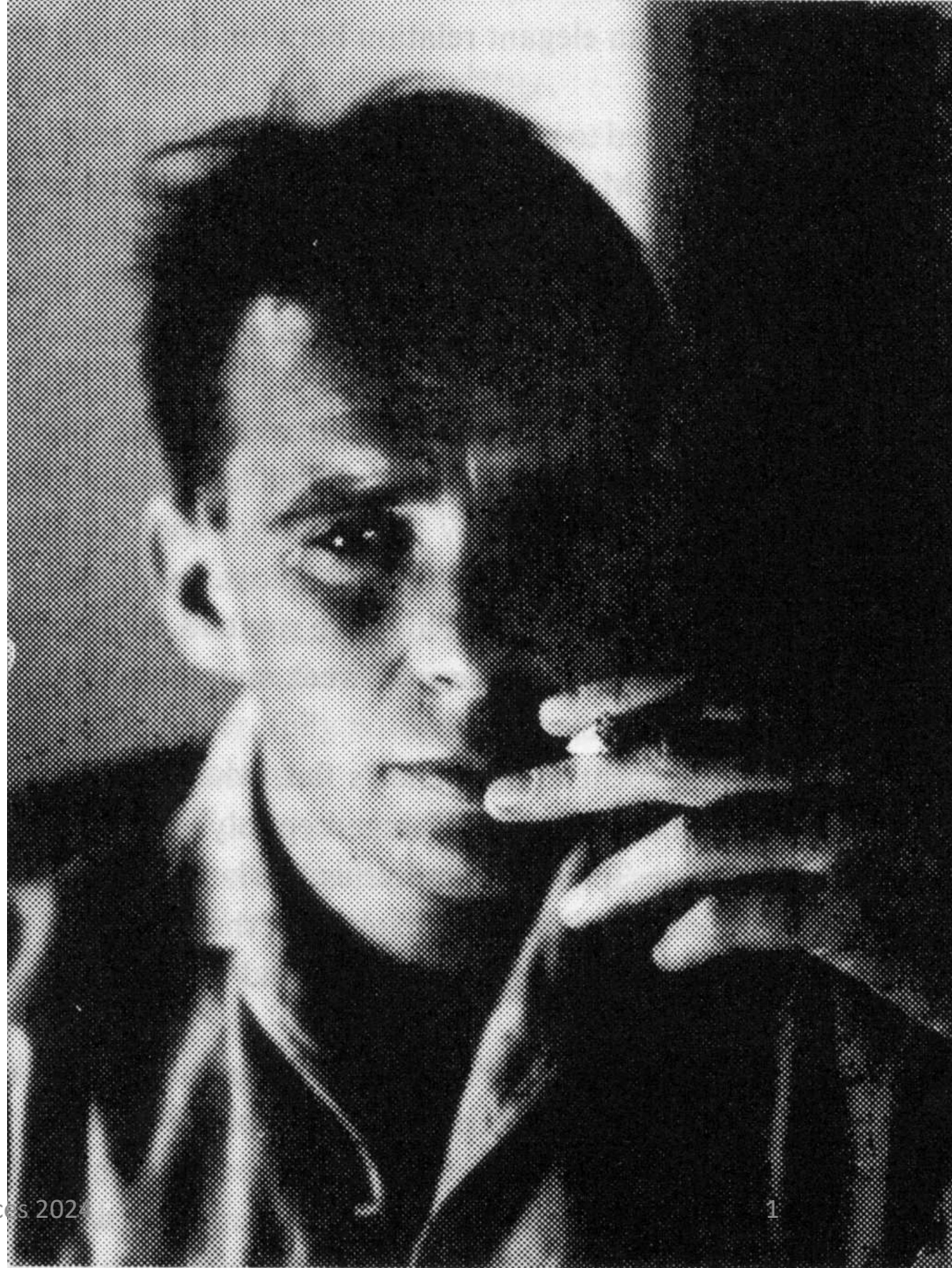
Bruno Touschek

Vienna 1921 – Innsbruck 1978

A master's legacy to elementary particle science

AdA: The first e+e- collider

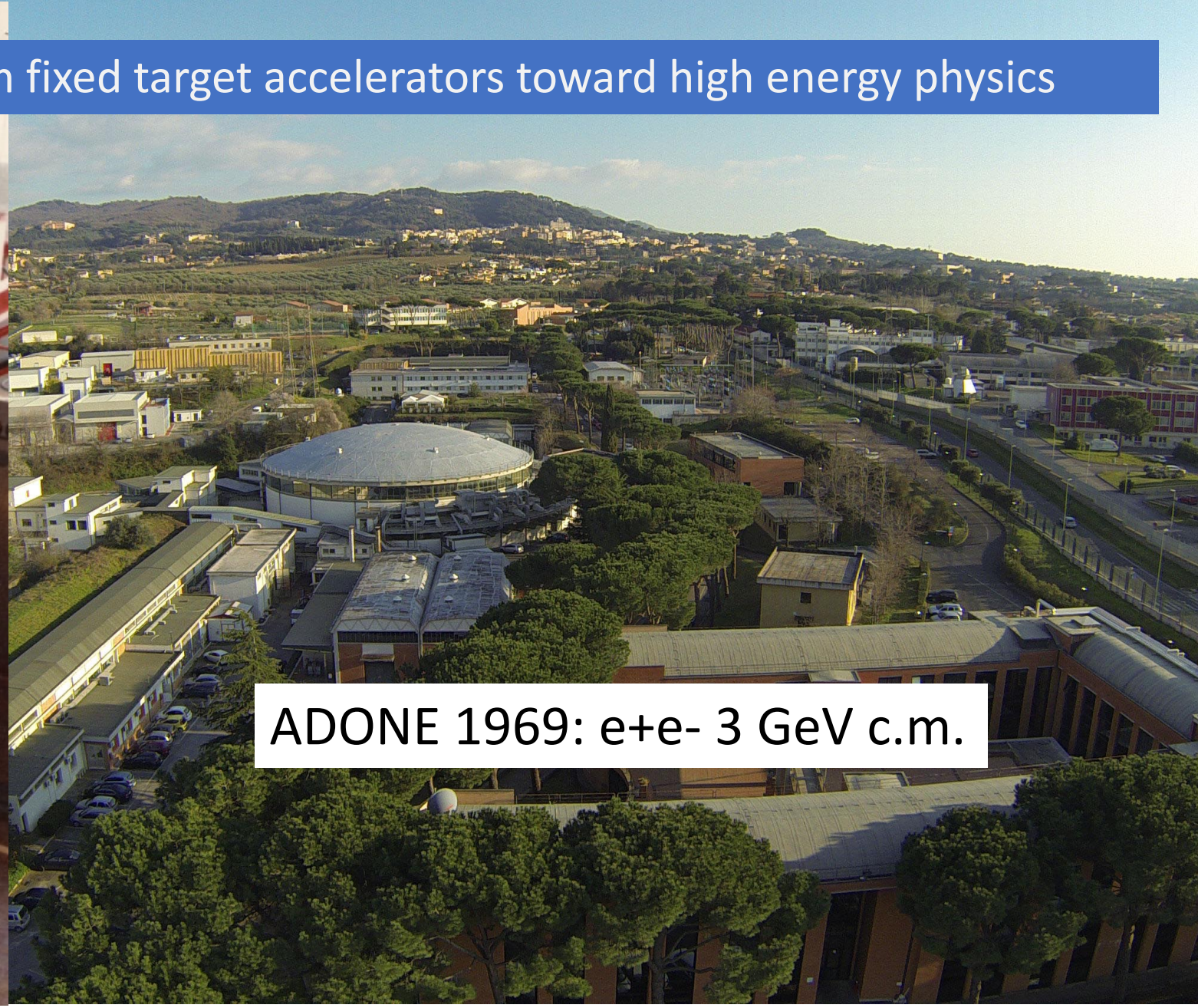


Giulia Pancheri

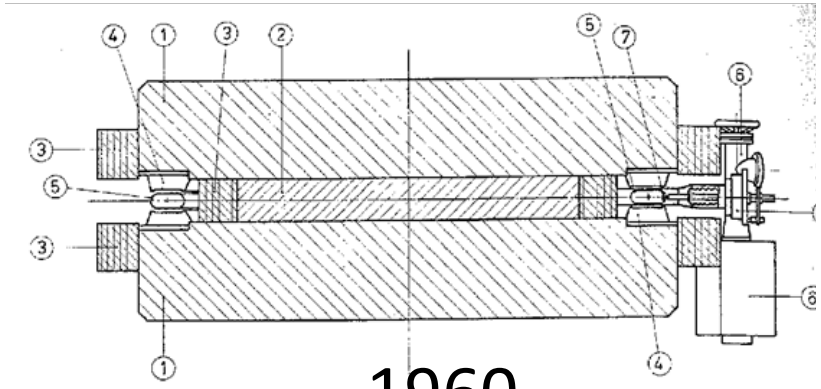
INFN Frascati National Laboratories

An Extraordinary Journey away from fixed target accelerators toward high energy physics

Frascati National Laboratory
AdA 1960: e+e- 0.5 GeV c.m.



ADONE 1969: e+e- 3 GeV c.m.



1960

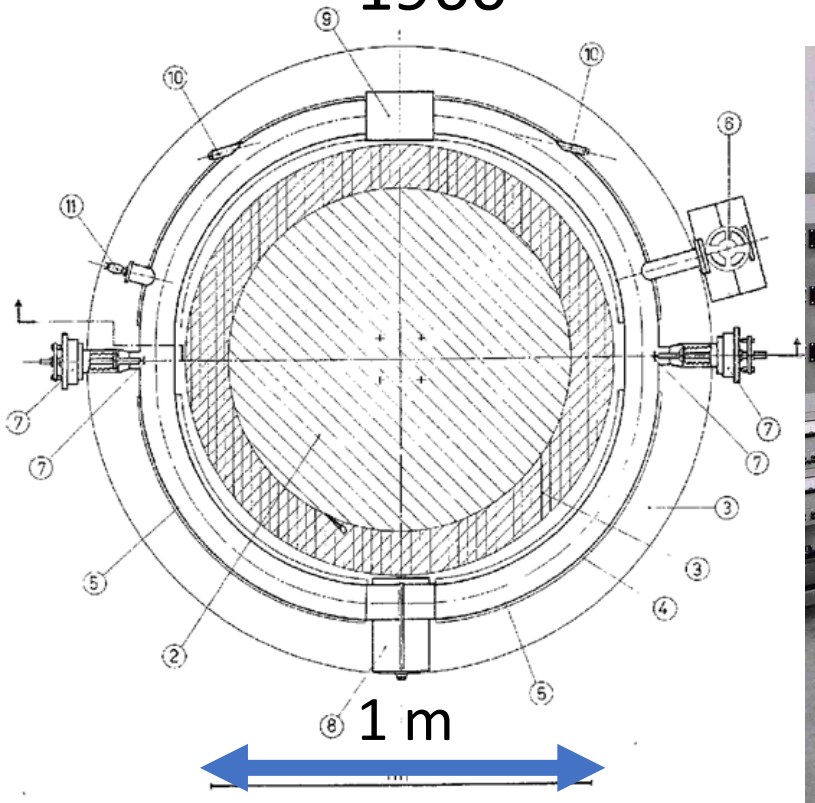
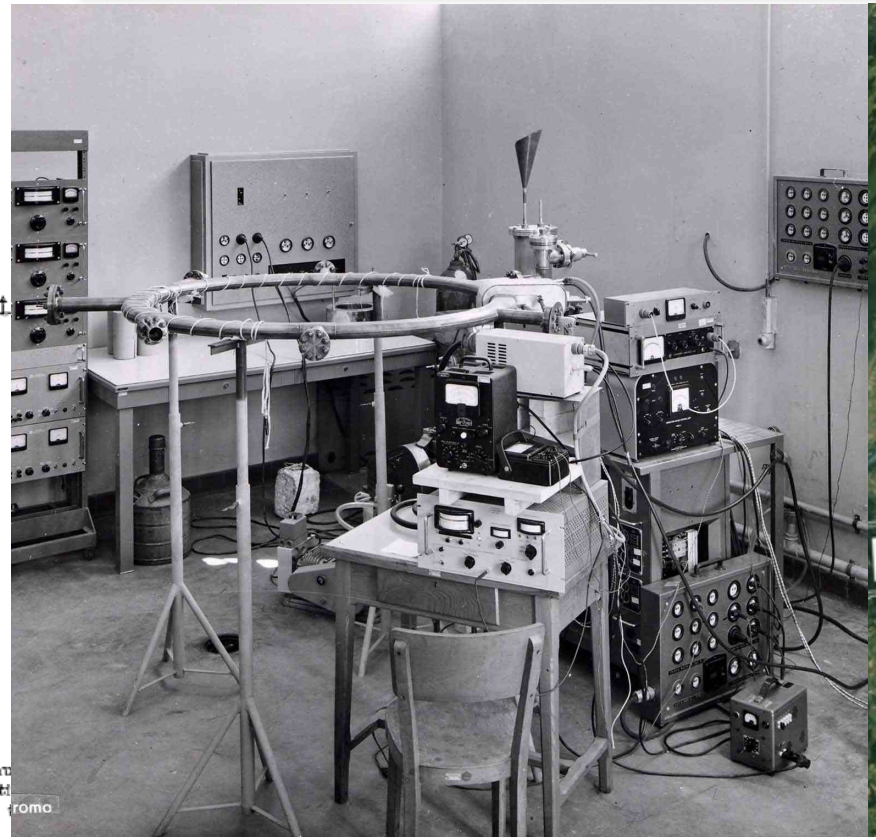


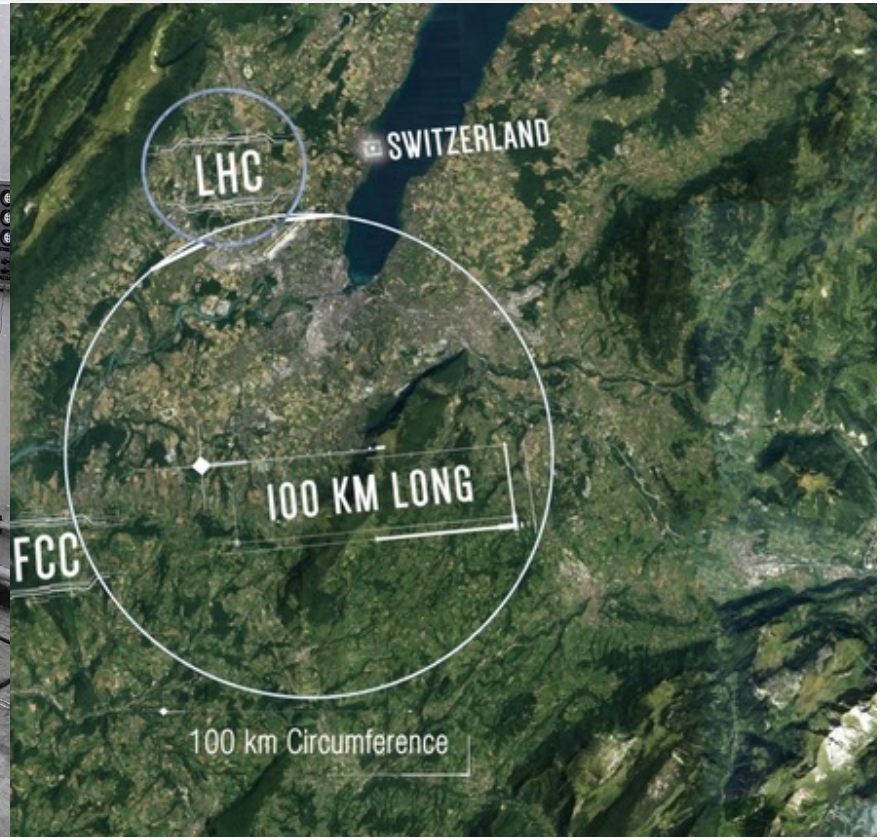
Fig. 1. – Elevation and plan section of the Frascati Storage Ring (anello di accumu
zione = AdA): 1) magnet yoke; 2) magnet core; 3) coils; 4) polepieces; 5) doughnut; 6) ti
nium pump; 7) injection ports; 8) RF cavity; 9) experimental section; 10) windows for
observation of the synchrotron radiation; 11) vacuum gauge.

Electrons against positrons:

from AdA's ring

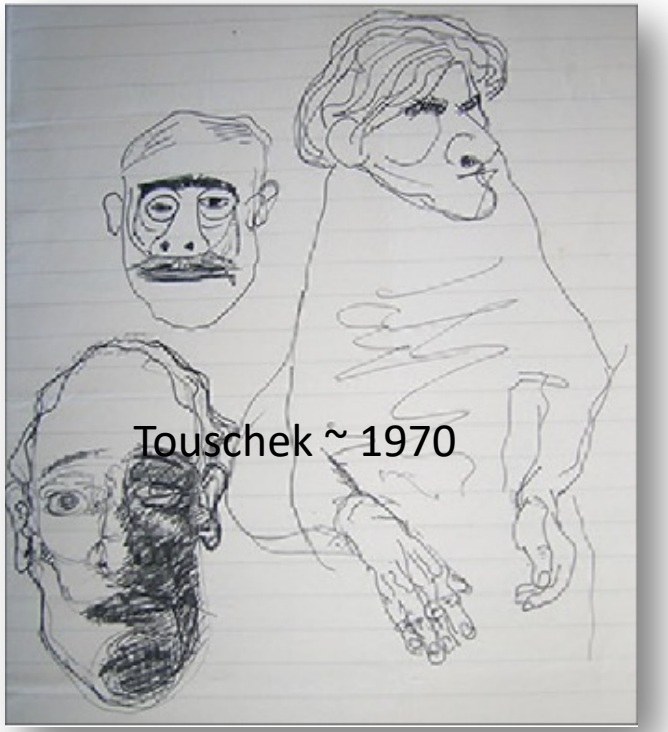
to future colliders

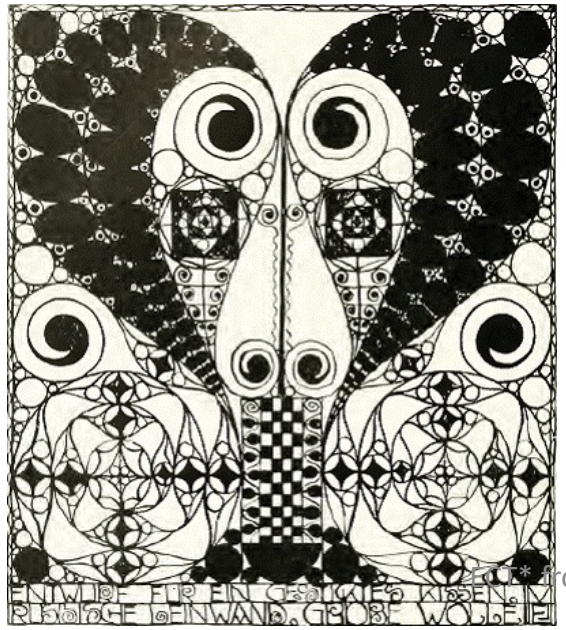




Bruno Touschek was born in Vienna on February 3rd, 1921, his mother was Jewish, the father an officer in the Austrian Arny

- Secession cultural Influences (mother's side)
- Egon Schiele
- Oskar Kokoschka with whom Bruno studied drawing as a child
- Karl Kraus

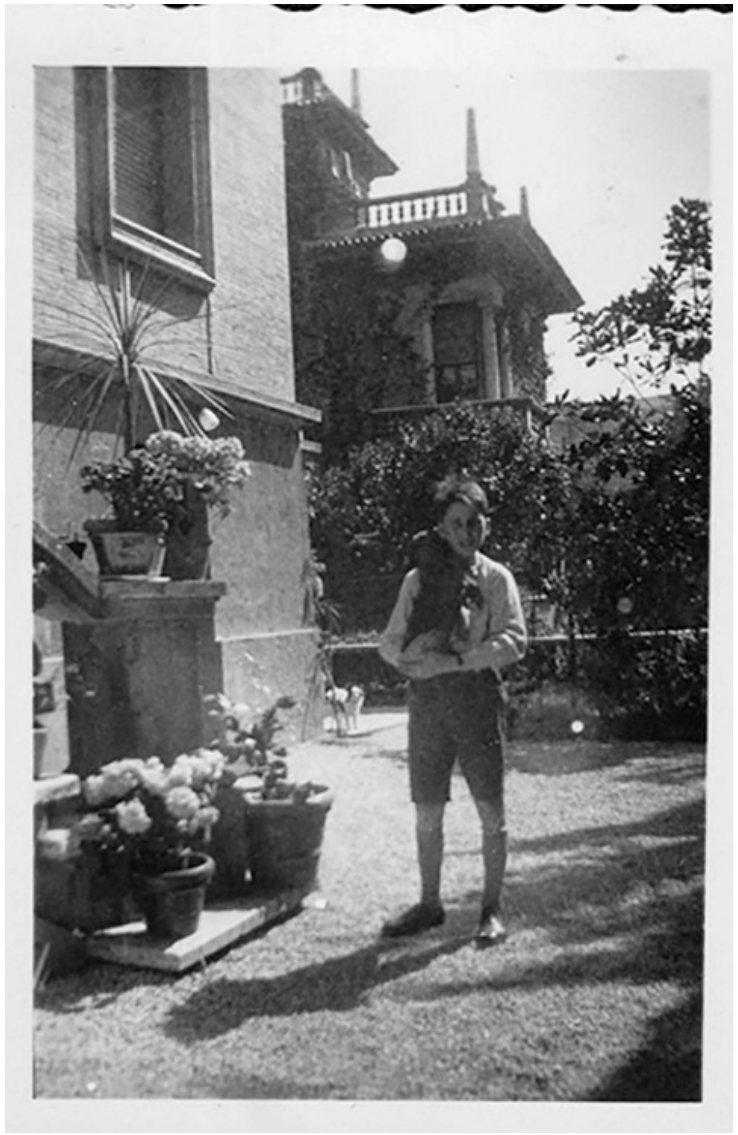




Kokoschka was Bruno's drawing teacher

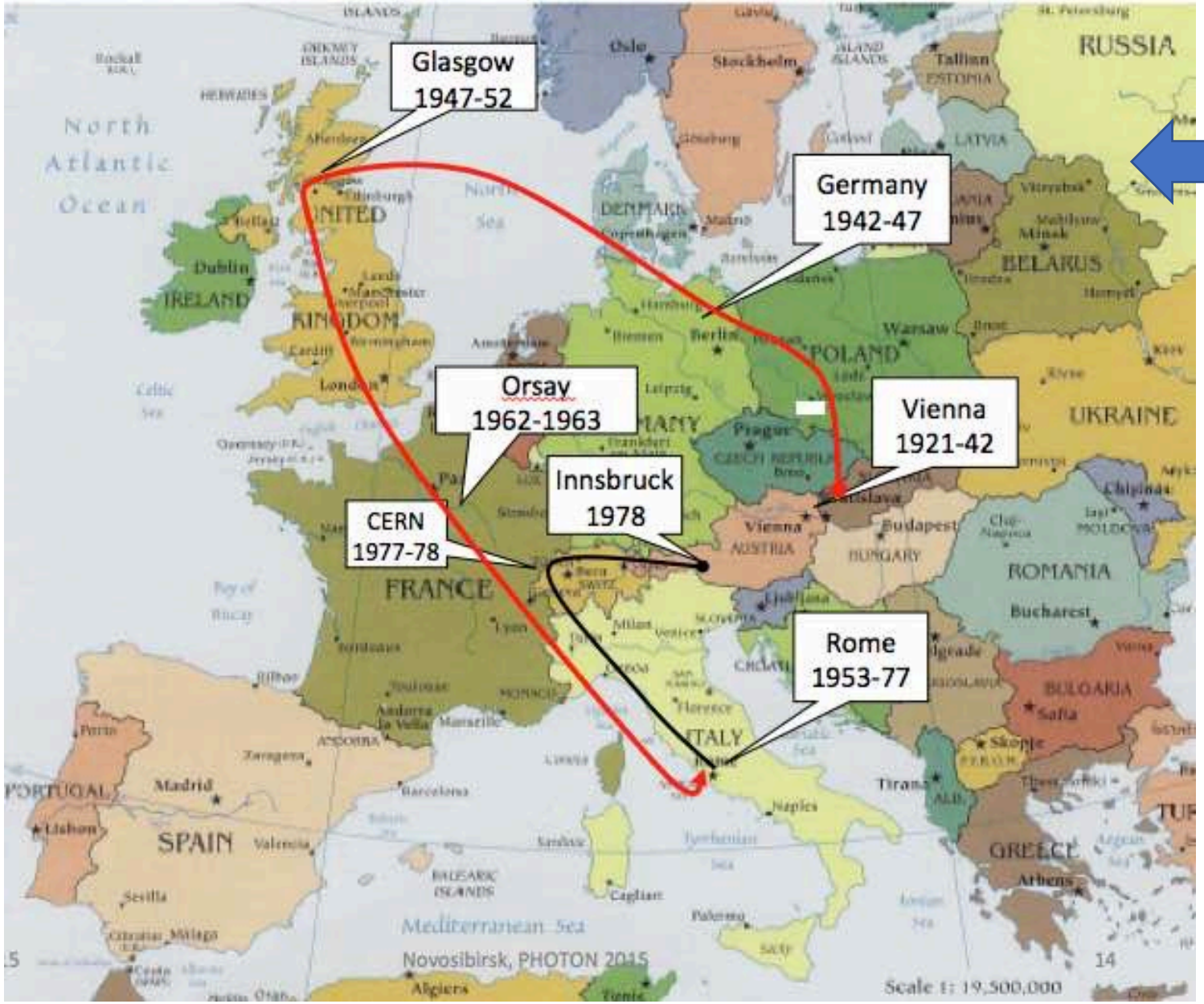
Works by Josef Emanuel Margold
Artist of the Wiener Werkstätte Circle and family member from maternal side

Rome: visits to aunt Ada and lectures in Theoretical Physics at the University of Rome (1938 or 1939)



- March 1938 : Annexation of Austria to Germany
- BT was probably in Rome early May 1938 (during Hitler's visit)
- and certainly in 1939, as from 3 letters sent to his father in March 1939
- In 1939 tried to emigrate to the UK

  but ????
- In September 1939 he enrolled to study physics at University of Vienna



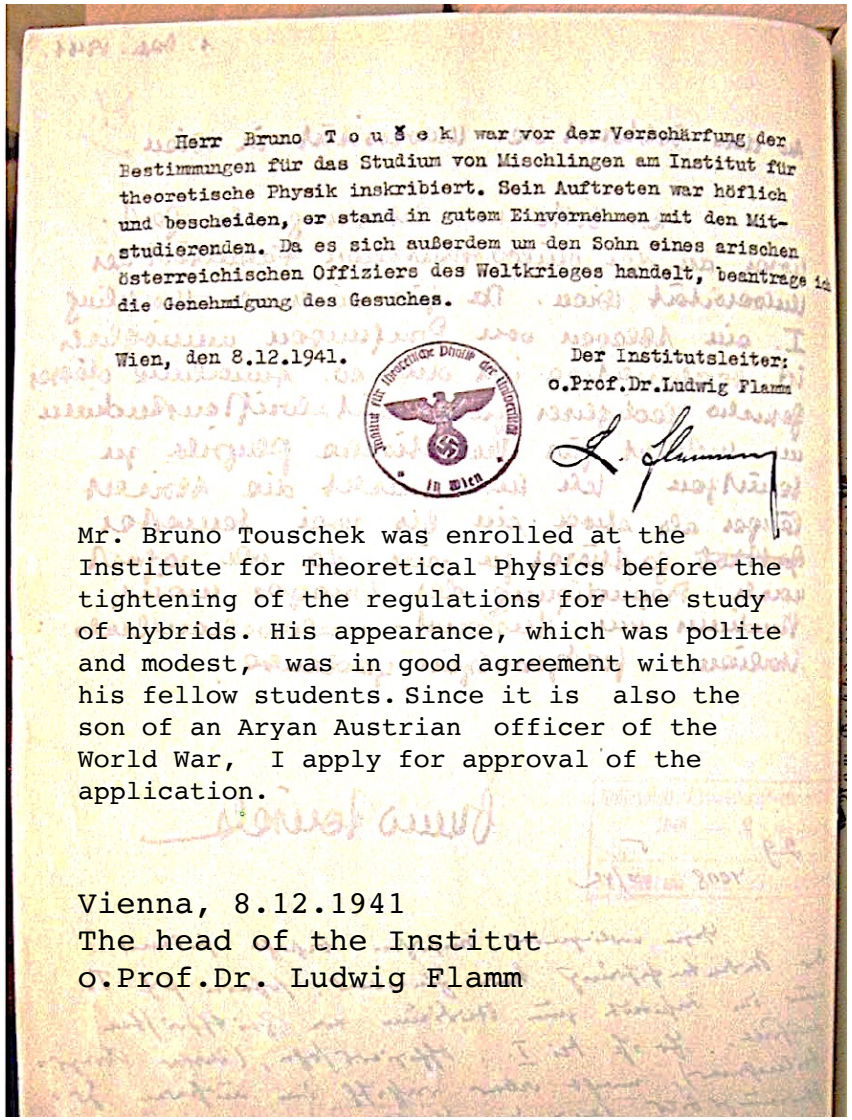
Europe in 1930s

Bruno Touschek

and his life journey

through Europe

In 1942 Bruno was expelled from the University for being of "mixed race"



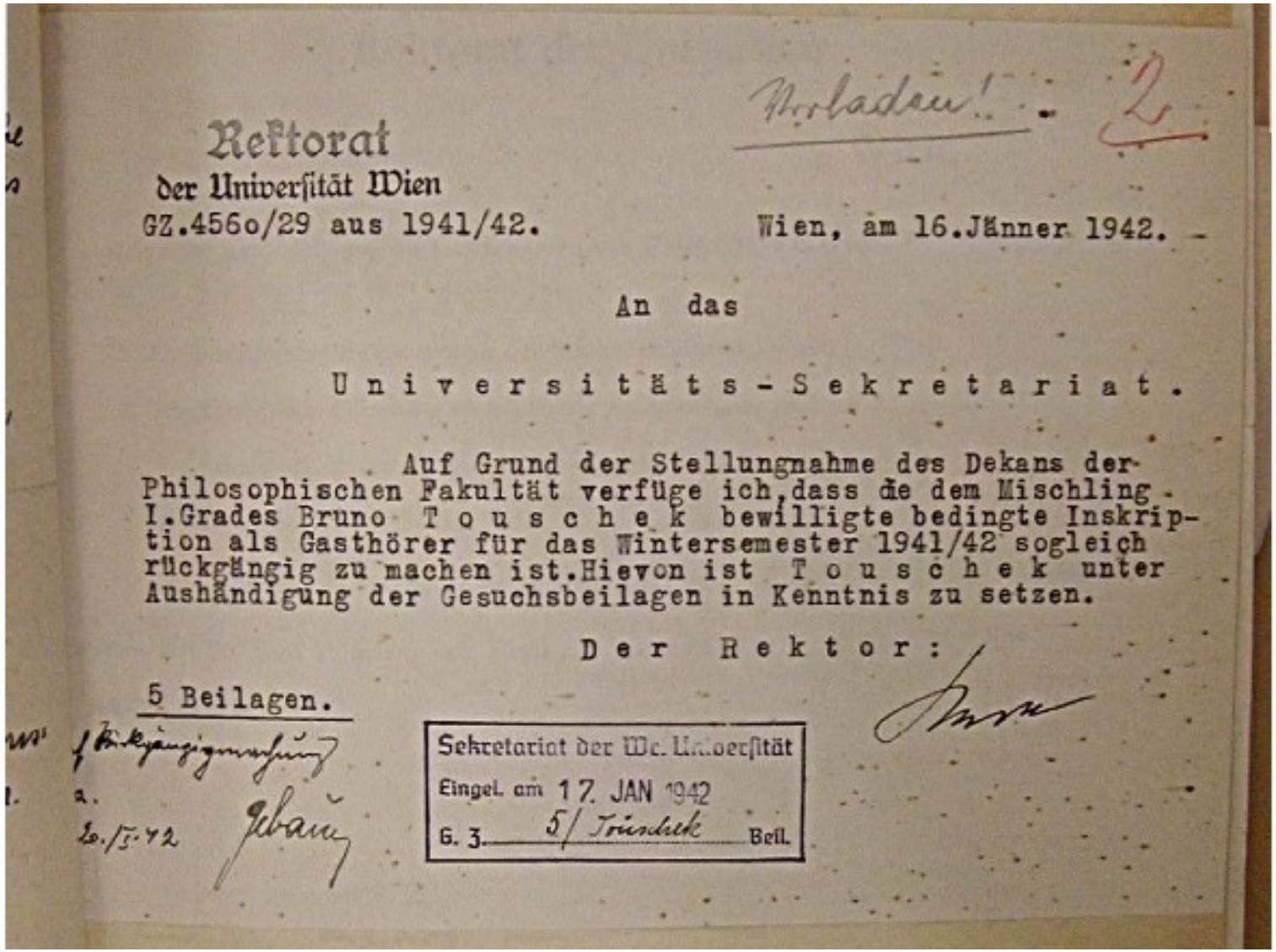
Herr Bruno T o u š e k war vor der Verschärfung der Bestimmungen für das Studium von Mischlingen am Institut für theoretische Physik inskribiert. Sein Auftreten war höflich und bescheiden, er stand in gutem Einvernehmen mit den Mitstudierenden. Da es sich außerdem um den Sohn eines arischen österreichischen Offiziers des Weltkrieges handelt, beantrage ich die Genehmigung des Gesuches.

Wien, den 8.12.1941.

Der Institutsleiter:
o.Prof.Dr.Ludwig Flamm

Mr. Bruno Touschek was enrolled at the Institute for Theoretical Physics before the tightening of the regulations for the study of hybrids. His appearance, which was polite and modest, was in good agreement with his fellow students. Since it is also the son of an Aryan Austrian officer of the World War, I apply for approval of the application.

Vienna, 8.12.1941
The head of the Institut
o.Prof.Dr. Ludwig Flamm



Nochladen! 2

Rektorat
der Universität Wien
GZ.456o/29 aus 1941/42.

Wien, am 16.Jänner 1942.

An das

U n i v e r s i t ä t s - S e k r e t a r i a t .

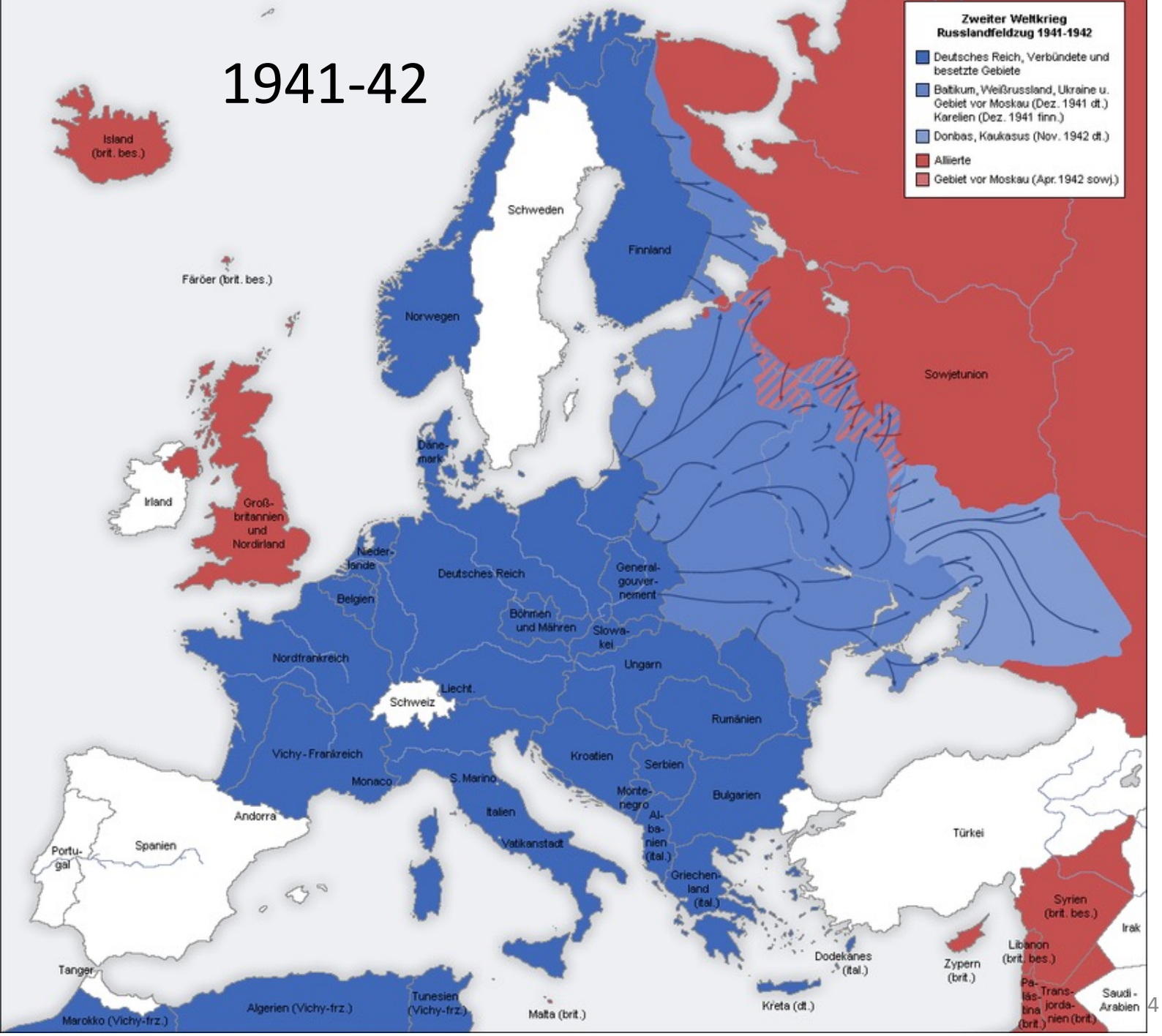
Auf Grund der Stellungnahme des Dekans der Philosophischen Fakultät verfüge ich, dass de dem Mischling I.Grades Bruno T o u s c h e k bewilligte bedingte Inskription als Gasthörer für das Wintersemester 1941/42 sogleich rückgängig zu machen ist. Hievon ist T o u s c h e k unter Aushändigung der Gesuchsbeilagen in Kenntnis zu setzen.

D e r R e k t o r :

5 Beilagen.

Sekretariat der Wr. Universität
Eingel. am 17. JAN 1942
G. 3. 5/ Touschek Beil.

Courtesy Prof. H. Posch, U Vienna

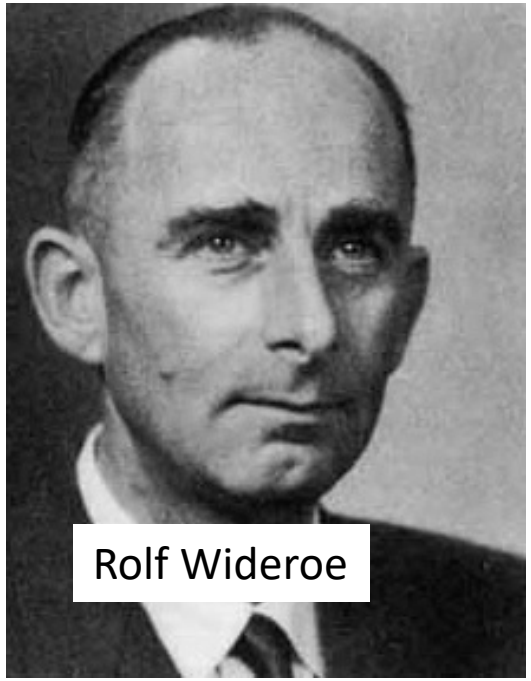


Pedro Waloschek

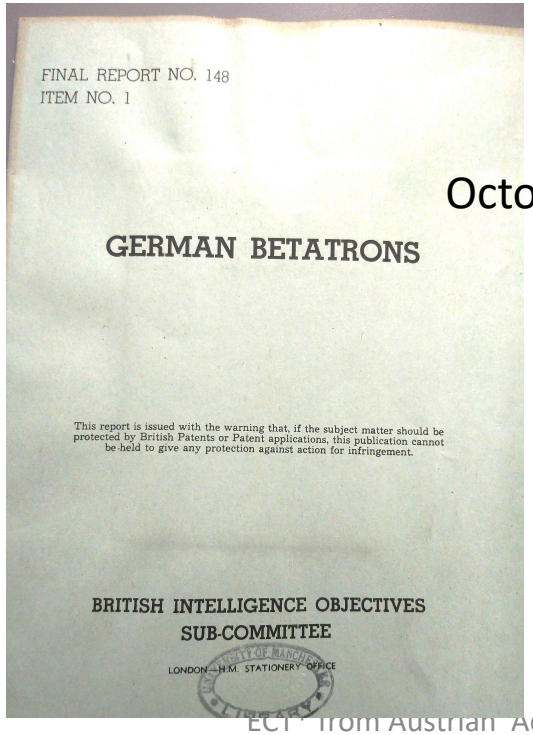
Death-Rays as Life-Savers in the Third Reich

Contents

March 1942: Bruno left Vienna for Germany and in November 1943 joined a secret project led by Rolf Wideroe to build a betatron in Hamburg, financed by the Reich



Rolf Wideroe



FINAL REPORT NO. 148
ITEM NO. 1

GERMAN BETATRONS

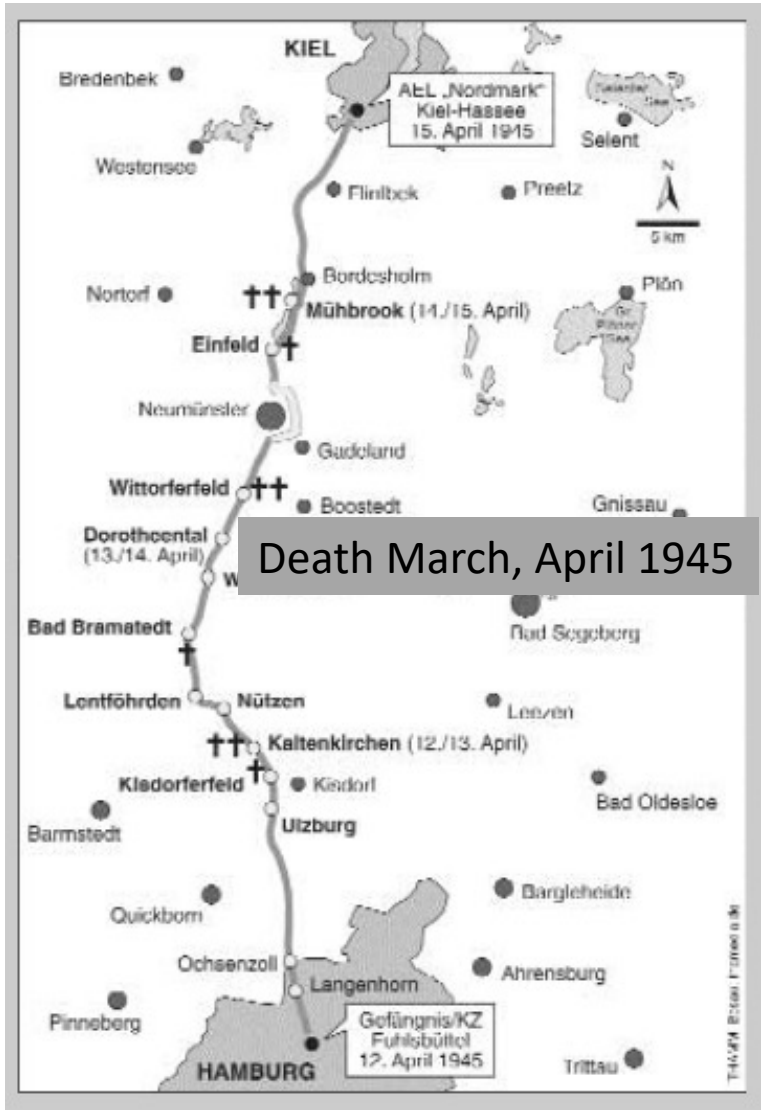
This report is issued with the warning that, if the subject matter should be protected by British Patents or Patent applications, this publication cannot be held to give any protection against action for infringement.

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

October 1945

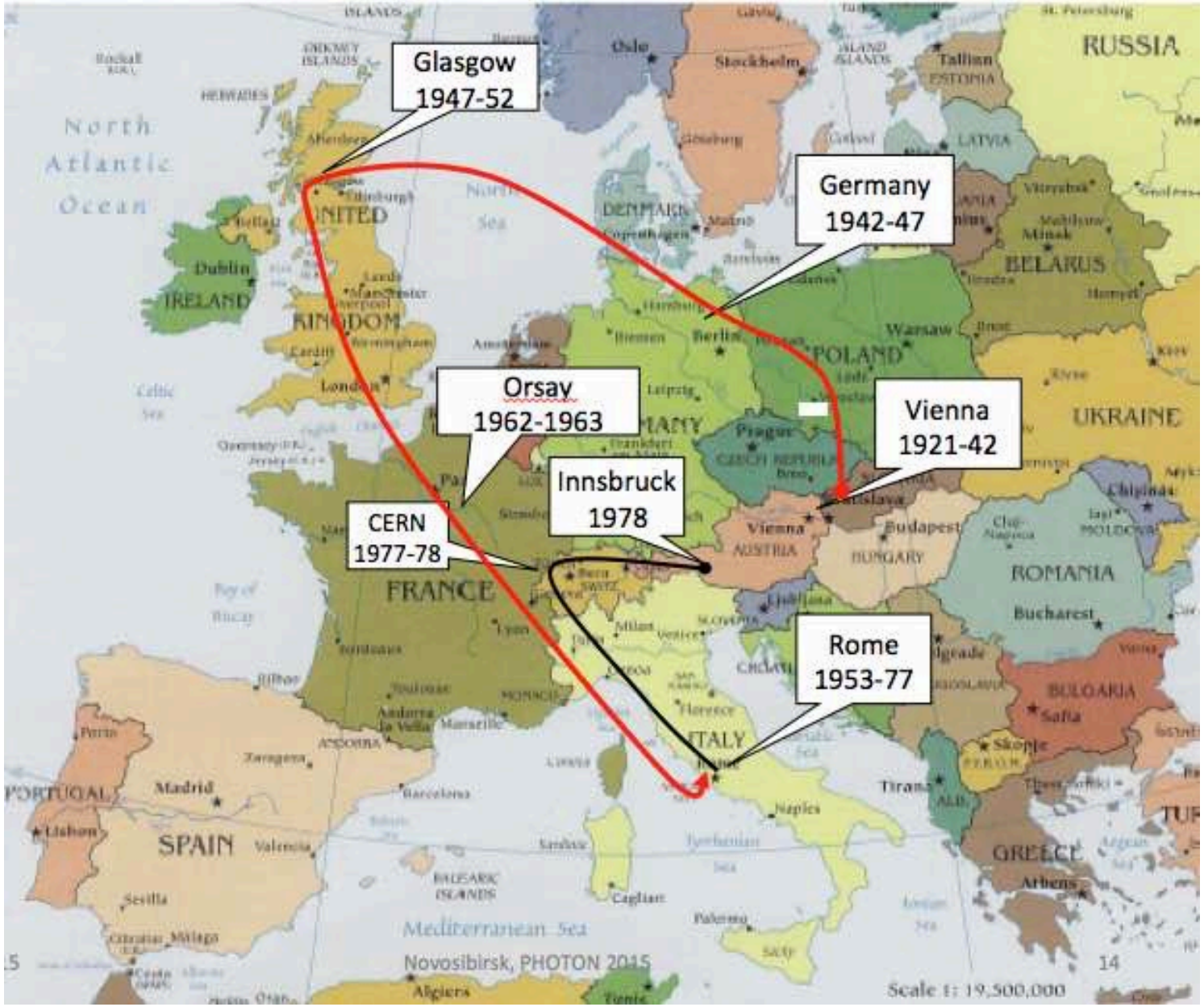
Arrested by the Gestapo in March 1945, he narrowly escaped death and deportation to the Kiel deportation camp.



In 1946 Bruno got his Physics Diploma from U. Göttingen, Letter to father from 6 th May 1946

Werner Heisenberg Max von Laue Otto Hahn

…aber ich will Physiker werden nicht Dozent.



On April 1st 1947

Bruno Touschek

was brought to Glasgow

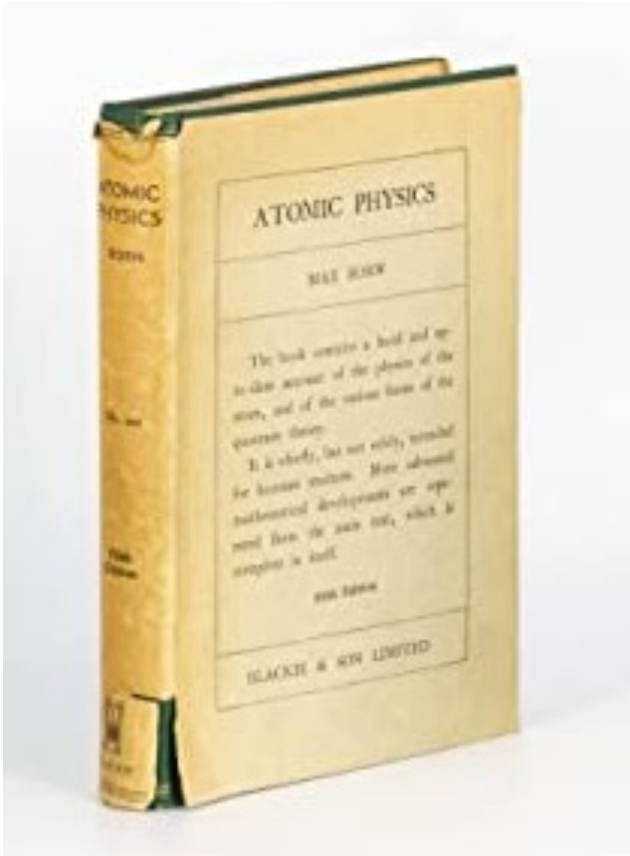
by the British Task Force,

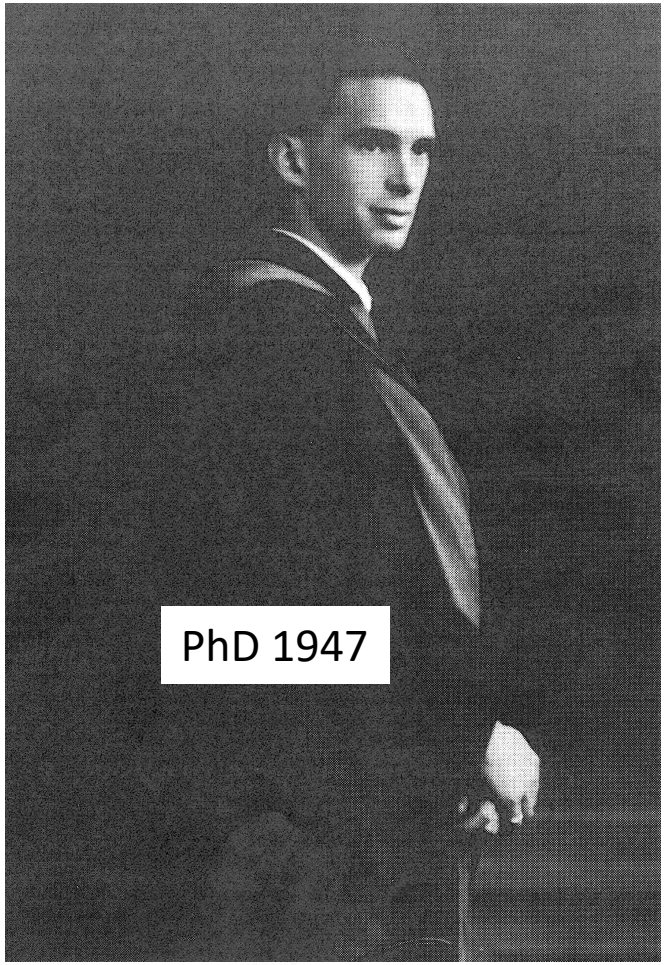
to start his doctorate

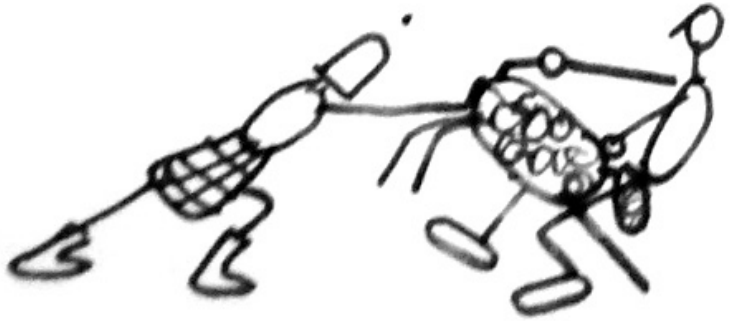
Glasgow 1947-1952

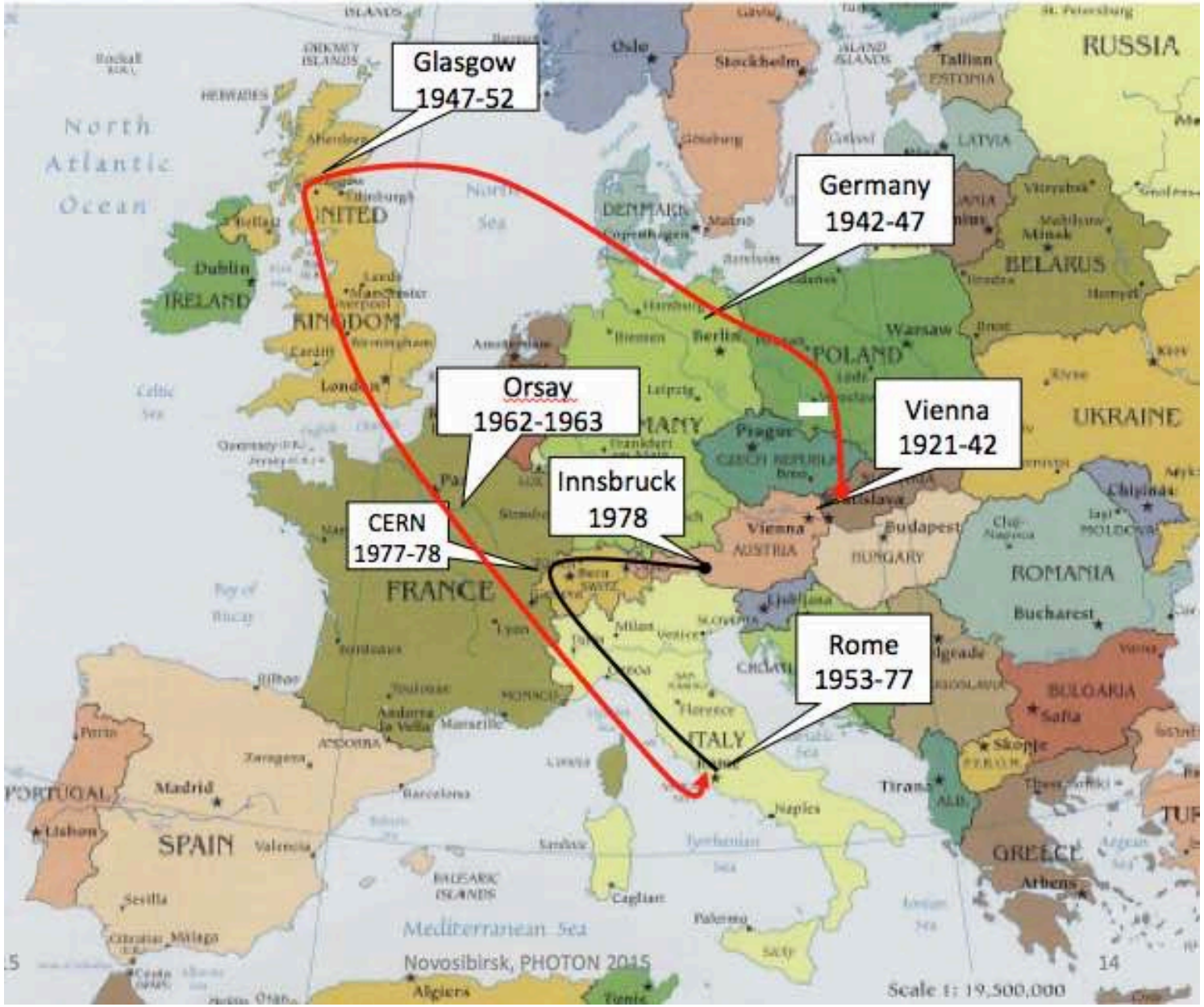
" In January I worked with Max Born in Edinburgh and wrote a chapter and an appendix for him . "

Bruno Touschek, letter to father from Glasgow, 13th February ,1950.

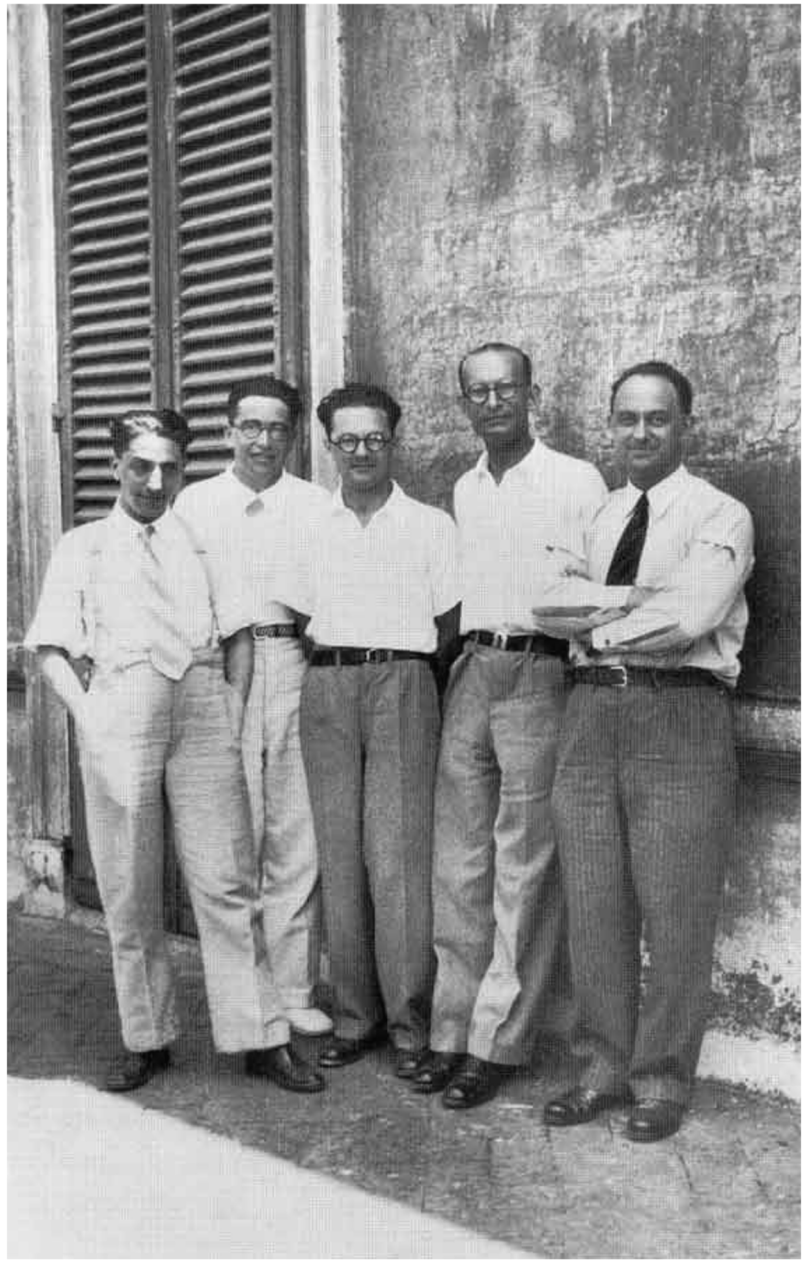








1952: Bruno Touschek left Glasgow to join the Rome Physics Institute



Albano lake (Rome) ~ 1953

1937 Rome- E. Majorana, E. Segre, E. Amaldi, F. Rasetti, E. Fermi (photo taken by B. Pontecorvo)

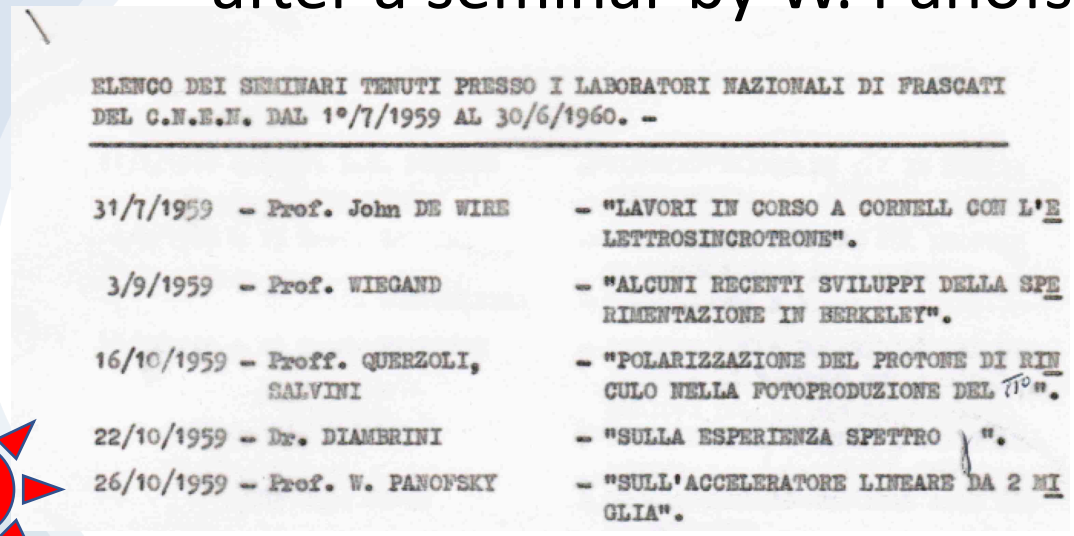
Touschek, CPT and Wolfgang Pauli

1953 Touschek with T.D. Lee and Wolfgang Pauli: Venice 1957

Kiev 1959 Conferences and seminars in Frascati and Rome by Wolfgang Panofsky

- 1959: An electron synchrotron was operating in Frascati – April
- Rochester conference in Kiev - July
- e-e- collider projects were under way in US (Stanford Princeton project) and USSR (Novosibirsk)
- Orsay : a powerful linear accelerator is operational

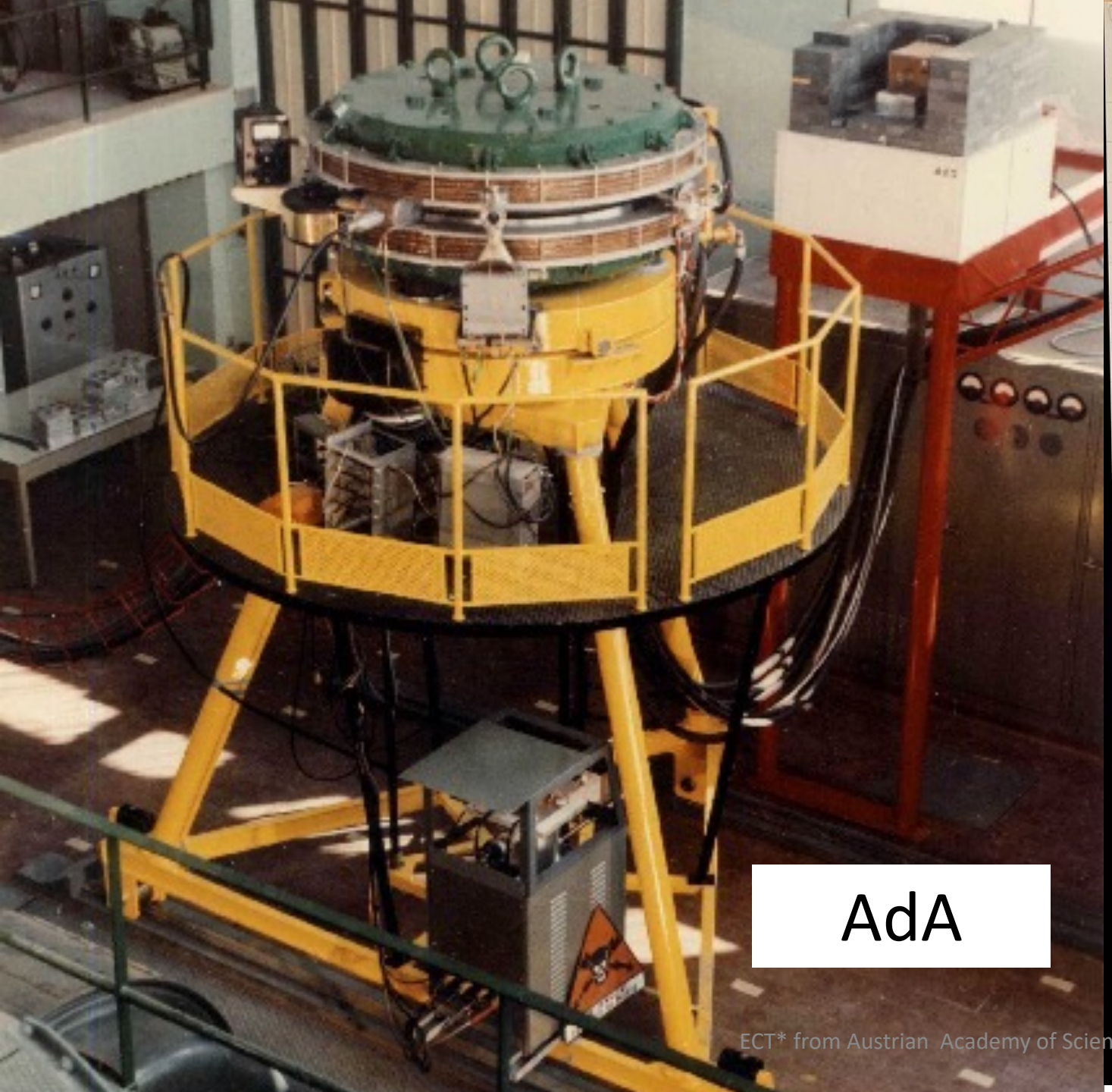
Discussions start in Rome after a seminar by W. Panofsky



ELENCO DEI SEMINARI TENUTI PRESSO I LABORATORI NAZIONALI DI FRASCATI DEL C.N.E.N. DAL 1°/7/1959 AL 30/6/1960. -

31/7/1959	- Prof. John DE WIRE	- "LAVORI IN CORSO A CORNELL CON L'ELETTROSINCROTRONE".
3/9/1959	- Prof. WIEGAND	- "ALCUNI RECENTI SVILUPPI DELLA SPERIMENTAZIONE IN BERKELEY".
16/10/1959	- Proff. QUERZOLI, SALVINI	- "POLARIZZAZIONE DEL PROTONE DI RINCULO NELLA FOTOPRODUZIONE DEL π^0".
22/10/1959	- Dr. DIAMBRINI	- "SULLA ESPERIENZA SPETTRO ".
26/10/1959	- Prof. W. PANOFSKY	- "SULL'ACCELERATORE LINEARE DA 2 MIGLIA".

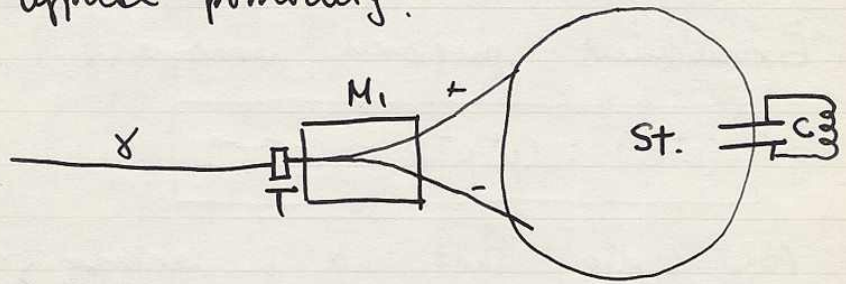
26.10.1959 e+e- physics start…



AdA

18.2.60.

State of affairs. Discussed plan with Ghigo. Decided for "outside" storage. G. proposed use of γ-beam also for electrons.
Typical possibility:

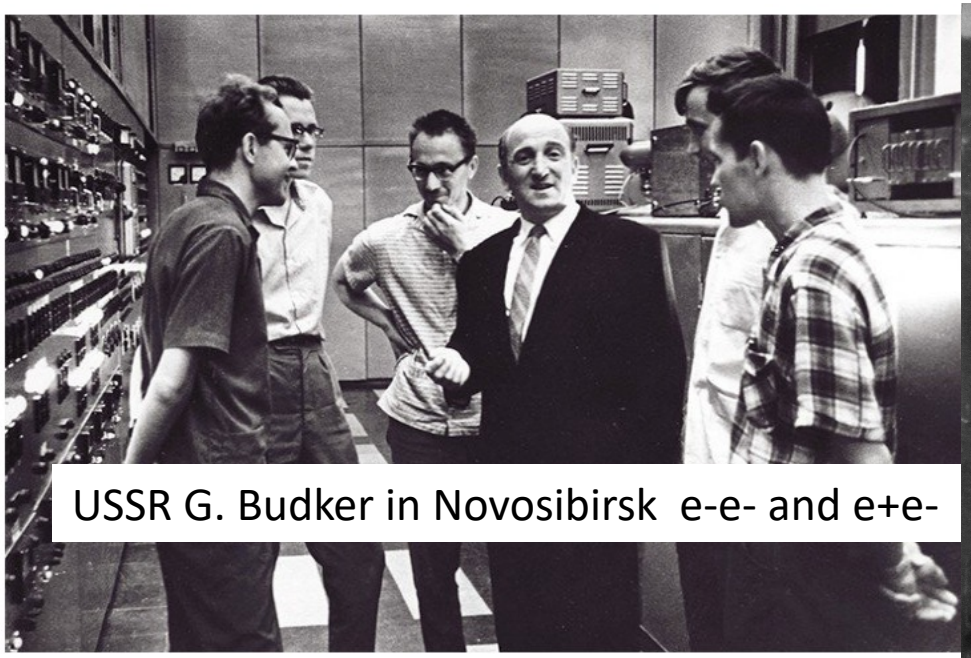


γ = γ-beam, T = target M_1 = separating magnet, St. = Storage magnet, C = Acc. circuit.

Basic formula

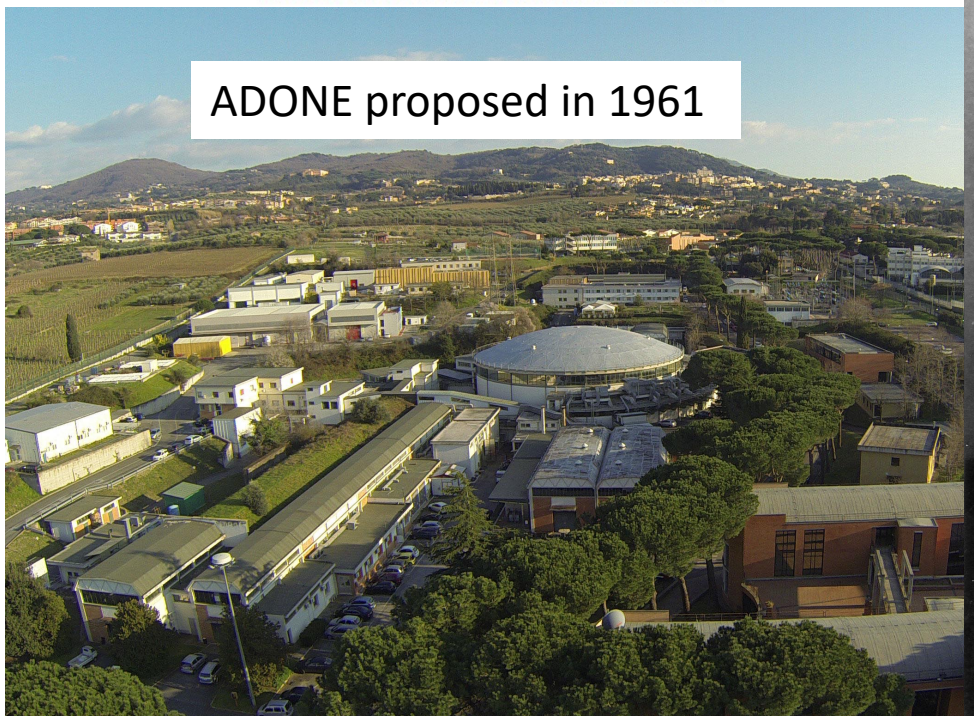
$$q = N^2 (\nu\tau)^2 \frac{\sigma}{q} \cdot \frac{c}{\pi R}$$

N = number of particles accepted per pulse
ν = repetition rate of the Synch (ν = 20)

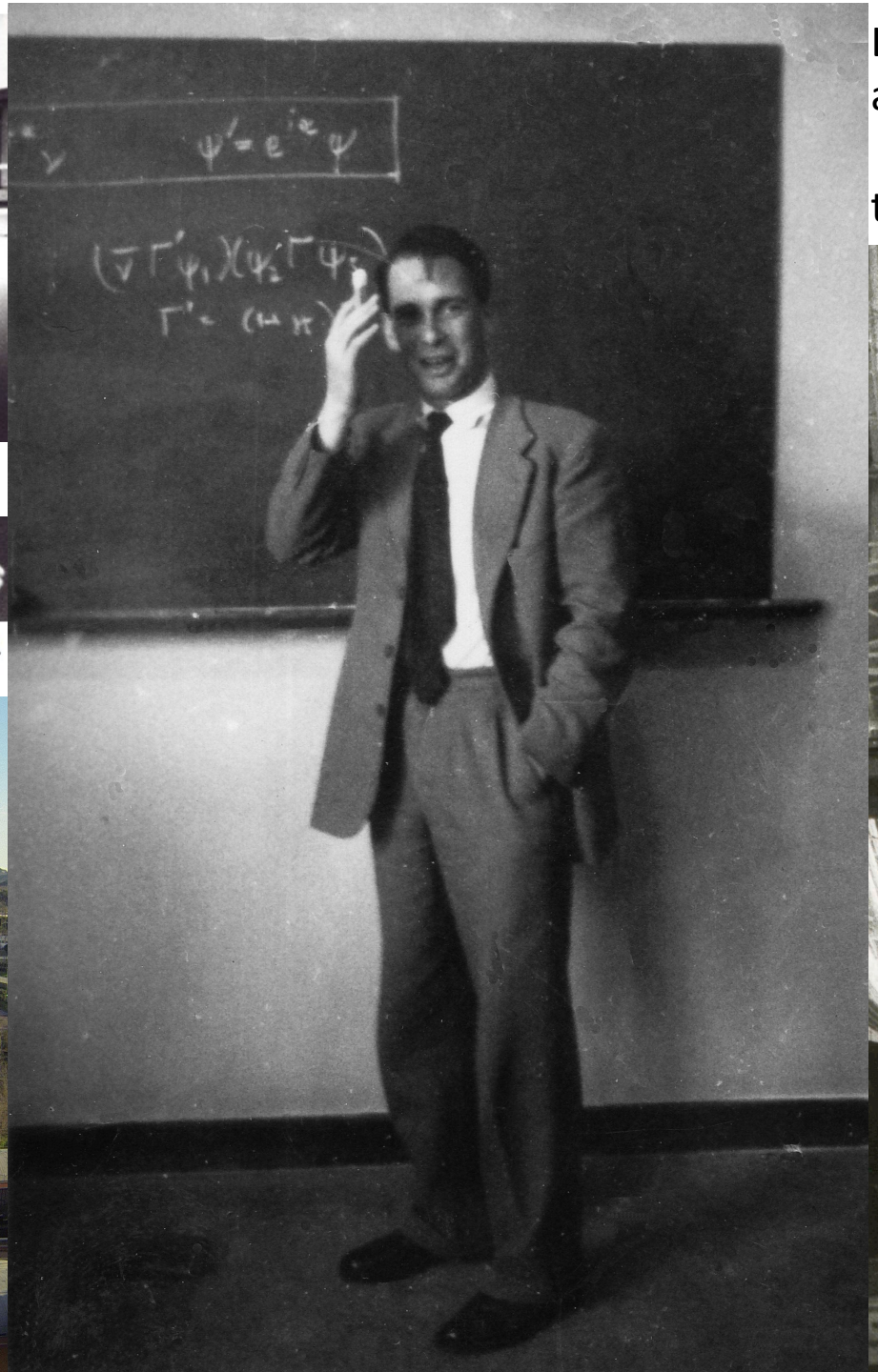


USSR G. Budker in Novosibirsk e-e- and e+e-

In the VEPP-2 control room. From left to right: V. A. Sidorov, I. Ya. Protopopov, S. G. Popov, G. I. Budker, A. N. Skrinsky, and V. V. Petrov. 1964. Photo by R. Akhmerov



ADONE proposed in 1961



Linear accelerator Orsay, 1963, allowed to feed AdA with enough photons to prove collisions had taken place e+e- → e+e- photon

Touschek QED Resummation procedure (1967)

IL NUOVO CIMENTO Vol. LI B, N. 2 11 Ottobre 1967

The Infra-Red Radiative Corrections for Colliding Beam (Electrons and Positrons) Experiments.

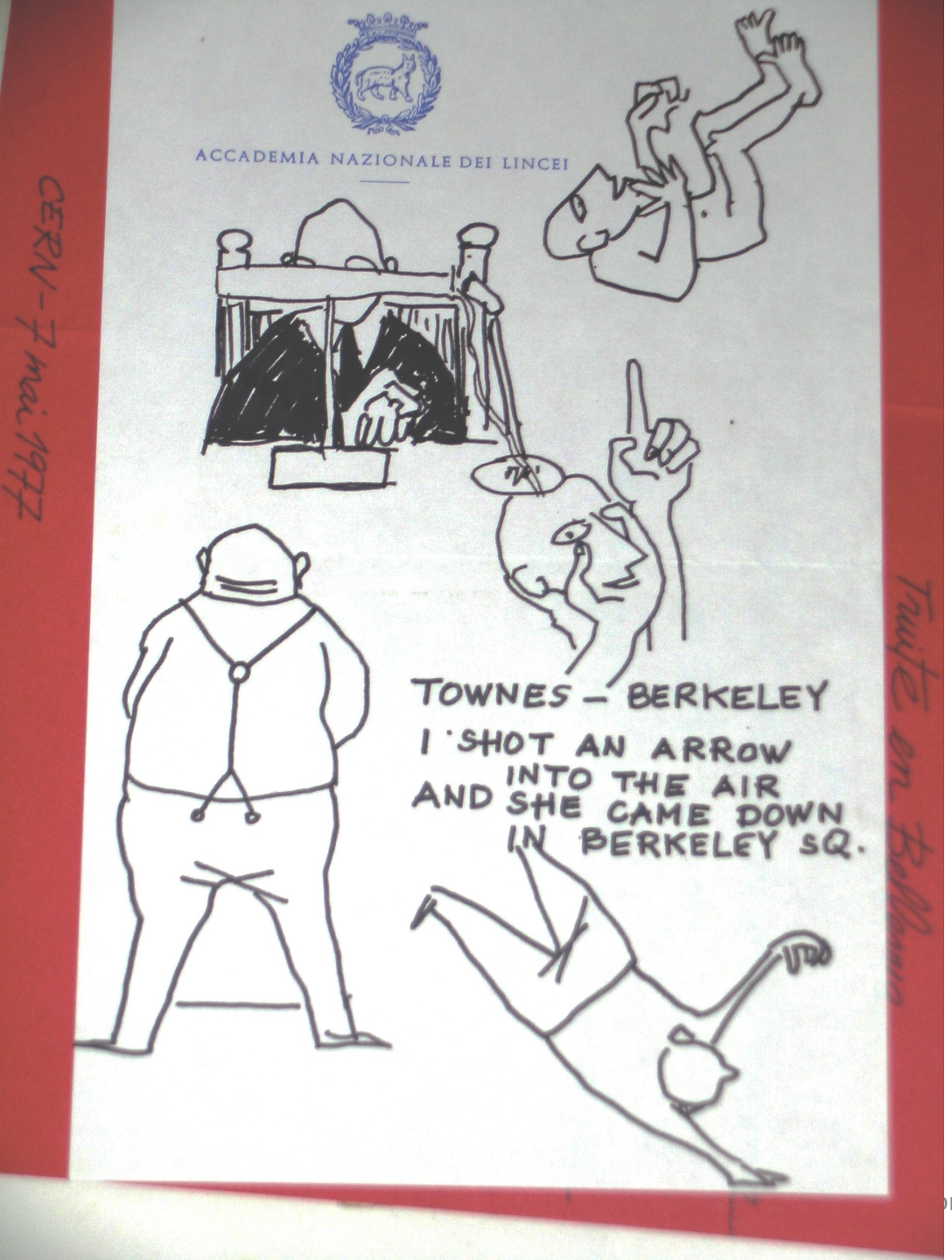
E. Etim, G. Pancheri and B. Touschek

Laboratori Nazionali di Frascati del CNEN - Frascati

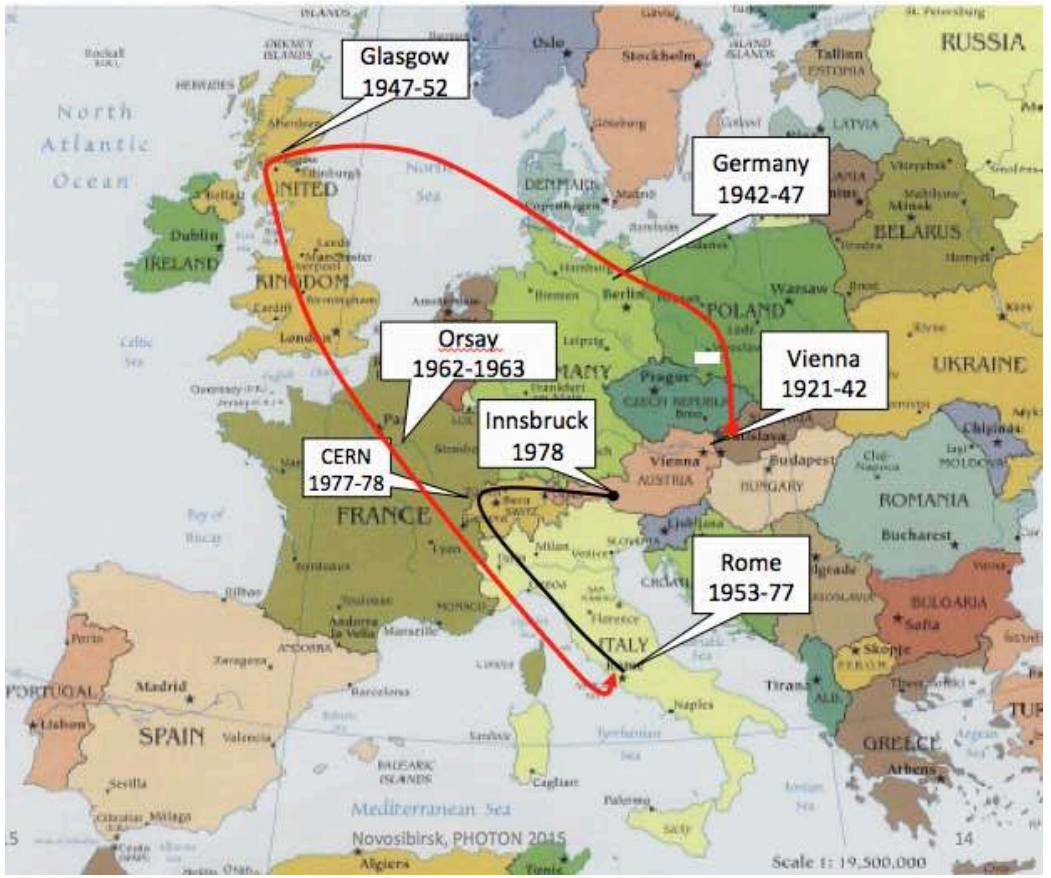
(ricevuto il 30 Gennaio 1967)

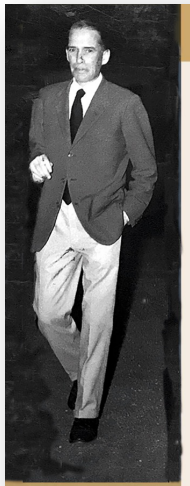
Summary. — The infra-red corrections to be applied to the results expected from an electron positron colliding beam experiment are determined with the help of the Bloch-Nordsieck theorem. Experiments are characterized by a resolution function $\varrho(k)$ of a four-dimensional timelike energy-momentum vector, which represents the probability that a four-momentum loss k escapes detection. The results are applicable to a class of experiments in which the statistical error is matched to the error of the energy-momentum resolution. Various approximations which allow a rapid and accurate estimate of radiative corrections are discussed.

Inspired QCD Extensions by Frascati Labs and Rome theory groups (Parisi Petronzio 1979 Drell-Yan, Wpt M. Greco, etc.)



Touschek passed away on May 5th, 1978





Springer Biographies

GIULIA PANCHERI

Bruno Touschek's Extraordinary Journey

From Death Rays to Antimatter

This book tells the story of a unique scientific and human adventure, following the life and science of Bruno Touschek, an Austrian born physicist, who conceived and built AdA, the first matter-antimatter colliding-beam storage ring, the ancestor of the Large Hadron Collider at CERN where the Higgs Boson was discovered in 2012.

Making extensive use of archival sources and personal correspondence, the author offers for the first time a unified history of European efforts to build modern-day particle accelerators, from the dark times of war-ravaged Europe up to the rebuilding of science in Germany, UK, Italy and France through the 1950s and early 1960s.

This book, the result of several years of scholarly research work, includes numerous previously unpublished photos as well as original drawings by Bruno Touschek.

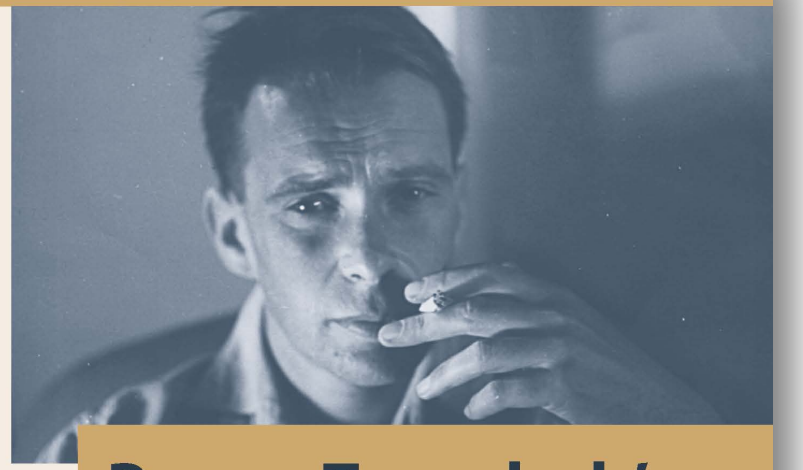
ISBN 978-3-031-03825-9

springer.com

PANCHERI

Bruno Touschek's Extraordinary Journey

Springer Biographies



Bruno Touschek's Extraordinary Journey

From Death Rays to Antimatter

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