IceTop status: 2007

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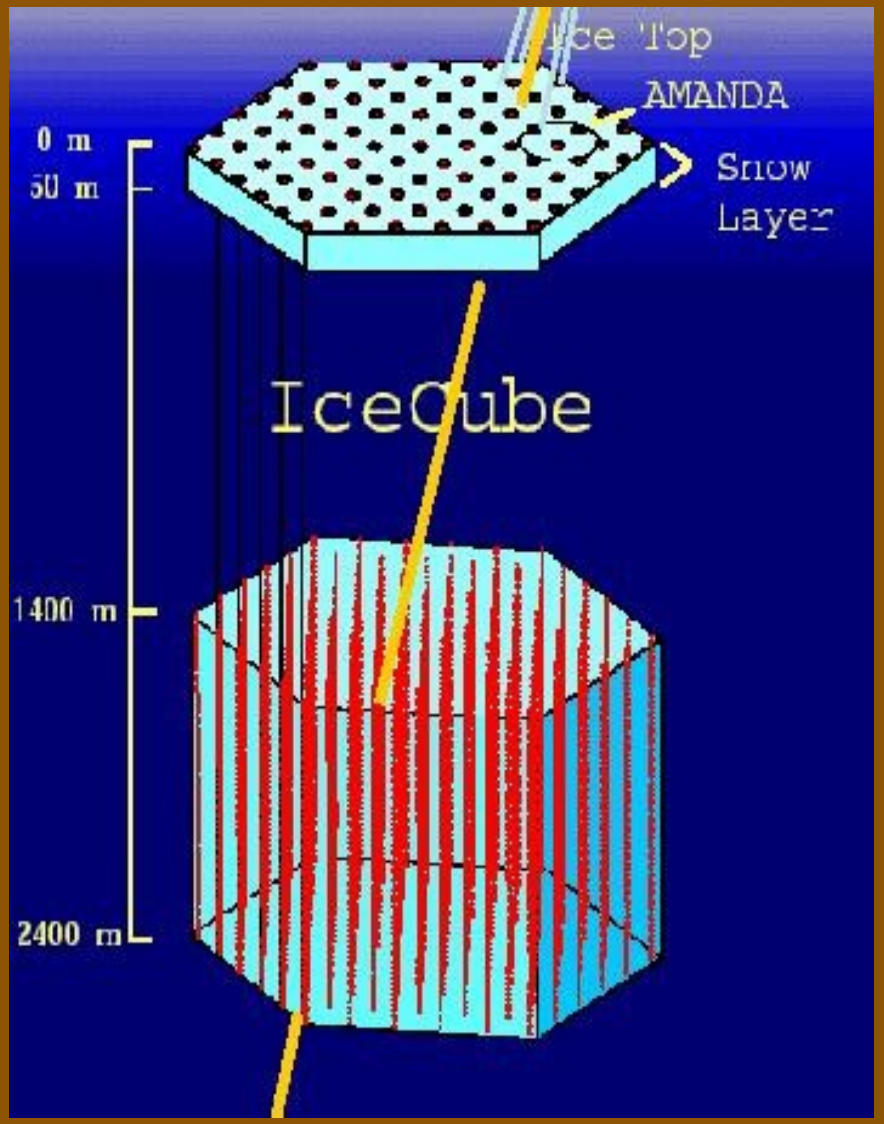
- What is IceTop ?
- Why is IceTop being built ?
- How is IceTop working ?
- When shall we have real physics results ?

IceTop is the surface air shower array that is going to complement the IceCube neutrino telescope at the South Pole.



IceTop will have 80 stations at average distance of 125 m from each other. The total surface area is 1 km^2. Each station is deployed at an IceCude hole. Stations consist of two frozen ice Cherenkov tanks. The tanks are viewed by two PMTs.

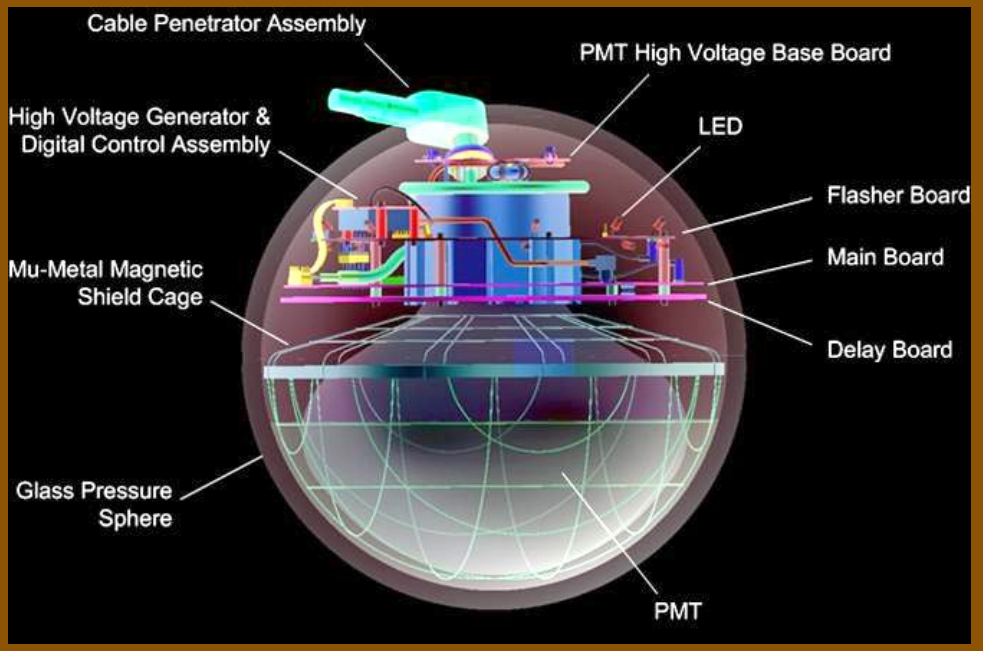
IceTop will

1) Inform IceCube about hits of small showers on the surface. One of the biggest backgrounds for IceCube are two independent single muons at different locations of the telescope that may be misreconstructed as a horizontal or upward going muon or shower signal.

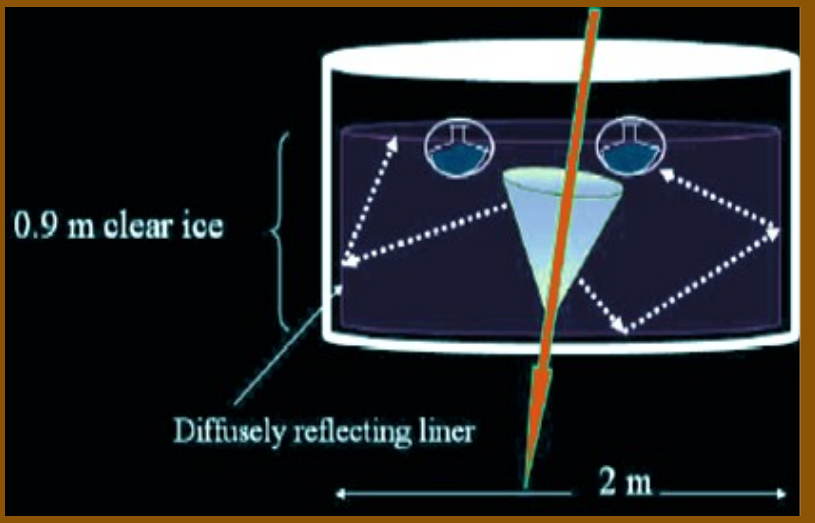
2) Veto events of large energy depositions inside IceCube when large showers are detected at the surface. IceTop will be able to cover a large fraction of the upper hemisphere at energies approaching 10^{17} eV.

3) Help determine the angular resultion of IceCube by coincidence detection of air showers and the ice quality determination. Already tested with SPASE2/AMANDA coincidences.

4) Study air showers around the `knee' and up to 10^{18} eV. It will be a powerful air shower array in this energy range. South Pole is at 700 g/cm^2.



IceTop uses the standard IceCube digital optical modules (DOMs) deployed in frozen tanks. PMTs are run on two different gains, high and low. Currently we have a dinamic range of more than four orders of magnitude.

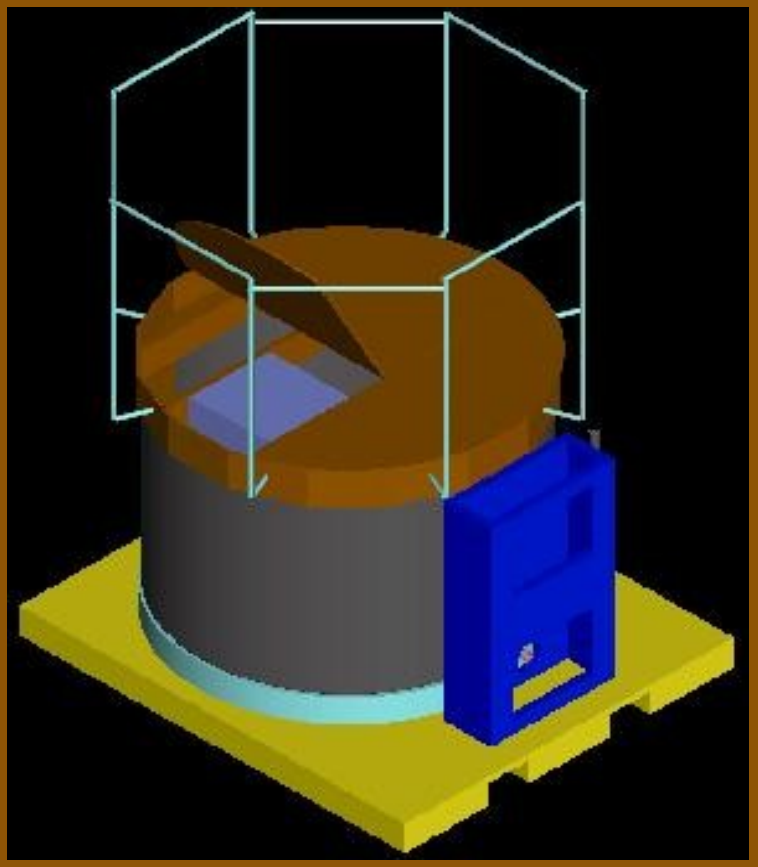


Achieving high quality ice is not trivial even at South Pole

IceTop frozen Cherenkov tank

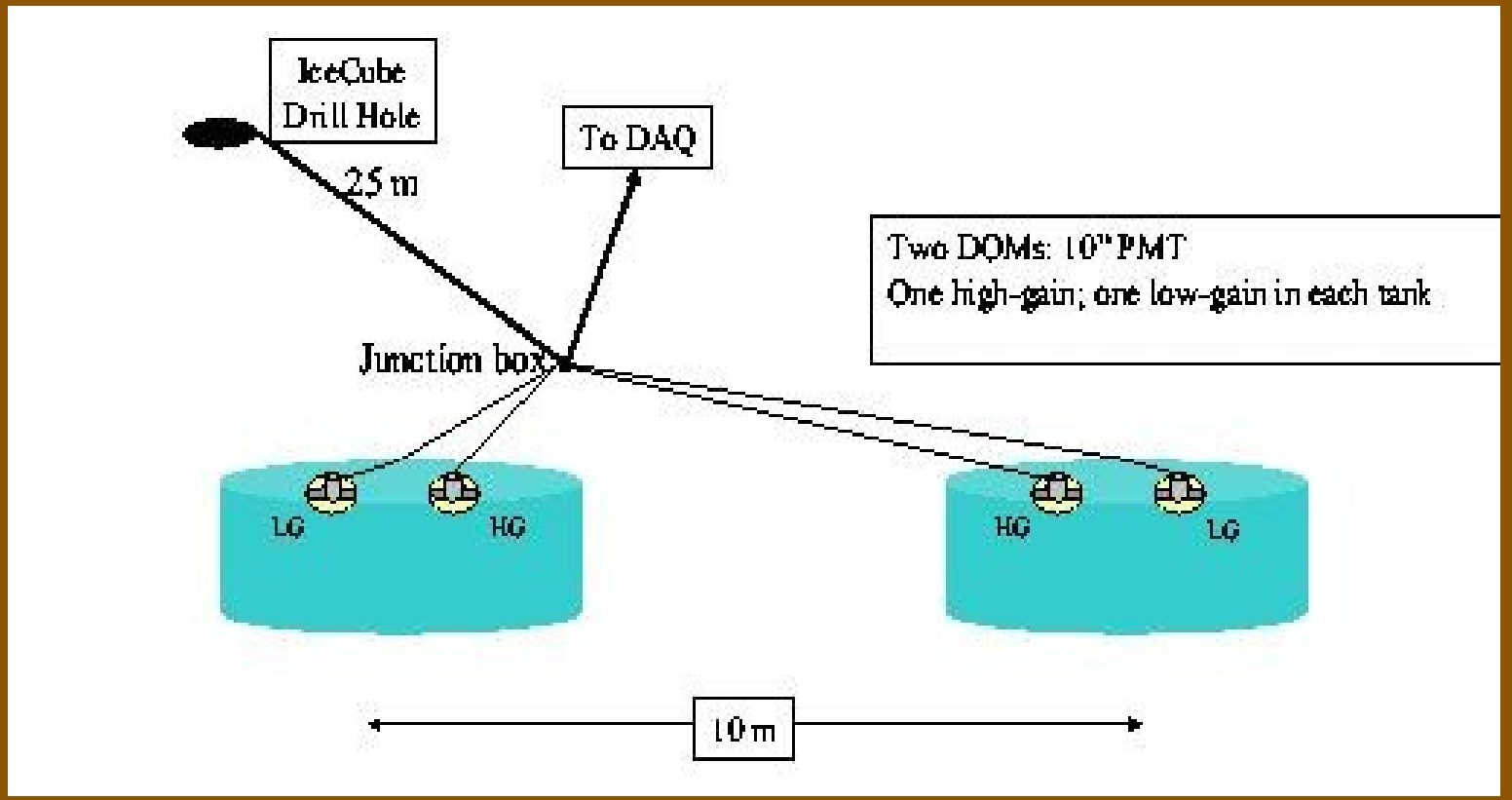
The ice quality in the tank has to be fairly good so the sensitivity to particle signals is uniform throughout the tank. A top-down freezing method was developed and tested in Delaware and used at South Pole.

High quality ice obtained in the laboratory at Bartol.



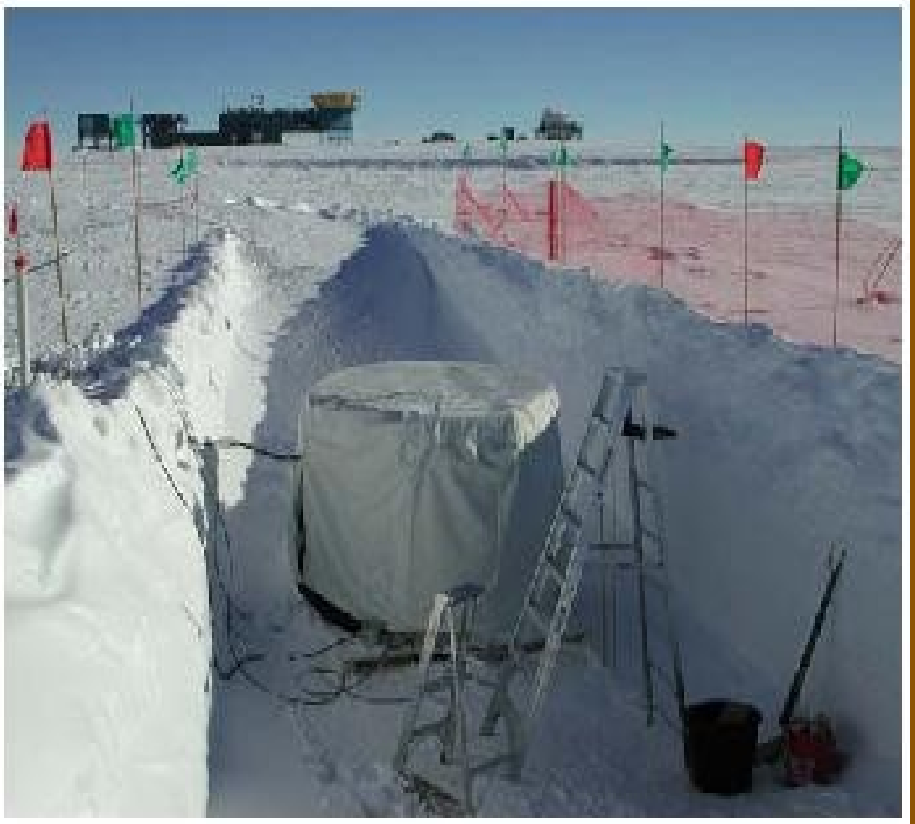
The tank design is shown with the freezing and control equipment on the side of the tank and the sunshade on top of the tank.

The IceTop stations are deployed approximately 25 m away from the IceCube holes, not to interfere with the hole drilling process. Ideally the tanks are 10 m apart from each other. The tank power supply and the DOM input/output cables are connected to a junction box that is common for the IceCube string and the IceTop station. Each tank has one `high gain' (5.E6) and one `low gain' (5.E5) to increase the dynamic range of the stations.



tanks are transported to their locations.

After cables are layed out to the tank location a trench is made for each tank. Trenches have to be oriented such that they are not filled with show. The tanks are transported to their positions and put in the trenches. Freezing equipment is attached and tested and the tanks are filled with clean water. The freezing equipment is switched on and the freezing process starts.



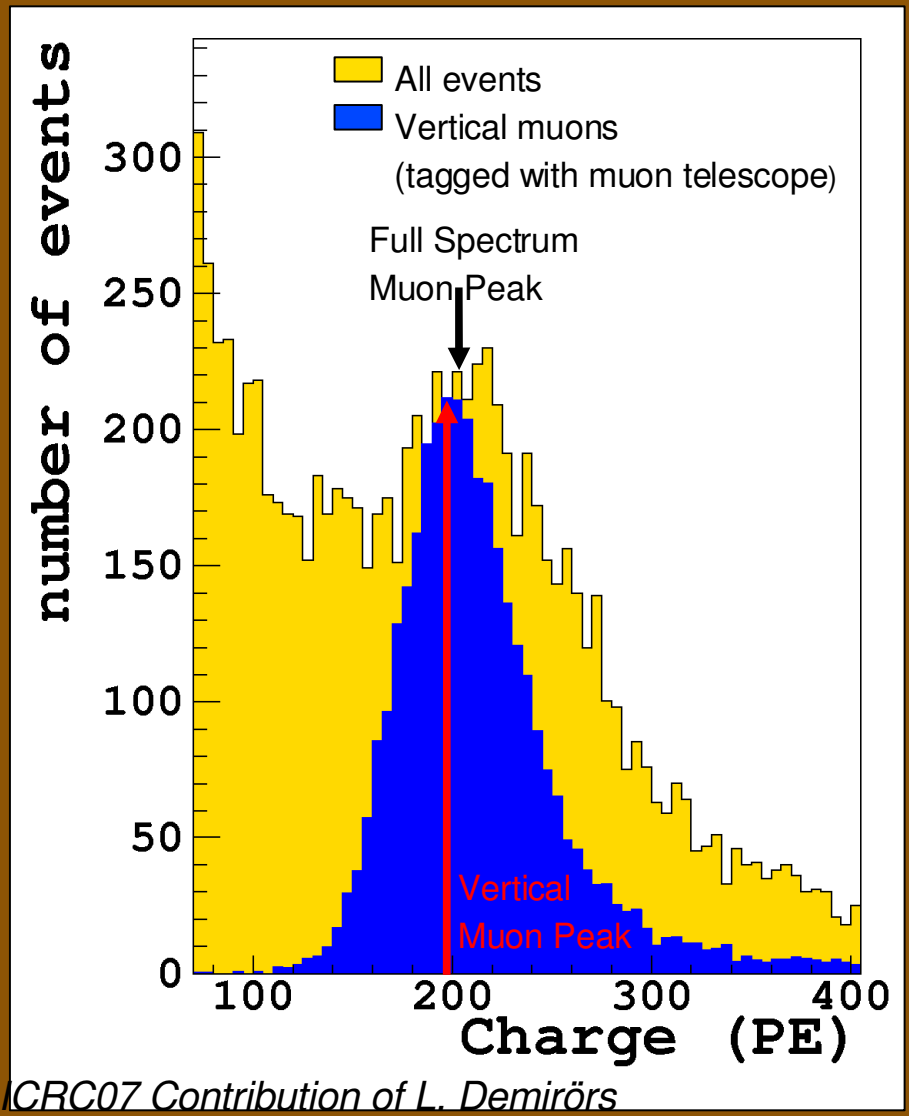
A tank is shown during freezing (left) and after close-up. Tank freezing at South Pole turns out to be a difficult job. A hat is employed as a sun shield during freezing to decrease the heat input. Tanks are well insulated on the sides and bottom. At close-up the tanks are also insulated at the top and the trench is filled with snow.

The two tanks at the end of the season, after the freezing equipment is disconnected. On top of the left hand tank is a muon telecope that is used for DOM/tank calibration. Positions of the tanks are well marked. We have to do that in the future to measure the amount of snow on top of the tanks.

CALIBRATION: DOMs return waveform in 64 time bins of 3.3ns each. The pedestals for each time bin and the offset are measured each week. There are three channels with different amplification: 16, 2, & 0.25.

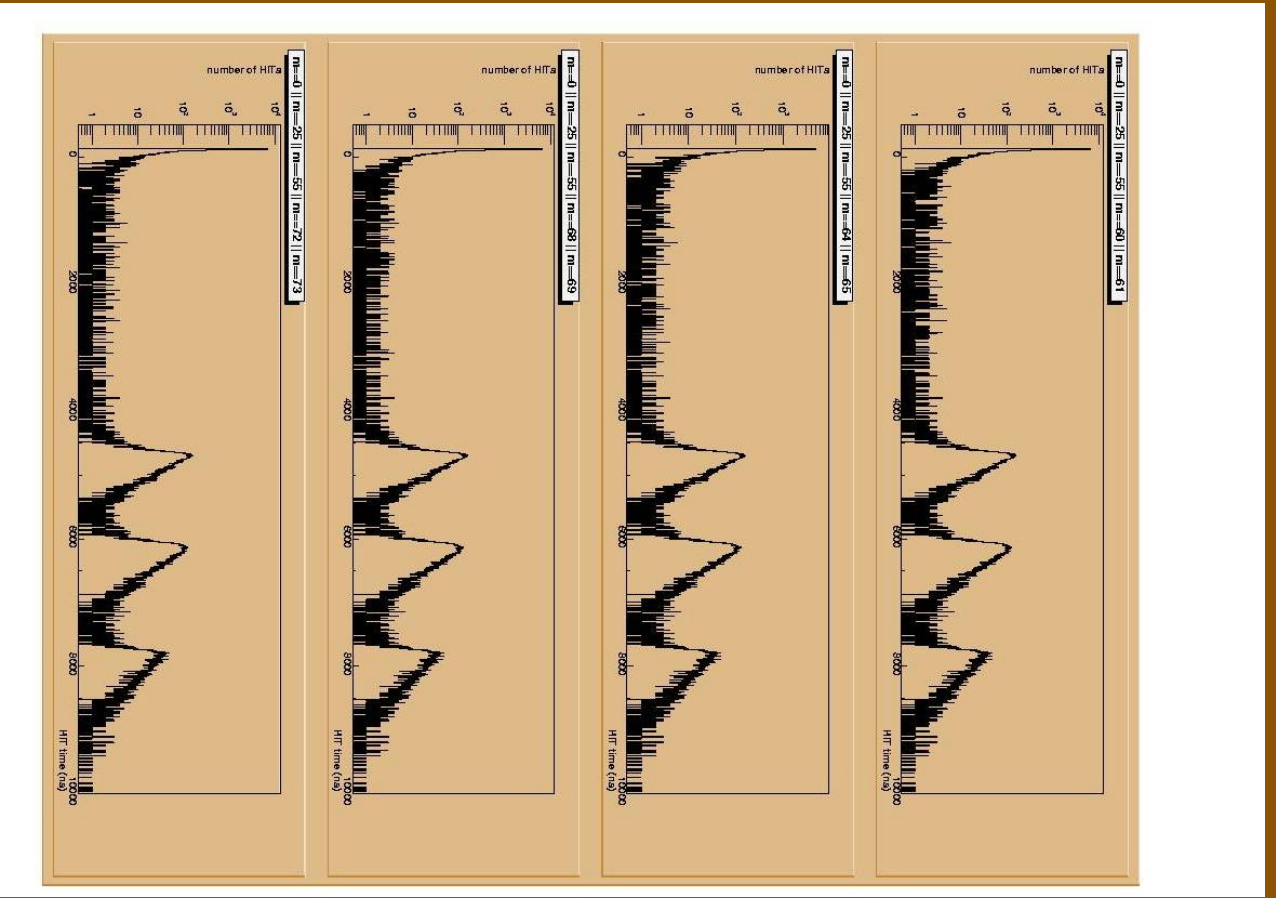
Once a week we have `muon runs' of duration 900 s. The DOMs report waveforms without any triggering. Muon peak is clearly visible.

1 pe = 0.8 MeV
1 VEM – 0.16 GeV in this tank



Coincidence timing test: comparison of time hits on the surface with string 21, DOMs 1, 25, 55.

depth meters	time μs
1450	4.8
1880	6.3
2390	7.9



Analysis of the 2007 data:

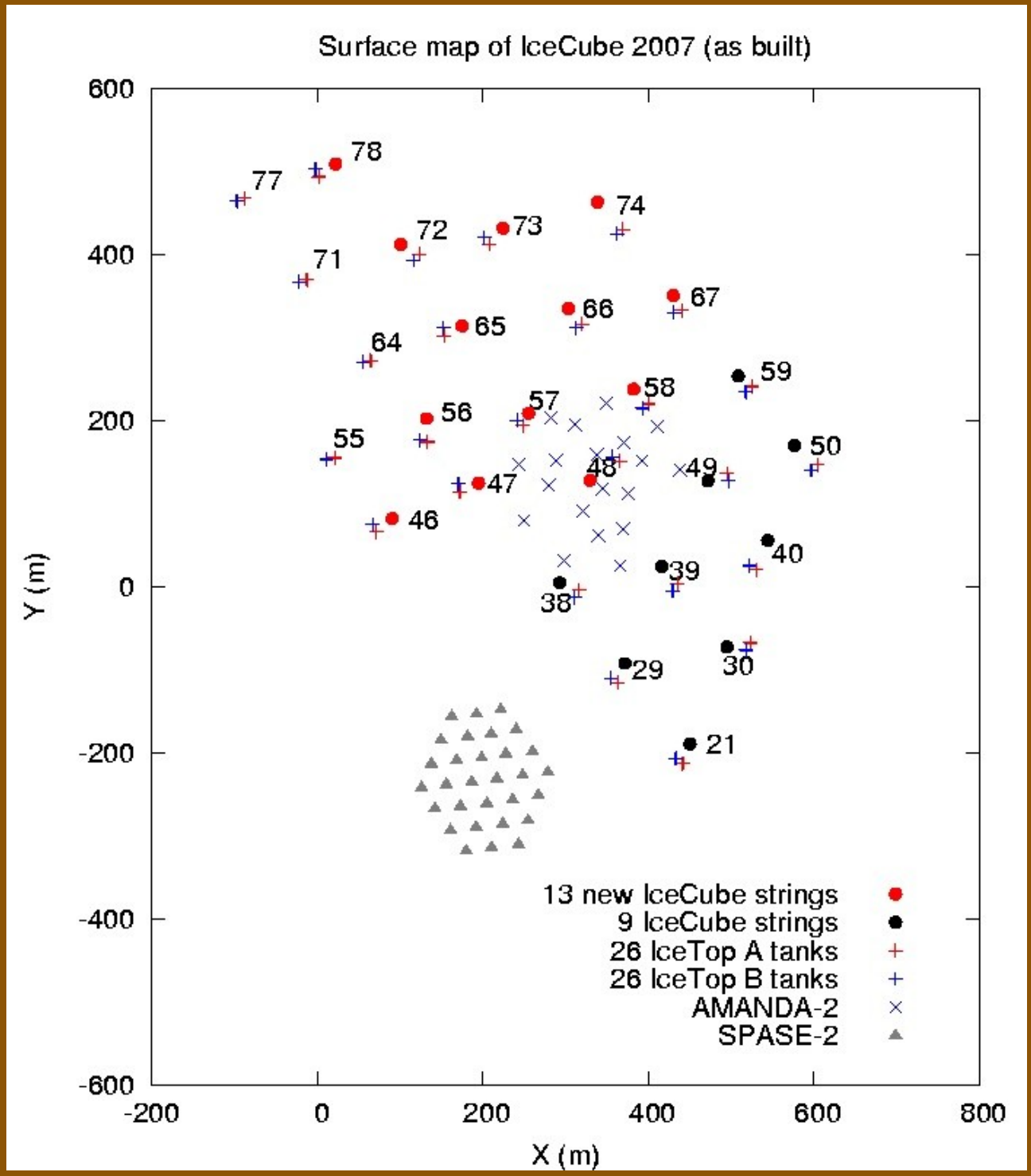
The freezing process of the new IceTop tanks ended in May. By now we have four months of data taken in 2007 – 26 stations + 22 InIce strings. All data are 'filtered' for transmission to the Northern Hemisphere - there is not enough bandwidth to send everything. All most interesting events are send while `regular' events go through 1/20, 1/100 etc random filters. The rest are recorded at South Pole.

IceCube us aiming at unified low level analysis of all data including IceTop. This includes

- low level verification
- level 0 analysis and data selection
- level 1 analysis includes calibration
- level 2 analysis is the first step of physical aanalysis

Data is then supplied to all working groups to perform their high level analysis.

Tom Gaisser and Stefan Klepser reported on the 2006 data analysis at the cosmic ray conference in Merida

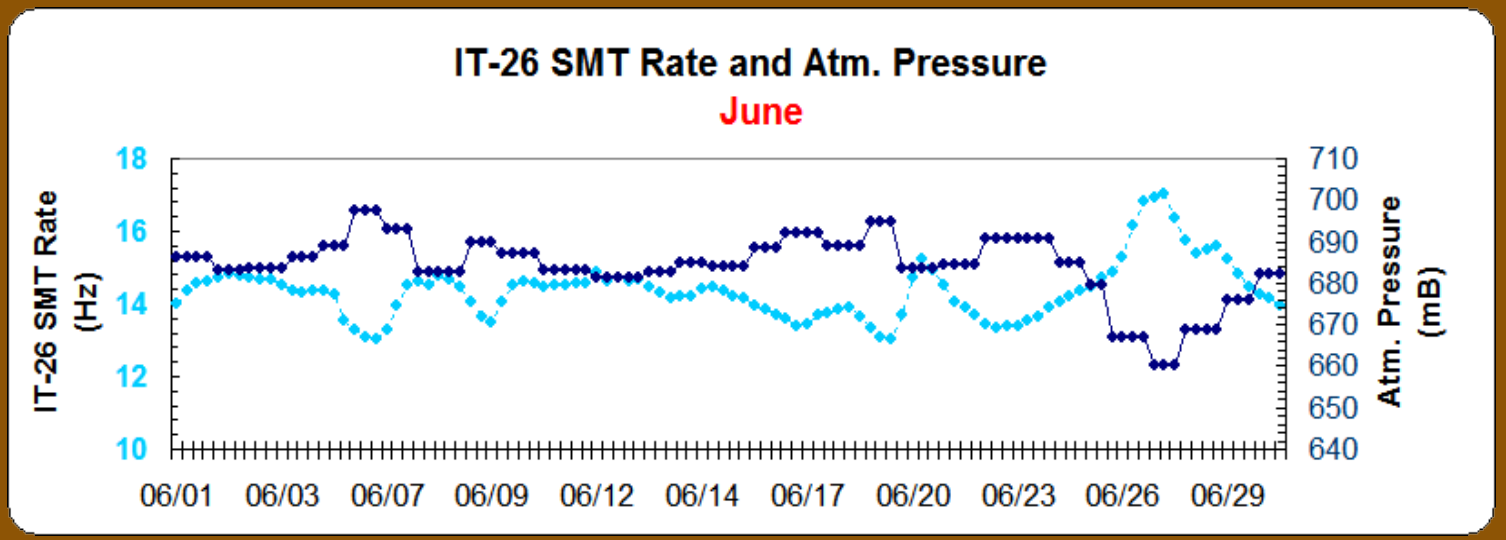


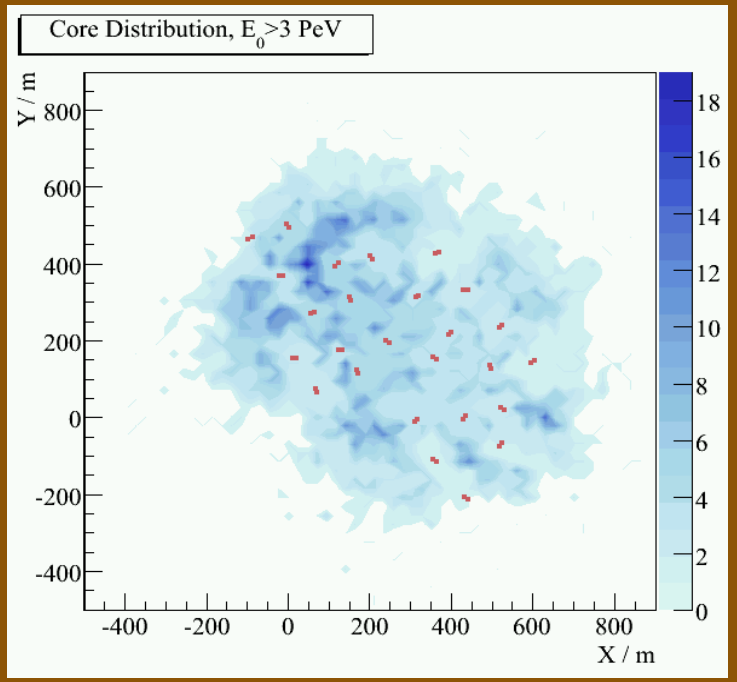
During the 2006/07 season IceTop deployed 12 stations as planned.

The idea now is to deploy >14 holes and stations per year. This way the esperiment will be deployed during the 2010/11 season.

Partial view after the 2007/07 deployment

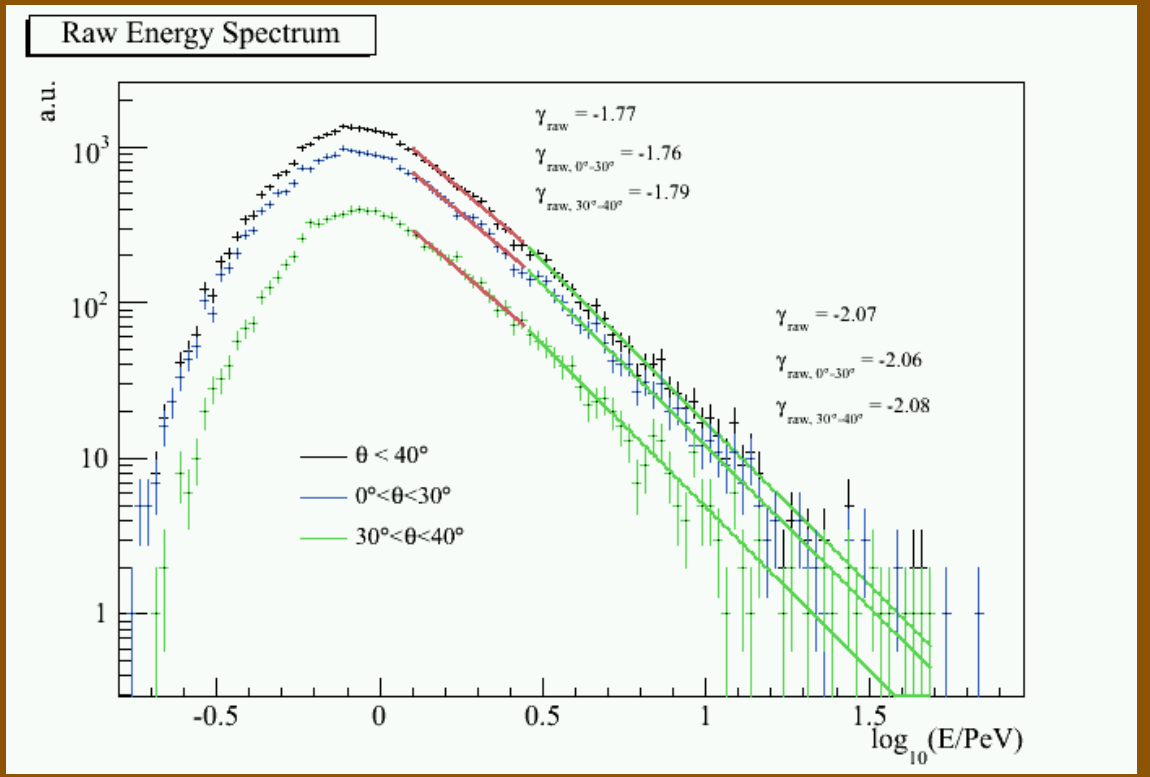
Needs to be accounted for.

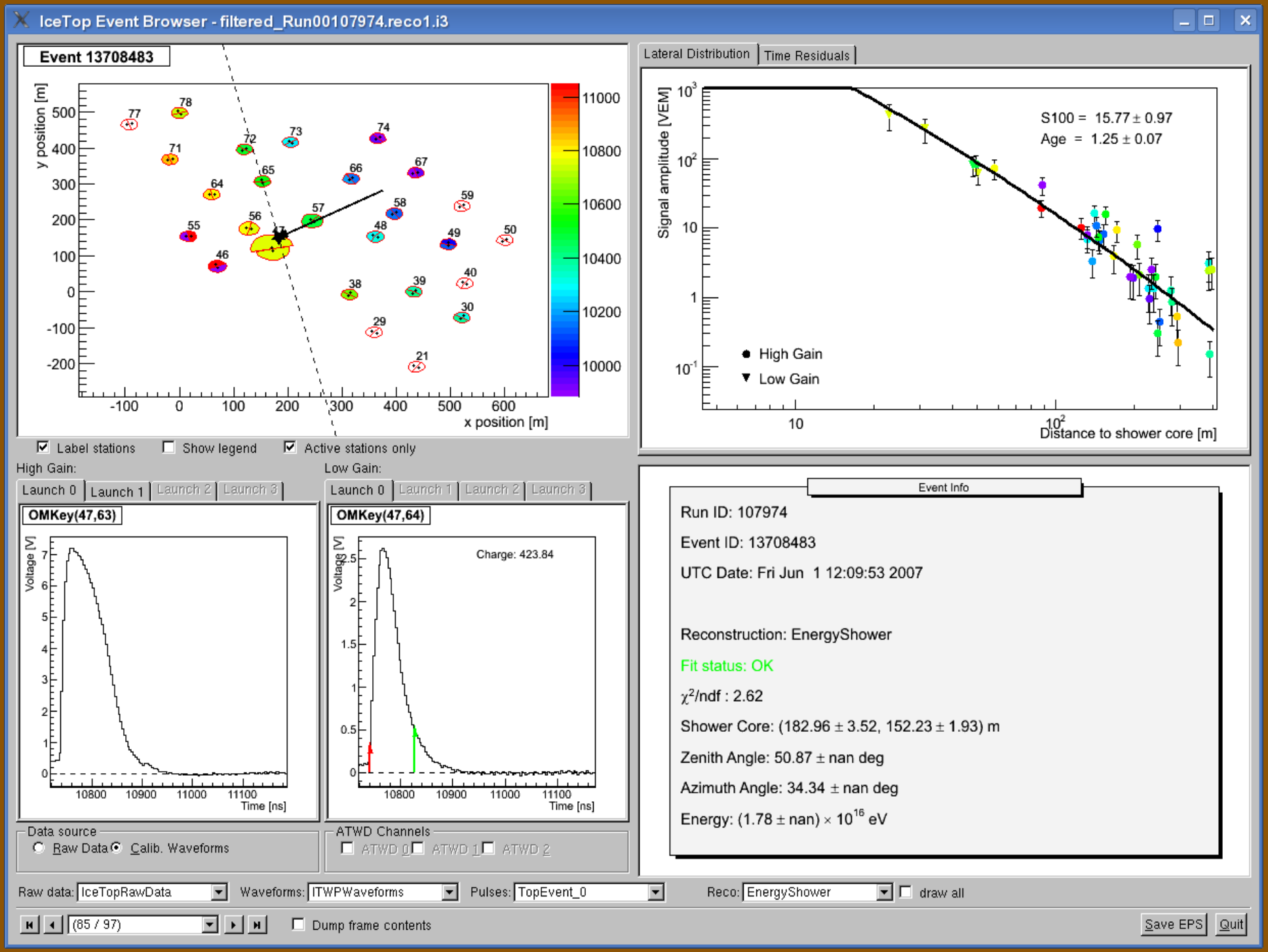




The newly deployed tanks are not well calibrated yet. For this reason the new station have enhanced triggering. Calibration is still behind data taking.

Energy distribution derived from less than two weeks of data still without calibration.





One of the higher events in this set. Core probably outside the array.

SUMMARY

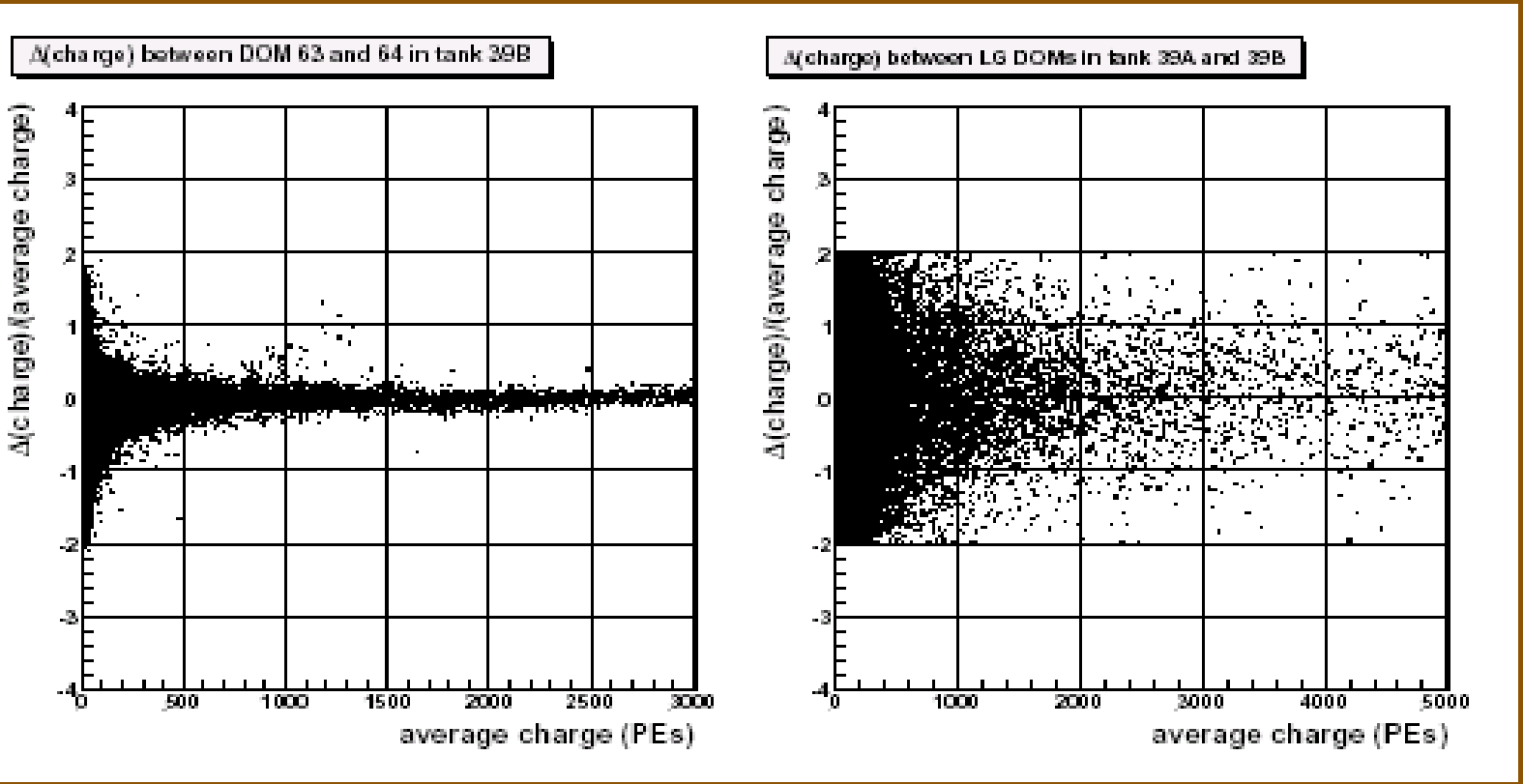
IceTop with InIce is a three dimensional air shower array. The cosmic ray spectrum and composition will be studied in three different ways:

- IceTop only – as shown
- InIce only – as done by MACRO but muon energy more than 300 GeV
- IceTop/InIce coincident events – best, but with lower stastistics

In the future we will also trigger on horizontal showers.

2007 data are taken with 1/3 of the detector completed. During the next season we will have ½ of the detector installed with the full deployment finished by the end of the 2010/11 season.

Fluctuations:



DOM to DOM in 1 Tank

Tank to Tank in a station