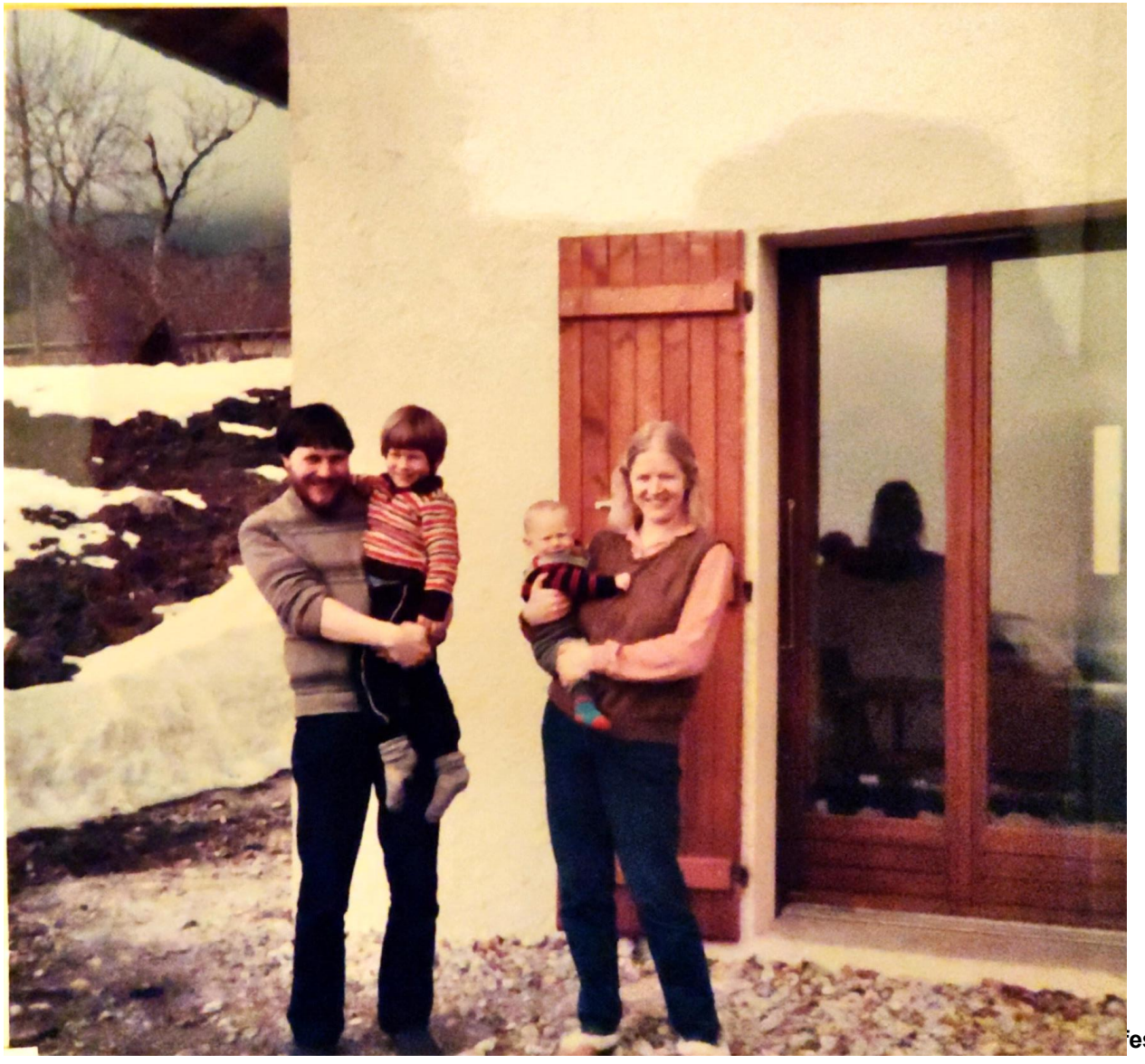
Neville and the UA2 (1983-1986) / PPRP (2001-2003) years

Many thanks to Guy and Neville for having asked me to enjoy this moment with all of you.

Neville and I share the same timeline more or less :
a) We worked as CERN fellows in UA2 almost forty years ago
b) We had kids who were ~ the same age
c) We worked as senior physicists in an arcane UK peer review body called PPRP (an emanation of the Science Committee at the time I believe) about twenty years ago
d) I retired three years ago and had the immense pleasure of experiencing a Fest in my honour then. I sincerely hope that today will be an unforgettable day for you, Neville!

30-40 cm overnight snowfall in Geneva area in ~ 1985 (?)

Do Ben and Joe remember these years?



Historical perspective: the 80's in UA1/UA2 at the SppS

UA2 data-taking campaigns

Year	Energy (GeV)	Luminosity (max.) $cm^{-2}\ s^{-1}$	Luminosity (integrated) cm^{-2}	
1981	546	$\sim 10^{27}$	2×10^{32}	← Hadronic jets
1982	546	5×10^{28}	2.8×10^{34}	← $W \rightarrow e\ \nu$
1983	546	1.7×10^{29}	1.5×10^{35}	← $Z \rightarrow e^+ e^-$
1984-85	630	3.9×10^{29}	1.0×10^{36}	
1987-90	630	$\sim 1 \times 10^{30}$	1.6×10^{36}	

Historical perspective: the 80's in UA1/UA2 at the SppS

From the beginning, with the observation of two-jet dominance and of 4 W → eν and 8 Z → e^+e^- decays

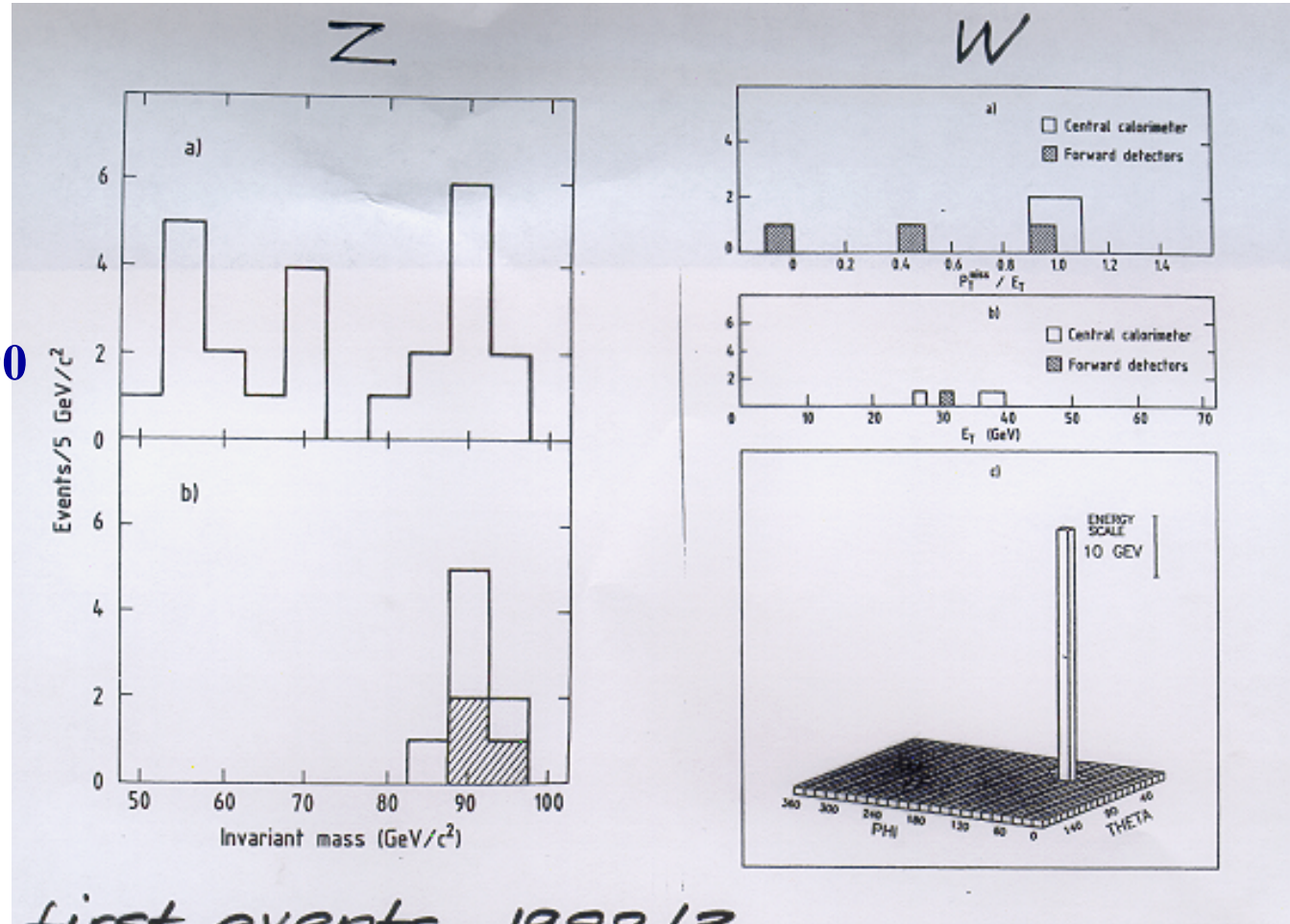
$\sqrt{s}$ = 546 GeV, L ~ 10^{29} $cm^{-2}s^{-1}$

UA2 was perceived as large at the time:

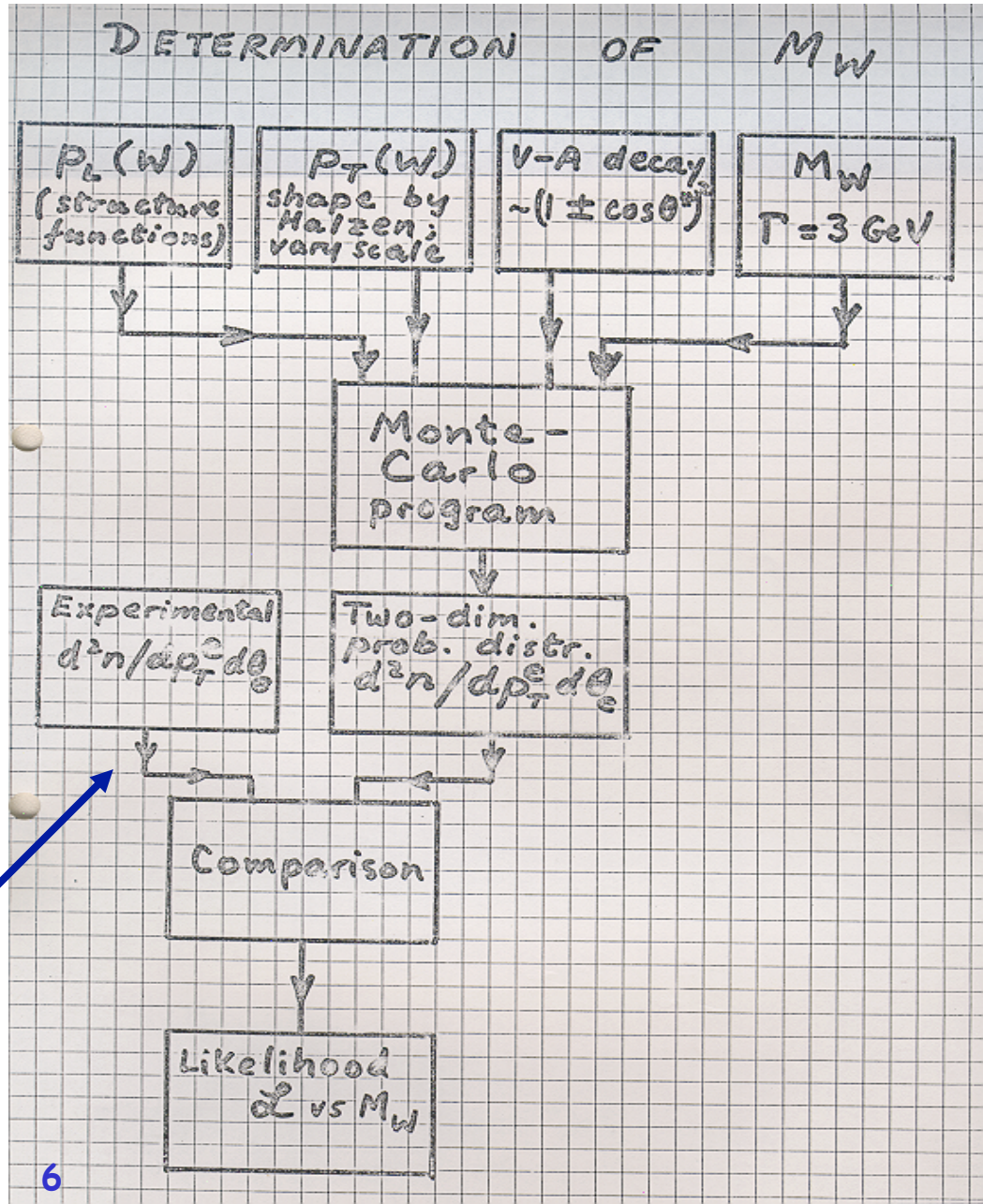
- ♥ 10-12 institutes
- ♥ from 50 to 100 authors
- ♥ cost ~ 10 MCHF
- ♥ duration 1980 to 1990

Physics analysis was organised in two groups:

- Electrons → electroweak
- Jets → QCD



Historical perspective: the 80's in UA1/UA2 at the SppS



Software design in UA2

Historical perspective: the 80's in UA1/UA2 at the SppS

Software documentation in UA2

W MASS

For each value of M_W generate $dn/dP_T^e d\theta_e$, using

parametrisation of P_L^W from Glück et al.

– " – P_T^W from Halzen et al.

V-A production and decay

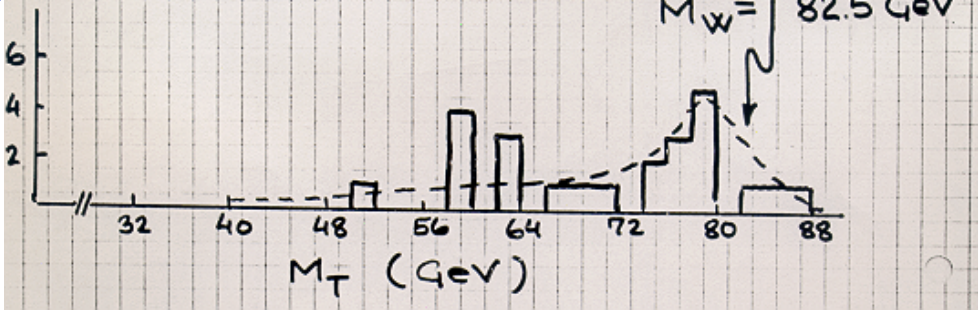
$\Gamma(W) = 3$ GeV

Maximum likelihood for events with $P_T^e > 25$:

$$M_W = 82.5 \pm 1.5 \pm 1.3 \text{ GeV}/c^2$$

Same result from fit to M_T - dist for events with $P_T^W < 5$ GeV/c :

$$M_T = \left(2 P_T^e P_T^\nu (1 - \cos\Delta\varphi)\right)^{1/2}$$



Historical perspective: the 80's in UA1/UA2 at the SppS

1984-1985 were exciting (and confusing) times!
Beware false positive signals!!

Over-abundance of $Z \rightarrow ee\gamma$ events

Monojets

Dijets with missing E_T

High-p_T electrons with jets and missing E_T

Top quark "discovery"

Bumps in distributions
(jet-jet mass in UA2,
W decay electron spectrum in UA1)

Neville and the UA2 (1983-1986) years

One winter without snow, Pierre (who is exceptionally gifted at drawing) decided to put most of the UA2 collaboration (more or less from memory) into a deck of cards (seven family game).

I invite you to recognise who among the people below is present here!

Règle du jeu

Un joueur distribue les 42 cartes (le joker est une carte parfaitement inutile qui n'est pas distribuée). Si le nombre des joueurs n'est pas un diviseur de 42, certains d'entre eux auront une carte de moins que les autres. Le but du jeu est de rassembler le plus possible de familles complètes (il y a 7 familles de 6 cartes chacune).

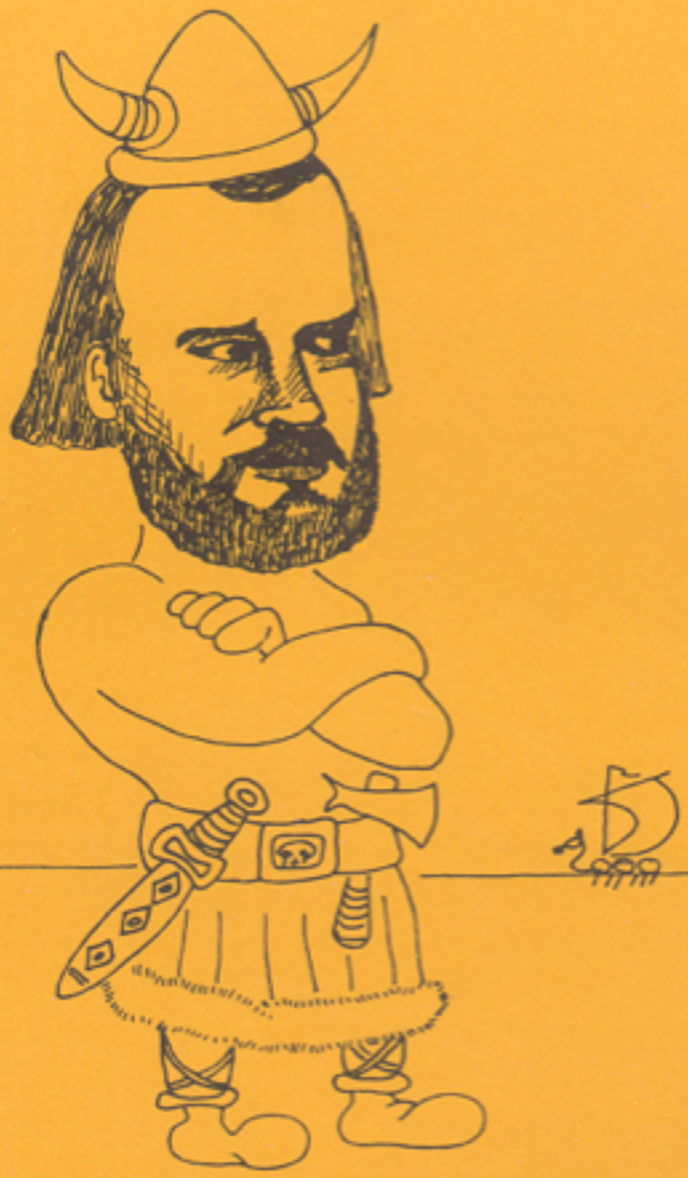
FAMILLE SAINT-QUANTÔME 6

Kevin

FAMILLE JET 1

Peter

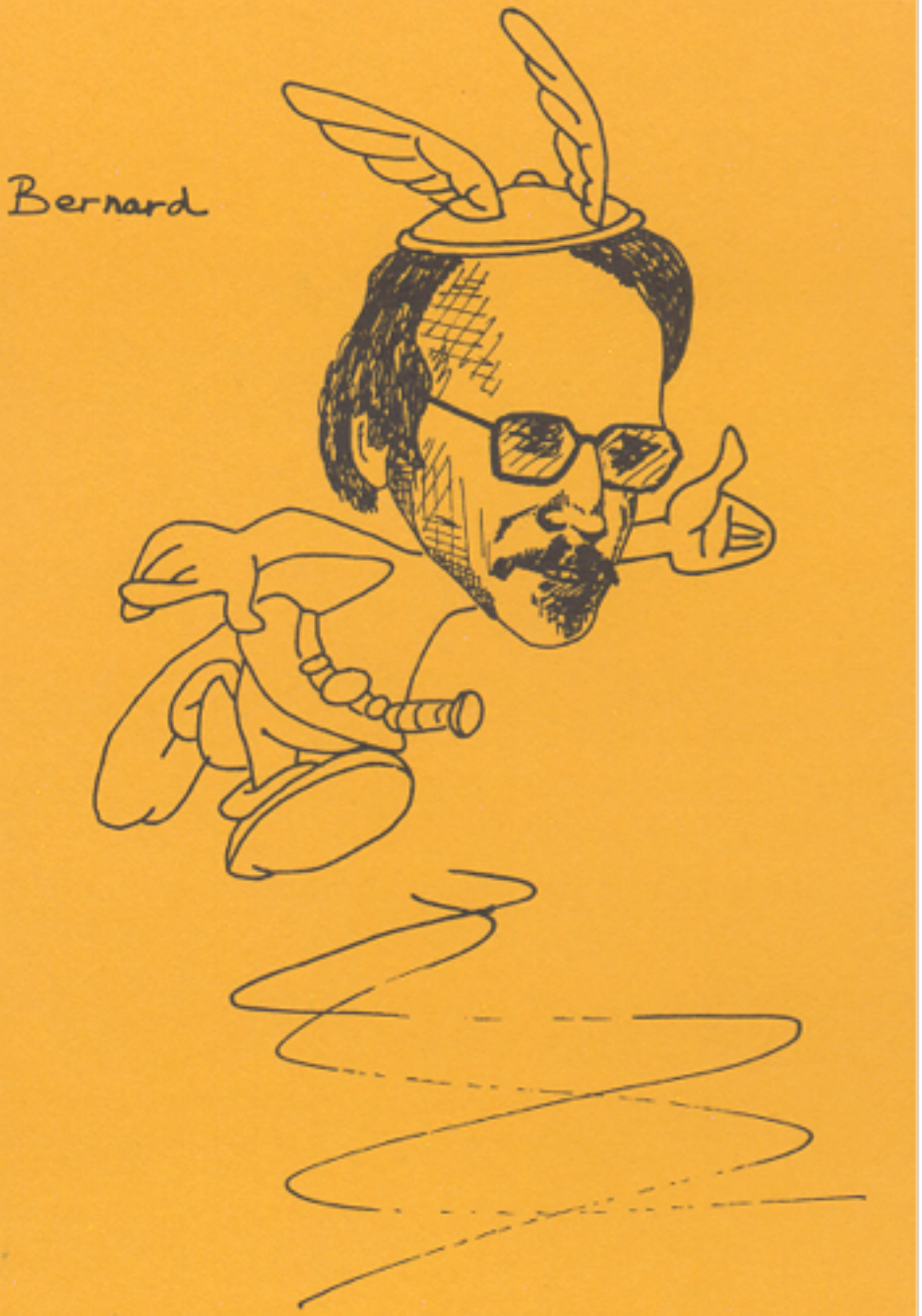
FAMILLE SAINT-QUANTÔME 1



John

FAMILLE JET 4

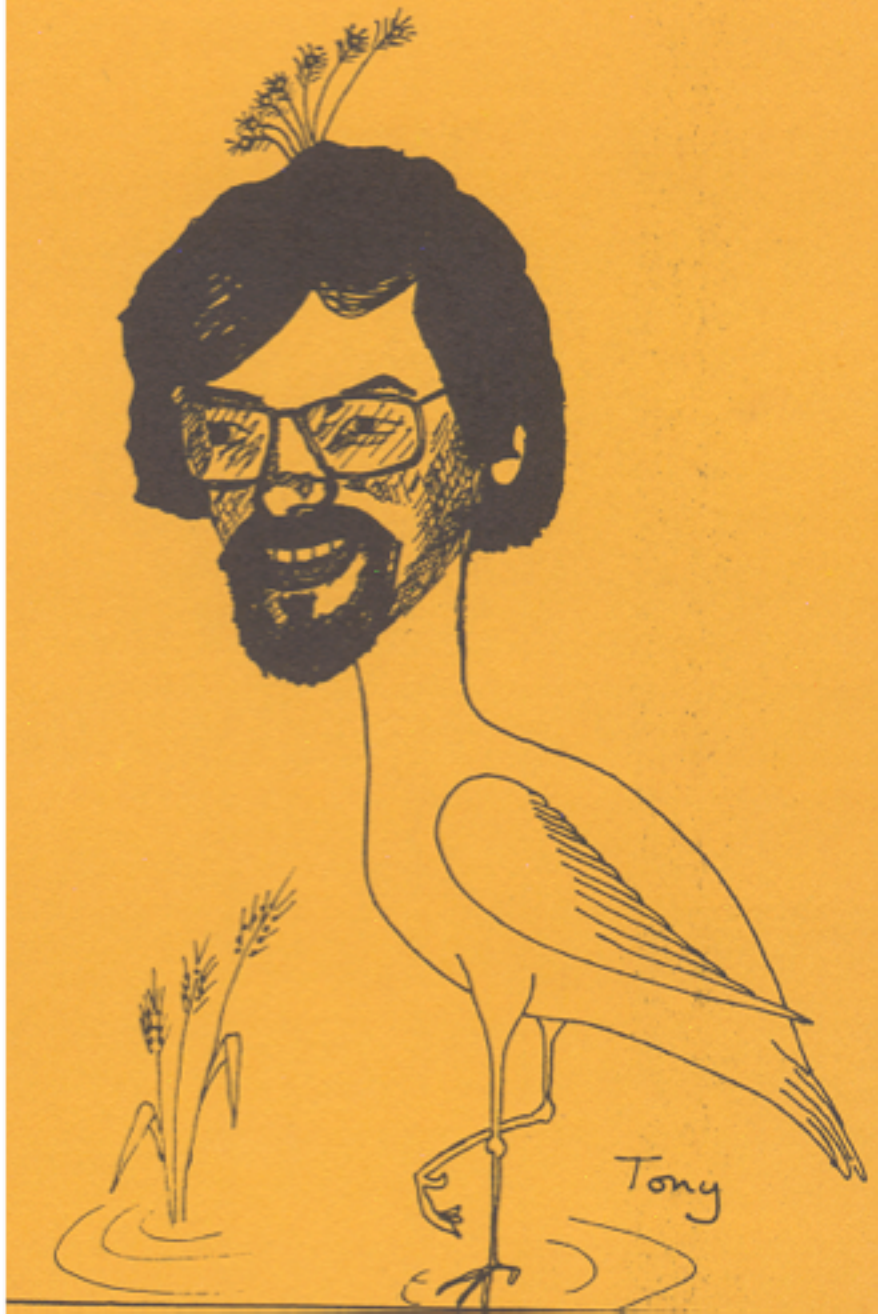
Peter

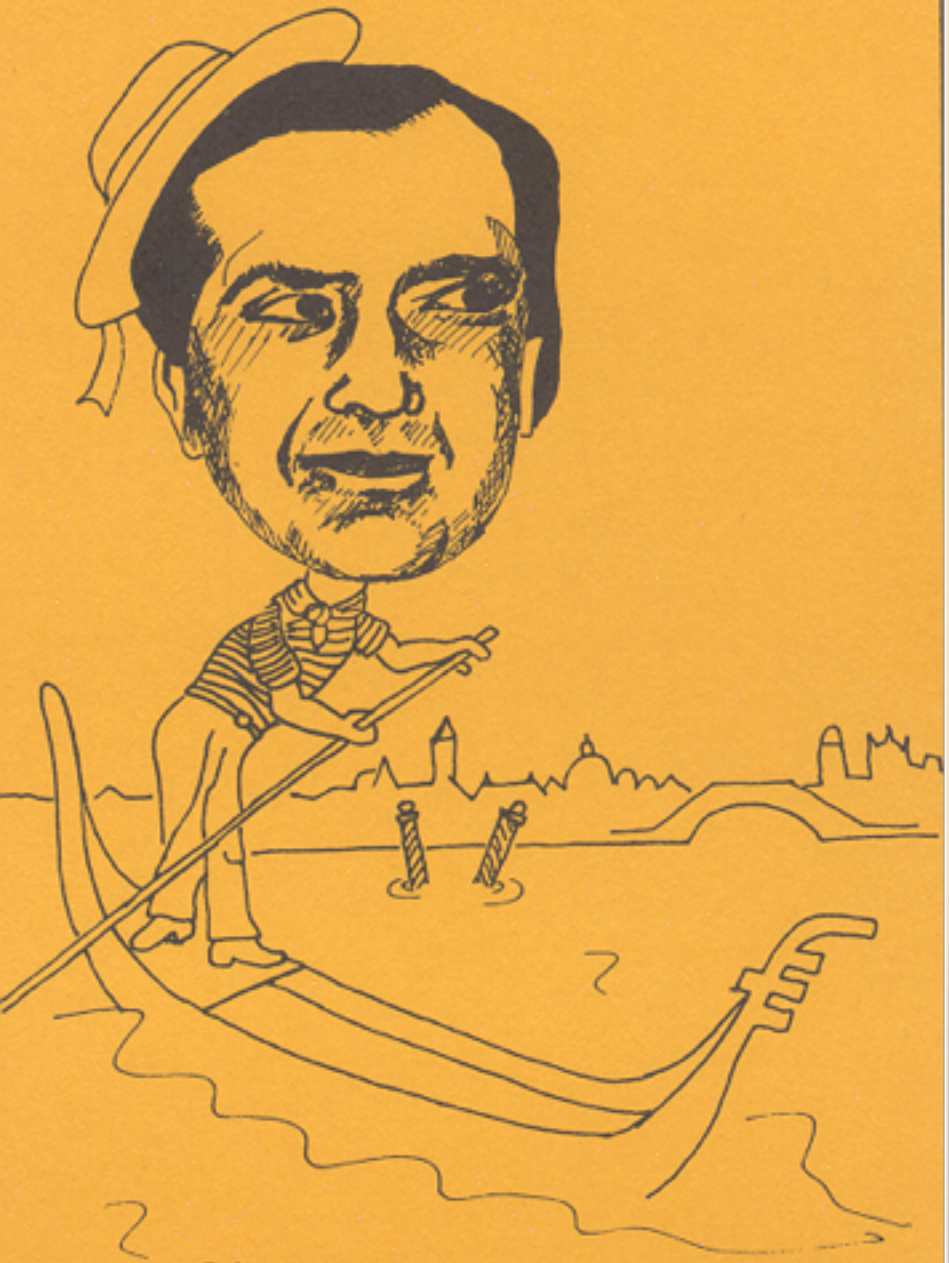

Bernard


André

FAMILLE TOURNEBANDE 3

6 FAMILLE JET

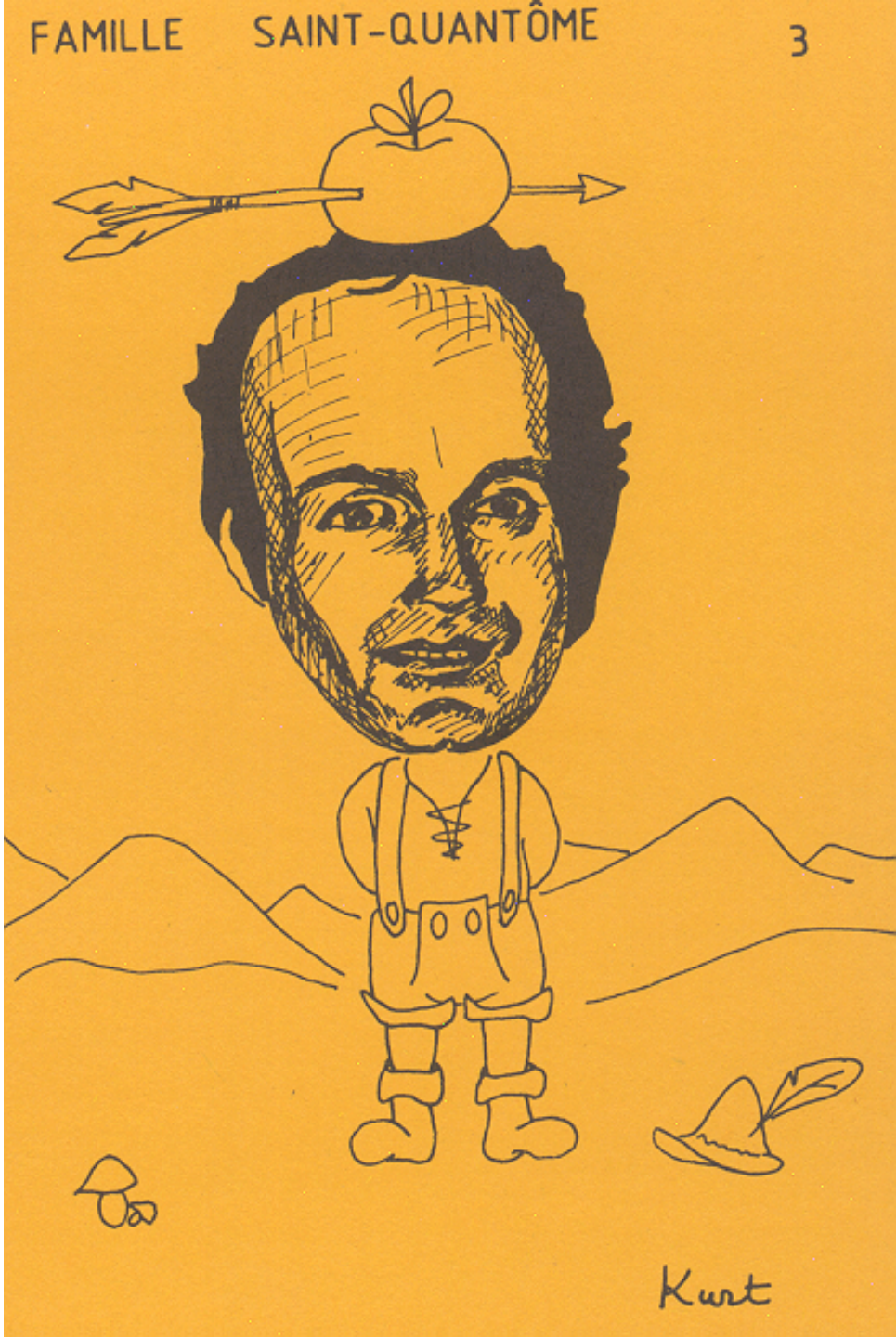



Claudio

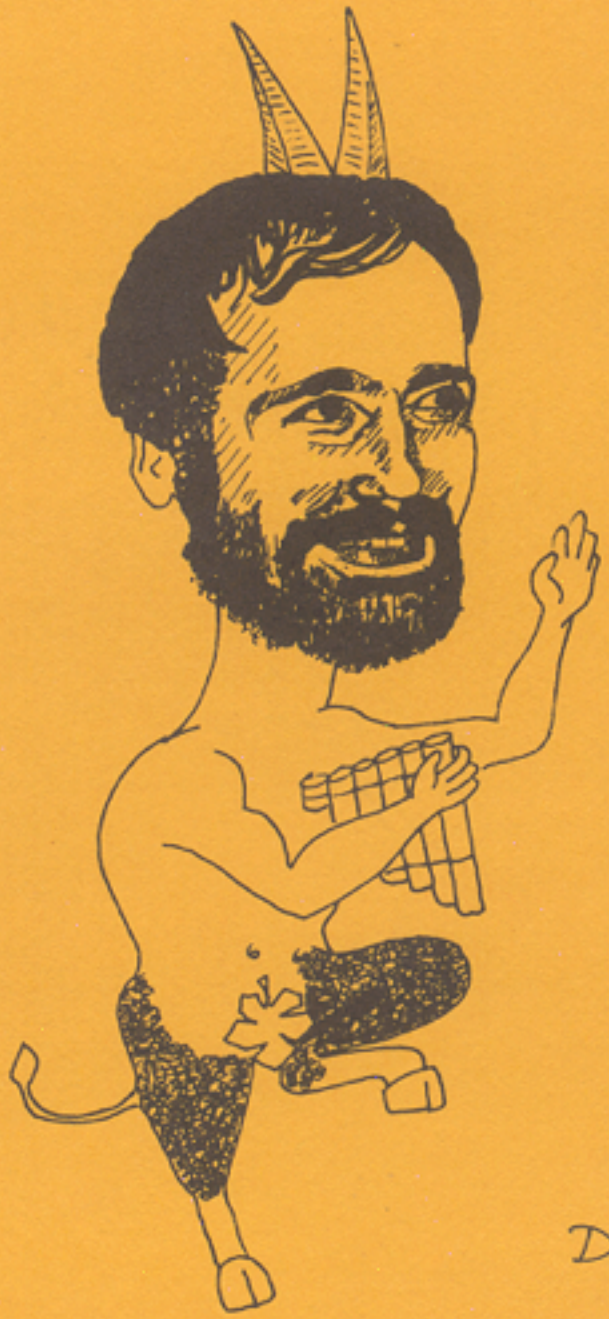

Patrizia

4 FAMILLE BOSON

FAMILLE SAINT-QUANTÔME 3



FAMILLE BOSON 5



Daniel

3 FAMILLE JET

Louis

NEVILLE'S

FAREWELL

LUNCH

MONDAY

24th

MARCH 1986

12:30

AUBERGE

COMMUNALE

DE

SATIGNY

R.S.V.P

Neville and the UA2 (1983-1986) years

What did Neville do in UA2?

If you recall on UA2, I recalibrated the calorimeter from testbeam data and modified the code that was originally written by Pierre.

I then re-ran the Z^0 mass with the improved calibration. I was working mainly with Allan Clark and yourself - what a dream team :-) ! .

There were only a handful of events, but it turned out to be the world's best measurement at the time.

Another thing ... at the time I considered joining UA1 or UA2 as a CERN Fellow. UA1 was the default since it had a whole load of UK institutes and I was looking for a permanent job in the UK. But I was so impressed with the UA2 guys, that I decided to join instead of UA1. This to me was a huge risk at the time, but the rest is history ! Tony Weidberg and myself both got permanent jobs in Oxford at the same time in 1989.

LIST OF INSTITUTIONS

9 INSTITUTIONS, 82 NAMES

BERN

K. [illegible]
G. [illegible]
H. [illegible]
K. [illegible]
K. MÜNING
J. SCHACHER
F. STOCKER
W. ZELLER

CERN

P. BAGNAIA
D. BORGHINI
J. BÜRGER
A. CLARK
F. DARRIULAT
L. DI LELLA
K. EINSWEILER
R. ENGELMANN
U. GILDE HEISTER
C. GÖSSLING
J. HANSEN
P. HANSEN
N. HARNEW
T. HIMEL
I. JENNI
L. MAPELLI
K. MEIER
C. ONIONS
A. PARKER
A. ROTHENBERG
G. STIMPFL
M. SWARTZ
J. TOVEY
W. TSANG
A. WEIDBERG
T. ZAKRZEWSKI

COPENHAGEN

J. DINES-HANSEN
O. KOFOED-HANSEN
B. MADSEN
R. MÖLLERUD

HEIDELBERG

K. BERNLÖHR
E. KLUGE
H. PLOTHOW-BESCH
A. PUTZER
M. SCHLÖTELBURG
K. TITTEL
H. WUNSCH

ORSAY

C. CHOLLET
B. DE LOTTO
L. FAYARD
D. FROIDEVAUX
J.M. GAILLARD
M. MONIER
B. MERKEL
L. ICONOMIDOU
G. PARROUR
J.P. REPELLIN
G. SAUVAGE

PAVIA

C. CONTA
M. FRATERNALI
G. GOGGI
M. LIVAN
F. PASTORE
A. RIMOLDI
V. VERCESI

PERUGIA

R. BATTISTON
P. CENCI
A. CODINO
G. MANTOVANI

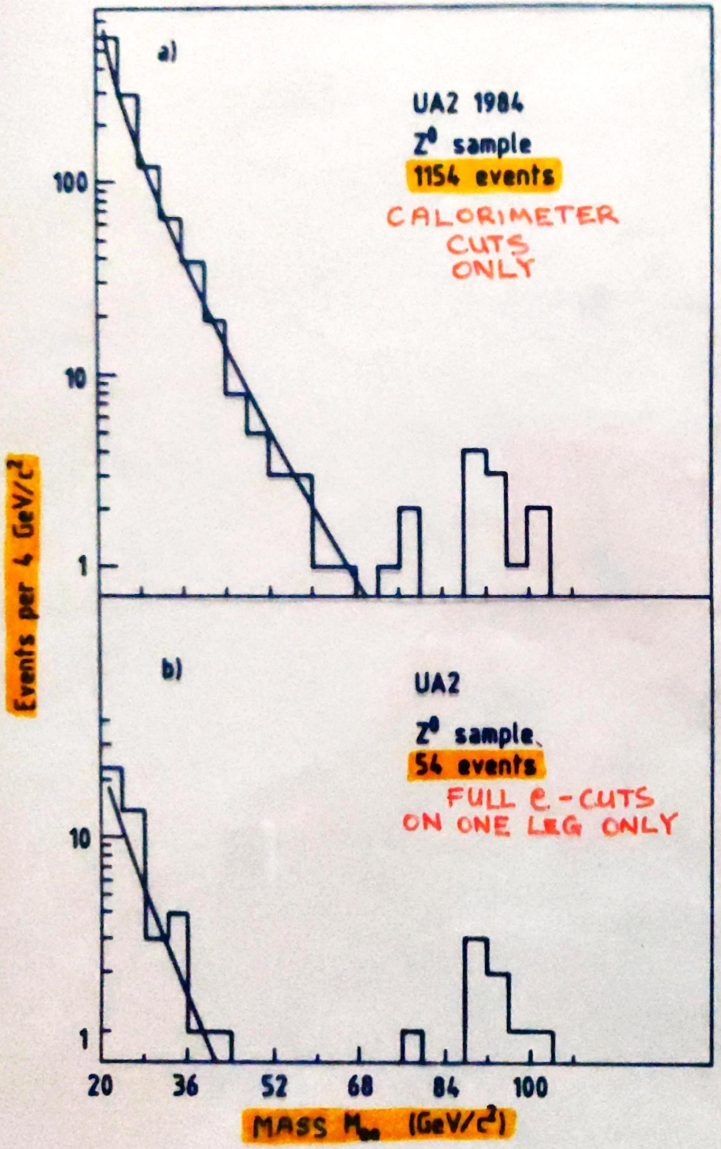
PISA

G. CARBONI
V. CAVASINNI
T. DEL PRETE
M. MORGANTI
M. VALDATA-NAPP

SACLAY

J. APPEL
M. BANNER
P. BLOCH
E. LANÇON
S. LOUCATOS
B. MANSOULIE
M. POLVEREL
A. ROUSSARIE
V. RUHLMANN
J. TEIGER
H. ZACCONE

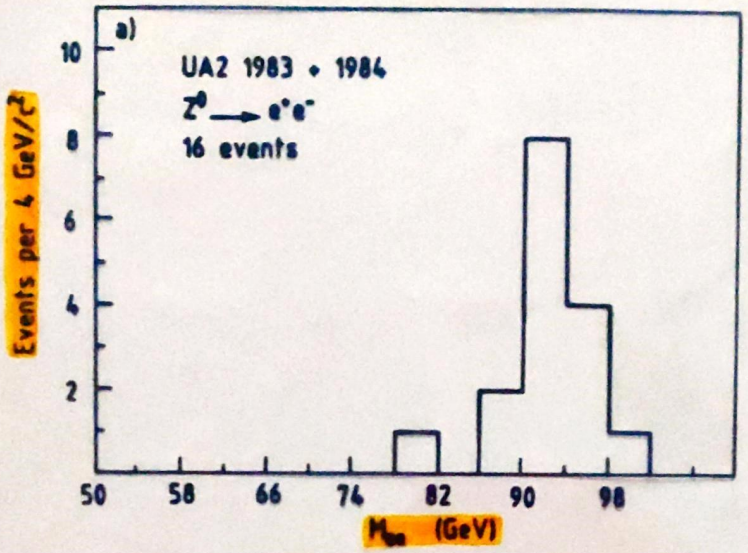
UA2 1984 DATA MASS (e^+e^-)



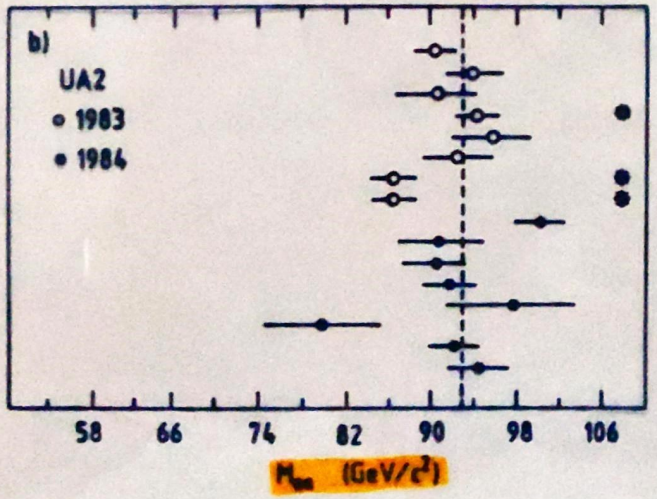
13 EVENTS WITH $M_{ee} > 70$ GeV (EXPECT 3.8 ± 0.4 ev. BACKGROUND)

8 EVENTS WITH $M_{ee} > 70$ GeV (EXPECT 0.21 ± 0.02 ev. BACKGROUND)

UA2 MASS(e^+e^-) 1983+84



MASS DETERMINATION

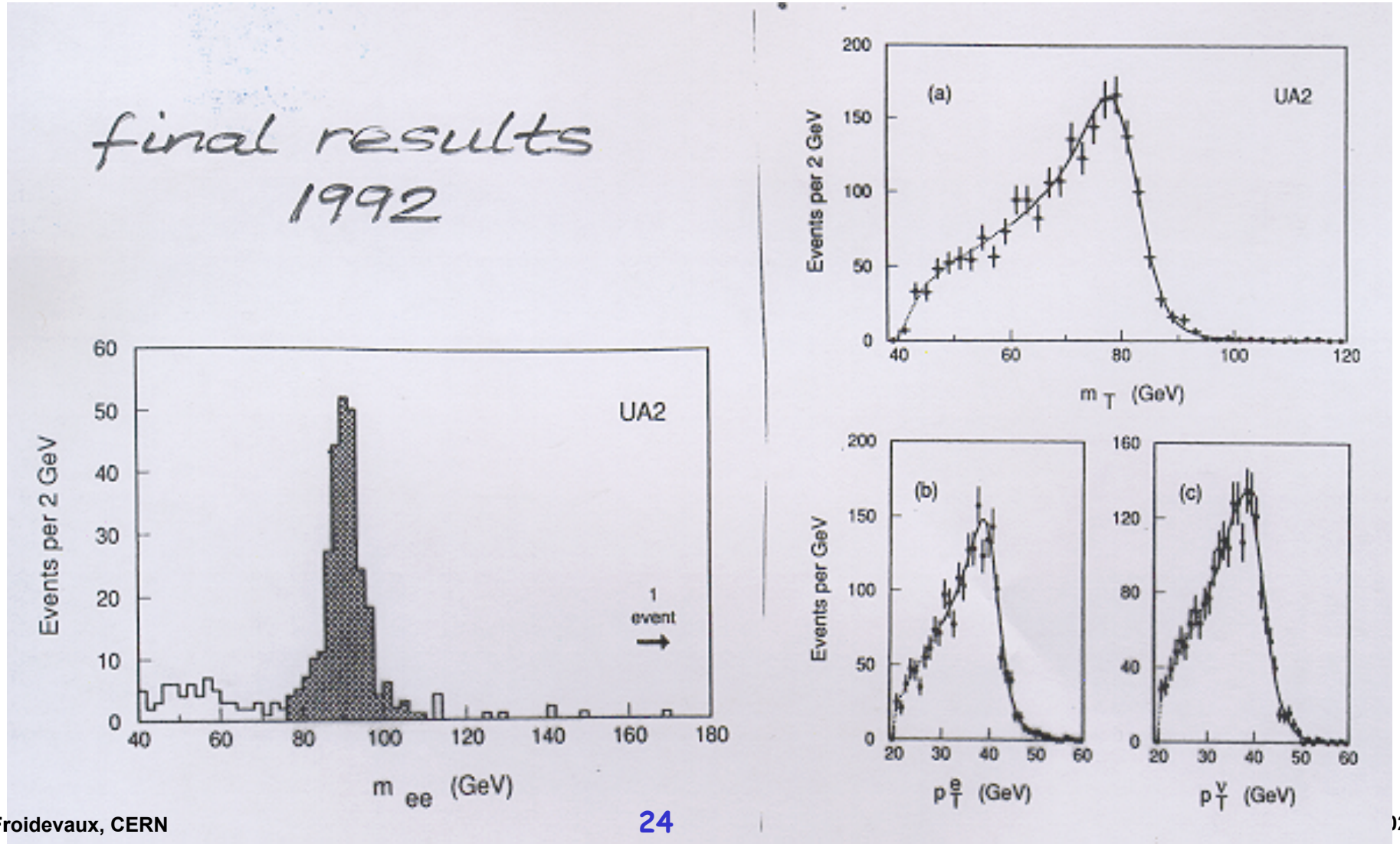


* NOT USED IN MASS FIT

$M_{Z^0} = 92.5 \pm 1.3 \pm 1.5$ GeV
(STAT.) (SYST.)
(FIT WITH BREIT WIGNER + RESOLUTION SMEARING)

Historical perspective: the 80's in UA1/UA2 at the SppS

To the end, with first accurate measurements of the W/Z masses and the search for the top quark and for supersymmetry



Historical perspective: the 80's in UA1/UA2 at the SppS

First ever EW fits in UA2 before LEP turned on

From these events we measure the mass of the Z^0 boson to be :

$$M_Z = 91.9 \pm 1.3 \pm 1.4 \text{ GeV}/c^2 \quad (2)$$

where the first error accounts for measurement errors and the second for the uncertainty on the overall energy scale.

The rms of this distribution is 2.6 GeV/c^2, consistent with the expected Z^0 width[14] and with our experimental resolution of $\sim$ 3%.

Under the hypothesis of Breit-Wigner distribution we can place an upper limit on its full width

$$\Gamma < 11 \text{ GeV}/c^2 \quad (90\% \text{ CL}) \quad (3)$$

corresponding to a maximum of $\sim$ 50 different neutrino types in the universe[15]

The standard SU(2) $\times$ U(1) electroweak model makes definite predictions on the Z^0 mass. Taking into account radiative corrections to 0 (α) one finds[14]

$$M_Z = 77\, \rho^{-\frac{1}{2}} (\sin 2\theta_W)^{-1} \text{ GeV}/c^2 \quad (4)$$

where θ_W is the renormalised weak mixing angle defined by modified minimal subtraction, and ρ is a parameter which is unity in the minimal model.

Assuming $\rho = 1$ we find

$$\sin^2\theta_W = 0.227 \pm 0.009 \quad (5)$$

However, we can also use the preliminary value of the W mass found in this experiment[16]

$$M_W = 81.0 \pm 2.5 \pm 1.3 \text{ GeV}/c^2.$$

Using the formula[14]

$$M_W = 38.5 (\sin\theta_W)^{-1} \text{ GeV}/c^2 \quad (6)$$

we find $\sin^2\theta_W = 0.226 \pm 0.014$, and using also Eq. (4) and our experimental value of M_Z we obtain

$$\rho = 1.004 \pm 0.052 \quad (7)$$

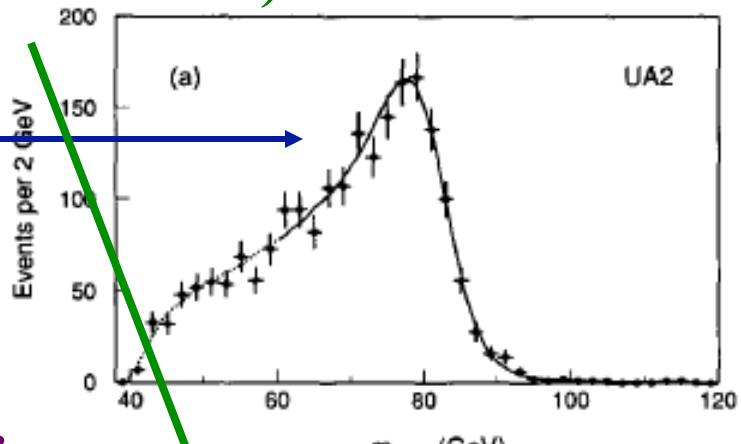
Historical perspective: the 80's in UA1/UA2 at the SppS

Most important results from 1987-1990 campaign with UA2:

precise measurement of m_W/m_Z

and direct limit on top-quark mass ($m_{top} < 60$ GeV)

Transverse mass distribution for electron-neutrino pairs



$$\frac{m_W}{m_Z} = 0.8813 \pm 0.0036 \pm 0.0019$$

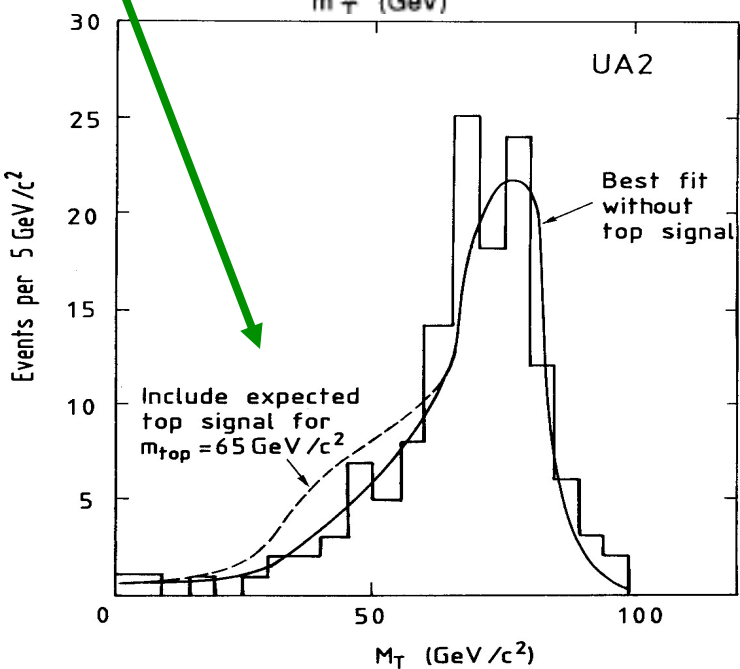
Using the precise measurement of m_Z (LEP):

$$m_W = 80.35 \pm 0.33 \pm 0.17 \text{ GeV}$$

→ **Indirect limits on top-quark mass in the context of the Standard Model:**

$$m_{top} = 160^{+50}_{-60} \text{ GeV}$$

(four years before the discovery of the top quark at Fermilab)



Neville as (co)-Chair of the Project Peer Review Panel from 2001 to 2003

I served for 3+ years on this panel as the only non-UK member:

- **This turned out to be a big advantage because I was the only member present during all the discussions. In contrast, Neville, even though chair, was a member of perhaps the largest collection of University research groups reviewed by this panel in the UK, and therefore obliged because of rather dim-witted regulations issued by bureaucrats to leave the room whenever a recommendation was about to be voted concerning any project where any member of his university was involved.**
- **This terrible feature compounded by the fact that a financial bureaucrat as emissary from the higher levels was edicting precisely sometimes what was expected of us as recommendations almost made me resign (thanks to Ken Peach who in his greater wisdom made me reconsider).**
- **Throughout these ordeals (for him personally!), Neville never once lost control, never once showed any sign of stress despite the magnitude of the projects discussed, and did a great job given the constraints! :**
-

First major funding for e-science **Setting up of new accelerator lab(s)**

plus **Linear collider bias of UK science leadership**

ARE MADE FULLY "HERMETIC" DOWN
TO 0.2 DEGREES, IN ORDER TO DETECT
ALL HADRONIC, ELECTROMAGNETIC, A
MUON DEBRIS.

NEUTRINOS ARE THEREFORE IDENTIFI
BY THE APPARENT TRANSVERSE ENERG
MOMENTUM UNBALANCE, THE SO CAL
[redacted].

SINCE W→eν IS CHARACTERIZED BY A L
TRANSVERSE MOMENTUM $M_W/2 \simeq 40G$
THIS TECHNIQUE IS USED IN THE TRAN
COORDINATES WITH RESPECT TO THE B

MAY JUNE

AND $\Delta\phi > 60$

~700K triggers of each ty

Z^0 candidates were recognised

line and fully reconstructed within

than one hour.

The whole data sample has been

reprocessed. Full event reconstruction

has been completed on a selected

sample to allow for speedy analysis.

S VAN DER MEER 1970

K HÜBNER et al 1972, 1973, 1974

$\mathcal{L} \lesssim$ a few 10^{25} cm^{-2} s^{-1}

ELECTRON COOLING

GI BUDKER 1966

A.S. DERBENEV & A. SKRINSKI 1968

STOCHASTIC COOLING

S VAN DER MEER 1972 (BETATRON)

L. THORNDAHL 1975 (LONGITUDINAL)

W SCHNELL et al 1976 (ISR TESTS)

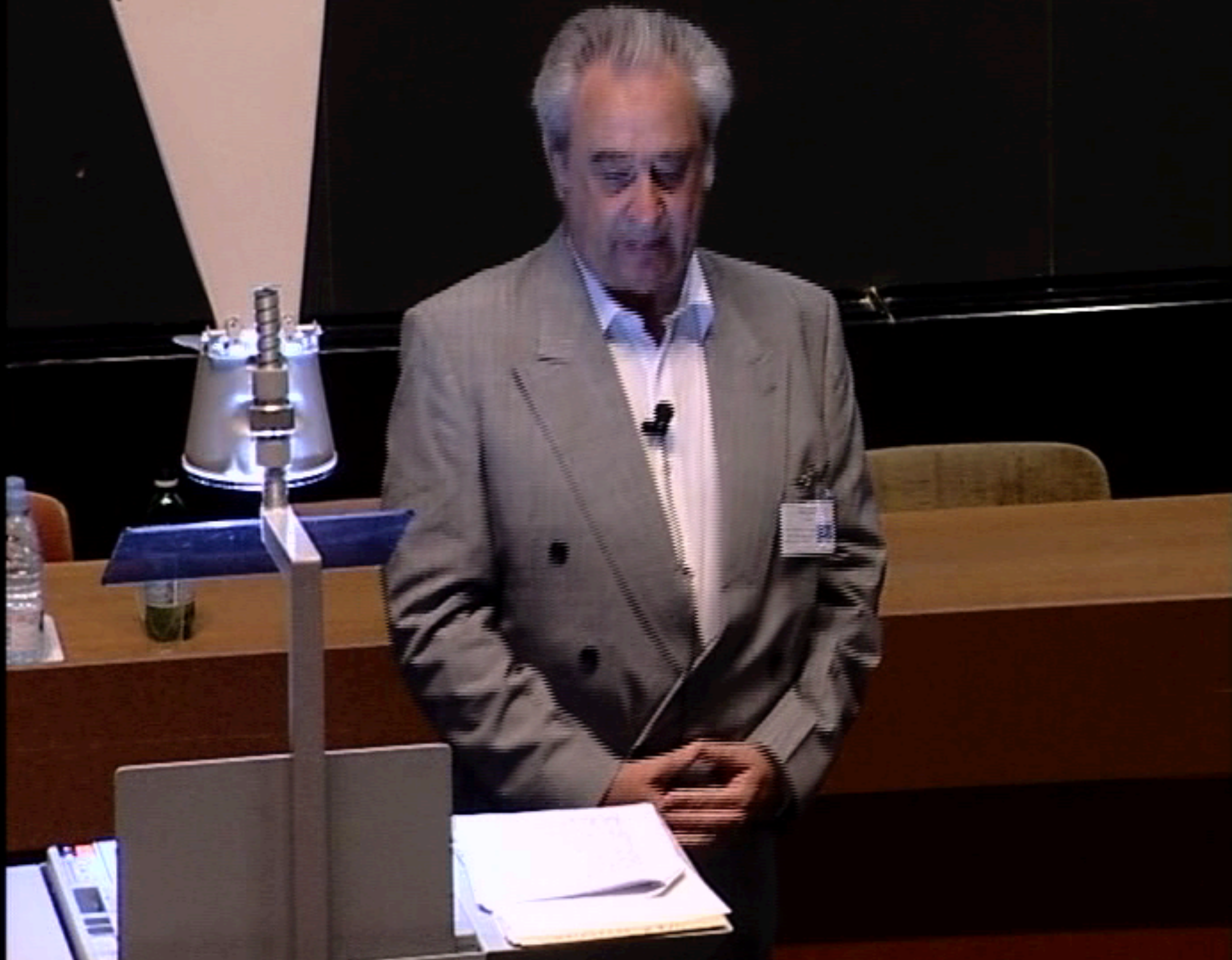
C. RUBBIA P. McINTYRE D. CLINE

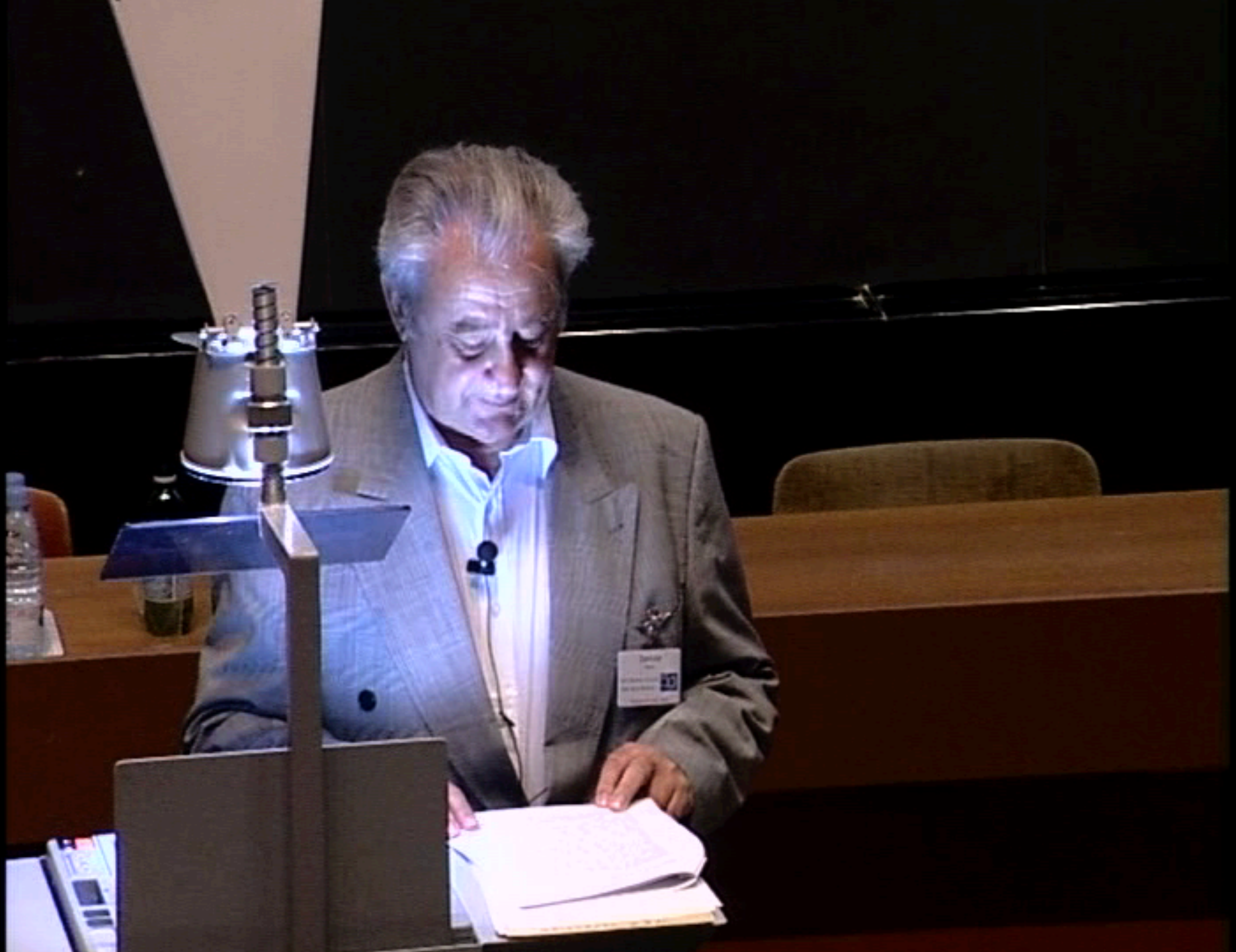
1976

PRODUCING W/Z WITH EXISTING MACHINES

PROPOSALS TO CERN AND FERMILAB

1977 AT CERN





Backup