In celebration of Phil Allport

Cambridge and the OPAL Microvertex Detector

* All inaccuracies due to historical documents

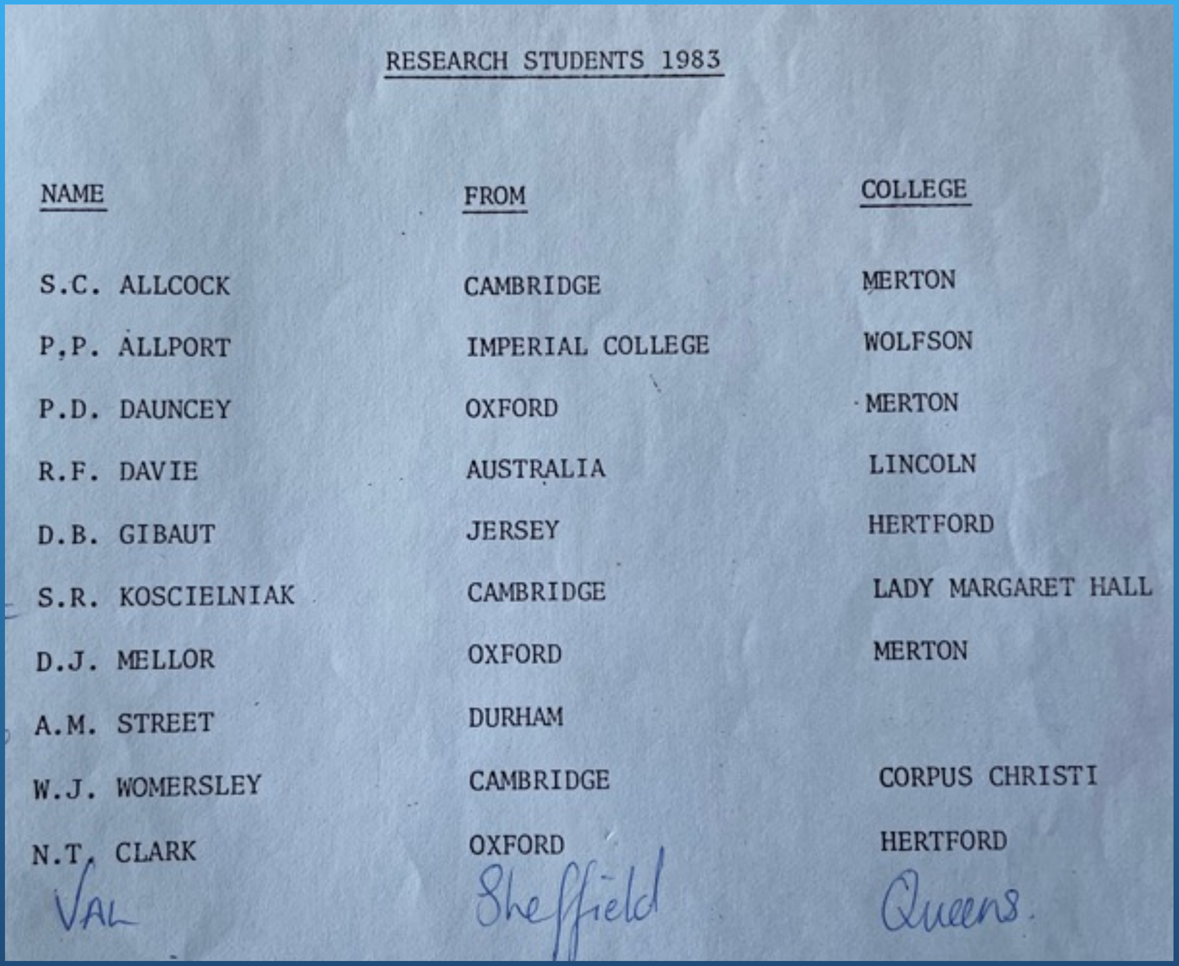
Oxford Particle Physics Cohort 1983

Oxford Particle Physics Cohort 1983

RESEARCH STUDENTS 1983

NAME	FROM	COLLEGE
S.C. ALLCOCK	CAMBRIDGE	MERTON
P.P. ALLPORT	IMPERIAL COLLEGE	WOLFSON
P.D. DAUNCEY	OXFORD	MERTON
R.F. DAVIE	AUSTRALIA	LINCOLN
D.B. GIBAUT	JERSEY	HERTFORD
S.R. KOSCIELNIAK	CAMBRIDGE	LADY MARGARET HALL
D.J. MELLOR	OXFORD	MERTON
A.M. STREET	DURHAM	
W.J. WOMERSLEY	CAMBRIDGE	CORPUS CHRISTI
N.T. CLARK	OXFORD	HERTFORD
VAL	Sheffield	Queens.

Oxford Particle Physics Cohort 1983



RESEARCH STUDENTS 1983

NAME	FROM	COLLEGE
S.C. ALLCOCK	CAMBRIDGE	MERTON
P.P. ALLPORT	IMPERIAL COLLEGE	WOLFSON
P.D. DAUNCEY	OXFORD	MERTON
R.F. DAVIE	AUSTRALIA	LINCOLN
D.B. GIBAUT	JERSEY	HERTFORD
S.R. KOSCIELNIAK	CAMBRIDGE	LADY MARGARET HALL
D.J. MELLOR	OXFORD	MERTON
A.M. STREET	DURHAM	
W.J. WOMERSLEY	CAMBRIDGE	CORPUS CHRISTI
N.T. CLARK	OXFORD	HERTFORD
VAL	Sheffield	Queens.

Oxford Particle Physics Cohort 1983

- Neutrino experiments (BEBC, Tevatron)
- Muon scattering (EMC)
- TASSO experiment at PETRA
- European Hybrid Spectrometer at CERN (EHS)

Oxford Particle Physics Cohort 1983

- Neutrino experiments (BEBC, Tevatron)

  Phil Allport: Supervisor Dusan Radojicic

- Muon scattering (EMC)

  Val Gibson, John Womersley

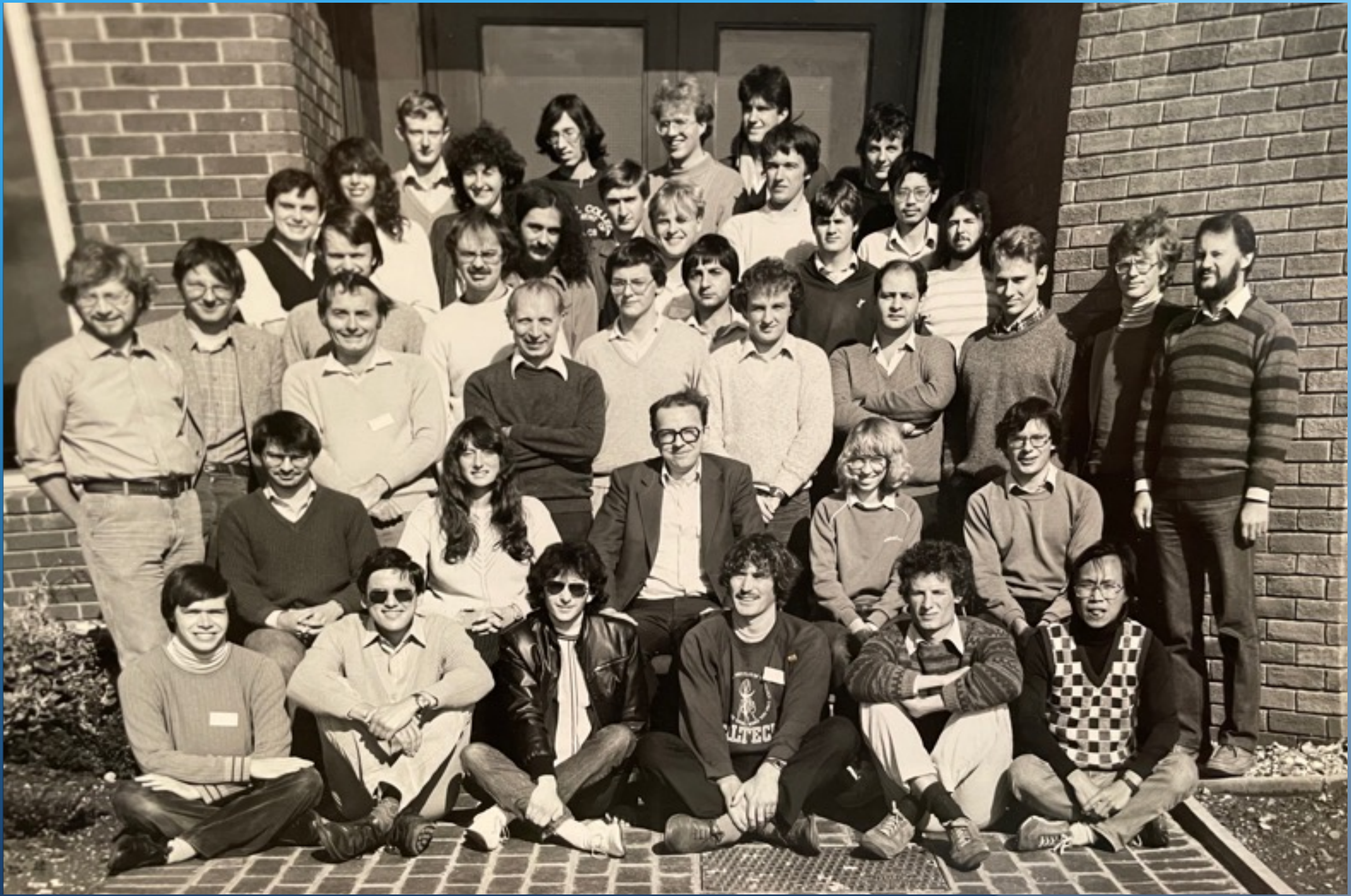
- TASSO experiment at PETRA

  Paul Dauncey, Dave Mellor

- European Hybrid Spectrometer at CERN (EHS)

  Duncan Gibaut

Rutherford Summer School 1984



Oxford Particle Physics Cohort 1983

- Neutrino experiments (BEBC, Tevatron)

  Phil thesis (RAL-T-045): High-energy neutrino scattering at low q^2

- Muon scattering (EMC)

  Val thesis (RAL-T-035): The structure functions of free and bound nucleons in deep inelastic muon scattering

- TASSO experiment at PETRA

- European Hybrid Spectrometer at CERN (EHS)

Oxford Particle Physics Cohort 1983

- Neutrino experiments (BEBC, Tevatron)

  Phil thesis (RAL-T-045): High-energy neutrino scattering at low q^2

  Number of citations = 1

- Muon scattering (EMC)

  Val thesis (RAL-T-035): The structure functions of free and bound nucleons in deep inelastic muon scattering

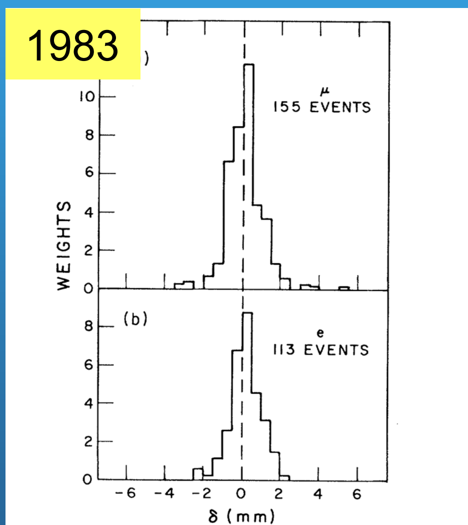
  Number of citations = 1

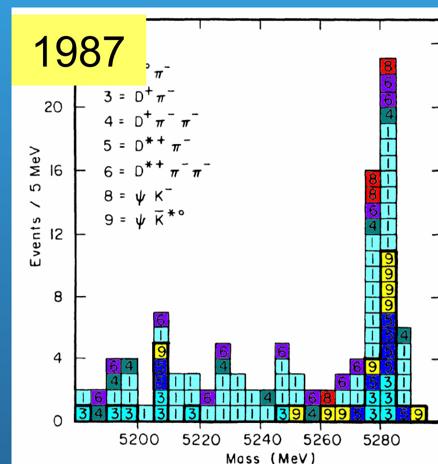
- TASSO experiment at PETRA

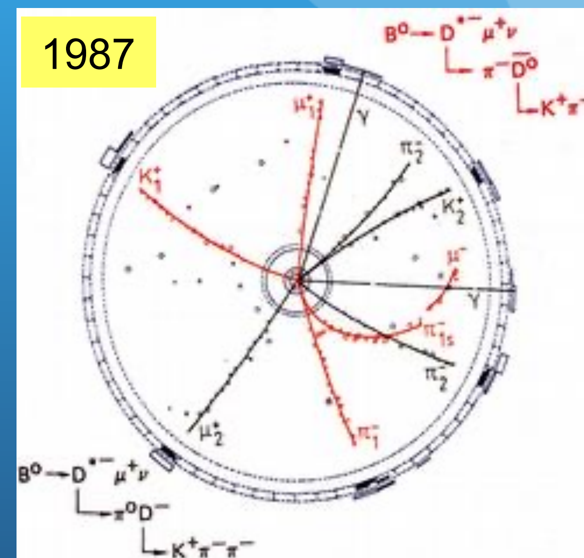
- European Hybrid Spectrometer at CERN (EHS)

History of Silicon Detectors

In the 1980s heavy flavour (charm and beauty) physics was a very “hot” topic….







B meson lifetime
MAC-Mark II
$c\tau$ ~490 μm

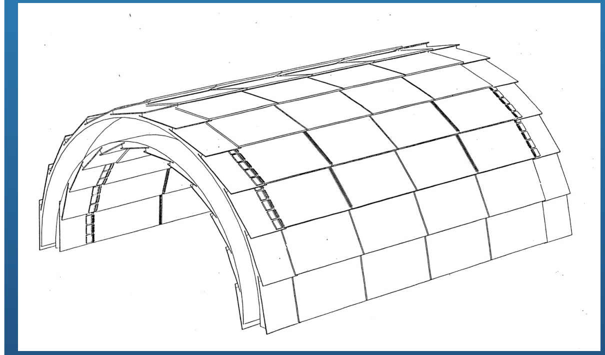
Exclusive reconstruction of several $b \rightarrow c$ decay modes
CLEO

B mixing observed
ARGUS

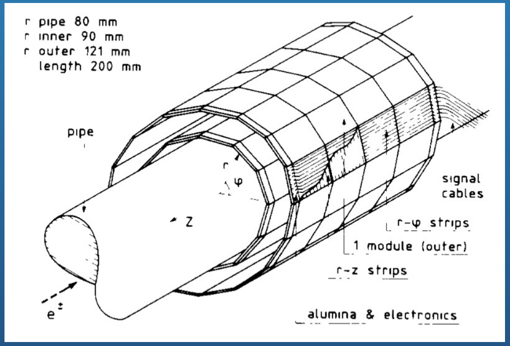
History of Silicon Detectors

Early 1980's: Silicon microstrip detectors with better than 3μm spatial resolution had been developed and used in charm and beauty search experiments at the CERN SPS and the Tevatron at Fermilab.

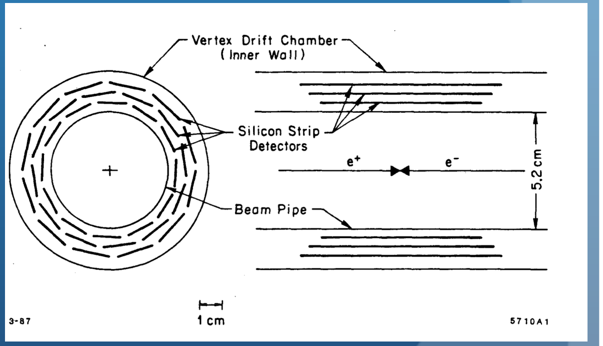
Mid 1980's: Silicon microvertex detectors were being developed for LEP and the SLC.



DELPHI microvertex detector
DELPHI 86-86 GEN-52



ALEPH minivertex detector
NIM A257 (1987) 587



Mark II silicon strip vertex detector
NIM A265 (1988) 93

1988

630 Nuclear Instruments and Methods in Physics Research A273 (1988) 630–635
North-Holland, Amsterdam

A LOW POWER CMOS VLSI MULTIPLEXED AMPLIFIER FOR SILICON STRIP DETECTORS

P.P. ALLPORT, P. SELLER and M. TYNDEL

Rutherford Appleton Laboratory, Chilton, Oxon, UK

A low power CMOS VLSI circuit has been designed and built for the readout of 25 μm pitch silicon strip detectors. Each detector strip is connected directly to one of 128 electronic channels on the chip. A channel consists of a charge sensitive amplifier incorporating correlated double sample and hold for noise reduction. There is a single differential multiplexed output for the 128 channels on each chip. Results are presented on the performance of a detector equipped with the VLSI circuits.

Planned vertex detectors requirements:
Readout in confined space, 10^5-10^6 channels
low power, low noise, radiation hard

Each 6.4 mm × 6.4 mm VLSI circuit, fabricated with 5 μm CMOS technology, consists of 128 individual amplifiers and a single multiplexed differential output. The outputs from several devices can be daisy-chained together to allow readout of multiples of 128 channels along a single twisted pair lead.

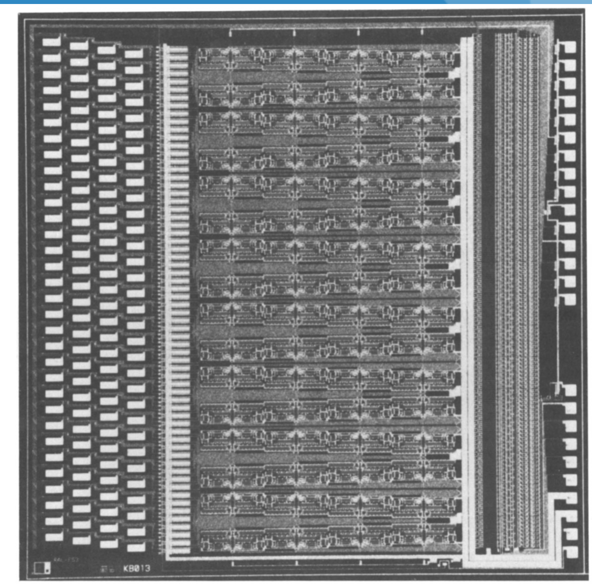


Fig. 3. The CMOS VLSI 128 channel amplifier with multiplexed readout.

MX series

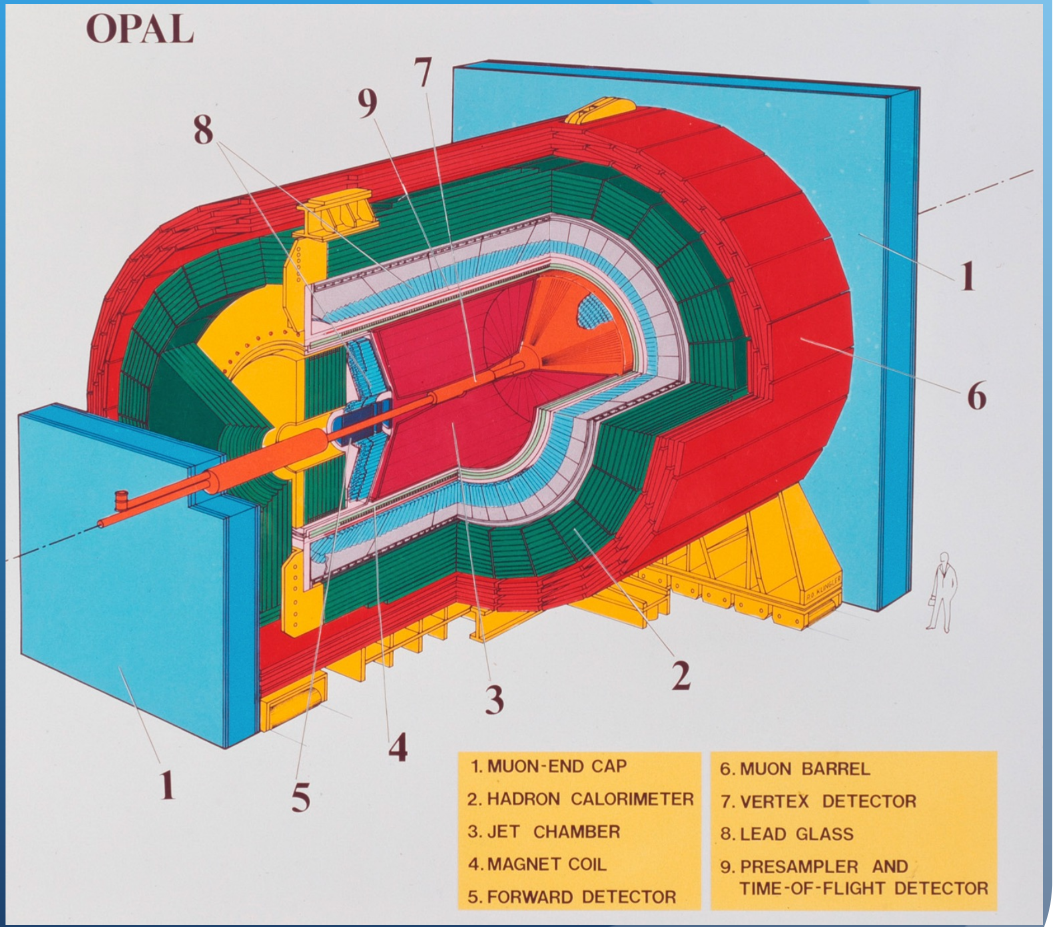
First results:
Power 55 mW, noise 2000e- connected to 25μm strip
Crosstalk <1%, readout rate 3 MHz, works up to 3krad

Cambridge 1989

Cambridge 1989

The OPAL experiment at LEP started taking data in 1989 to study the Z^0 (1989-1995) and $W^{\pm}$ (1996-2000) bosons.

Cambridge responsibilities:
Vertex drift chamber
Track trigger
Endcap EM calorimeter
Software

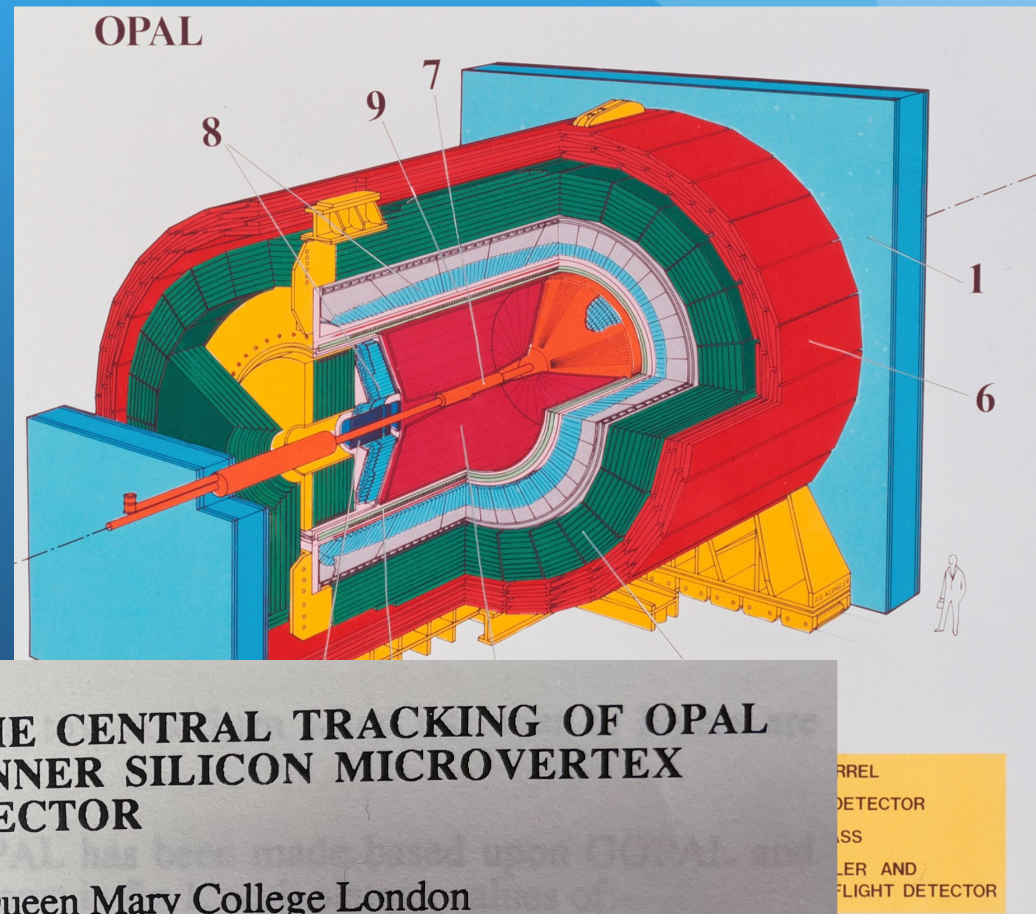


Cambridge 1989

The OPAL experiment at LEP started taking data in 1989 to study the Z^0 (1989-1995) and $W^{\pm}$ (1996-2000) bosons.

Cambridge responsibilities:
Vertex drift chamber
Track trigger
Endcap EM calorimeter
Software

Discussions were also ongoing to insert a silicon microvertex detector around a reduced diameter (53mm) beam-pipe



A SCHEME FOR UPGRADING THE CENTRAL TRACKING OF OPAL BY THE ADDITION OF AN INNER SILICON MICROVERTEX DETECTOR

Cambridge University, Queen Mary College London
and Electronics Development Group Rutherford Appleton Laboratory

Cambridge 1989

Phil arrives in Cambridge to develop silicon strip detectors for the proposed OPAL microvertex detector

Janet Carter

and
Sven Katvars

Cambridge 1989

Phil arrives in Cambridge to develop silicon strip detectors for the proposed OPAL microvertex detector

Janet Carter

serc

Science and Engineering Research Council
Programmes Directorate
Polaris House, North Star Avenue, Swindon SN2 1ET
Telephone (0793) 411000 Fax (0793) 411400 GTN 1434 Telex 449466
Direct line 41 1278 Direct Fax line 411348

Dr J Carter
BAT 28 S008
EP Division
CERN
CH-1211
Geneva 23
SWITZERLAND

NP/106/14

6 September 1989

Dear Dr Carter

FUNDING AND MONITORING OF HEP DETECTOR AND ACCELERATOR RESEARCH & DEVELOPMENT

The Particle Physics Committee has decided to introduce a new mechanism for the support, monitoring and review of HEP detector and accelerator research and development at the next round of grant applications.

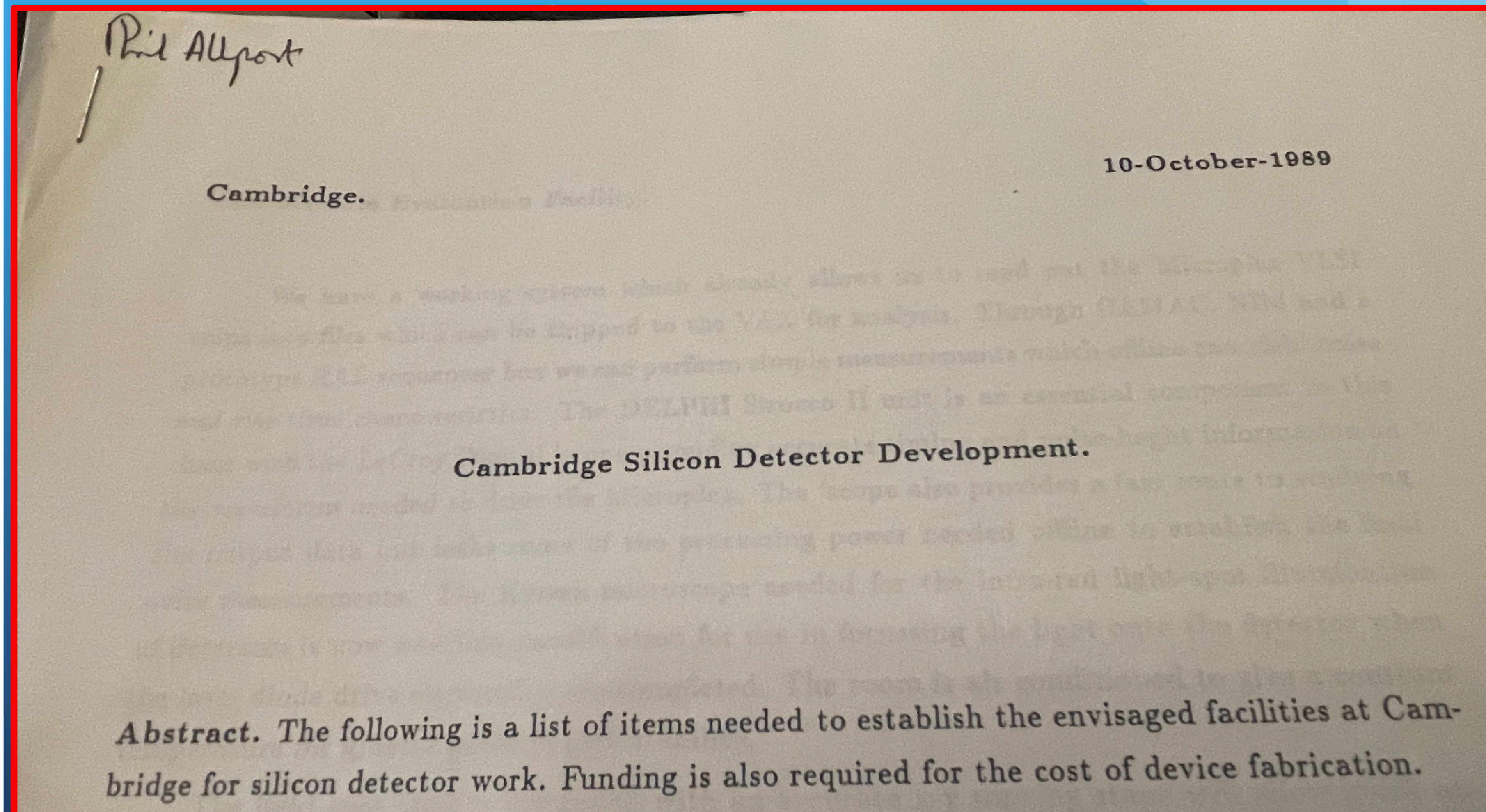
The attached documents describe the mechanism and give guidance for the preparation of proposals. I would like to draw your attention to the closing date of 15 November for receipt of applications in Swindon Office.

Yours sincerely

R.J.Cashmore

Cambridge 1989

Phil arrives in Cambridge to develop silicon strip detectors for the proposed OPAL microvertex detector



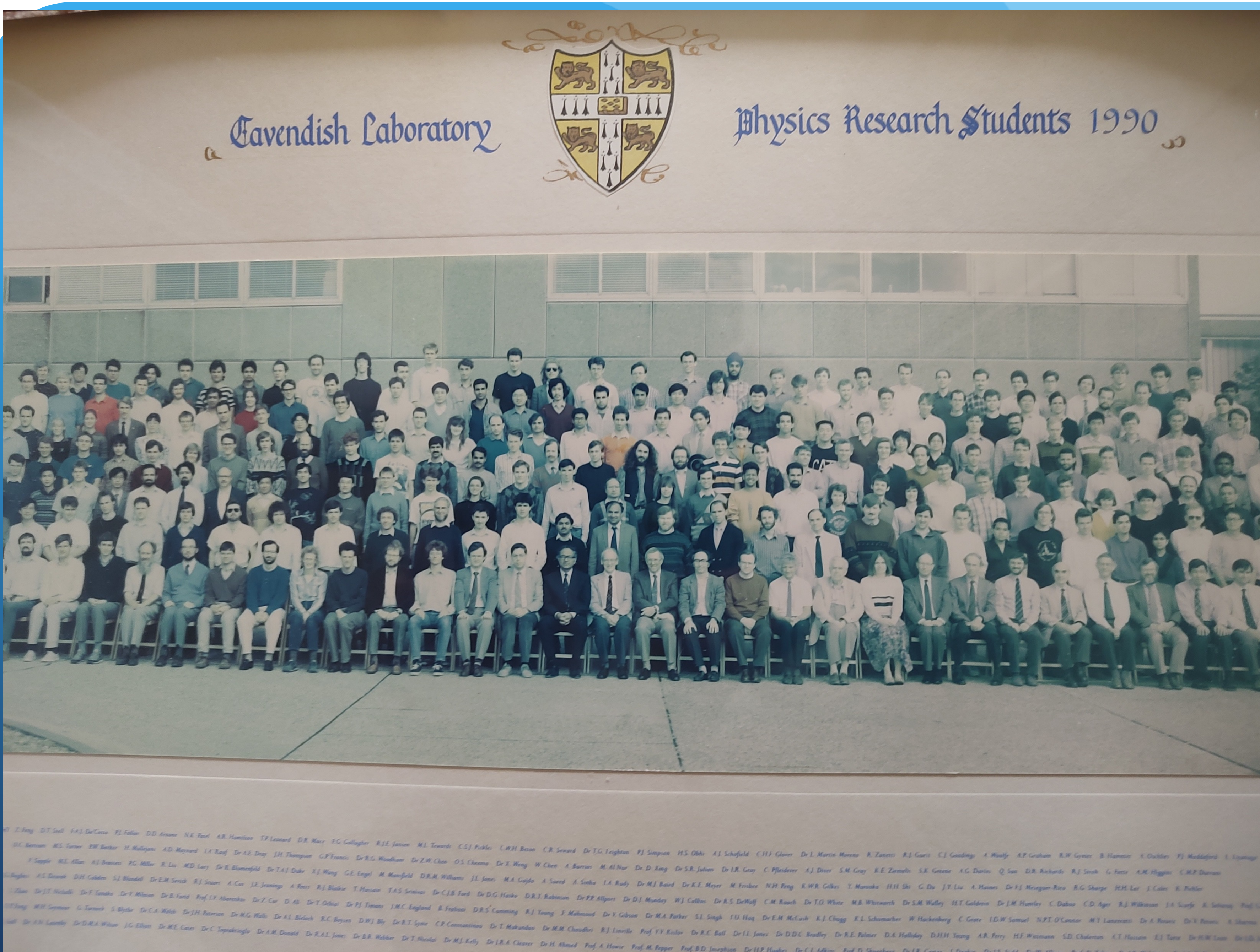
Phil Allport

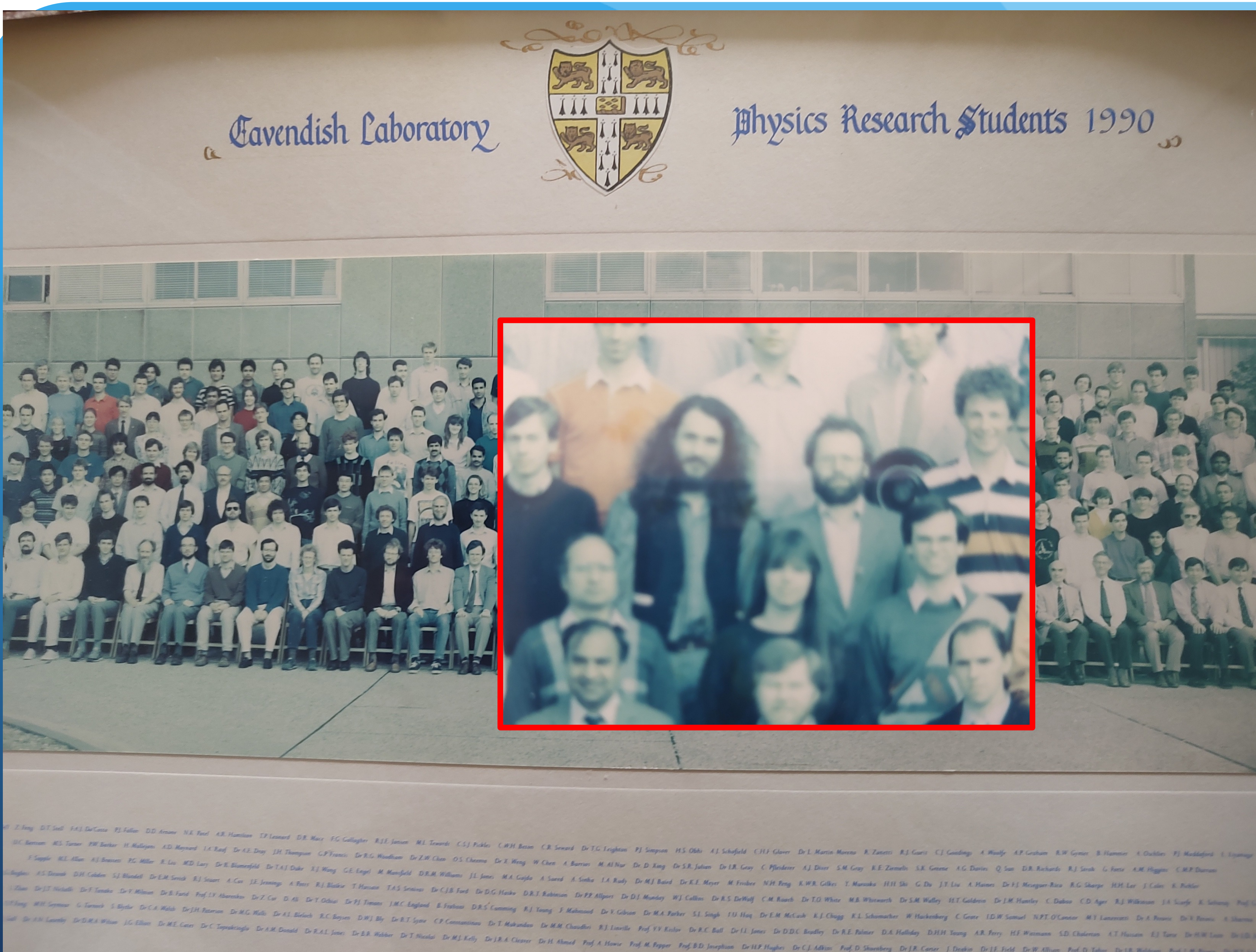
10-October-1989

Cambridge.

Cambridge Silicon Detector Development.

Abstract. The following is a list of items needed to establish the envisaged facilities at Cambridge for silicon detector work. Funding is also required for the cost of device fabrication.


Cavendish Laboratory
Physics Research Students 1990


Cavendish Laboratory
Physics Research Students 1990

1990

Nuclear Instruments and Methods in Physics Research A310 (1991) 155–159
North-Holland

FOXFET biassed microstrip detectors

P.P. Allport, J.R. Carter, V. Gibson, M.J. Goodrick, J.C. Hill and S.G. Katvars
Cavendish Laboratory, University of Cambridge, Cambridge, UK

M.A. Bullough, N.M. Greenwood, A.D. Lucas and C.D. Wilburn
Micron Semiconductors Limited, Lancing, Sussex, UK

A.A. Carter and T.W. Pritchard
QMW, London University, London, UK

L. Nardini, P. Seller and S.L. Thomas
Rutherford Appleton Laboratory, Didcot, Chilton, Oxfordshire, UK

Previous approaches:

- Polysilicon resistors – reliable strip connection, but high resistor values (>2MΩ) requires intricate frabrication

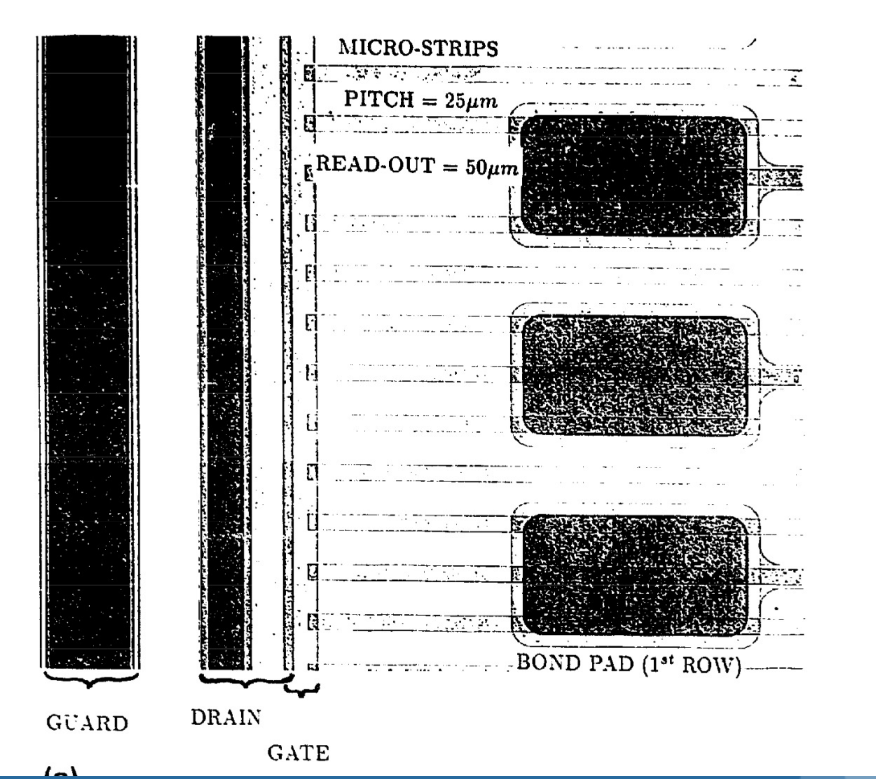
- Punch-through – leakage current dependent dynamic resistance affects resolution

FoxFET biassing

FoxFET biassing retains the simplicity of fabrication of the punch-through design whilst allowing the dynamic resistance to be tuned through the gate voltage control

Built in collaboration with

Micron Semiconductor Ltd



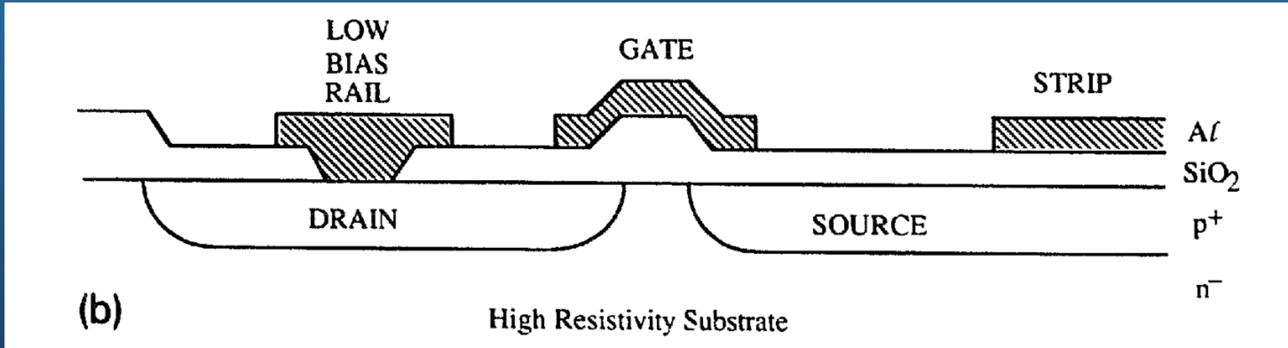
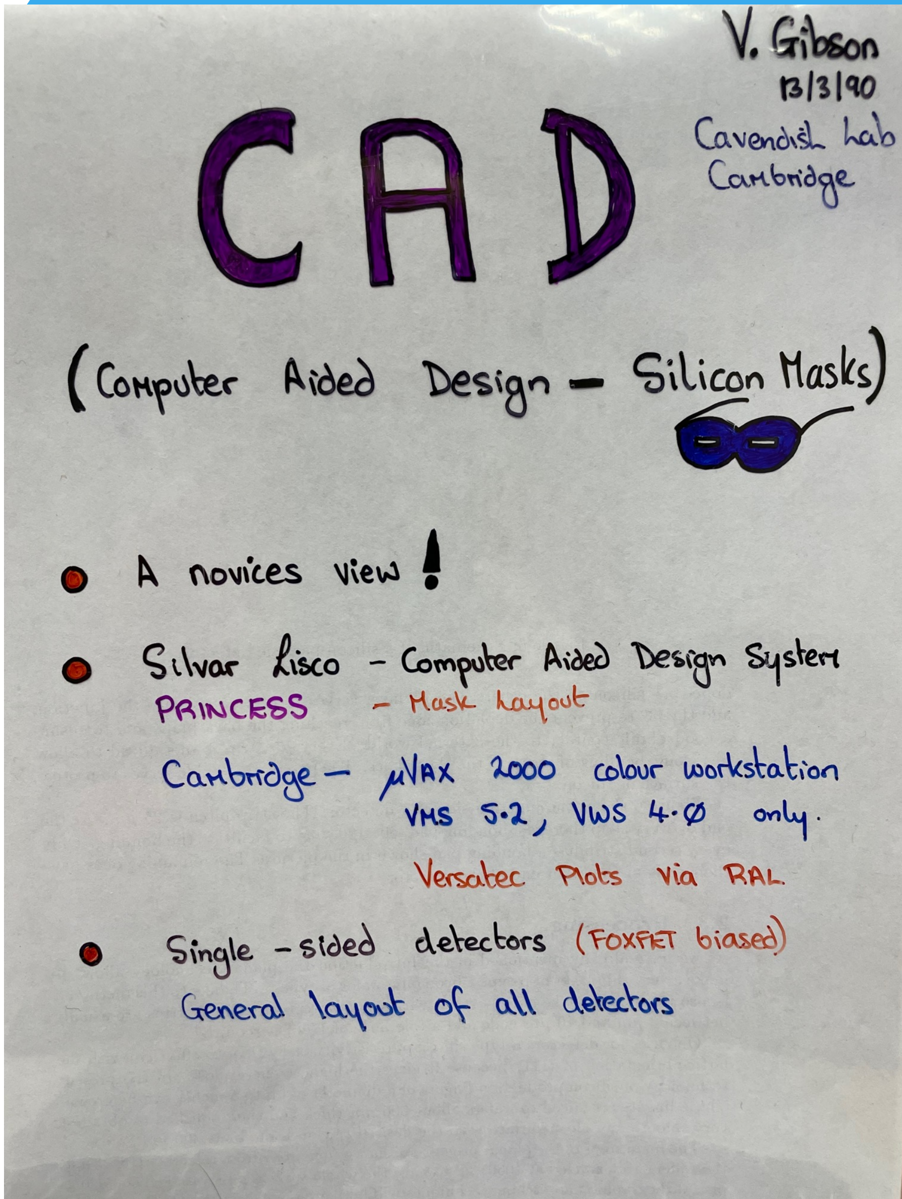


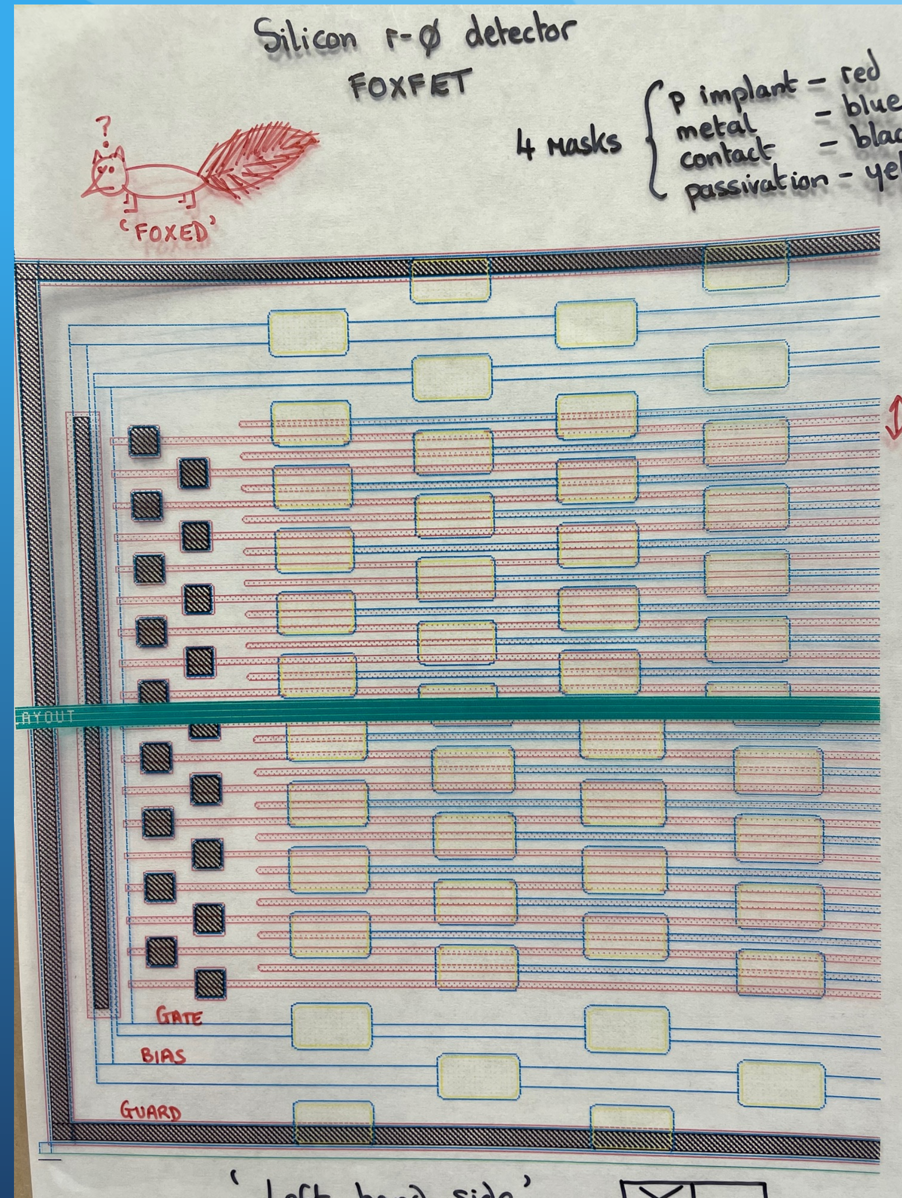
Fig. 1. FOXFET detector bias structure.


V. Gibson
13/3/90
Cavendish Lab
Cambridge

CAD

(Computer Aided Design — Silicon Masks)

- A novices view!
- Silvar Lisco – Computer Aided Design System
  PRINCESS – Mask layout
  Cambridge – μVAX 2000 colour workstation
  VMS 5.2, VWS 4.0 only.
  Versatec Plots via RAL
- Single-sided detectors (FOXFET biased)
  General layout of all detectors



First test-structures arrive…

First test-structures arrive…

“Everyone was very excited and Janet Carter decided to come down to the new cleanroom at the Cavendish to be present for the momentous first measurement.

First test-structures arrive…

"Everyone was very excited and Janet Carter decided to come down to the new cleanroom at the Cavendish to be present for the momentous first measurement.

As I was explaining to Janet how we would do the measurement, in an expansive gesture I leant back onto a nearby table and heard an ominous crunch. Janet looked at the box, which now contained the smashed remains of precious test-structure (I blame the packaging), and simply said "You're allowed to do something like that once".

First test-structures arrive…

"Everyone was very excited and Janet Carter decided to come down to the new cleanroom at the Cavendish to be present for the momentous first measurement.

As I was explaining to Janet how we would do the measurement, in an expansive gesture I leant back onto a nearby table and heard an ominous crunch. Janet looked at the box, which now contained the smashed remains of precious test-structure (I blame the packaging), and simply said "You're allowed to do something like that once".

However, I since was informed that one definition of an "expert" is someone who has made every possible mistake. – On that definition I am proud to say I probably do qualify!"

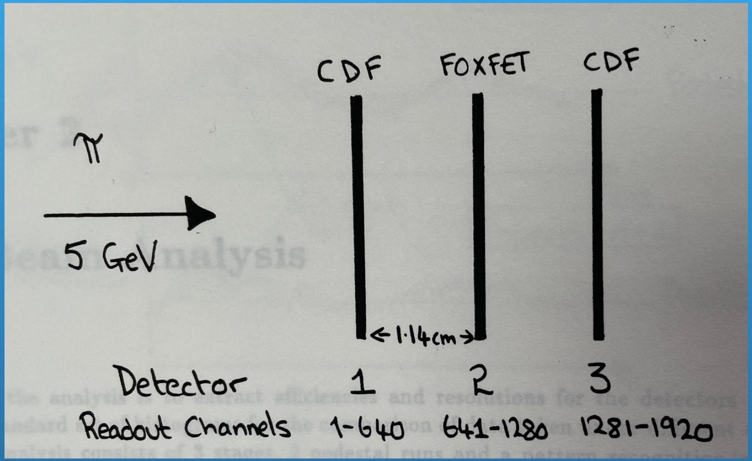
Phil Allport 2023

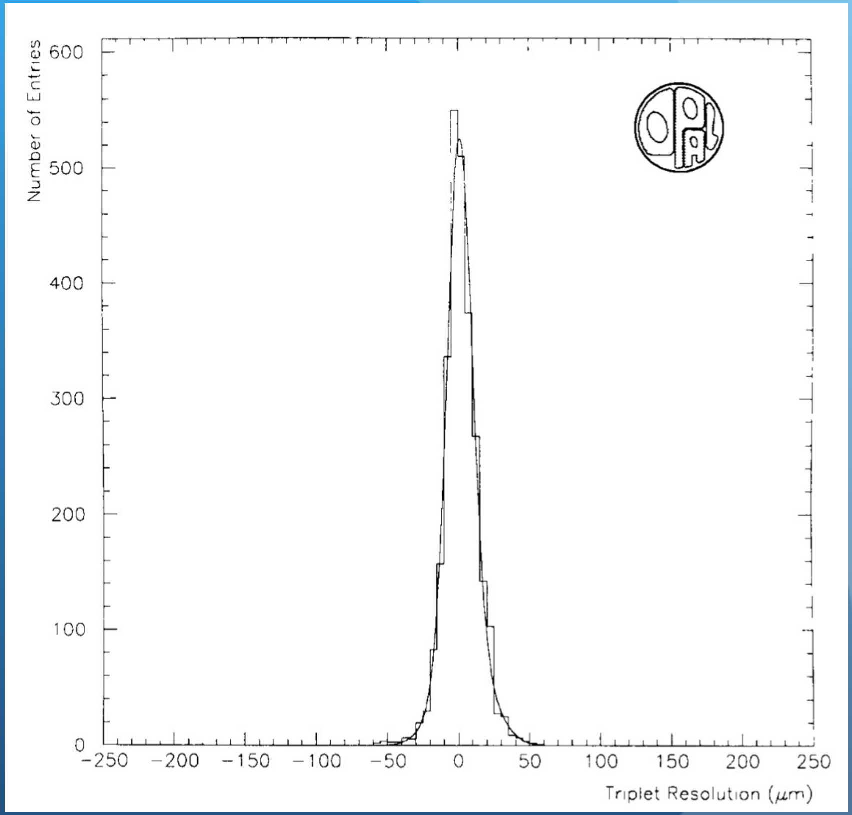

Cambridge University
St. Edmunds College · 1991
Matriculation
M. Schmid C. Cruttwell A. Banks C.R. Brown S. Aliwell K-J. Chew M.C. Dunn A. Mold K. Parel
T. Edwards M. de Jong I. Aqdasi C.J. Wilson J. Doxat T. Crowe O. Edagbami R. Capps F. Carrera E. Ugalde M. Dodd L.L. Egusquiza P.K. Narain A.P. Sabharwal J.A. Munoz S. Hall D. Hubert E. Giunchi F. Galindo M. Gonzalez C. Galvin
A. Picca Piccon C.D. Herring H.G. Henry M.K.H. Fung S. Hartley P. Sinnaeve A. Nickalls K. Ishida R.E. Hornby G. Jones D. Pickup J. Suhua F. Proetsch S.M. Lake T. Kuwana A.A. Kohn S. Nettleton R. Judd N.J. Loader M.G. Lazo J. Page C. Morgan
J. Nimmo C. Olivo-Valverde L.M. Nicholson N. Parmenter L.E. Mumba D. Maxwell S. Sharafi F.L.P. Serrano P. Blond M.J.K. Storey C. Slater I.Q.R. Thomas I. Selby R.J. Walters J.P. Rogers A. Walliker G. Thompson P. Salcedo C. Outterson R. Terry S. Ryang E. Yannouli T. Worcester
I. Burton H. Archibald A. Dircks Fr.M. Thamert H. Mason P. Jackson F.B. McHugh C. Hazard R. O'Keeffe C. Richardson G.M.W. Cook R.M. Laws J.P. Luzio R.M. O'Flynn E. Moss M.J. Unsworth B.White M. Herrtage P. Allport P. McCann S.N.S. Bather F. Barton M. Dalton D. Swannell


Cambridge University
Matriculation

Test beam

August 1990 started beam tests of prototype detectors:





3 detectors separated by ~1cm in 5 GeV charged pion beam:

Resolution ~6μm

OPAL Microvertex Detector

Nuclear Instruments and Methods in Physics Research A324 (1993) 34–52
North-Holland

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

The OPAL silicon microvertex detector

P.P. Allport [b], J.R. Batley [b], P. Capiluppi [a], A.A. Carter [h], J.R. Carter [b], S.J. De Jong [c], U.C. Dunwoody [b], V. Gibson [b], W. Glessing [c], P.R. Goldey [f], M.J. Goodrick [b], W. Gorn [i], R. Hammarstrom [c], G.G. Hanson [e], J.D. Hobbs [c], J. Hill [c], J.C. Hill [b], R. Humbert [d], F. Jacob [j], M. Jiminez [c], P. Kyberd [h], C. Leroy [g], X.C. Lou [c], A.J. Martin [h], J-P. Martin [g], C. Moisan [g], C.J. Oram [k], T.W. Pritchard [h], O. Runolfsson [c], P. Seller [j], R. Shaw [b], P. Singh [h], M.F. Turner [b], M. Uldry [c], D. Voillat [c], D.R. Ward [b] and K.H. Wolf [d]

[a] *Dipartimento di Fisica dell'Università di Bologna and INFN, Bologna, 40126, Italy*
[b] *Cavendish Laboratory, University of Cambridge, CB3 OHE, UK*
[c] *CERN, European Organisation for Particle Physics, 1211, Geneva 23, Switzerland*
[d] *Fakultät für Physik, Albert Ludwigs Universität, D-7800 Freiburg, Germany*
[e] *Indiana University, Department of Physics, Swain Hall West 117, Bloomington, IN 47405, USA*
[f] *Department of Physics and Astronomy, University of Maryland, College Park, MD 20742, USA*
[g] *Laboratoire de Physique Nucleaire, Universite de Montreal, Montreal, Quebec, Canada H3C, 3J7*
[h] *Queen Mary and Westfield College, University of London, London E1 4NS, UK*
[i] *Department of Physics, University of California, Riverside, CA 92521, USA*
[j] *Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 OQX, UK*
[k] *TRIUMF, Vancouver, Canada V6T 2A3*

Received 23 July 1992

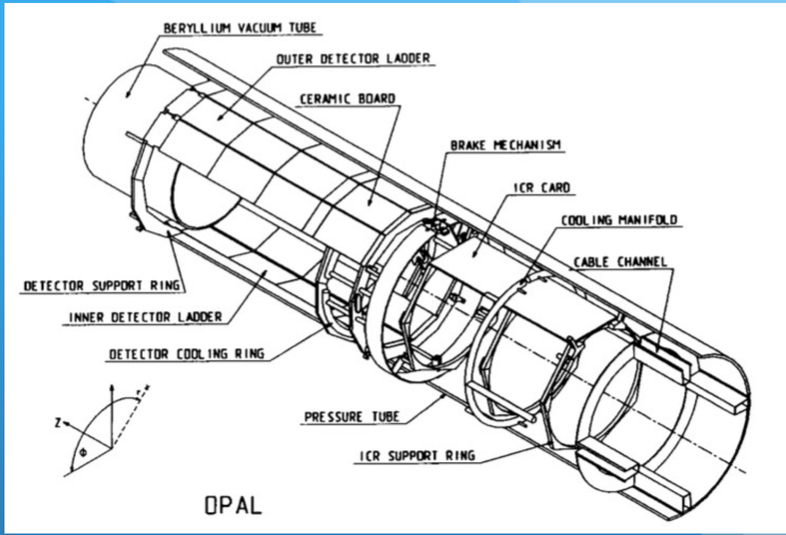
Installed and commissioned by May 1991

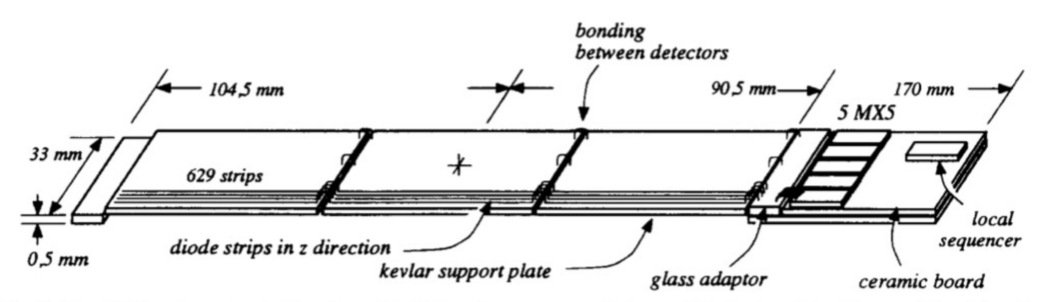
OPAL Microvertex Detector

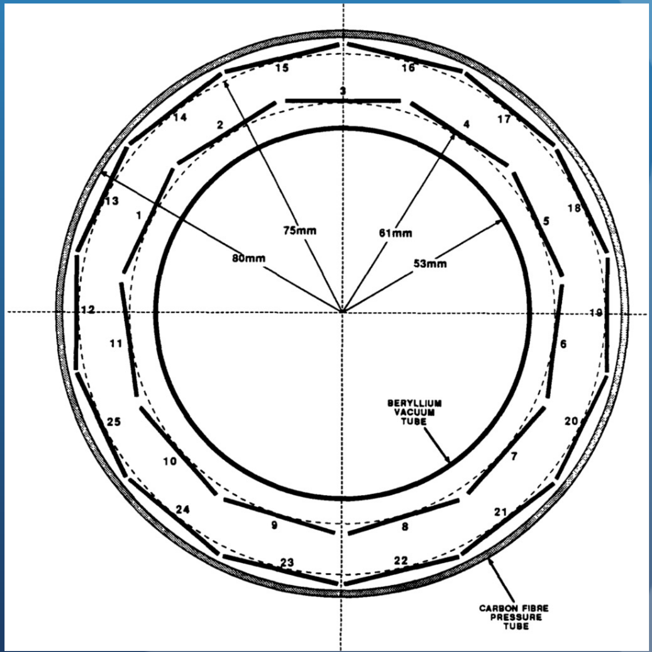
Two layers single-sided silicon devices separated by 14mm

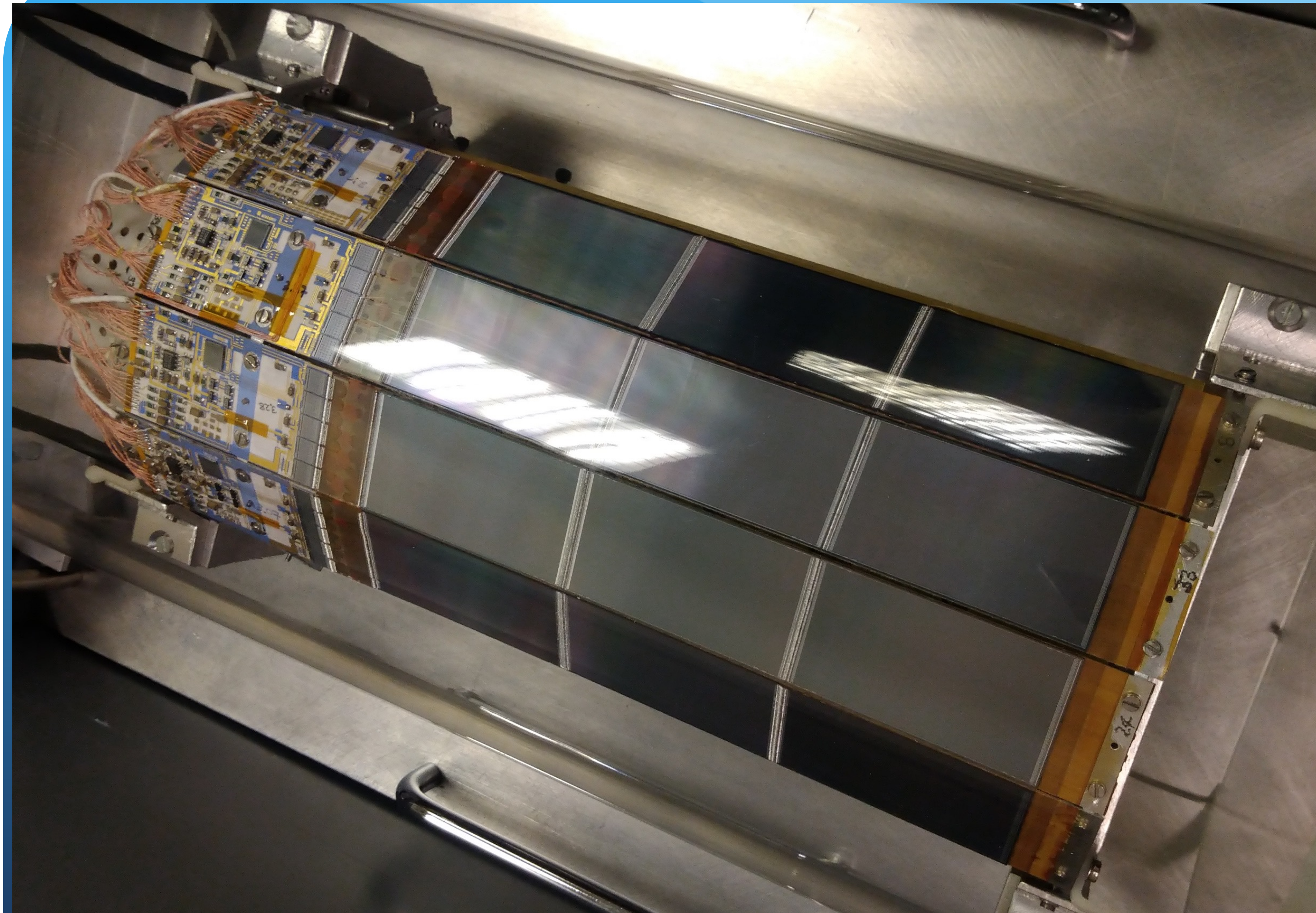
11 inner and 14 outer ladders

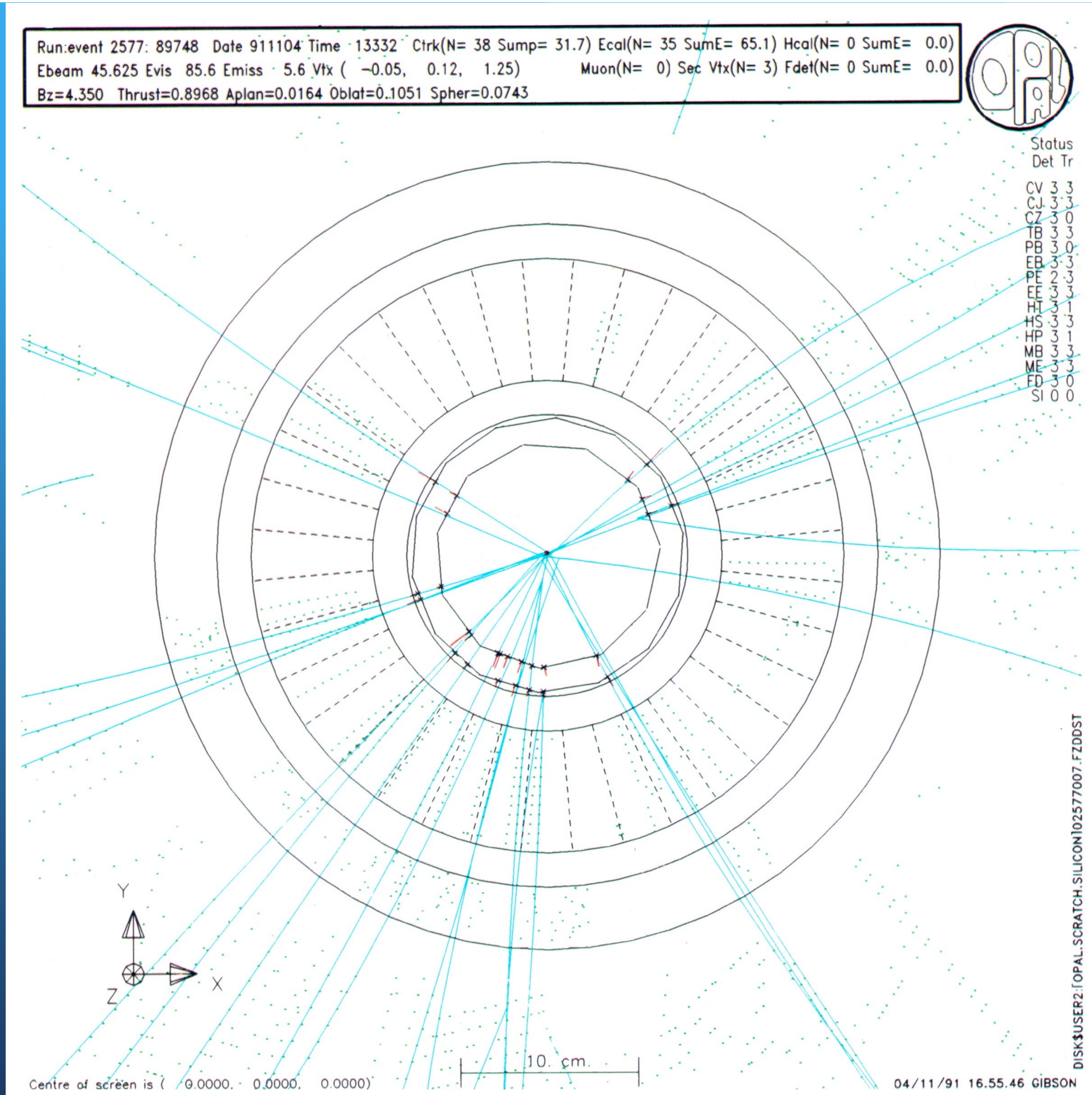
Dimensions: 33 x 60mm
Thickness: 300μm
Strip pitch: 25μm
Readout: 50μm, 629 channels

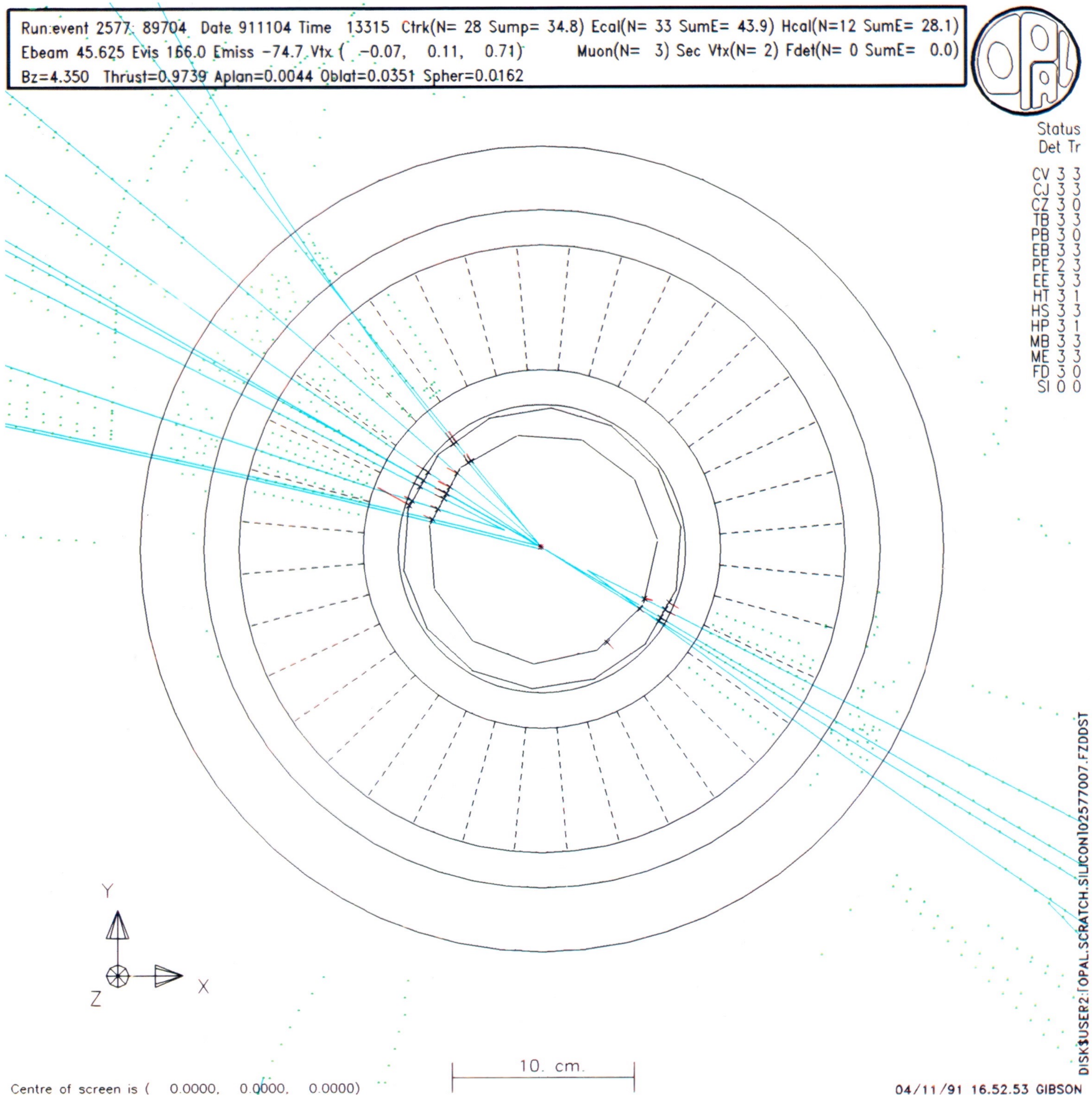









Run:event 2577: 89748 Date 911104 Time 13332 Ctrk(N= 38 Sump= 31.7) Ecal(N= 35 SumE= 65.1) Hcal(N= 0 SumE= 0.0)
Ebeam 45.625 Evis 85.6 Emiss 5.6 Vtx (-0.05, 0.12, 1.25) Muon(N= 0) Sec Vtx(N= 3) Fdet(N= 0 SumE= 0.0)
Bz=4.350 Thrust=0.8968 Aplan=0.0164 Oblat=0.1051 Spher=0.0743
Status
Det Tr
CV 3 3
CJ 3 3
CZ 3 0
TB 3 3
PB 3 0
EB 3 3
PE 2 3
EE 3 3
HT 3 1
HS 3 3
HP 3 1
MB 3 3
ME 3 3
FD 3 0
SI 0 0
Y
X
Z
10. cm.
Centre of screen is (0.0000, 0.0000, 0.0000)
04/11/91 16.55.46 GIBSON
DISK$USER2:[OPAL.SCRATCH.SILICON]02577007.FZDDST



Run:event 2577: 89704 Date 911104 Time 13315 Ctrk(N= 28 Sump= 34.8) Ecal(N= 33 SumE= 43.9) Hcal(N=12 SumE= 28.1)
Ebeam 45.625 Evis 166.0 Emiss -74.7 Vtx (-0.07, 0.11, 0.71) Muon(N= 3) Sec Vtx(N= 2) Fdet(N= 0 SumE= 0.0)
Bz=4.350 Thrust=0.9739 Aplan=0.0044 Oblat=0.0351 Spher=0.0162
Status
Det Tr
CV 3 3
CJ 3 3
CZ 3 0
TB 3 3
PB 3 0
EB 3 3
PE 2 3
EE 3 3
HT 3 1
HS 3 3
HP 3 1
MB 3 3
ME 3 3
FD 3 0
SI 0 0
Y
X
Z
10. cm.
Centre of screen is (0.0000, 0.0000, 0.0000)
04/11/91 16.52.53 GIBSON
DISK$USER2:[OPAL.SCRATCH.SILICON]02577007.FZDDST

OPAL Microvertex Detector

Dilepton events

Ladder hit efficiencies

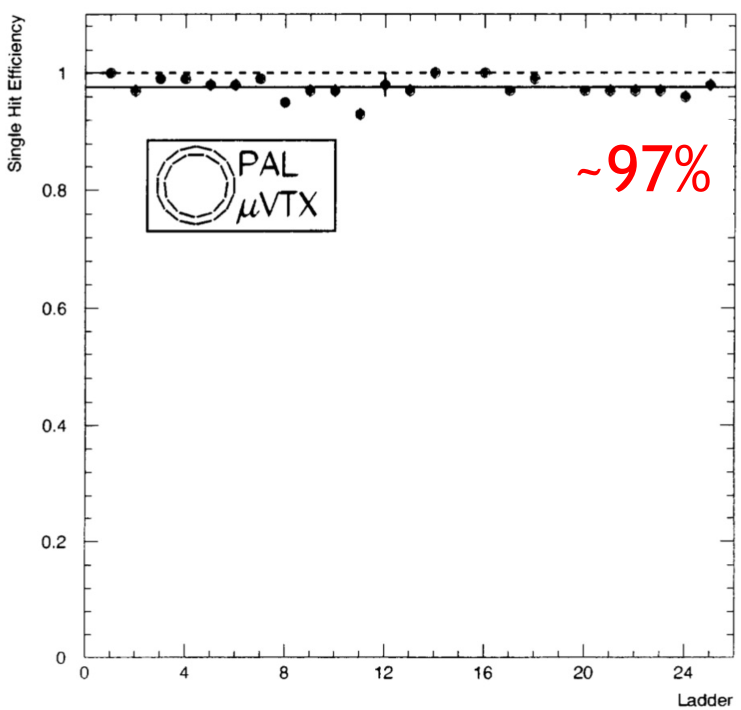
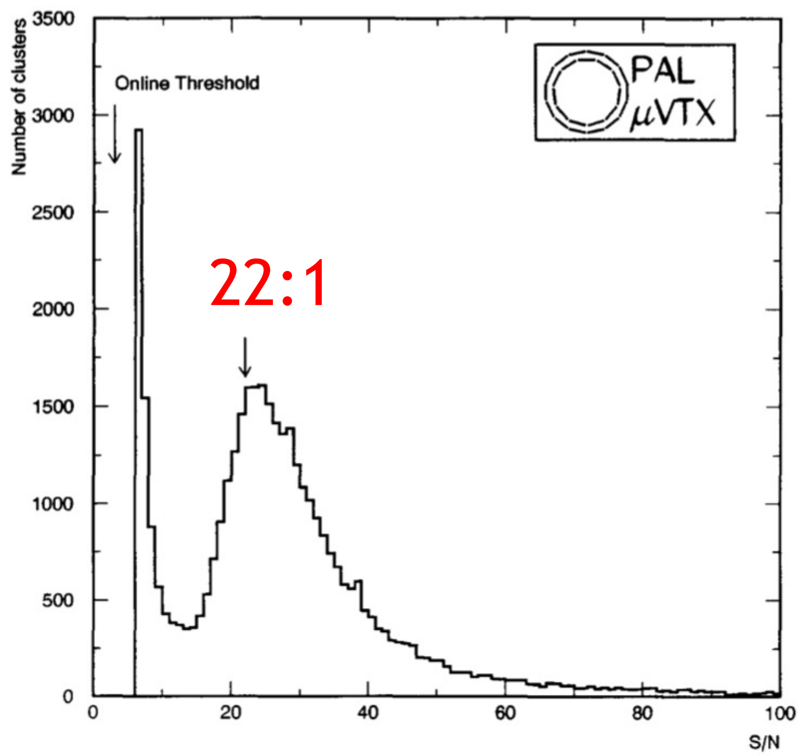


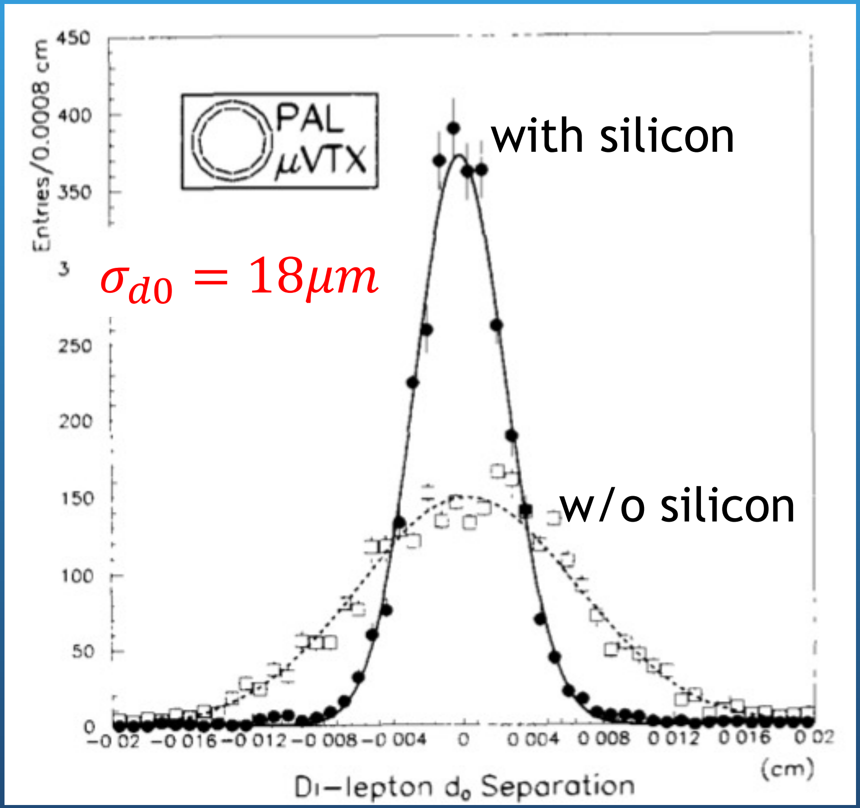
Fig. 11. The hit efficiency for each microvertex detector ladder from dimuon events.

Signal/Noise

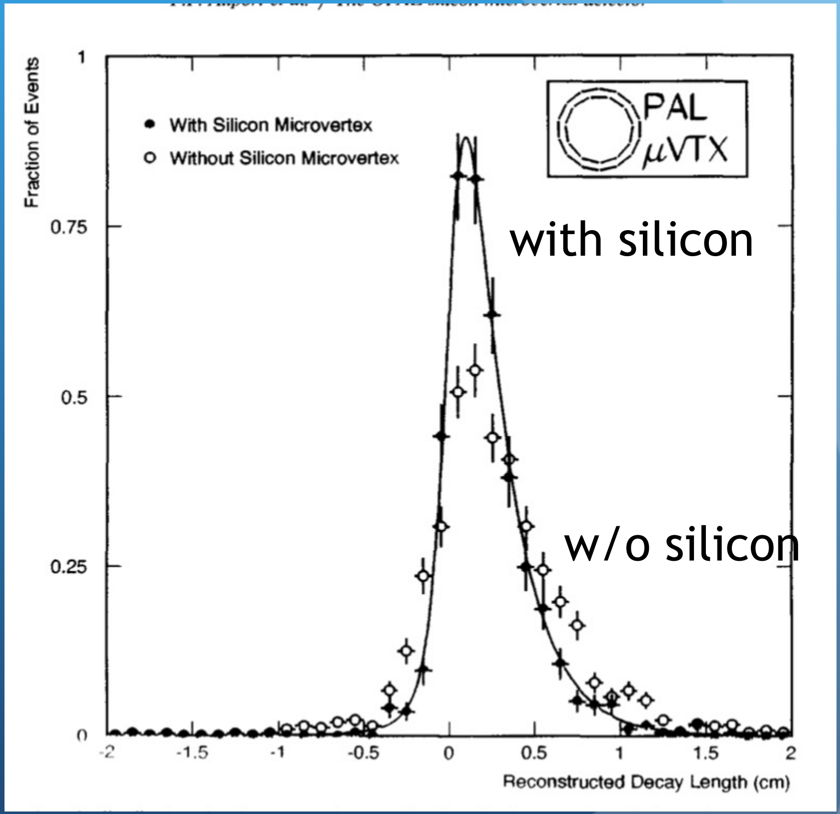


OPAL Microvertex Detector

Dilepton separation at interaction point



Decay length 3-prong τ decays



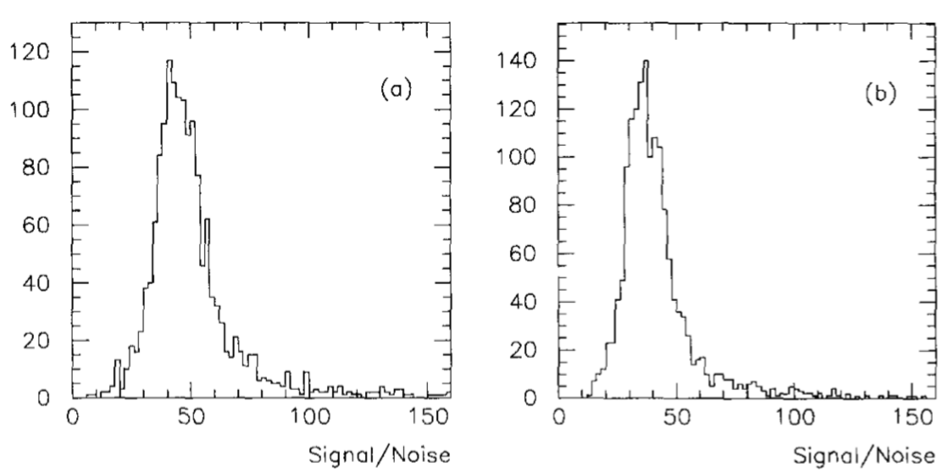
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS

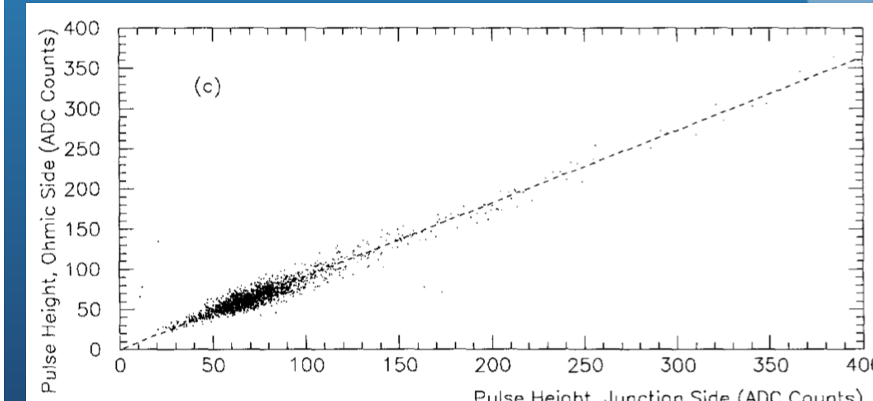
Nuclear Instruments and Methods in Physics Research A 348 (1994) 416–420
North-Holland

Double-sided FoxFET biased microstrip detectors

P.P. Allport [a,*], J.R. Carter [a], U.C. Dunwoody [a], V. Gibson [a], M.J. Goodrick [a], G.A. Beck [b], A.A. Carter [b], A.J. Martin [b], T.W. Pritchard [b], M.A. Bullough [c], N.M. Greenwood [c], A.D. Lucas [c], C.D. Wilburn [c]

[a] *Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge CB3 0HE, UK*
[b] *Queen Mary and Westfield College, University of London, Mile End Road, London, UK*
[c] *Micron Semiconductors Ltd, Marlborough Road, Lancing, Sussex, UK*





Philosophy and Physics

Philosophy and Physics

Synthese 94 (2):245 - 290 (1993)

P. P. ALLPORT

ARE THE LAWS OF PHYSICS 'ECONOMICAL WITH THE TRUTH'?*

Philosophy and Physics

Synthese 94 (2):245 - 290 (1993)

P. P. ALLPORT

ARE THE LAWS OF PHYSICS ‘ECONOMICAL WITH THE TRUTH’?*

“Happy memories of a warm-hearted man and very astute about philosophy, not just philosophy of physics: a very welcome participant in the 1990s philosophy of physics seminars run in the Cambridge history and philosophy of science department.

I recall he wrote a super paper on the nature of fundamental physics (as a critique of views of Cartwright); with super quotes eg Nietzsche and Camus. It is a most excellent essay!”

Jeremy Butterfield 2023

OPAL Microvertex Detector II

Nuclear Instruments and Methods in Physics Research A 346 (1994) 476–495
North-Holland

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

The OPAL silicon strip microvertex detector with two coordinate readout

P.P. Allport [a,1], J.R. Batley [a], G.A. Beck [e], A.A. Carter [e], J.R. Carter [a], S.J. de Jong [e], E. do Couto e Silva [d], J.E. Duboscq [b], U.C. Dunwoody [a], V. Gibson [a], W. Glessing [b], P.R. Goldey [f], M.J. Goodrick [a], R. Hammarström [b], G.G. Hanson [d], A.K. Honma [i,2], R. Humbert [c], F. Jacob [h], M. Jimenez [b], D.S. Koetke [b], J.F. Kral [b,3], P. Kyberd [e], J.A. Lauber [b], C. Leroy [g], A.J. Martin [e], J.P. Martin [g], R. Mir [d], C. Moisan [g], D. Petry [c], T.W. Pritchard [e], Ö. Runolfsson [b], D.R. Rust [d], P. Seller [h], T.G. Shears [a], D. Voillat [b], M. Yurko [g]

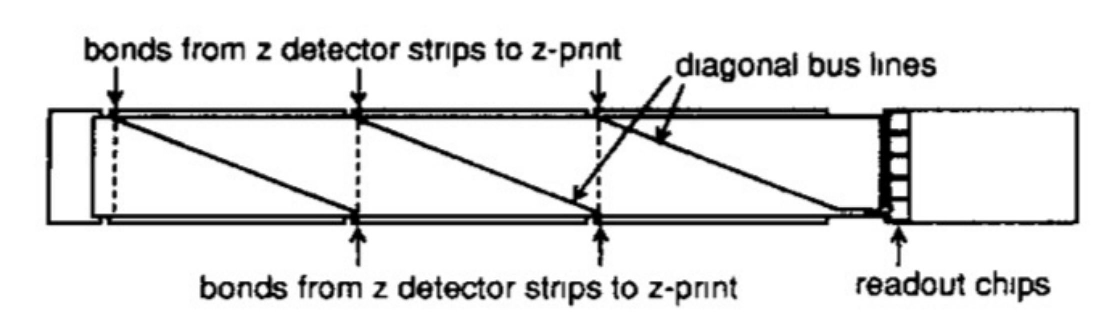
[a] *Cavendish Laboratory, Cambridge, CB3 0HE, UK*
[b] *CERN, European Organisation for Particle Physics, 1211 Geneva 23, Switzerland*
[c] *Fakultät für Physik, Albert Ludwigs Universität, D-79104 Freiburg, Germany*
[d] *Indiana University, Dept. of Physics, Swain Hall West 117, Bloomington, Indiana 47405, USA*
[e] *Dept. of Physics, Queen Mary and Westfield College, University of London, London, E1 4NS, UK*
[f] *Department of Physics, University of Maryland, College Park, Maryland 20742, USA*
[g] *Laboratoire de Physique Nucléaire, Université de Montréal, Montréal, Quebec, H3C 3J7, Canada*
[h] *Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, OX11 0QX, UK*
[i] *University of Victoria, Dept. of Physics, P.O. Box 3055, Victoria, BC, V8W 3P6, Canada*

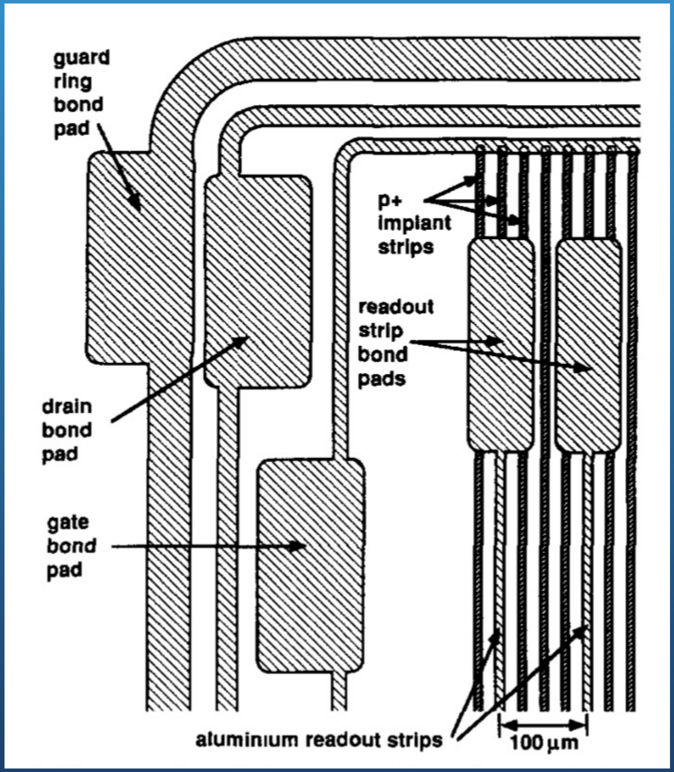
(Received 15 February 1994)

Installed and commissioned by March 1993

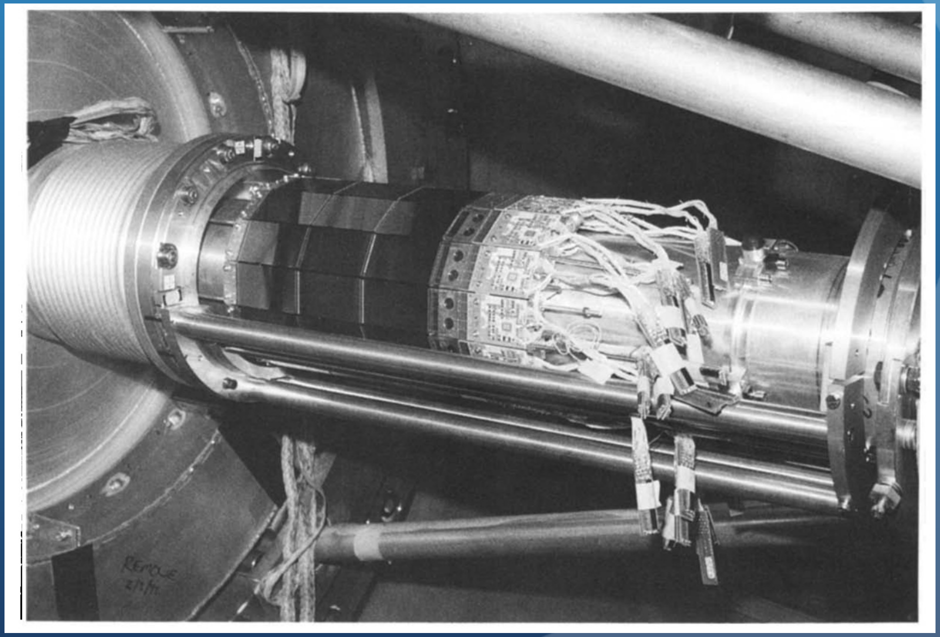
OPAL Microvertex Detector II

Thickness: 250μm
Readout: r-ϕ: 50μm
r-z: 100μm



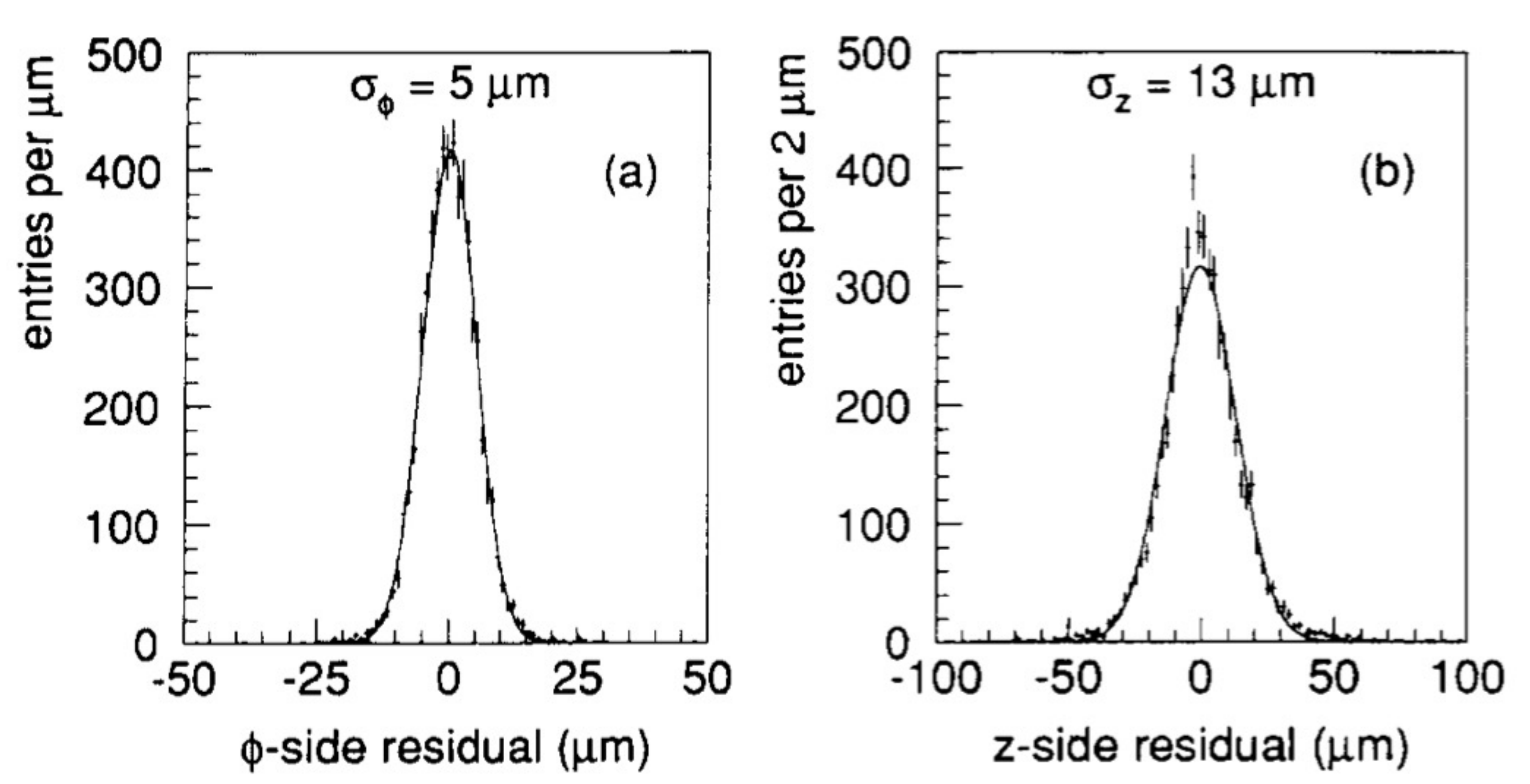


z readout routed via gold printed circuit on thin glass substrate



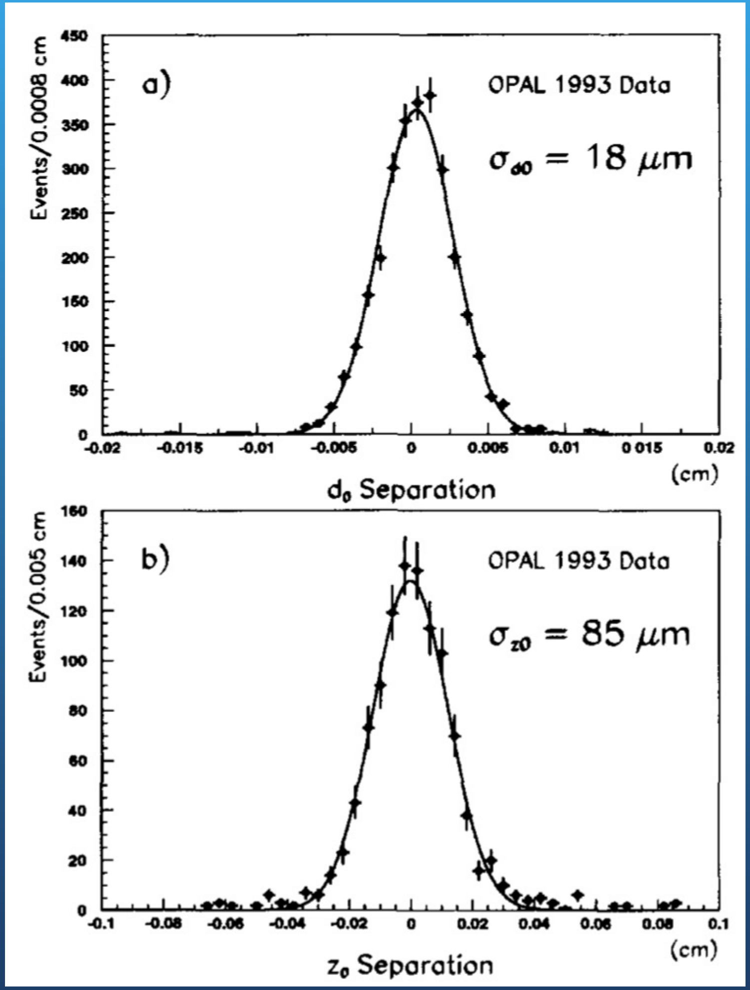
OPAL Microvertex Detector II

Single hit resolutions

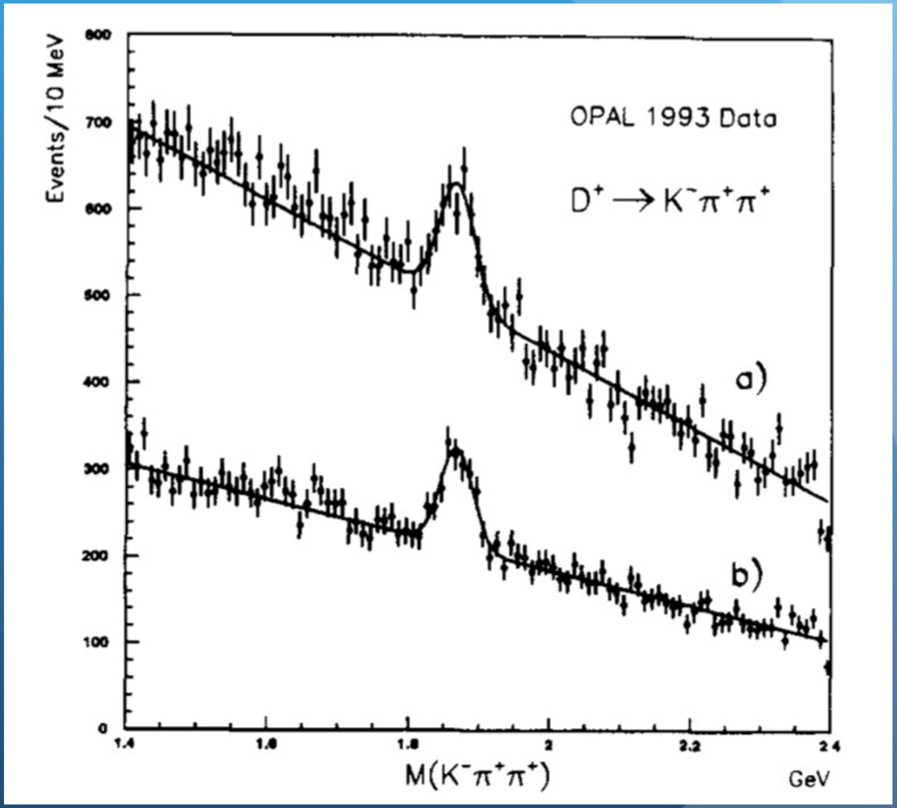


OPAL Microvertex Detector II

Dilepton separation at interaction point



Effect of z-hit information on $D^+ \rightarrow K^-\pi^+\pi^+$ invariant mass



OPAL Microvertex Detector III

The final extended silicon micorvertex detector was installed in OPAL for the 1995 LEP2 running.

The “Waldegrave visit” 1995…

The “Waldegrave visit” 1995…

Final thoughts…

Final thoughts…

Phil led the development of silicon microvertex detectors and their readout prior to, during and following the era of LEP.

Without Phil, the OPAL microvertex detectors and the physics that came from them (τ and b-hadron lifetimes and identification of b-hadron decays etc) simply would not have been possible.

Final thoughts…

Phil led the development of silicon microvertex detectors and their readout prior to, during and following the era of LEP.

Without Phil, the OPAL microvertex detectors and the physics that came from them (τ and b-hadron lifetimes and identification of b-hadron decays etc) simply would not have been possible.

Thank you Phil for being a friend and colleague over the past 40 years.

Final thoughts…

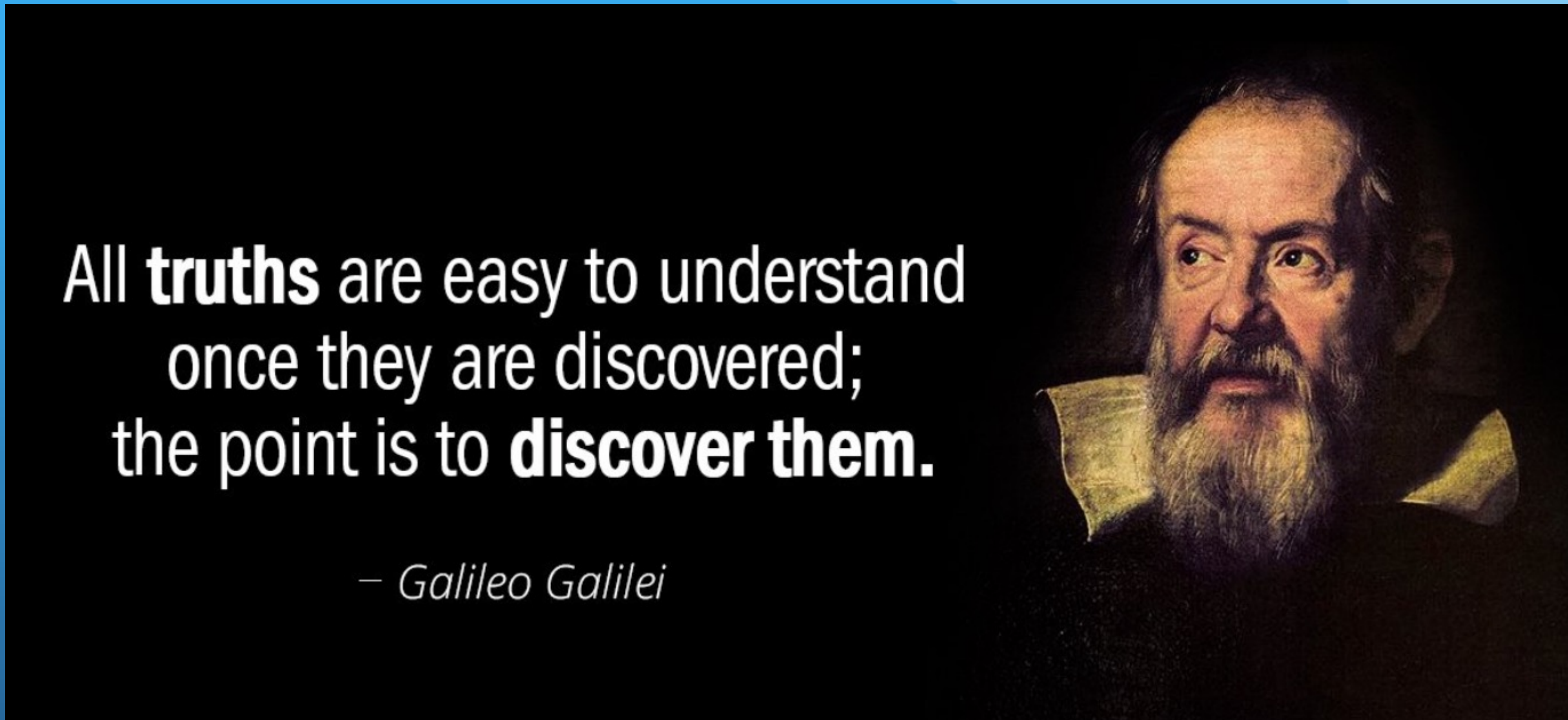
Phil led the development of silicon microvertex detectors and their readout prior to, during and following the era of LEP.

Without Phil, the OPAL microvertex detectors and the physics that came from them (τ and b-hadron lifetimes and identification of b-hadron decays etc) simply would not have been possible.

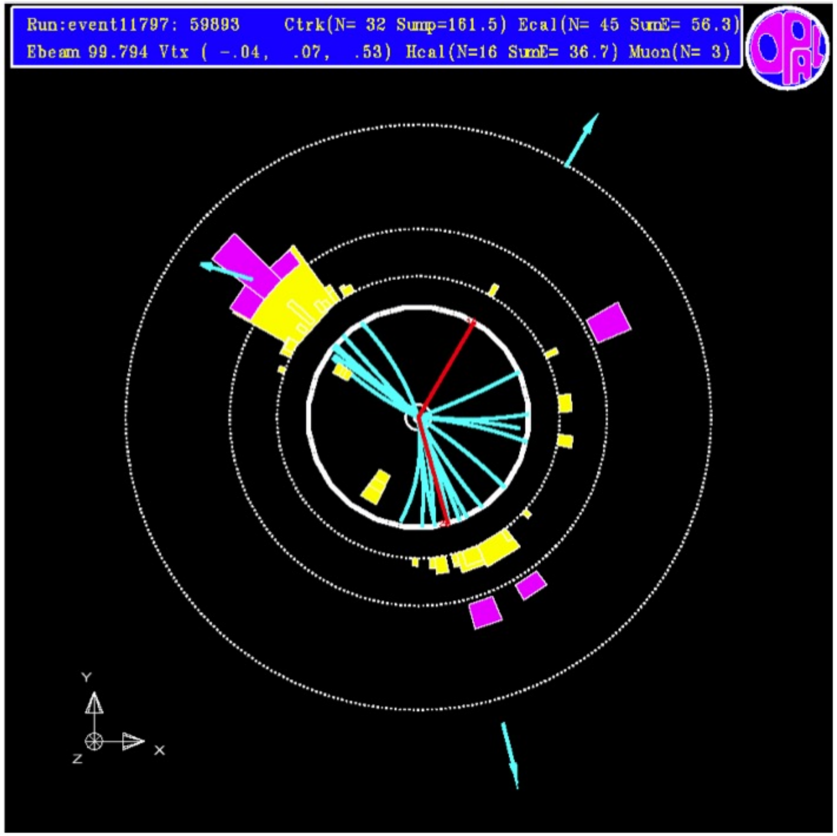
Thank you Phil for being a friend and colleague over the past 40 years.

Janet (and Tony) Carter would have liked to be here today….

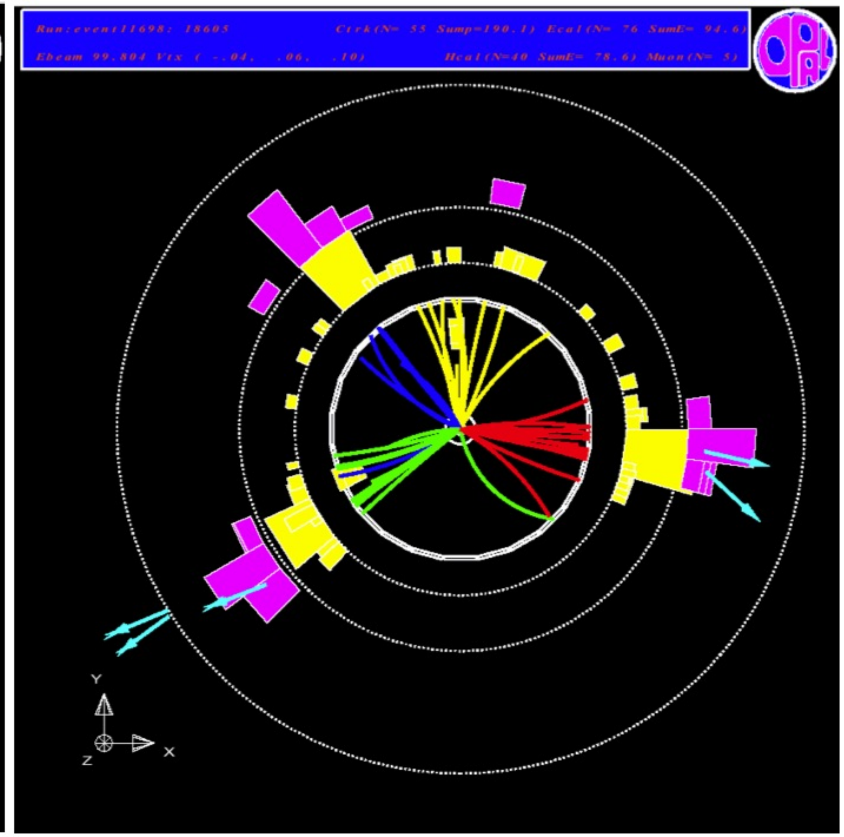
"We owe so much to Phil as an extremely talented and likeable colleague."



…and to discover truths you need the best experimental scientists like Phil!


Run:event11797: 59893 Ctrk(N= 32 Sump=161.5) Ecal(N= 45 SumE= 56.3)
Ebeam 99.794 Vtx (-.04, .07, .53) Hcal(N=16 SumE= 36.7) Muon(N= 3)
Y
X
Z

q q μ μ


Run:event11698: 18605 Ctrk(N= 55 Sump=190.1) Ecal(N= 76 SumE= 94.6)
Ebeam 99.804 Vtx (-.04, .06, .10) Hcal(N=40 SumE= 78.6) Muon(N= 5)
Y
X
Z

q q q q

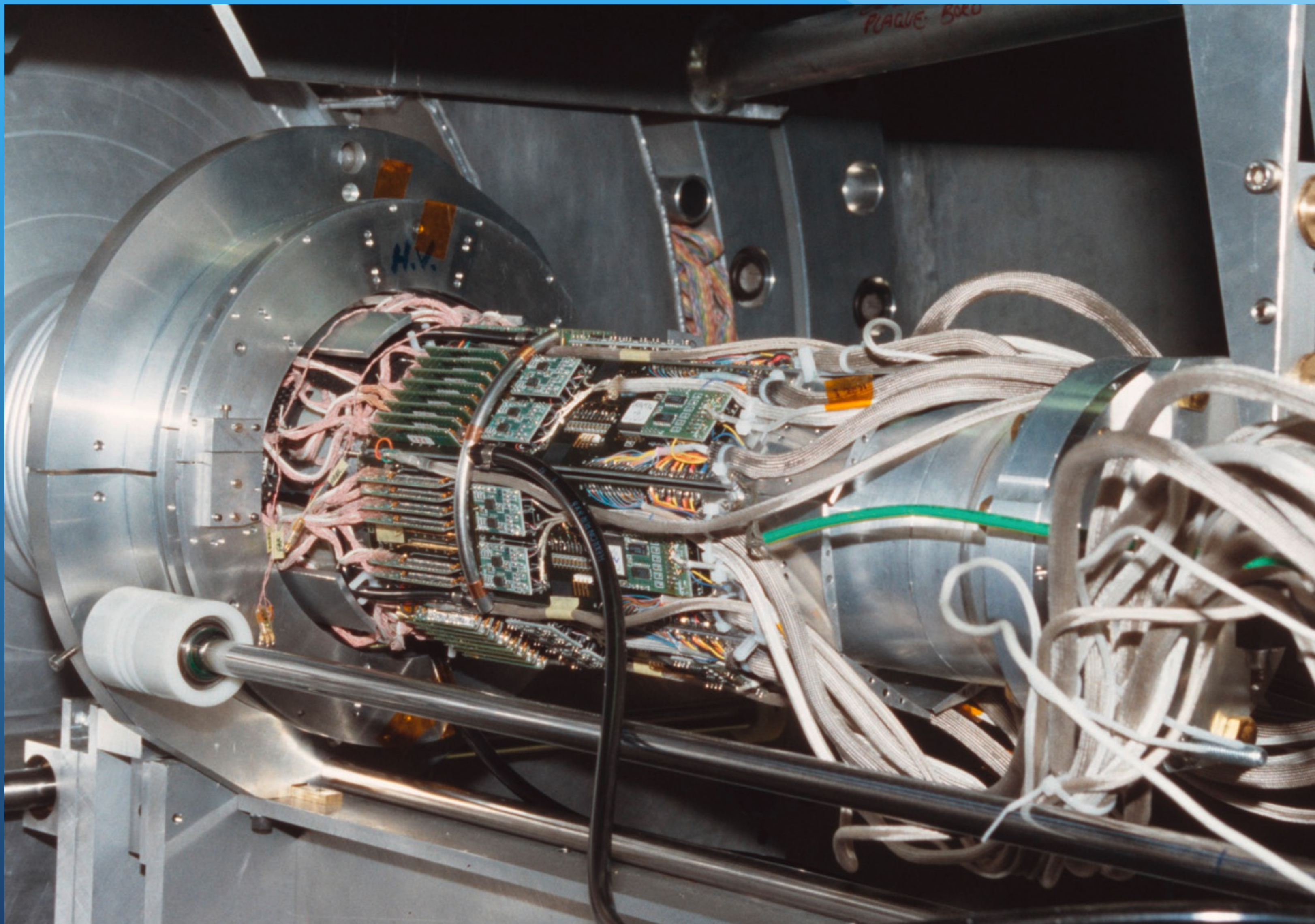
OPAL Microvertex Detector II

Characteristics of OPAL μVTX2 Ladders

Ladder parameter	ϕ side	z side
Silicon thickness [μm]	250	250
Implant strip pitch [μm]	25	25
Readout strip pitch [μm]	50	100
Intrinsic resolution [μm]	≈ 5	≈ 13
Number of readout channels	629	584
Signal to noise ratio (peak)	24	20

Characteristics of the new OPAL microvertex detector

μVTX2 parameter	Value
Number of ladders/layer	11 (inner), 14 (outer)
Effective radius of layer [mm]	61 (inner), 75 (outer)
maximum $\|\cos\theta\|$ acceptance	0.83 (inner), 0.77 (outer)
ϕ acceptance	88% (inner), 91% (outer)
Avg. material [rad. lengths]	1.5% at normal incidence
Strip biasing method	FoxFET (gated reachthrough channel)
2 coord. detection	back-to-back ϕ and z single-sided detectors
z readout scheme	gold printed circuit on 200 μm thick glass
Number of active channels	30325
Readout chip, noise, power	MX7, 350 e + 15 e/pF, 2 mW/channel
Radiation hardness	about 500 Gy (MX7 chip)
Cooling method	water cooling
Number of good channels	$\approx 99\%$


H.V.