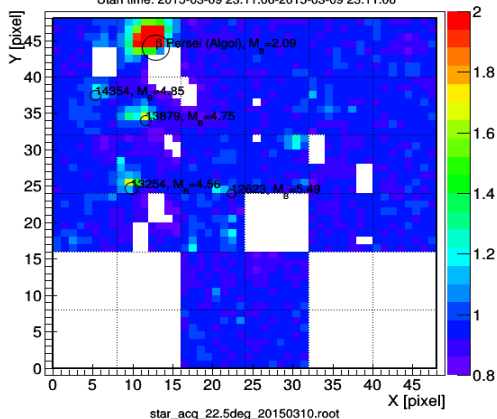
- We can detect on some frames vertical laser with 1 mJ energy, ~ 33 km from EUSO-TA



Stars in EUSO-TA with Hipparchos catalogue superimposed

U: 0-1280, pkt: 0-10, GTU in pkt: 0-0, UTC time: 2015-03-10 05:11:06-2015-03-10 05:11:1

Utah time: 2015-03-09 23:11:06-2015-03-09 23:11:06



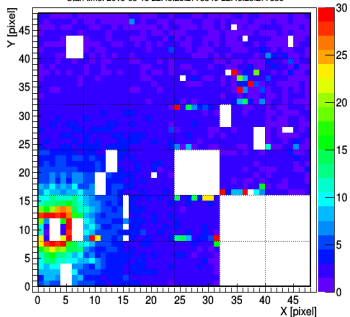
Current superimposing can not be perfect due to very complicated EUSO-TA PDM geometry.

Plane triggers

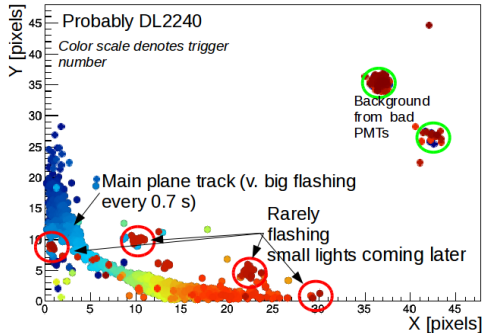
A scheme of triggers caused by a plane during a half hour run of EUSO-TA.

'68-113776, pkt: 888-888, GTU in pkt: 104-112, UTC time: 2015-05-16 04:45:23.2773349-04:45:

Utah time: 2015-05-15 22:45:23.2773349-22:45:23.277355

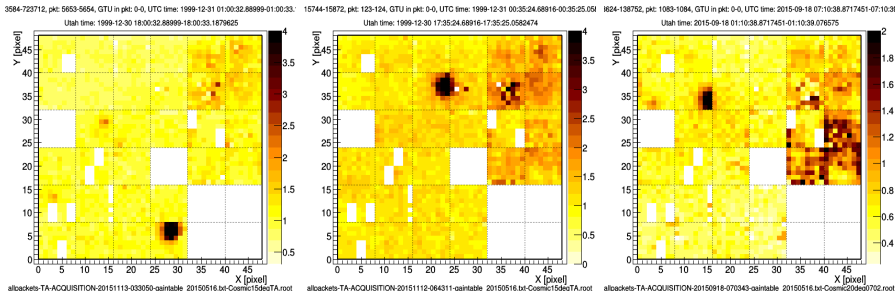


allpackets-TA-ACQUISITION-20150516-043908-gaintable_20150510_1.txt-et25deg.root



Meteors

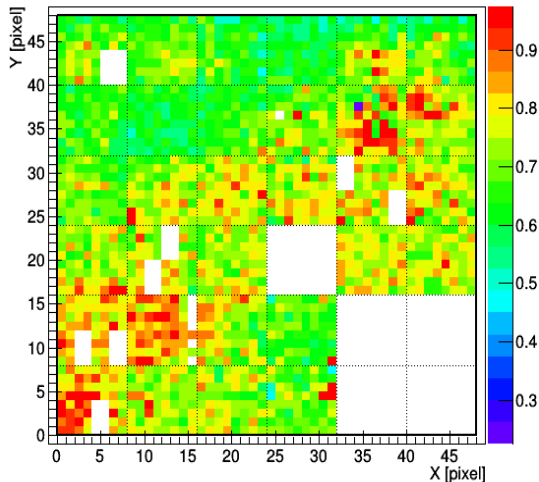
- 5 candidates so far, but I started to distinguish them from planes last Friday
- TA triggers (probably) on meteor brightening, or on something else – number of packets with meteors limited
- All cross $>2^\circ$ in <1 s (5 mach airplane 100 m above does $<1^\circ$ in 1 s)



Sometimes well visible when flat frame used

ΓU: 0-1280, pkt: 0-10, GTU in pkt: 0-0, UTC time: 2015-05-17 05:55:45.5967126-05:55:54.45424'

Utah time: 2015-05-16 23:55:45.5967126-23:55:54.4542475



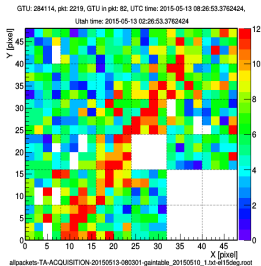
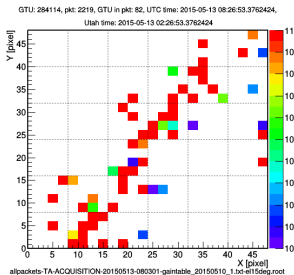
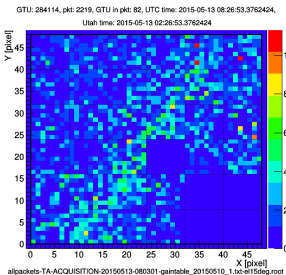
allpackets-TA-ACQUISITION-20150517-055510-gaintable_20150516.txt-el20deg.root

UHECR, confirmed track

Found in some TA UHECR candidate data (preliminary analysis)

Preliminary data from TA:

- $E \simeq 10^{18}$ eV
- Distance: 2.5 km



UHECR, confirmed track

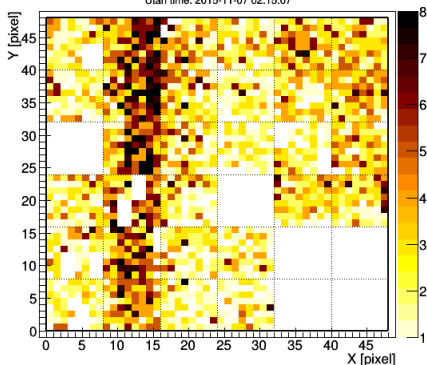
Found in November data

Very preliminary data from TA:

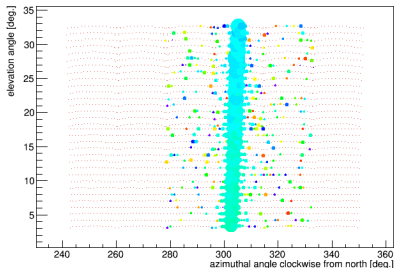
- $E \simeq 10^{18.36}$ eV (highly uncertain)
- Distance: 2.6 km

GTU: 39873, pkt: 311, GTU in pkt: 65, UTC time: 2015-11-07 09:15:07,

Utah time: 2015-11-07 02:15:07



allpackets-TA-ACQUISITION-20151107-091314-gaintable_20150516.bt-Cosmic15degTA.root



UHECR, confirmed track

First moving event! (even though only 2 frames)

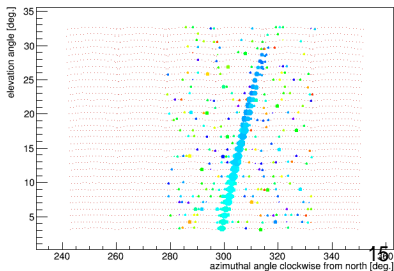
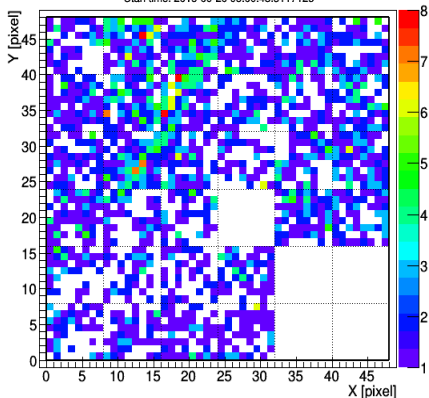
It was first mismached with a “diffused” event (due to time matching problems)

Very preliminary data from TA:

- $E \simeq 10^{18.63}$ eV (highly uncertain)
- Distance: 6.7 km

GTU: 11712, pkt: 91, GTU in pkt: 64, UTC time: 2015-09-20 11:00:43.3117125,

Utah time: 2015-09-20 05:00:43.3117125



Next step

- Absolute calibration
- Long term observation to test the reliability and usability of our system and to observe the cosmic ray air shower.
- Test of EUSO-SPB

