Fermilab | U.S. DEPARTMENT OF ENERGY | Office of Science

Illinois Accelerator Research Center (IARC)

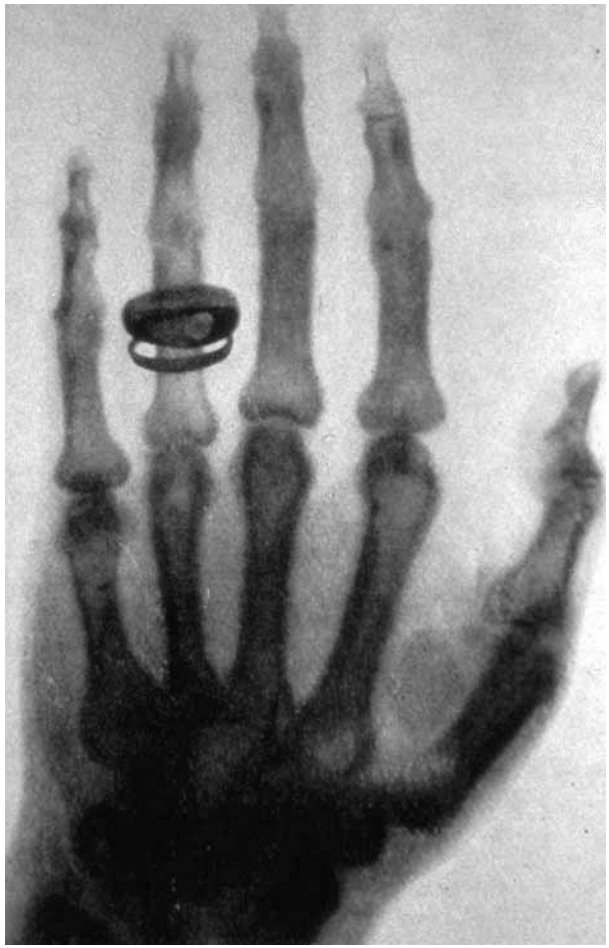
DeepTech for emerging challenges

Jayakar Thangaraj

For Community Advisory Board Meeting Jan 23, 2020

Exactly 124 years before: on this day

January 23, 1896 - Dr. Roentgen's First Public Lecture and Demonstration



X-ray of Kölliker's hand, made by Röntgen on 23 Jan 1896

A Physicist *stumbles* into innovation

https://www.emory.edu/X-RAYS/century_06.htm
https://www.wikiwand.com/en/Albert_von_K%C3%B6lliker

Chicago Tribune
BUSINESS

Jan 21, 2020

'Pretty substantial' change for X-rays

Some hospitals say lead aprons do more harm than good

Physics meets business

BY MARY CHRIS JAKLEVIC
Kaiser Health News

Patients have come to expect a technician to drape their torsos with a heavy lead apron when they get an X-ray, but new thinking among radiologists and medical physicists is upending the decades-old practice of shielding patients from radiation.

Some hospitals are ditching the ritual of covering reproductive organs and fetuses during imaging exams after prominent medical and scientific groups have said it's a feel-good measure that can impair the quality of diagnostic tests and sometimes inadvertently increase a patient's radiation exposure.

ANTONIO PEREZ/CHICAGO TRIBUNE 2005

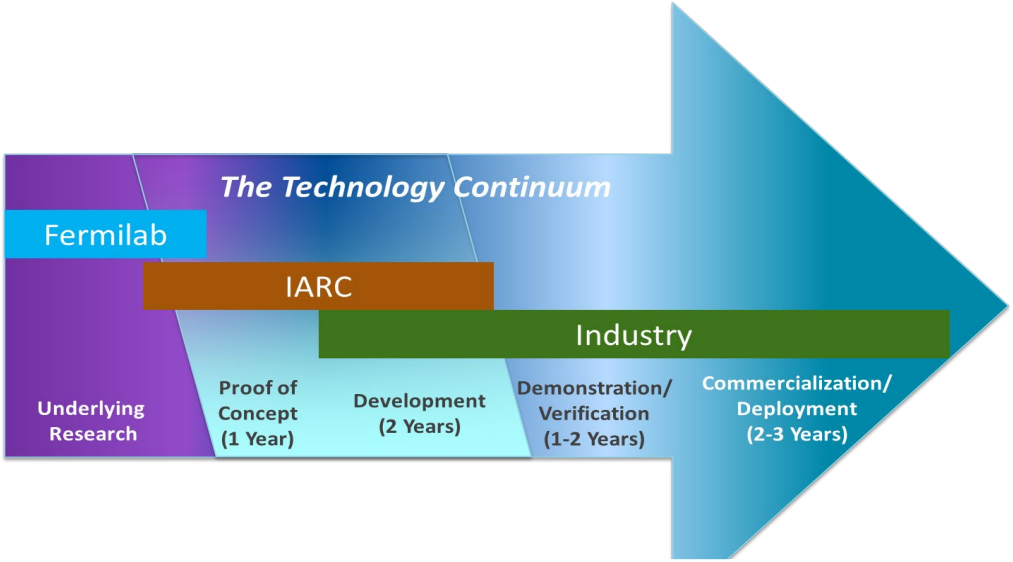
Dr. Gerald Ciebien, a dentist, prepares to take an X-ray of patient Andrew Lyons' teeth in 2005.

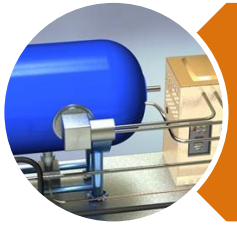
Illinois Accelerator Research Center (IARC)

Mission

To partner with industry to exploit technology developed in the pursuit of science to create the next generation of industrial accelerators, products, and new applications.

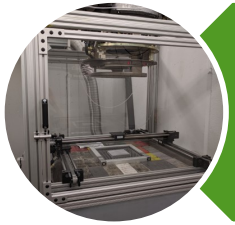
IARC: Bridging the Gap from R&D to industrial applications





The Technology Roadmap: Compact SRF Accelerator

- Technology Push Strategy
- Five key enabling technologies
- Scale from science to industry

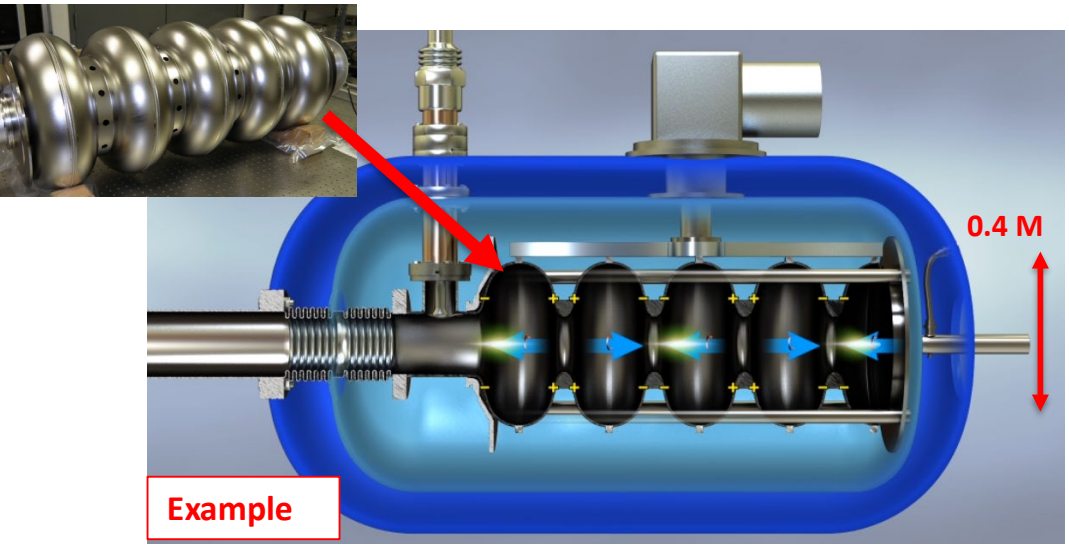


Accelerator Applications Development & Demonstration (A2D2)

- Market Pull Strategy
- Feasibility studies for partners
- Demonstrate ROI

Initiatives & Opportunities for the compact SRF

A compact, high-power industrial SRF accelerator

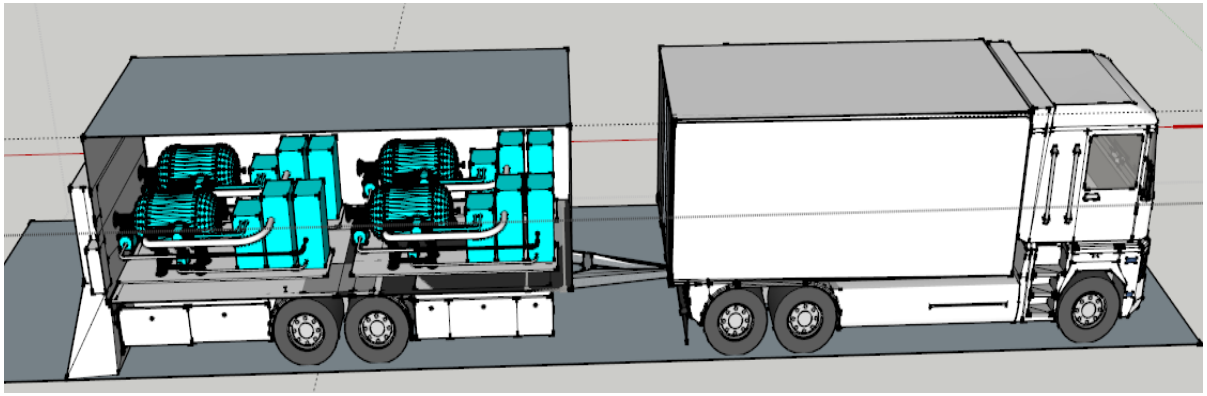


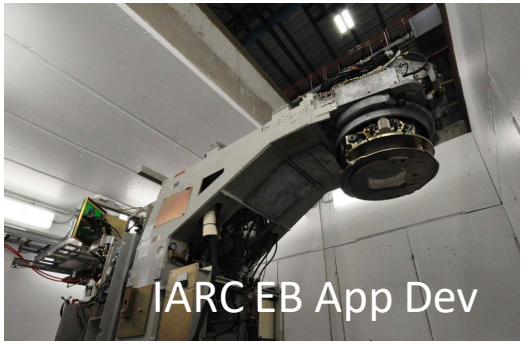
- Energy: ~ 10 MeV
- Power: 250 KW
- Compact
- Simple, reliable
- Affordable

- 650 MHz elliptical cavity (well understood from PIP-II)
- Magnetron RF source & commercial cryo-cooler
- Modular design scales to MW class industrial applications
- Accelerator system <3000 lbs ➔ mobile applications

In-Situ Cross-Link of Materials

- Electron accelerators are widely used to cross link materials
- High power mobile accelerators enable entirely new construction techniques that can alter materials properties after placement
  - e.g. Improve the strength, toughness, and/or temperature range
- One applications: Improved Pavement
  - US Army Corps of Engineers partnership (FY17 ERDC funding)





- Collaborating to create a tough, strong binder with improved temperature performance vs bitumen to extend pavement lifetime

Driving change: Transitioning from Cobalt-60 to e-beam or X-ray for Sterilization

Midwest Medical Device Sterilization Workshop

Gain practical information and insights on the latest advances in irradiation for medical devices sterilization and how to apply these technologies

Share experiences and gain greater understanding of the barriers to adoption of alternative technologies

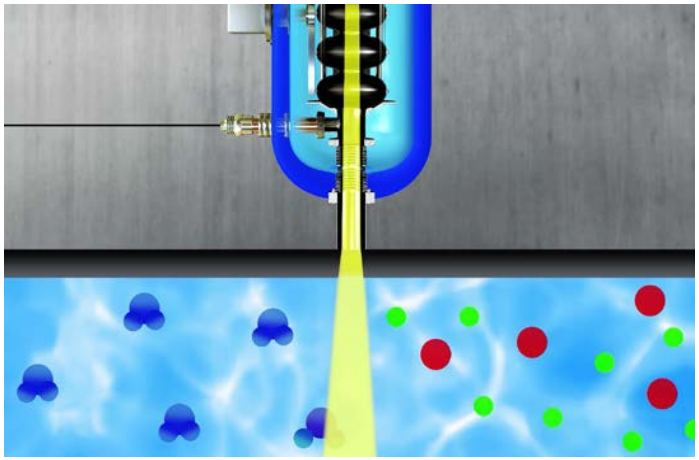
Shape a dialog to pave the way to safer, more secure, more economic device sterilization options

- Peter Baker (Quantum EBX)
- Tim Carlson (BD Medical)
- Debbie Cotton (Baxter)
- Emily Craven (Mevex)
- Arved Deecke (Benebion)
- Lance Garrison (NNSA)
- Ken Kohler (Steris)
- Thomas Kroc (Fermilab)
- Byron Lambert (Abbott)
- Christophe Malice (IBA)
- Josef Mittendorfer (High Tech Consulting)
- Mark Murphy (Pacific Northwest National Laboratory)
- Larry Nichols (Steri-Tek)
- John Schlecht (Sterigenics)

Water Treatment via Electron Beam Accelerator

Description:

- E-beam accelerators induce water radiolysis creating species that can break down multiple contaminants at once, with no secondary waste
- E-beam treatment can degrade persistent pollutants that are challenging to remove via conventional treatment technologies, such as perfluorinated compounds (PFAS).



Current Collaborations: *Municipal, Industrial, Military, Academic, Federal*

- Chicago Metropolitan Water Reclamation District – kill pathogens, increase phosphorus recovery, increase dewaterability, boost methane gas production
- Industrial Partners – multiple partners interested in remediating wastes from petroleum (PCBs), chemical and mixed waste sectors
- Military Partners – discussions with Navy, Air Force (TCE) and Army
  - Proof of Principal CRADA with Army Engineering Research and Development Center, Vicksburg

Accelerator Applications Development and Demonstration Facility (A2D2)

Beam Energy
- 9 MeV Electron Beam

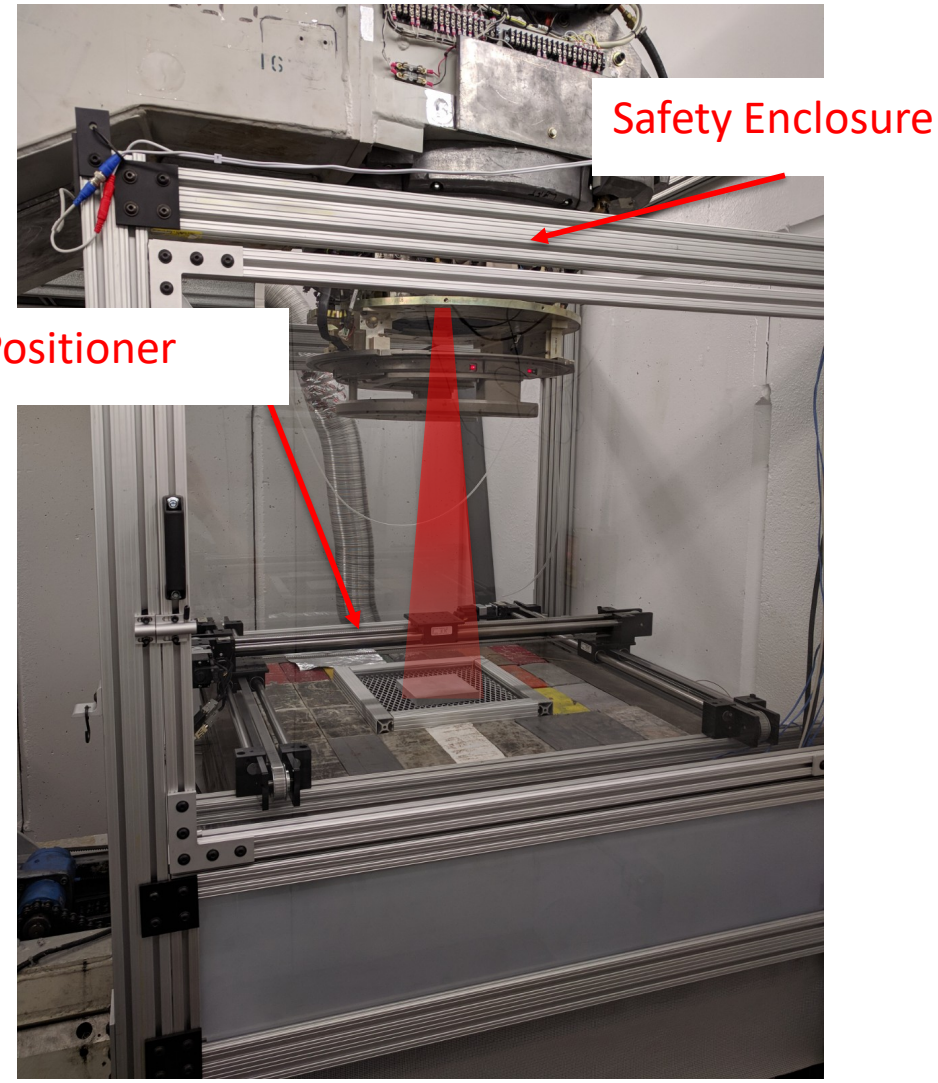
Beam Power
- 0.2/1.2 kW in 6 increments

Dose Rate
- 0.2 to1.2 kGy/sec

Dose
- Typically 1 – 100 kGy, but can go much higher

Sample Size

- Beam width, 21.6 cm FWHM
- typical: 3.5 in diam. by 1 in tall
- Can accommodate much larger samples (4ft by 4ft by 4ft)
  - Note: this is NOT the irradiation volume



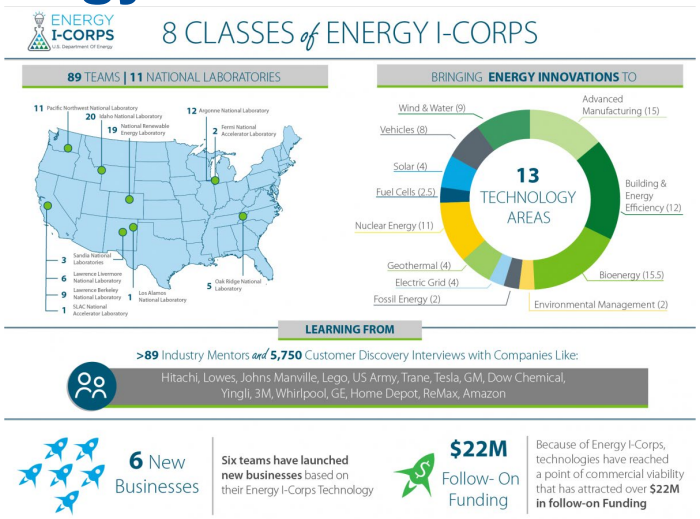
IARC – active in its commitment to DOE for fostering technology transfer and entrepreneurship

- Being a change agent in the lab by assisting and helping our employees better articulate the value of their research to a broader group of stakeholders, from elected officials, to funding agencies, to our local communities.

- Highlight our work at the Defense Innovation Summit and the TechConnect National Innovation Summit

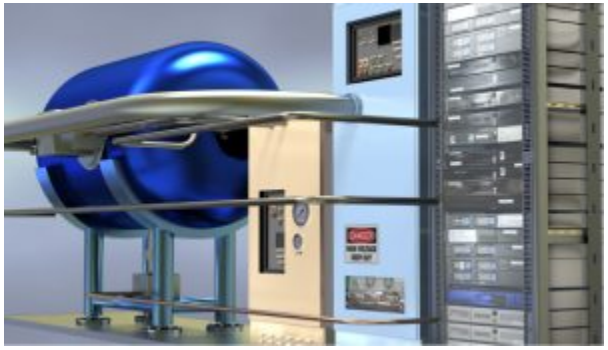
- Engaging staff in preparation for the DOE XLAB summit on AI.

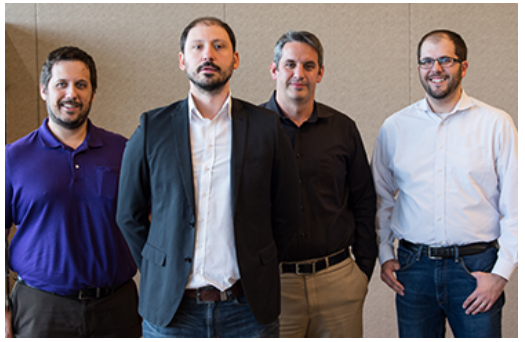
The Road to Successful technology transfer….



Funded by AMO (2016)

Funded by EM (2018)





One technology – Two markets

News at work

Calendar

Search all laboratory news

From lab leadership

Seventeen innovators graduate from first Fermilab Entrepreneurship and Commercialization Practicum

July 24, 2019 | Laura Rogas

Instructors:

Daniel Bowring, Fermilab
Brendan Kiburg, Fermilab, PPD
Steve Lehman, Polsky Center at University of Chicago
Jason Pariso, Polsky Center at University of Chicago
Aaron Sauers, Fermilab, OPTT
Cherri Schmidt, Fermilab, OPTT & IARC
Ray Stochowiak, Founder and CEO, Shared Imaging LLC
Charles Thangaraj, Fermilab, IARC
Charlie Cooper, Fermilab, IARC

IARC activities: Summary

Activity	Example
Technology Development	Conduction cooling , Nb3Sn, Injection-locked magnetron
Industrial engagement by hosting workshops	• EB Water workshop, • ASTFP workshop (leading to GA) • Baxter workshop on medical device sterilization
Technical assistance and application development	• Loma Linda • A2D2
Partnership activities: Non-DOE agencies, Universities, Industries	ERDC, NIU, TAMU*, Euclid, RadiaBeam, MWRD, NNSA*, General Atomics*
Change agent at the lab to foster technology transfer activities and entrepreneurial culture	Two teams on Energy I-Corps (AMO, EM) First cohort of students

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Resources

Partnering With Fermilab

Becoming a Partner

Letters of Support

Partnering Agreements

Reporting Success

Technology Portfolios

Accelerator Technologies

- **Compact SRF Accelerator**
- Pavement
- Magnetron
- 3D Additive Manufacturing with High Power Electron Gun
- Conduction Cooling
- Low Heat Leak Power Coupler
- Fast Faraday Cup

Computers & Information Science

Detector Technologies

Engineering Technologies

Environmental & Safety

Compact SRF Accelerator

Technology Summary

Accelerators developed for science now are used broadly for industrial, medical, and security applications. Over 30,000 accelerators touch over $500B/yr in products producing a major impact on our economy, health, and well-being. Industrial accelerators must be cost-effective, simple, versatile, efficient, and robust. Many industrial applications require high average beam power.

The Invention

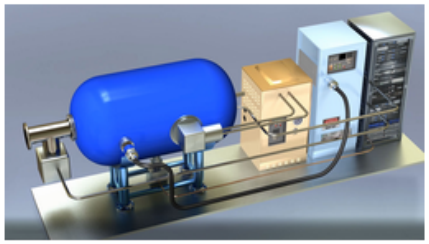
Exploiting recent advances in Superconducting Radio Frequency (SRF) cavities and RF power sources as well as innovative solutions for the SRF gun and cathode system we have developed a design for a compact SRF high-average power electron linac. Capable of >250 kW average power and continuous wave operation, this accelerator produces electron beam energies up to 10 MeV.

Benefit

Small and light enough to mount on mobile platforms, Fermilab Compact SRF accelerators enable new in-situ environmental remediation, in-situ crosslinking of materials, and security applications. More importantly, this accelerator will be the first of a new class of simple, turn-key SRF accelerators.

Applications and Industries

- Industry
- Medicine
- Security
- Science



Invention Details

Patent Status: Multiple patents pending

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Batavia, IL 60510

Let us chat……

- Compact, high energy, high power electron accelerators can enable a variety of entirely new industrial applications
- Several applications may have enormous market potential
- If you are interested in exploring more in this area, kindly speak to me or any member of our IARC team!
- IARC is exploring new technologies and new application areas

- Q&A?