Auger Torino (6.8 FTE)

Membri del gruppo (TL = task leader)

Marco Aglietta	I ric. INAF	TL smallPMT; co-TL manutenz. SD-PMT
Enrico Arnone	ric. UniTO	
Mario Bertaina	prof. ord. UniTO	
Marta Bianciotto	dottoranda UniTO	
Antonella Castellina	dir. ric. INAF	spokesperson
Armando di Matteo	ric. INFN	co-TL fenomenologia
Alessio Gorgi	coll. tecn. INAF	
Roberto Mussa	I ric. INFN	TL LIDAR elastici; co-TL cosmo-geofisica
Carla Taricco	prof. ass. UniTO	

Attività

1. Hardware
   - Manutenzione dei large PMT dell'SD
   - Commissioning degli small PMT di AugerPrime
   - Manutenzione LIDAR elastici
2. Analisi dati Phase 1
   - Ricerche di anisotropie UHECR
   - Analisi dati LIDAR elastici
   - ELVES multipli e aloni
   - Scaler rate e attività solare
3. Analisi dati AugerPrime
   - Ricerca di fotoni nei dati SD-433 + Underground Muon Detector
   - Ricostruzione SD con small PMT (dynamic range maggiore) e nuova elettronica

Manutenzione dei large PMT dell'SD

Per mantenere costante il numero di LPMT funzionanti occorre cambiarne ∼100/anno

- 2 "PMT weeks"/anno (15 giorni di maintenance nel campo):
  staff locale (2 persone + tecnici INFN-TO)
- Lo staff locale prepara ∼50 PMT con basi ricondizionate per ogni PMT week
  - Selezione e identificazione del tipo di failure sulla base
  - Smontaggio dell'HVPS
  - Preparazione dei PMT

Componenti

- Condensatori da 10nF 3kV
- Connettori SMA per i cavi
- Componenti attivi (buffers, amplificatori)

Strumentazione

- 2 microscopi (saldatura e riparazione elettronica)
- 2 saldatori a gas
- 2 estrattori fumi di saldatura

PMT reconditioning

- PMT cleaning
- removal of PVC support
- new flying leads welding
- new base installation
- PMT full test
- potting (need many PMTs ready)
- packing




>60% of PMTs return from the field with rusty corroded pins, due to a combination of humidity and salinity

Base reconditioning

reconditioning procedures established (starting mid 2012) to stop production of new bases

- base cleaning
- fast HV module test (~88% ok)
- LTT 1 week (~80% ok)
- HV capacitors replacement
- other actions (e.g. cure for raining, short pins…)
- full functional test (automatic system)


At most ~70% of old bases can be recovered
Their retrieval requires a long process (= working time = manpower)
The final result is still uncertain (some bases after LTT are now in the field, need time to see if LTT was effective)

Numero PMT (o basi o HV) difettosi

- Nell'ultimo anno, $\sim$ 600 PMT spenti o difettosi (di solito $<$ 200 negli anni '10)
  - Tasso di rotture $\sim$ costante
  - Tasso di riparazioni molto ridotto (manodopera non disponibile per pandemia nel 2020–2021, impegnata nel deployment AugerPrime nel 2022–2023)

Problemi con le alte tensioni SensTech

- Riparazione in loco delle ultime forniture
- Riparazione dei moduli smontati dal campo a INFN-TO, KIT, Malargüe
- Altre alte tensioni da ordinare per recuperare più rapidamente i PMT

A Torino siamo responsabili al 50% (con Orsay) per i large PMT (3 per stazione) e al 100% per gli small PMT (1 per stazione) e i LIDAR elastici

Commissioning degli small PMT di AugerPrime

1 unit =
- sPMT R8619 + divider
- HVPS A7501
- mechanics
- cables

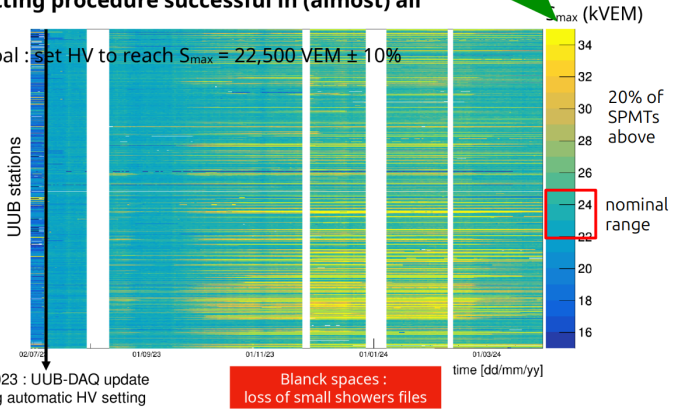
Da fare:

- Sigillare con silicone i tappi degli sPMT installati prima del ’23
- Verificare le instabilità (in fase di studio)
- Lavorare su monitoraggio e settings degli allarmi

1477 SPMT installed and taking data
- only 16 hardware failures/issues since the beginning

HV setting procedure successful in (almost) all cases
- goal : set HV to reach S_{max} = 22,500 VEM ± 10%

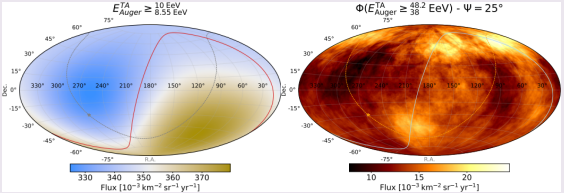
Maximum signal without saturation S_{max} **estimated using small showers data**



Ricerche di anisotropie UHECR

Working group congiunto con Telescope Array

- Gruppo attivo dal 2012, presieduto (*de facto*) da AdM dal 2019
- Analisi di tutto il cielo, impossibili con un solo esperimento



(Marta Bianciotto, AdM)

Ricerca di eccessi lungo il SGP e follow-up Telescope Array

- **Coming soon!**
  - v. prossima slide

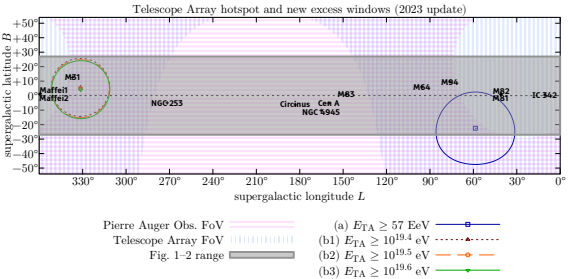
(AdM)

Correlazione in spazio armonico

- Lavori in corso
- Risultati preliminari da mostrare a UHECR 2024

(Marta Bianciotto, AdM)

Ricerca di eccessi lungo il SGP e follow-up Telescope Array

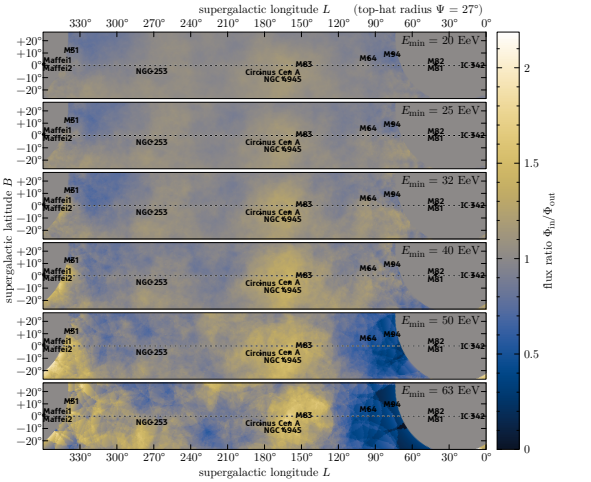


esposizione Auger in queste regioni confrontabile a quella TA

(es. 0.84%×135k km^{2}sr yr vs 5.9%×18k km^{2}sr yr)

Spoiler:

non confermiamo gli hotspot visti da TA



Analisi dati LIDAR elastici

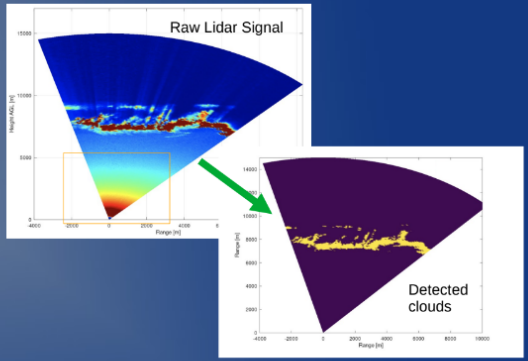
(Roberto Mussa)

Work in progress

Juan : multiangle analysis to produce vertical aerosol profiles starting from Rayleigh nights

RM+Arnone : comparison of cloud parameters with ERA5 archives (25 km grids)

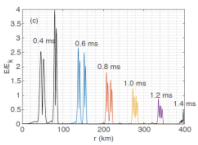
RM+Perrone: compare old vs new lidar cloud DB on event selection



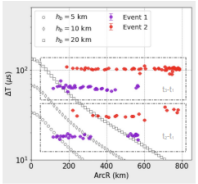
ELVES multipli e aloni

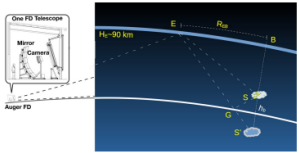
(Roberto Mussa, Enrico Arnone)

Triple elves: observation vs models



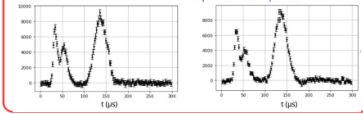
Terrestrial Gamma ray Flashes (TGF,[15]) prove that thunderstorms can accelerate electrons at relativistic energies. The correlation between TGFs and ELVES has been established [20,21] by ASIM in 2019, but it is still unclear whether specific details of ELVES light waveforms can be associated to TGF generation. Triple and even quadruple elves have been suggested as possible signatures [22]: if the source of the EM pulse is at the top of high clouds (i.e. above 10 km), a mirror image which is reflected at the ground should be resolved.





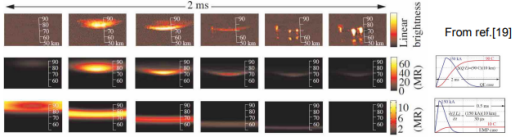
The time resolution of Auger FD can be exploited to detect multiple flashes and study the dependence of the time gap on the emission point E. The distribution of time gaps t_2-t_1 and t_3-t_1 for all the pixels in two events is shown in the left figure. If the second flash were due to ground reflection, the smaller time gaps should have decreased with ArcR as one of the three curves, depending on the height h_b(here 5,10,20km).

EVT1272074855-73362500 ~ 46 pixels with 3 peaks

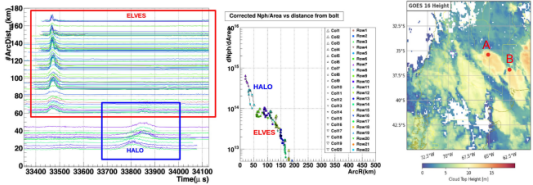


Examples of the triple peak structure, as seen in two pixels, are shown in the traces on the left for the event occurring at GPS time 1272074855.

Halos: observation vs models

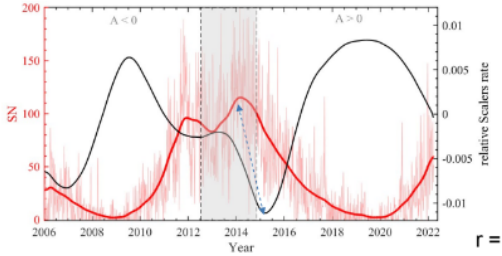


Since 2017, the ELVES triggers in Auger are acquired with trace lengths up to 900 us, in order to study the full region of maximum emission around the vertical of the lightning source. This allowed to detect other phenomena which are correlated with ELVES, such as halos. Halos are created by the quasi static component [19] of the EM pulse which produce the ELVES, at heights around 80 km. Halos are typically brighter than ELVES and have diameters around 80km. Halos are 10 times less frequent than ELVES, according to the ISUAL three years dataset from space [24]. Halos are often followed by sprites, when the originating lightning leader has positive charge.



Traces from the ELVES and the subsequent halo are sorted with arc distance respect the vertical of the lightning source. Halos are observed in the region of sky at the center of the ELVES ring. The event shown on the left (A) has been followed, 65 s after, by another ELVES+halo pair (B), originating from the top of another thunderstorm, as shown from GOES-16 satellite images.

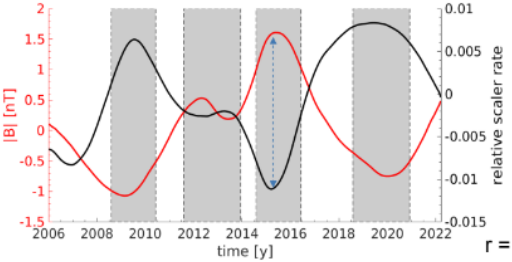
SCALER DATA AND SUNSPOT NUMBER: DECADAL CYCLE



r = -0.62

general agreement

scalers delay of ~1-year
in the period 2014-2015



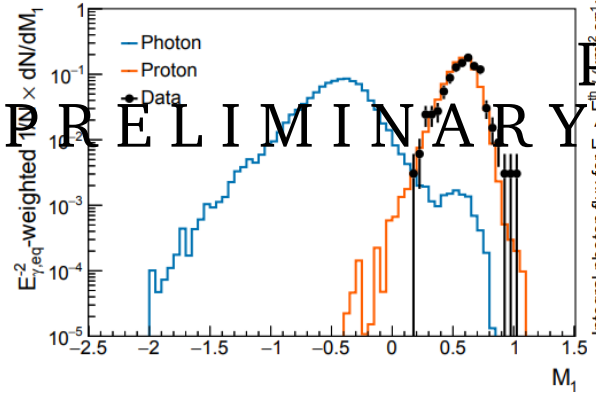
r = -0.65

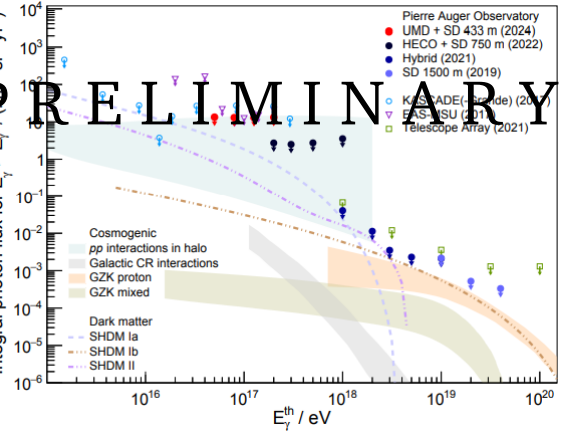
The high delay in the Auger scaler's response to the sunspot number maximum occurring at the beginning of 2014 disappears using SMF intensity as solar activity proxy

|B| is a better marker for solar activity than sunpot number

(Carla Taricco, Enrico Arnone, Roberto Mussa)

Ricerca di fotoni nei dati SD-433 + UMD

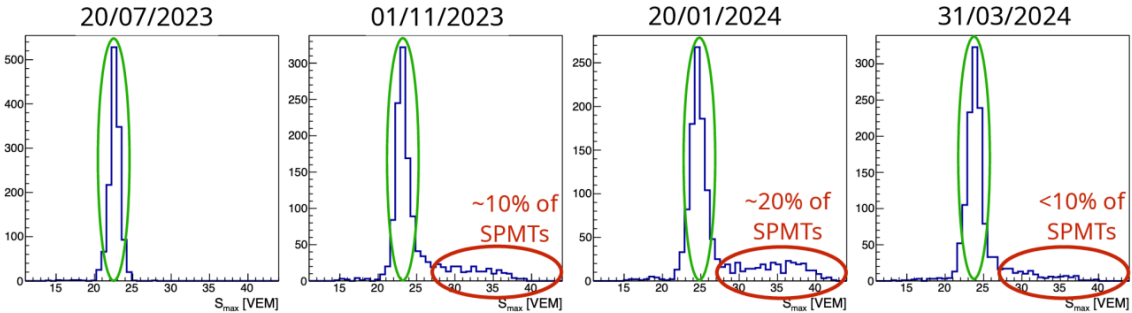




Coming soon!

(Nicolás Martín González (in visita da ITeDA))

Estensione del range dinamico con small PMTs



Richieste finanziarie 2025

Capitolo	Descrizione	Parziali (k€)	
		Richieste	SJ
apparati	100 alte tensioni SensTech (da 200 euro l'una) di ricambio per i large PMT dei rivelatori di superficie Auger	0.00	20.00
consumo	Condensatori (10 nF, 3 kV; 22 nF, 1kV; 2.1 muF, 100V) di ricambio per le basi dei large PMT dei rivelatori di superficie Auger	6.00	0.00
	Minuteria ottica e elettronica di ricambio per manutenzione LIDAR elastici	2.00	0.00
missioni	attivita` dello spokesperson (Antonella Castellina): Project Management, Finance Board e mobilita`	20.00	0.00
	meeting del responsabile locale con i referee	0.50	0.00
	turni di test e manutenzione degli small PMT dell'upgrade AugerPrime (2 turni di 2 tecnici ciascuno)	16.00	0.00
	turni di manutenzione dei 5000 large PMT dei rivelatori di superficie Auger (2 turni di 2 tecnici ciascuno)	16.00	0.00
	meeting di collaborazione a Malargue: 2 meeting (marzo 2025, novembre 2025) x 3 persone (spokesperson + 2 responsabili di task)	18.00	0.00

Richieste finanziarie 2025

	meeting di collaborazione a L'Aquila (maggio 2025) x 4 persone (spokesperson + 3 responsabili di task)	4.00	0.00
	meeting di analisi in Europa: 1 persona a Parigi per cosmo-geofisica	1.50	0.00
	Turni di presa dati FD a Malargue (due turni, una persona per turno)	8.00	0.00
	Turno di manutenzione e allineamento LIDAR elastici a Malargue (una persona)	3.00	0.00
trasporti	Trasporti nel sito sperimentale per il turno presa dati FD	2.00	0.00
	Trasporti nel sito sperimentale per la manutenzione dei LIDAR elastici	2.00	0.00
	Trasporti nel sito sperimentale per i turni di manutenzione dei large PMT	2.00	0.00
	Trasporti nel sito sperimentale per i turni di test/manutenzione degli small PMT di AugerPrime	2.00	0.00
	invio a Malargue delle alte tensioni SensTech riparate a Torino	1.50	0.00