L'Observatoire Pierre Auger: Le Détecteur

Carla Macolino for the Auger group

Biennale du LPNHE
Beg Meil 20.09.2011
(Beg Meil en eté....pas de mer sur le site Auger!!)

The Auger group at LPNHE

- Permanent staff:
  - Julien Aublin: MdC
  - Pierre Billoir: Professeur Emerite
  - Piera Ghia: DR2
  - **Antoine Letessier-Selvon**: DR2
- Post-docs:
  - Carla Macolino (up to 11/12)
  - Ioana Mariș (up to 11/12)
- Stagiares:
  - Elie Thiery
- Informatics:
  - Richard Randriatoamanana
- PhD students:
  - Romain Gaïor (up to 09/13)
  - Moritz Münchmeyer (up to 09/12)
  - Hugo Rivera (4 months cotutèlle from Milano)
  - Silvia Gambetta (just went back to Genova)
- Technical staff:
  - Jacques David
  - Hervé Lebbolo

Many responsabilities in the Auger Collaboration:

- Julien Aublin: Anisotropy task leader
- Piera Ghia: Chair of the Publication Committee
- Antoine Letessier-Selvon: Analysis task leader
- Ioana Mariș: SD Reconstruction task leader
- Richard Randria: PC website webmaster

Outline

Research activity of the Auger group at LPNHE

Activities on the detector (in this talk):

- Detector Monitoring
- Detector Performances and Improvement
- SD and Infill Reconstruction

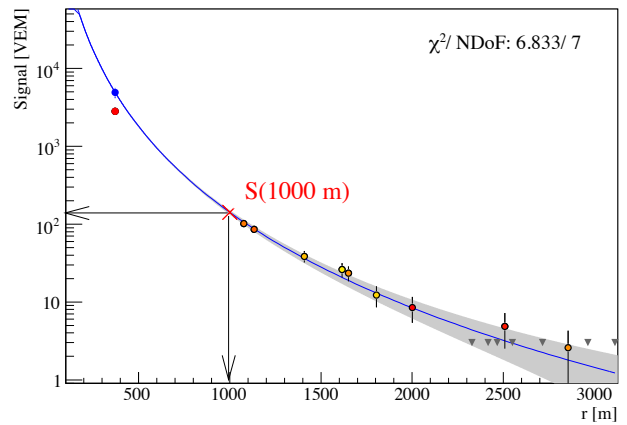
Other talks on the Auger group activities will follow:

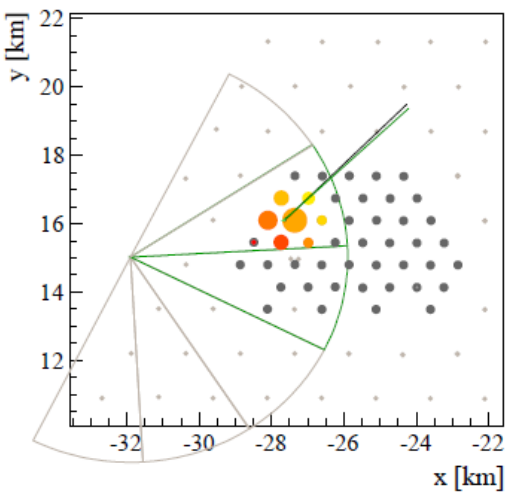
- Moritz Münchmeyer "Les analyses des donnés"
- Ioana Mariș "Les R&D radio: projects et résultats"
- Hervé Lebbolo "Les R&D radio: l'Electronique"

- **FD shifts**: Carla Macolino, Ioana Mariș, Moritz Münchmeyer for the last 2 years

The Surface Detector and Infill Array

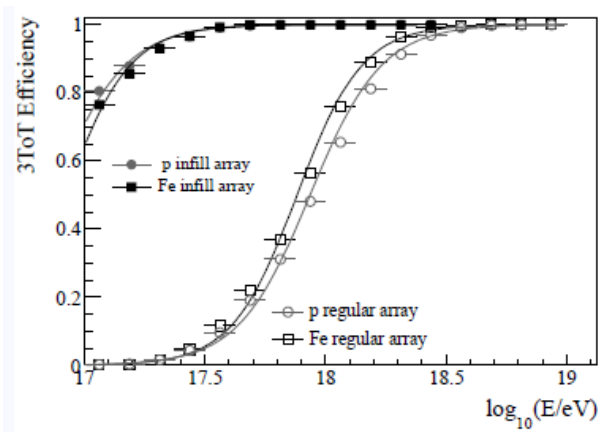
- 1680 tanks on a hexagonal grid
- Ultra-reflective tyvek liner
- GPS antenna, Comm. antenna
- Autonomous power supply (solar panel)
- 12000 l of distilled water
- 3 phototubes (Photonis XP1802)





Infill array

- 750m spacing w.r.t. 1.5Km
- 61 stations
- acceptance (26±1) Km^2 sr yr



Detector Monitoring

Observatory Monitoring for the detector online monitoring

CDAS

Pm	IkServer	Xb	Eb	Mr	Fd	Rc

SD

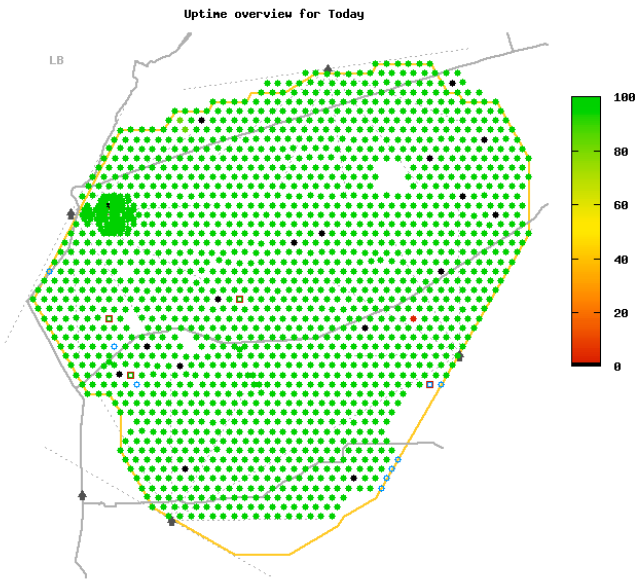
T2 Activity	Triggers	Black Tanks	Alarms	Deployment
In the last 20 minutes : Efficiency = 99.56 % - <LS> = 1622. In the last 24h : Efficiency = 99.44 % - <LS> = 1618. Maximum Number of LS ever seen : 1630 (last seen 3 days ago)	Last event : 23 minutes ago. Last hour : 3002 events (50.03 evts/min). Last 24h : 8410 events (5.84 evts/min).	15 black tanks	721 LS fired an alarm. 721 LS still in alarm. 508 LS not in masked alarms list.	1659 tanks deployed 1657 tanks with water 1648 tanks with electronics

FD Summary

Building	Last RUN started	RUN Id	RUN State	Status	NT2	NT3	Last Error Message (12 hrs)	occurred at UTC
Los Leones	2011-09-06 06:21:47	3819	stopped	ok	3201	198	None	---
Los Morados	2011-09-06 06:53:19	3264	stopped	ok	2229	161	None	---
Loma Amarilla	2011-09-06 07:58:48	1810	stopped	ok	1110	103	None	---
Coihueco	2011-09-06 06:17:31	4137	stopped	ok	3177	209	None	---
HEAT	2011-09-06 06:17:55	767	stopped	ok	4577	409	None	---

Weather Conditions

Weather Station	Time (UTC)	Elapsed Minutes	Temperature	WindSpeed	Humidity
LosLeones	2011-09-16 01:40:00	848	18.50 °C	5.37 km/hr	8.32
CLF	2011-09-16 01:35:00	853	19.14 °C	24.20 km/hr	9.59
Coihueco	2011-09-15 06:35:00	1993	10.15 °C	16.02 km/hr	32.90



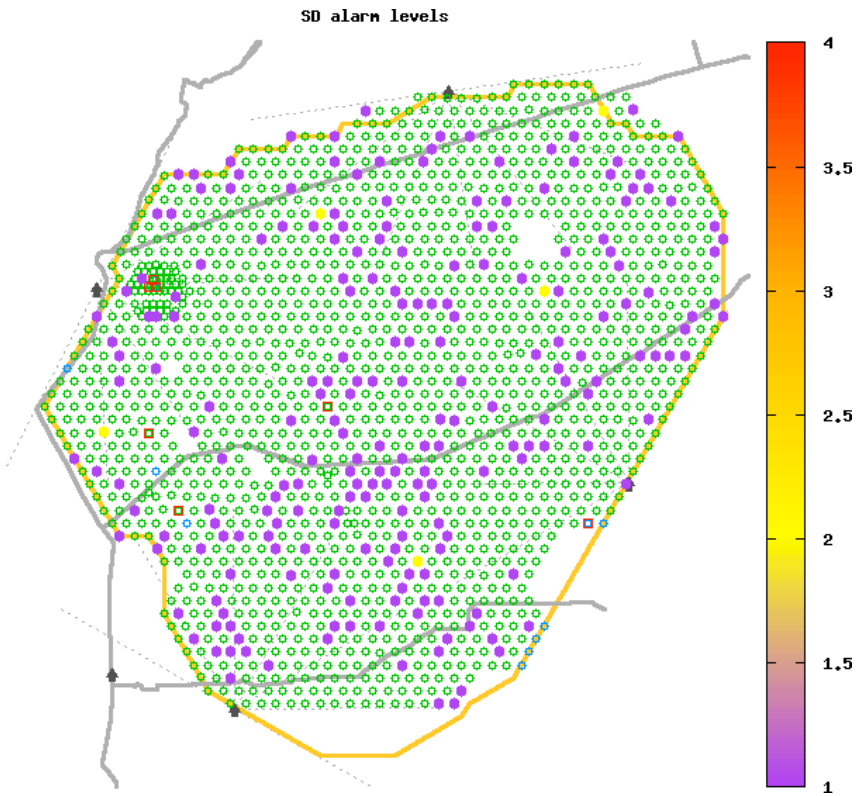
- PMT commissioning + monitoring
  - 95% of working PMTs
  - new and repaired PMTs commissioning

Detector Monitoring

Monitoring of Local Station alarms

- Algorithms to monitor local stations alarms, e.g.:
  - unstable PMT baseline
  - unstable a/d ratio
  - unstable Area over Peak
  - Battery discharging
  - etc., etc.
- Systematic study of the alarm rates:

  e.g. now 227 stations with 1 broken PMT and 5 with 2 broken PMTs
- 100, 150 repaired PMT per year

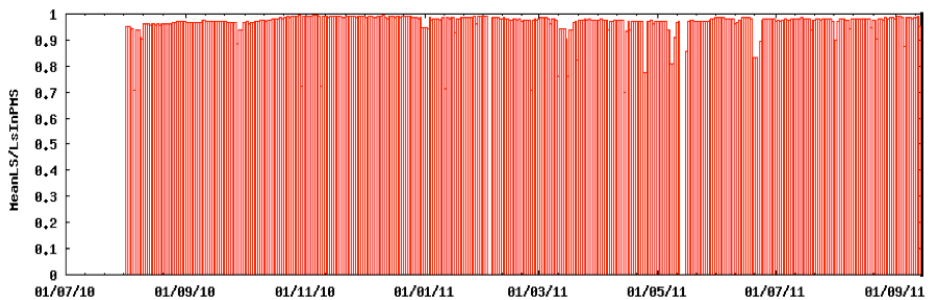


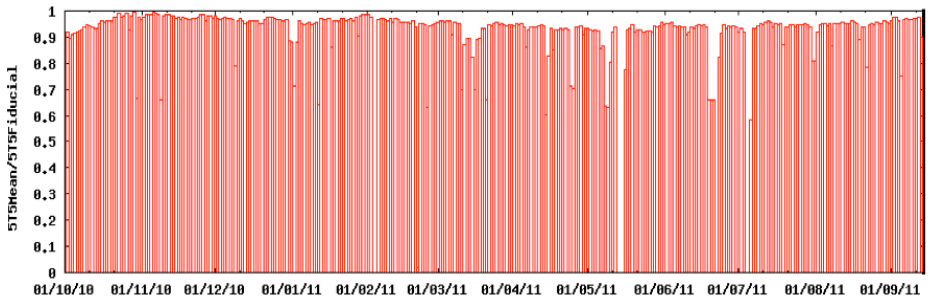
Detector Monitoring

Acceptance: number of active hexagons vs. time

Metrics to estimate the SD efficiency factor

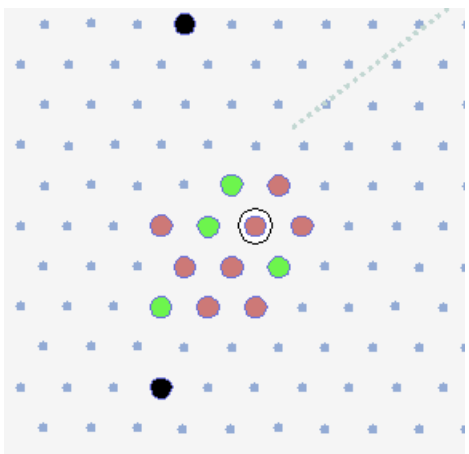
- Relative to nominal number of tanks
- Relative to nominal acceptance





Calculation of the SD acceptance uncertainty due to:

- Active tank not participating to the trigger
- Not-active tank participating to the trigger
- Tank participating to the trigger but data not sent to CDAS



Detector Performance and Improvement

Improvement of the SD local trigger for low-energy showers

TOTd = deconvolution of the trace

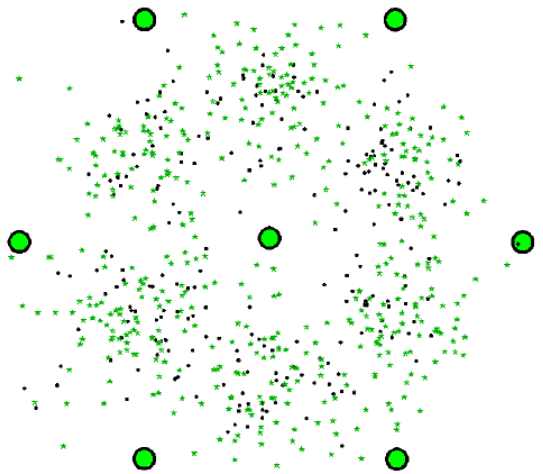
$A'_i = (A_i - fA_{i-1})/(1-f)$ with $f = \exp(-25/\tau)$

so that

- Background appears as one or two slots with high amplitude
- Real EAS signal appears as a long sequence of short peaks (> 25 ns)

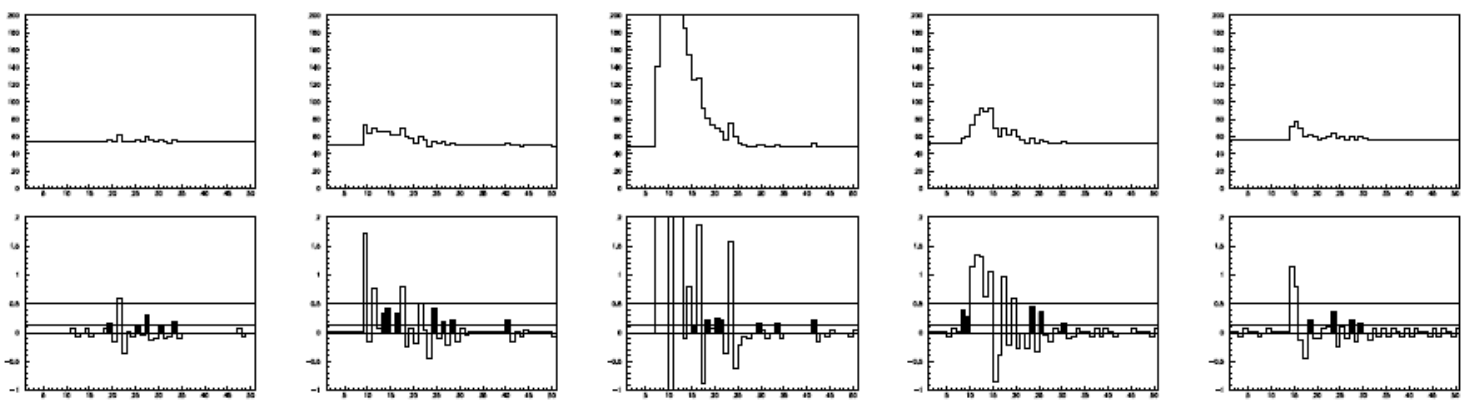
$\rightarrow$ gain of triggered stations for low-energy events (about a factor 2)

$\rightarrow$ better rejection of the background

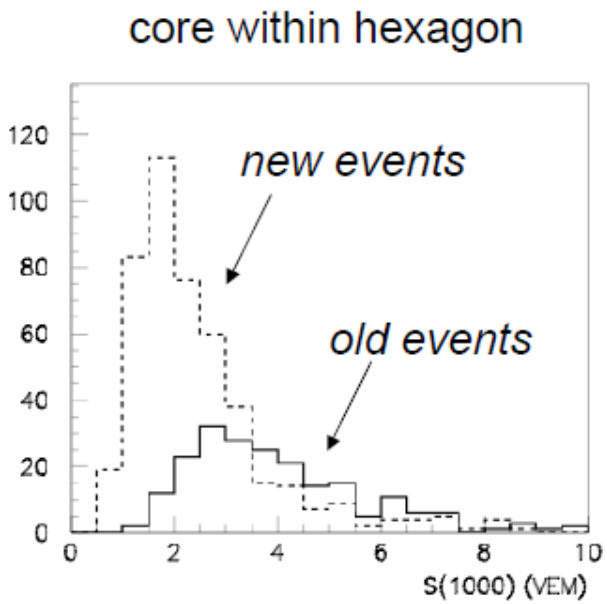


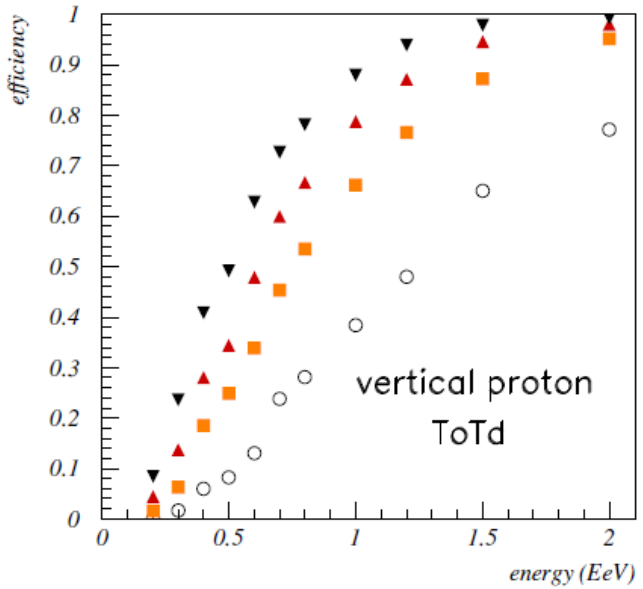
black points:
cores of "standard triggered" events (3ToT)

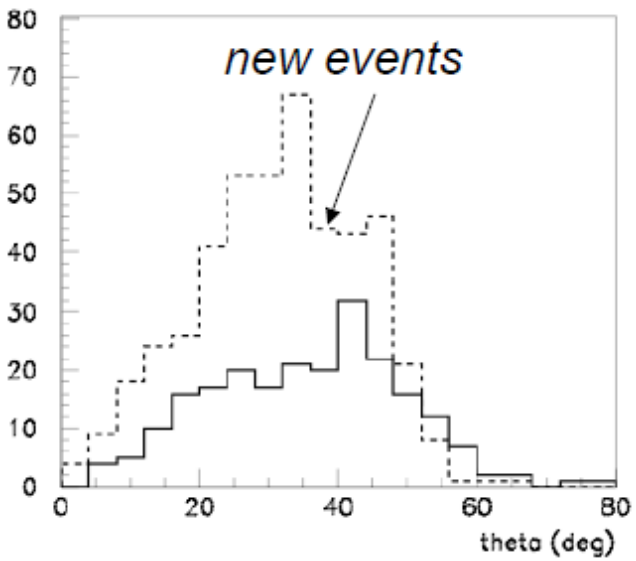
green stars:
events gained
(about twice as standard ones)
nToT+(3-n)ToTd

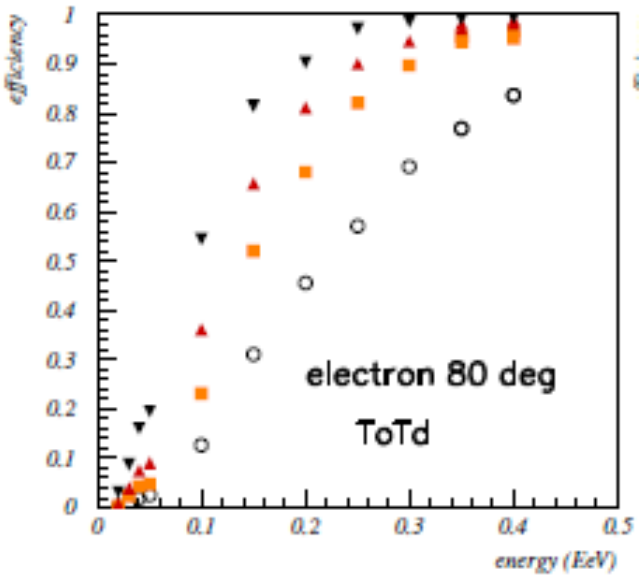


Detector Performance and Improvement









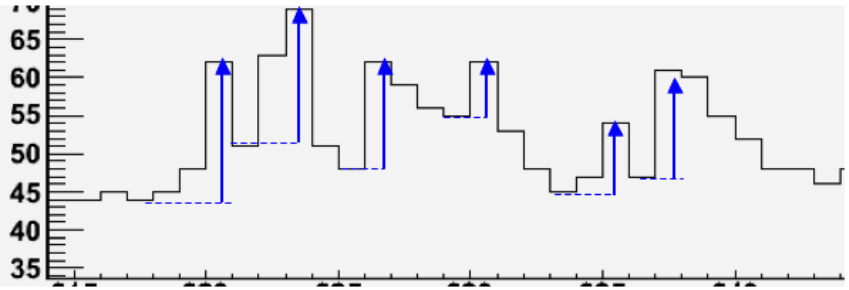
- Gain in low signal around 1 to 3 VEM
- Threshold lowered by a factor of 2

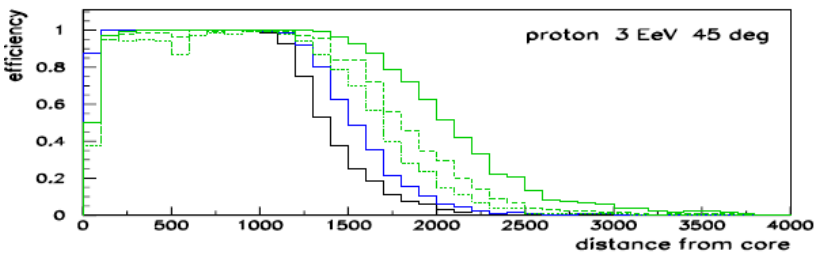
- Slight preference for low theta
- Neutrino sensitivity enhanced below 0.1 EeV

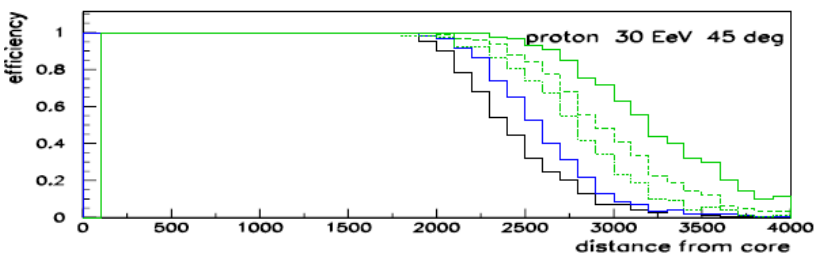
Detector Performance and Improvement

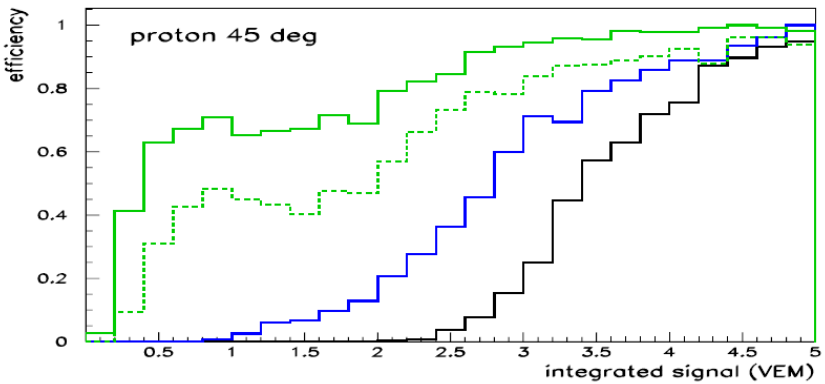
An alternative trigger: MOPS (Multiplicity of Positive Steps)
Much less sensitive to a possible distortion due to the electronic chain
Better efficiency:

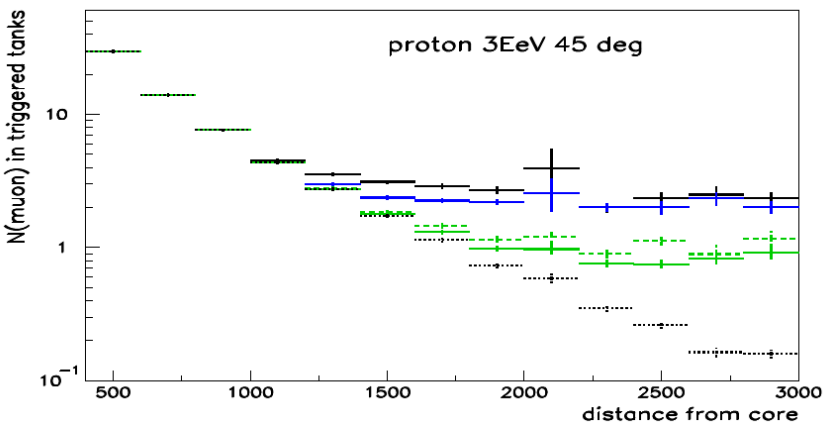
- Lower saturation energy for the trigger efficiency
- Better efficiency at large distance to the core
- A suppression of the trigger bias in favour of muon rich tanks





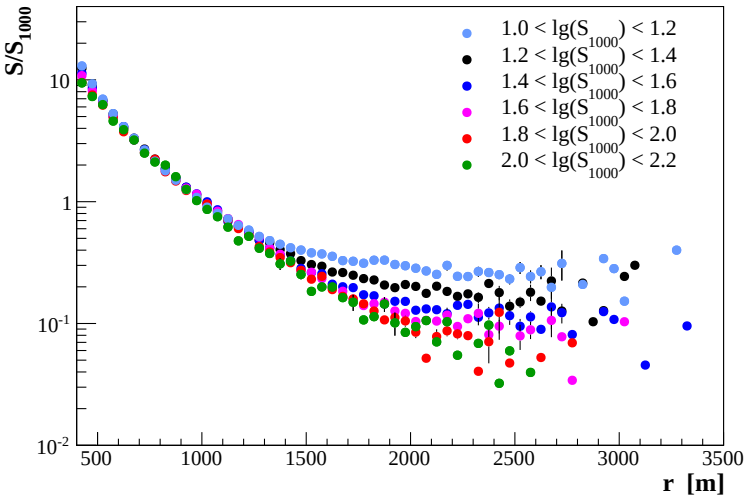


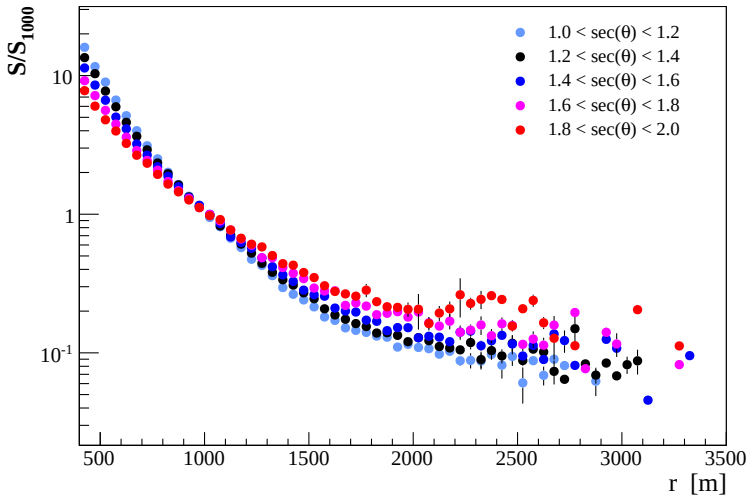




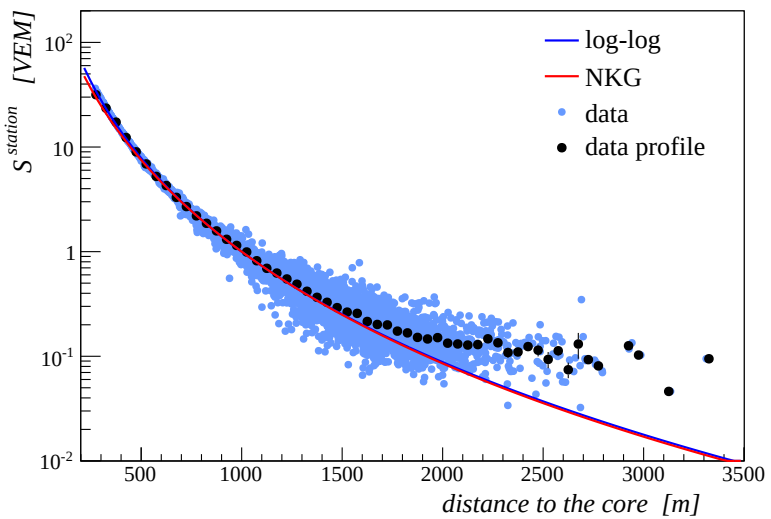
SD reconstruction

SD Data reconstruction: the LDF (**blue**Lateral Distribution Function)
Method to retrieve the LDF from the merging of all SD stations:
Iterative unbinned likelihood fit with real data





- Find the dependency on θ and energy
- Consider two different forms of LDF
- 3% bias

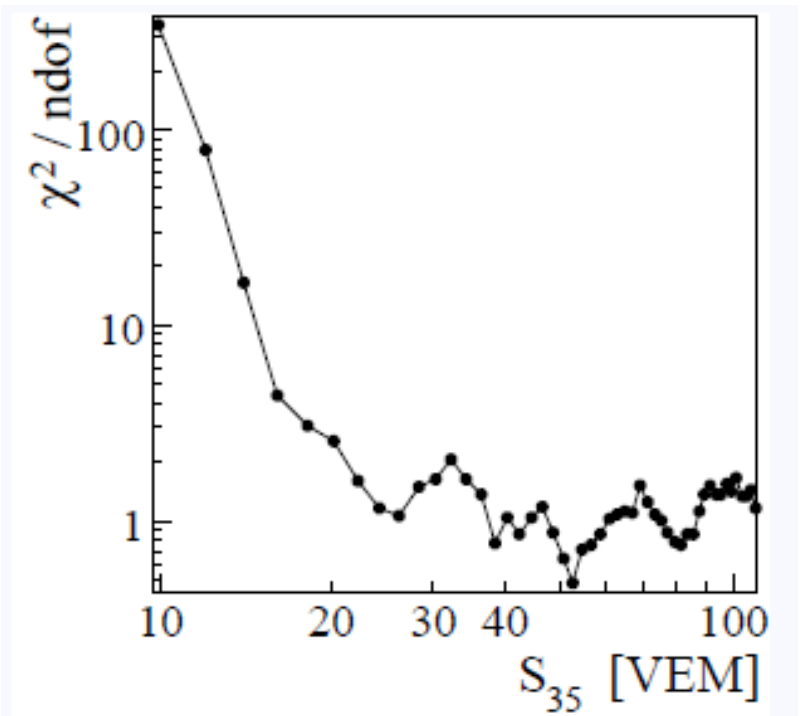


SD reconstruction

Infill data reconstruction

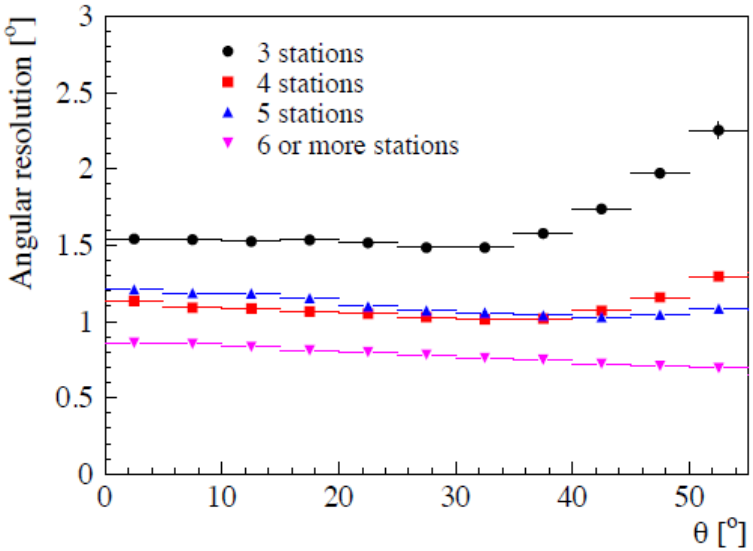
Retrieved from the CDAS reconstruction for the standard array (also developed in LPNHE in the previous years)

- Acceptance from real data
- 100% flat distribution in cos(θ) at about 20 VEM (E $\simeq 3\times10^{17}$ eV)



Angular resolution

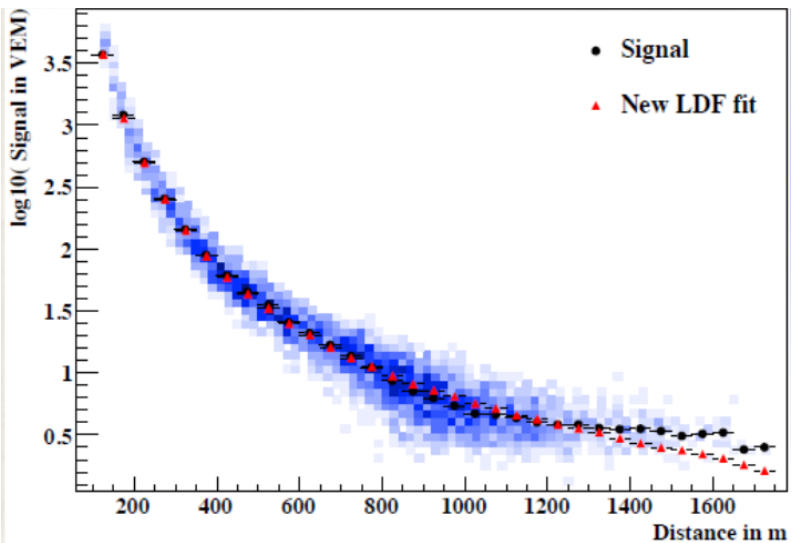
- Given by the fit uncertainties
- Better than 1° for more than 5 stations (E $\simeq 3\times10^{17}$ eV)

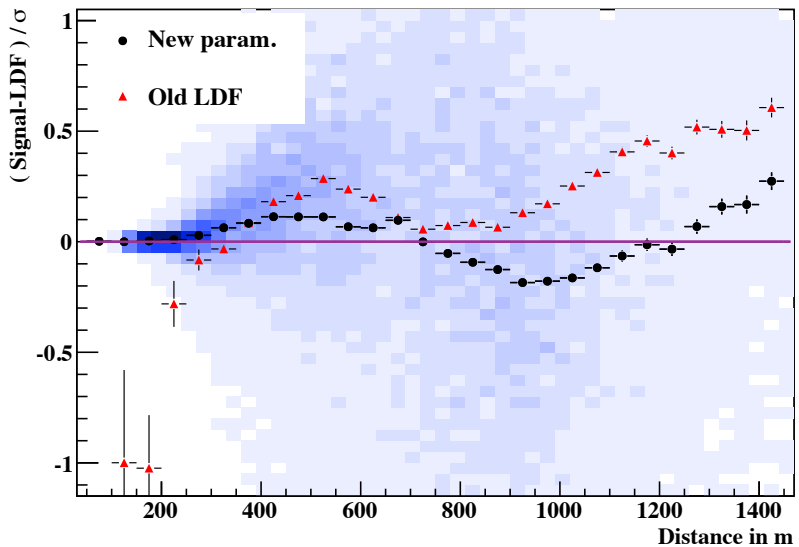


SD reconstruction

Infill data reconstruction

Lateral Distribution Function estimated from real events:





- Important contributions for the Infill spectrum shown at ICRC 2011
- Code applied for anisotropy searches

Conclusions and Future Perspectives

- Detector Monitoring: improvement of the systematic monitoring tools to ameliorate the detector maintanance
- Detector Performance improvement: optimize and apply the new triggers all over the detector
- SD reconstruction:
  - optimize the reconstructed parameters using higher statistics
  - full infill reconstruction

Merci pour votre attention!