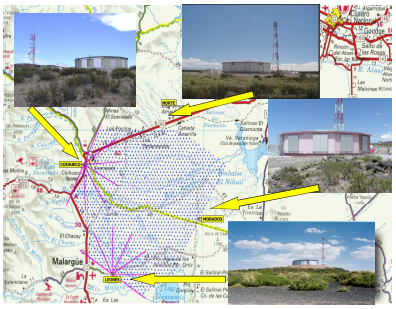
The Pierre Auger Observatory and Grid Computing

Pierre Auger Observatory

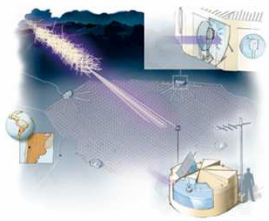
- The largest Cosmic Rays Observatory
  - 3 000 km² – in the Argentina Pampa
  - 1 600 Surface Detectors (Cherenkov)
  - 4 + 1 Fluorescence Telescopes
    - 6 x 5 Fluorescence Cameras
    - 10 % of the time (night – no moon)
  - Hybrid Events : SD + FD
    - Better determination of the energy
- High Energy Cosmic Ray
  - Energy 10^{20}
  - 1 / km² / century
  - Expected hybrid events: 10 per year
- Pierre Auger Observatory
  - Experimental Array : 2001-2004
  - Production Area : 2004
    - Full production : 2006
    - Inauguration in 2008



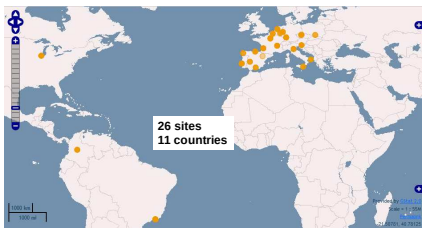
Cosmic Ray Showers

When a cosmic ray particle reaches the Earth, it collides with a nucleus high in the atmosphere, producing many secondary particles, which share the original primary particle's energy. The secondary particles subsequently collide with other nuclei in the atmosphere, creating a new generation of energetic particles that continue the process, multiplying the total number of particles. The resulting particle cascade, called "an extensive air shower," arrives at ground level with billions of energetic particles extending over a large area.

Simulations of Ultra High Energy Cosmic Ray Showers is a CPU intensive task and produces large outputs. Showers are independent, parallelization is trivial. Many independent simulation jobs can be run.



Worldwide collaboration



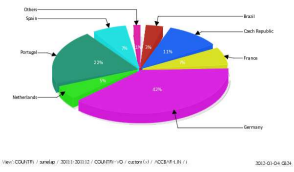
More than 500 scientists from 94 institutions from 19 countries

VO *auger* established in 2006 by the Prague group (CESNET and FZU)

Sites supporting the VO *auger* (Computing Elements)

Bulk Production on the Grid

Total elapsed time per country, statistics for 2011.



Many sites from several countries contribute to the total computing capacity available for the Pierre Auger Observatory.

MC simulations jobs are run by a **dedicated team** started in Prague, since 2009 moved to Granada team. Individual users may use the same resources

Grid is used only for the large scale MC production of cosmic ray showers with different models and parameters.

VO *auger* in Top Ten

TOP10 VOs January 2011 - December 2011

The following table shows the distribution of Total elapsed time grouped by VO and DATE (only information about **TOP 10 -ordered by CPU time- VOs** is returned).

Total elapsed time [wall] Hours by VO and DATE

VO	Jan 11	Feb 11	Mar 11	Apr 11	May 11	Jun 11	Jul 11	Aug 11	Sep 11	Oct 11	Nov 11	Dec 11	Total	%
alice	11,582,034	14,797,020	13,769,700	16,830,075	8,668,762	19,001,988	20,705,194	26,405,489	21,699,446	19,910,407	22,052,152	9,942,310	**204,964,577**	**14.59%**
atlas	50,891,437	49,091,420	47,103,255	44,521,518	54,045,840	62,895,500	68,956,107	53,721,409	64,764,585	67,196,507	65,990,437	32,796,555	**661,776,541**	**47.36%**
auger	861,772	1,285,847	1,794,425	1,527,831	1,810,718	1,845,510	1,458,992	1,821,581	1,253,848	1,820,343	738,977	627,963	**17,047,407**	**1.22%**
biomed	1,801,028	1,457,409	1,170,359	754,786	1,301,942	353,686	358,996	186,572	329,571	611,877	429,939	232,855	**8,997,639**	**0.64%**
cms	26,532,939	14,011,464	23,680,862	28,875,996	33,615,845	29,240,016	33,979,830	36,074,369	34,578,005	40,060,292	40,916,872	20,749,216	**362,314,905**	**25.90%**
compchem	472,746	1,332,250	649,066	1,866,343	835,368	902,299	571,997	437,091	228,391	139,848	309,530	129,642	**7,773,561**	**0.56%**
dteam	718,326	730,449	914,201	646,861	683,977	426,190	458,526	417,410	571,471	740,286	617,866	224,912	**7,040,363**	**0.50%**
ilc	675,327	466,149	425,870	416,692	592,079	923,154	1,613,379	2,132,573	264,477	205,176	315,980	70,214	**8,101,070**	**0.58%**
lhcb	13,948,267	13,994,479	9,662,592	10,354,957	13,571,275	9,014,881	7,890,565	7,420,585	10,715,424	9,625,468	4,978,829	1,955,502	**113,132,844**	**8.09%**
theophys	621,452	526,866	775,568	684,882	940,661	1,336,274	814,316	457,252	665,698	724,596	649,697	575,547	**8,772,598**	**0.63%**
Total	**108,105,348**	**97,693,042**	**99,953,668**	**106,678,938**	**115,966,457**	**125,739,417**	**136,807,900**	**127,874,331**	**135,070,977**	**141,033,800**	**136,300,169**	**67,306,666**	**1,399,130,705**	
Percentage	7.73%	6.98%	7.14%	7.62%	8.29%	8.99%	9.78%	9.14%	9.65%	10.08%	9.78%	4.81%		

VO *auger* is the biggest CPU consumer after the LHC VOs

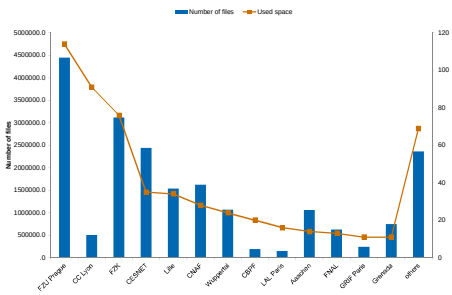
Source: EGI Accounting Portal

Physics Results

Front page of Science for the paper about anizotropy

Already 35 papers published with significant impact

Data Management



Total:

> 20 million files

> .5 PB

Acknowledgements

EGI.eu Grid Infrastructure enables access to many resources in a unified way. This environment offers the Pierre Auger Observatory a capacity required for cosmic ray showers simulations.

We thank to all sites and their administrators for supporting the VO *auger*.

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