Inexpensive Brazeless Medical Accelerator

Euclid Techlabs, LLC

12/17/2020

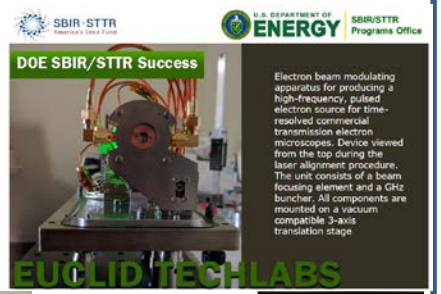
Euclid Techlabs LLC

Euclid Techlabs, LLC is a research and development company specializing in linear particle accelerators, ultrafast electron microscopy, and advanced material technologies for energy, defense, and medical applications. The company was formed in 2003. Euclid has developed expertise and products in several innovative technologies: time-resolved ultra-fast electron microscopy; ultra-compact linear accelerators; electron guns with thermionic, field emission or photo-emission cathodes; fast tuners for SRF cavities; advanced dielectric materials; HPHT and CVD diamond growth and applications; thin-film applications in accelerator technologies; and beam physics. Merging these technologies allows Euclid to create cost-effective, compact and reliable solutions, which provide potential access to a wide variety of markets.

- 2020: 16 people research staff, 3 technicians, and 3 administrative,
- 2 offices: Bolingbrook, IL (lab) and Washington DC(administrative).
- Tight collaborations with National Labs and Institutes: Fermilab, ANL, BNL, LBL, LANL, Jlab, NIST, NIU, IIT, etc.

In house Radiation Shielded Testing labs

200keV DC Beam Test Stand

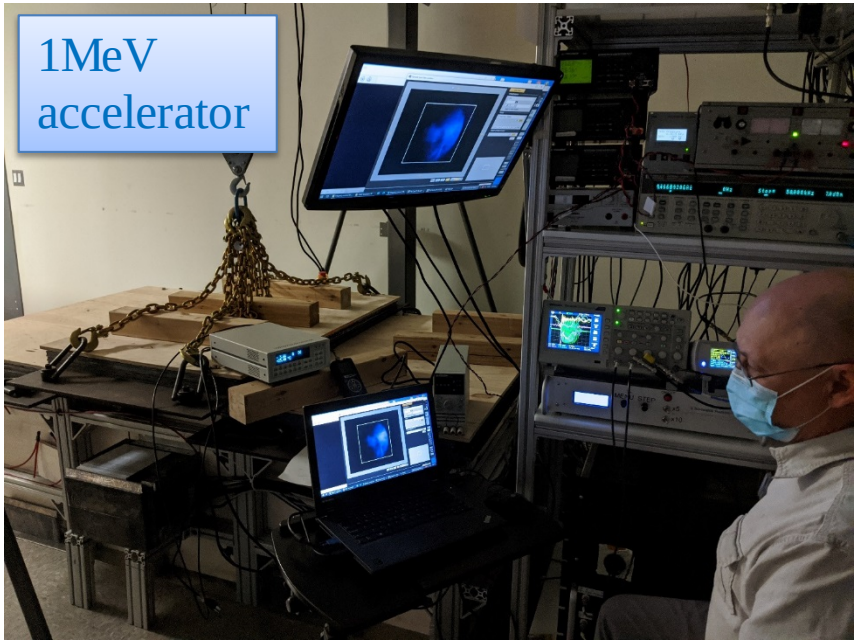


TEM pulser

Microscopy TODAY
2020 Innovation Award

MeV e-beam Test Bunker

1MeV accelerator



Introduction

- Originally based on Euclid's Patent US9913360B1
- **Ultimate goal: price reduction for accelerating waveguide - brazeless**
- Phase I SBIR grant from DOE – DNN (PM Dr. D. Hornback)
- Demonstrated proof of principle
- Phase II SBIR grant: further improved the idea
  - 1 MeV turn-key system ($100K price tag)
  - High gradient acceleration
  - High efficiency acceleration

Concept

Accelerating structure: copper parts **brazed** together

Varian Medical Systems

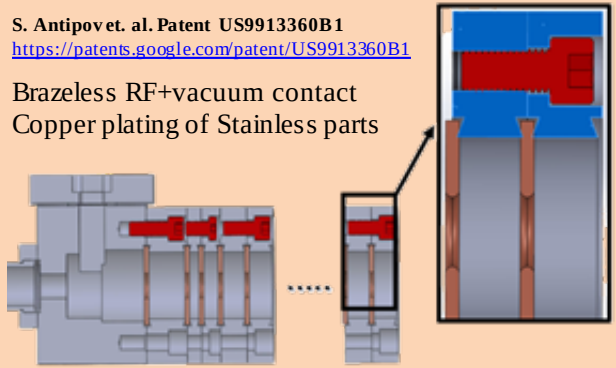
Brazing is what drives up the cost of the structure

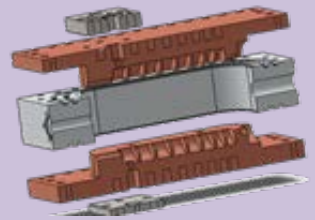
- Novel fabrication
  - Reduction of cost of accelerating waveguide
- New microwave design
  - Reduction of RF power required – cost of microwave supply
- Reduction in few MeV accelerator price tag!

Brazeless accelerating structure:

S. Antipov et. al. Patent US9913360B1
https://patents.google.com/patent/US9913360B1

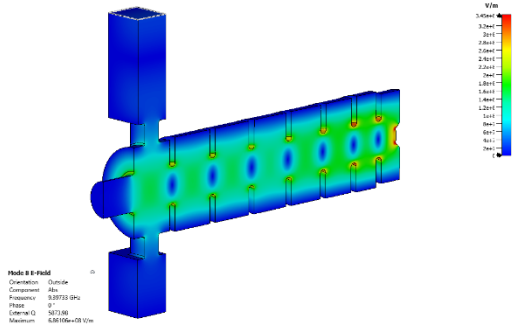
Brazeless RF+vacuum contact
Copper plating of Stainless parts

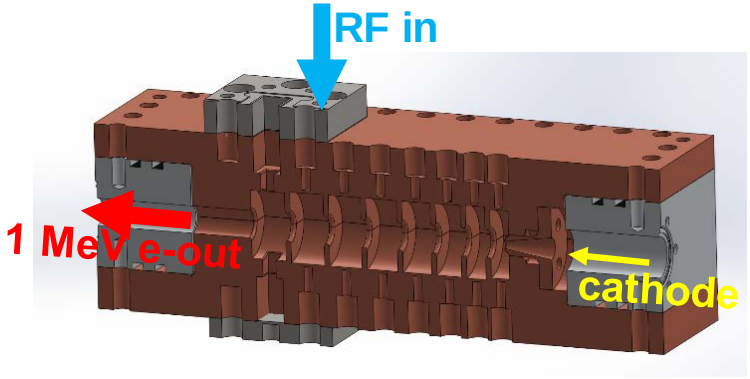


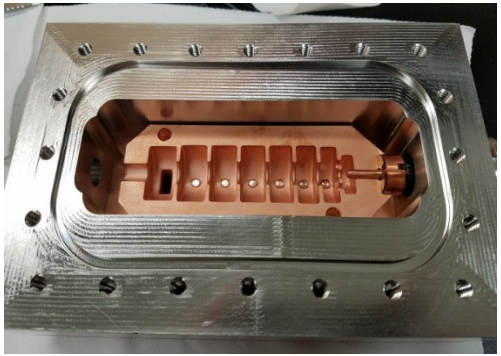


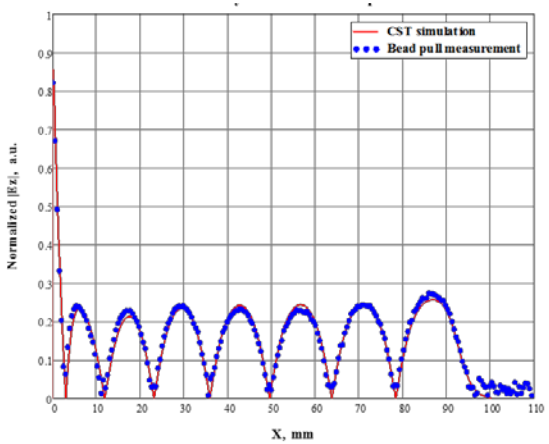
New! Brazeless split block

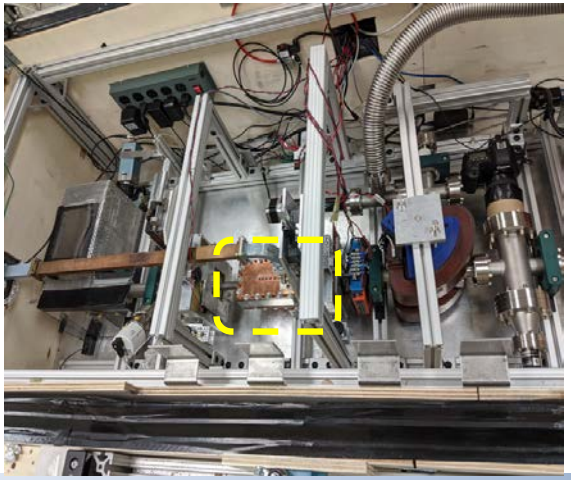
A Prototype: 1 MeV, 50W beam power

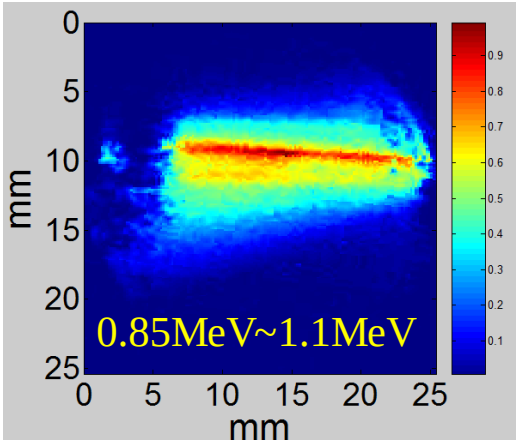






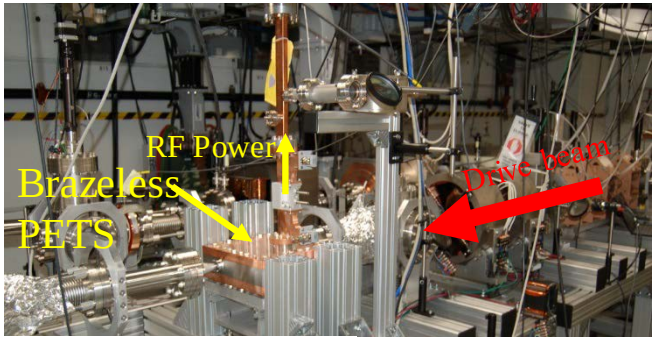


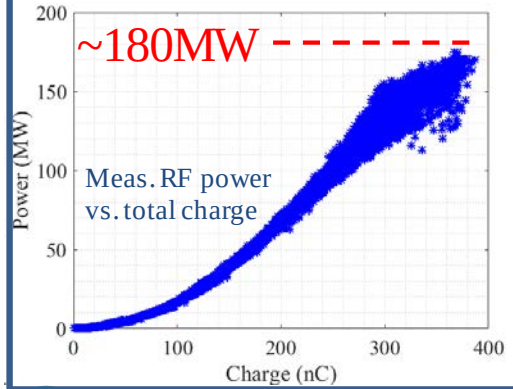


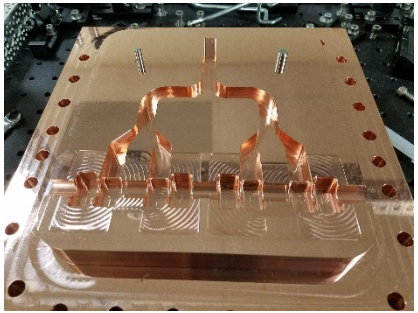


Technology can be scaled up for higher energy and power

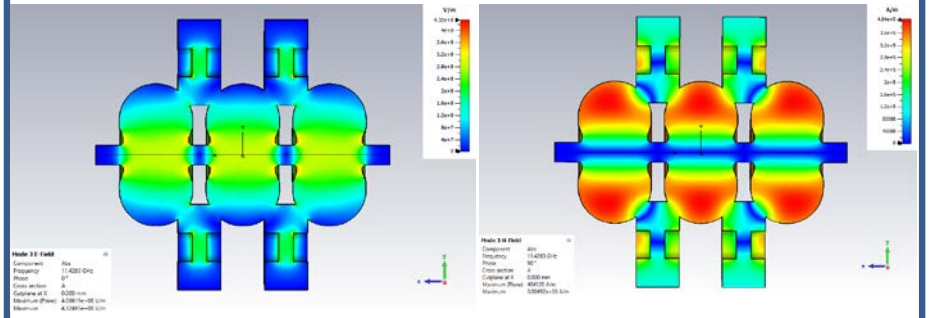
Example I: microwave generation at Argonne Wakefield Accelerator Facility

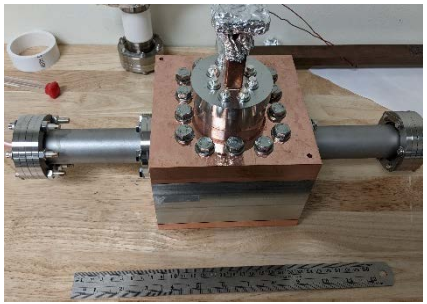


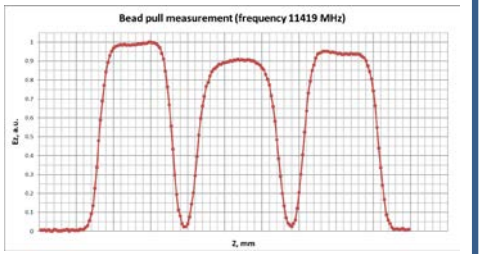




Example II: Side-coupled accelerating structure for testing at Stanford Linear Accelerator Center







To be tested soon.

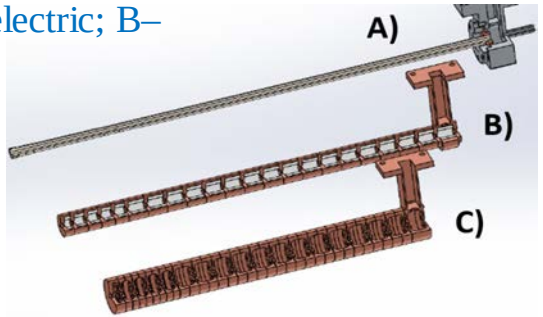
Alternative Approach at Euclid

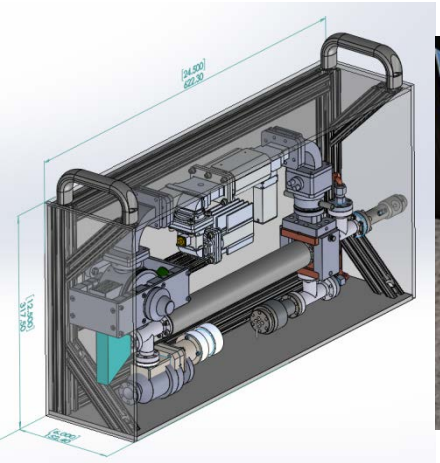
Description:

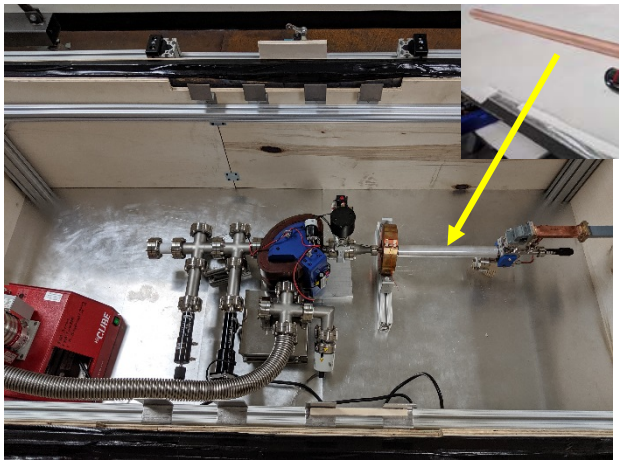
Supported by DHS under contract # HSHQDN-17-C-00007 to develop a dielectric accelerator based low energy X-ray source.

The project is to demonstrate a 1 MeV dielectric accelerator based suitcase X-ray source and also produce a cost-effective and compact medium energy (~4 MeV) design.

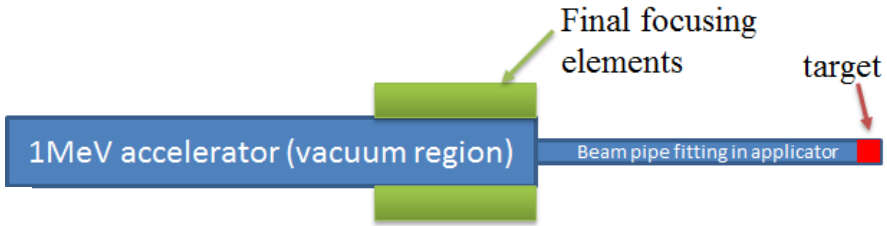
Dimensions of 3 types of accelerator in the same scale: A—dielectric; B–hybrid; C-- metalic

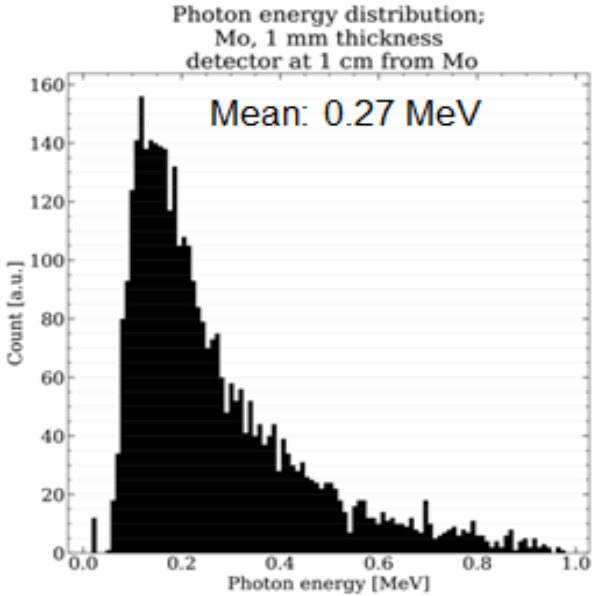






Dose Estimation for 1MeV accelerators

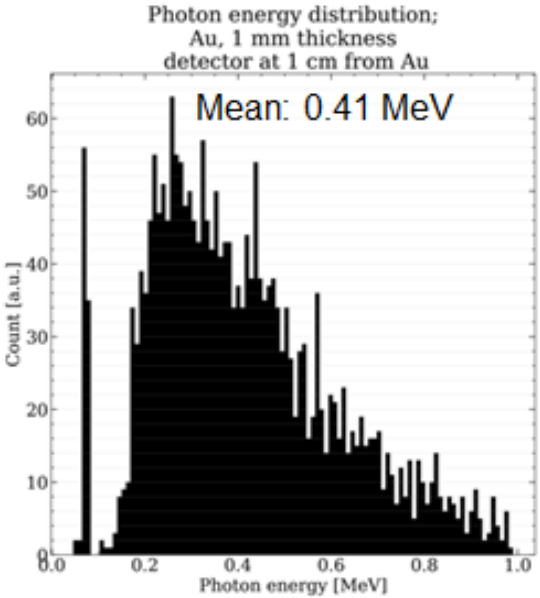




The average Dose value is **~40 mGy/min,** which can find its applications in radioactive material replacement in medical use, e.g. Electronic Brachytherapy Source**.**

As replacement of Ir-192

Dose can be enhanced using a higher energy beam, e.g. 3~4MeV, but modulator is a limit factor.



Remarks

- Thanks to DoE SBIR program, we have developed low cost low energy electron accelerator to generate X-rays. The is new fabrication technology can be scaled up for higher energy accelerators.

- Challenges remain to improve the duty cycle of the pulsed beam without a significant increase of cost and footprint so that the photo flux (dose) can be increased to the comparable level of the radioactive material.