About Bruno Touschek and the birth of e+e-

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INFN Istituto Nazionale di Fisica Nucleare

About the movie

- Bruno Touschek had died in 1978 in Austria
- 25 years later, in 2003 in Rome University and INFN Frascati, to remember BT's life and work, with
  - Carlo Bernardini, his friend and collaborator,
  - Luisa Bonolis, at the time Bernardini's student

it was decided to make a movie about Bruno Touschek and the birth of e+e- storage rings

- First in italian, now partly dubbed

Main sources

E. Amaldi,

The Bruno Touschek Legacy, CERN 81-19, 23 Decembre 1981 and

L'eredita' di Bruno Touschek, Quaderni del Nuovo Cimento, SIF, Vol. V, 1982

- *Bruno Touschek e l'arte della Fisica*, by E. Agapito and L. Bonolis, 2004, English version 2005.

- *Le carte di Bruno Touschek*, ed. by G. Battimelli, M. ~De Maria and G. Paoloni, U.La Sapienza, Rome, 1989.

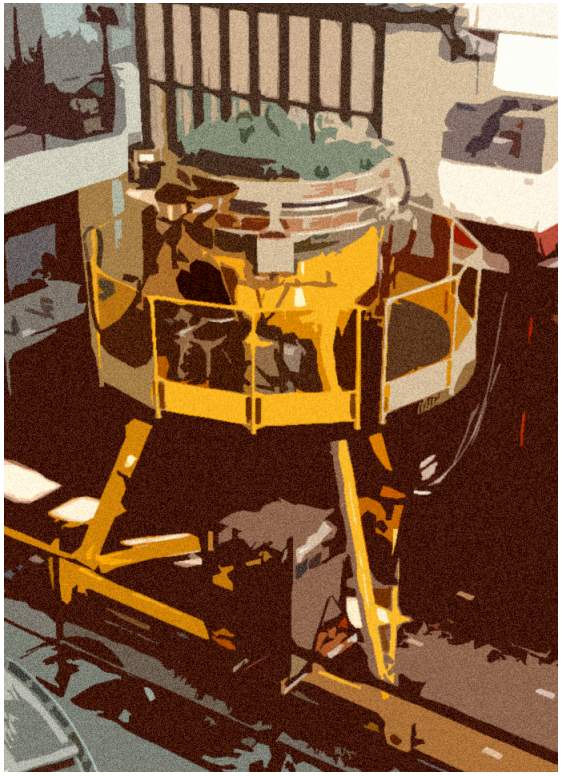
- *Bruno Touschek Memorial lectures 1987*, Frascati Physics series Vol. XXX, 2005

B. Touschek and E. Amaldi in 1958

Bruno Touschek used his theoretical knowledge of Electrodynamics and his experience during WWII with Wideroe to conceive, propose and build the first electron-positron accelerator named AdA

The long road of matter-antimatter collisions from 1960 to 2000

- The first electron-positron accelerator: AdA in Frascati ~5 meters around

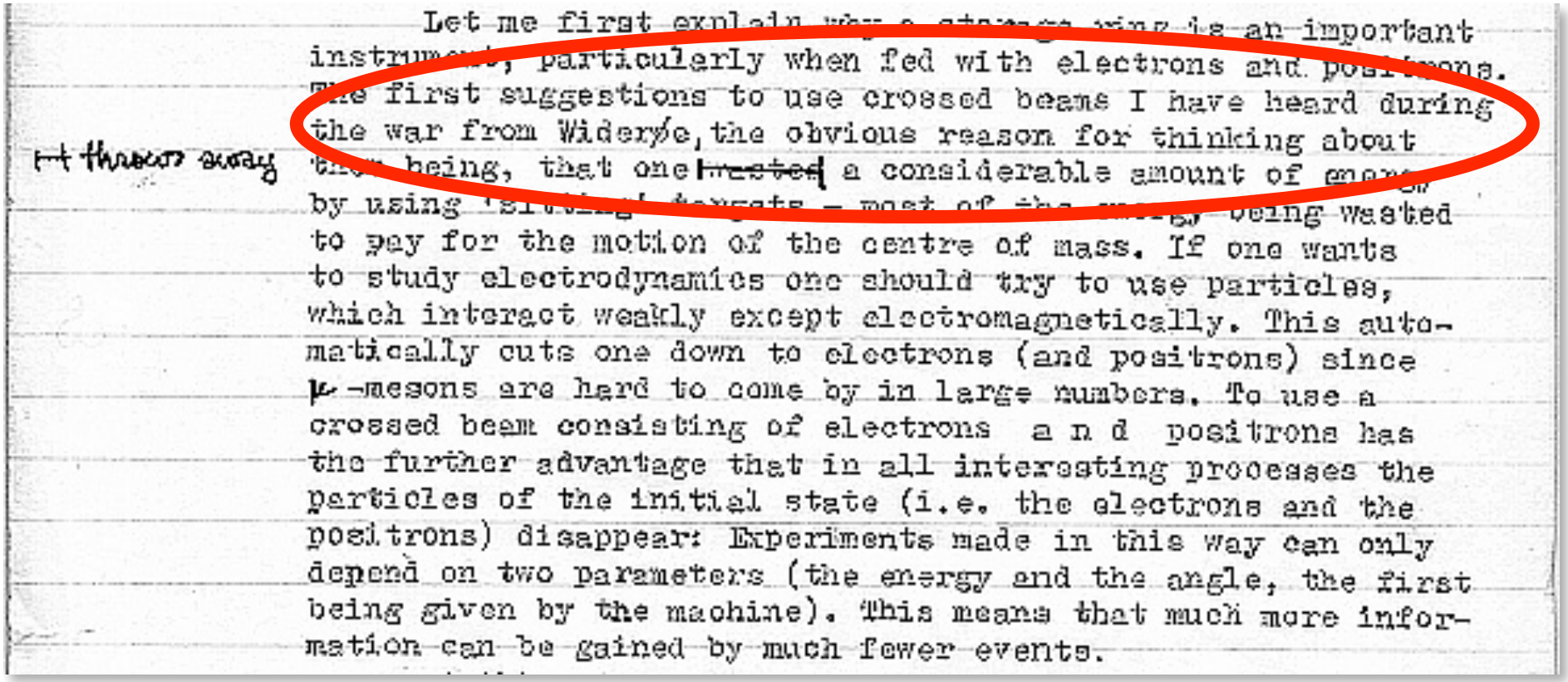


The largest : LEP in Geneva 27 Km around

Ada now in Frascati

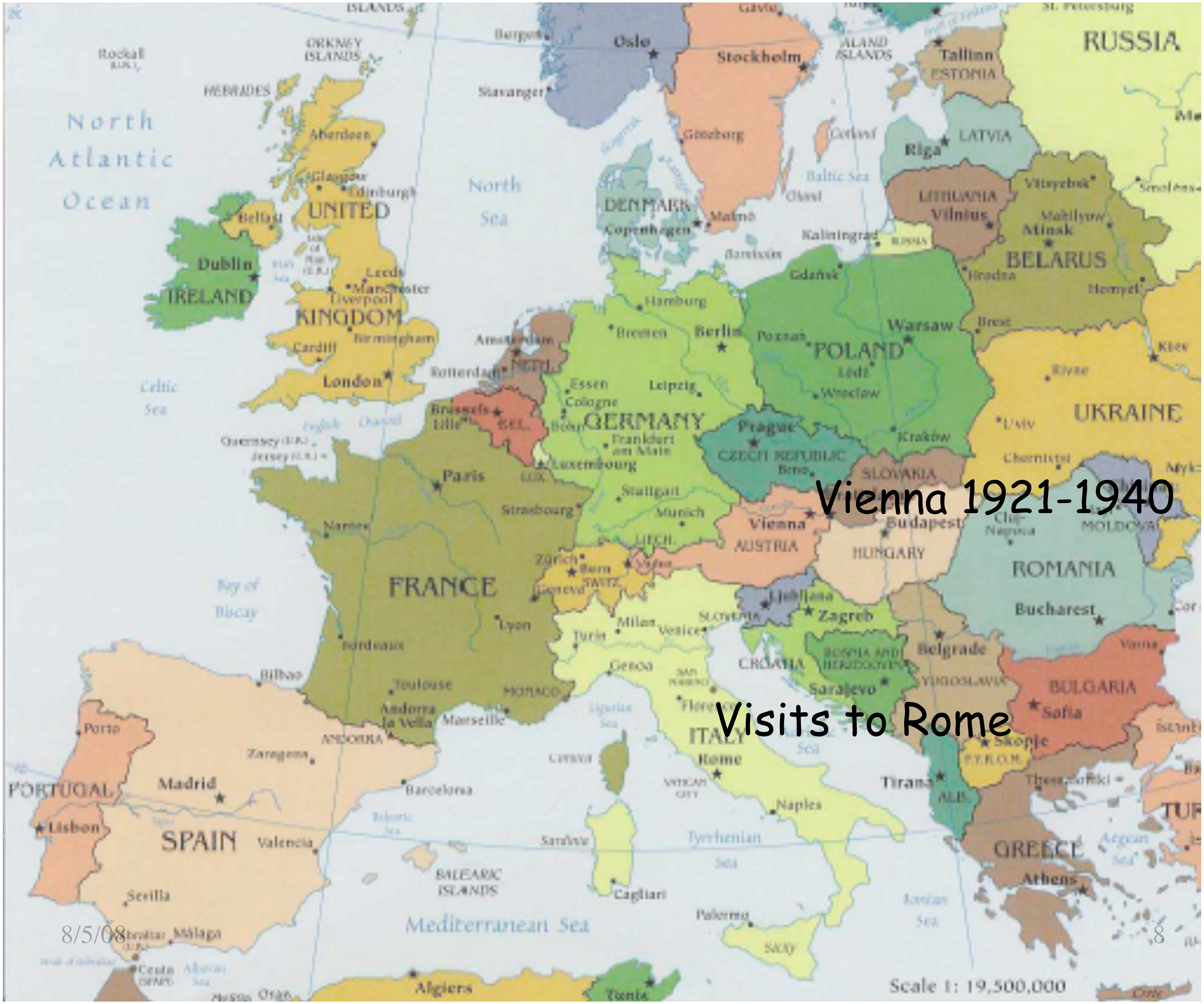
Adone in Frascati

From Touschek's notebook



Let me first explain why a storage ring is an important instrument, particularly when fed with electrons and positrons. The first suggestions to use crossed beams I have heard during the war from Wideröe, the obvious reason for thinking about them being, that one ~~wasted~~ a considerable amount of energy by using 'stirring' targets - most of the energy being wasted to pay for the motion of the centre of mass. If one wants to study electrodynamics one should try to use particles, which interact weakly except electromagnetically. This automatically cuts one down to electrons (and positrons) since μ-mesons are hard to come by in large numbers. To use a crossed beam consisting of electrons and positrons has the further advantage that in all interesting processes the particles of the initial state (i.e. the electrons and the positrons) disappear: Experiments made in this way can only depend on two parameters (the energy and the angle, the first being given by the machine). This means that much more information can be gained by much fewer events.

threw away


Vienna 1921-1940
Visits to Rome
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Mediterranean Sea
Algiers
Scale 1: 19,500,000

From Touschek's recollections (E. amaldi and G. Sacerdoti)

When Austria was annexed to Germany in 1938, life became very difficult for the jewish people in Vienna. Bruno had to stop attending classes because jewish students had been expelled from the lyceum and had to pass his matura as private student, as most jewish student had to do. He spent one year in Rome with his maternal aunt Adele, married to an Italian businessman, but then came back and enrolled in the University. When things became very difficult, Paul Urban, then a young Assistant Professor, himself in a precarious position, helped him meet Arnold Sommerfeld in Munich and through him continue his studies with Paul Harteck's help in Berlin.


Berlin-Hamburg 1940-1945
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Celtic Sea
Bay of Biscay
Mediterranean Sea
Adriatic Sea
Tyrrhenian Sea
Aegean Sea
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In Germany, during WWII, in Hamburg and Berlin, at the end in prison, Touschek started to work on particle accelerators

There had been a project to built a betatron and put it on an airplane and from it shoot a beam of electrons todestroy enemy's planes

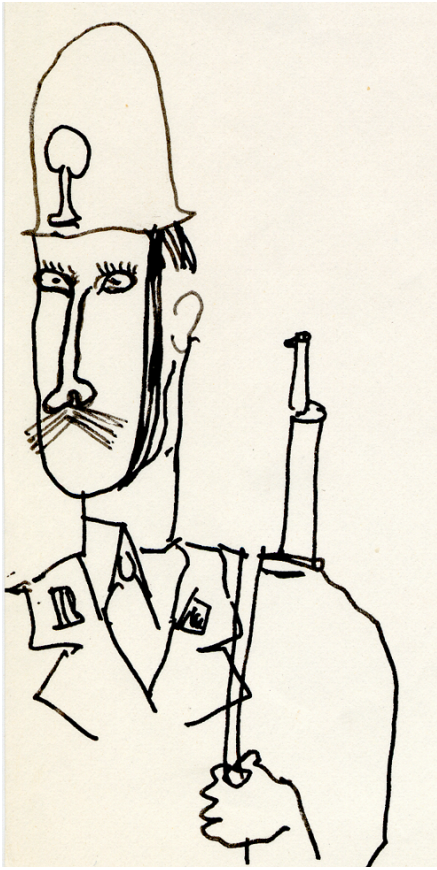
To do this, the Germans had called the norwegian physicist Rolf Wideroe

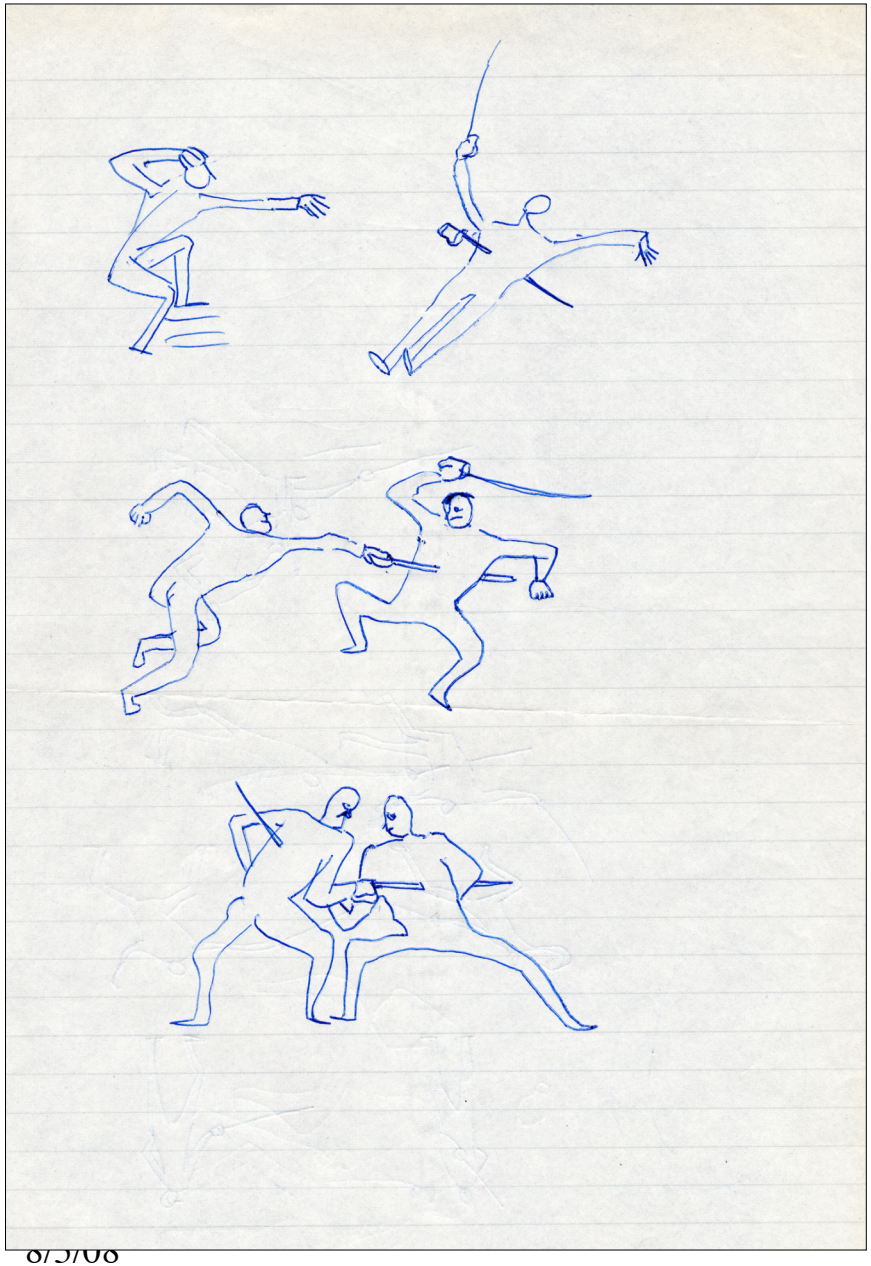
Wideroe would go to and talk physics with Touschek while Touschek was in prison and would bring him cigarettes and wine, while discussing in English Heitler's "Radiation Theory"

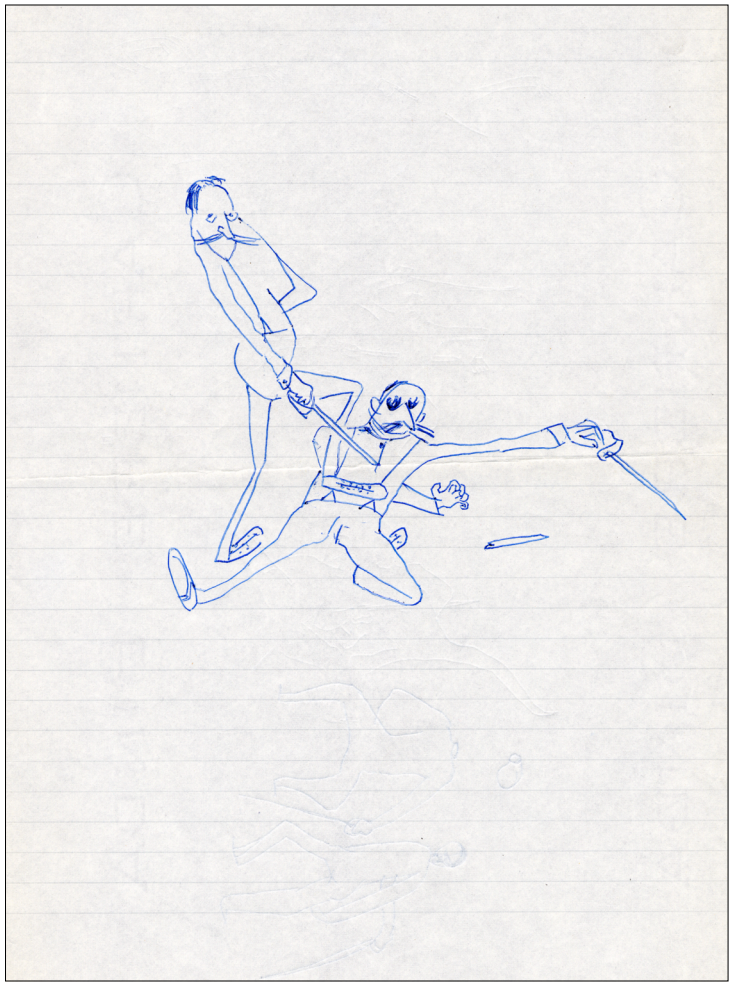
Rolf Wideroe a 18 anni

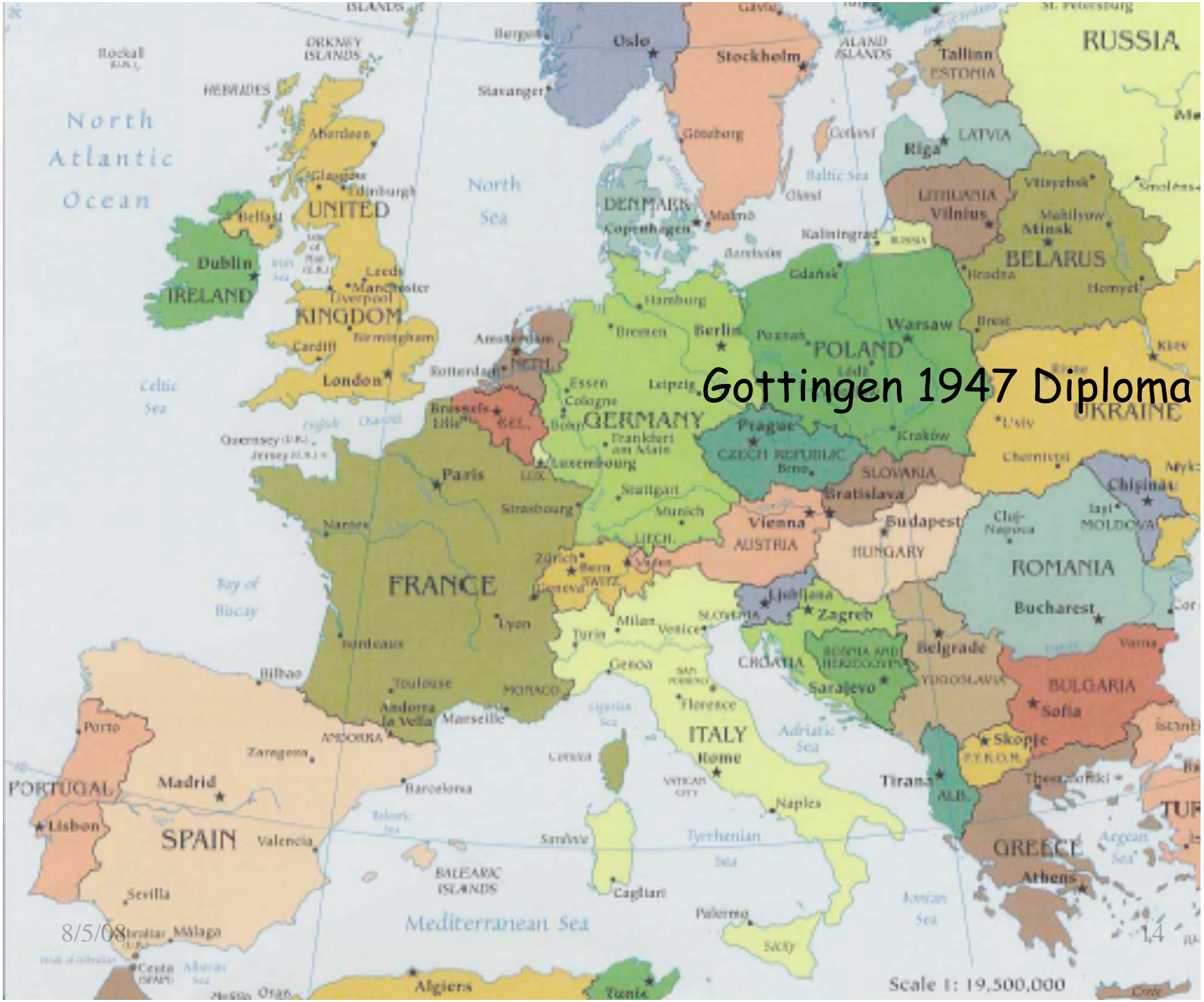
Giancarlo Sacerdoti remembers his conversations with BT in 1960 while going from Rome to Terni to get the magnets for AdA

- Wideroe's betatron was finished 1944, but the allied troops were soon arriving and BT was to be transferred from prison to the Kiel concentration camp
- Along the way, weakened by fever and slowed down by the heavy books he was always carrying with himself, he fell to the ground
- A soldier shot him to the head and left him for dead on the road side and the other prisoners and the soldiers moved away
- But it was only a superficial wound and he was able to get up and walk to a hospital, saving his life








Gottingen 1947 Diploma
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Glasgow 1947-1952 PhD
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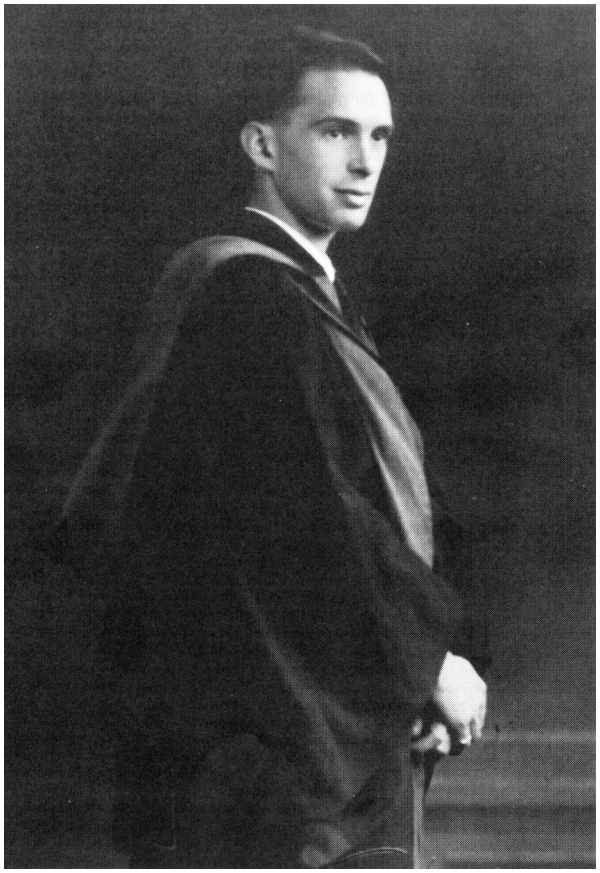
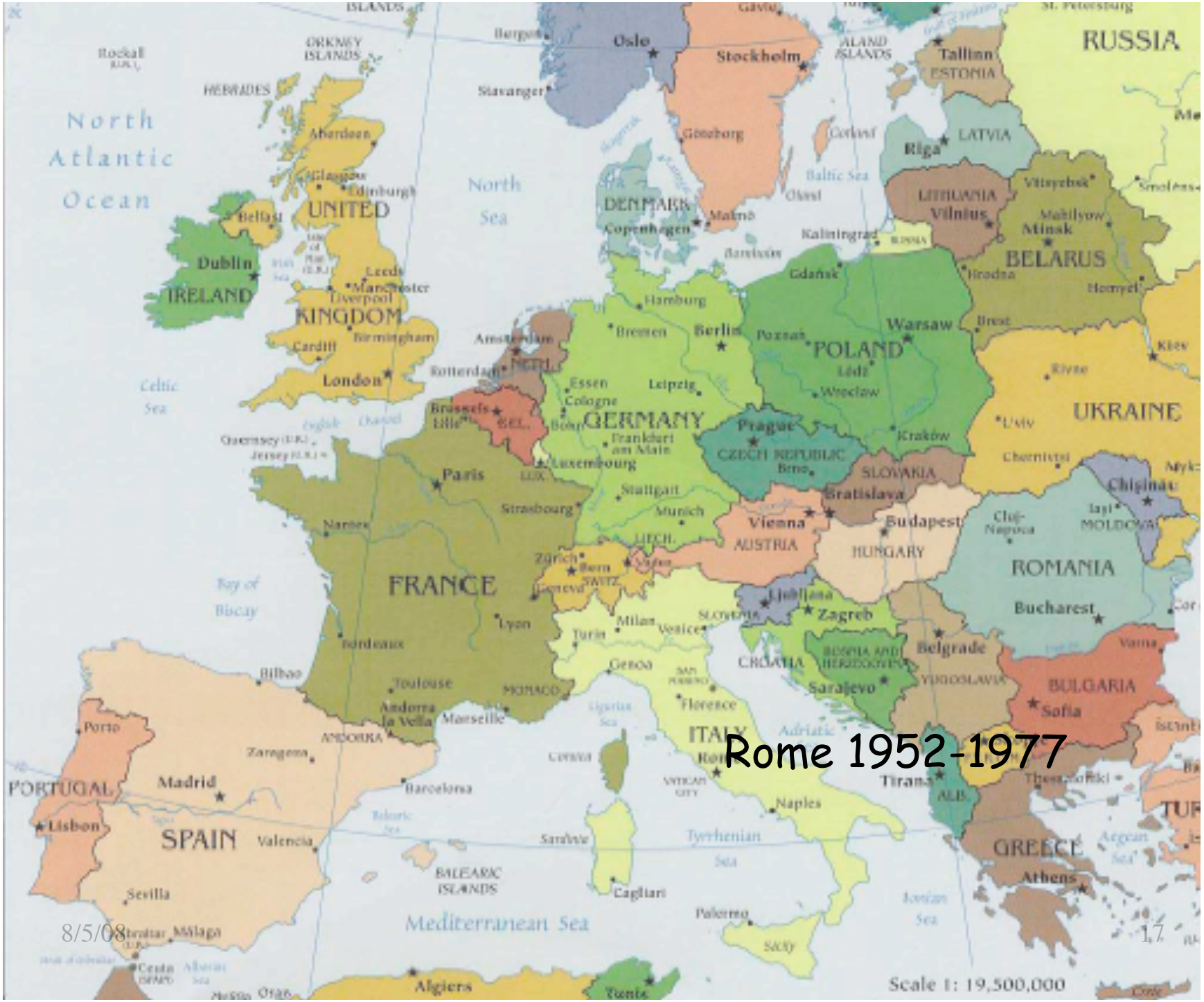
Touschek in Glasgow

- In 1947, after obtaining his diploma from Gottingen, Bruno Touschek went to Glashow where with a fellowship and started being interested in the construction of the 350 MeV synchrotron under the direction of P.I. Dee
- He was awarded his PhD in 1947 , his internal rapporteur was J.Gunn and the external one Rudolph Peierls
- In 1950 Walter Thirring came to Glasgow as a Nuffield fellow and they worked on the covariant formulation of the Bloch-Nordsieck method in electrodynamics with external currents

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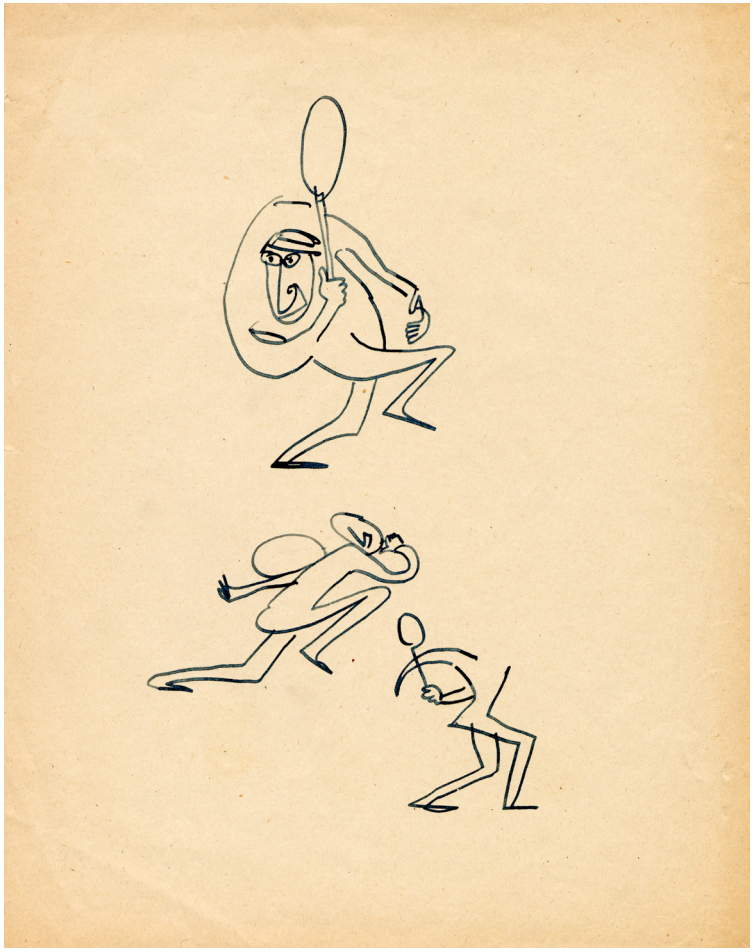
In the '50

BT had an aunt in Rome and started going to the Physics Department and discuss physics: he was offered a position by E. Amaldi e decided to come and live in Rome

E. Amaldi's rembers : Shortly after his arrival, we started playing tennis together, sometime Francesco Calogero would also join us



Bruno Touschek with Edoardo and Ginestra Amaldi during an excursion Castelli Romani (Frascati and surroundings) in 1953

Years in Rome

In Rome, in the '60s Bruno lived with his family and their two cats, named Pauli and Planck, in Via Saliceto, 5 , near the University

Students e Collaborators at University of Rome

- His two first diploma students were Nicola Cabibbo and Francesco Calogero
- With Raoul Gatto (and others) he wrote the proposal to build ADONE
- Other diploma students or postdocs
  - Paolo Di Vecchia
  - Giancarlo Rossi
  - Mario Greco
  - G.P.
  - Luciano Pietronero

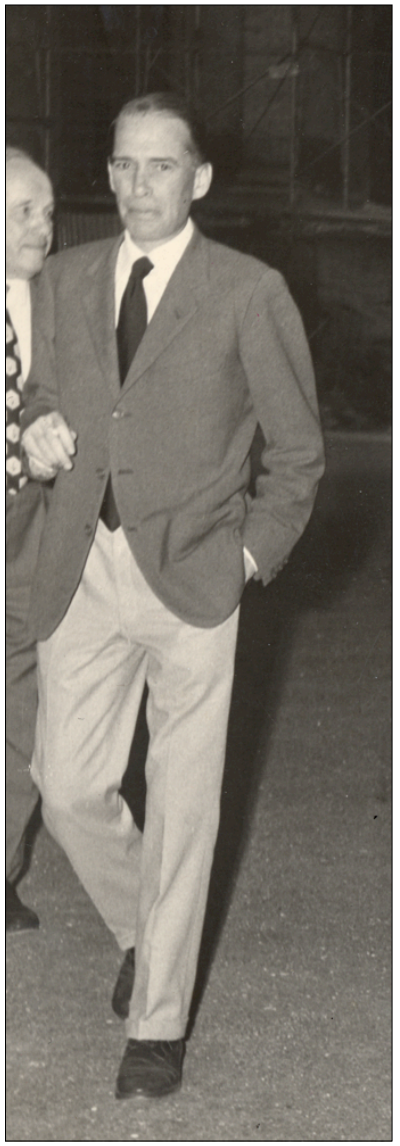
Carlo Rubbia writes

- I met him while I was studying in Pisa in 1956, and Touschek was coming from Rome to lecture at the Scuola Normale
- Parity violation had just been discovered
- Bruno was fascinated by the role played by symmetries
- A few years later, meeting him again in Rome, he would say forcefully : **electrons and positron must meet because of CPT !**

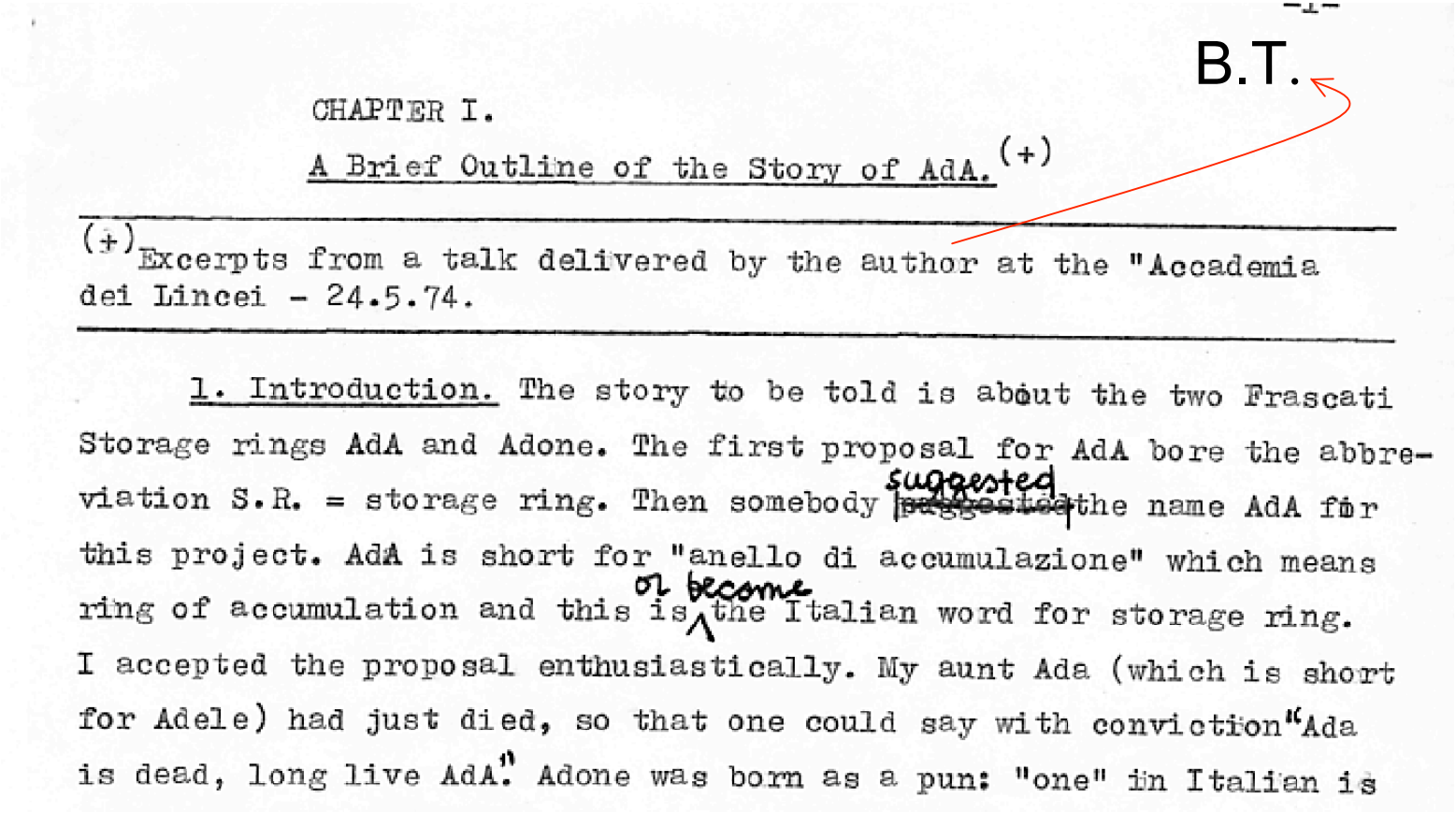
T.D. Lee, in a drawing by B. Touschek

Ada

- The machine was made in less than a year
- Touschek liked the idea to call it AdA, like his aunt
- The name came from Anello di Accumulazione (Storage Ring)



The origin of the name AdA



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B.T.

CHAPTER I.

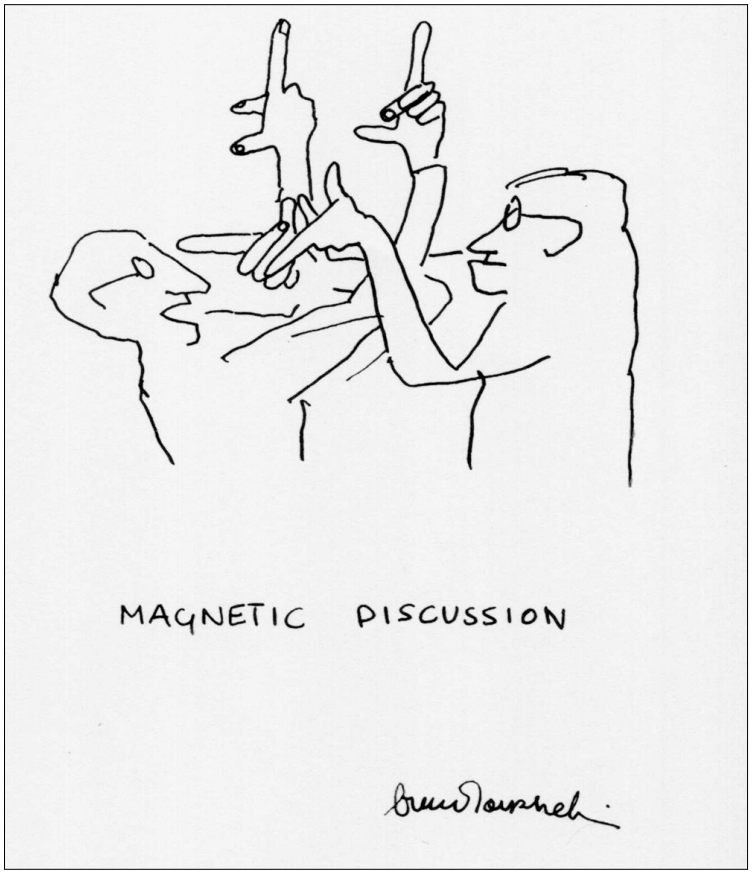
A Brief Outline of the Story of AdA.(+)

(+) Excerpts from a talk delivered by the author at the "Accademia dei Lincei - 24.5.74.

1. Introduction. The story to be told is about the two Frascati Storage rings AdA and Adone. The first proposal for AdA bore the abbreviation S.R. = storage ring. Then somebody ~~suggested~~ suggested the name AdA for this project. AdA is short for "anello di accumulazione" which means ring of accumulation and this is or become the Italian word for storage ring. I accepted the proposal enthusiastically. My aunt Ada (which is short for Adele) had just died, so that one could say with conviction "Ada is dead, long live AdA!" Adone was born as a pun: "one" in Italian is

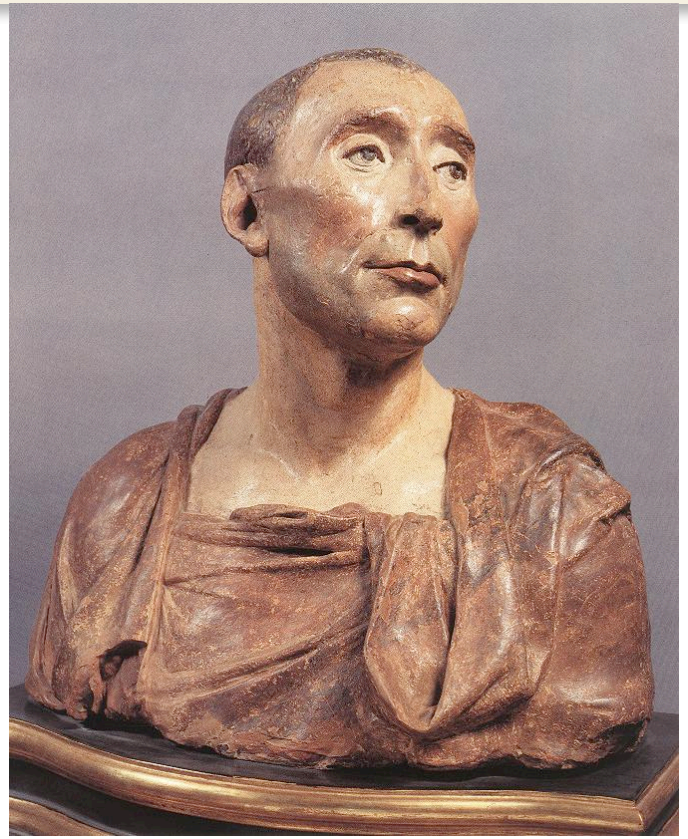
Adone

- At the end of 1960 Touschek proposed to build a more powerful machine, ADONE
- ADONE was built between 1965 e il 1968 in the building now housing the phi-factory DAFNE

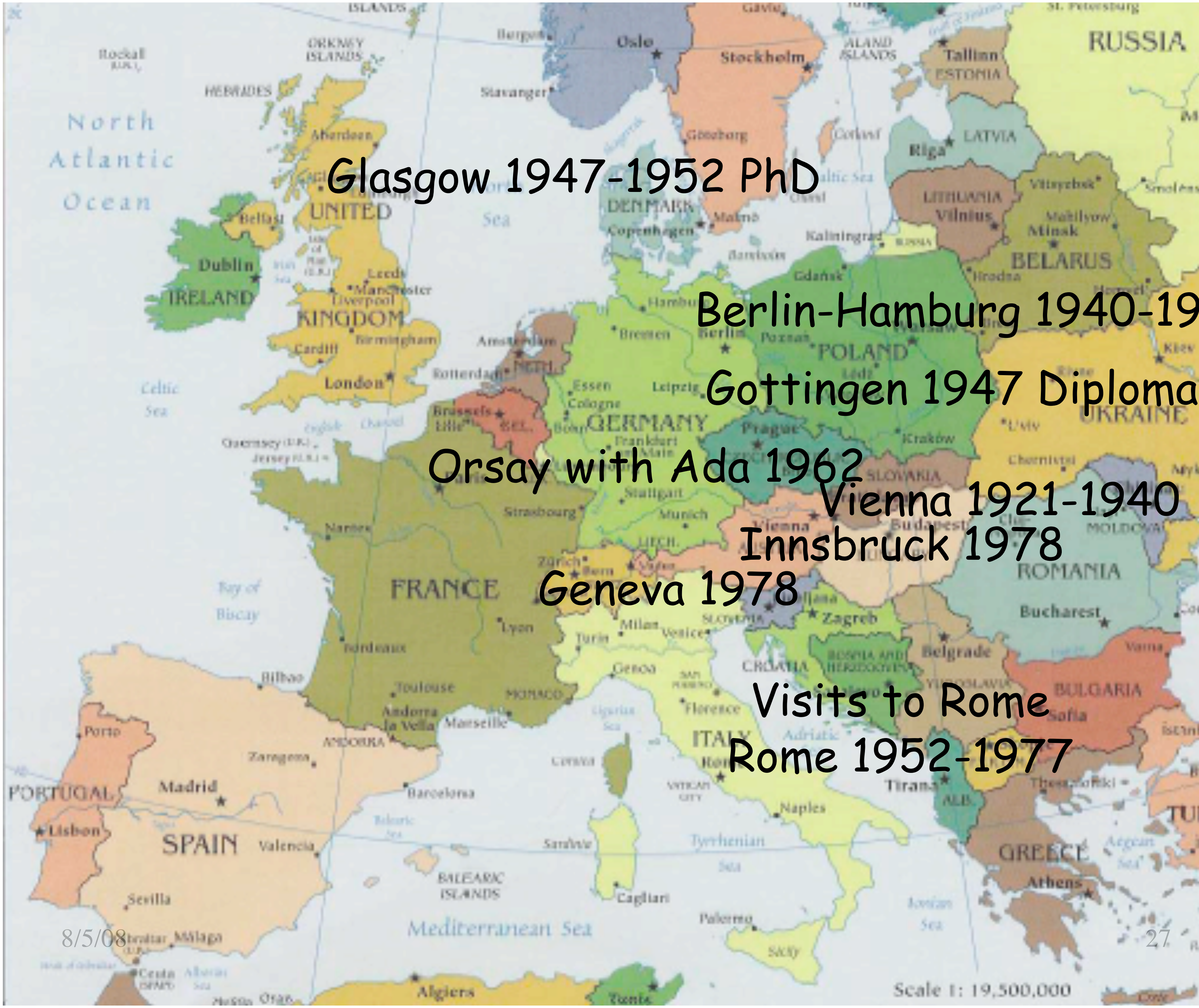


- Bruno died in 1978,four years before the discovery of W and Z
- Bruno had then lived only the first Renaissance of particle Physics(1960-1978): as if he had lived through the "Quattrocento" and missed the "Cinquecento" (the 80s)
- He was then like some figures by Donatello, the sculptor, who anticipated the great artistic and intellectual discoveries which were to come a few decades later

A comment by Gilberto Bernardini r



Niccolo' da Uzzano by Donatello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Orsay with Ada 1962
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Innsbruck 1978
Geneva 1978
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Rome 1952-1977

Touschek's life spans Europe in space and time

- 1921 BT was born in Vienna, Austria
- 1921-1940 in Austria (with periodic visits to Italy)
- 1940-1947 in Berlin, Hamburg and Gottingen,Germany
- 1947-52 in Scotland (with occasional visits to Italy)
- 1952-1977 in Rome, Italy (with an important travel to France)
- 1978 in Geneva, Switzerland with LEP
- May 1978, BT dies in Innsbruck, Austria