MICRO
Monitor for Intense Cosmic Ray Outbursts: a playground in Frascati for μ-astronomy training while waiting for MACRO (1986-1987)

G.B.

In memory of Aurelio Grillo and Sandro Marini

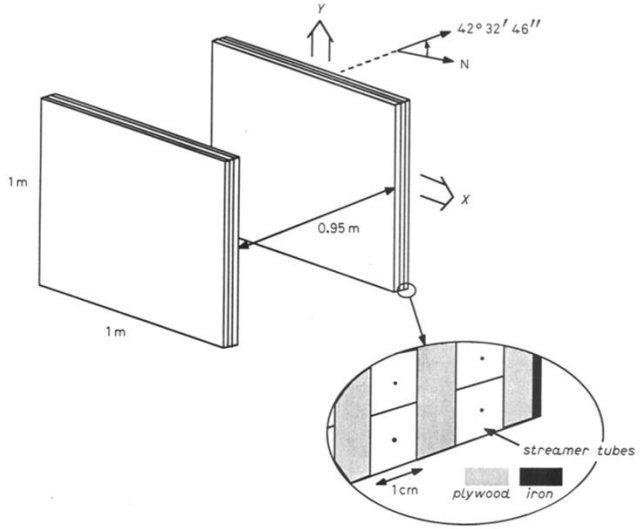
The idea

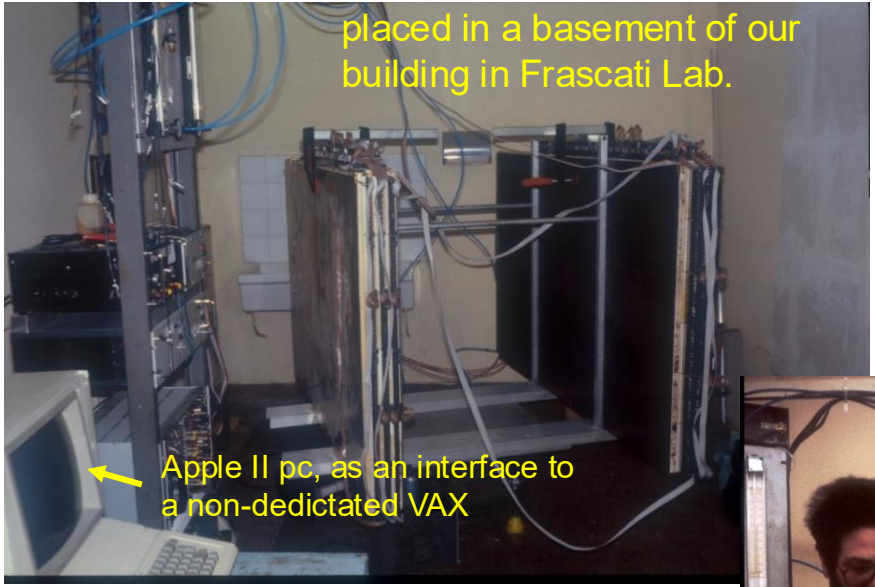
- In 1985 there was the claim from NUSEX of a possible TeV muon periodic signal from Cygnus-X3
- More or less a year later, Aurelio, with the support of a back-of-the-envelope calculation, made an intriguing suggestion: if that signal claim were true, under a shareable assumption on the possible shape of TeV γ spectrum, it would have been possible to detect a burst of muons in phase with Cygnus-X3 period, even with a rather small muon telescope operating at the surface
- In a very short time, we prepared the detector (using spares we had in the lab at that time), data acquisition and analysis framework

G.B., C. Bloise, A.F. Grillo, A. Marini, F. Ronga and V. Valente

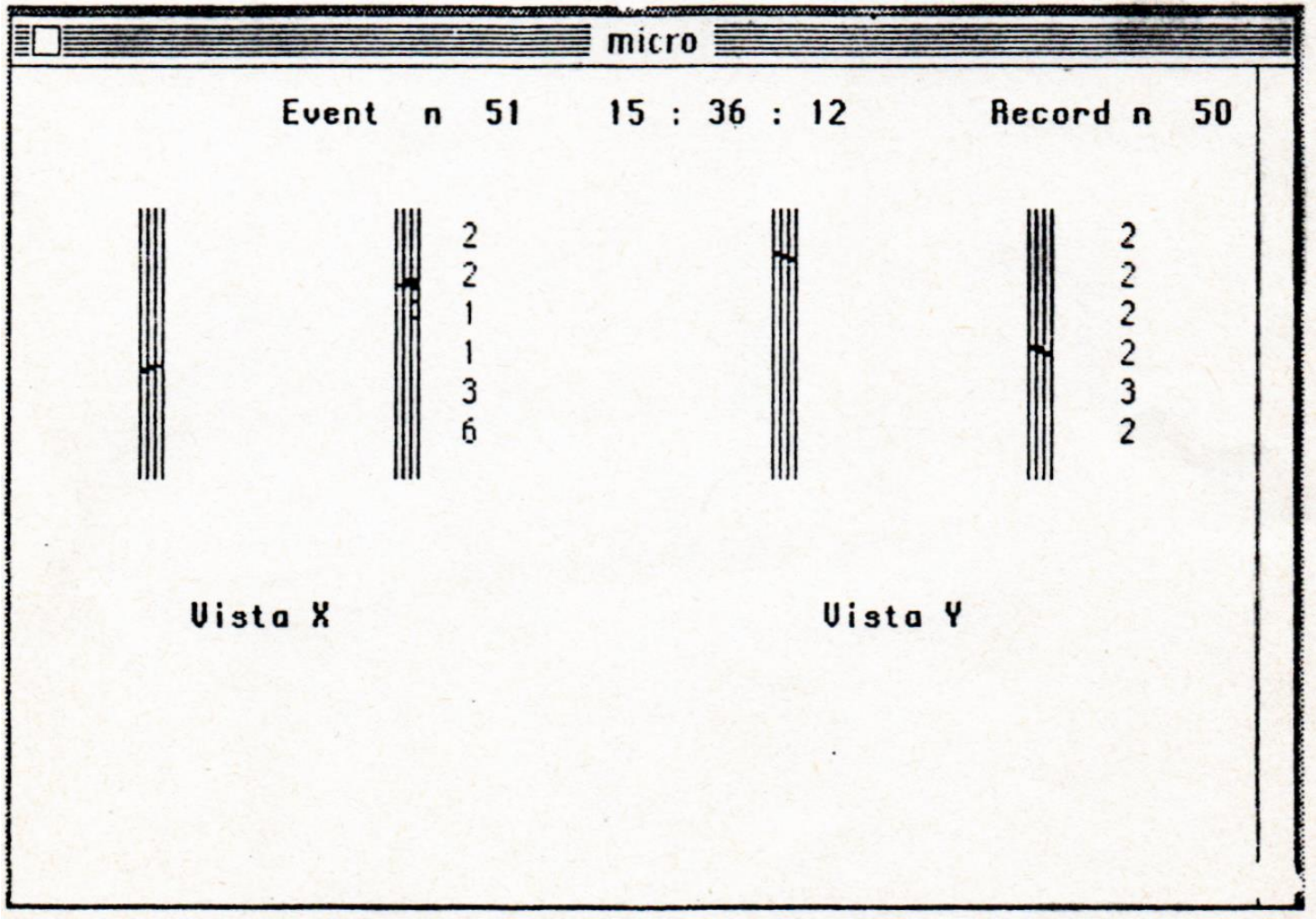
The data analysis of MICRO will also mark the scientific birth of Alessandra Di Credico (graduate student in Frascati at that time)

The MICRO detector





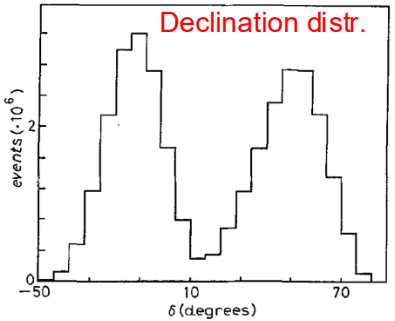
The tracking telescope was made of 1 m long NUSEX-like streamer tubes (~1 cm^2 cross section) equipped with 2-dim readout, oriented to look for muons at high zenith angle (to increase average muon energy)


micro
Event n 51
15 : 36 : 12
Record n 50
2
2
1
1
3
6
2
2
2
2
3
2
Vista X
Vista Y

Operation period: March ’86 - May ‘87

31 10^6 collected muons in the declination range $-50^o < \delta < 90^o$

By selecting $\theta > 80^o$, $E_\mu > 10$ GeV at 95% c.l.



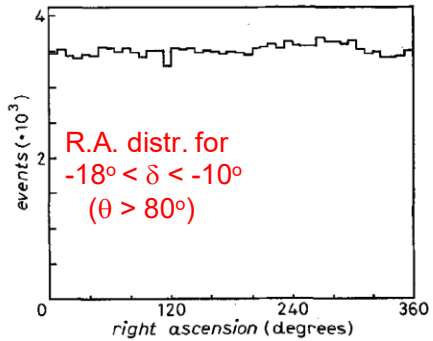


TABLE I. – 95% c.l. *upper limits for the flux coming from known* X- *and* γ-*ray sources.*

	RA (degrees)	δ (degrees)	95% UL (10^{-8} cm^{-2} s^{-1})
Cyg X1	299.1	35.1	5.1
Cyg X2	325.6	38.1	3.3
Her X1	254.0	35.4	1.2
Sco X1	244.3	−15.5	3.7
Geminga	97.7	17.8	8.2
4U1758-25	269.5	−25.1	2.1
Crab	82.9	22.0	9.8
AM Her	273.3	50.0	5.0
Kepler	261.9	−24.4	3.5
IC443	93.5	22.6	5.4

Cignus-X3 results

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High-Statistics Study of the Low-Energy Cosmic-Muons Angular Distribution: Results from MICRO.

G. Battistoni, C. Bloise, A. F. Grillo, A. Marini
F. Ronga and V. Valente
INFN, Laboratori Nazionali di Frascati, P.O. Box 13 - 00044 Frascati

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Summary. — We present results from MICRO, a muon telescope with good angular resolution, which has collected more than $31 \cdot 10^6$ cosmic muons. Upper limits are given for the flux coming from point sources and for the periodic component from Cygnus X3.

PACS 91.10 – Geodesy and gravity.
PACS 94.40 – Cosmic rays.

1. – Introduction.

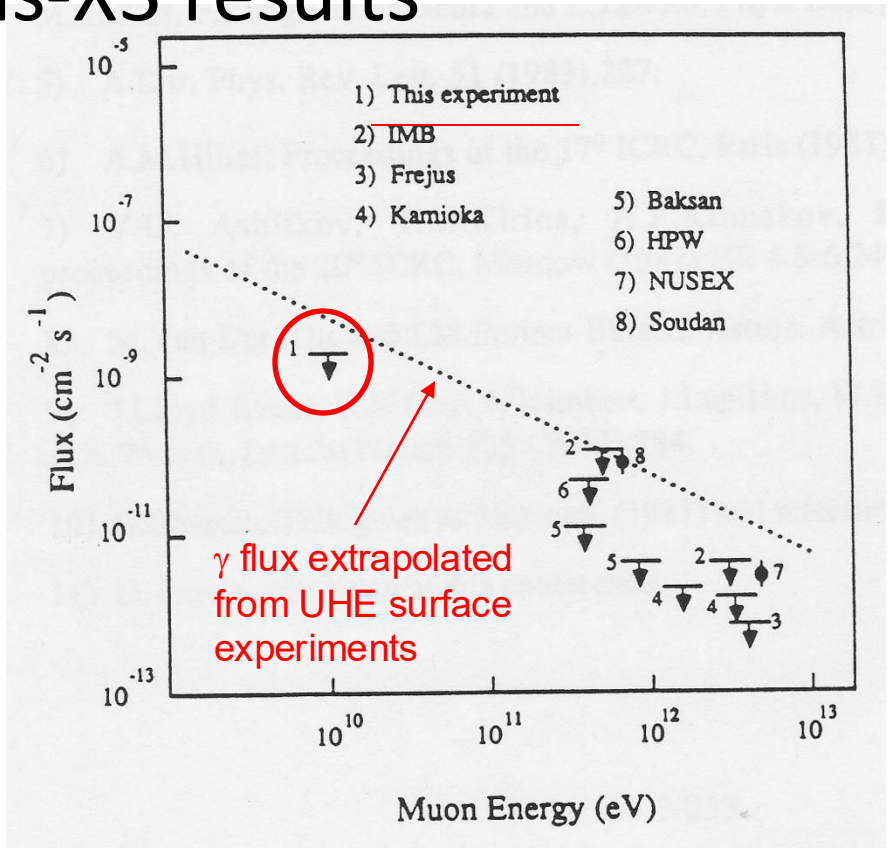
Wide-angle anisotropies in the arrival directions of high-energy cosmic muons have been reported by various experiments (1). The existence of narrow-angle anisotropies is however still an open question.

The aim of MICRO (monitor for intense cosmic-ray outbursts) is to give a high-statistics survey of the low-energy muon flux, with good angular resolution, to search for narrow peaks and time variations in the cosmic-muon distribution.

The apparatus has been operated since March 1986 through May 1987 in Frascati—latitude = 41° 47′, longitude = − 12° 40′ at 300 m above sea level—collecting more than $31 \cdot 10^6$ muons whose arrival directions cover the range (in celestial coordinates) $-50° < \text{declination } (\delta) < 90°$.

The μ arrival directions have been binned in (8×8) degrees (RA *vs.* δ) intervals. Minimum energy of detected μ's is ≈ 2 GeV, owing to absorption in the atmosphere. Selecting muons with zenith angle $\theta > 80°$ corresponds to a cut $E_\mu > 10$ GeV at 95% confidence level.

(1) O. C. Allkofer, W. D. Dan, H. Jokish, G. Klemke, R. C. Uhr, G. Balla and Y. Oren: *Astrophys. J.*, **291**, 468 (1985), and references therein.



Of course, MICRO was automatically terminated when MACRO construction was about to start…