The Synchrotron: Father of the Frascati Particle Accelerators

Andrea Ghigo
Istituto Nazionale di Fisica Nucleare
The Frascati Synchrotron (1959-1975)
Electro-synchrotron was the first high-energy accelerator made in Italy. It was approved in 1953 and its construction began in 1957. After just two years the accelerator was operational.
The desire to continue the studies begun by Enrico Fermi and by the "boys of via Panisperna" was strong but after the war the difficulties of the reconstruction slowed down the project to build high-energy particle accelerators as happened in USA. But the excitement of that school, which enumerated among the best nuclear and particles physicists of the world was not arrestable.

In 1948 a laboratory was set up on the Cervino mountain for the observation of cosmic rays waiting for "the accelerators that produce them at home", as Gilberto Bernardini said, and at the Testa Grigia at 3500 m height, physicists from all universities worked together establishing strong personal and professional relationship that were fundamental to the growth of the INFN and CNEN.
They believed that it would be important to build a high-energy accelerator in Italy.
Amaldi's request to build an accelerator in Italy came up to the Prime Minister, Alcide De Gasperi, through Leone Cattani Minister of Public Works, but public finance had other priorities in that period of reconstruction. The professor Francesco Giordani then contacted the Minister of Industry Pietro Campilli, who demonstrated strong interest in nuclear research initiatives.

Amaldi, Giordani and Campilli agreed to set up the National Committee for Nuclear Research, CNRN, financed by the Ministry of Industry. Minister Campilli, resident in Frascati, convinced his friend Senator Pietro Micara, mayor of Frascati, to give a plot of land with the curious name of “Macchia dello sterparo” (grove of brushwood…….)

It was decided to build a Synchrotron of energy between 500 and 1000 MeV.

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The construction of the Synchrotron and the related research center was entrusted to a 31-year-old physicist: Giorgio Salvini. He recruited a team of good and motivated physicists in the Italian universities.
Physics program (1)

- The Frascati Synchrotron aims to accelerate electron beam up to 1GeV energy.
- The electron beam had been used to generate a γ beam, up to 1 GeV, by bremsstrahlung on target placed inside the machine.
- The γ beam were had been used to study the interactions between matter and electromagnetic radiation.
- And in particular to study nuclear and electromagnetic forces between elementary particle.
Physics program (2)

• Single and multiple photoproduction of charged and neutral pions.

• Photoproduction of strange particle: heavy meson and hyperon
  \[ \gamma + p \rightarrow \Lambda^0 + K^+ \text{ (threshold 910 MeV)} \]
  \[ \gamma + p \rightarrow \Sigma^0 + K^0 \text{ (threshold 1040 MeV)} \]

• Electron – photon experience to study nuclear form factors

• Photoproduction of particle pairs \((\mu^+\mu^-, \pi^+\pi^-)\)

In 1955 the accelerator section of the INFN in Pisa moved to Rome for the construction of the synchrotron. Following the decision to build the synchrotron in Frascati, this team will become the INFN-CNEN National Laboratories of Frascati.
The Synchrotron building during construction

The inner view of the building with the large synchrotron concrete basement

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Cryogenic lab

The first building built in Frascati contained the liquefier bought to make cryogenic plates as a target for the synchrotron beam.

1956: The first canteen in Frascati. The photo is taken during the lunch break in a phase of the installation of the liquefier for the cryogenic of the Synchrotron. Recognizable Scaramuzzi, Bellatreccia, Careri and Moneti.
A temporary RF laboratory was set up in a tent waiting for the building
The problem of lack of water was solved by digging a well of 160 m "Absurdly deep almost to the antipodes" (Touschek)
Great work of the technicians:

large part of the accelerator components were made in house

Magnetic measurements
In the picture: Di Stefano

Vacuum chamber quality control
In the picture: Clozza

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RF cavity with power supply

Injection deflector

3 MeV Van de Graaf injector

Sala controllo nella foto: Eddy Grad

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Rotating group for magnet supply

Protection inductor

capacitors hall
Synchrotron installation
Final magnet inspection: Dr. Murtas inside the gap
The Sinchrotron ready for the commissioning
Ghira, Quercia, Toschi, Bologna, Querzoli, Zanetti, Agostini, Di Stefano Guido, Trevisan, Pistoni, Santangeli, Cavusotti, Brolatti, Murtas, Marra, Pecchi, Scaramuzzi, Bonini, Cerchia, Properzio, Stipchic, Puglisi, Sanna, Martellucci, Eddi, Ivagnes, D'Amato, Sacerdoti, Piredda, Ghigo, Bernardini, Grilli e Cinti.
11 February 1959: the Sychrotron is ready for the experiments

The funny official announcement “we are pleased to announce the birth of the one billion electron-volts synchrotron. The child is alive and viable”

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Notoriety: famous guests arrive

Italian president: Gronchi
3 April 1959

Prince Philip of Edinburgh
3 May 1961

1959: President of EURATOM

16/11/1959 The most famous visit:
Ranieri di Monaco and Grace Kelly
The four synchrotron beam lines with the arrangement of the experimental apparatus at the beginning of 1961
Experimental hall

17/09/1959 (Vasari)

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Forward Angle Photoproduction of Single Positive Pions on Hydrogen.

M. Beneventano, G. Finocchiaro, R. Finzi
L. Mezzetti, L. Paoluzzi and C. Schaerf
Istituto di Fisica dell’Università - Roma
Istituto Nazionale di Fisica Nucleare - Sezione di Roma
(ricevuto il 25 Luglio 1960)

Preliminary Results of a Measurement of the Differential Cross Section for Single $\pi^+$ Meson Photoproduction in Hydrogen.

G. Cortellessa and A. Reale
Istituto Superiore di Sanità - Roma
(ricevuto il 6 Giugno 1960)

SEARCH FOR THE $\omega^0$ IN PHOTOPRODUCTION
K. Berkelman,* G. Cortellessa, and A. Reale
Laboratori di Fisica, Istituto Superiore di Sanità, Roma, Italy
(Received February 8, 1961)
EXPERIMENTAL EVIDENCE FOR A QUASI-MONOCROMATIC BREMSSTRAHLUNG INTENSITY FROM THE FRASCATI 1-GeV ELECTRONSYNCHROTRON

G. Barbiellini, G. Bologna, G. Diambrini, and G. P. Murtas
Laboratori Nazionali di Frascati del Comitato Nazionale per l'Energia Nucleare, Frascati, Roma, Italia
(Received April 24, 1962)

Device with diamonds for single crystal generation

Cerenkov counter
Positive-Pion Photoproduction by Linearly Polarized $\gamma$ Rays.

I. - Experimental Method and Results.

M. Grilli, P. Spillantini and F. Soso
Laboratori Nazionali di Frascati del CNEN - Roma

M. Nigro, E. Schiavuta and V. Valente
Istituto di Fisica dell'Università - Padova
Istituto Nazionale di Fisica Nucleare - Sezione di Padova

(ricettuto il 10 Ottobre 1967)

Summary. — The apparatus and the experimental method used for the measurements of the single-$\pi^+$ photoproduction by linearly polarized $\gamma$ rays are described. The present results on the asymmetry ratio $A(\theta)$ are summarized. The range covered by our results is $\theta = (30\div145)^\circ$ (c.m.) and $E_\gamma = (200\div450)$ MeV.

Goniometer for crystal polarizer

Spectrometer with counters
frame of the bubble chamber: in red the point at which the photon, interacting with a proton, has created a pair of pions; the third trace is that of the proton

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Traces in the Spark chamber

First Spark chamber, 1959
Great availability and reliability

Synchrotron duty cycle: in red the working hours for experiments per year, in blue the hours lost due to faults.
The study of the physics of the nucleos requires the extraction from the synchrotron to send the electron beam on target. The difficult problems had been solved with a RF resonant excitation.
To switch from electron to positron injection the magnet had been rotated around its axis: a technique called “the rotisserie.”

The beam extracted was also used to inject in the first electron-positron collider of the world, called ADA (Anello Di Accumulazione) invented by Bruno Touschek.

Nobody could tell which were positrons and which electrons.

But this is another story……….
Thanks for the attention

bibliographic and photo sources: E. Amaldi, G. Battimelli, C. Bernardini, P. Campana, M. Ricci-Ghigo, G. Salvini, V. Valente and ... many friends