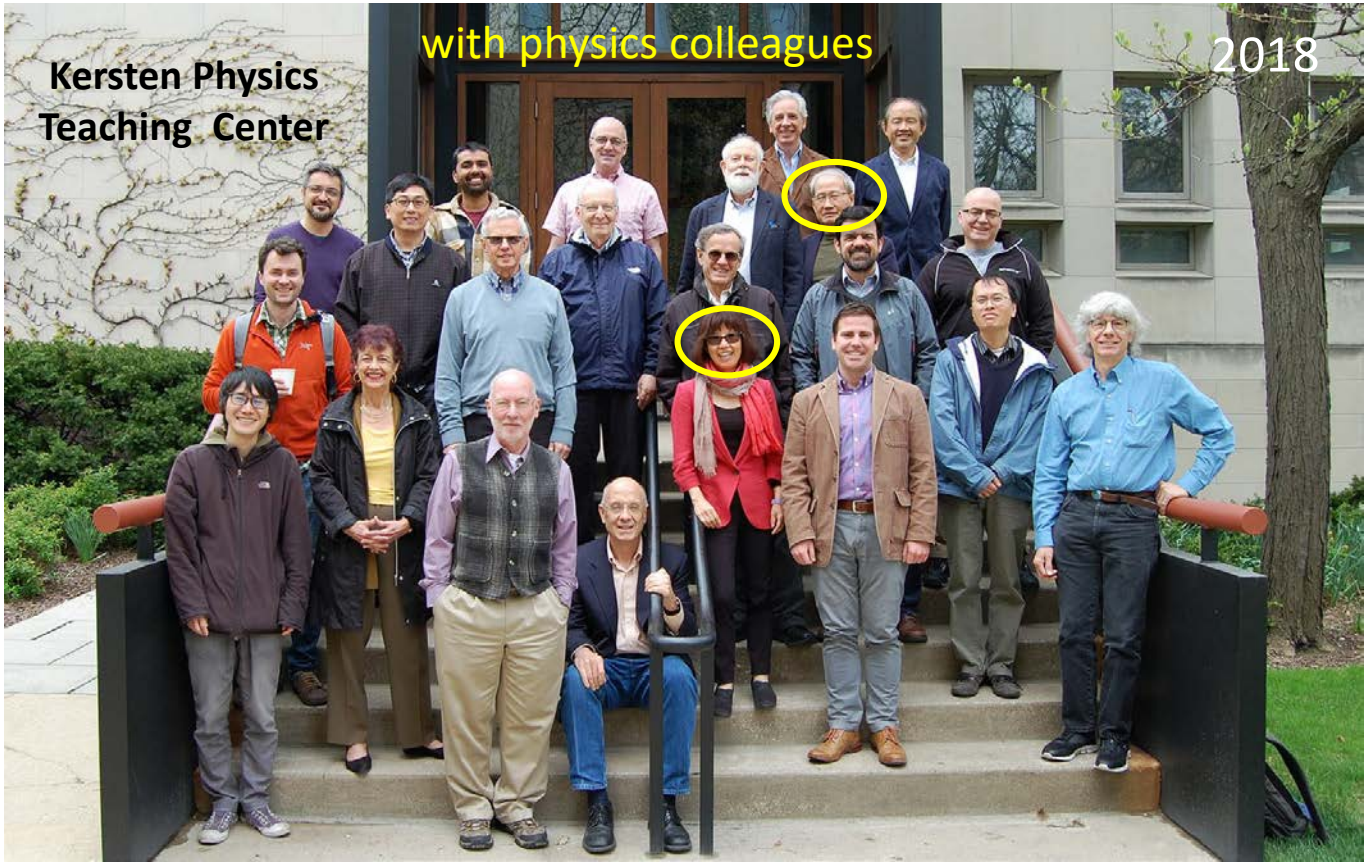
Kwang-Je Kim and U.Chicago

Department of Physics and Enrico Fermi Institute Faculty (1998 – Present)



Coherence in particle and photon beams: Past, Present, and Future Symposium

March 15, 2019, Argonne National Laboratory

Young-Kee Kim, University of Chicago

Our paths crossed

Kwang-Je's path

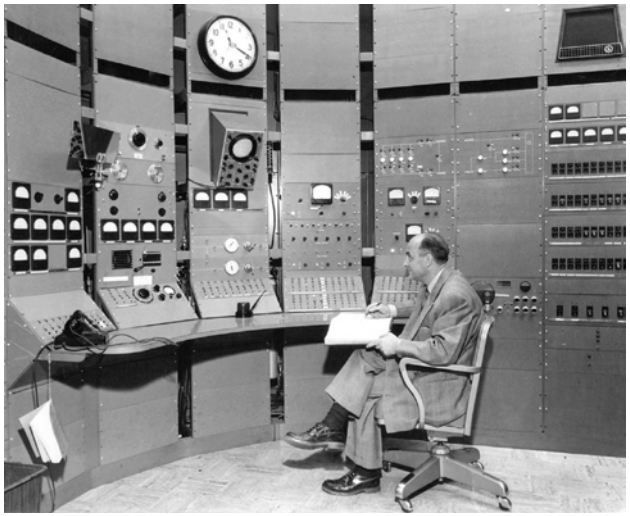
My path

Met Kwang-Je

Accelerator / Accelerator Physics at U.Chicago

(1947 - 1970) → (1970 – 1998) → (1998 – Present)

Chicago Cyclotron



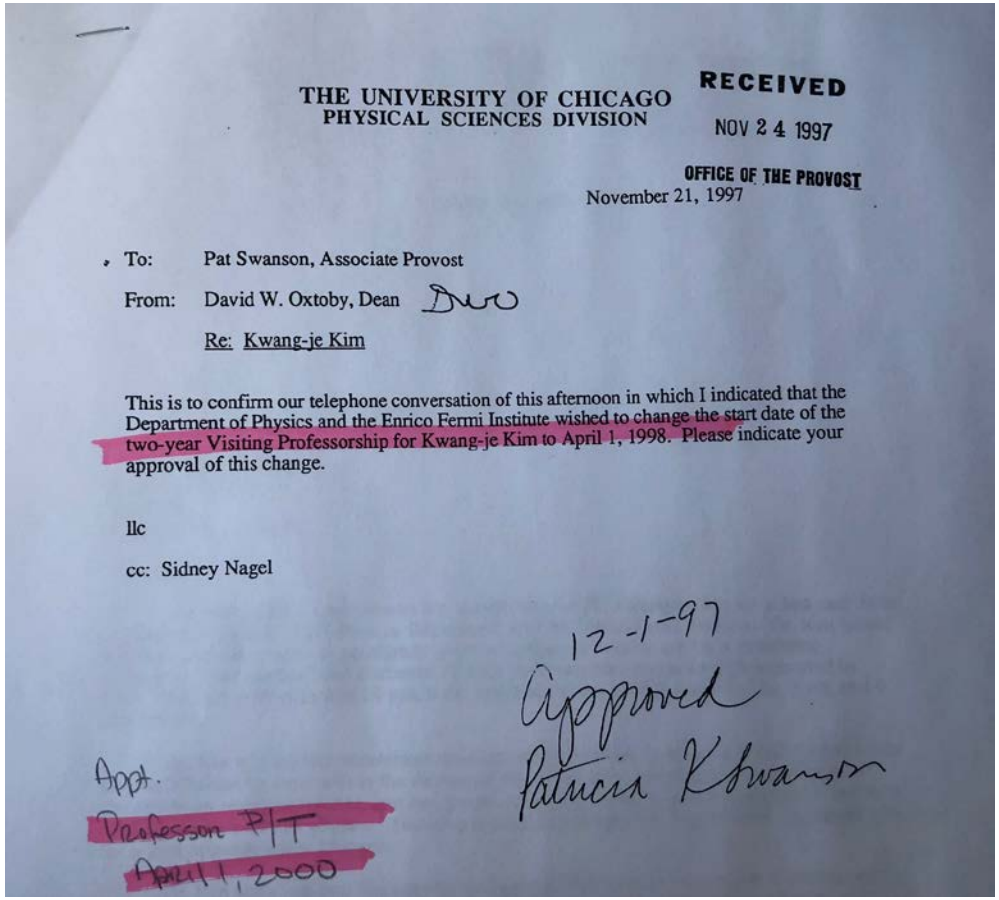
Enrico Fermi

Chicago Accelerator Physics

Kwang-Je's arrival to Chicago

Academic Appointments at U.Chicago

Visiting Professorship (April 1998 – March 2000)



THE UNIVERSITY OF CHICAGO
PHYSICAL SCIENCES DIVISION

RECEIVED
NOV 24 1997
OFFICE OF THE PROVOST

November 21, 1997

To: Pat Swanson, Associate Provost

From: David W. Oxtoby, Dean DWO

Re: Kwang-je Kim

This is to confirm our telephone conversation of this afternoon in which I indicated that the Department of Physics and the Enrico Fermi Institute wished to change the start date of the two-year Visiting Professorship for Kwang-je Kim to April 1, 1998. Please indicate your approval of this change.

llc

cc: Sidney Nagel

12-1-97
Approved
Patricia Swanson

Appt.
Professor P/T
April 1, 2000

Part-time Professor (April 2000 – Present)

Physics Faculty (~20 years ago)

Dean Eastman
Director of Argonne (1996-1998)

Kersten Physics
Teaching Center

Robert Rosner
Director of Argonne (2005-2009)

Physics Faculty (Now)

Kersten Physics Teaching Center

Starting Accelerator Classes at U.Chicago

A New Course for Fall 1999 Quarter (Physics 409)

Synchrotron Radiation and Free Electron Lasers

Instructor: Kwang-Je Kim (kwangje@aps.anl.gov)

Synchrotron radiation is the electromagnetic radiation emitted by high-energy electrons travelling in curved trajectories. Its high intensity, coherence, wide spectral coverage, and other properties (polarization, time structure,..) make synchrotron radiation a powerful tool for basic and applied studies of physical and biological systems. A number of major research institutions using synchrotron radiation have been built in the U.S. and abroad. In the future, the intensity and coherence will be further enhanced by developing free-electron lasers (FELs). This course will provide an introduction to the basic principles of these radiation devices. The course is aimed for senior undergraduate as well as graduate students.

Prerequisites: undergraduate E&M.

Course Contents:

Particle and Radiation Beam
Particle beam and radiation beam, phase space description, diffraction and wave optics, coherence and brightness

Synchrotron Radiation
Radiation phenomena and retardation effect, bending magnet radiation, electron storage ring, radiation damping and fluctuation, undulator radiation, spectral and angular distribution, polarization, laser-Thomson scattering, the third-generation light sources

Free Electron Lasers (FELs)
Interaction of radiation and particle beam, pendulum equation, Maxwell-Vlasov equation, principle of FEL oscillators, high-gain FEL and self-amplified spontaneous emission, electron beam requirements, rf photocathode gun and linear accelerator, particle beam manipulation through FEL interaction

Starting Accelerator Classes at U.Chicago

~1 quarter class per year

Synchrotron Radiation and Free Electron Lasers

Accelerator Physics

Advanced Electrodynamics

Advanced Classical Mechanics

Intermediate Mechanics

Starting Accelerator Research at U.Chicago

- Produced the first accelerator physics Ph.D. at U.Chicago
  - Yin-E Sun: Ph.D. 2005
    - "Angular Momentum Dominated Electron Beams and Flat Beam Generation"
    - Currently Scientist at Argonne National Lab

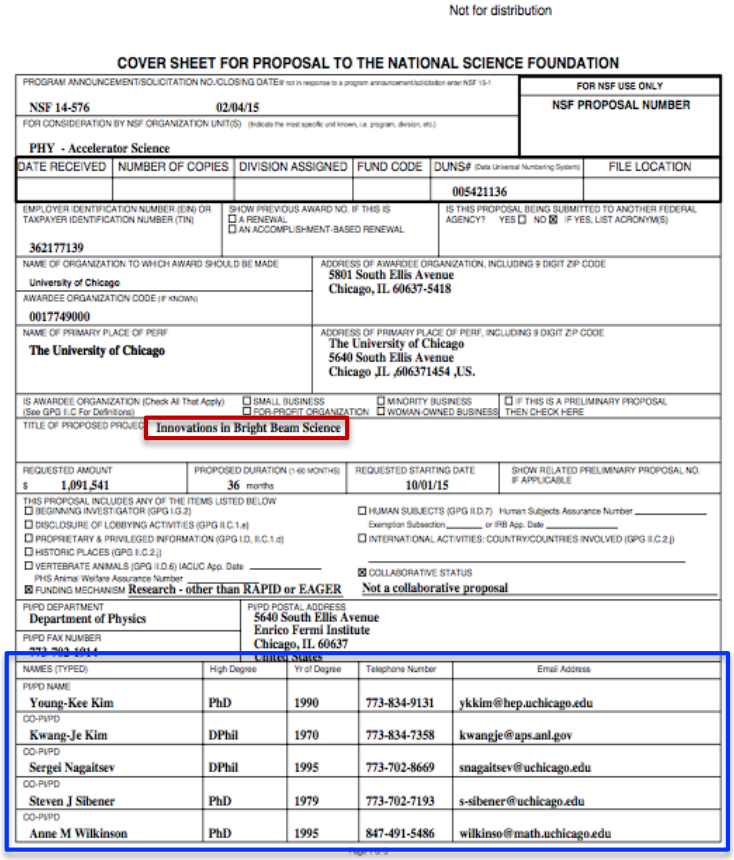
Smith-Purcell FEL set up using a used electron microscope built with the help of Albert Crewe, Bud Kapp, and Yine Sun. The device was intended to confirm the publication in PRL to have observed lasing at infrared wavelength with such a device. We had to conclude, unfortunately, that it was not the FEL lasing but the blackbody radiation that the PRL article reported—we correlated the radiation power with the Stefan-Boltzmann law!

Expanding Accelerator Research at U.Chicago

- Young-Kee Kim started producing accelerator Ph.D.s
  - 1st Ph.D. 2013: Satomi Shiraishi
    - "Investigation of Staged Laser-Plasma Acceleration"
    - Currently Faculty at Mayo Clinic

- Sergei Nagaitsev from Fermilab joined as Part-time Professor and started producing accelerator Ph.D.s
  - 1st Ph.D. 2017: Sergey Antipov
    - Co-advisors: Young-Kee Kim & Sergey Nagaitsev
    - "Fast Transverse Beam Instability Caused by Electron Cloud Trapped in Combined Function Magnets" (APS thesis award)
    - Currently CERN Fellow

NSF Grant (since 2015)



Not for distribution

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE (if not in response to a program announcement/solicitation enter NSF 15-1)

NSF 14-576 02/04/15

FOR NSF USE ONLY — NSF PROPOSAL NUMBER

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

PHY - Accelerator Science

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				005421136	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN): 362177139

SHOW PREVIOUS AWARD NO. IF THIS IS: ☐ A RENEWAL ☐ AN ACCOMPLISH-MENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE: University of Chicago

AWARDEE ORGANIZATION CODE (IF KNOWN): 0017749000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE: 5801 South Ellis Avenue, Chicago, IL 60637-5418

NAME OF PRIMARY PLACE OF PERF: The University of Chicago

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE: The University of Chicago, 5640 South Ellis Avenue, Chicago ,IL ,606371454 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT: Innovations in Bright Beam Science

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 1,091,541	36 months	10/01/15	

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
PHS Animal Welfare Assurance Number
☒ FUNDING MECHANISM: Research - other than RAPID or EAGER
☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
☒ COLLABORATIVE STATUS: Not a collaborative proposal

PI/PD DEPARTMENT: Department of Physics

PI/PD FAX NUMBER: 773-702-4914

PI/PD POSTAL ADDRESS: 5640 South Ellis Avenue, Enrico Fermi Institute, Chicago, IL 60637, United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address
PI/PD NAME: Young-Kee Kim	PhD	1990	773-834-9131	ykkim@hep.uchicago.edu
CO-PI/PD: Kwang-Je Kim	DPhil	1970	773-834-7358	kwangje@aps.anl.gov
CO-PI/PD: Sergei Nagaitsev	DPhil	1995	773-702-8669	snagaitsev@uchicago.edu
CO-PI/PD: Steven J Sibener	PhD	1979	773-702-7193	s-sibener@uchicago.edu
CO-PI/PD: Anne M Wilkinson	PhD	1995	847-491-5486	wilkinso@math.uchicago.edu

Title: Innovations in Bright Beam Science

PI: Young-Kee Kim (Physics: U.Chicago)
co-PI: Kang-Je Kim (Physics: Argonne/U.Chicaago)
co-PI: Sergei Nagaitsev (Physics: Fermilab/U.Chicago)
co-PI: Steve Sibener (Chemistry: U.Chicago)
co-PI: Amie Wilkinson (Mathematics: U.Chicago)

INNOVATIONS IN BRIGHT BEAM SCIENCE

THE UNIVERSITY OF CHICAGO

NSF

Faculty

Kwang-Je Kim Argonne lab / U.Chicago (Physics)	Young-Kee Kim U.Chicago (Physics)	Sergei Nagaitsev Fermilab / U.Chicago (Physics)	Steven J. Sibener U.Chicago (Chemistry)	Amie Wilkinson U.Chicago (Mathematics)
				

INNOVATIONS IN BRIGHT BEAM SCIENCE

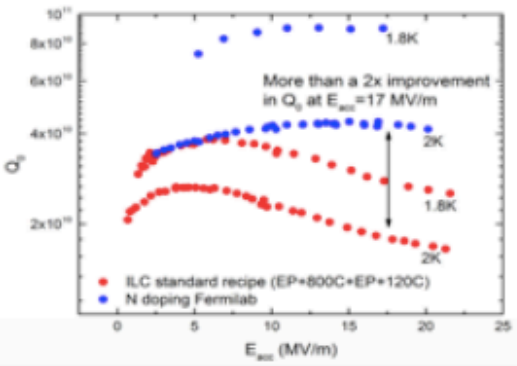
THE UNIVERSITY OF CHICAGO

NSF

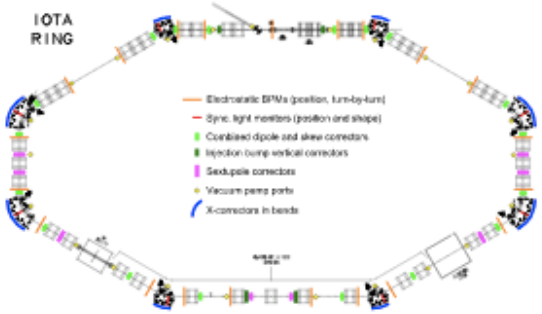
The group of accelerator science and beam physics at the University of Chicago exploits novel concepts in accelerator science and technology, studies limitations affecting the acceleration, control, intensity and quality of particle beams at a fundamental level, and develops new approaches to overcome these limitations.

Specifically the group is:

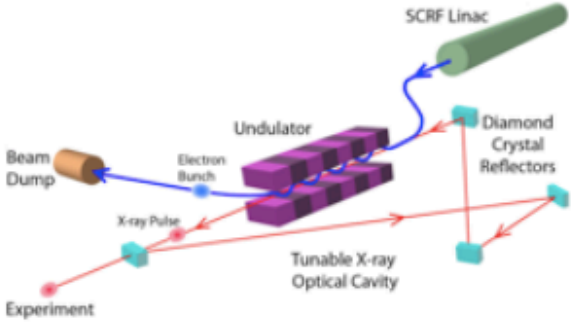
understanding science that underlies recent dramatic improvements in the quality factor of superconducting radio-frequency cavities via nitrogen doping for efficient operations of bright beams, thus reducing capital and operational costs.



performing a proof-of-principle experiment for integrable accelerator lattice with highly non-linear optics whose innovative concept could suppress instabilities of bright beams and mitigate the effects of space charge and beam loss



developing new mechanisms to produce bright X-rays, an indispensable tool for studying the atomic and molecular arrangement of materials

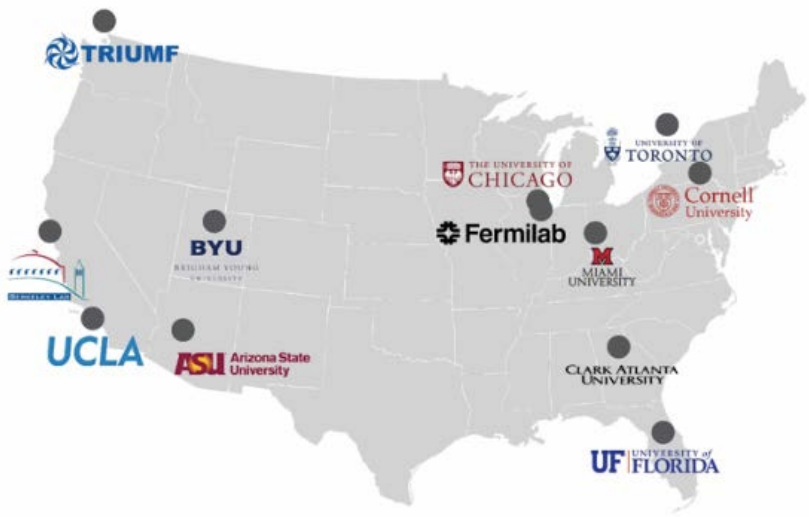


Center for BRIGHT BEAMS
A National Science Foundation Science & Technology Center

NSF Science and Technology Center (since 2016)

Center Vision:

- Revolutionize the brilliance of beams available to science, medicine and industry.



Center Mission:

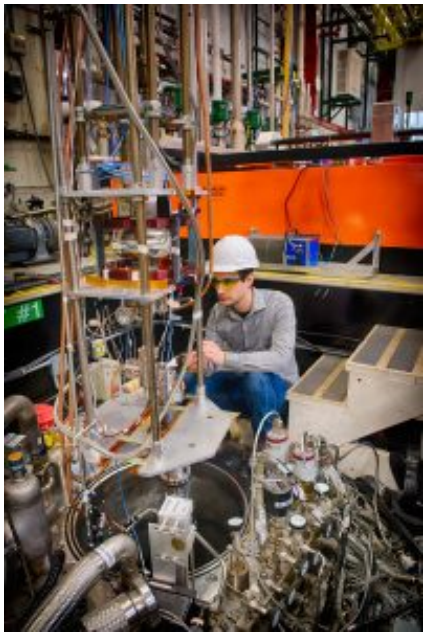
- Transform the reach of electron beams by
  - increasing brightness x100 and
  - reducing the cost and size of key technologies
- Transfer the best of these technologies to national labs and industry.
- Prepare a diverse generation of students for a broad set of career paths.

Expanding Accelerator Research

- Monthly Accelerator Seminars since 2015
- Adding Enrico Fermi Institute Collaborators in 2017

Ryan Lindberg, Argonne

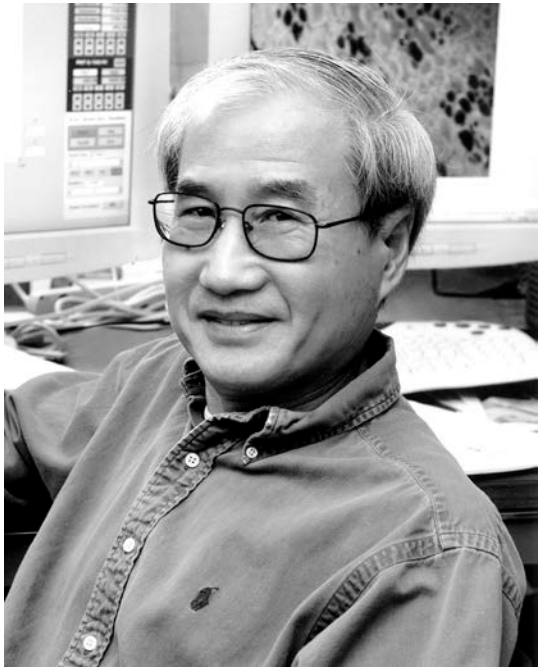
Sam Posen, Fermilab



Sam Posen sets up a superconducting accelerating cavity in a vertical test stand.

Accelerator Program at U.Chicago

1998



1 senior scientist

2018

11 students, 3 postdocs, 6 senior scientists

Thank you, Kwang-Je