Latest news from the HAWC outrigger array

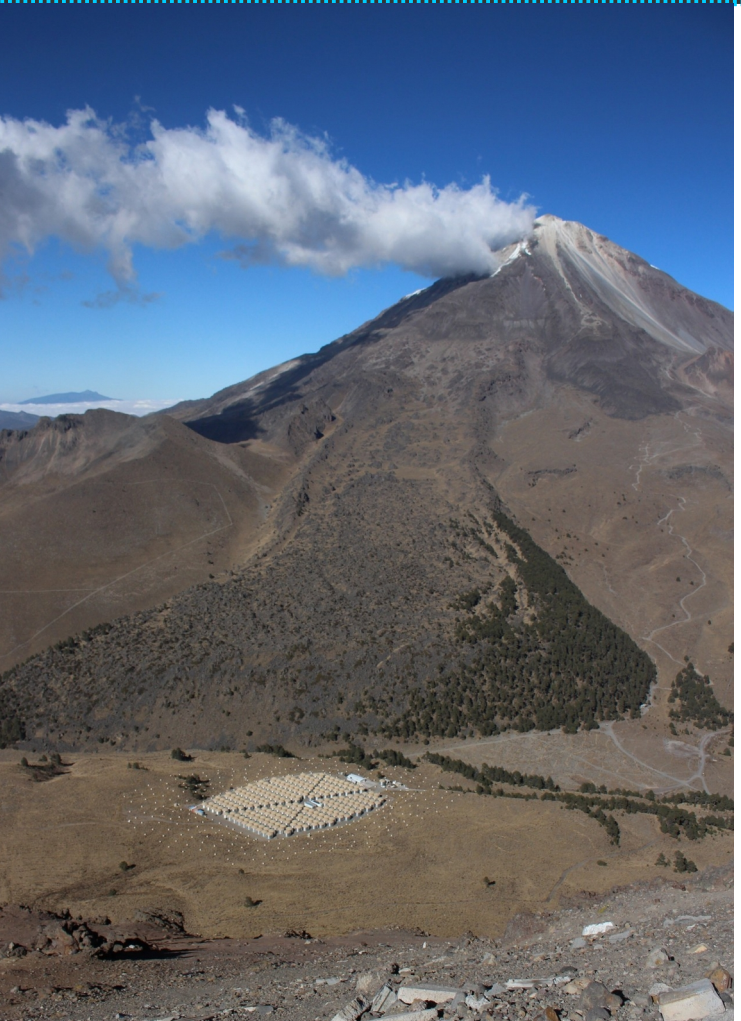
Vincent Marandon
on behalf of the HAWC collaboration

36th ICRC 2019, Madison

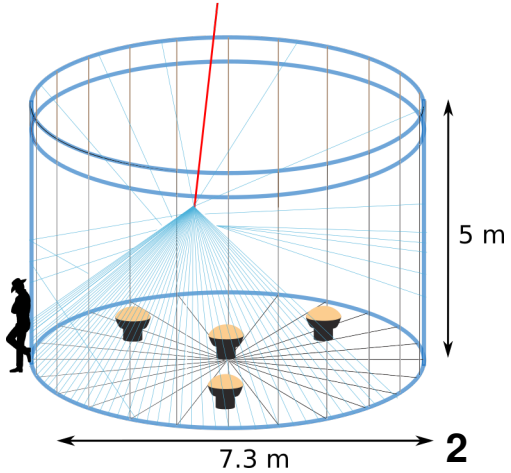
MAX-PLANCK-GESELLSCHAFT

MAX-PLANCK-INSTITUT FÜR KERNPHYSIK

HAWC γ-ray observatory

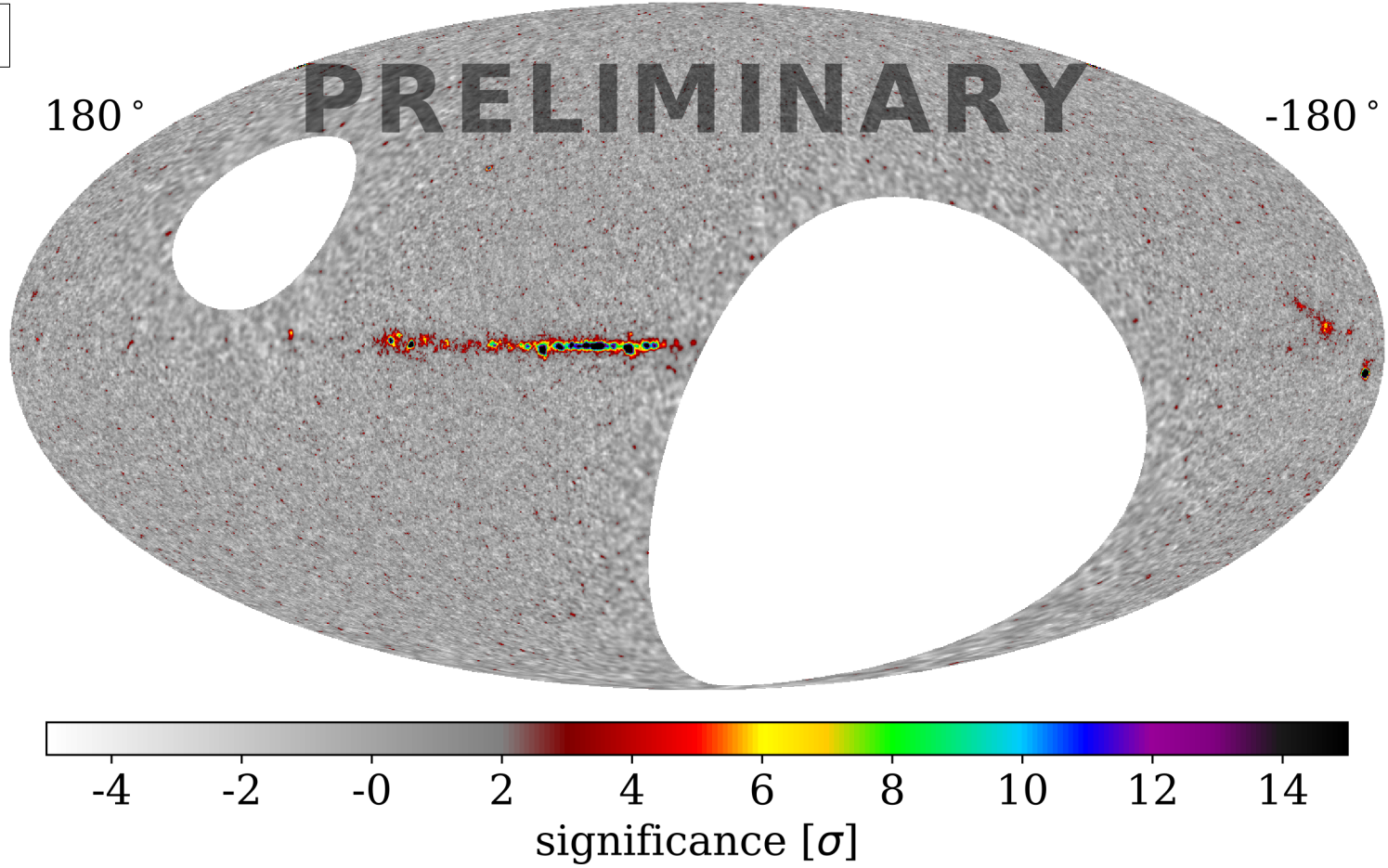


- 300 WCD
  - Each : 4 PMT, 200 000 l
- Mexico (+19° N)
- Elevation : 4100 m
- Area ~22 000 m²
- Duty Cycle > 95%
- FoV : ~2sr
- Energy Range : ~0.3 to >100 TeV



HAWC Sky Map

1346 days



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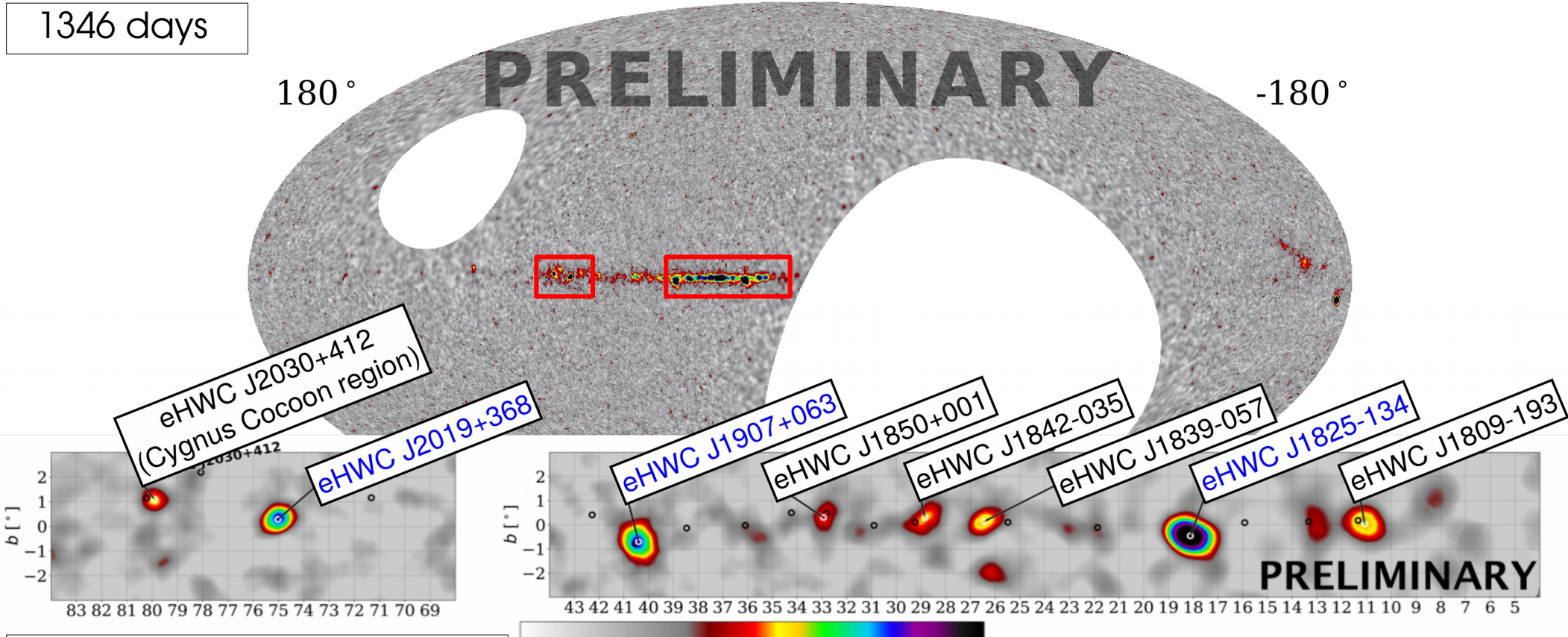

> 56 TeV, >100 TeV

(See K. Malone, GAI2b)

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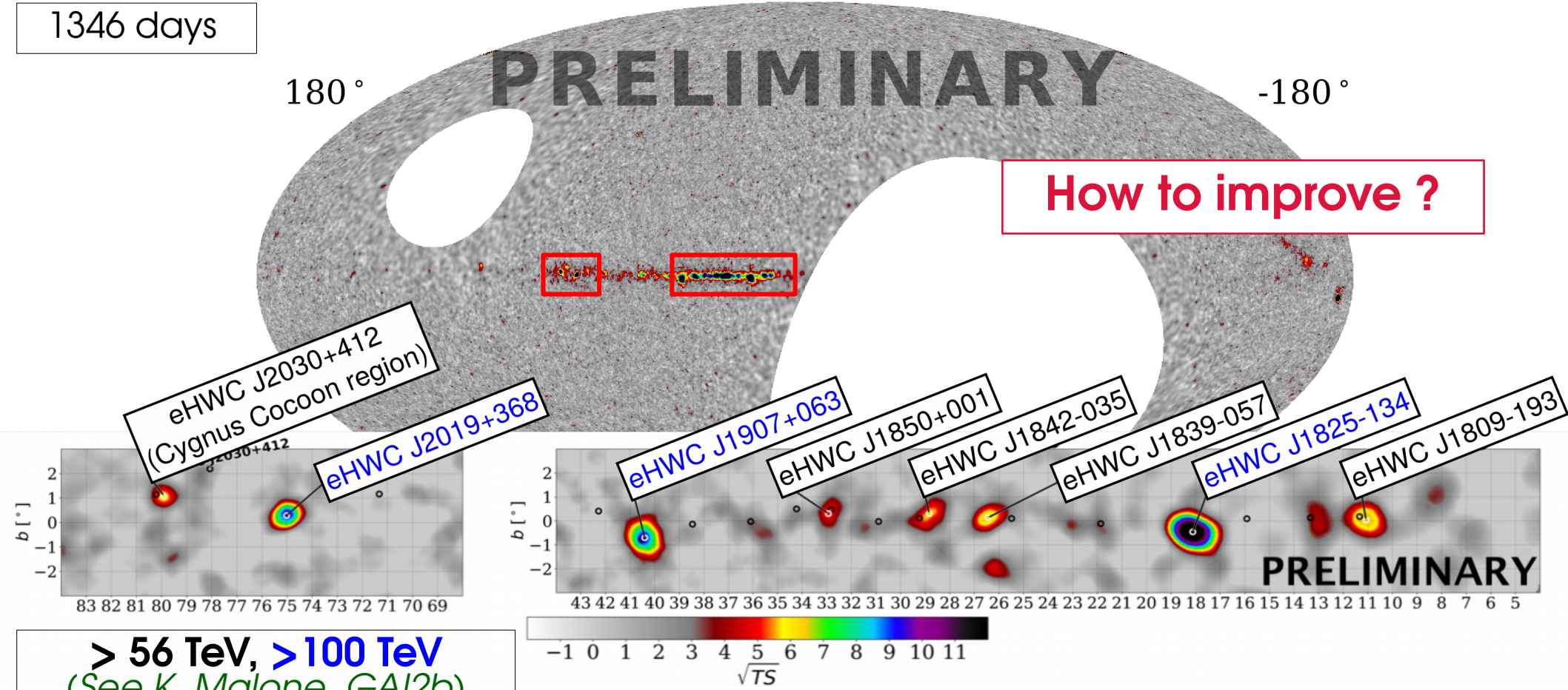

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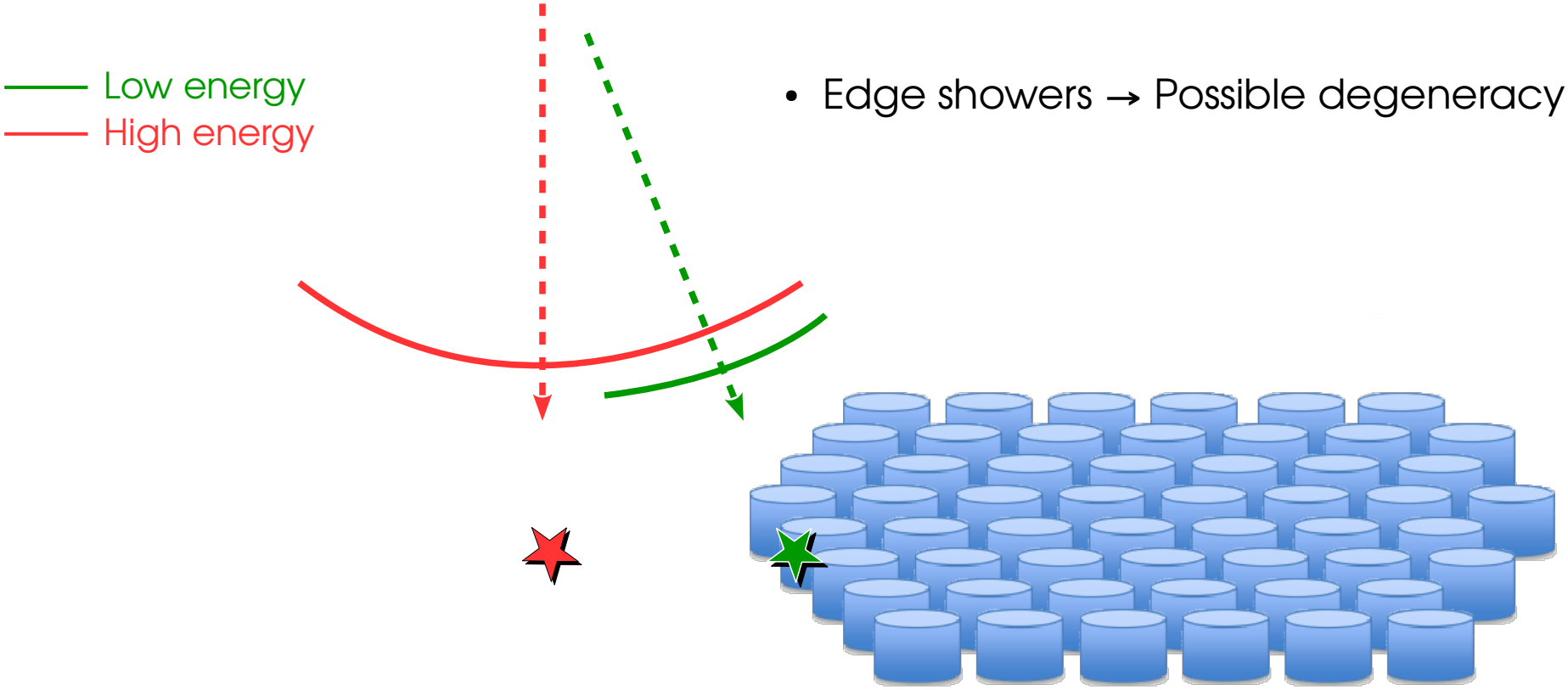
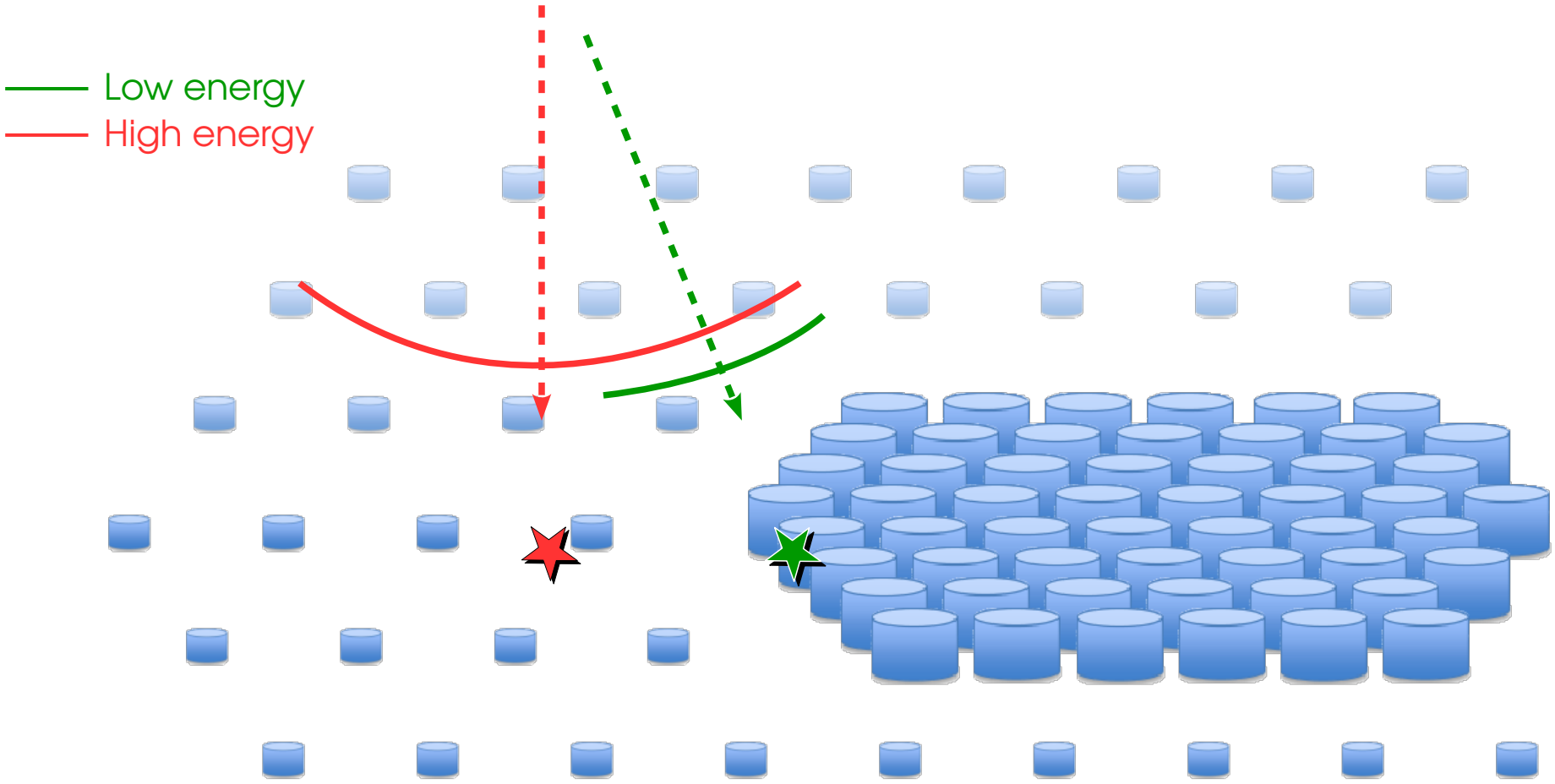
Outer Array Showers



- Edge showers → Possible degeneracy

Outer Array Showers

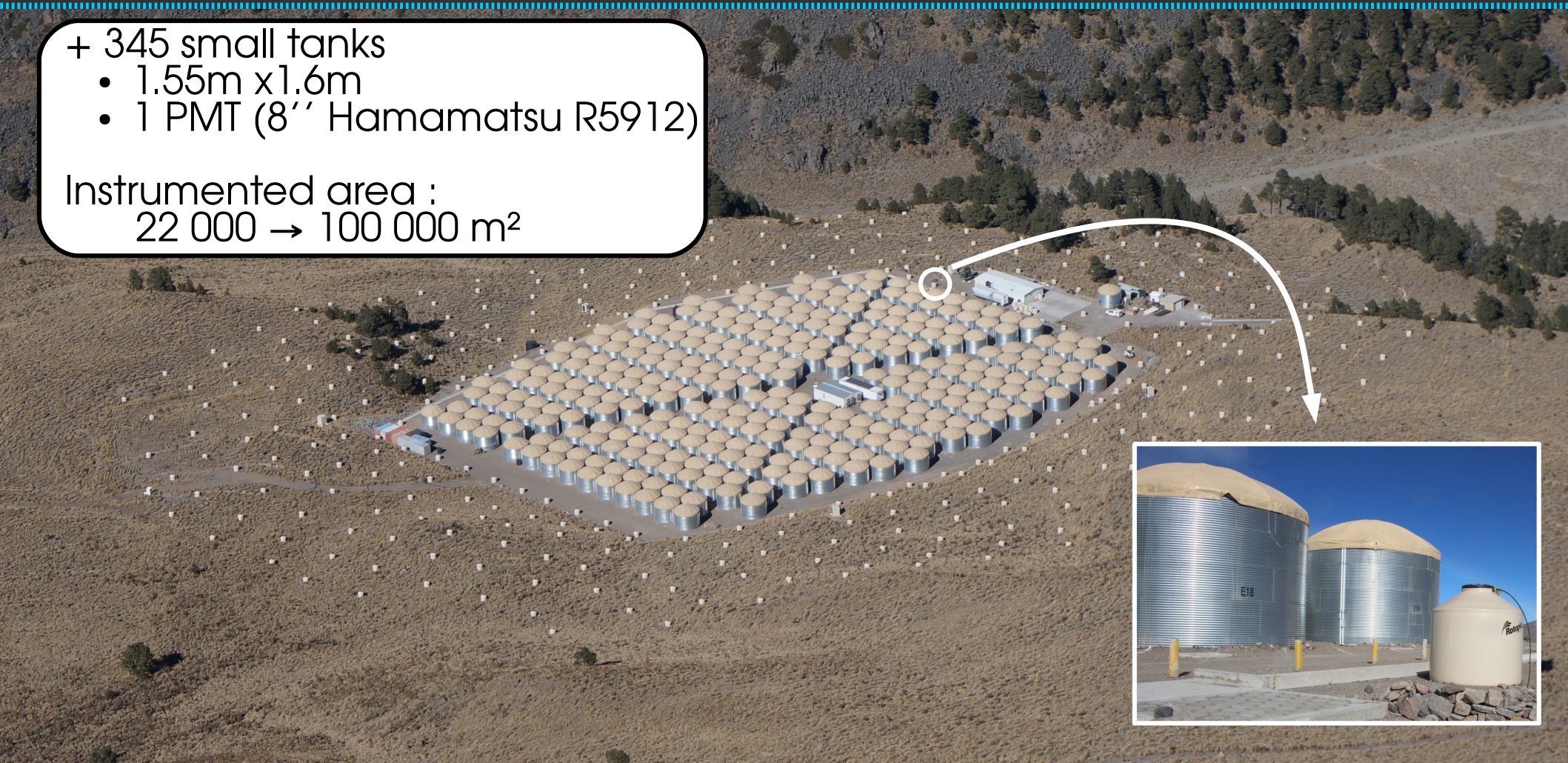


The HAWC Outrigger Array

The HAWC Outrigger Array

+ 345 small tanks
  - 1.55m x1.6m
  - 1 PMT (8'' Hamamatsu R5912)

Instrumented area :
22 000 → 100 000 m²



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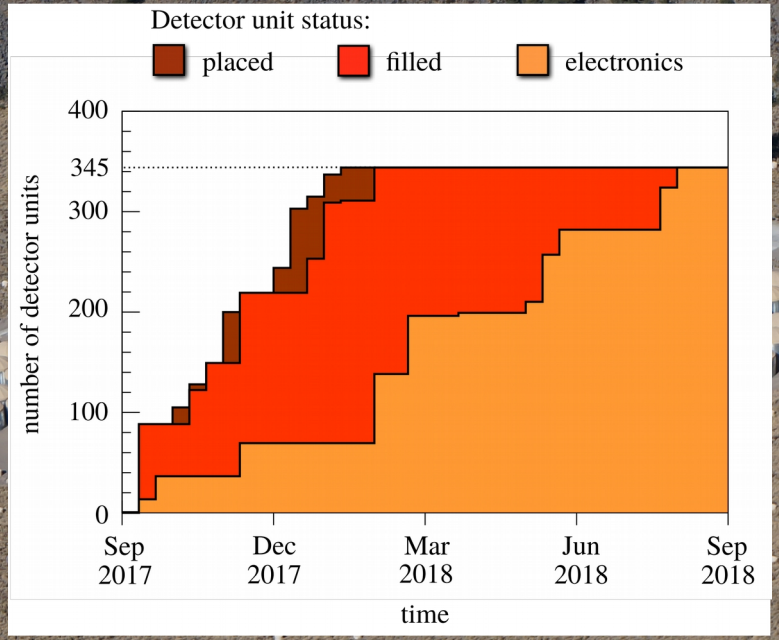

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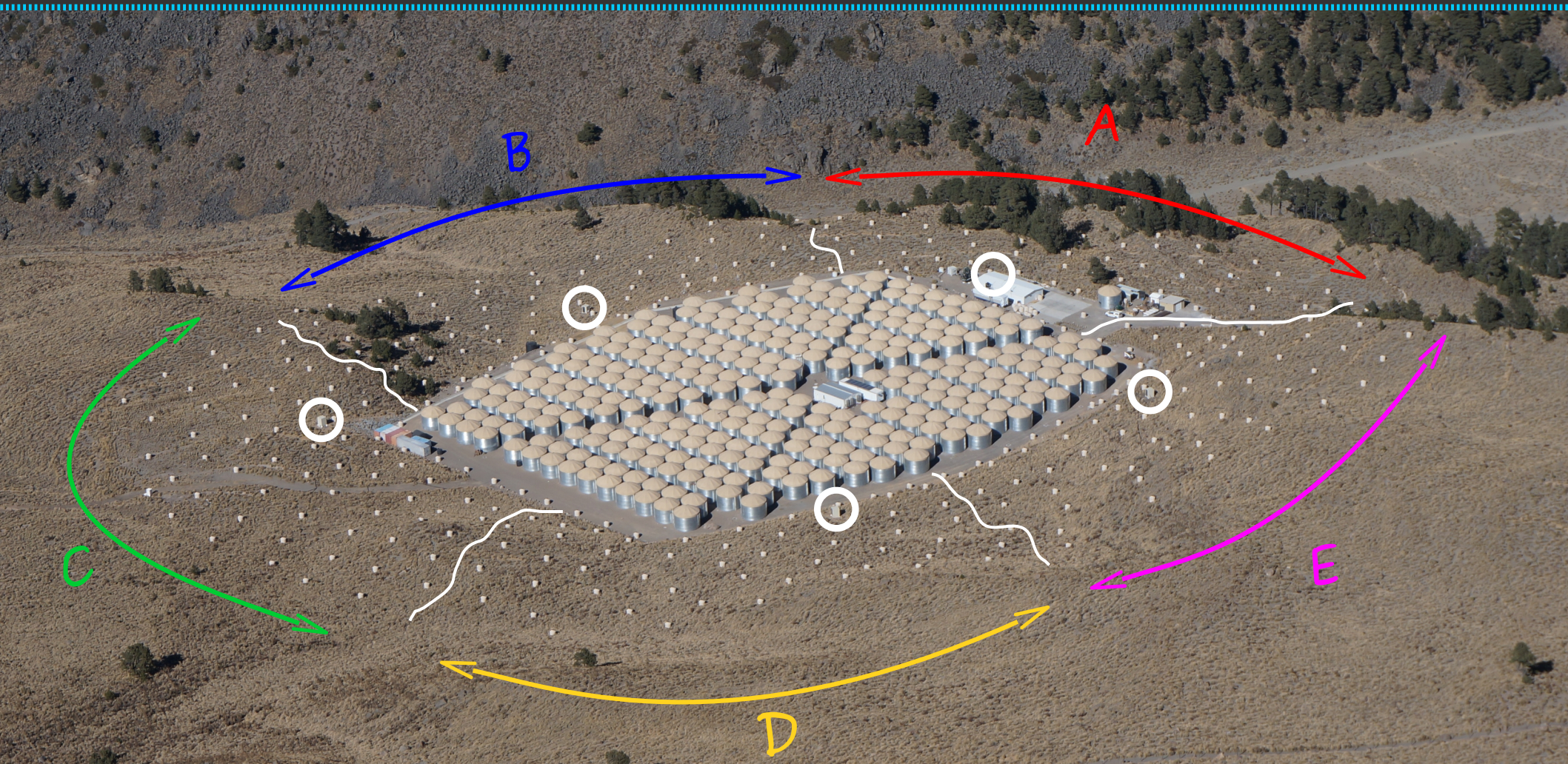

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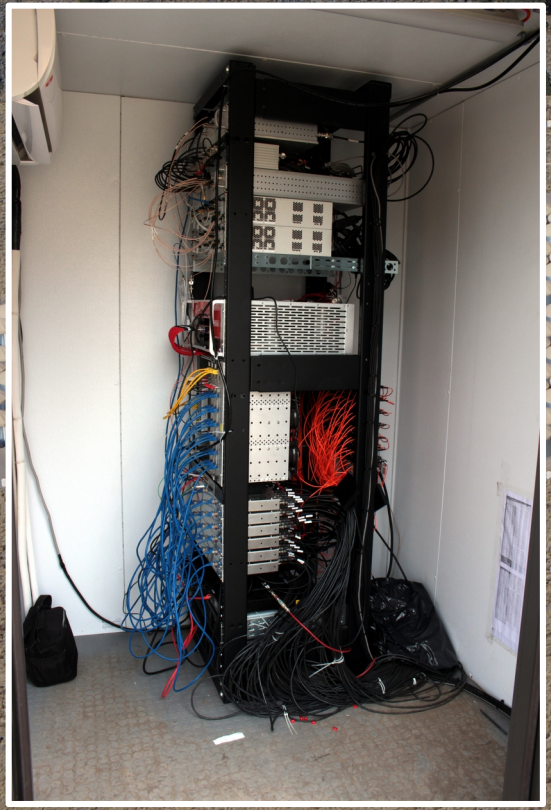
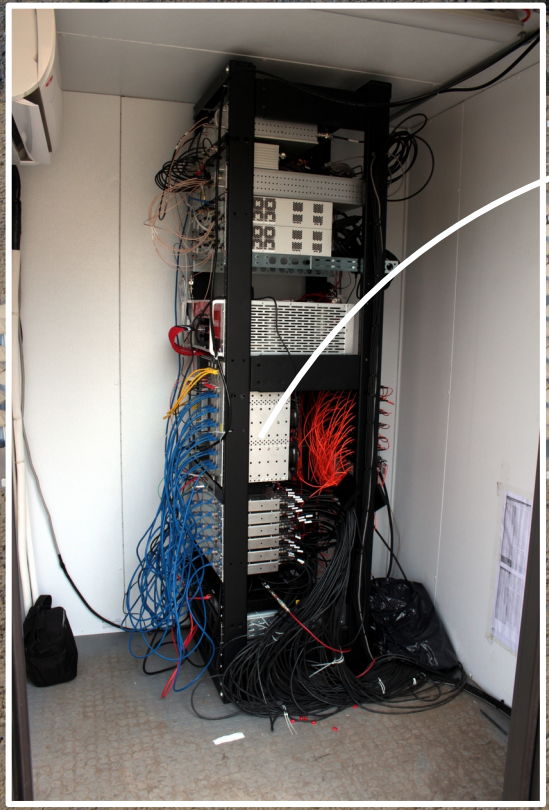
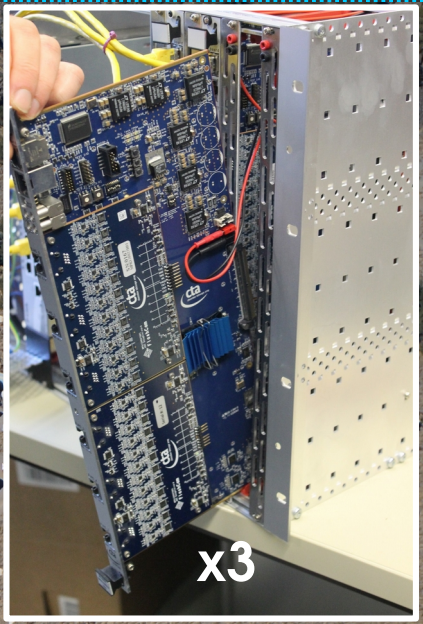


Rack :

- PMT HV
- Calibration light splitting
- Readout electronics
- White Rabbit (Time sync)

The HAWC Outrigger Array





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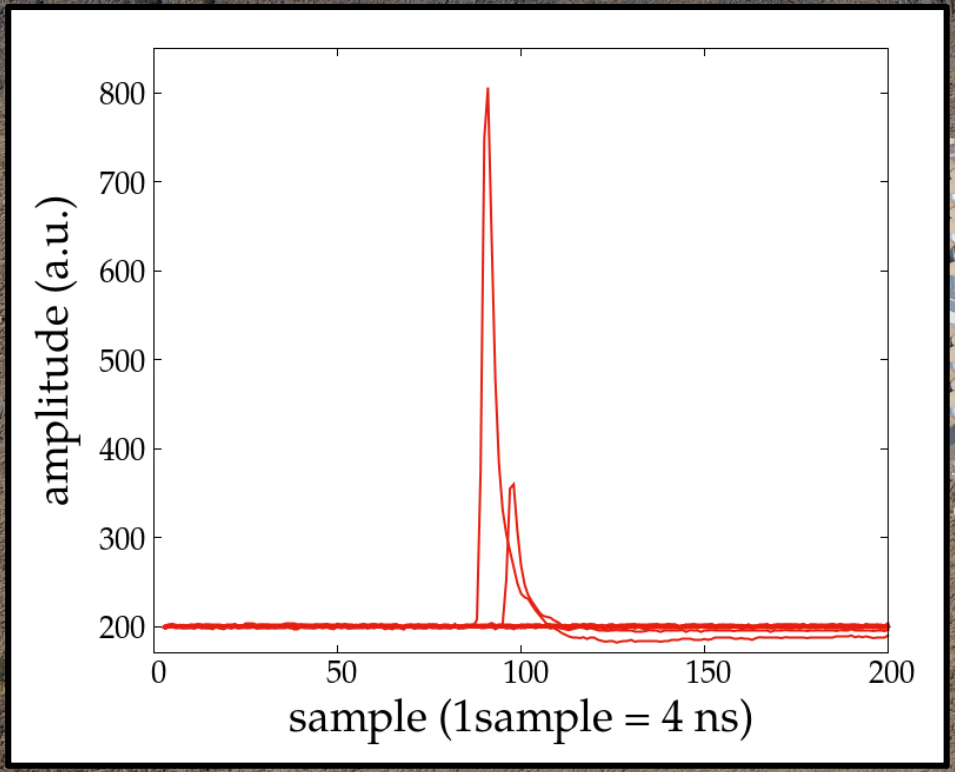
Readout Electronics :

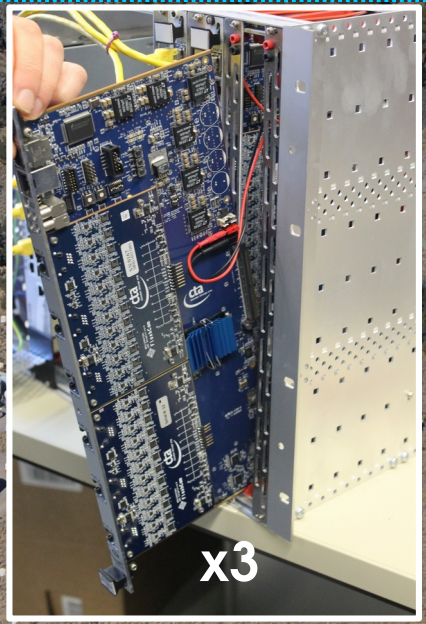
- 12 bit FADC, 250 MHz sampling
- 24 channels per card
  → 23 tanks + 1 calibration

→ 3 FADC board per Node

The HAWC Outrigger Array

Trigger Condition (per FADC) :
At least 2 tanks > 1 pe within 160 ns





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Outrigger Array : Calibration

2 parts :

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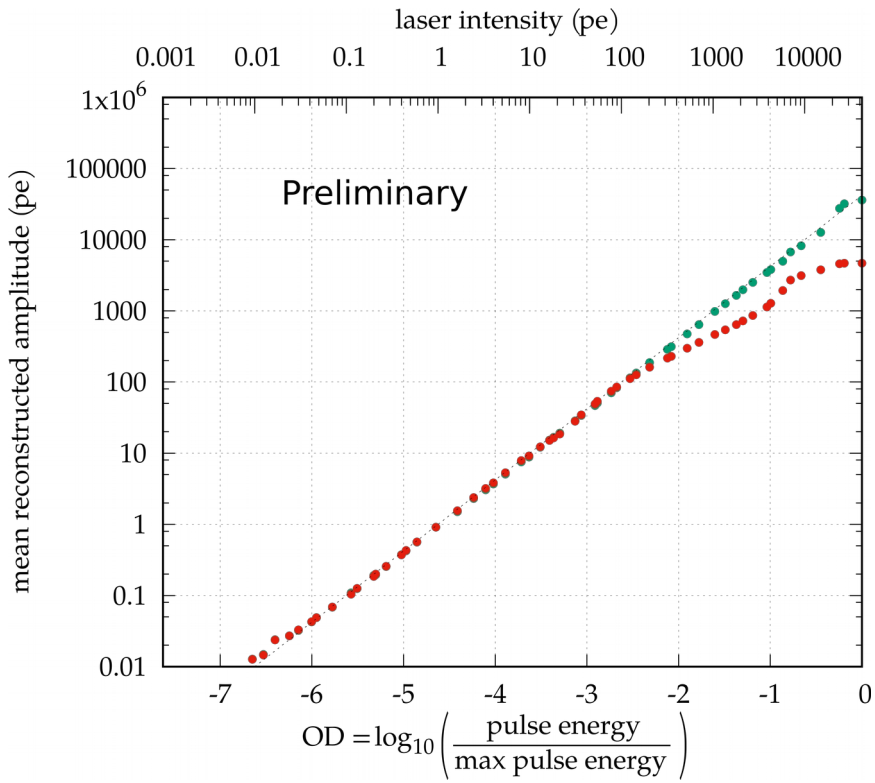

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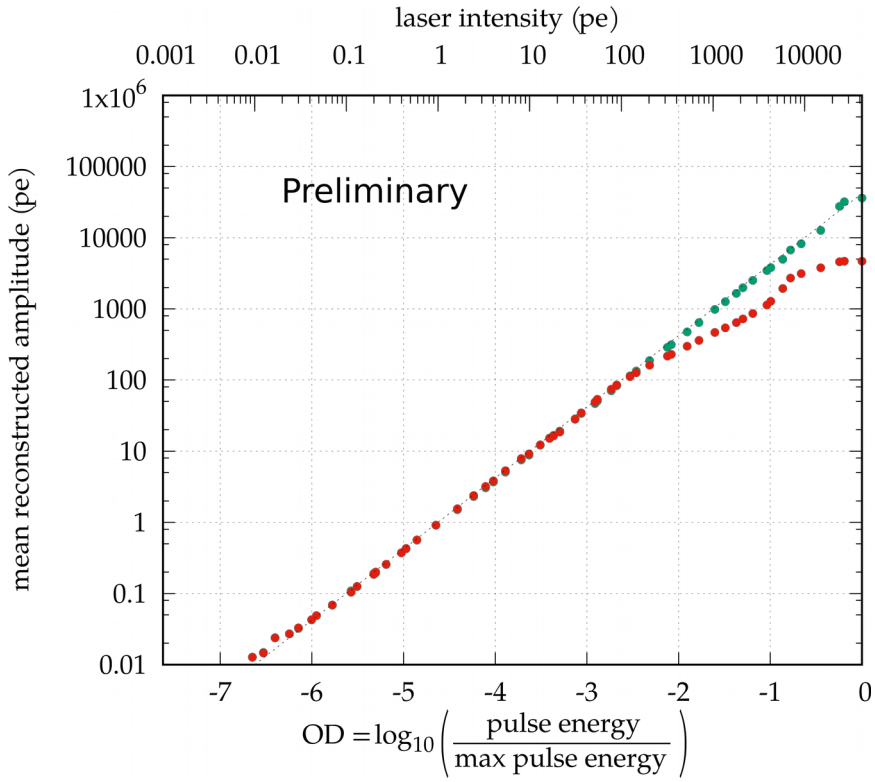
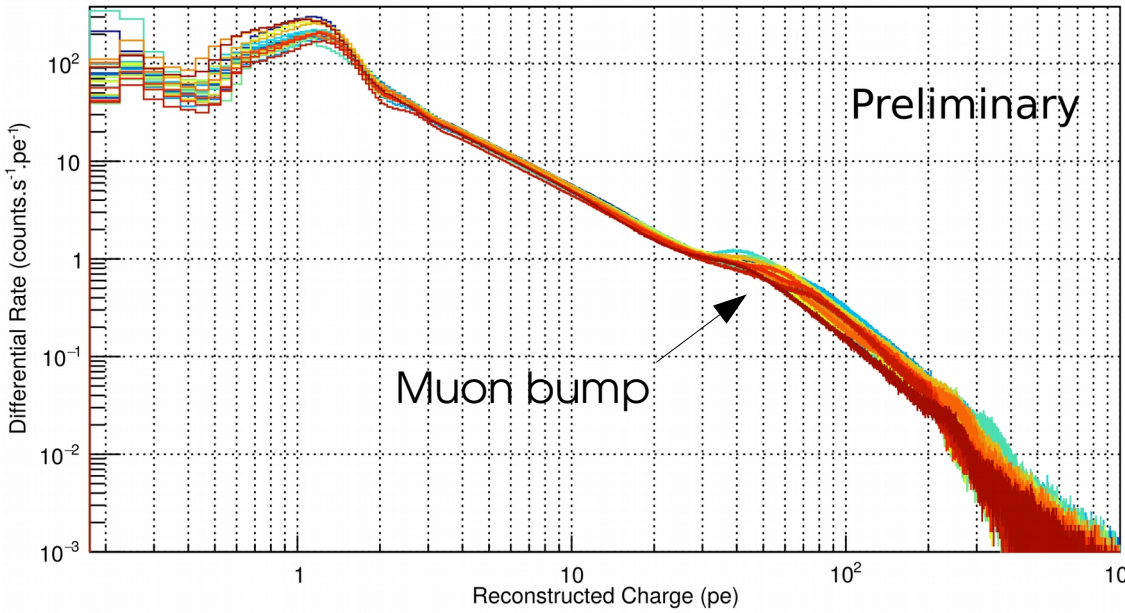
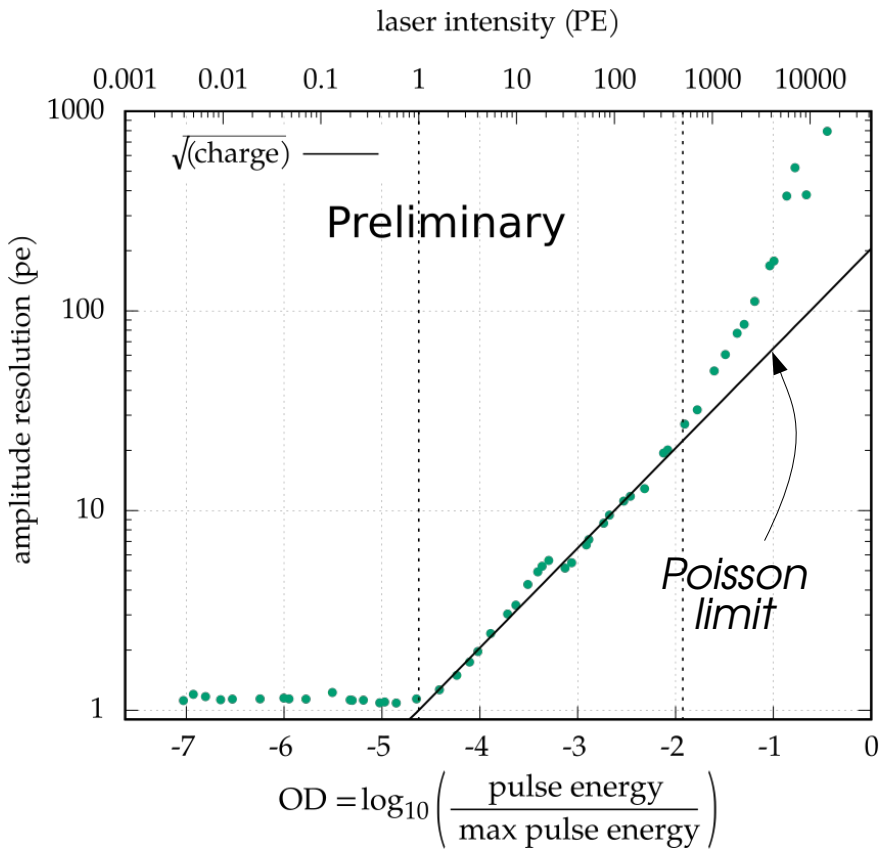


Charge distribution for 23 channels

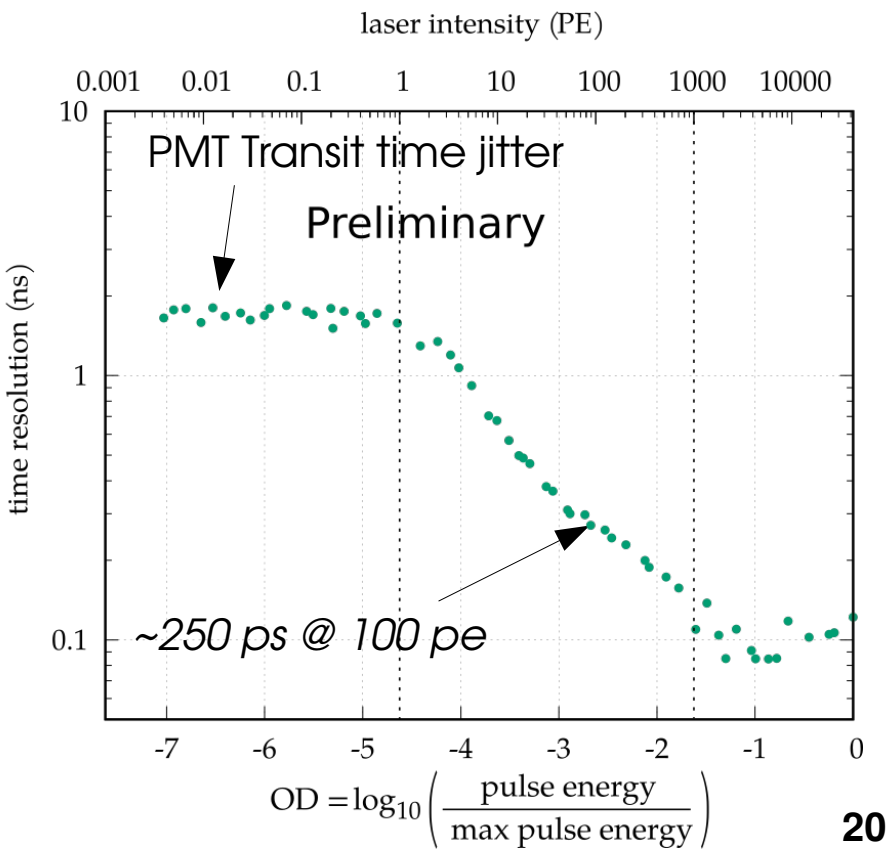


Outrigger Array : Calibration Performances

Charge Resolution



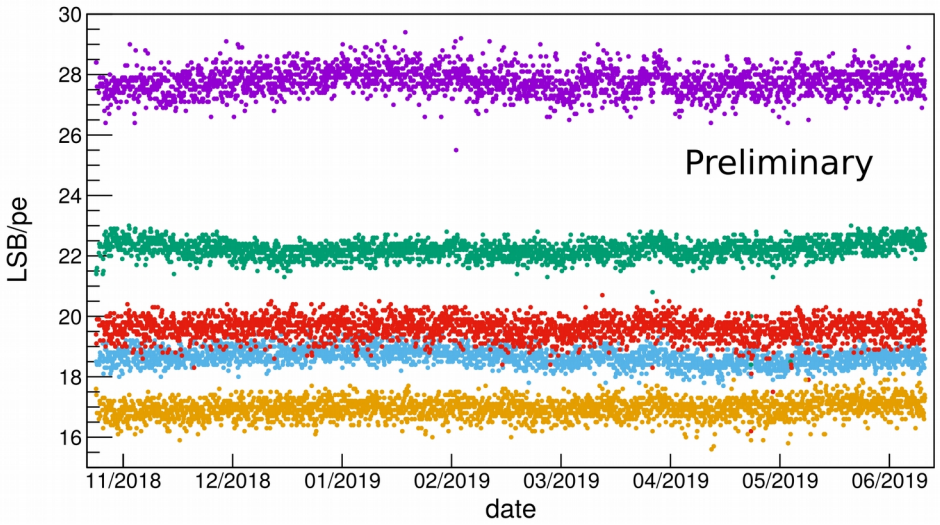
Time Resolution



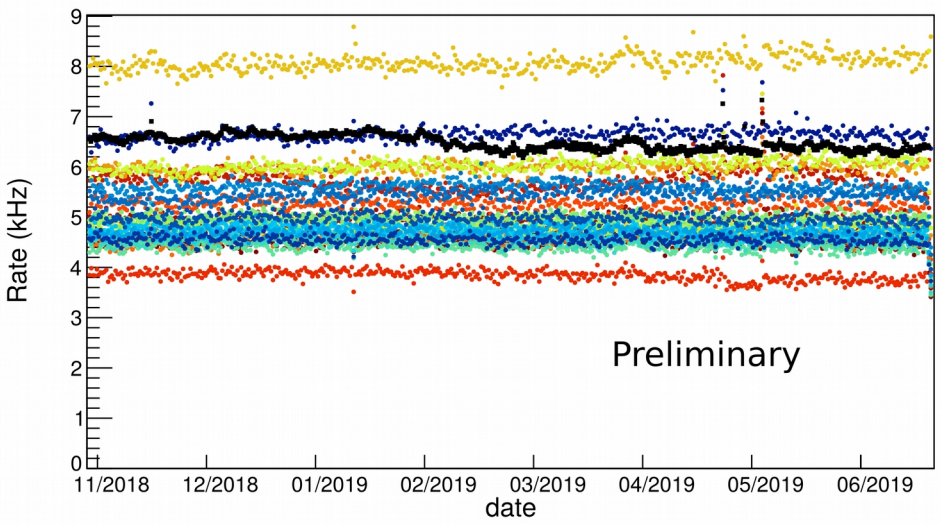
Outrigger Array : Monitoring

→ Array continuously monitored !

- Gain Evolution



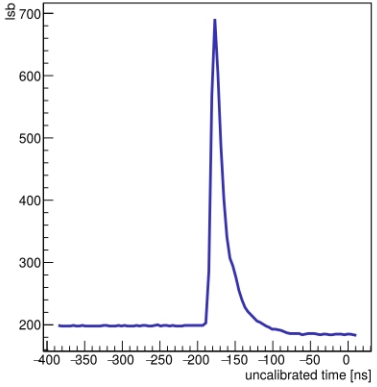
- Single tank rates for 23 channels
- System rate (black)

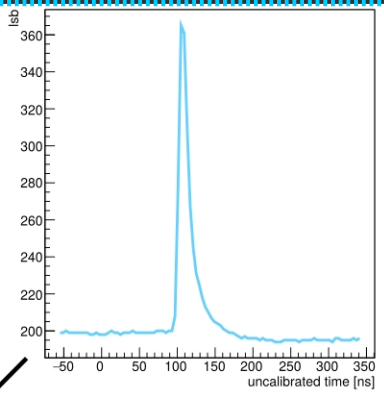


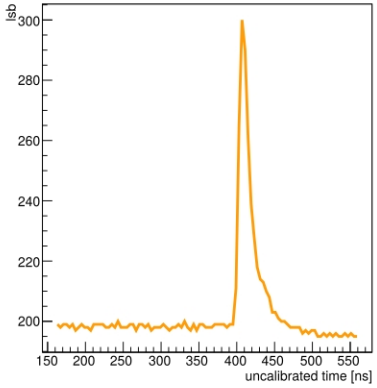
→ Stable system since 7 months

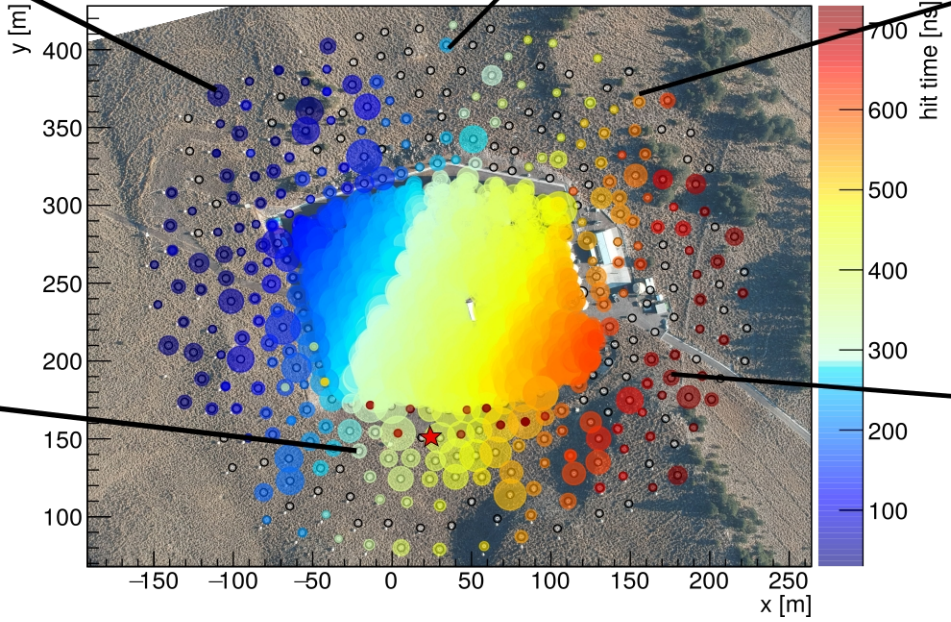
Example of a typical event

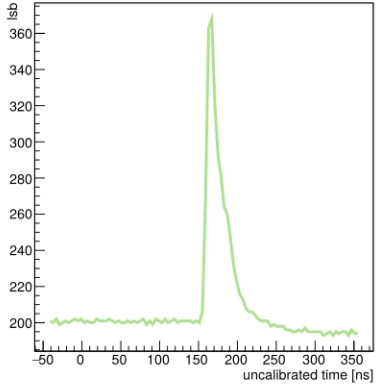
OR-Main array merging :
Coincidence [-0.5, 1] µs

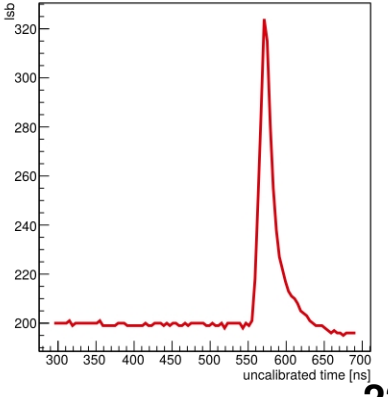




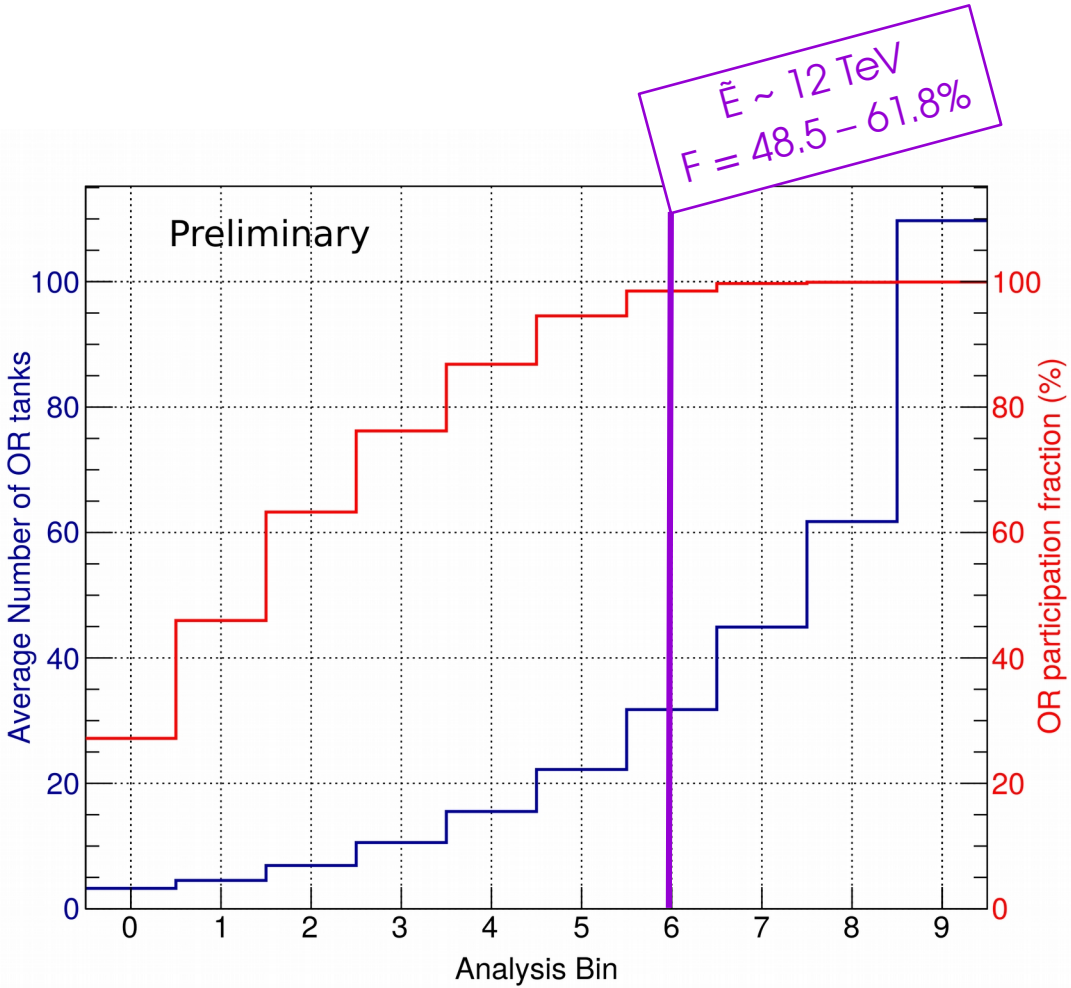








Outrigger Array : Participation Fraction

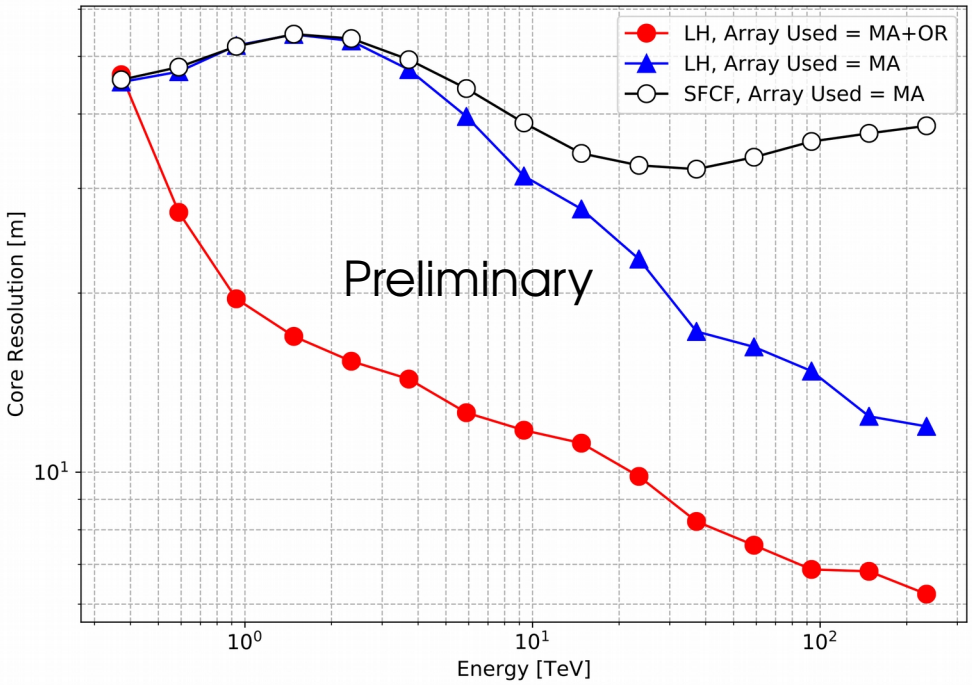


High multiplicity for high energy event

- bin 6-9 : Always OR information !
- Bin 6 : 30 OR Tanks hit in average

→ **Works as designed !**

Outrigger Array : Expected Improvement



See V. Joshi's poster (PS1-71)

Time structure of shower front : see D. Huang (PS3-60)

Core resolution :

- MC simulation
- True core on outrigger array (i.e outside main array)

→ x2-3 Improvement !

<u>Should improve PSF and energy resolution !</u>

Conclusions

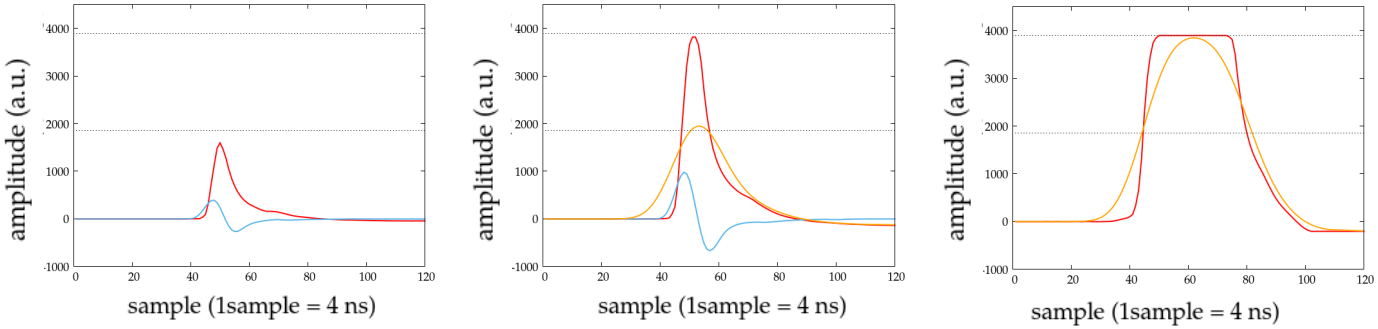
- Outrigger Array taking data since end 2018
- Smooth operation
- Understood instrument

- Next Steps : Integration to main array for science analysis

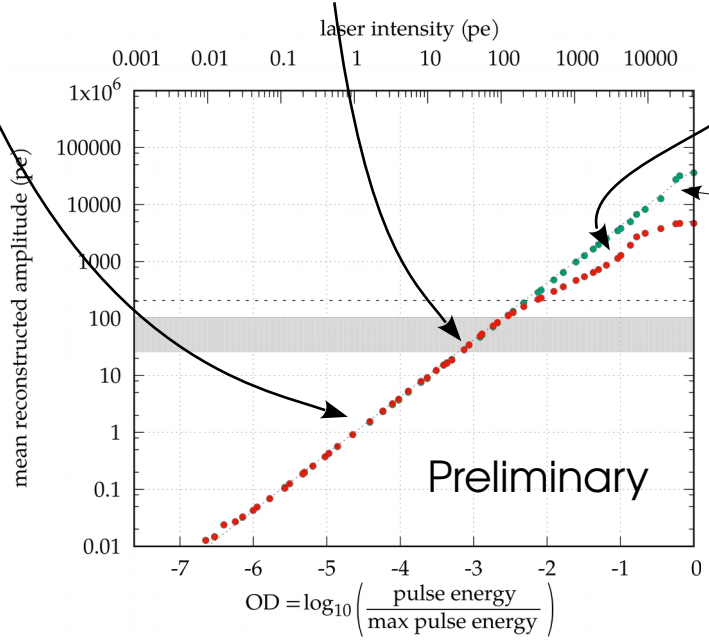
→ More details in a forthcoming publication !

Thank you !

Pulse Reconstruction



+ Additionnal correction



Calibrated Data