



Codogno (LO)
Liceo "G. Novello"

ERICE
6-7 Dicembre 2017

ARRIVAL DIRECTION OF MUONS DEPENDING ON THE EARTH'S POSITION IN THE ROTATIONAL MOTION

WHO WE ARE

The “G. Novello” High School of Codogno is located about 25 kilometers from Lodi.

We entered the project last spring as a school without a telescope, involved by prof. Abele Bianchi who, after a preparatory course in the study of Cosmic Rays, has included us in the data analysis activity together with other schools in Lombardy.

THEORETICAL CONDITIONS OF OUR WORK

The Cosmic Rays that invest the Earth are mainly made up of Protons and nuclides. Being equipped with electric charge, on their journey from the site of origin to the Earth they are deflected, as well as accelerated, by extragalactic, galactic, solar and terrestrial magnetic fields.

Their path follows the “rule of the right hand”.

Being influenced by the same galactic field, their path follows a spiral pattern and in proximity to intense magnets fields, the curvature of the spiral increases as a function of the particle energy.

Thus, when they enter the Earth's magnetic field, the protons that hit the Earth's atmosphere are forced to a trajectory from West to East.

The flux of cosmic rays on the ground also varies with the latitude: at the lower ones the geomagnetic field has more influence on the charged particles and at the equator the effect is maximum.

At latitude of Lodi the direction of origin is random and their flow is substantially isotropic.

If, however, the energy of the charged particle is sufficiently high and if the source that has accelerated it is sufficiently close, then the deflection of its trajectory in the magnetic fields may be small.

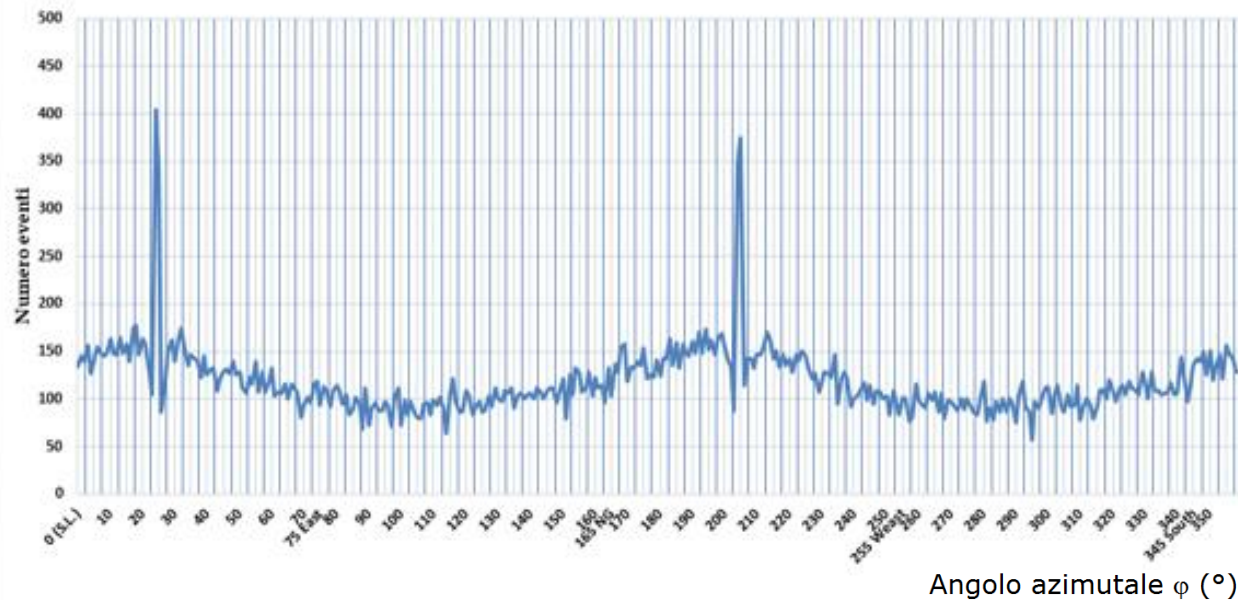
Waiting to identify a variation of the muon flow according to the direction of origin due to very high energy particles, our work has been oriented towards a possible (though unlikely) anisotropy as a function of the Earth's rotation.

Furthermore, we also wanted to verify the East - West effect hypothesized by the physicist Bruno Rossi. The analysis was carried out on some RUN of January 25, 2017 from the LODI-01 Telescope, installed at the Liceo Giovanni Gandini di Lodi.

Initially our efforts focused on the direction of origin with respect to the zenith and azimuthal angle, obtaining as output the following graphs⁽¹⁾ for each of the RUNs.

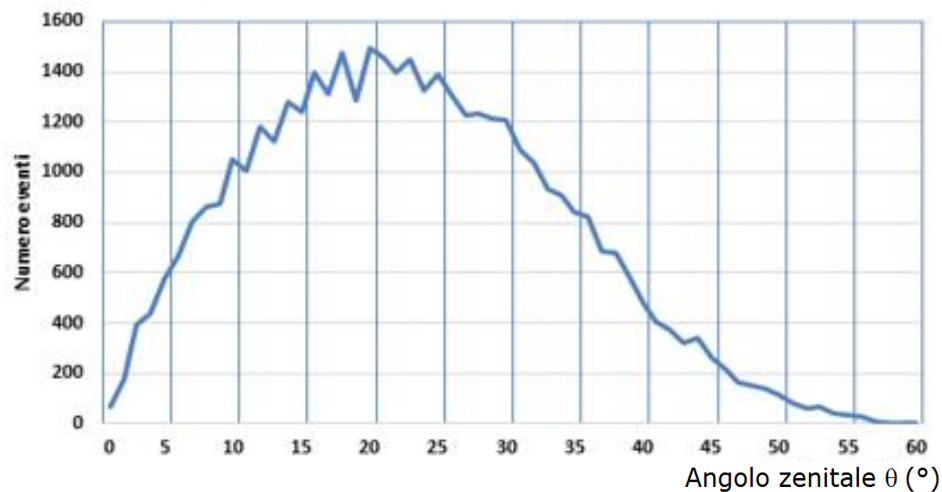
(1) Data processing takes place automatically through a standard format.

LODI-01-2017-01-25-00001; Distribuzione azimutale

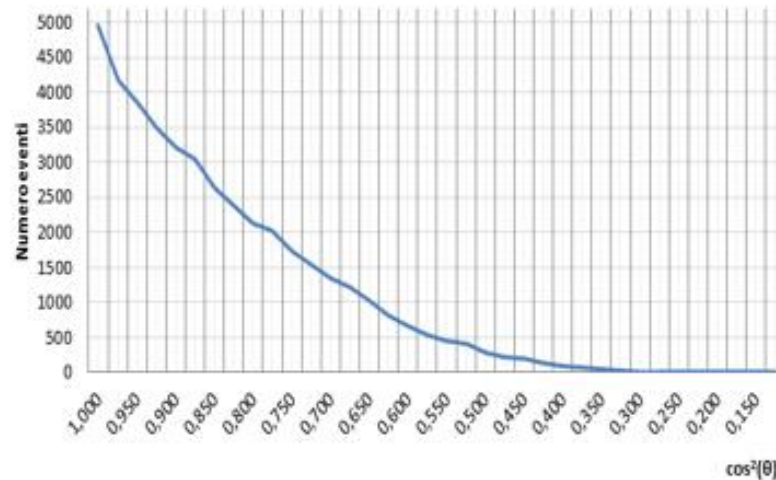


RUN n°	1
del	24/01/2017
Run Start:	23h 1m 20s
Local Mean Sidereal Time:	7h 14m 43s
Run End:	23h 15m 44s
Δt	864s
Events with Hits:	44.983
Events No Hits:	5.017
Events with $\chi^2 > 10$:	2.068
Events with T.O.F. < 0:	259
Events with T.O.F. < 0 & $\chi^2 > 10$:	153
Number of analyzed events	42.640
Track length Min (cm)	93,000
Track length Max (cm)	177,060
Rate (Hz)	52

LODI-01-2017-01-25-00001; Distribuzione zenitale

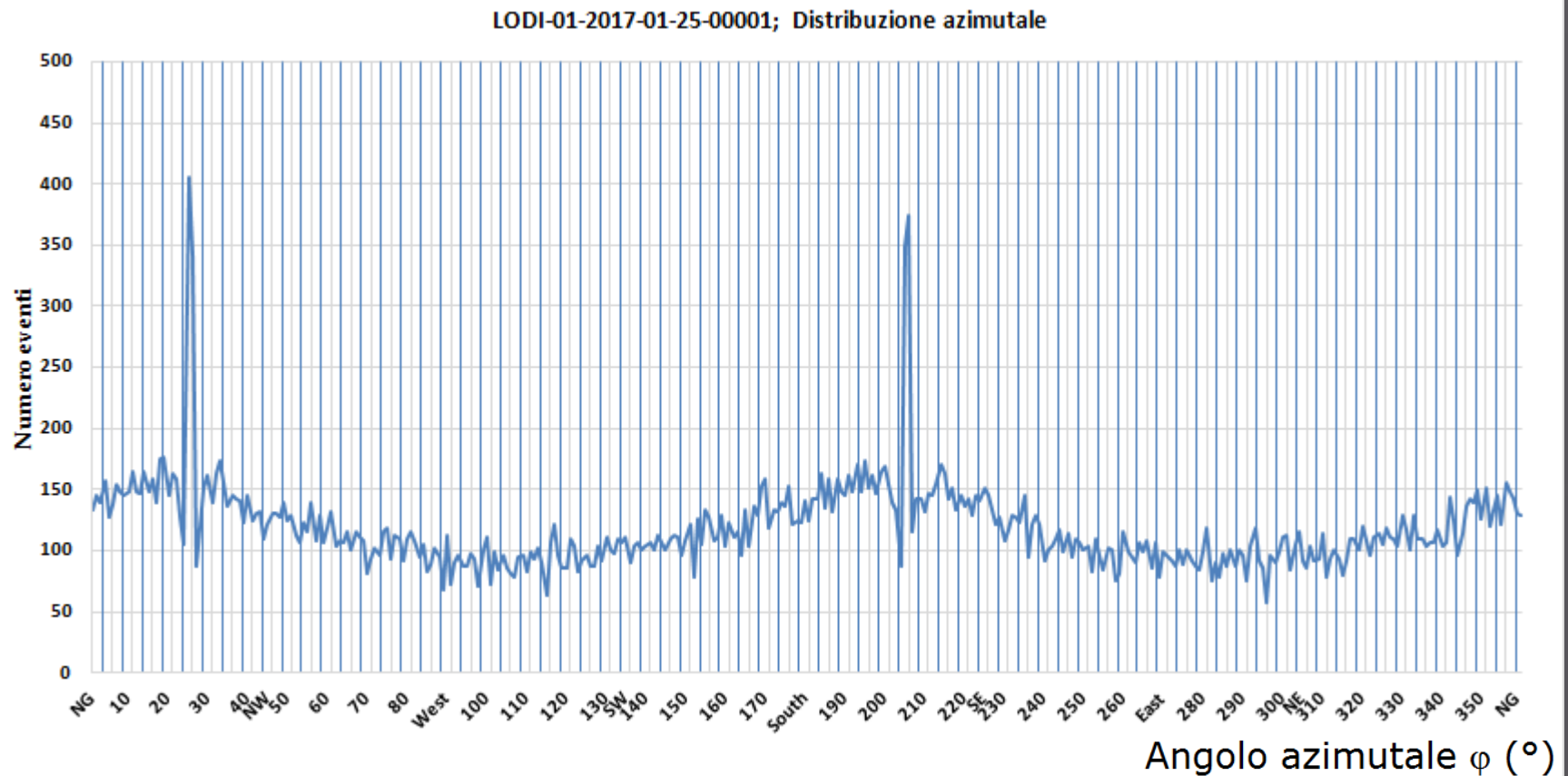


LODI-01-2017-01-25-00001; distribuzione eventi in funzione di $\cos^2(\theta)$



		RUN n°	1
		del	24/01/2017
		Run Start:	23h 1m 20s
		Local Mean Sidereal Time:	7h 14m 43s
		Run End:	23h 15m 44s
		Δt	864s
		Events with Hits:	44.983
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		Events with $\chi^2 > 10$:	2.068
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		Events with T.O.F. < 0 & $\chi^2 > 10$:	153
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Comparing the graphs obtained at different times of January 25, 2017, we realized that the muon flow had two symmetrical peaks (180 °): one at 25° and the other at 205° (in the reference system of the Telescope).



Realizing that it was very unlikely that in these two positions there was a flow three times greater than the media, we thought about the geometry of the telescope.

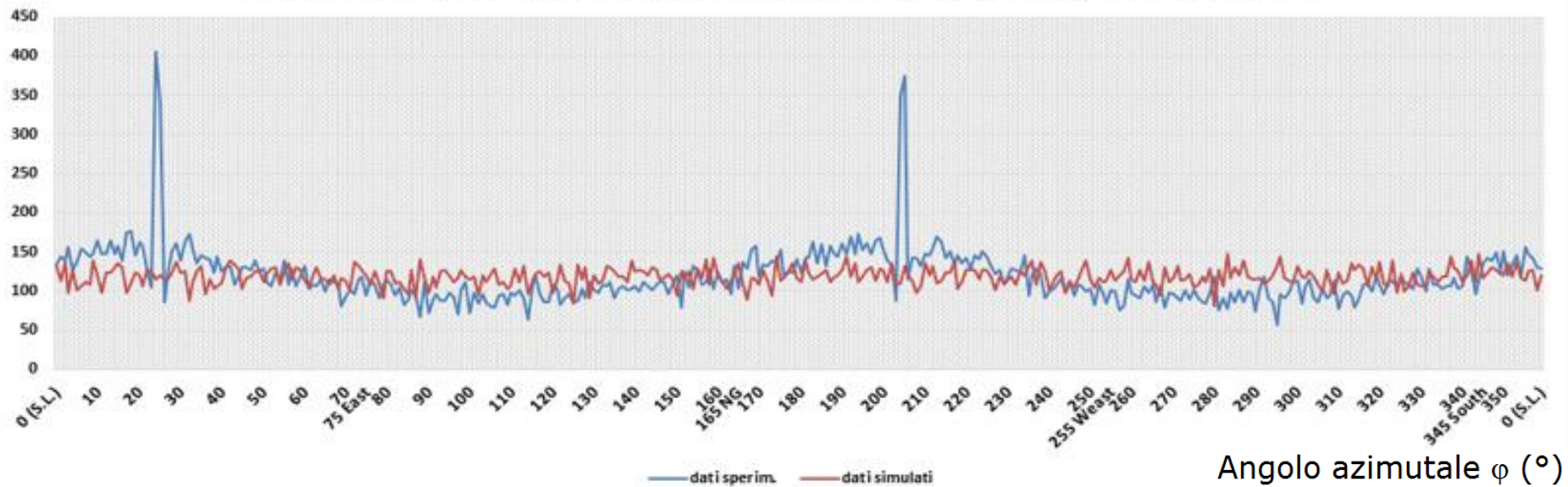
After the exercise done during the I.C.D. we considered the possibility of using the Monte Carlo method as the direction of origin of the Cosmic and Random rays.

Thus, we generated a random distribution of angles from 0 to 360 degrees and calculated the number of events with a 1 degree step. So we have superimposed the two graphs: the experimental one and the random one.

Furthermore, after normalizing the experimental events, we generated a graph in «Dispersion» mode, approximating with the trend line.

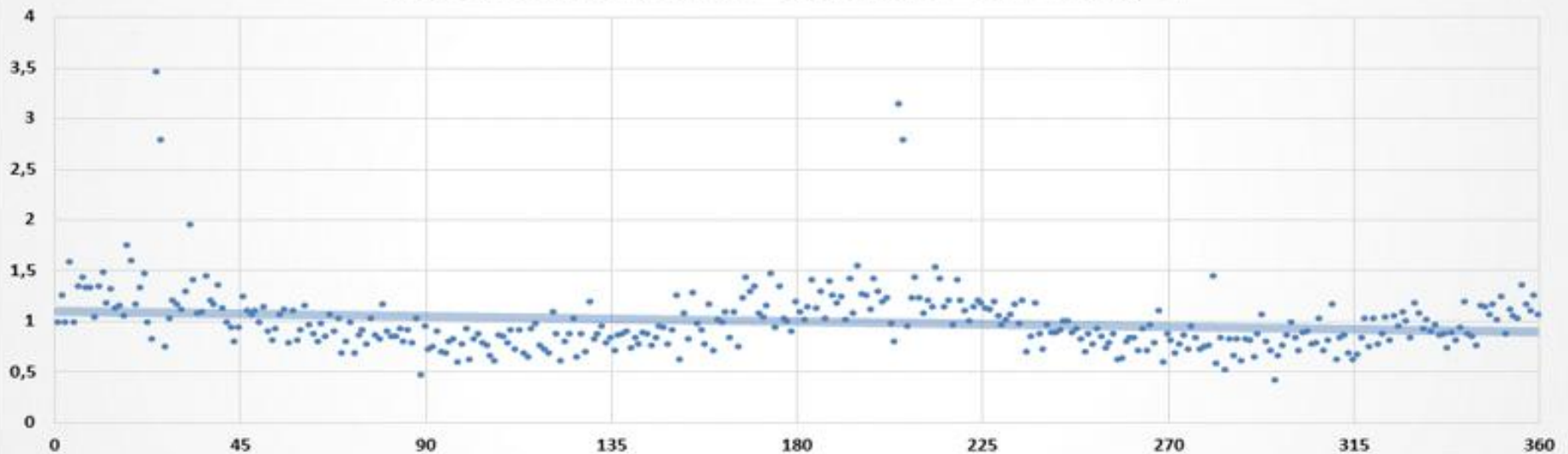
The results were these:

LODI-01-2017-01-25-00001 - Azimuthal distribution with/ without factor of acceptance

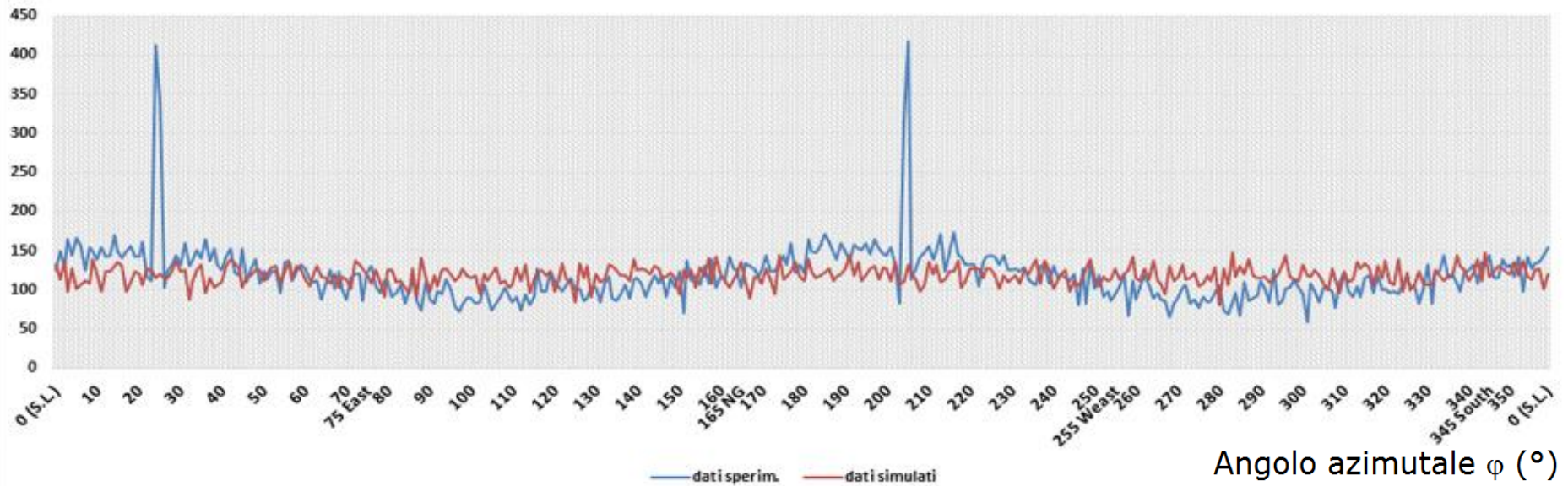


Angolo azimutale ϕ (°)

LODI-01-2017-01-25-00001 - Correct data - Trend line: $y=1$

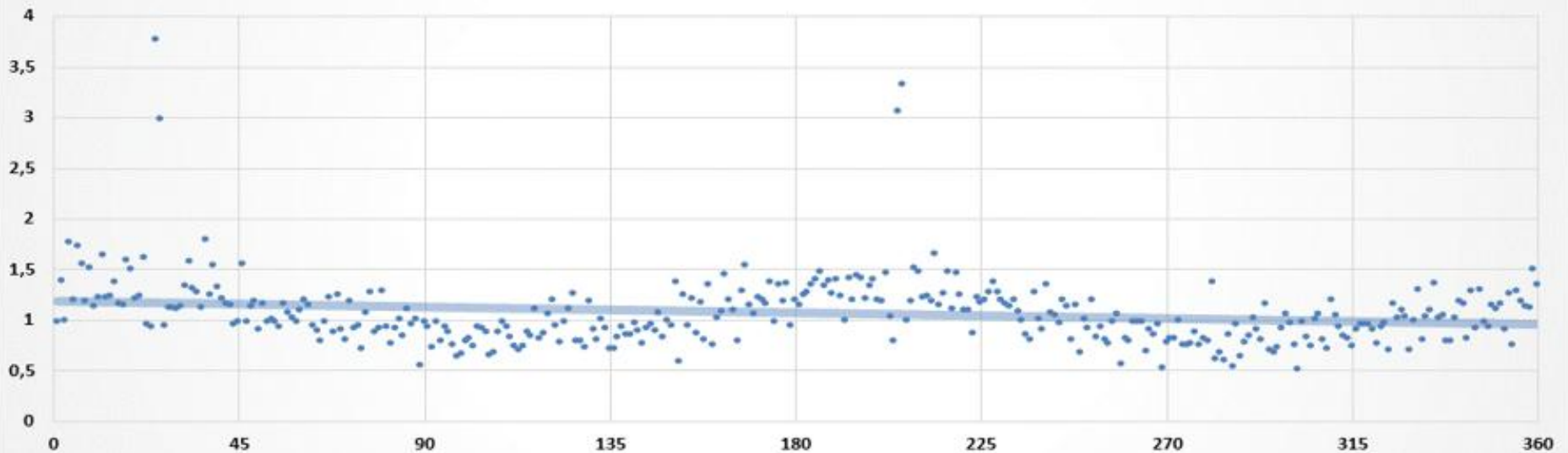


LODI-01-2017-01-25-00025 - Azimuthal distribution with/ without factor of acceptance

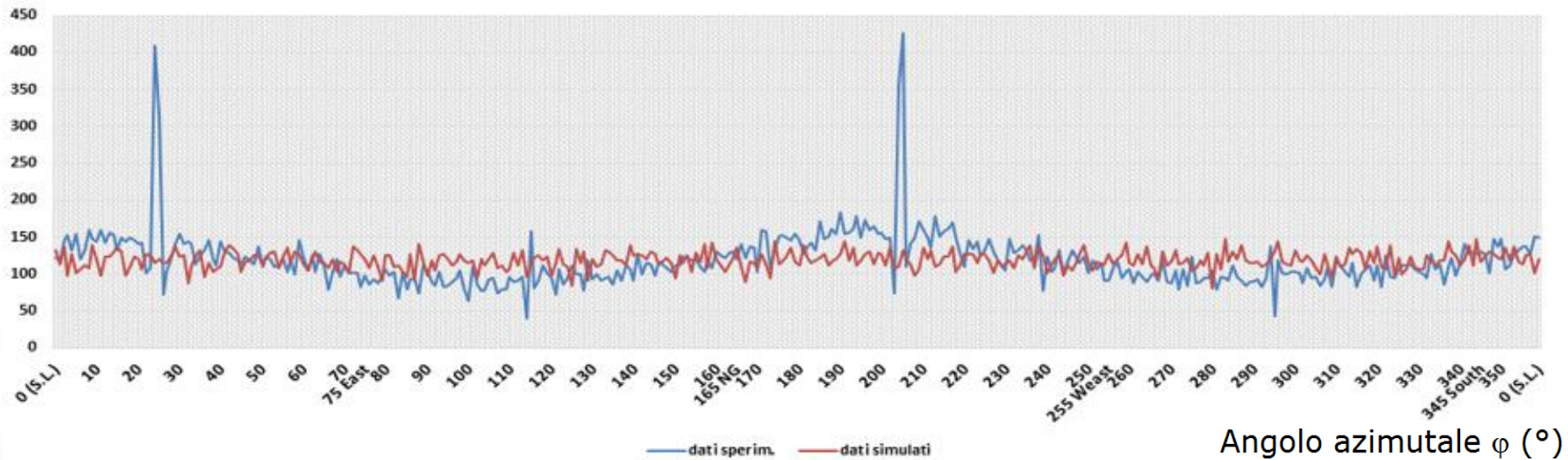


Angolo azimutale ϕ (°)

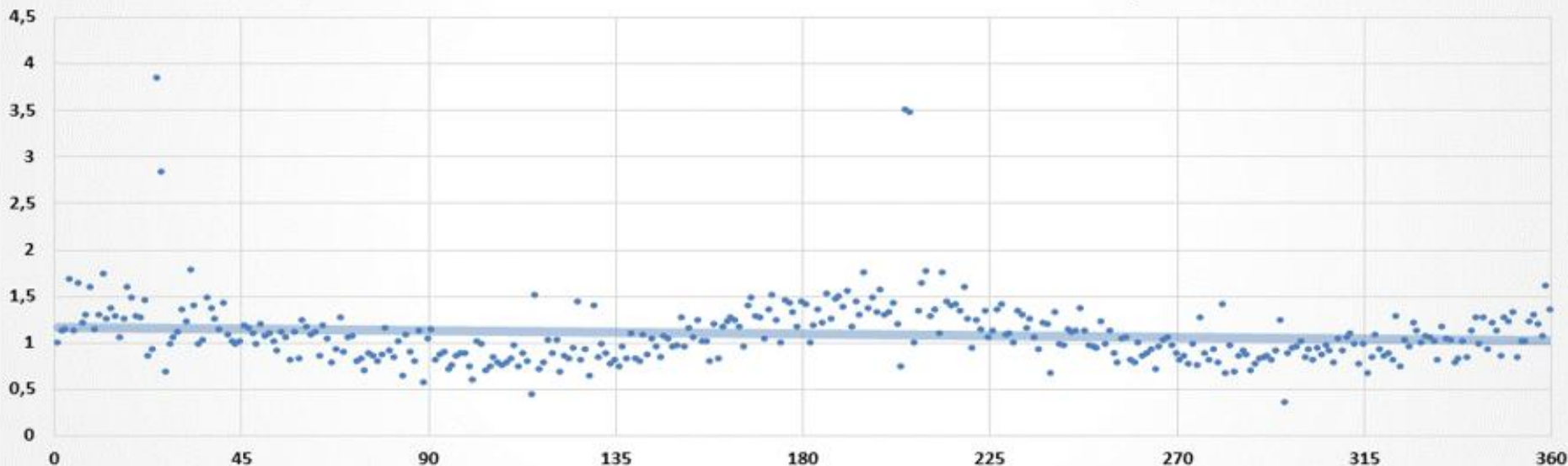
LODI-01-2017-01-25-00025 - Correct data - Trend line: $y=1,2$



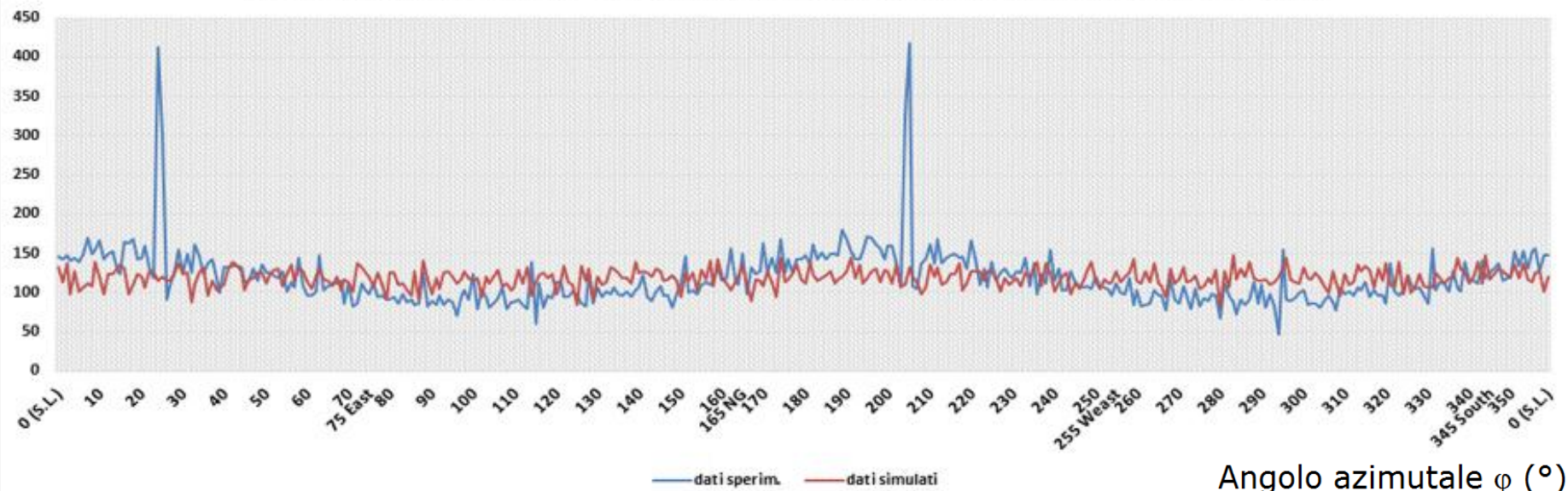
LODI-01-2017-01-25-00050 - Azimuthal distribution with/ without factor of acceptance



LODI-01-2017-01-25-00050 - Correct data - Trend line: $y=1,1$

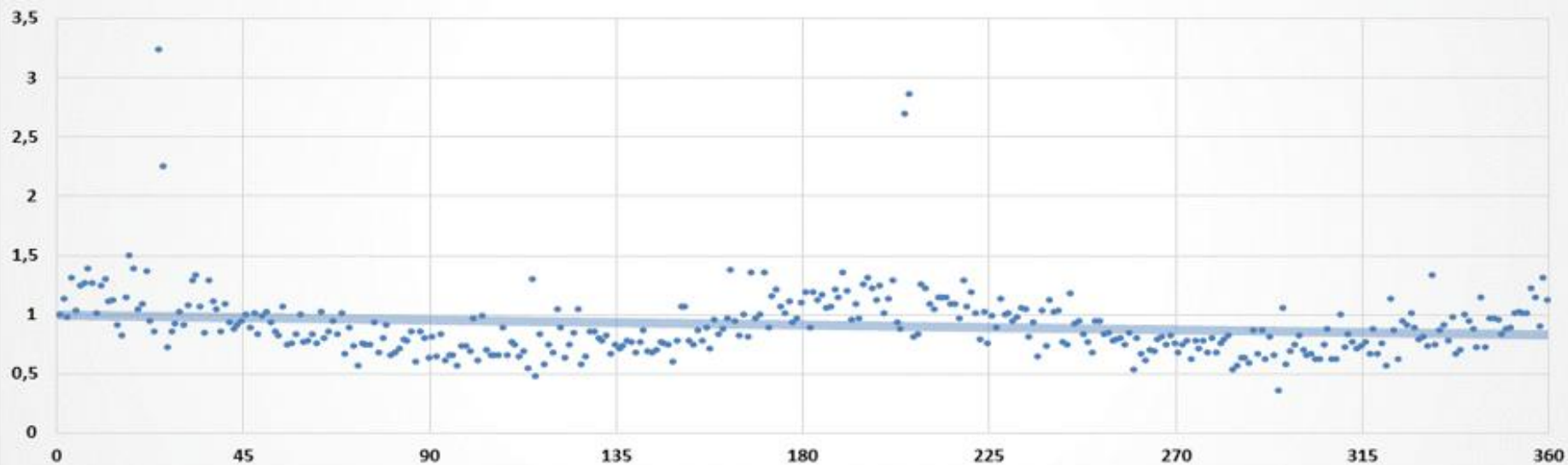


LODI-01-2017-01-25-00078 - Azimuthal distribution with/ without factor of acceptance



Angolo azimutale ϕ (°)

LODI-01-2017-01-25-00078 - Correct data - Trend line: $y=1$



Conclusions

At our latitude of 45° and $30'$ we could not expect variations in flow as a function of the direction thus confirming the theoretical prediction.

It was our intention to download data from telescopes located in southern Italy in order to verify the East-West effect, but it was not possible due to the incident that created major problems of the CNAF.

As soon as this data can be accessed, we will continue our investigation.

Another area of research will be to identify the coincidences detected by the Telescopes LODI-01, LODI-02 and LODI-03.

**THANKS
FOR YOUR ATTENTION**