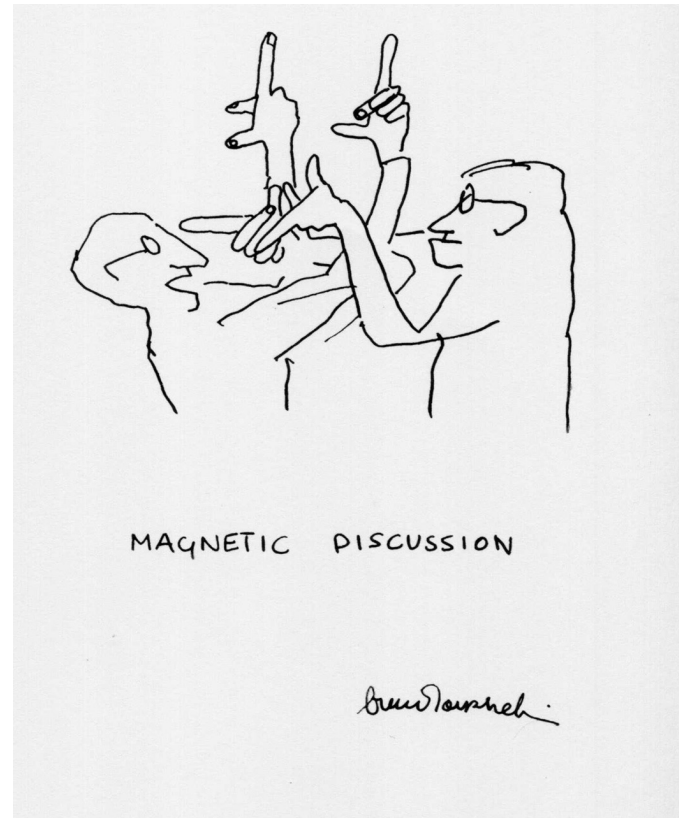
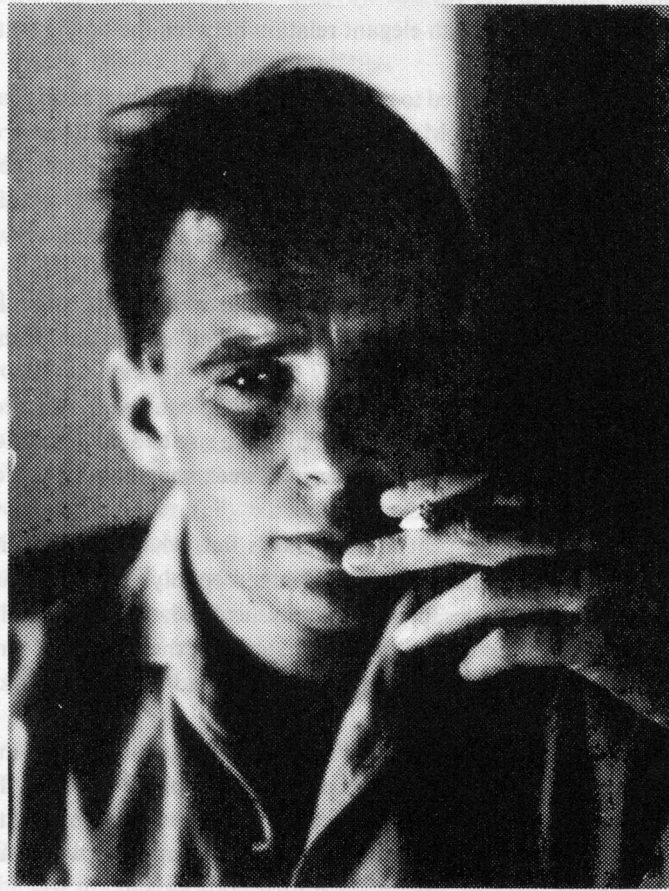
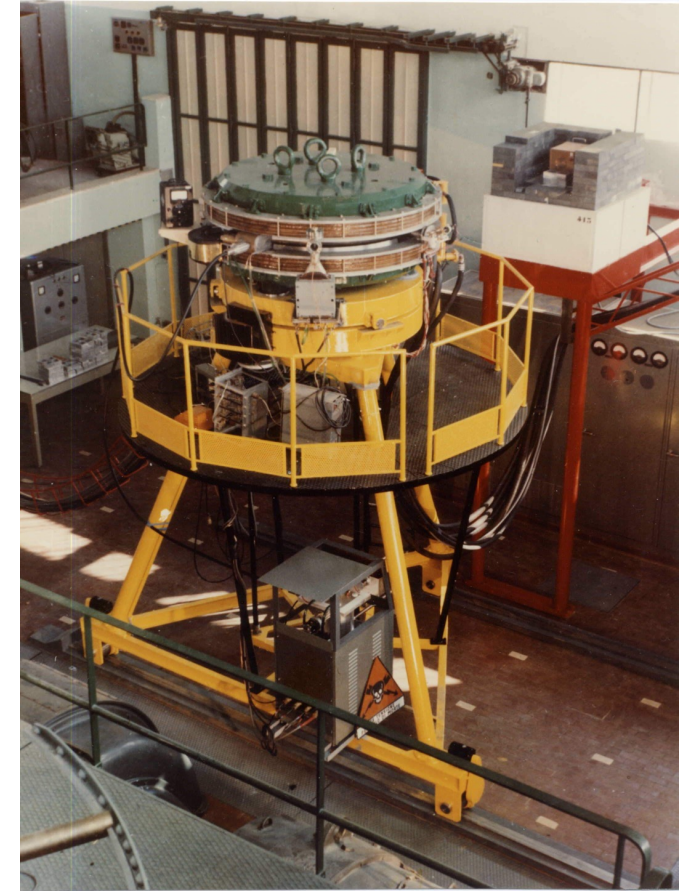


Bruno Touschek: the birth of electron positron colliders

G.Pancheri INFN National Laboratories

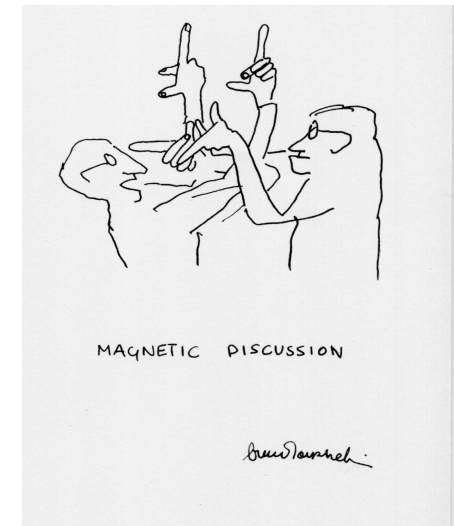


AdA Anello di Accumulazione



The birth of electron positron colliders

- Post-war: A political will toward European science reconstruction
→ CERN
- Many scientists : USA, USSR, Europe
- New large research facilities (laboratories)
- A joining of pre-war and post-war physics



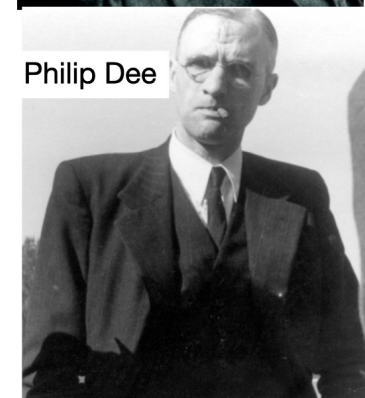
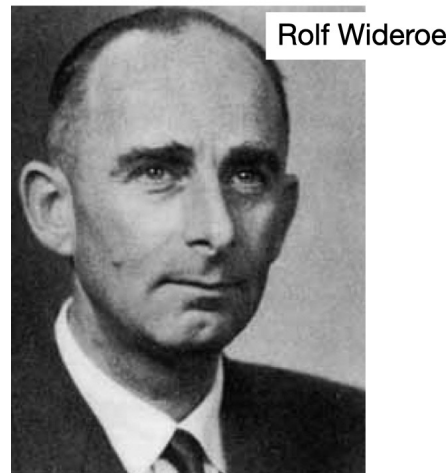
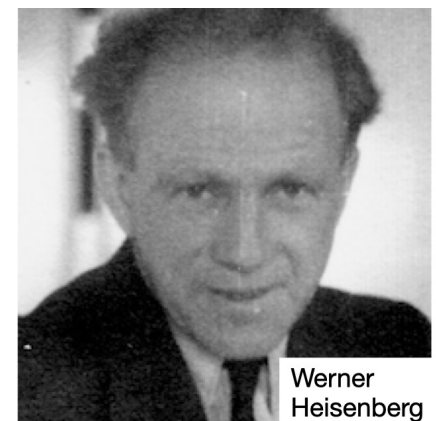
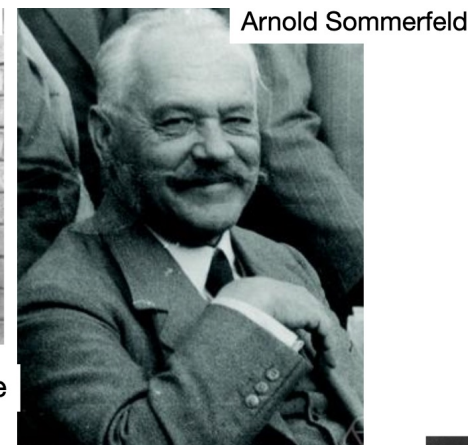
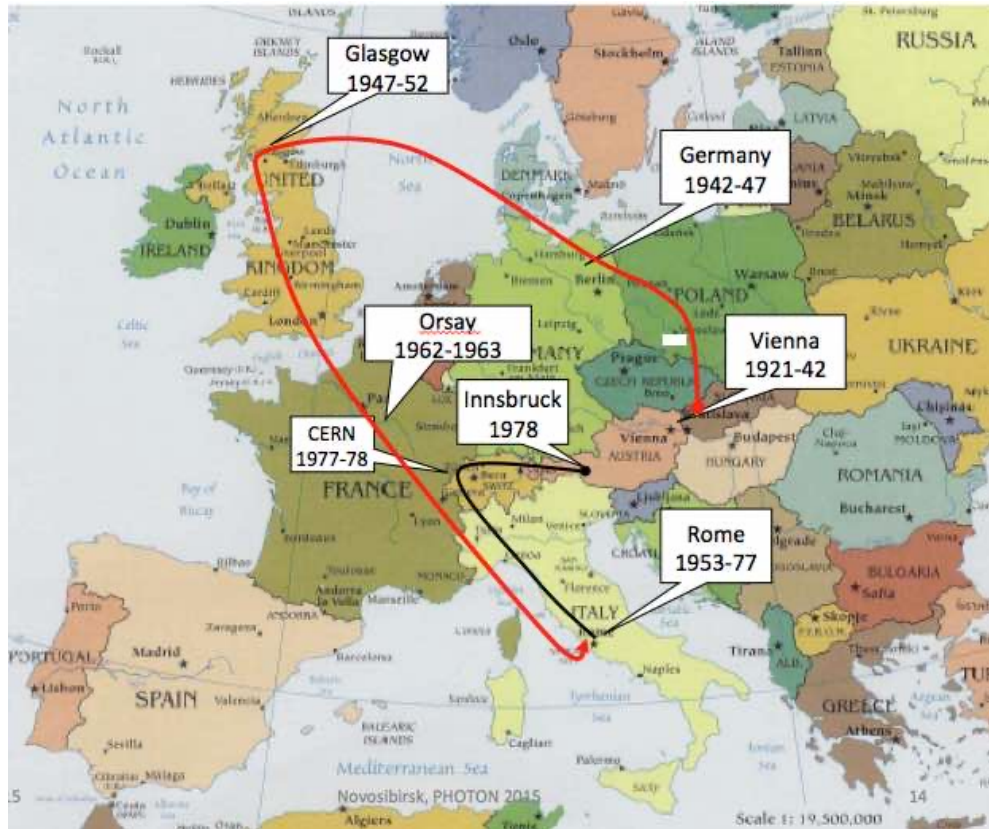
The world wide net of collider enthusiasts 1956 → ~ 1970

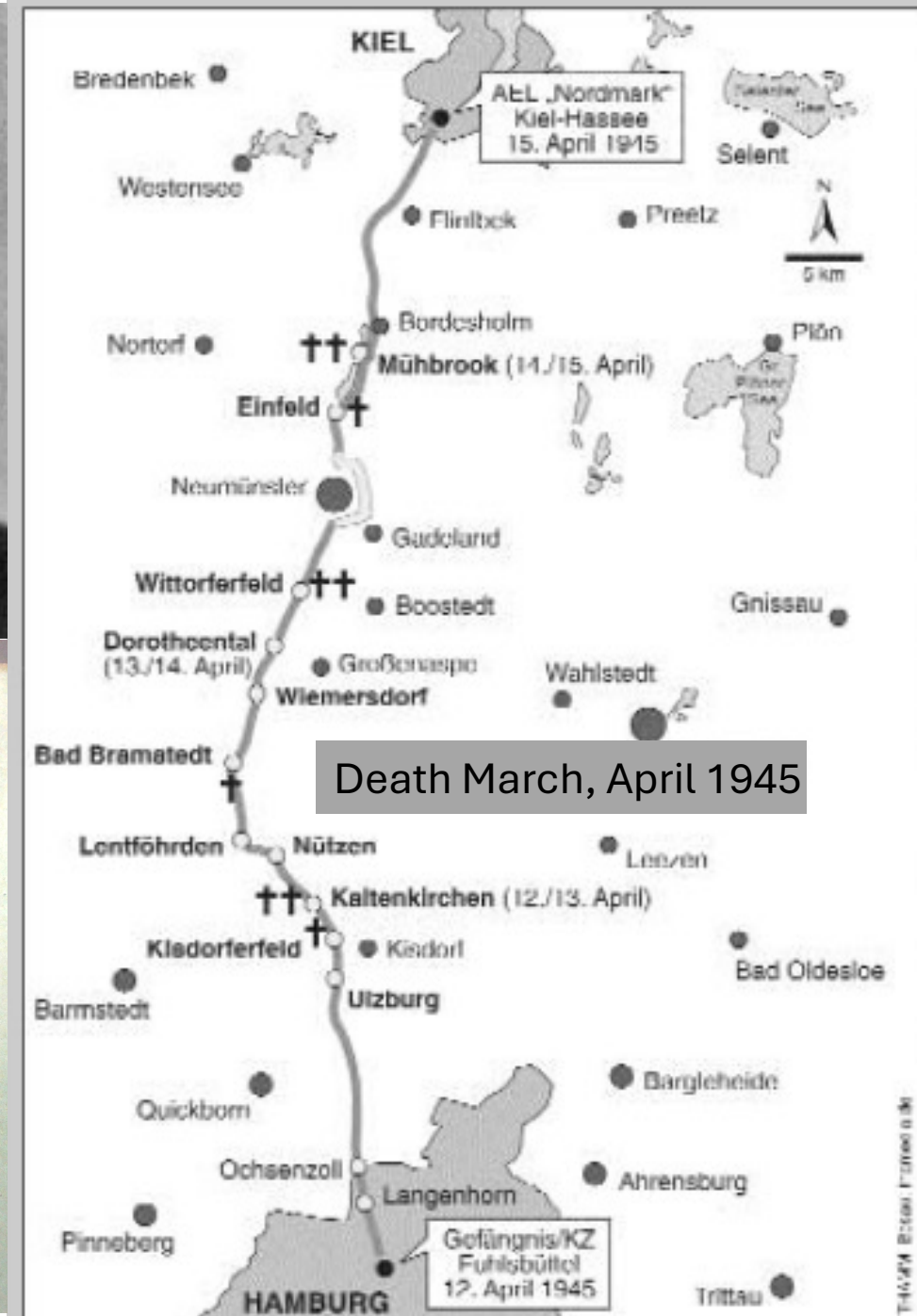
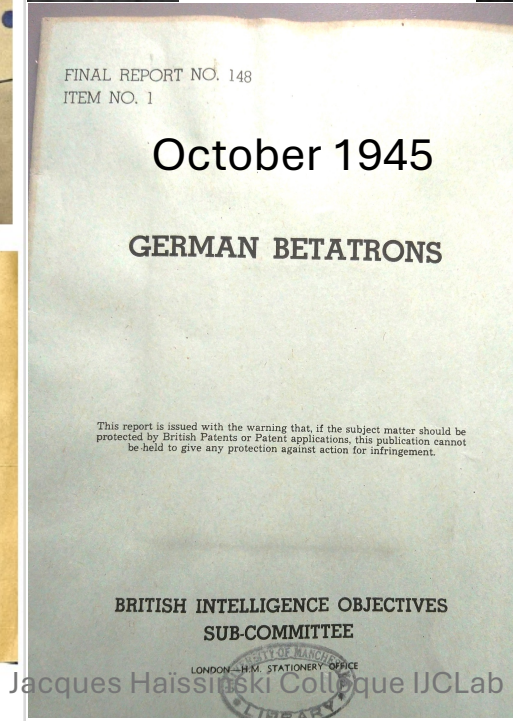
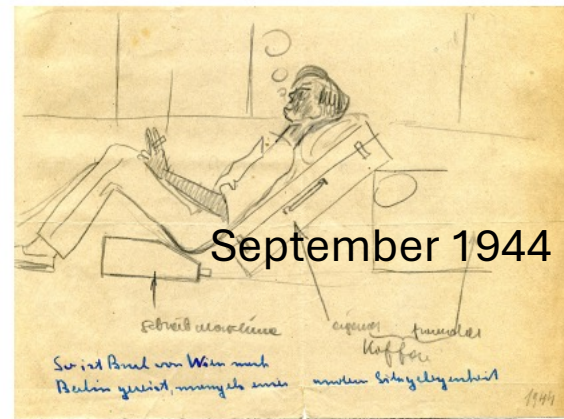
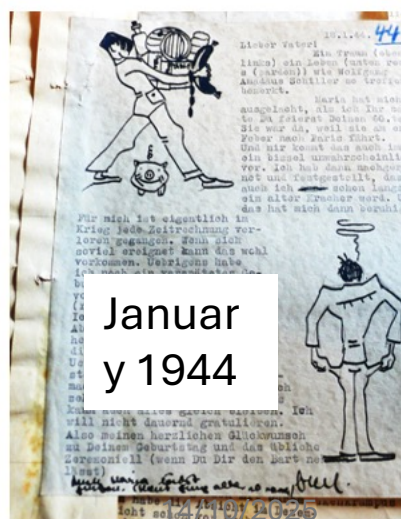
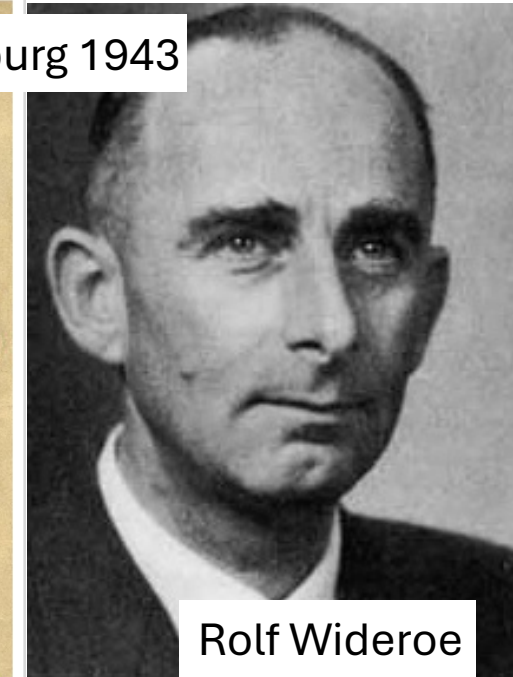


1959: in
Europe, across
the Alps,
postwar
reconstruction
had started



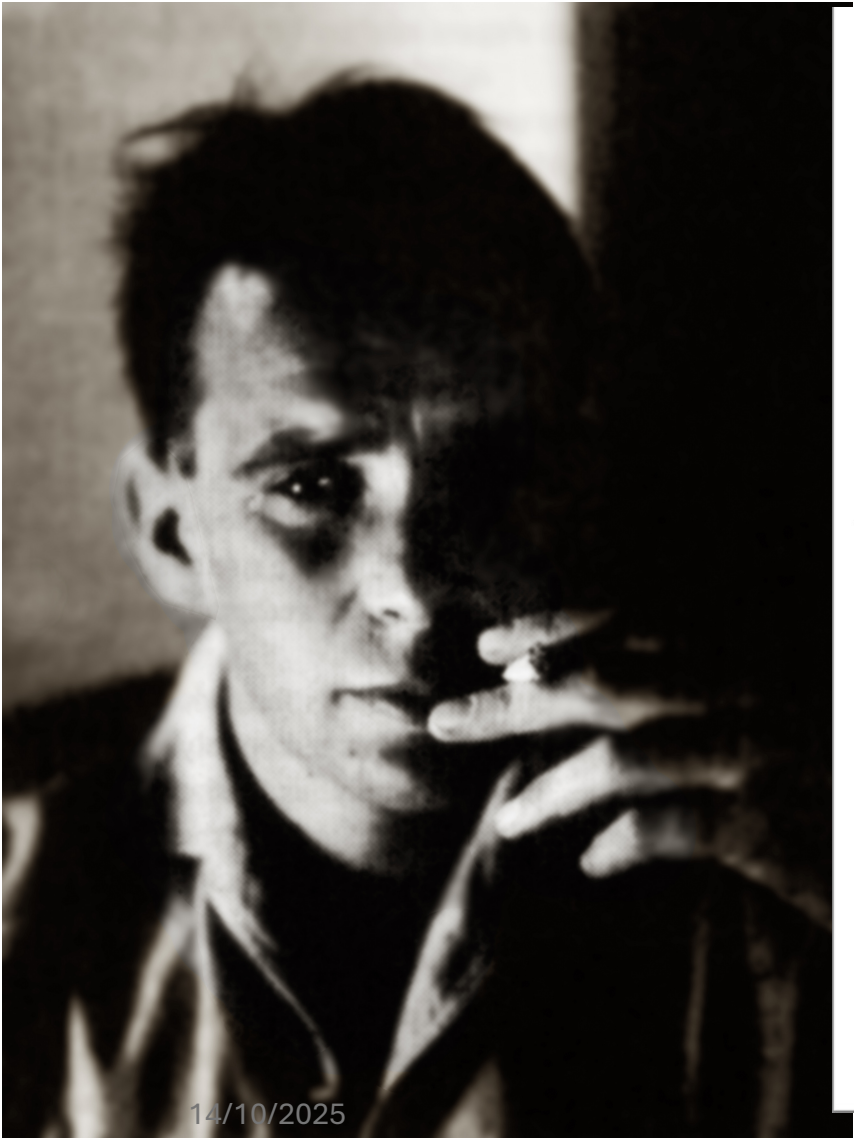
When Touschek proposed to build AdA, he was no newcomer to particle accelerators and theoretical physics





The first suggestion to use crossed beams I have heard during the war from Widerøe.

On the Storage Ring B. Touschek ~ February 1960



Erteilt auf Grund des Ersten Überleitungsgesetzes vom 8. Juli 1949
(WGBL S. 175)

BUNDESREPUBLIK DEUTSCHLAND

AUSGEGEBEN AM
22. AUGUST 1955

DEUTSCHES PATENTAMT

PATENTSCHRIFT

Nr. 932 082

KLASSE 21g GRUPPE 36

W 693 VIII c / arg

Dr.-Ing. Rolf Widerøe, Ennetbaden (Schweiz)
ist als Erfinder genannt worden

Aktiengesellschaft Brown, Boveri & Cie, Baden (Schweiz)

Anordnung
zur Ausführung von Elektronen aus der Beschleunigungs-
röhre eines mit elektrostatischen Stabilisierungslinsen ausgerüsteten
Strahlentransformators

Zusatz zum Patent 927 590

Patentiert im Gebiet der Bundesrepublik Deutschland vom 27. Januar 1944 an
Das Hauptpatent hat angefangen am 2. September 1943
Patentanmeldung bekanntgemacht am 5. Februar 1953
Patenterteilung bekanntgemacht am 20. Juli 1955

Im Hauptpatent ist bereits vorgeschlagen worden,
zur Stabilisierung der Elektronenbahnen in der Be-
schleunigungs- röhre eines Strahlentransformators
den Bahnkreis auf dem ganzen Umfang mit elektro-
statischen, elektronenoptischen Linsen zu besetzen.
Diese bestehen aus aufeinanderfolgenden Blenden,
deren Ebene jeweils senkrecht zur Bahnkreistangente
an der betreffenden Stelle liegt, wobei jede Blenden-
elektrode gegenüber den beiden benachbarten auf
einem möglichst hohen positiven oder negativen
Gleichspannungspotential liegen soll. Im Haupt-
patent ist auch bereits vorgeschlagen, an der Stelle,
an welcher der beschleunigte Elektronenstrom aus
der Beschleunigungs- röhre abgeführt werden soll,
die Beschleunigungs- röhre derart, wie in Abb. 1 dar-
gestellt, auszuführen. Dort bedeutet 10 die Flug-
richtung der beschleunigten Elektronen, 11 den der
einfacheren Zeichnung halber als gerade Linie dar-
gestellten Bahnkreis und 12 die sich an der Aus-
trittsstelle für den Elektronenstrom nach Art eines
Trichters erweiternde Beschleunigungs- röhre. Die
Linsenelektroden sind in Abb. 1 nur mit ihrem in
der Zeichenebene liegenden Querschnitt dargestellt.
Sie befinden sich, wie erwähnt, auf abwechselnd

On The Storage Ring

The following is a preliminary proposal for the construction of a storage ring. No literature has been consulted in its preparation, since this invariably slows down progress in the early stage, necessary though it may be in the consecutive stages of the development. I shall present you here all I have thought about it and much, which others have suggested to me and to anticipate the question: No, I have not properly read O'Neil, but I hope that somebody will.

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 Widerøe, the obvious reason for thinking about them being, that one wasted a considerable amount of energy by using 'sitting' 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.

At this stage it appears necessary to define the project a little better: I prefer to think of it as an experiment rather than as a machine - a fact which may change considerably our attitude to the project. As I think I will be able to demonstrate the project is closer to an experiment than to a machine in two important respects: in cost and in the limited range of applicability of the ironware. Talking of it as an experiment I propose to study the reactions

(1)
$$\begin{array}{lcl} e^+ + e^- & \begin{array}{l} \nearrow 2\gamma \\ \rightarrow \mu^+ + \mu^- \\ \searrow \pi^+ \pi^- (2\pi^0) \end{array} & \begin{array}{l} (A) \\ (B) \\ (C) \end{array} \end{array}$$

and I admit that I think that there is nothing else of importance, which can be studied with the same set up.

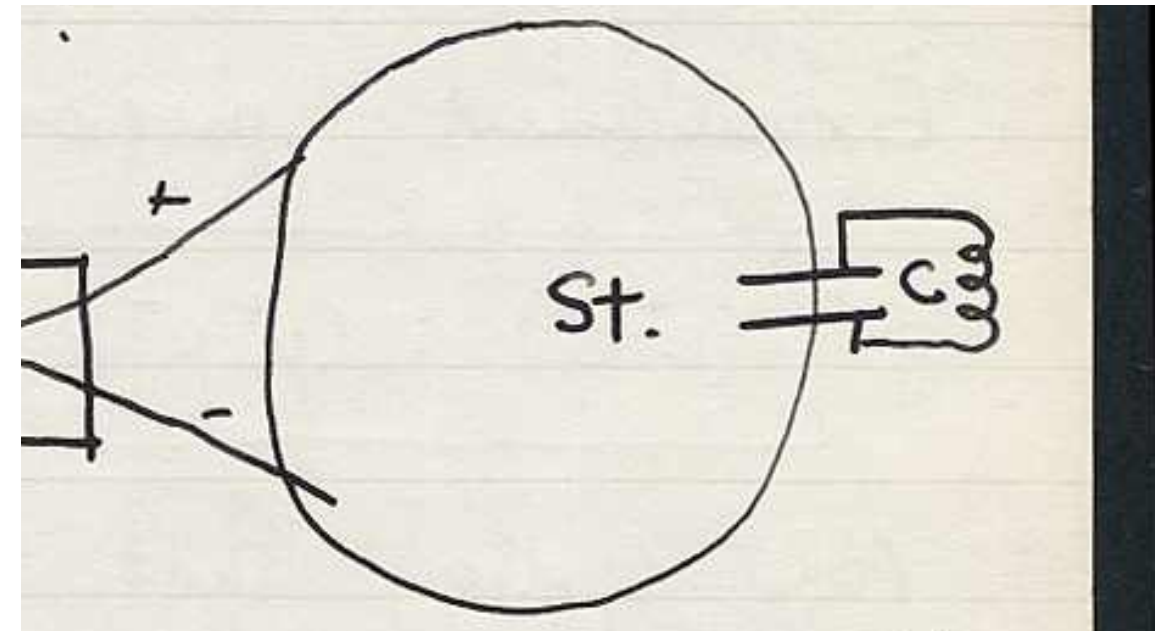
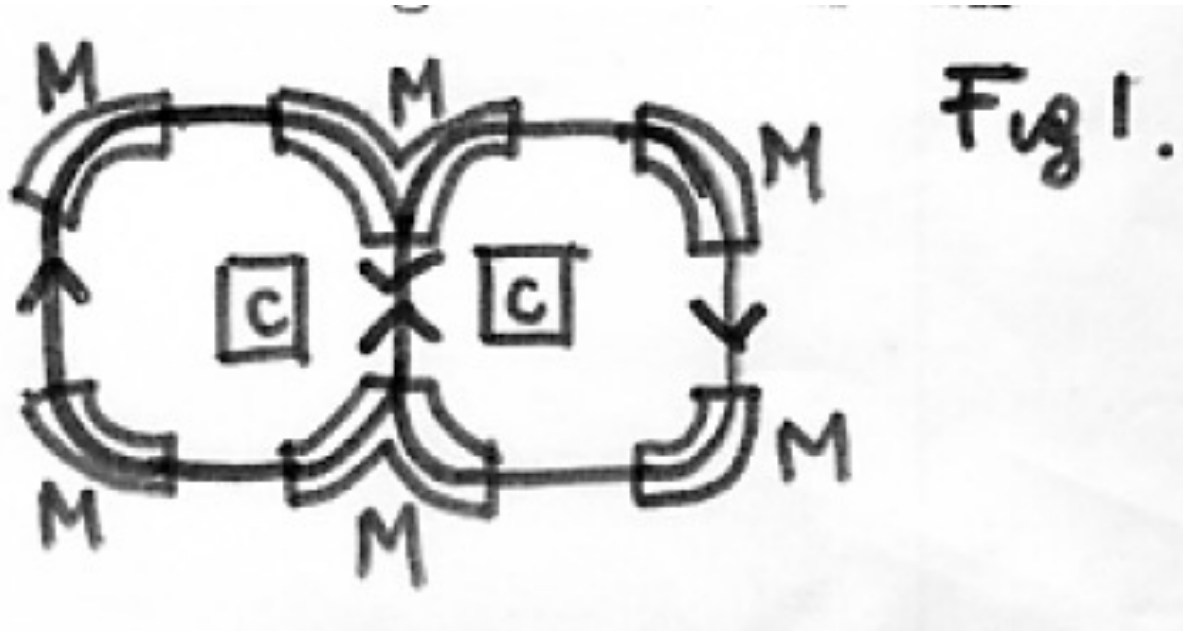
The first of the processes listed is two quantum annihilation. The process is predominantly backward-forward in the C.M. system and in these preferred directions no 'radiative corrections' are to be expected. The cross section for this process is

(2)
$$\sigma(A) = 6.3 \cdot 10^{-20} \text{ cm}^2$$

at 250 Mev and it diminishes a little less than quadratically with rising energy.

I propose to use (1A) as a monitoring process. This is a

Touschek : one could change O'Neill's double ring in a single ring and then put in electrons against positrons



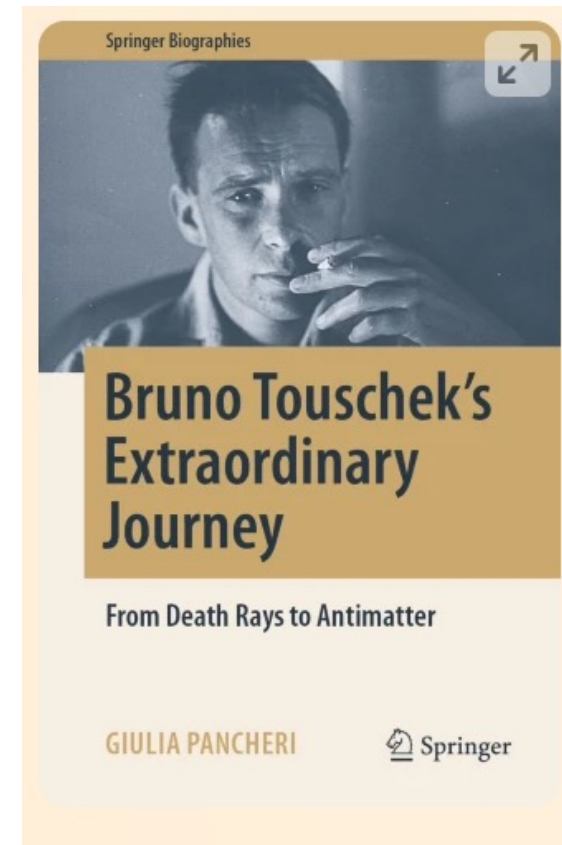
Touschek about O'Neill's proposal in
April 1974 , Accademia Nazionale dei Lincei

A single ring, February 18.2.60

Further reading and movies

Bibliography and sources therein

- E Amaldi, in 1981 CERN Yellow Report
- P Marin 2009 Ed. Dauphin
- [V.N. Baier, hep-ph/0611201](#)
- L. Bonolis & GP, EPJH 2011
- L. Bonolis, F. Buccella and GP, EPJH 2024



Links to docu-films by E. Agapito with L. Bonolis GP

https://www.lnf.infn.it/edu/materiale/video/AdA_in_Orsay.mp4

<https://webcast.in2p3.fr/video/60-ans-dexploration-de-la-matiere>

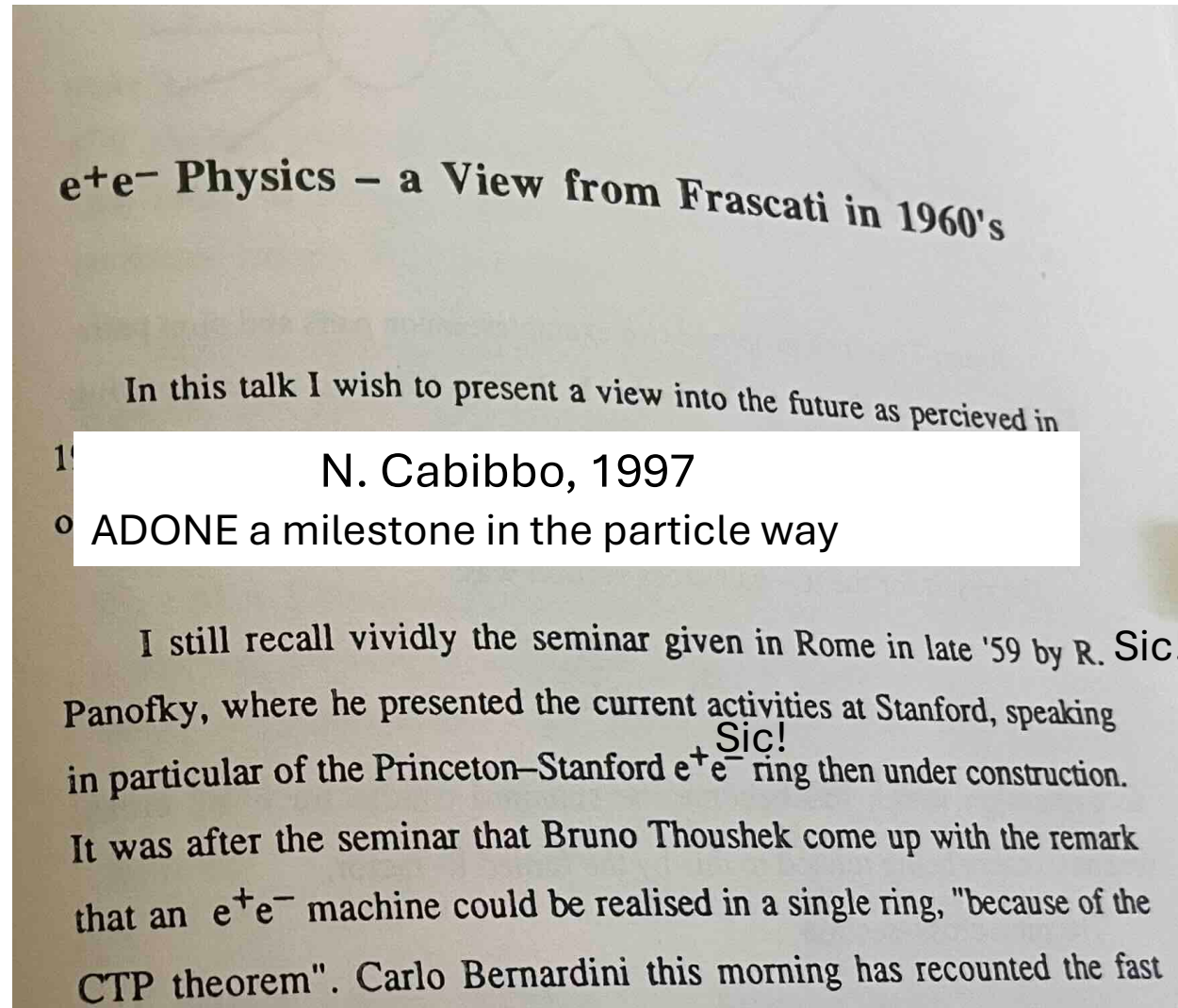
October 1959



Theoretical physics
work starts in Rome,
- N. Cabibbo, R. Gatto,
- L. Brown, F. Calogero,

Feb.1 and Feb.17 1960,
two theory papers on
electron-positron physics
are submitted from Rome
U. and published in PRL on
March 15th, 1960

November 9th 1960,
Touschek's **ADONE memo**



Feb.17 1960

Touschek proposes to Frascati
an **experiment worth doing**
electrons against positrons

March 7th, 1960

Frascati scientists
approve Touschek's
detailed proposal

March 24th, 1960

INFN approves the proposal
with 8ML Lire initial financing

February 1961

Electrons circulate in AdA

Nov. 6, 1960 , BT letter to father : My spies tell me we have at least a year ahead of them [the Americans]