Learning from Gus Voss

at the Cambridge Electron Accelerator (*CEA*) and

at *SESAME*

Herman Winick

SLAC National Accelerator Laboratory

winick@slac.stanford.edu

Presented at

Lord of the Rings

Colloquium Honoring Gus Voss on his 80th Birthday

September 4, 2009 at DESY

Cambridge Electron Accelerator, Harvard/MIT

a 6 GeV alternating-gradient, 60 Hz, electron synchrotron (1962-73)

A BRIEF HISTORY OF CEA

CAMBRIDGE ELECTRON ACCELERATOR

- Started operation as a 6 GeV, 60 Hz electron synchrotron in 1962
- 1st multi-GeV electron accelerator built on strong focusing principle
- Main designer: ***Stanley Livingston***

A LOW POINT 1965

- Began operation as a colliding-beam storage ring in 1970. Experiments at 4 and 5 GeV (CM)
- Synchrotron radiation beam line completed in April, 1972 (see Proc. 1973 Particle Accelerator Conf. San Francisco. Page 984)
- Facility shut down one year later

1965 EXPLOSION and FIRE

CEA loses to SLAC in competing proposals to build an Electron-Positron Colliding Beam Machine Norman Ramsey offers a case of champagne to get us back into the colliding beam business

Gus Voss, Stanley Livingston, Ewan Paterson

Gus Voss & Herman Winick, Chairing a session at the 1967 International High Energy Accelerator Conference at CEA, Harvard University

Sasha Skrinsky Gus Voss Karl Strauch Gersh Budker Herman Winick

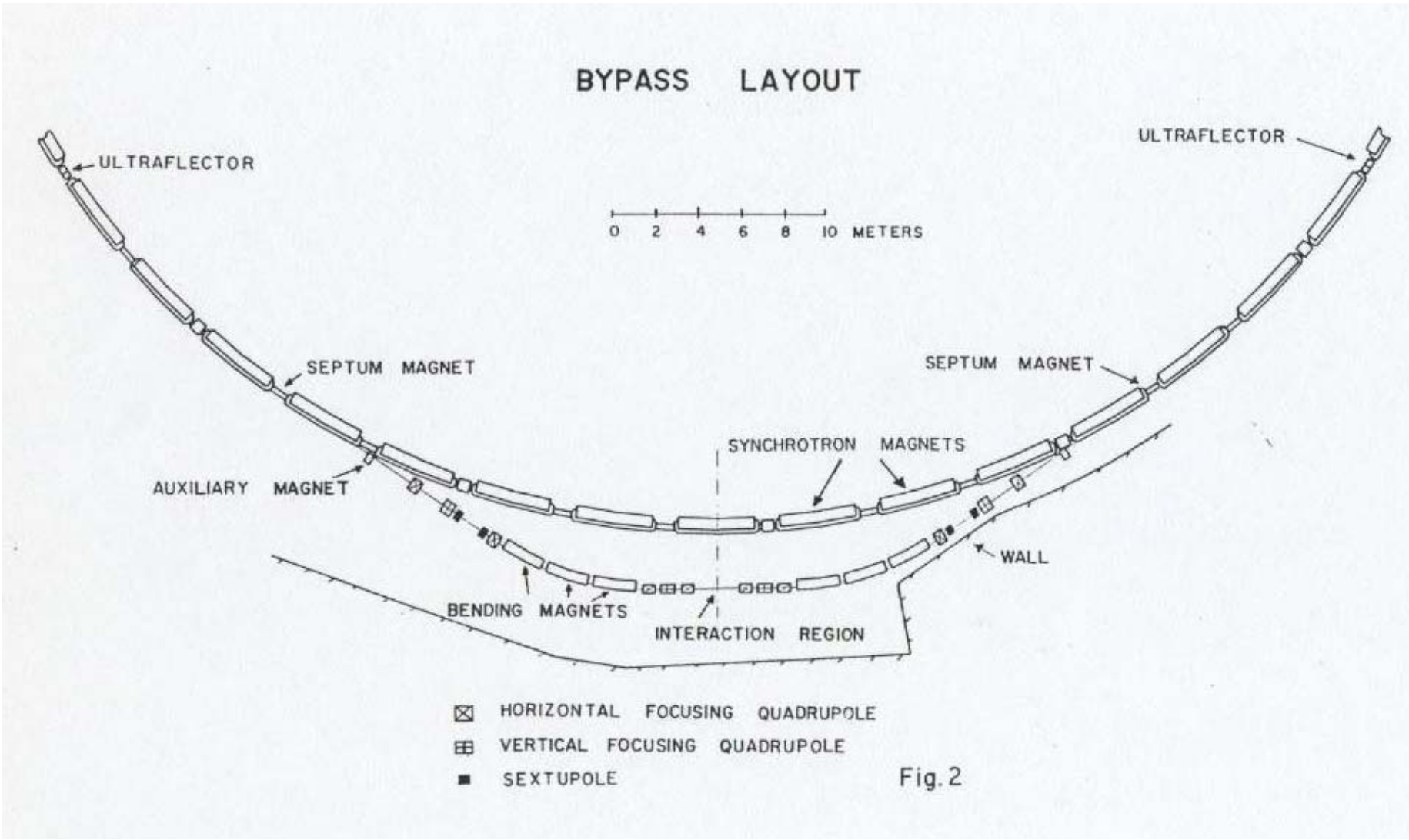
At The Institute of Nuclear Physics, Novosibirsk, 1969

October, 1965

CEAL TM – 149

Ken Robinson and Gus Voss

Possible Use of the CEA in a Colliding Beam Facility



Electron-Positron Colliding Beam Experiments at Center of Mass Energies of 4 and 5 GeV; *Cambridge Electron Accelerator;* 1971-1973

A 6 GeV synchrotron is not a storage ring we needed -

LOW BETA INSERTION (BYPASS)

To enhance luminosity and provide a straight section for experiments

DAMPING SYSTEM

To rearrange the damping partitions functions

To provide radiation damping for radial betatron oscillations.

A POSITRON LINAC

In 1965 the injector was a 30 MeV linac and a new 130 MeV linac was on order.

MULTICYCLE INJECTION AND ACCUMULATION

Necessary to accumulate large currents with a low energy injector.

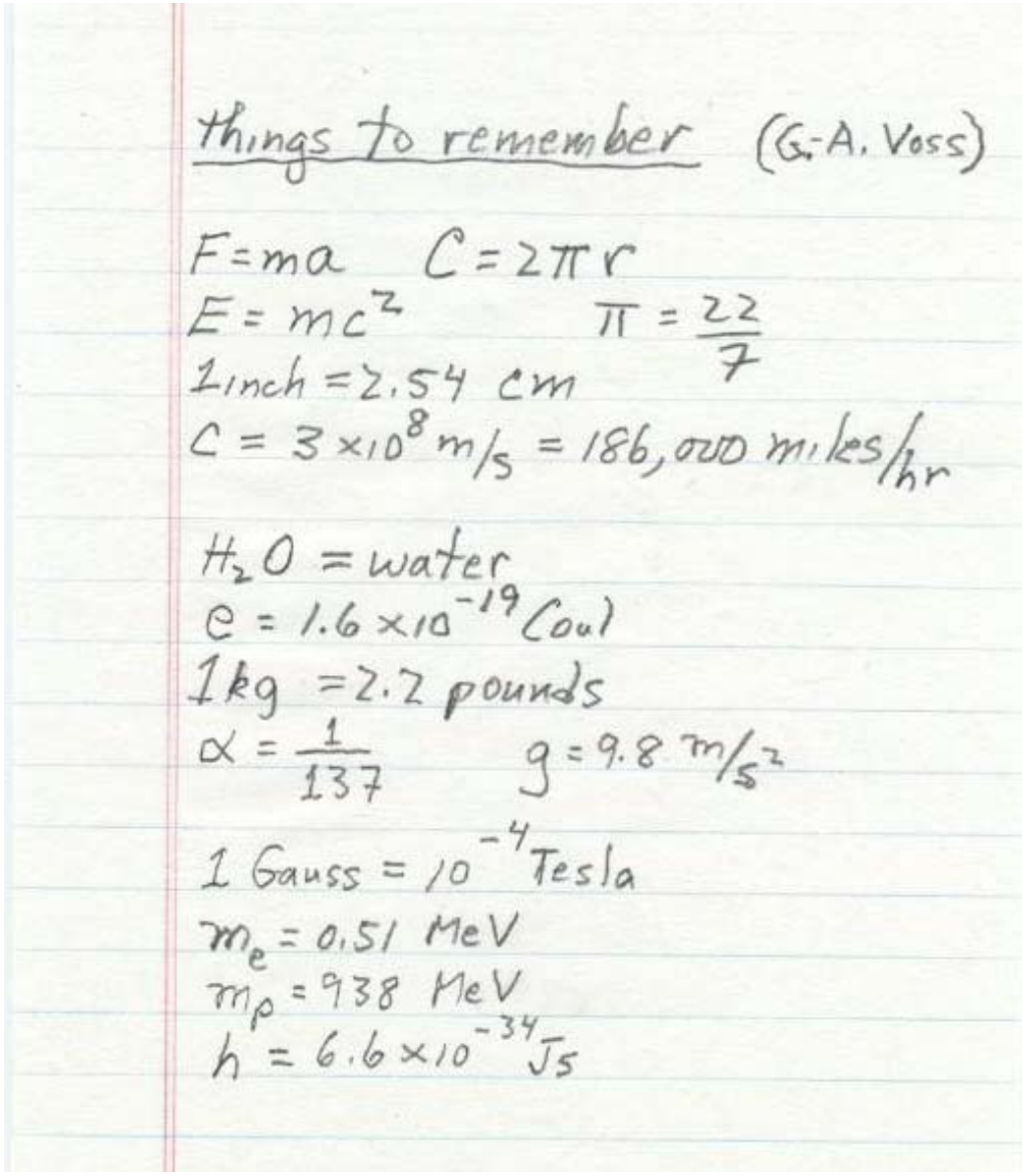
A NEW ULTRA HIGH VACUUM SYSTEM

New everything and new ceramic chambers

A FAST SWITCHING SYSTEM

To switch beam into bypass

The Secret to Gus' Success as a Scientist



Things to remember (G.A. Voss)

$F = ma$ $C = 2\pi r$

$E = mc^2$ $\pi = \frac{22}{7}$

1 inch = 2.54 cm

$c = 3 \times 10^8$ m/s = 186,000 miles/hr

H_2O = water

$e = 1.6 \times 10^{-19}$ Coul

1 kg = 2.2 pounds

$\alpha = \frac{1}{137}$ $g = 9.8$ m/s^2

1 Gauss = 10^{-4} Tesla

$m_e = 0.51$ MeV

$m_p = 938$ MeV

$h = 6.6 \times 10^{-34}$ Js

Gus Voss

Herman Winick

Harry Meiras

Ewan Paterson

Roy Little

Albert Hofmann

Ewan Paterson	Harry Meiras	Herman Winick	Bob Averill	Roy Little	Fritz Dell	Gus Voss	Karl Strauch	Bob Richardson

Working on colliding beams in the CEA control room, ~1971-2

Herman Winick

Harry Meiras

Gus Voss

Ken Robinson

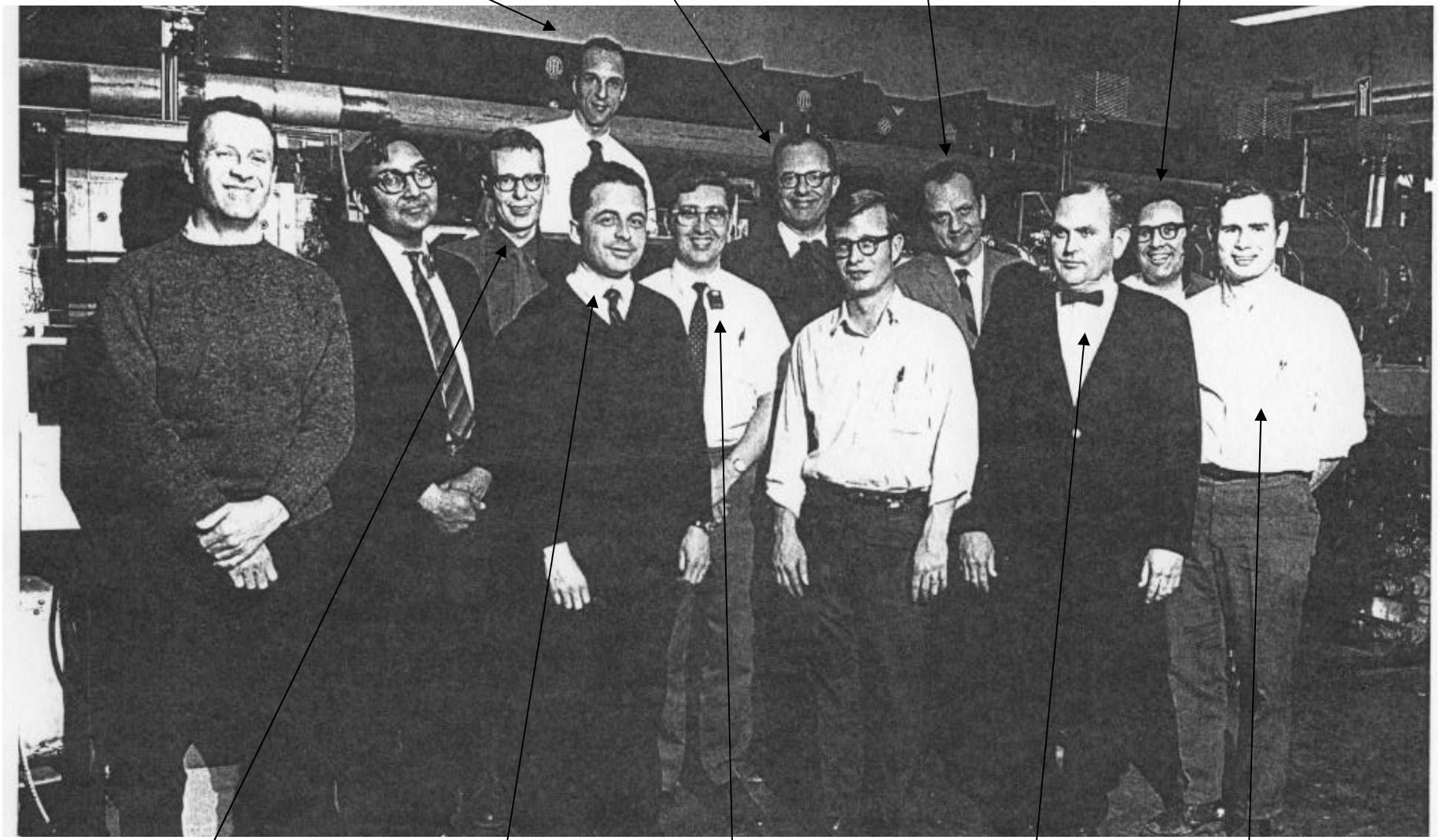
Karl Strauch

Albert Hofmann

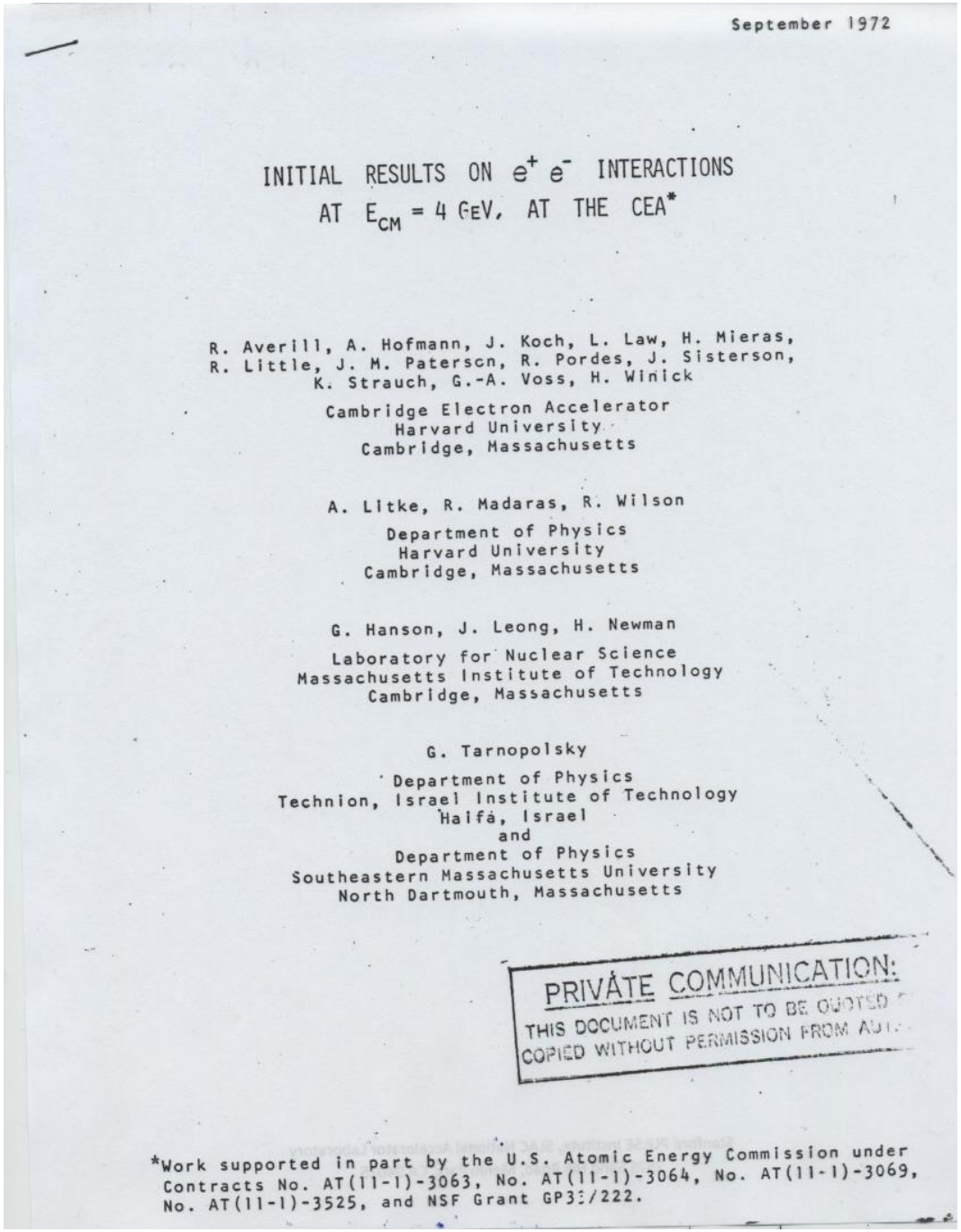
Ewan Paterson, Roy Little, Gus Voss, Herman Winick

in the CEA Control Room (~1970)

John Cerino Karl Strauch Gus Voss Herman Winick



Roy Little, Albert Hofmann, Ewan Paterson, Ken Robinson, Harry Meiras



September 1972

INITIAL RESULTS ON $e^+ e^-$ INTERACTIONS AT $E_{CM} = 4$ GeV, AT THE CEA*

R. Averill, A. Hofmann, J. Koch, L. Law, H. Mieras, R. Little, J. M. Paterson, R. Pordes, J. Sisterson, K. Strauch, G.-A. Voss, H. Winick

Cambridge Electron Accelerator
Harvard University
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A. Litke, R. Madaras, R. Wilson

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Department of Physics
Technion, Israel Institute of Technology
Haifa, Israel
and
Department of Physics
Southeastern Massachusetts University
North Dartmouth, Massachusetts

*Work supported in part by the U.S. Atomic Energy Commission under Contracts No. AT(11-1)-3063, No. AT(11-1)-3064, No. AT(11-1)-3069, No. AT(11-1)-3525, and NSF Grant GP3[illegible]/222.

Sept. 1972

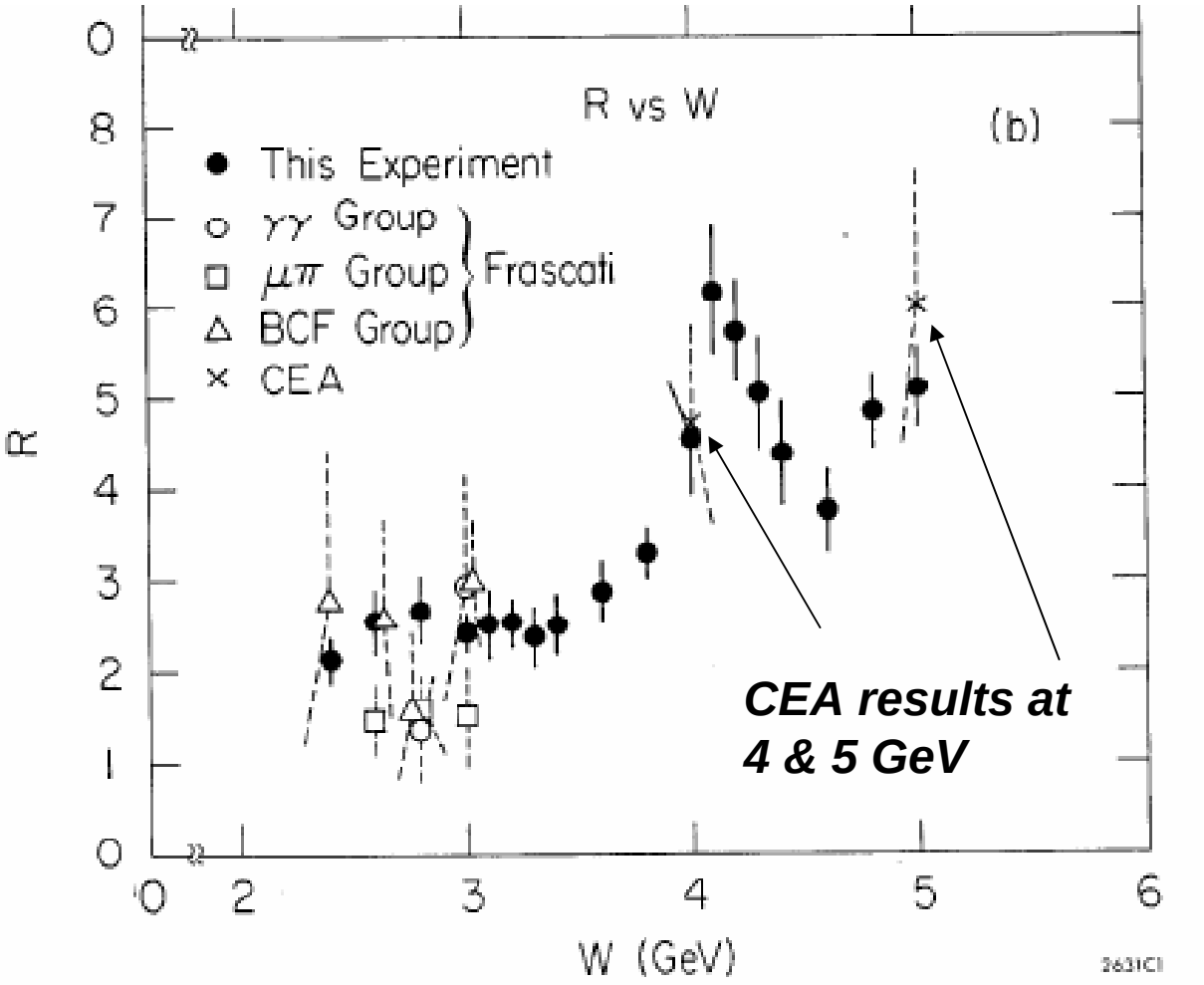
First results from CEA Bypass

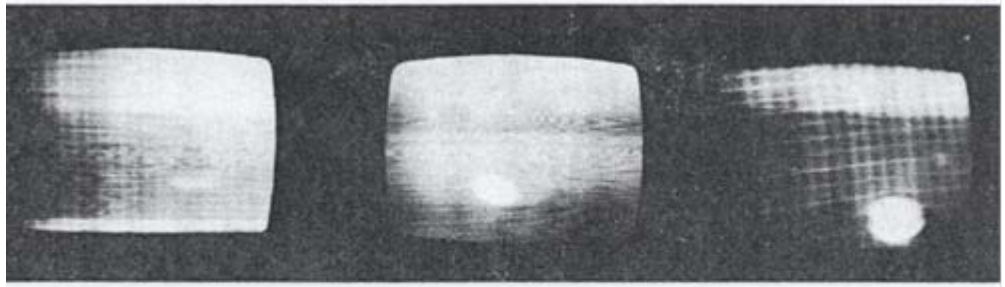
Comment by John Rees, SLAC

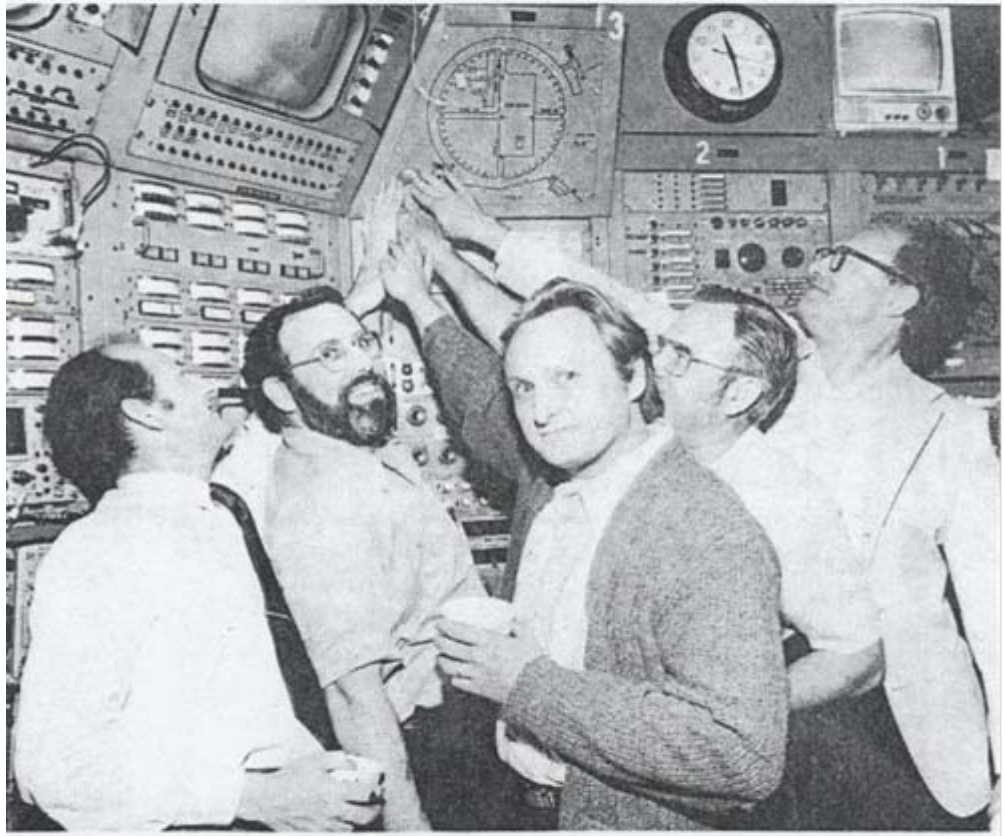
And even then the luminosity of *CEA* was not limited by the beam-beam limit, it was limited by the incredible complexity and difficulty of the *CEA* operating cycle. I think that the saga of *CEA* is the Book of Job of the accelerator builders. They were afflicted by every handicap that could have been visited upon them, yet they persevered, and in the end the Lord loved them and they got the right value of *R*. Of course nobody believed it. The machine was too hard to operate.

SLAC-PUB-1520, LBL-3621; January 1975

Total Cross Section for Hadron Production by Electron Positron Annihilation for Center of Mass Energies 2.4 - 5.0 GeV







SHUTDOWN. The staff and alumni of the Cambridge Electron Accelerator shut down the instrument for good with a party last Thursday night (May 31). Pushing the "crash" button in the Control Room are (*l* to *r*): Lewis Law, former engineer at the CEA (now at the Science Center); Herman Winick, Assistant Director; Robert Richardson, Engineer; Alfred Kennedy, Engineer; and Professor Karl Strauch (Physics), Director. That's champagne in the cups. A bigger farewell party followed the next afternoon. *Top:* Cathode-ray tube representations of the last beam in the CEA. *Photos by Rick Levy.*

May 31, 1973

End of operation of CEA colliding beam operation

Gus and the SESAME Project

SESAME

Synchrotron-Light for Experimental Science and Applications in the Middle East

SESAME

A 3rd Generation Synchrotron Light Source for the Middle East

- **A UNESCO sponsored project; all countries in Middle East invited**
- **Initiated by a gift from Germany of the 0.8 GeV BESSY I facility**
- **9 Members of SESAME Council; Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, Turkey**
- **Observer Countries: Armenia, France, Germany, Iran, Italy, Japan, Kuwait, Libya, Morocco, Russia, UK, United Arab Emirates, US**
- **Jordan is host country; selected from 7 competitors**
- **Jordan provided the site and funds for the completed new building**
- **Capital funds sought from other sources (EU, Japan, US…)**
- **First operation on schedule for 2012-13**
- **Open to all countries in the region & qualified scientists from everywhere**

www.sesame.org.jo

Why a Synchrotron Radiation Facility in the Developing World?

- **World-class basic & applied research**
- **Train graduate students who will no longer have to go abroad**
- **Attract scientists working abroad to return (*reverse the brain drain*)**
- **Address particular regional issues/concerns**
  - ***Biomedical:*** **HIV, tuberculosis, malaria**
  - ***Environmental:*** **Soil contamination due to mining**
- **Promote development of high-tech industry (*capacity building*)**
- **Promote international collaborations**

SESAME uses scientific cooperation to promote peace & understanding between people from different traditions, religions, races, & political systems.

www.sesame.org.jo

Gus played a key role in initiating SESAME

November 1997; Gus presents the idea of a synchrotron radiation facility to Middle East scientists at a meeting of the Middle East Scientific Cooperative (***MESC***) at a meeting in Torino.

Nov-Dec 1997; Gus contacts the German government and UNESCO

April 1998; Gus presents BESSY 1a to a ***MESC*** meeting in Uppsala, Sweden. MESC Chair Herwig Schopper becomes very interested.

1998; Gus organizes and leads efforts to design BESSY 1a (a 1 GeV upgrade of the 0.8 GeV BESSY 1). More straight sections and use of superconducting wigglers to extend the spectrum to hard X-rays. Report issued January 1999.

June 1999; Gus presents BESSY 1a at UNESCO Headquarters in Paris. Gus becomes Chair of the SESAME Technical Advisory Committee.

Sept 2000; Gus initiates a10 day Accelerator Workshop/School in Jordan. 20 students chosen for advanced training for 2 years at European labs.

2001; Gus persuades Dieter Einfeld to become the Technical Director of SESAME and works with him and others on the design for a 2 GeV upgrade.

Gus Voss (DESY) watching the boat leave Hamburg harbor on its way to Aqaba, Jordan with BESSY I on board; June 7, 2002

MEMBERS of SESAME Council

Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, Turkey

Iraq is completing details for Membership!!

OBSERVERS

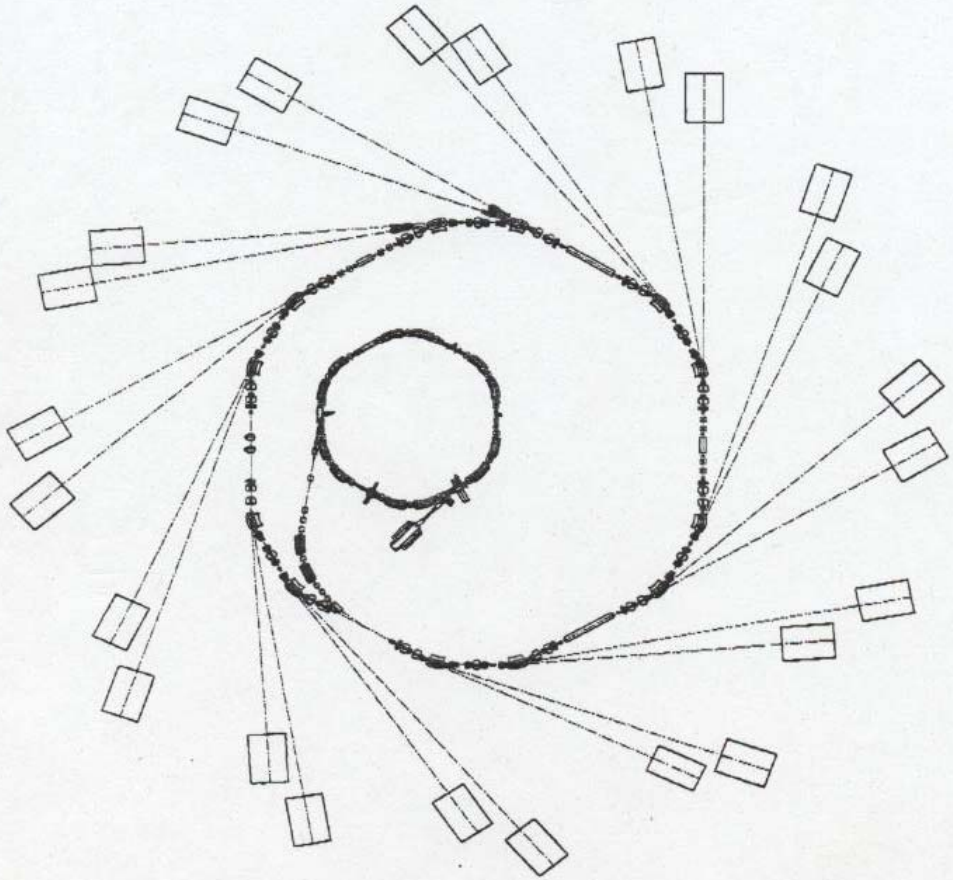
France
Germany
Greece
Italy
Japan
Kuwait
Morocco
Portugal
Russia
Sweden
UK
USA

Chris Llewellyn-Smith replaced Herwig Schopper as Council President, Nov. 08.

Amor Nadji has replaced Gaetano Vignola as Technical Director.

BESSY Ia

A Conceptual Study for a Synchrotron Radiation Source with Extended Spectral Range



January 1999

SESAME

A Proposal for a Synchrotron Radiation Source in the Middle East

Members of the Study Group

M. Abo-Bakr[1], M. Al-Kofahi[6], E. Alp[26], W. Anders[1], F. Asfour[11], K. Baberschke[29], D. Bilderback[21], K. Bürkmann[1], C. Christophides[19], V. Dürr[1], A.M. El Nadi[20], A. Gaupp[1], W. Gericke[1], W. Gudat[1], M. Hadizadeh[7], H. Hallak[14], M. v. Hartrott[1], N. Holtkamp[27], T. Ishii[15], H. Kaiser[2], J. Koupsidis[2], G. Kryger[18], P. Kuhn[3], P. Kuske[1], M. Lamehi-Rachti[16], C. Limborg[3], S. Mahmood[6], G. Margaritondo[4], M. Martin[1], M. Marx[2], H. Moser[28], E.N. Moudrianakis[17], A. Nadji[5], V. Nikoghosyan[13], G. Meyer[2], R. Müller[1], K. Ott[1], C. Papanicolas[8], W. Peatman[1], T. Rabedeau[3], J. Rahn[1], G. Saffarini[23], S. Salman[9], M. Scheer[1], T. Schneegans[1], J.L. Sussman[18], S. Suzer[10], A. Tadjeddine[5], J.W. Taylor[25], A. Thompson[24], G.A. Voss[2], E. Weihreter[1], H. Winick[3], G. Wüstefeld[1], Y. Yacoby[12], T. Yamazaki[22], H. Zyngier[5]

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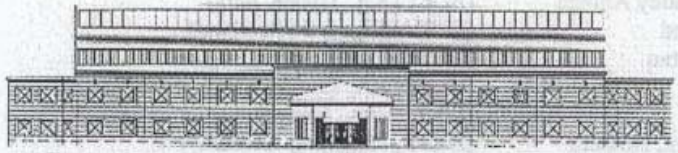
October 1999

SESAME

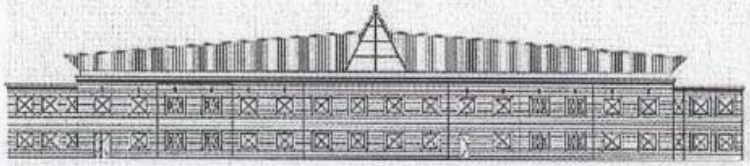
Synchrotron Light for Experimental Science and Applications in the Middle East



NORTH ELEVATION

Conceptual Design for the Upgrading of SESAME to 2GeV

April 2002



WEST ELEVATION

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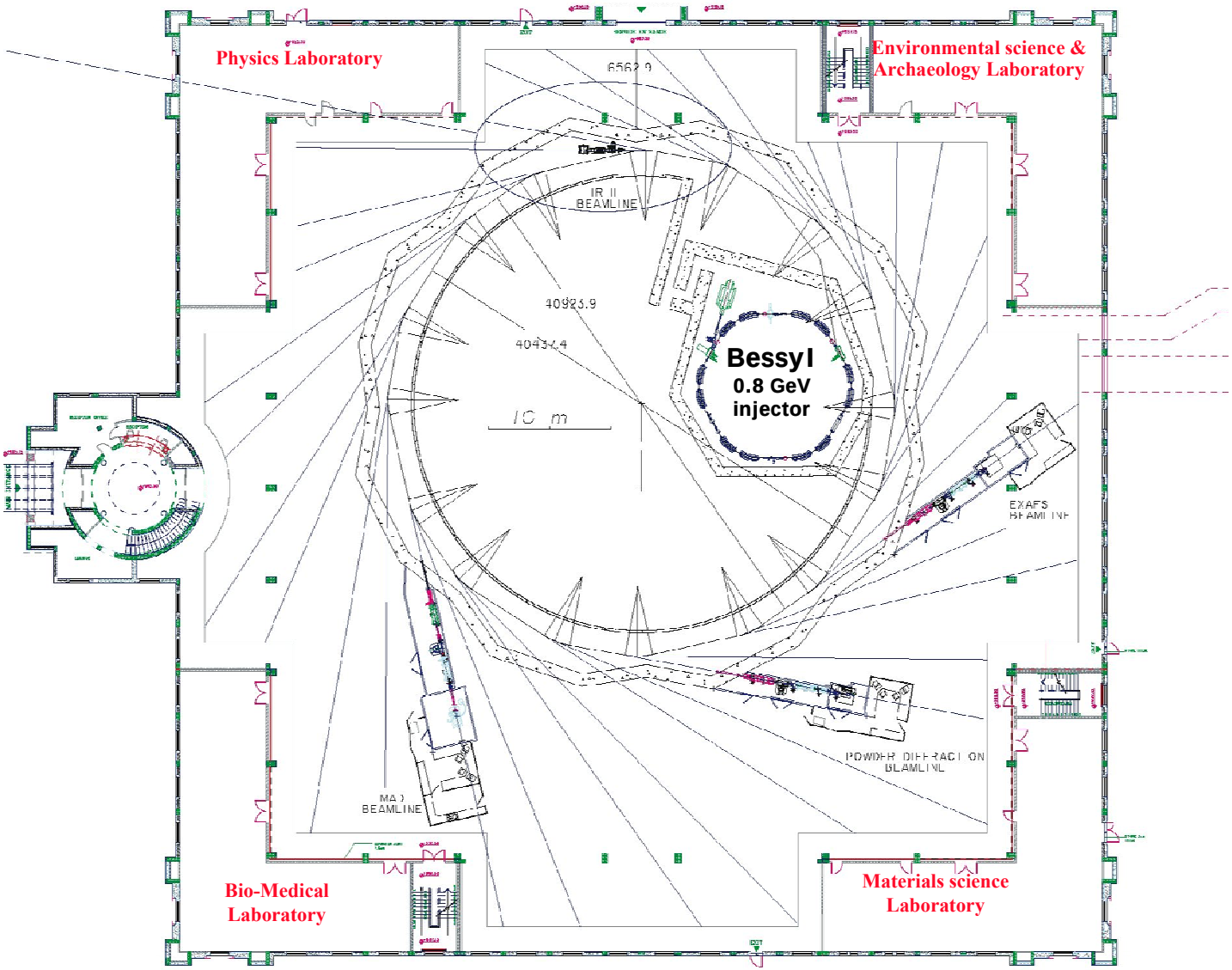
Acknowledgements:

The authors gratefully acknowledge the contributions of Gustav-Adolf Voss, Mark Plesko, Amor Nadji, Lothar Schulze and Ernst Weihreter without whom this work could not have been made and for all the ideas and information they provided. Many thanks to all the colleagues at the different host laboratories of the trainees for educating them. Grateful acknowledge for the ANKA team and the building department of the Research Center Karlsruhe.

SESAME; *in construction in Jordan*
www.sesame.org.jo



2.5 Gev

400 mA

C = 133 m

Emitt; 26 nm

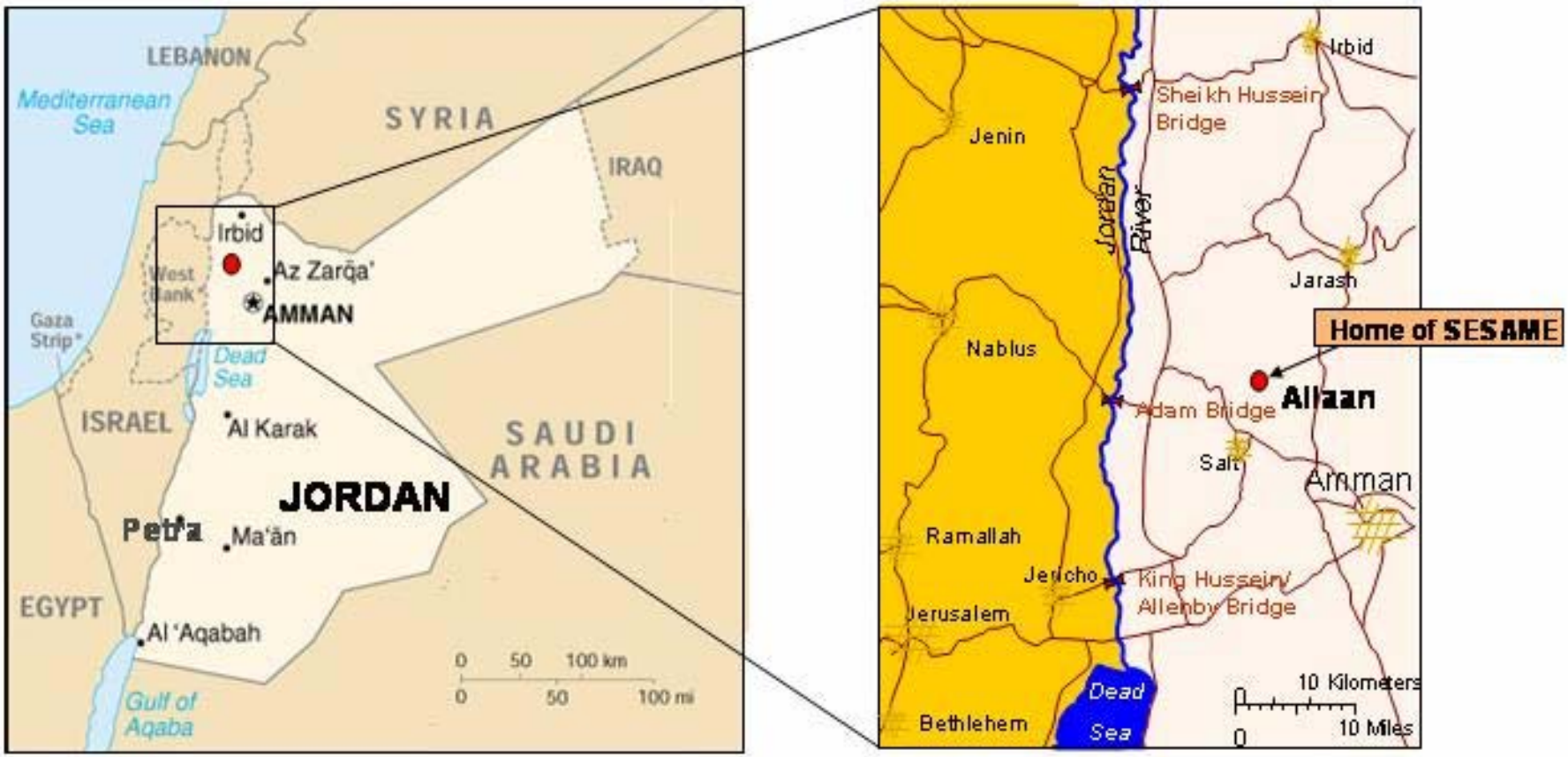
12 spaces for wigglers or undulators

16 bend magnet lines

Beam lines up to 36 m long

Operational in 2012

Members of the SESAME Council (2008)



SESAME location in Allaan, Jordan

King Abdullah II (Jordan) & Koïchiro Matsuura (Director-General of UNESCO) at SESAME Ground Breaking Ceremony on January 6, 2003

12th Meeting of SESAME Council; Uppsala Sweden, June 9-10, 2008

Dinçer Ülkü; **Vice President of the SESAME Council**
Chris Llewellyn-Smith; **Council President starting in November, 2008**
Yasser Khalil; **Administrative Director**
Khaled Toukan; **Sesame Director**
Herwig Schopper; **Council President until November, 2008**
Hafeez Hoorani; **Scientific Director**
Amor Nadji; **Technical Director**
Albin Wrulich; **Chair of SESAME Technical Advisory Comm.**

Missing; ***Zahid Hussain*** **(Chair, Beamlines Comm.)** ***Zehra Sayers*** **(Chair, Scientific Comm.)** ***Javad Rahighi*** **(Chair, Training Comm.)**


R.Sarraf 12-2-2008

Inside the SESAME building; May 2008

BESSY I 0.8 GeV Booster Synchrotron set up in SESAME building for “soft” inauguration on November 3, 2008

Mayor of Salt, Mr. Salameh, and Herman Winick

Nobel Laureates visit SESAME site in June, 2008

45 Laureates endorse SESAME “as a beacon, demonstrating how shared scientific initiatives can help light the way towards peace”.

Tests of the MICROTRON Subsystems (2)

July 14, 2009; *Accelerated electrons in the microtron*

SESAME Scientific Collaborations

Human Histone Deacetylases are flexible enzymes: insights from solution structural analysis of human apo-histone deacetylase 8 (HDAC8)

Authors:

Tzvia Selzer[1], Brian Vash[2], Said Ali[3], Rotem Sertchook[1], Guenter Grossmann[4], Peter Atadja[2], Travis Stams[2], Dalia Cohen[2], and Irit Sagi[1] *

1. Dept of Structural Biology, the Weizmann Inst. of Science, ***Rehovot, Israel.***
2. Novartis Institutes for Biomedical Research, ***Cambridge, MA USA****.*
3. Department of Biophysics, ***Cairo University, Giza, Egypt.***
4. Molecular Biophysics Group, CCLRC ***Daresbury Lab, Warrington, UK***

**Corresponding author*
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ANOTHER WORLD?

"As a string theorist, I work on parallel universes. I was always curious about what a parallel universe was like, and now I know. I'm living in one when I go to *SESAME* meetings"

Eliezer Rabinovici; Hebrew University and Israeli representative to the SESAME Council

SESAME is Happening!!

www.sesame.org.jo

Speech by President Obama; June 4, 2009, Cairo Univ.

On science and technology, we will launch a new fund to support technological development in Muslim-majority countries, and to help transfer ideas to the marketplace so they can create jobs. ***We will open centers of scientific excellence in Africa, the Middle East and Southeast Asia***, and appoint new Science Envoys to collaborate on programs that develop new sources of energy, create green jobs, digitize records, clean water, and grow new crops. And today I am announcing a new global effort with the Organization of the Islamic Conference to eradicate polio. And we will also expand partnerships with Muslim communities to promote child and maternal health.

Selected Tributes to Gus

At the meeting to mark his retirement, I spoke about the key role that Gus played at DESY, which I observed with admiration as a member of various advisory committees, and from which I learned a lot, and the contributions that he made as an advisor at CERN. I should not have been surprised that Gus did not really retire but took on a new role as a founding father and promoter of SESAME, the synchrotron-light source now under construction near Amman.

As the current President of the SESAME Council, my admiration for the founders of SESAME grows daily. No doubt Gus is well up to date with the status of the project, but for those who are not, I am pleased to report that the microtron is now working, the old BESSY ring is ready to be installed as the booster, and calls for tender are being prepared to build a new 2.5 GeV main ring.

I believe that SESAME is set to fulfill it's founders' dreams as a scientific success, which will foster science and technology in the Middle East, and help build bridges between diverse countries. ***On behalf of the SESAME Council: thank you Gus for your key contributions, and - Happy Birthday****.*

Sir Chris Llewellyn-Smith

Another tribute to Gus by Llewellyn-Smith

In a speech during Gus's retirement party Chris Llewellyn-Smith said:

"He asked the important questions and he investigated the details, until he either understood what the presenter said, or he understood that the presenter did not understand what he was talking about".

From Reza Mansouri
Deputy Science Minister of Iran in Khatami administration
President of the Iranian Physical Society
Representative of Iran to the SESAME Council

Dear Gustav,
Although I am not any more on board of SESAME, I remember exactly your essential contribution to take off of the SESAME . Let me congratulate you very warmly your 80th birthday. Let's hope we all will be able to contribute more to humanity and peace through more scientific activity. Thanks again for all you effort.
Reza

Dear Gus,
Alas I will not be in DESY on 4th September to greet you in person. But I cannot let the occasion pass without comment and greeting.

I am not sure whether to congratulate you on reaching 80, or commiserate with you that our youth has passed! But I invite you to think of it as the French do. One starts counting again at age 80. Thus 90 is quatres vingt **dix** (not nonant as the upstart Quebecois call it)

I still remember the years we worked closely from 1964 to 1974. I do not remember why you came to the CEA but whoever invited you had has my thanks. I remember explaining to you why electron-positron colliding rings were going to be the wave of the future. Above all I remember going into Ken Robinson's office one morning and seeing on the blackboard the formula:

L = (2eIDelta Nu)/beta.

I naively asked "why not reduce beta?" "One can't" said Ken. That is determined by the machine lattice. But you and he had the solution the next day - a low beta section.

This was one more example of the famous dictum - there are no silly questions. Only silly answers.

Again Gus , I write again as a man who started counting again at age 80 three years ago:

It was fun when we worked together 40 years ago. I have always admired your work, your measured optimism, your cheerfulness and enthusiasm

There are many more years to come!
Dick Wilson

Dear Gus,
No longer an intrepid traveler, I am afraid I cannot get to the colloquium celebrating your eightieth birthday, however I want to celebrate the occasion and our friendship with this letter.

First I want to congratulate you on reaching the age of eighty at all. I understand that everybody born today expects to live that long, but when we were born, the odds weren't so good, and I never grew confident of reaching that age (which I will—barring unforeseen misfortune—in six months) until recently. Good luck! And may you reach ninety.

I congratulate you, Gus, on a long, productive and notable scientific career. Your many accomplishments will surely be much recited and lauded at the colloquium, and very deservedly. But I have always admired one of them above all the others: the discovery of the use of low beta at an interaction region. There are three principal reasons it is my favorite. First, although it was the child of necessity at the CEA, it was a mother bountiful at all the storage rings that followed; it had a profound effect on the colliding-beam industry, and not least at Spear to my gratitude. Second, the principle of low-beta, although not obscure, had escaped the notice of many clever people, people such as Dave Ritson, Fernando Amman and the others at Frascati who were building Adone and therefore strongly motivated to notice it. And third, you worked it out with Ken Robinson, and consequently you had to scale the enormous Robinsonian communication barrier, a barrier that had defeated many people in the past. I know from experience that it is a demanding task.

On a personal note Gus, I want to tell you how much I have admired you and treasured your friendship. In my experience, you have always been honest, fair, gracious and considerate, a true gentleman; and I have observed that those attributes do not invariably accompany the sophistication and culture that you also possess. In the Yiddish language, you are "ein Mench." I am proud to know you.

Marian says, Happy Birthday.
Affectionately,
John Rees

End of Presentation

Thank you

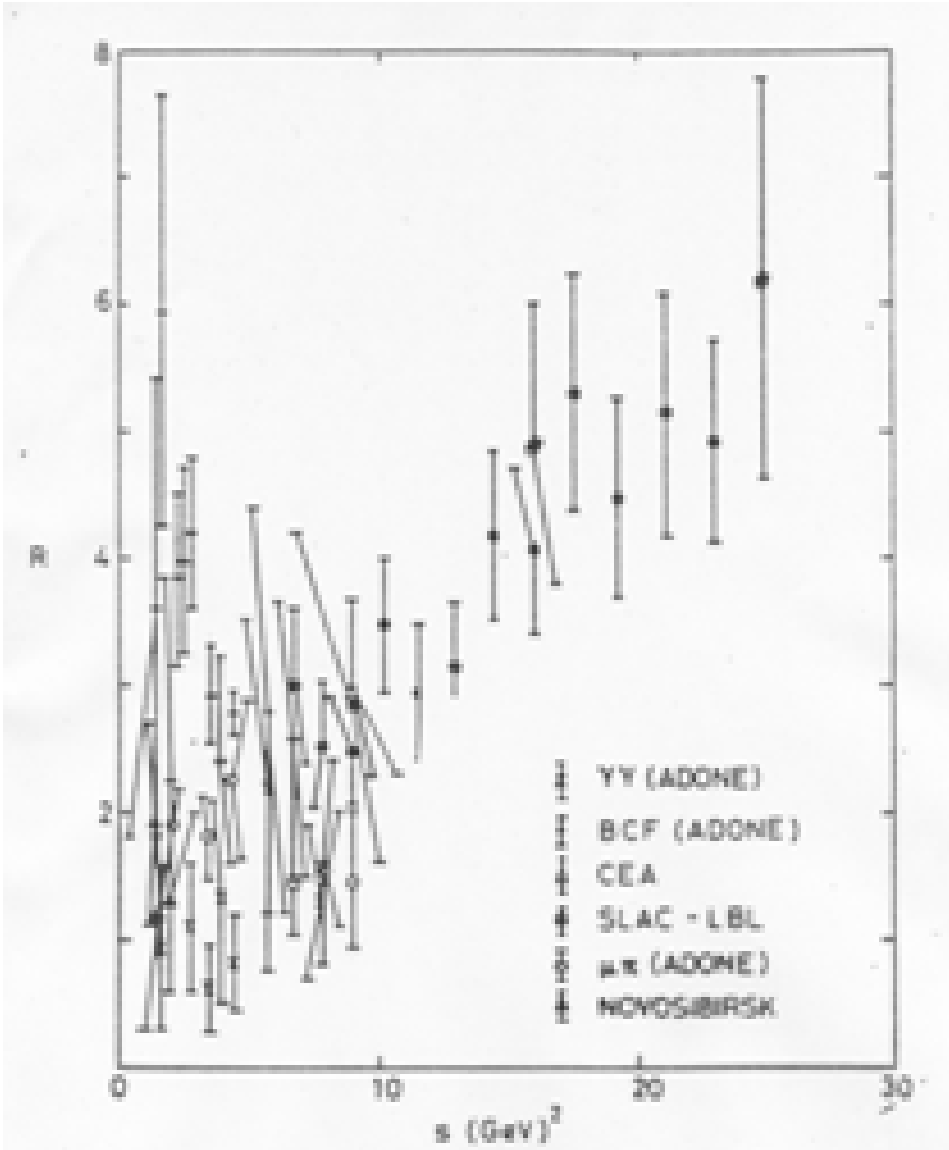


Fig. 4. All measurements of the ratio of σ_{TOT} to $\sigma_{\mu\mu}$ vs S, for $S \geq 1.5$ $(GeV)^2$.

Damping magnet to damp horizontal betatron oscillations which are anti-damped in an alternating gradient magnet lattice (concept by Ken Robinson)

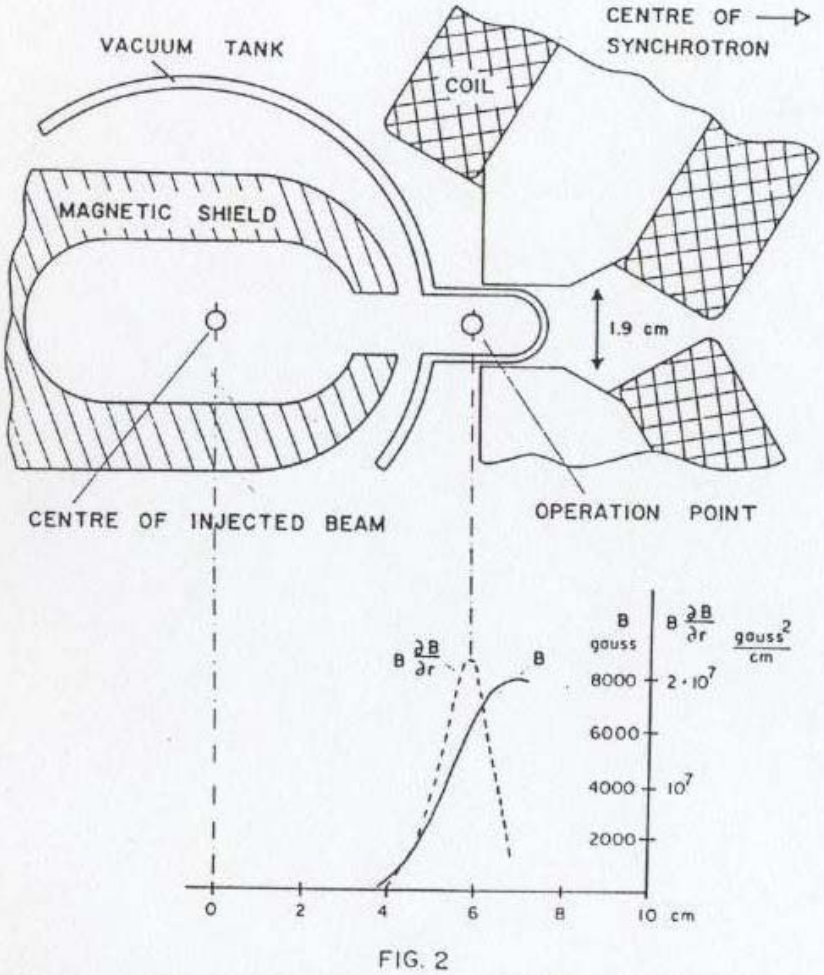


FIG. 2

CROSS SECTION THROUGH THE DAMPING MAGNET

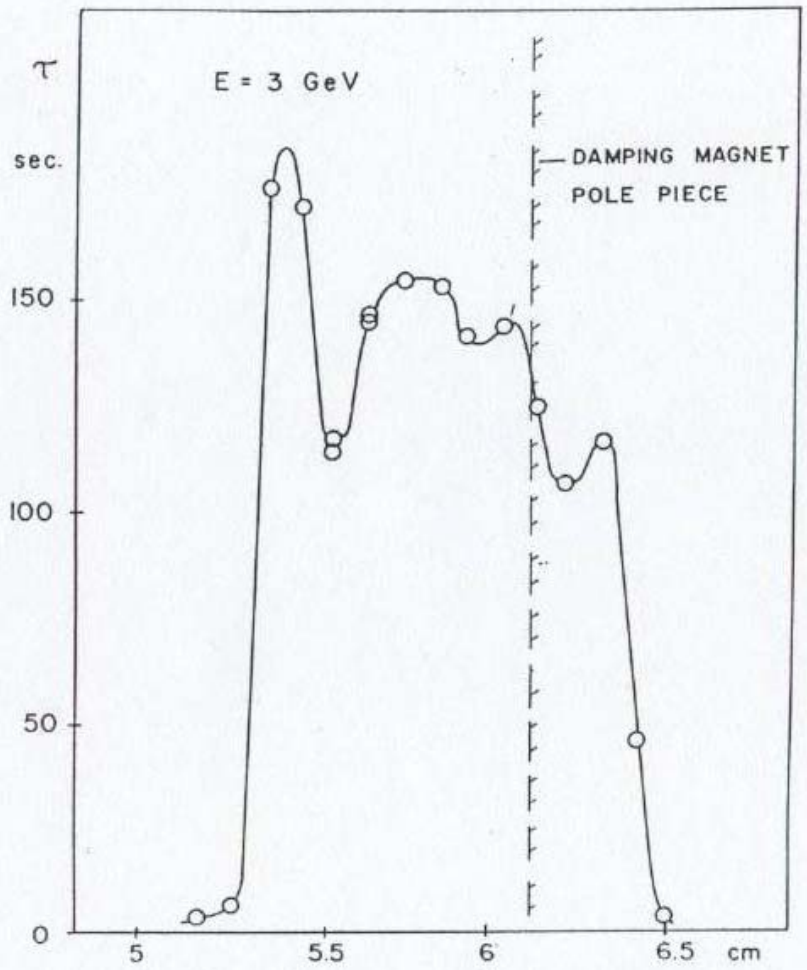
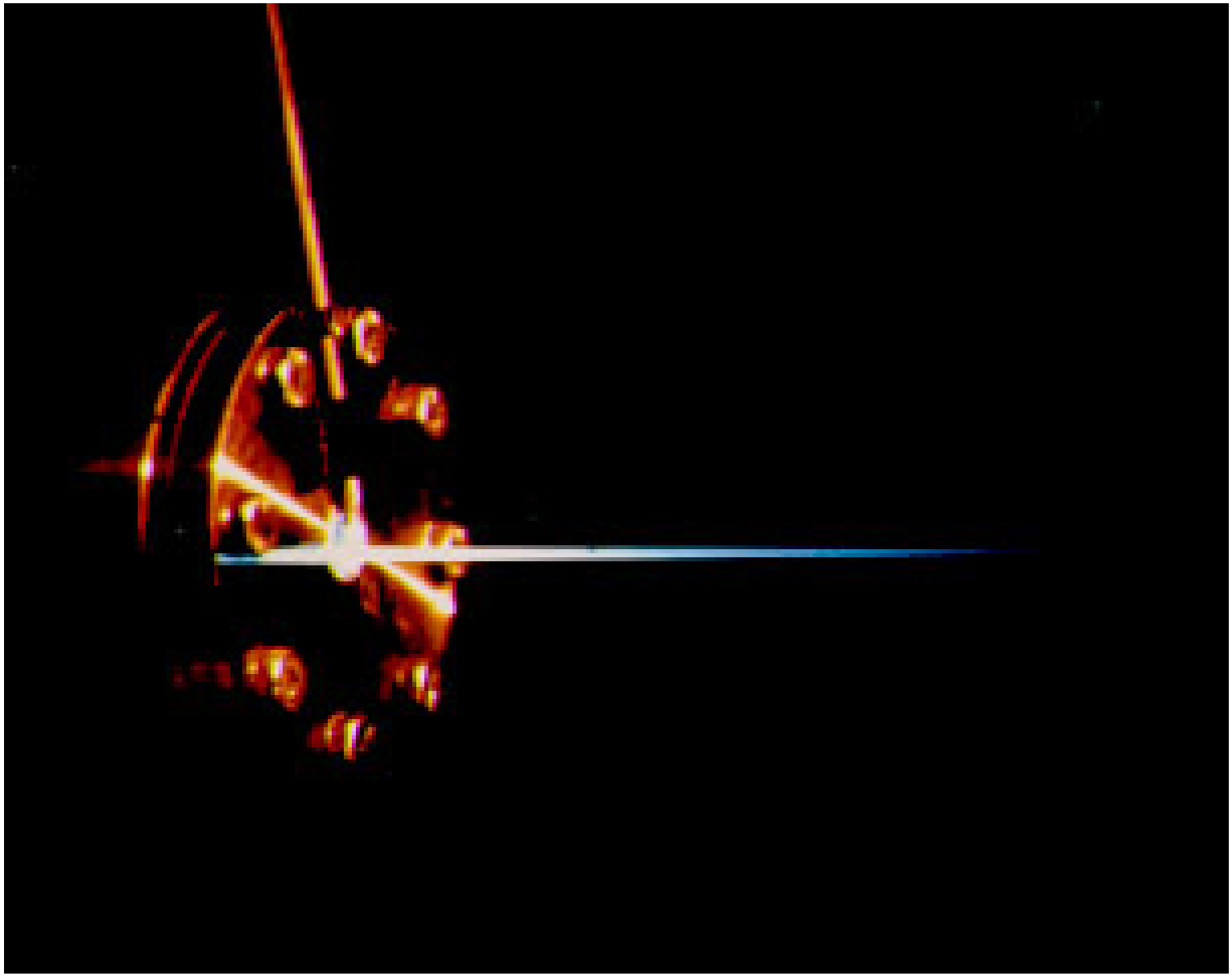


FIG. 3. BEAM LIFE TIME VERSUS BEAM POSITION

Focused x-ray beam from the Cambridge Electron Accelerator – 1972 (Paul Horowitz, Harvard University)



Date: Fri, 14 Nov 1997 13:06:36 +0100

From: Gus Voss <gavoss@mail.desy.de>

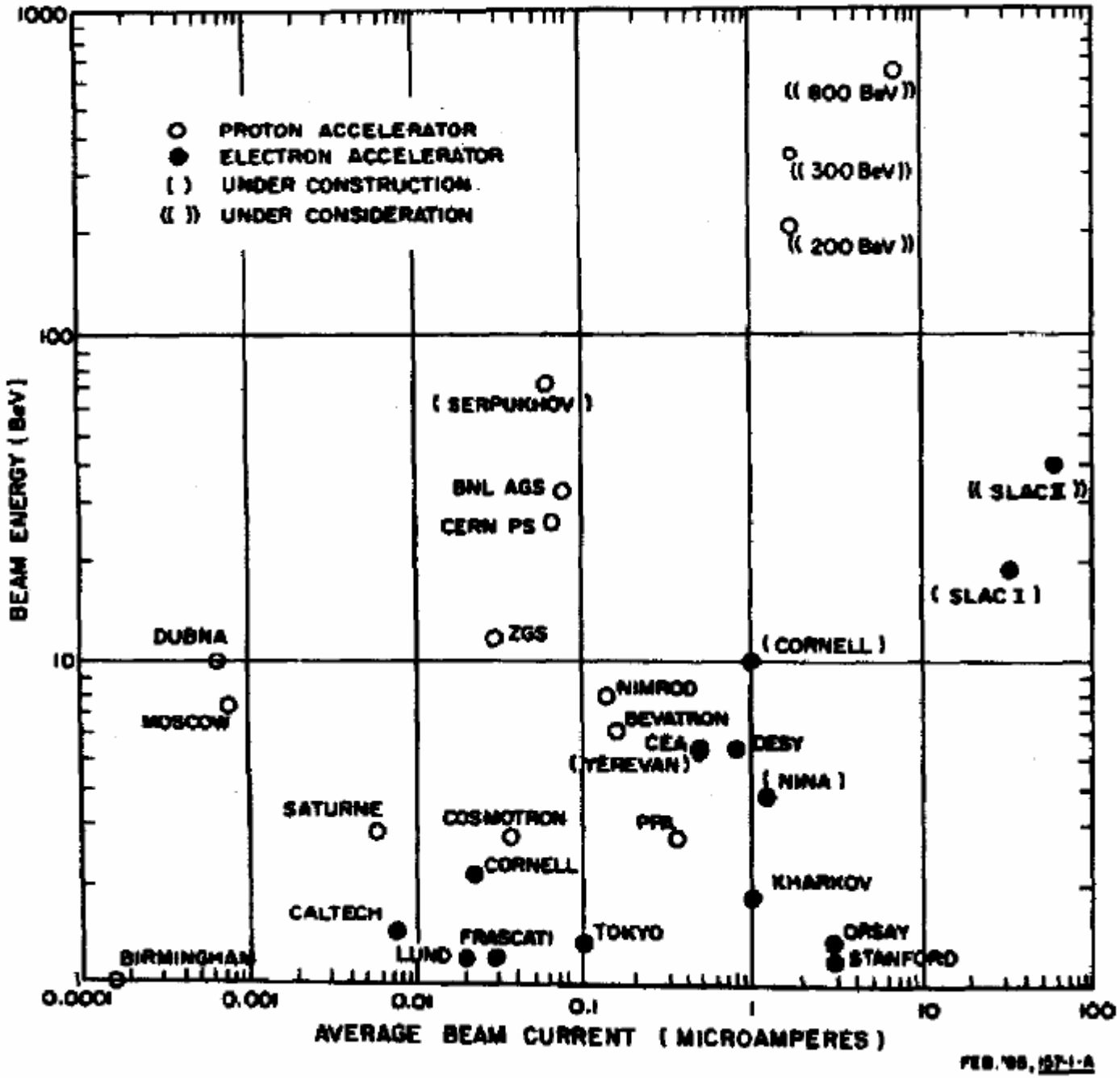
Subject: BESSY I in Palestine

To: Herman Winick <Winick@SLAC.Stanford.EDU>

Dear Herman,

Remember,it was you who had this idea first and in all my conversations I do not fail to point this out. But even after having had this on my mind for several weeks now, I cannot see anything basically wrong with this idea.

Figure 1-1 Comparative graph of various accelerators.



W. Kirk & R. Neal

The SLAC Two Mile Accelerator

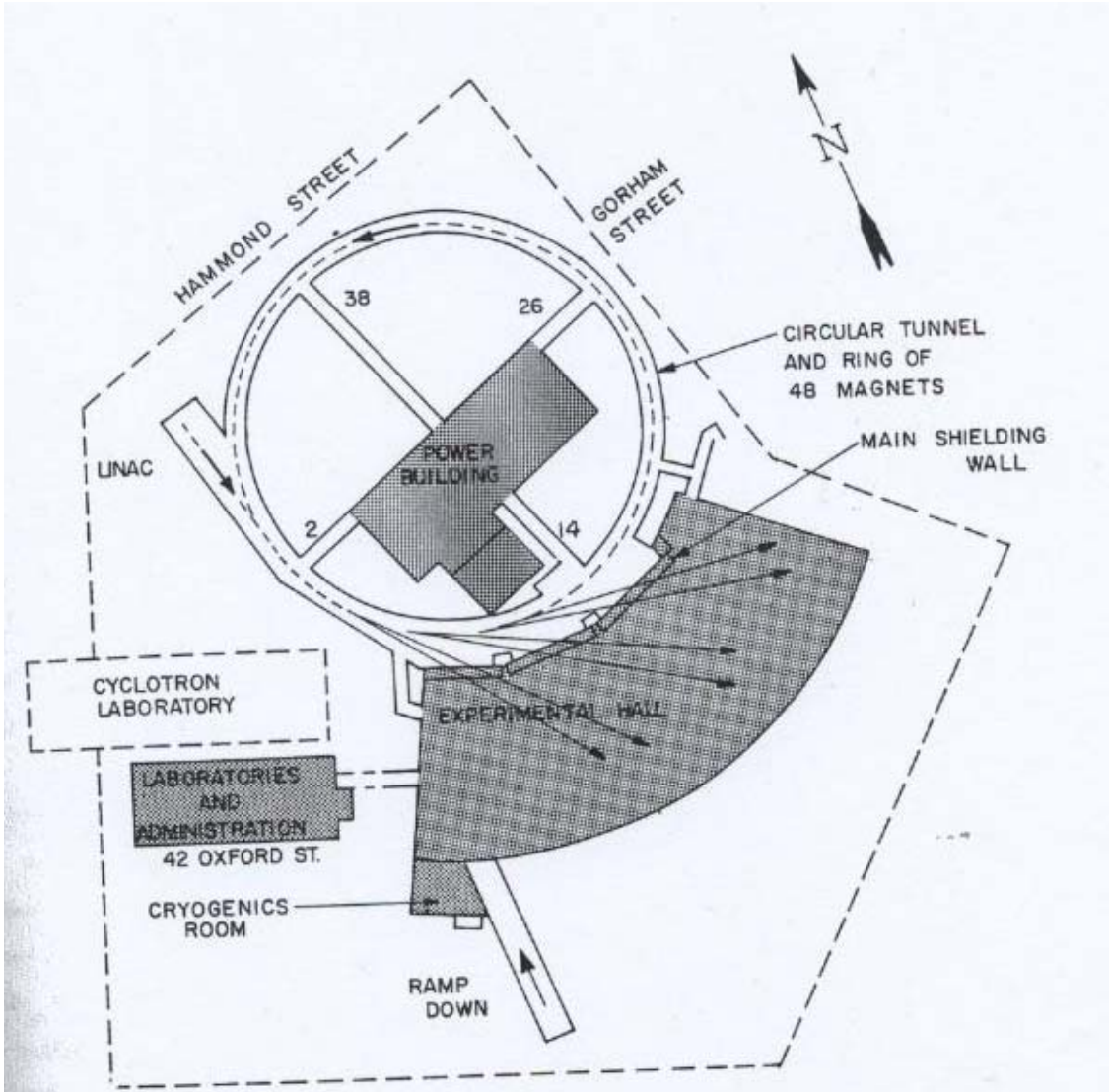


Fig. 3.1. Plan of Cambridge Electron Accelerator, located on Harvard University grounds adjacent to the Physics Department, the Division of Engineering and Applied Physics, and the Cyclotron Laboratory. Not drawn to scale.

Tom Collins; during the cleanup after the 1965 explosion of the bubble chamber

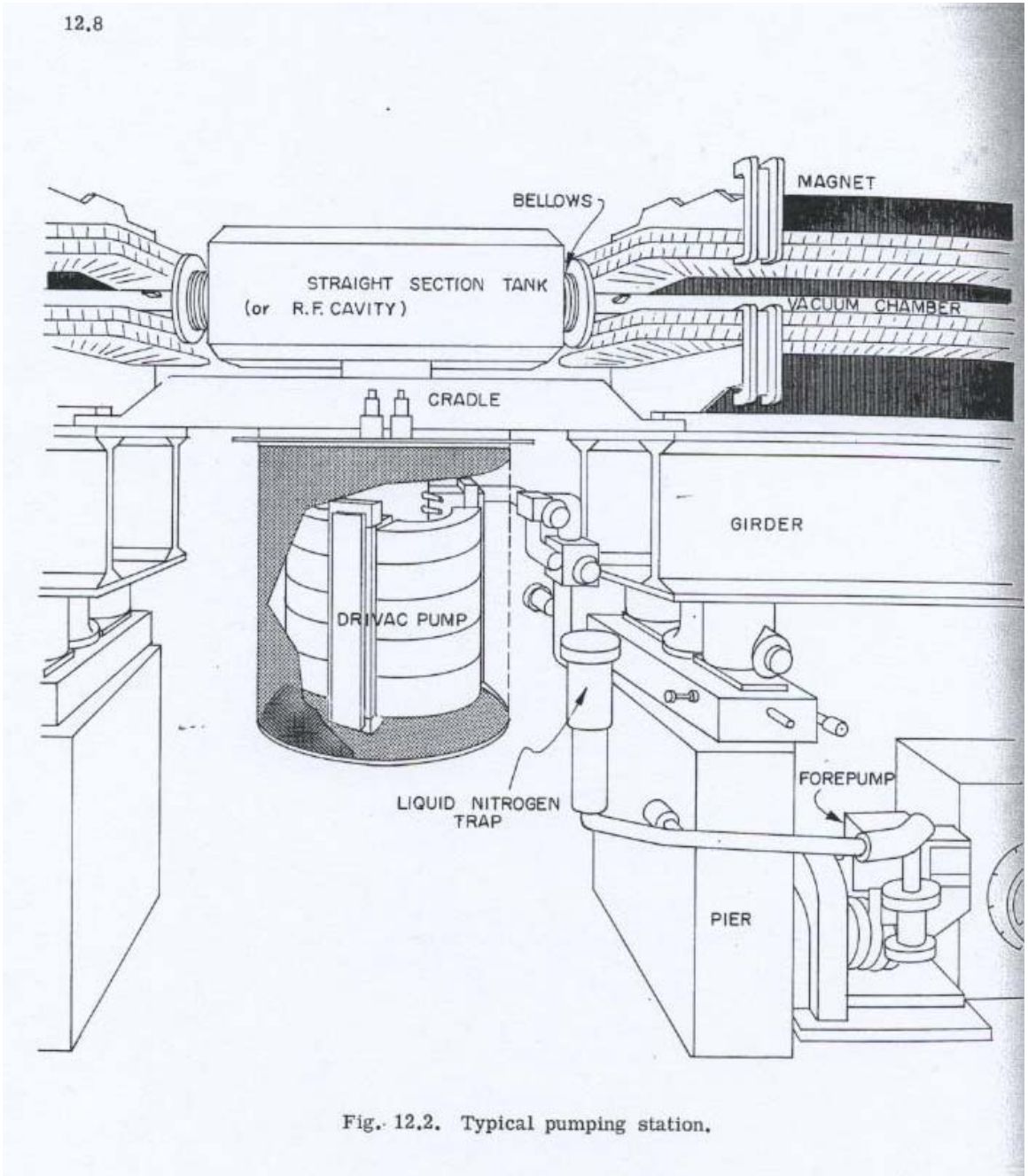
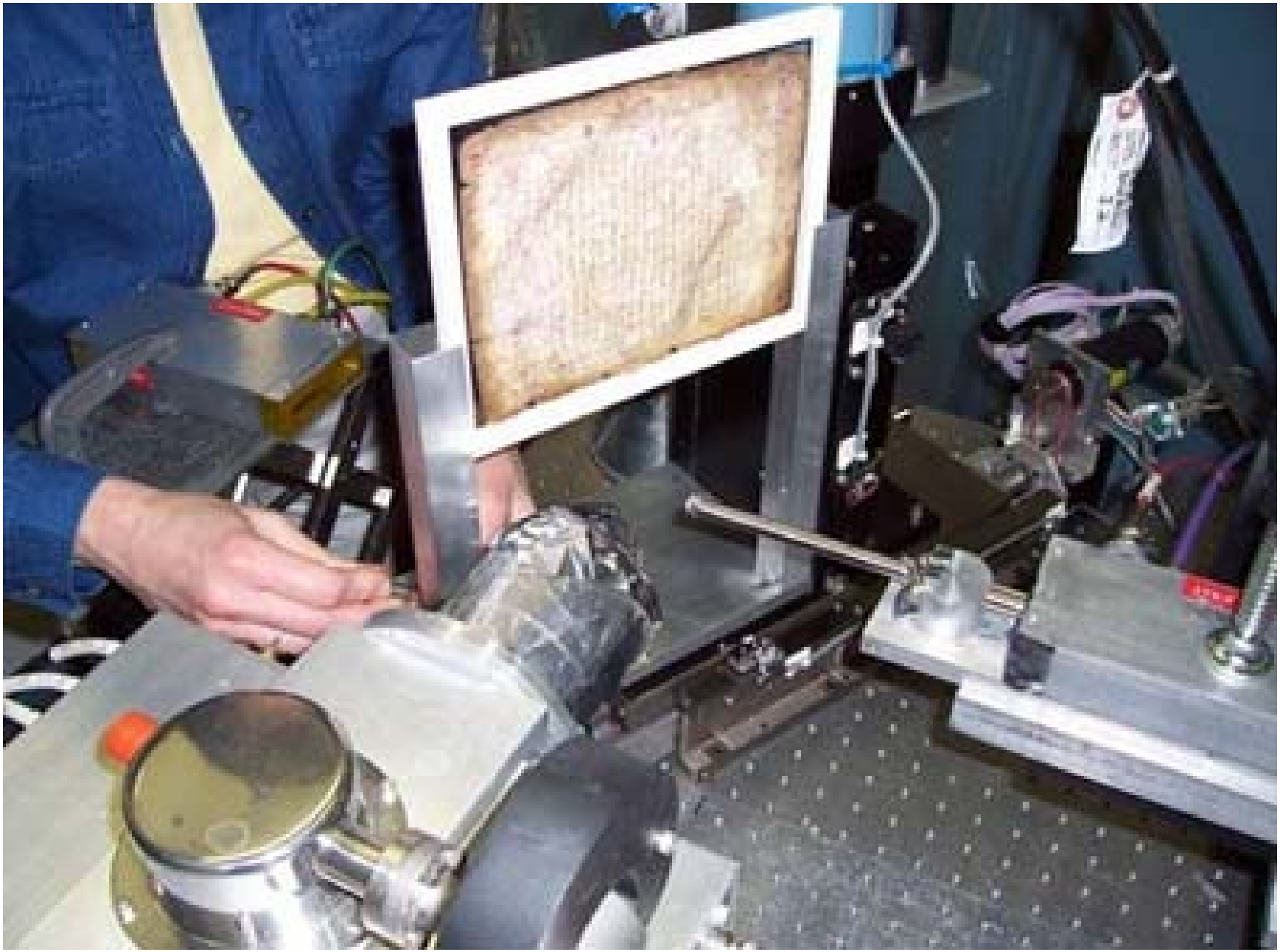
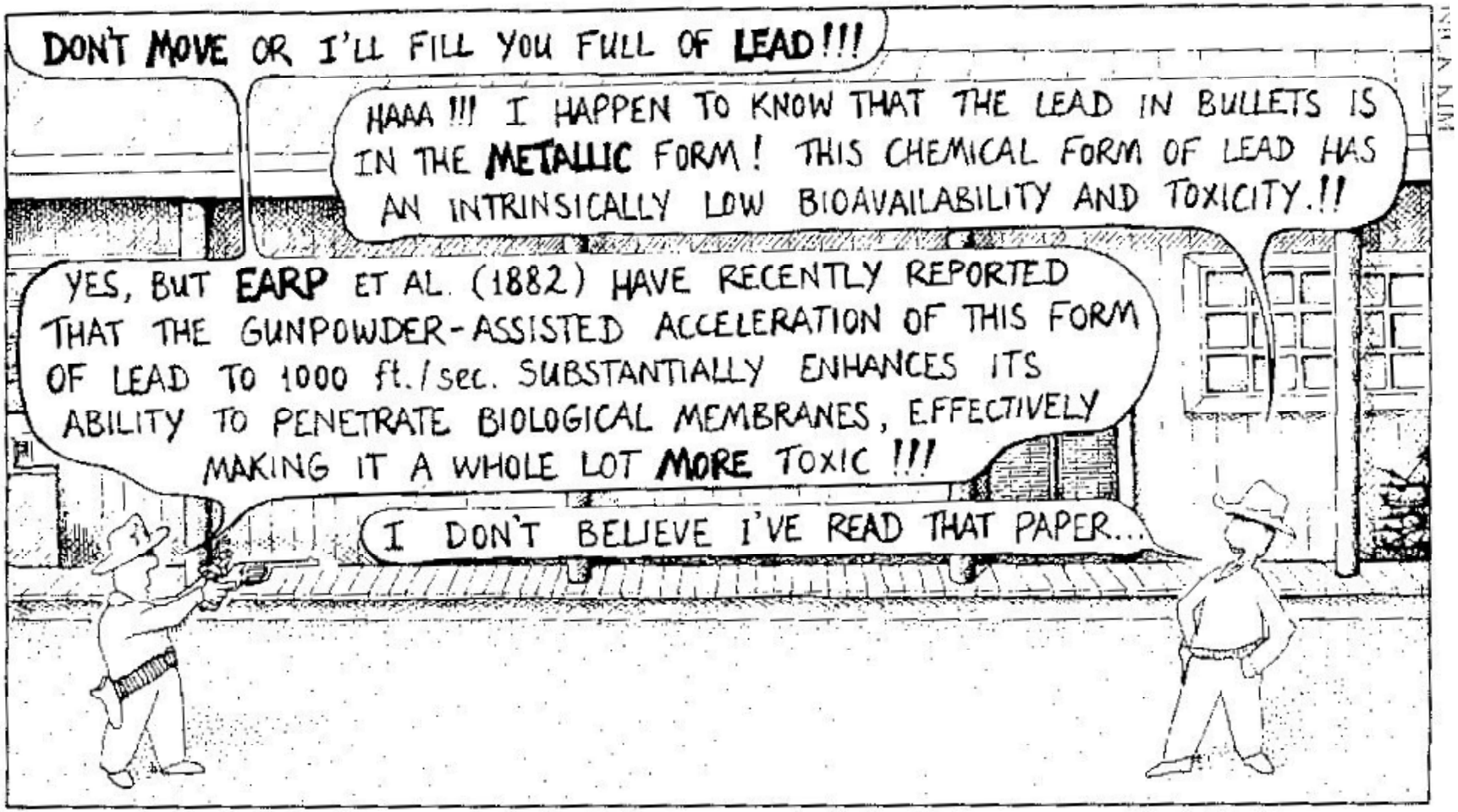


Fig. 12.2. Typical pumping station.

48 Straight Sections, each ~60 cm long.

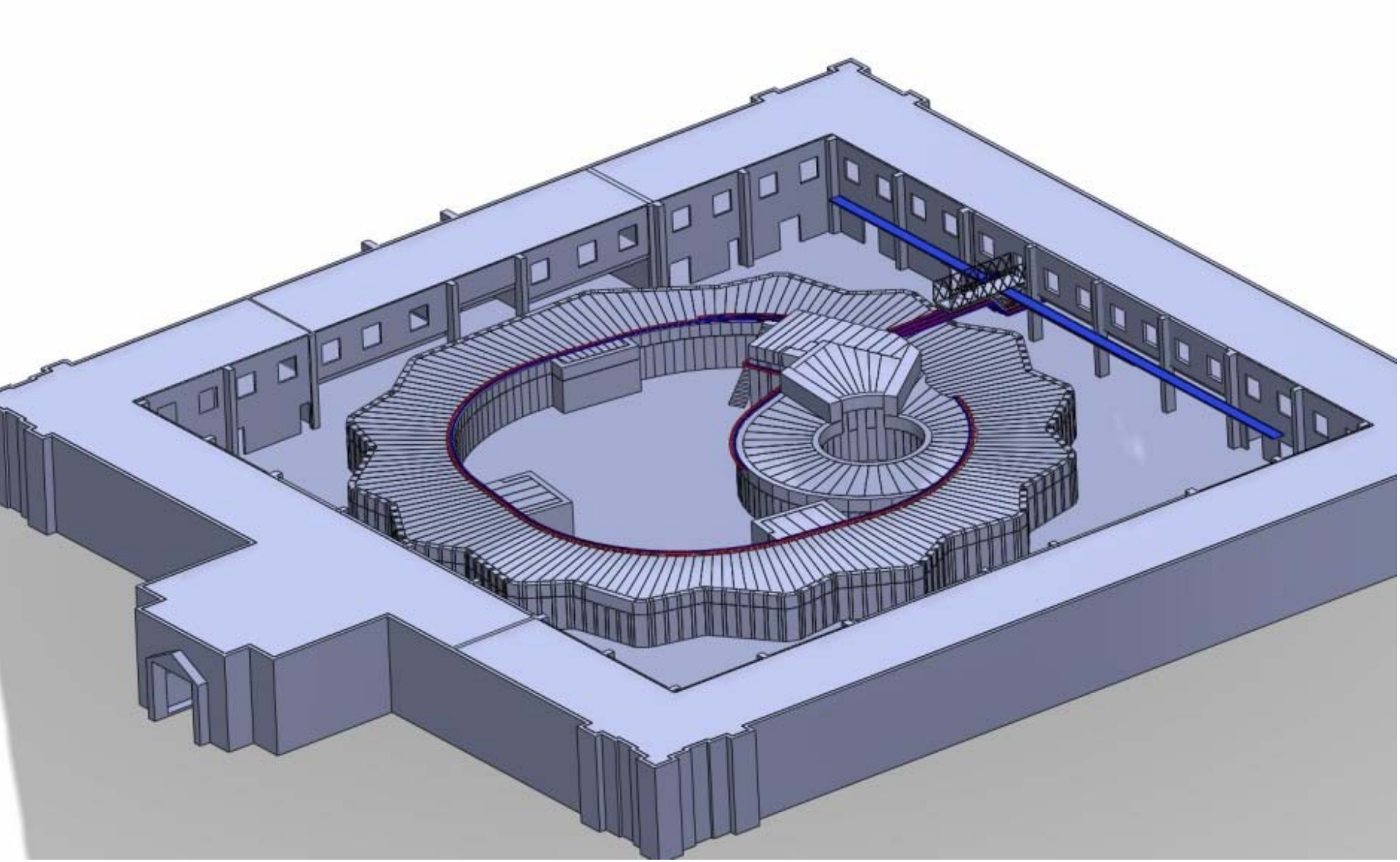
CEA was the first accelerator to use ion pumps.





Environmental Scientists in the Wild West

3D View of the New Shielding



SESAME site visit by *Mohamed ElBaradei*, Director-General of the International Atomic Energy Agency; April 14, 2007

A Brief History of the Cambridge Electron Accelerator (CEA)

- **Started operation in 1962 – a 6 GeV, 60 Hz electron synchrotron**
- **1st Multi-GeV electron accelerator to use strong focusing**
- **Main designers (Stan Livingston, Tom Collins, Ken Robinson)**
- **Began operation as a colliding beam storage ring in 1970**
- **Experiments at 4 and 5 GeV center of mass**
- **Brief use of a synchrotron radiation beam line starting in 1972**
- **Shut down in 1973**

1965: EXPLOSION and FIRE
CEA proposal for a 3 GeV colliding beam storage ring not funded

Groundbreaking Ceremony for the Cambridge Electron Accelerator (~1959)

Stanley Livingston,
Director of CEA

Julius Stratton,
President MIT

Nathan Pusey,
President Harvard