From SSRP to SSRL, 1972-1998

SSRL 50th Anniversary Celebration

Arthur Bienenstock

April 20, 2023

U.S. DEPARTMENT OF ENERGY | Stanford University

SLAC NATIONAL ACCELERATOR LABORATORY

Before SSRP

1962-72 SLAC linac and SPEAR constructed

Pief Panofsky, Burt Richter

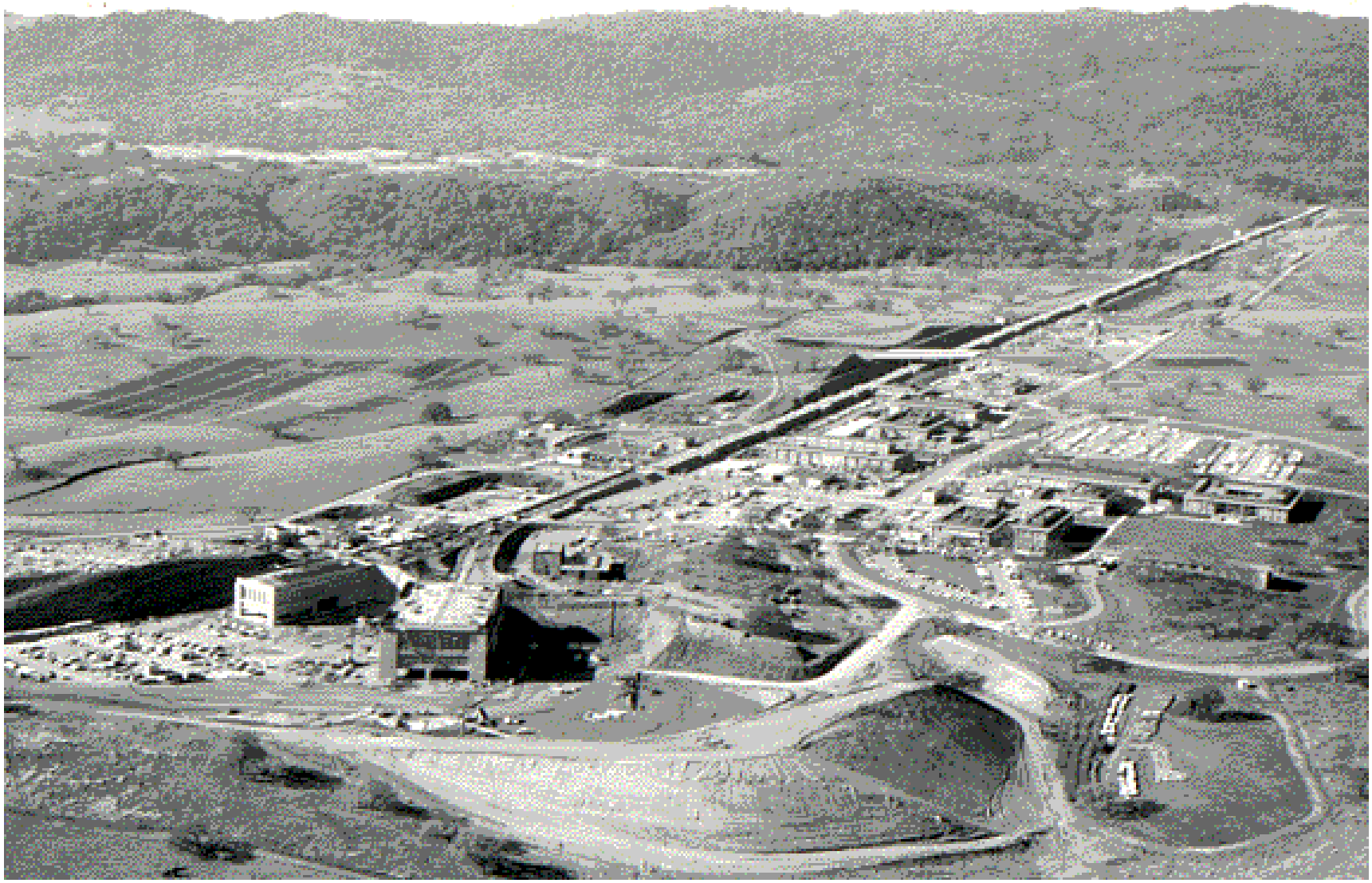
1968 – The Idea – SPEAR as a SR source

Stig Hagstrom, Bill Spicer, Seb Doniach

1972 – SSRP Proposal submitted to NSF

1972 – Campus funds first SR experimental station on SPEAR

Ingolf Lindau, Piero Pianetta



SLAC – Late 1960s

First SR station on SPEAR-1972
Stanford Campus funding

Postdoc I. Lindau and Grad. Student P. Pianetta + SLAC help

SSRP

1973 – NSF selects parasitic SSRP over dedicated CEA

- $1.2M grant to Stanford
- Seb Doniach director
- Seb brings in Herman Winick as associate director

1974 – SSRP starts functioning

- Beam line with 5 experimental stations
- Building to house it
- Many people and organizations contributing
- Exciting new science from the beginning

11/74 – Psi particle discovered

- SPEAR operated at <2 Gev much of the time
- X-ray drought

~1975 – Winick proposes wiggler beam line

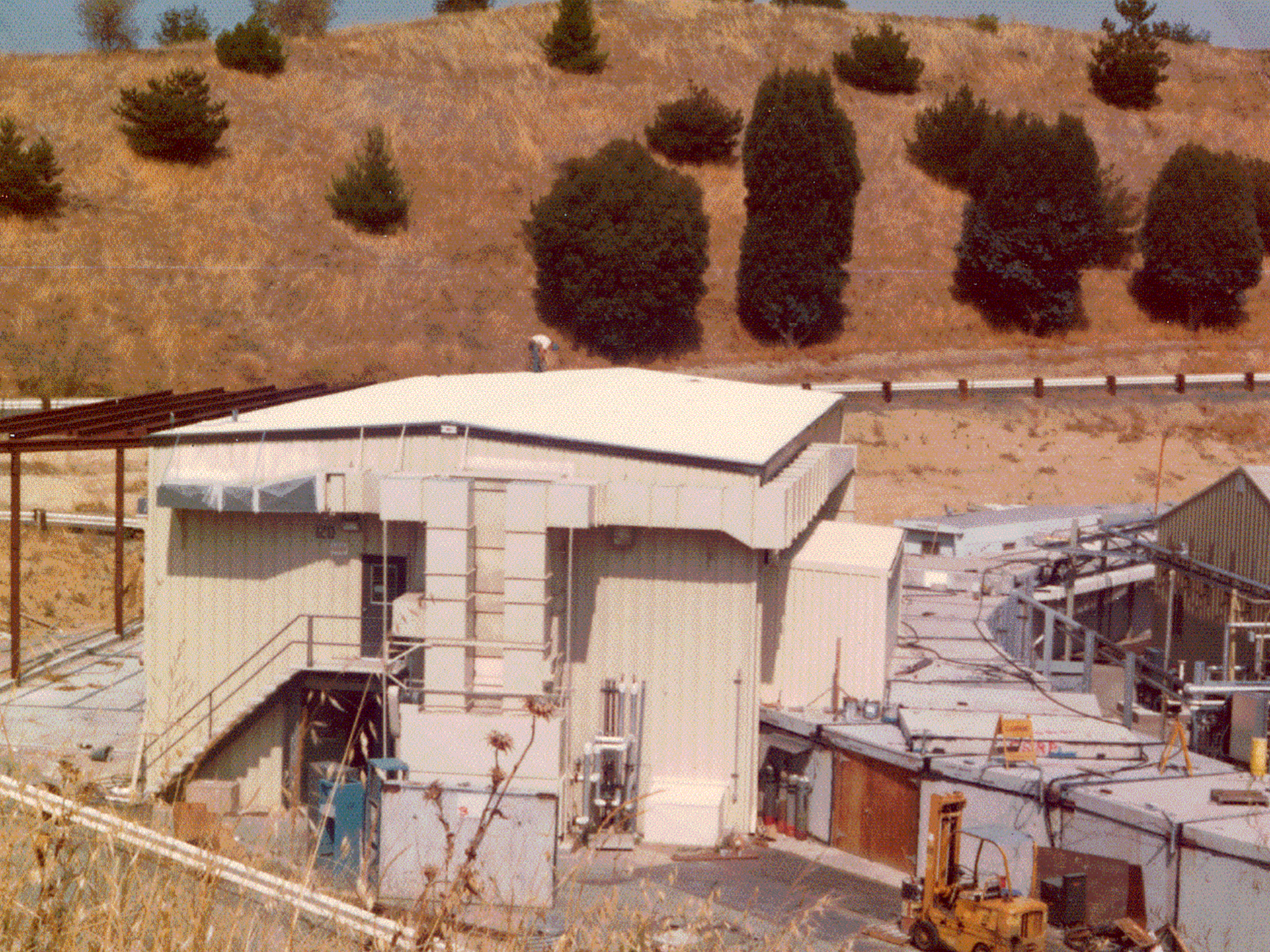
- Risky - might interfere with HEP

1976 – Beam line 2 completed

1976 – Panofsky pledges 50% dedicated SPEAR time when PEP is operational

Bill Spicer and Seb Doniach

Herman Winick



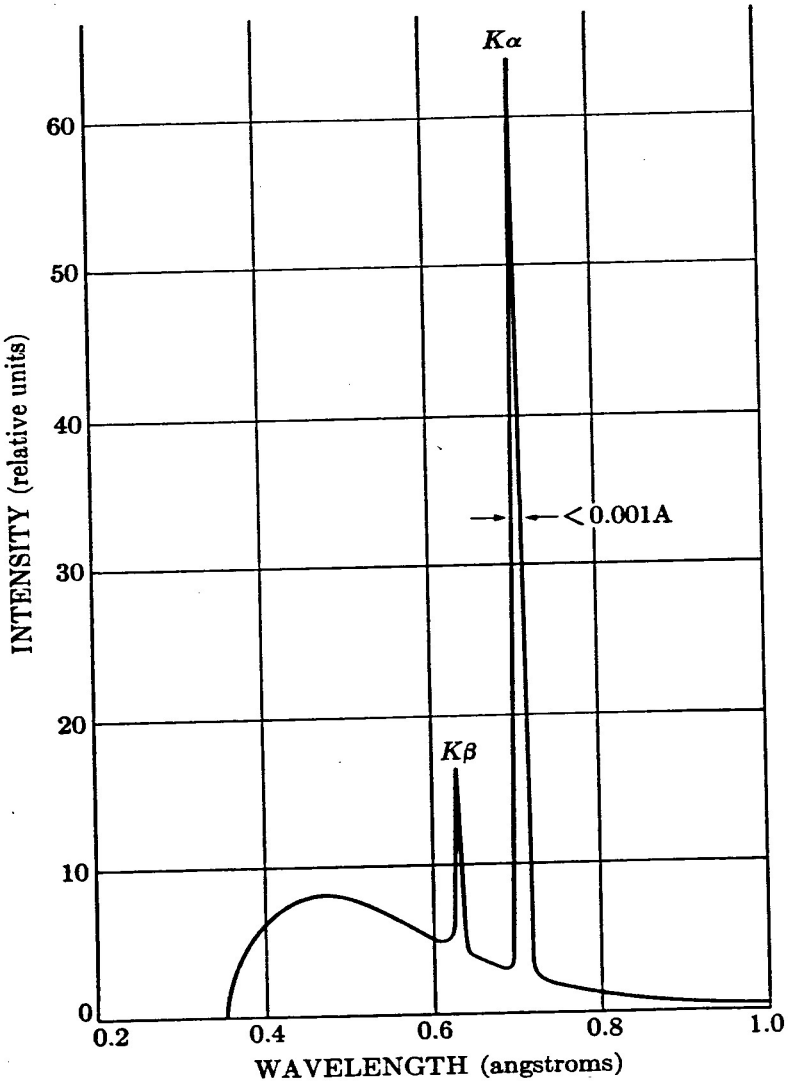
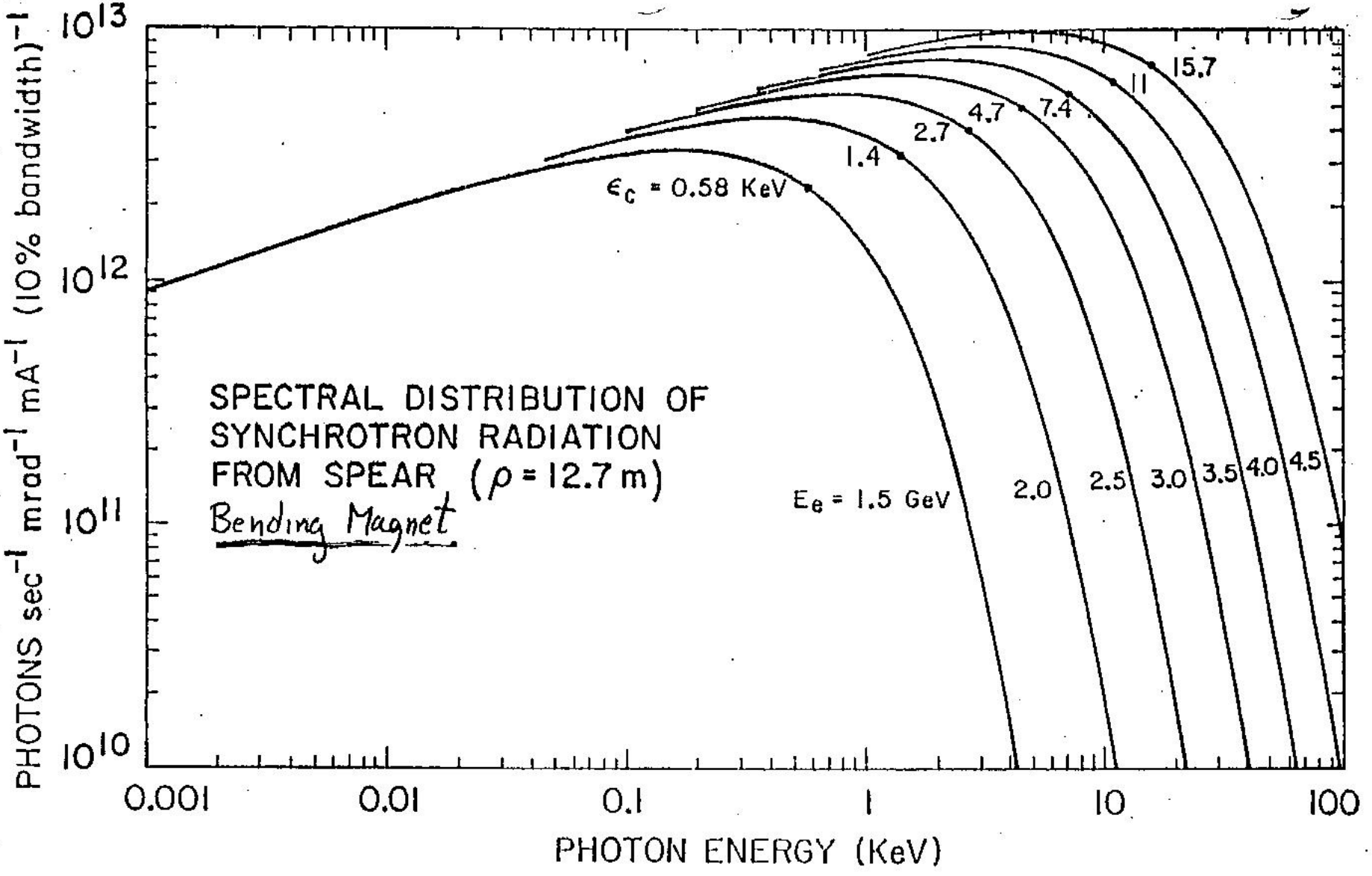


FIG. 1–5. Spectrum of Mo at 35 kv (schematic). Line widths not to scale.


PHOTONS sec^{-1} mrad^{-1} mA^{-1} (10% bandwidth)$^{-1}$
10^{13}
10^{12}
10^{11}
10^{10}
SPECTRAL DISTRIBUTION OF
SYNCHROTRON RADIATION
FROM SPEAR (ρ = 12.7 m)
Bending Magnet
ϵ_c = 0.58 KeV
1.4
2.7
4.7
7.4
11
15.7
E_e = 1.5 GeV
2.0
2.5
3.0
3.5
4.0
4.5
0.001
0.01
0.1
1
10
100
PHOTON ENERGY (KeV)

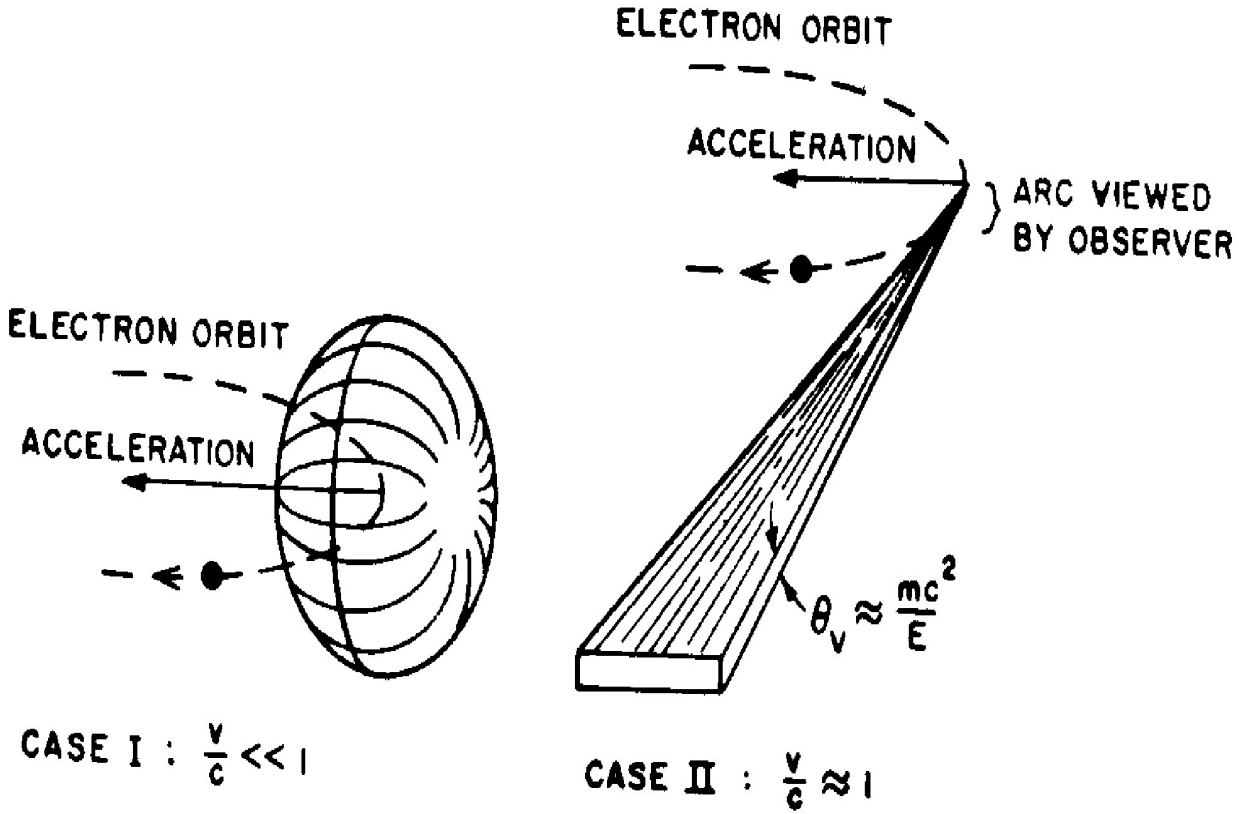
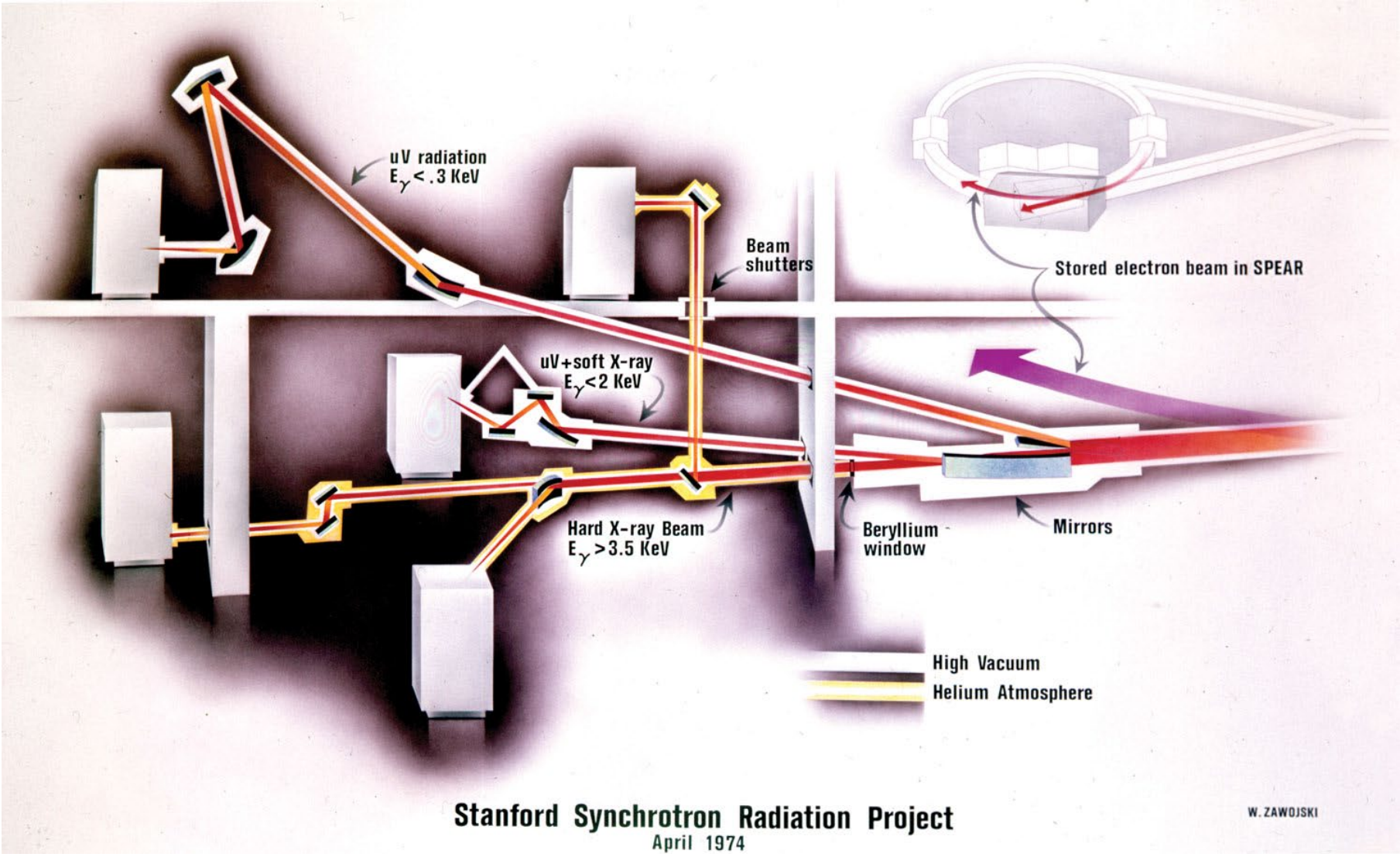


Figure 1. Radiation emission pattern of electrons in circular motion: Case I, nonrelativistic electrons. Case II, relativistic electrons.



Stanford Synchrotron Radiation Project

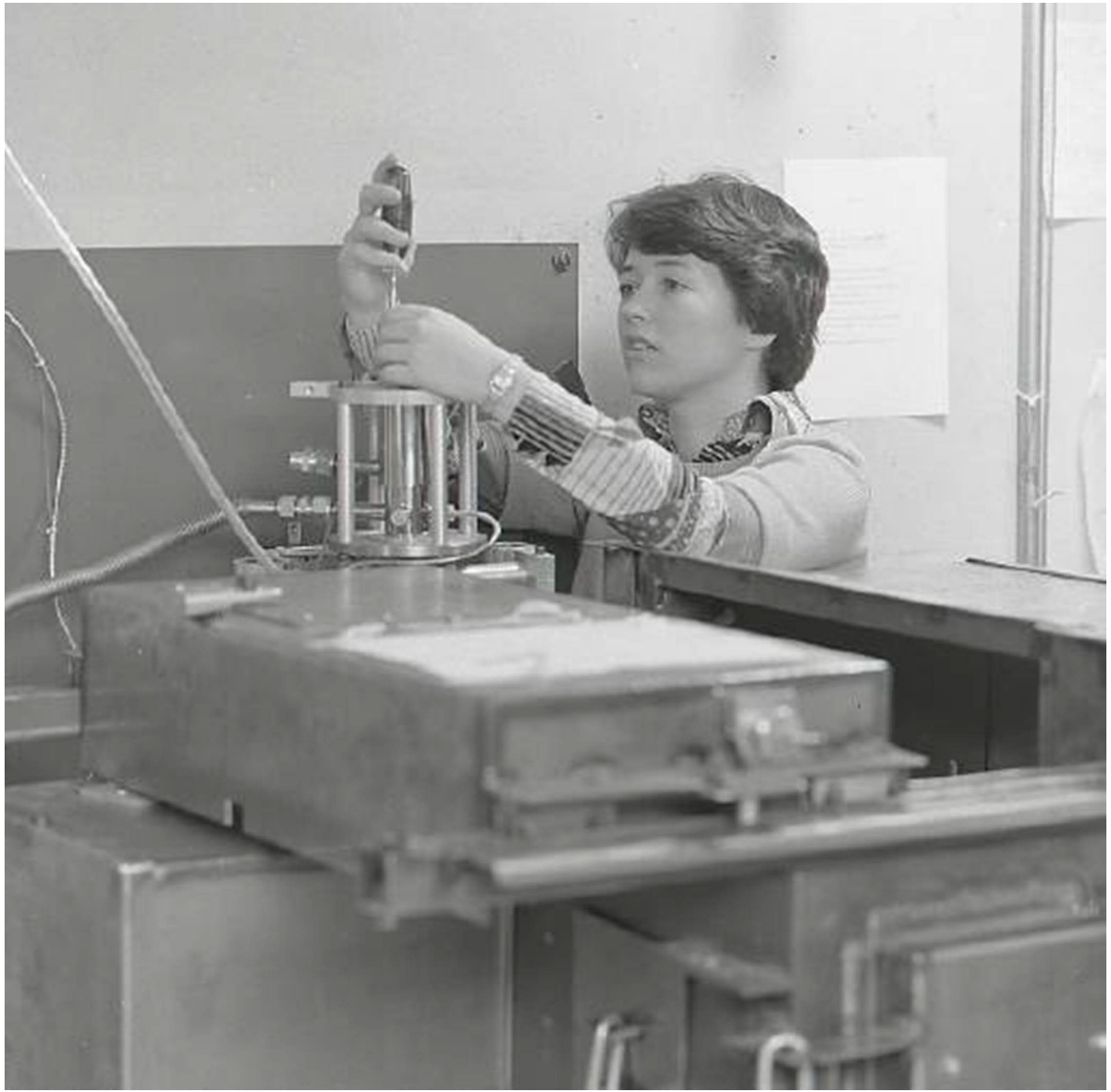
April 1974

W. ZAWOJSKI

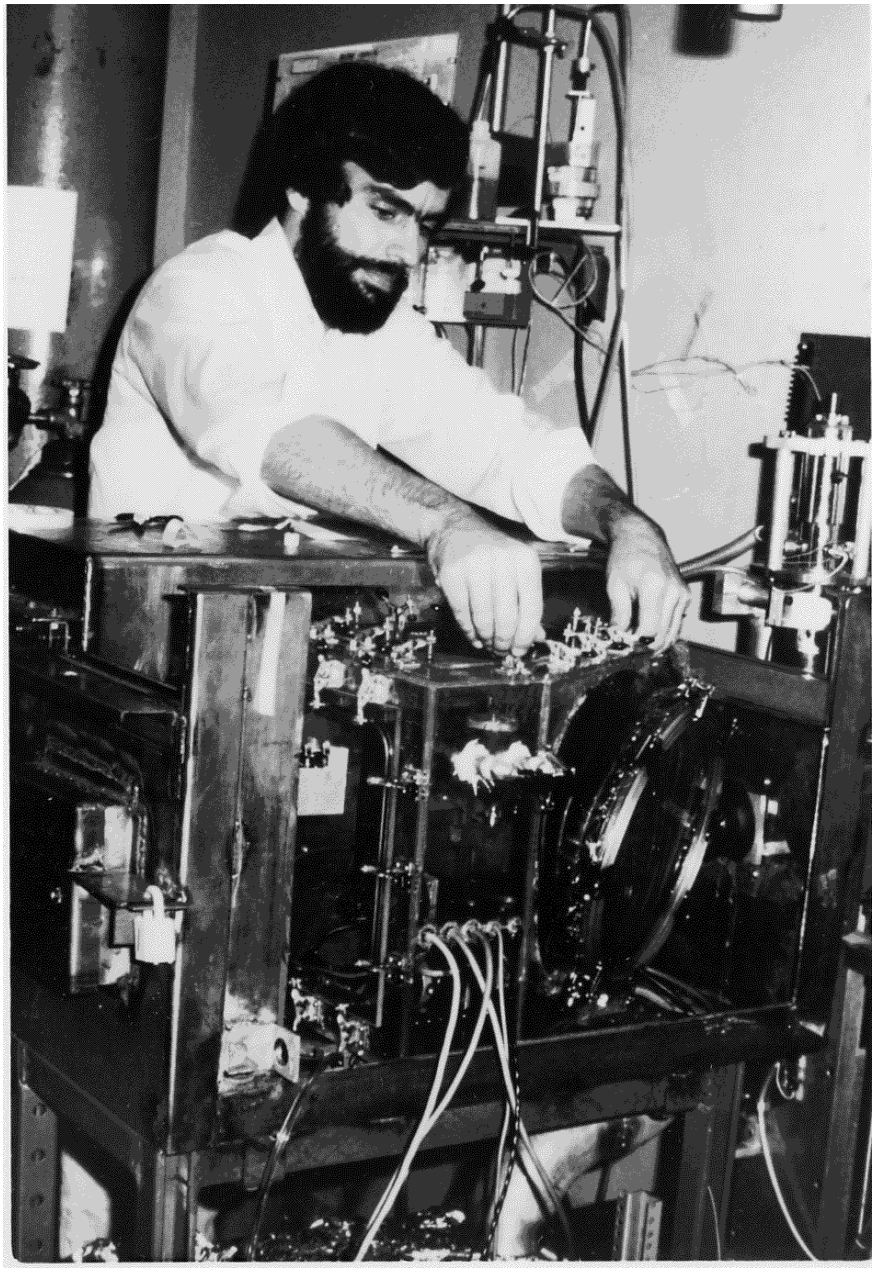
Beam Line 1 Contributors

- Hard X-ray Lines
  - Peter Eisenberger and George Brown (Bell Labs.)
  - Dale Sayers and Ed Stern (University of Washington)
  - Boeing (Farrel Lytle)
  - Nick Webb (Cal. Tech.)
  - Sally Hunter and Brian Kincaid Stanford University (Graduate students)
- VUV lines
  - Vic Rehn and and Jim Stanford (China Lake Naval Weapons Laboratory)
  - Bob Bachrach and Fred Brown (Xerox PARC)
  - Post-doc Ingolf Lindau and Graduate student Piero Pianetta (Stanford University)

Sally Hunter – First EXAFS Station



George Brown on first EXAFS station



Doniach/Winick Leadership

- Bringing in Herman Winick as Associate Director
  - Accelerator technology
  - Large project management
  - Vision
- Getting outside organizations to help fund and develop experimental stations
  - Origin of PRT/CAT system – but with SSRL operating, maintaining & scheduling
- Solutions to many technical problems unique to SR
  - Dealing with extreme beam heating of optics and windows
  - Monochromators getting beam to sample as photon energy is varied
- Developing safety systems
- Open solicitation for proposals
- Proposal ratings by Proposal Review Panel
  - Members not associated with Stanford
- Establishment of Science Policy Board
- Encouragement of Users' Organization
- Graduate student education

SSRP->SSRL

1977 – NSF funds Phase 2

SSRP becomes SSRL

Additional building

3 bending magnet beam lines

6 pole electromagnetic wiggler beam line

1978 - Bienenstock becomes director

SSRL Groundbreaking - 1977

Ground Breaking for the 1977 SSRL Expansion Program
(L to R) S. Doniach, R. Gould, W. Spicer, S. Hagström, W. Oosterhuis, A. Bienenstock, A. Sessler, W. Miller, H. Winick, W.K.H. Panofsky, S. Stamp and G. Pimentel

SSRL Early Challenges

- Ensuring user success under uncertain SPEAR operating conditions
  - Ensure instrumentation is functioning properly
  - Longer experimental runs
  - Technical support
- Ensuring fairness faced with extreme overdemand

Katherine Cantwell

Insertion Device Fever

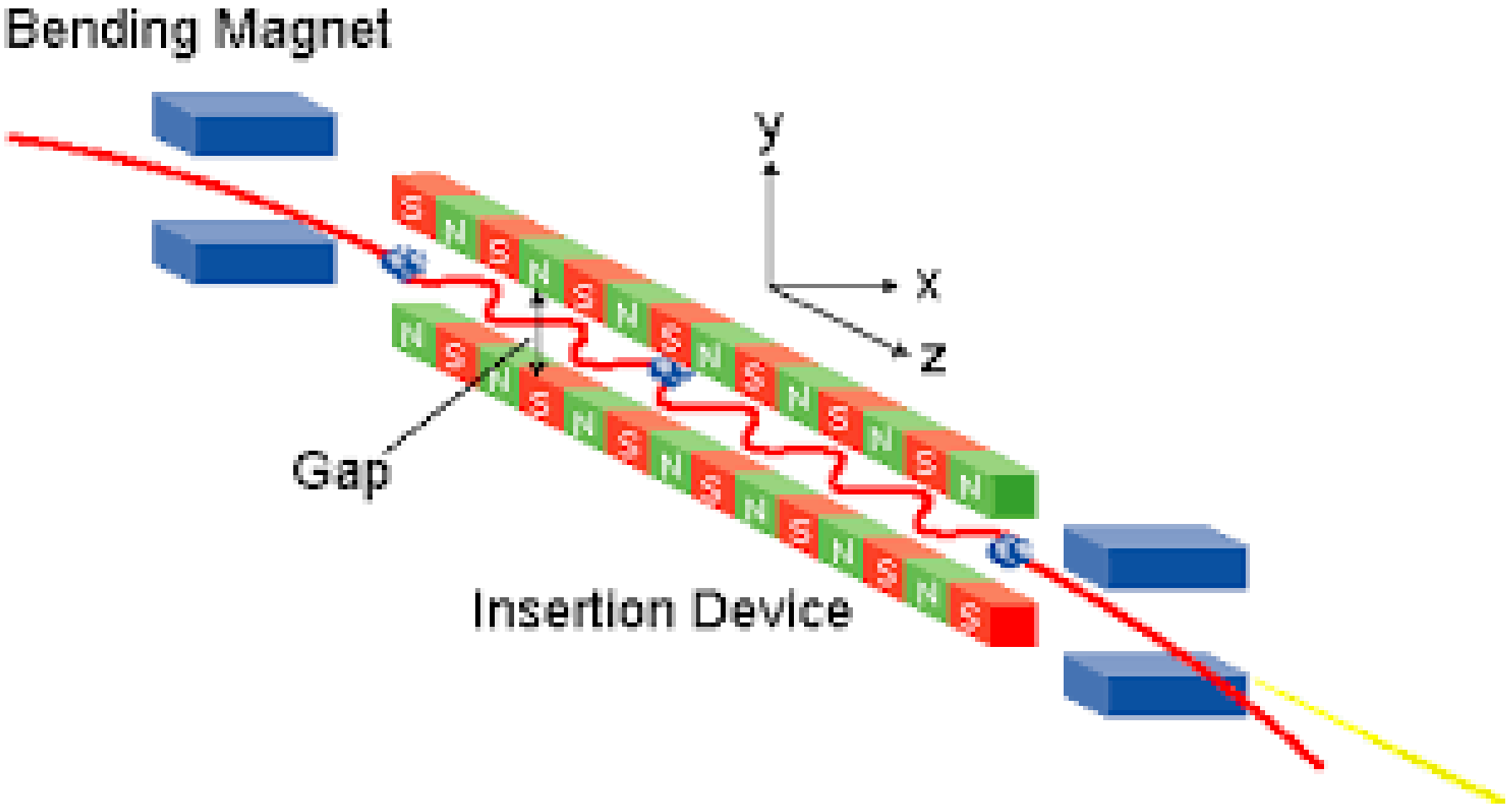
1978 – NSLS begins construction
- VUV (1982) and X-ray rings (1984)
- Bending magnet beam lines

1979 – Wiggler beam operational
- Provides hard X-rays at low SPEAR energies
- Improves HEP collision rate
- Trade 2 Phase 2 bending magnet lines for one additional wiggler line
  - 54 pole permanent magnet line – Klaus Halbach
  - LBNL-SSRL collaboration

1979 – SPEAR dedicated to SR 50% time

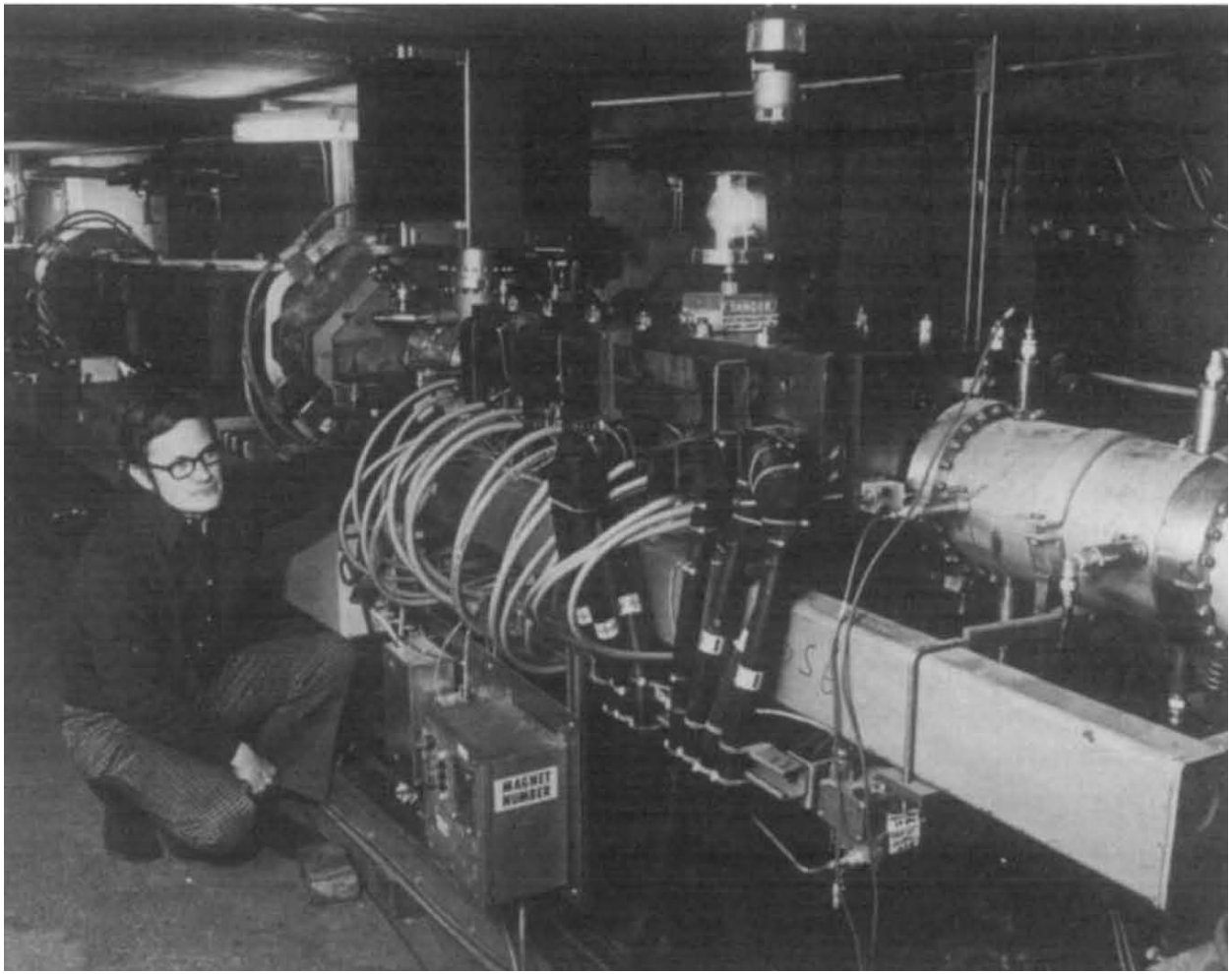
1980 – First undulator beam line – VUV
- Big brightness increase over wiggler in fundamental
- World sees effectiveness of undulators as SR source
- SPEAR energy too low for hard X-rays

Other insertion device lines constructed subsequently.


Bending Magnet
y
x
z
Gap
Insertion Device

SSRL's First Wiggler

H. Winick and J.E. Spencer / Wiggler magnets at SSRL



H. Winick and J. Spencer, Nucl. Inst. Methods **172,** 45 (1980)

SPEAR Spectrum with Wigglers

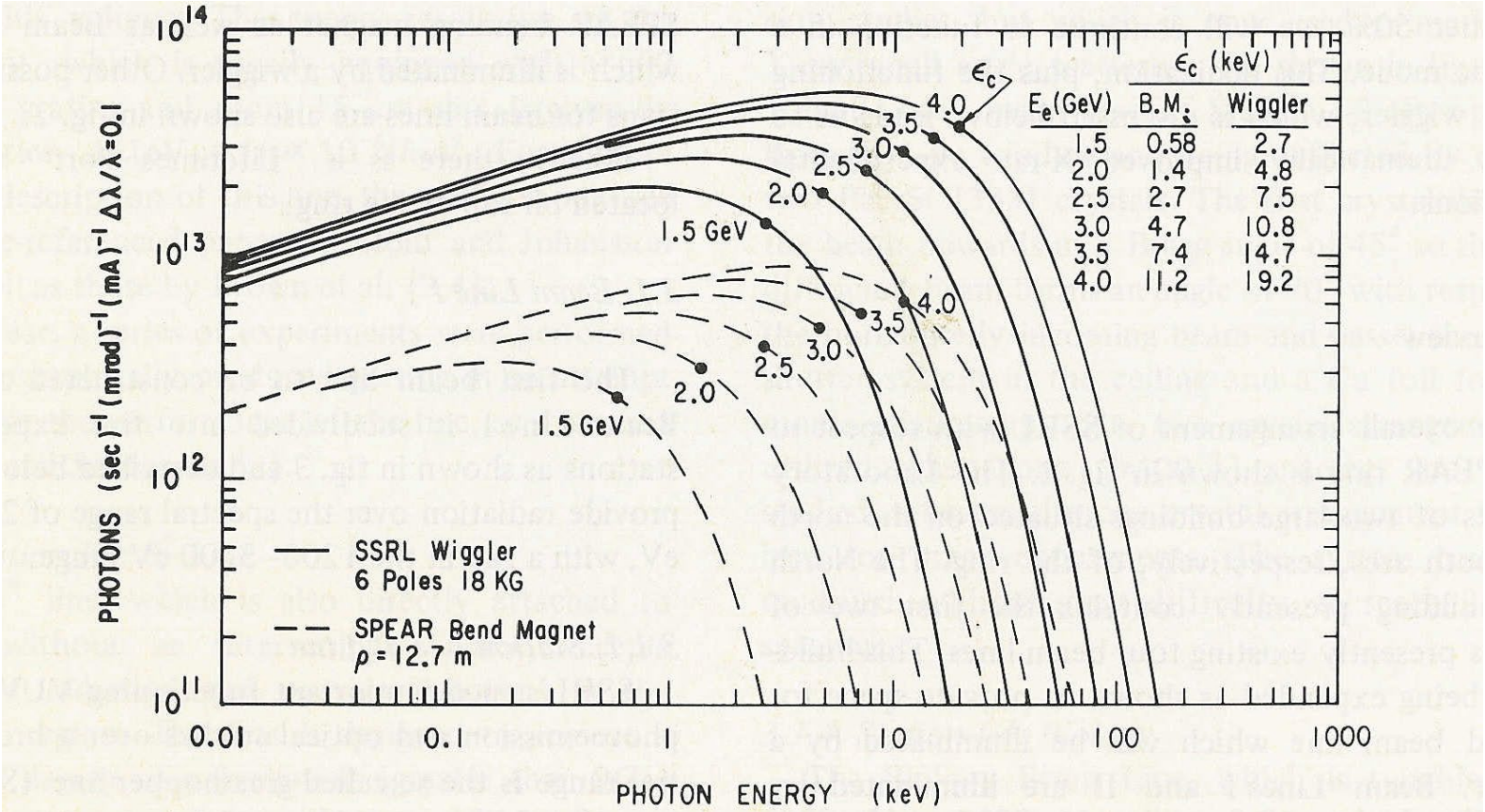
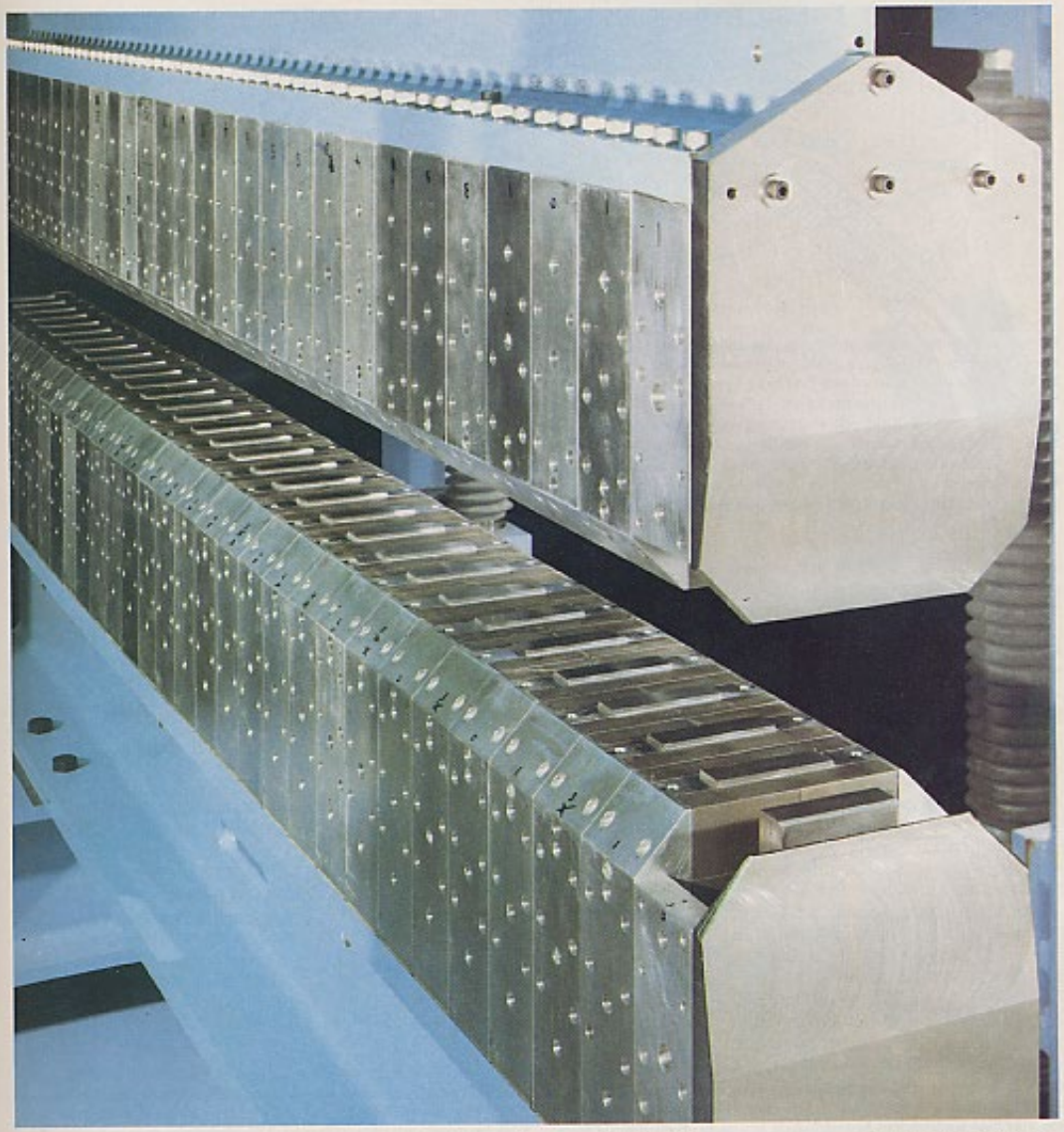


Fig. 1. SPEAR bending magnet and SSRL wiggler spectra for various stored electron energies, E_e.



WIGGLER induces electrons traveling through the evacuated tube it straddles to emit intense ultraviolet light and X rays. The device, which was designed and built at the Lawrence Berkeley Laboratory, consists of two rows of 30 permanent-magnet poles. It was developed for a group composed of many institutions, including national laboratories (led by the Lawrence Livermore National Laboratory), various branches of the University of California system and the Stanford Synchrotron Radiation Laboratory.

SSRL->DOE

1982 – SSRL shifted from NSF to DOE

1983 – Seitz-Eastman Committee

6 GeV facility – APS 1995

1-2 GeV facility – ALS 1993

NSLS and SSRL to get construction funds for insertion device lines and buildings

Spallation Neutron Source also

1983-4 Short supply of accelerator physicists.

Wiedemann starts teaching and mentoring graduate students

1984 – NSLS X-ray ring commissioned

PEP

1985 – World first X-ray undulator beam line on PEP

12 GeV =>Hard X-rays

1986 – PEP run in dedicated mode

Inelastic X-ray scattering

Structure of very thin amorphous films

1988 – Second undulator beam line on PEP

Using funds originally planned for SPEAR beam line

1990 - PEP shut down

The Booster Injector and SPEAR Dedicated

~1986 – Wiedemann proposes booster synchrotron injector to gain independence from SLAC linac

1989 – SLC becomes operational

SPEAR operation unreliable again as injection interferes with SLC

Another X-ray drought

1990 – Booster synchrotron injector operates

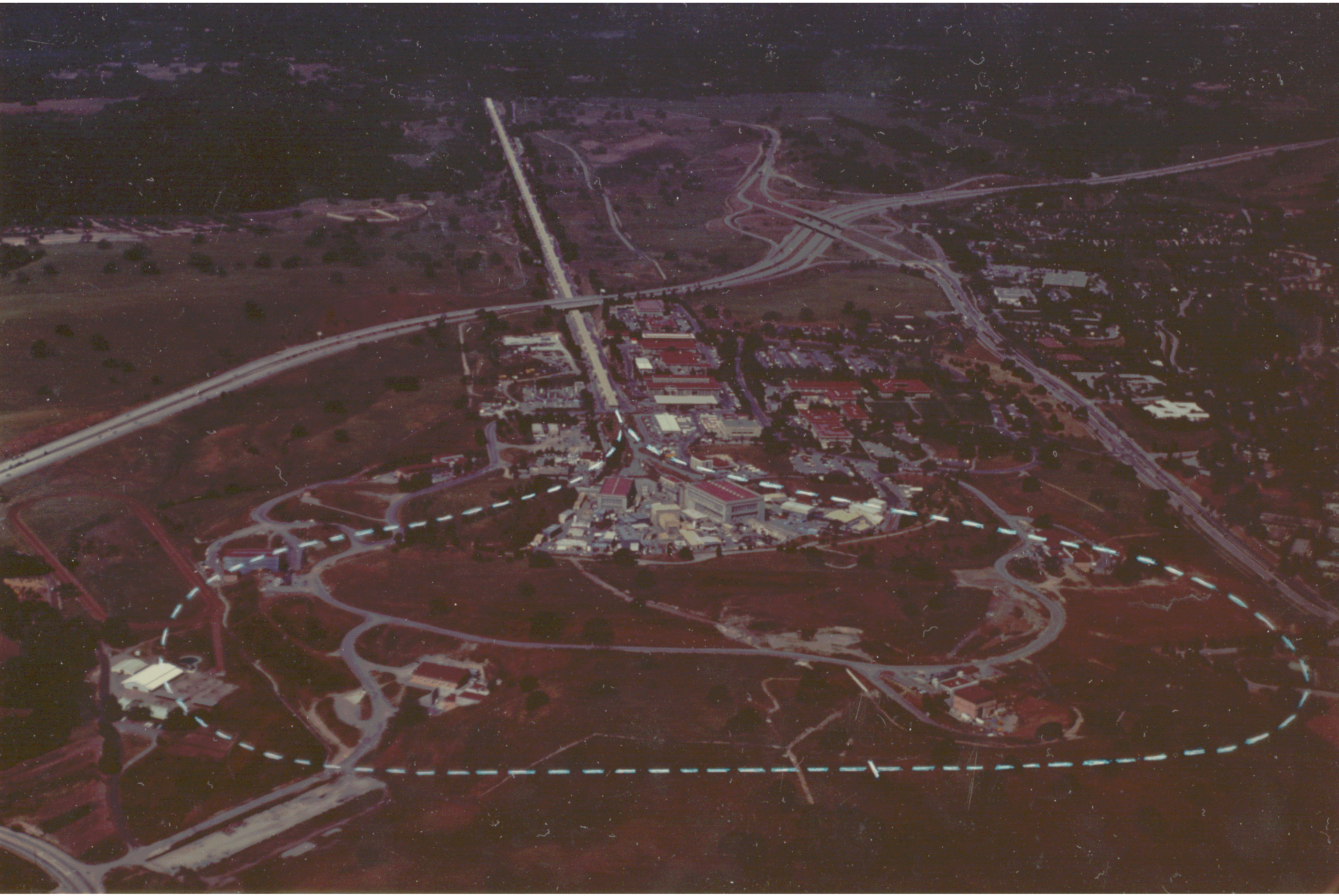
SPEAR becomes independent of SLAC linac

Helmut Wiedemann and his graduate students

1990 – SPEAR fully dedicated to SR

High reliability, long lifetimes

Funding limits it to operation half the year



Helmut Wiedemann and the SPEAR Injector

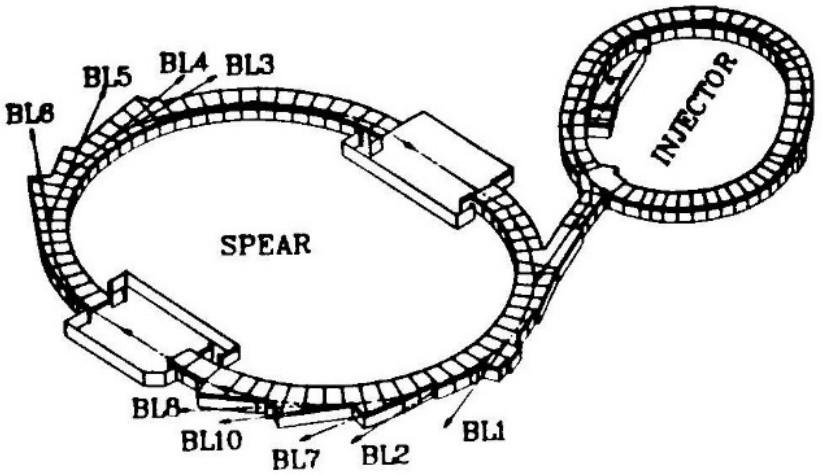


Figure 1
3 GeV SPEAR injector

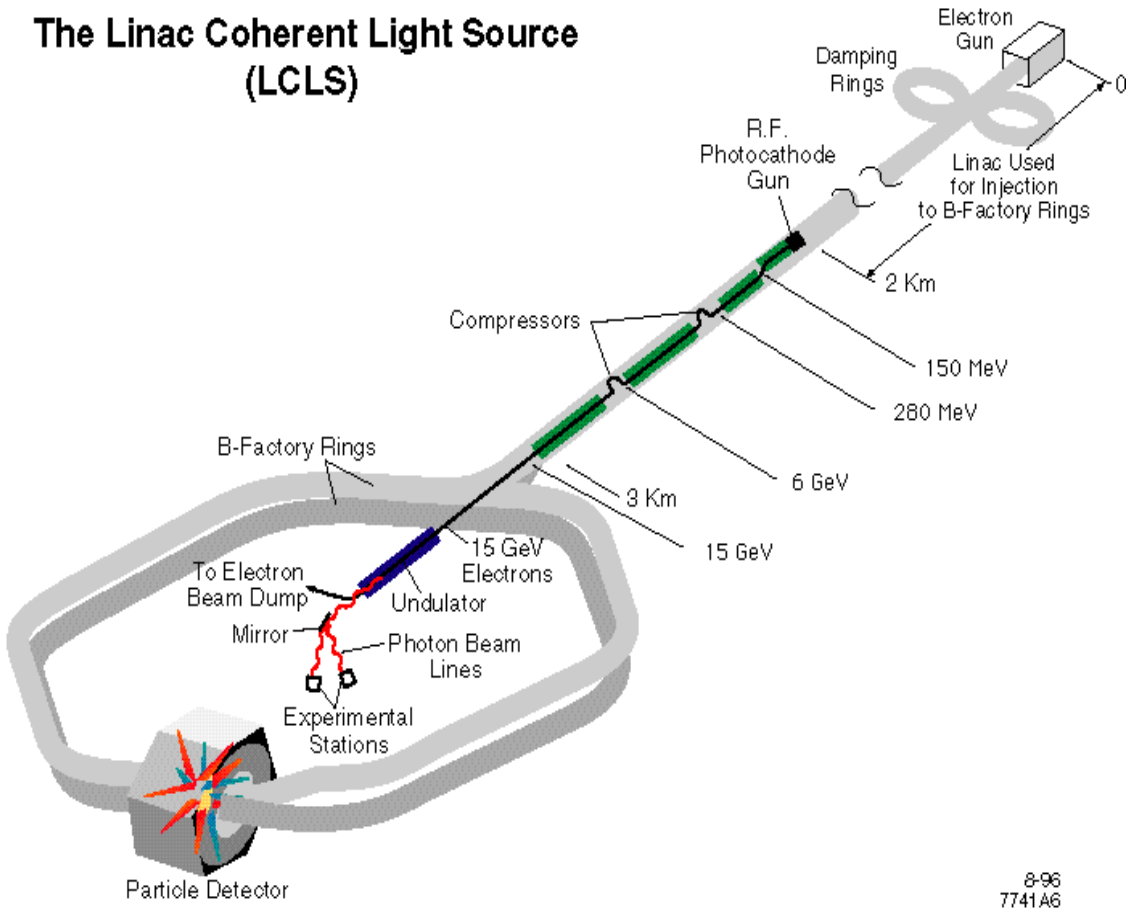
Source, H. Wiedemann et al. Particle Accelerator Conference, 1991. Accelerator Science and Technology., Conference Record of the 1991 IEEE

LCLS, SPEAR3 and Full-Time SPEAR Operation

1992 – SSRL becomes division of SLAC
SSRL director becomes SLAC associate director
1992 – Fourth Generation SR Workshop
Cornacchia and Winick organize
Pellegrini presents XFEL concept
1992 – LCLS study group formed
Cornacchia and Winick lead
1994 – ESRF becomes operational
First dedicated X-ray undulator facility
1994 – Facilities Initiative
SSRL gets funds for full-time operation
1995 – APS becomes operational
1996 – Grenoble Fourth Generation SR Workshop
Recognition of LCLS importance
1996 – SPEAR3 proposed
Wiedemann, Bill Davies-White, graduate students
1996 – SSRL decides to seek funding for LCLS and SPEAR3

Max Cornacchia

LCLS Layout - 1996



The End