U.S. DEPARTMENT OF ENERGY | Office of Science

An Overview of
The DOE Nuclear Physics SBIR/STTR Program :

Michelle D. Shinn, Ph.D.

Program Manager for Industrial Concepts
DOE Office of Science
Office of Nuclear Physics

International Particle Accelerator Conference
Melbourne, Australia
May 22, 2019

Outline

- The SBIR/STTR program – history and goals
- How the SBIR/STTR program operates at the DOE
- The Office of Science, Office of Nuclear Physics (NP) mission and the accelerators used to help accomplish its mission
- How NP's influences topic development and selection of proposals.
  - Advance technologies unique to NP
  - Develop software tools and hardware to advance NP Instrumentation and projects
- Initiatives to increase commercialization
- Outcomes - observations on commercialization
- Conclusions

U.S. DEPARTMENT OF ENERGY | Office of Science

SBIR/STTR Program History and Goals

Small Business Innovation Research (SBIR) *est. 1982*

- Stimulate technological innovation
- Use small business to meet Federal R&D needs
- Foster and encourage participation by women and socially and economically disadvantaged persons in technological innovation
- Increase private-sector commercialization of innovations derived from Federal R&D

Small Business Technology Transfer (STTR) *est. 1992*

- Stimulate and foster scientific and technological innovation through cooperative research and development carried out between small business concerns and research institutions
- Foster technology transfer between small business concerns and research institutions

SBIR and STTR were reauthorized on December 23, 2016 (P.L. 114-840) through September 30, 2022

Slide courtesy M. Oliver, SBIR/STTR Office

U.S. DEPARTMENT OF ENERGY | Office of Science

The DOE SBIR/STTR Phases

PHASE I: FEASIBILITY, PROOF OF CONCEPT
- Award Amount: $150,000 (guideline), $225,000 (max.)
- Project Duration: 12 months

PHASE II: CONTINUE R/R&D FOR PROTOTYPES OR PROCESSES
- Award Amount: $1,000,000 (guideline), $1,500,000 (max.)
- Project Duration: 2 years

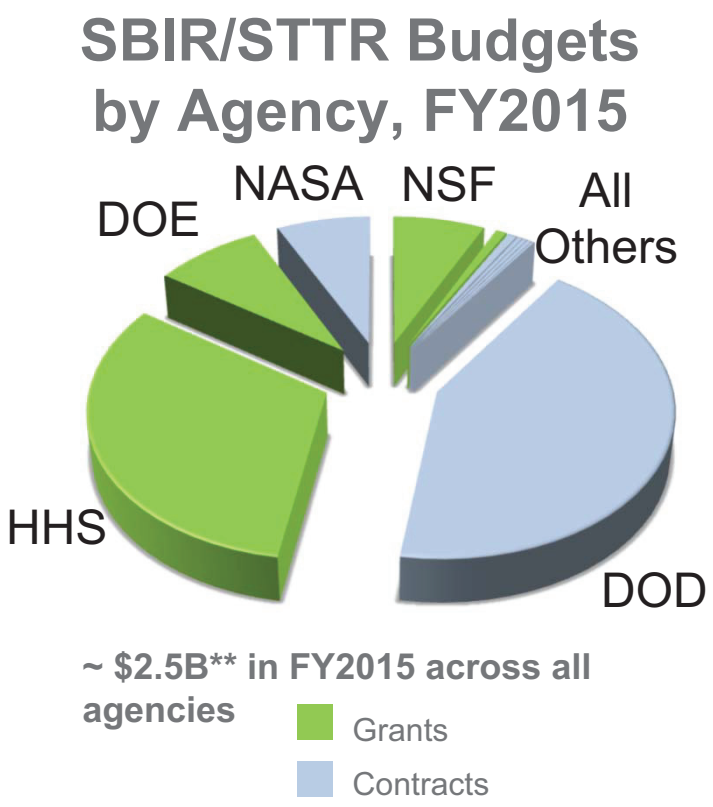
SEQUENTIAL PHASE IIA OR IIB: CONTINUE R/R&D FOR PROTOTYPES OR PROCESSES
- **PHASE IIA: FOR CERTAIN PROTOTYPES, PRODUCTS, OR PROCESSES THAT NEED MORE DEVELOPMENT**
- **PHASE IIB: FOR R&D FUNDING REQUIRED TO TRANSITION AND INNOVATION TOWARDS COMMERCIALIZATION.**
- Award Amount: $1,000,000
- Project Duration: 2 years

PHASE III: COMMERCIALIZATION
- Federal or Private Funding (non-SBIR/STTR funds)
- No dollar or time limits

- New Sequential Phase IIC to be implemented soon to help increase commercialization potential

Slide modified from M. Oliver, SBIR/STTR Office

SBIR/STTR Budgets by Federal Agency



$ = USD

Agencies with SBIR and STTR Programs	Budget
Department of Defense (DOD)	$ 1.070 B
Department of Health and Human Services (HHS), including the National Institutes of Health (NIH)*	$797.0 M
Department of Energy (DOE), including Advanced Research Projects Agency – Energy (ARPA-E)	$206.1M
National Aeronautics and Space Administration (NASA)	$ 180.1 M
National Science Foundation (NSF)	$176.0 M
Agencies with SBIR Programs	**Budget**
U.S. Department of Agriculture (USDA)	$20.3M
Department of Homeland Security (DHS): Science and Technology Directorate (S&T) and Domestic Nuclear Detection Office (DNDO)	$17.7 M
Department of Commerce: National Oceanic and Atmospheric Administration (NOAA) and National Institute of Standards and Technology (NIST)*	$8.4M
Department of Transportation (DOT)	$7.9 M
Department of Education (ED)	$7.5 M
Environmental Protection Agency (EPA)	$4.2 M

**NIH also issues contracts*

Slide courtesy M. Oliver, SBIR/STTR Office

U.S. DEPARTMENT OF ENERGY | Office of Science

U. S. Department of Energy Mission

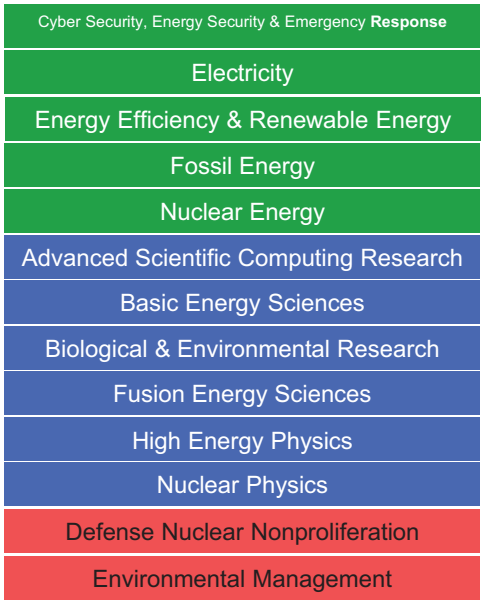
- **DOE's Mission** is to ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions.

  - **Goal 1**: Catalyze the timely, material, and efficient transformation of the nation's energy system and secure U.S. leadership in **energy** technologies.

  - **Goal 2**: Maintain a vibrant U.S. effort in **science and engineering** as a cornerstone of our economic prosperity, with clear leadership in strategic areas.

  - **Goal 3**: Enhance **nuclear security** through defense, nonproliferation, and environmental efforts.

Program Offices Participating in the DOE SBIR/STTR Programs



Slide courtesy M. Oliver, SBIR/STTR Office

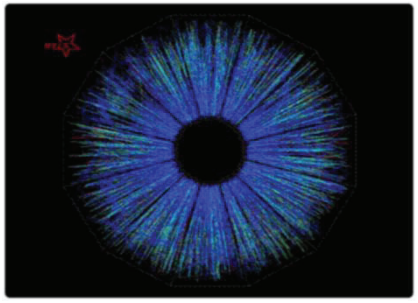
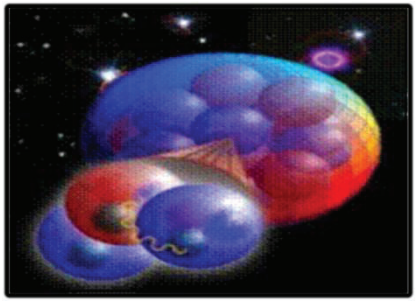
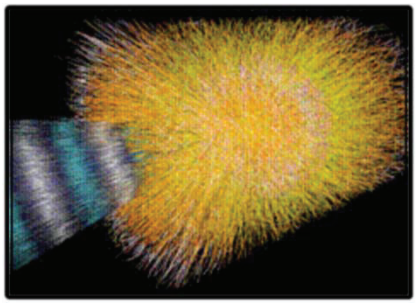
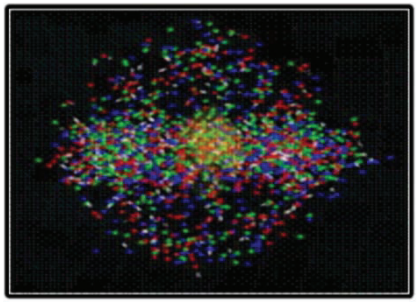
U.S. DEPARTMENT OF ENERGY | Office of Science

Nuclear Physics' Mission

Discovering, exploring, and understanding all forms of nuclear matter

The Scientific Challenges

- The existence and properties of nuclear matter under extreme conditions, including that which existed at the beginning of the universe
- The exotic and excited bound states of quarks and gluons, including new tests of the Standard Model
- The ultimate limits of existence of bound systems of protons and neutrons
- Nuclear processes that power stars and supernovae, and synthesize the elements
- The nature and fundamental properties of neutrons and the neutrino and their role in the evolution of the early universe

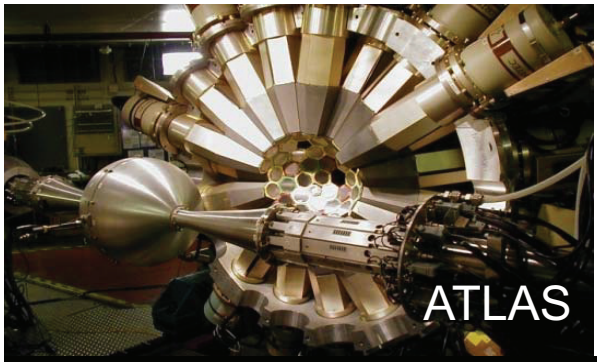
U.S. DEPARTMENT OF ENERGY | Office of Science

At Present NP Operates 3 National Scientific User Accelerator Facilities and is building a 4th

"Microscopes" capable of groundbreaking research support the NP mission

Relativistic Heavy Ion Collider

Continuous Electron Beam Accelerator Facility



Argonne Tandem Linac Accelerator System

Facility for Rare Isotope Beams at MSU

How the NP Mission translates into programs

- NP's major program areas are:
  - Heavy Ion Nuclear Physics
  - Medium Energy Physics
  - Nuclear Structure-Nuclear Astrophysics
  - Fundamental Symmetries

  } Low Energy Nuclear Physics

  - Nuclear Theory (not involved in the SBIR/STTR Program)
  - Isotope Development and Production for Research and Applications

  - Accelerator Science and Technology is major component that facilitates all of the NP subprograms.

NP SBIR/STTR Topics for FY 2019* support those programs

- Software and Data Management
- Electronics Design and Fabrication
- Accelerator Technology
- Instrumentation, Detection Systems and Techniques
- Isotope Science and Technology

- Every year there is subtopic revision, based on community input.

*FY = Fiscal Year. In 2019, this runs from October 1, 2018 to September 30, 2019

NP yearly SBIR/STTR topic development process

- Start with last year's published topics and make initial revisions based on year-round observation of needs by Program Managers and input we hear about during meetings with the NP community,

- Request input for each topic from subject matter experts within the NP community,

- Collect and implement input meeting on existing subtopics. Add or delete subtopics as necessary, based on work funded and recently published advancements.

- Review HEP and BES Topics to insure we don't unnecessarily duplicate-fund the same R&D, unless complimentary,

Subtopic requests must be right-sized & timed

- Match Facility Accel. Improvement Projects and Cap. Equip. activities and mid-term upgrade plans to 3 year SBIR/STTR funding cycle.
  - Same for universities or other collaborations working on detectors.

- Coordinate with other Offices to not duplicate efforts unless a particular technology is synergistic.
  - An example might be lower cost SRF cavity fabrication that would benefit from additional investment.

- Projects must be of sufficient value to the NP community to justify the investment

Our subtopic narratives reflect areas of NP strategic importance – our "brand"

- Our subtopics reflect the following strategy,
- Use SBIR/STTR funding of small businesses to maintain leadership in technology areas where NP has unique needs.
  - SRF accelerators and related technologies (*e.g.* cryogenics)
  - Polarized sources
  - CW RF sources
  - Detectors with emphasis on particle identification

NP Topic introductions reflect our community and mission emphasis and serve as a filter

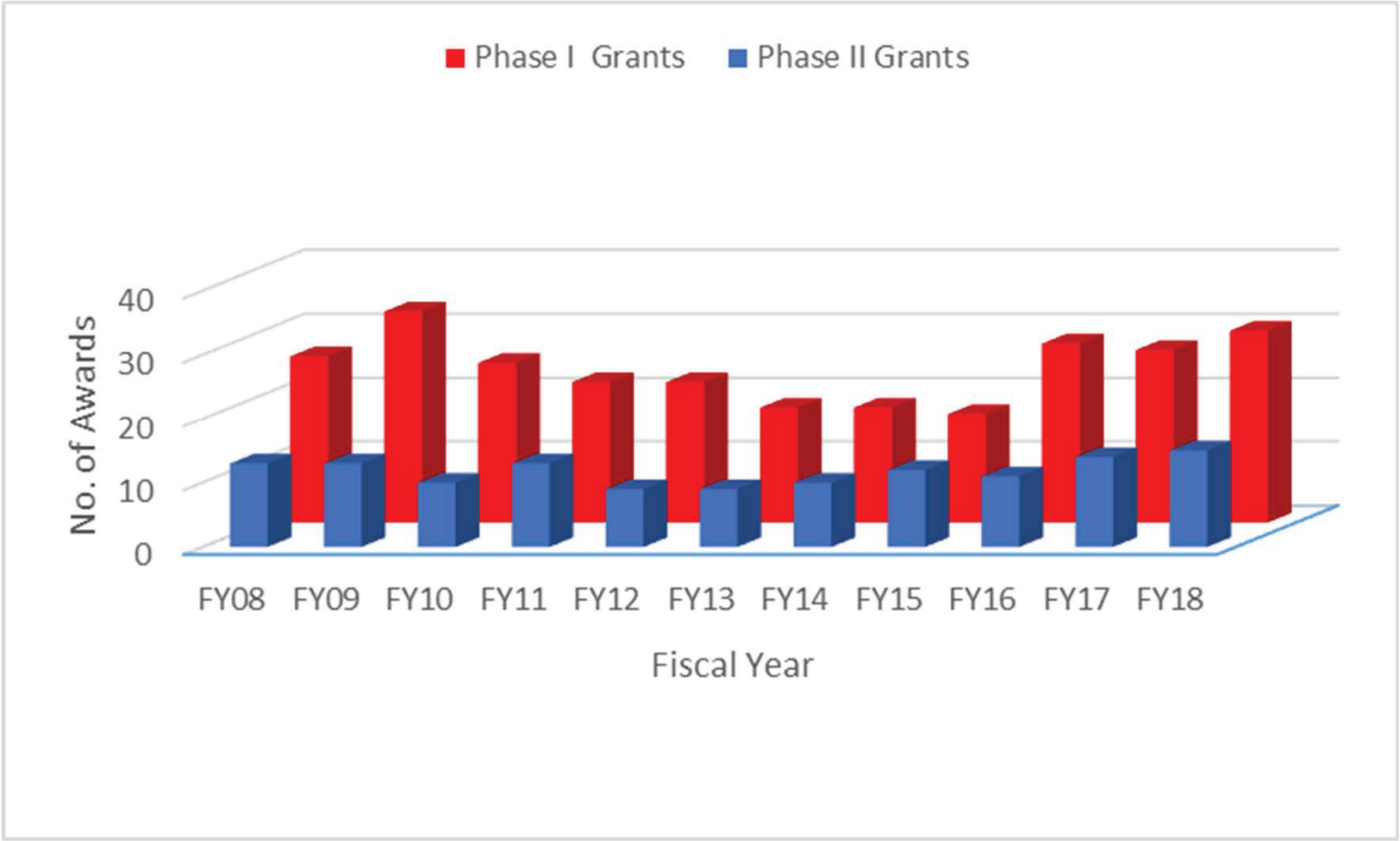
- All grant applications must explicitly show relevance to the DOE Nuclear Physics Program. Grant applications must be informed by the state of the art in nuclear physics applications, commercially available products, and emerging technologies

- A proposal based on merely incremental improvements or little innovation will be considered non-responsive unless context is supplied that convincingly shows its potential for significant impact or value to the DOE Nuclear Physics Program.

- Applications which are largely duplicative of previously funded research by the Office of Nuclear Physics will be considered nonresponsive to this topic.
  - We do make exceptions for NP strategic technologies

- The goal of the program is to seek innovations that will advance our nation's capability to perform nuclear physics research, and more specifically to improve DOE Nuclear Physics (NP) Scientific User Facilities and the wider NP community's experimental programs.

NP SBIR/STTR Award Trend (FY08 – FY18)



- Total value of grants funded FY 2014 - 2018: ~$81M USD
- 118 companies funded (some multiple times) during this time span.
- ~$20 M USD awarded in FY19

Our SBIR/STTR Program → NP mission and strategic priorities are tied to our community and its facilities

- The 2016 National Academy of Sciences review of the DOE SBIR/STTR Phase II program had several recommendations. Two of significance are:
  - DOE should seek to develop programs linking Laboratories' procurement actions with relevant SBIR/STTR projects.
  - DOE should examine from a strategic perspective how the relationship of SBIR/STTR with the National Laboratories works today.

- One way to make the adoption by a Lab of the product from a finished grant more likely is to require that a prototype or method be ready for testing in a NP application by the grant's conclusion
  - This increases the likelihood there will be hardware that can be rapidly purchased and deployed to fulfill the NP community's needs.
  - Which leads to higher rates of commercialization

The key to commercialization is to build relationships through communication

- Our scientific community needs products and methods for an identified future need that requires some R&D, but have constraints, in funding or workforce, that make it hard to pursue
- The NP SBIR/STTR program is structured to foster partnerships between business and community to fulfill those future needs
- The conundrum – how are we, as a Federal agency to publicize a company's product to the wider community without creating an unfair advantage?
  - Use the required public announcement of our awards
  - Last 3 years found on DOE SBIR-STTR Office awards page
- Let reviewers and leadership at facilities & universities know what companies received awards.
- Add DOE press releases on SBIR/STTR awards to the News section on our landing page
    - Make this resource known to our community

Other SBIR/STTR Program Updates

- We have another initiative to better connect businesses to the NP community.
  - Since 2017, offer companies the opportunity to have a kickoff meeting about 1 month after they receive funding
    - During the meeting, discuss community members to contact to ensure compatibility with their needs

- A new Sequential Award, Phase IIC, to be rolled out DOE-wide
  - Mandates that agencies issue a third Phase II award ($1 M)
  - Applicants must have received an initial Phase II and a second Phase II (IIA or IIB)
  - Applicants are required to have 1:1 matching funds
  - This additional assist to companies helps them move into markets beyond those of the particular funding Office (*e.g.*, NP)

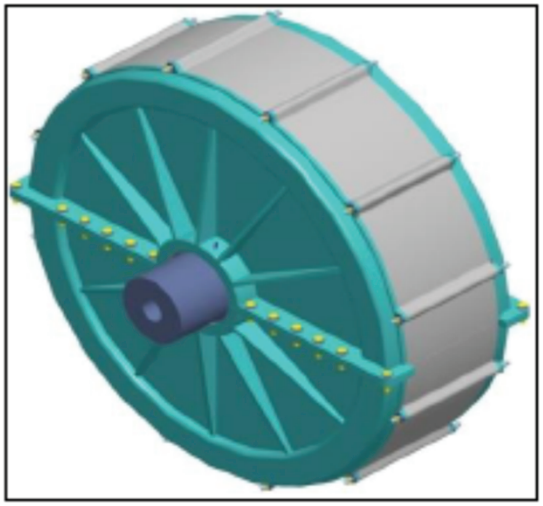
- Increased minimum award amounts for the first time since 2011.
  - Phase I: $200k, 12 months (was $150k, typically 9 months)
  - Phase II: $1.1M, 2 years (was $1M, 2 years)
    - Will be fully implemented in FY20

Outcomes

- The short answer is – it's early days since program changes occurred over FY18-19
- The DOE SBIR-STTR Office collects Ph III outcomes for sales only to US National Laboratories
- NP has expanded this request to include sales to other US and foreign research institutions.
- Collected first data for FY18
  - Will be an annual process
- Found that sales to Labs roughly equal to other research institutions
- Accelerator sales, primarily in sources, magnet components, and diagnostics and accounted for about 25% of the total
- The majority was in instrumentation – detectors and electronics.

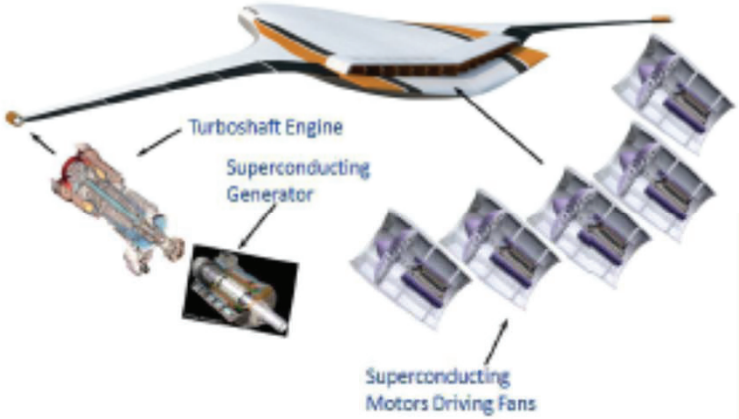
Commercialization Highlight #1

- In FY18 HyperTech made a major sale of $MgBr_2$ magnet cable to another Federal agency



Advantages of MgB_2:

- Reduction of size and weight of machine
- No joints in rotor pole (long length conductor)
- Faster normal zone propagation
- Meets current density requirements (< 4T)
- Made round to be easier to configure into complex coil geometries
- Significant reduction of cost
- Persistent coils



Concepts and projects using MgB_2:

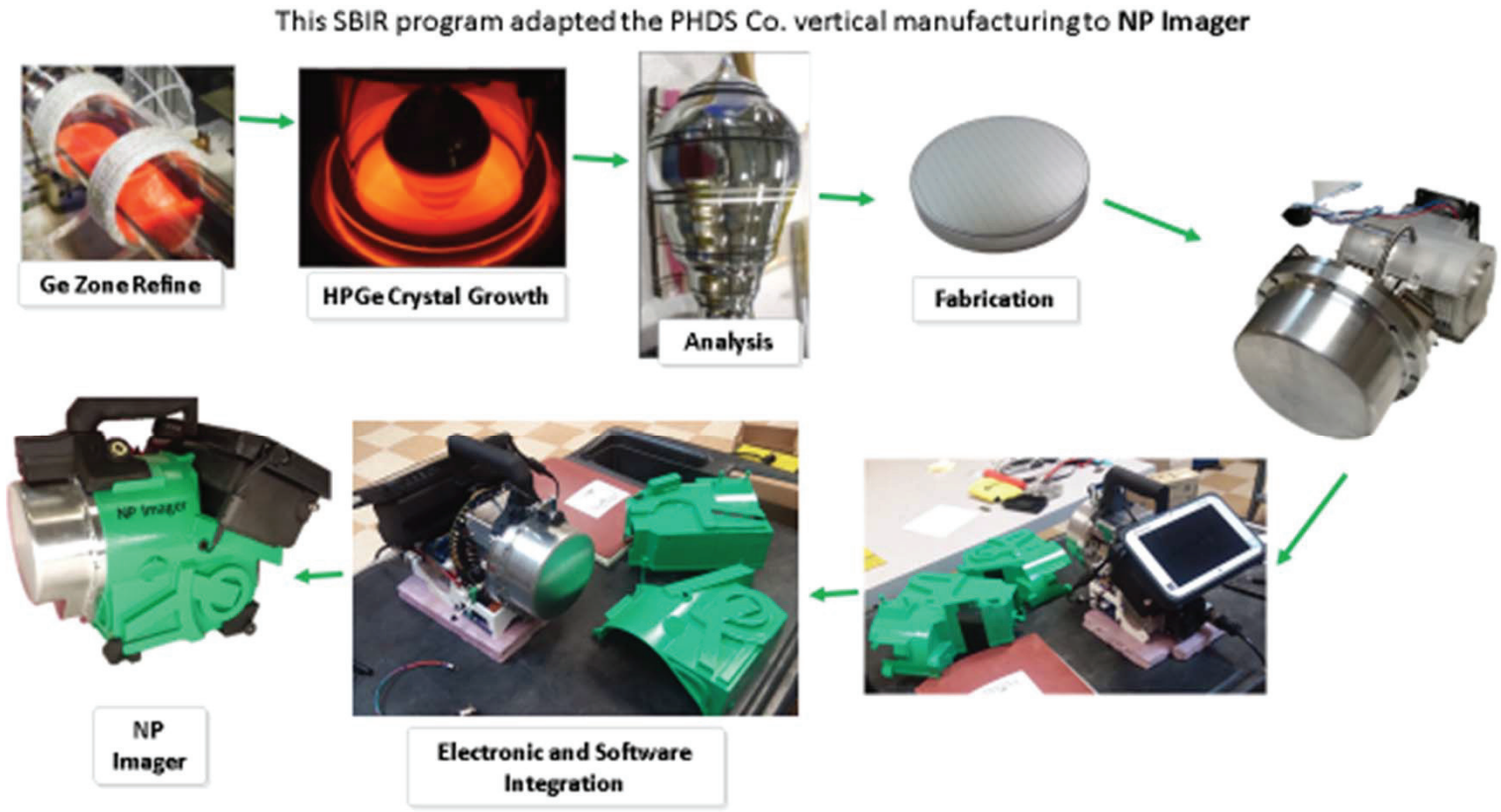
- Hyper Tech has designed a modular 5 MW land based direct drive wind turbine generator that is transportable, sponsored by DOE
- All cryogenic 10 MW Superconducting wind turbine rotor and stator, S. Kalsi (2014 *IEEE Transactions of Applied Superconductivity* **24**)
- NASA 1-2 MW high speed motor demonstrator
- Studies in being conducted in Europe-electric aircraft

Hyper Tech

Slide courtesy of Mike Tomsic

Commercialization Highlight 2

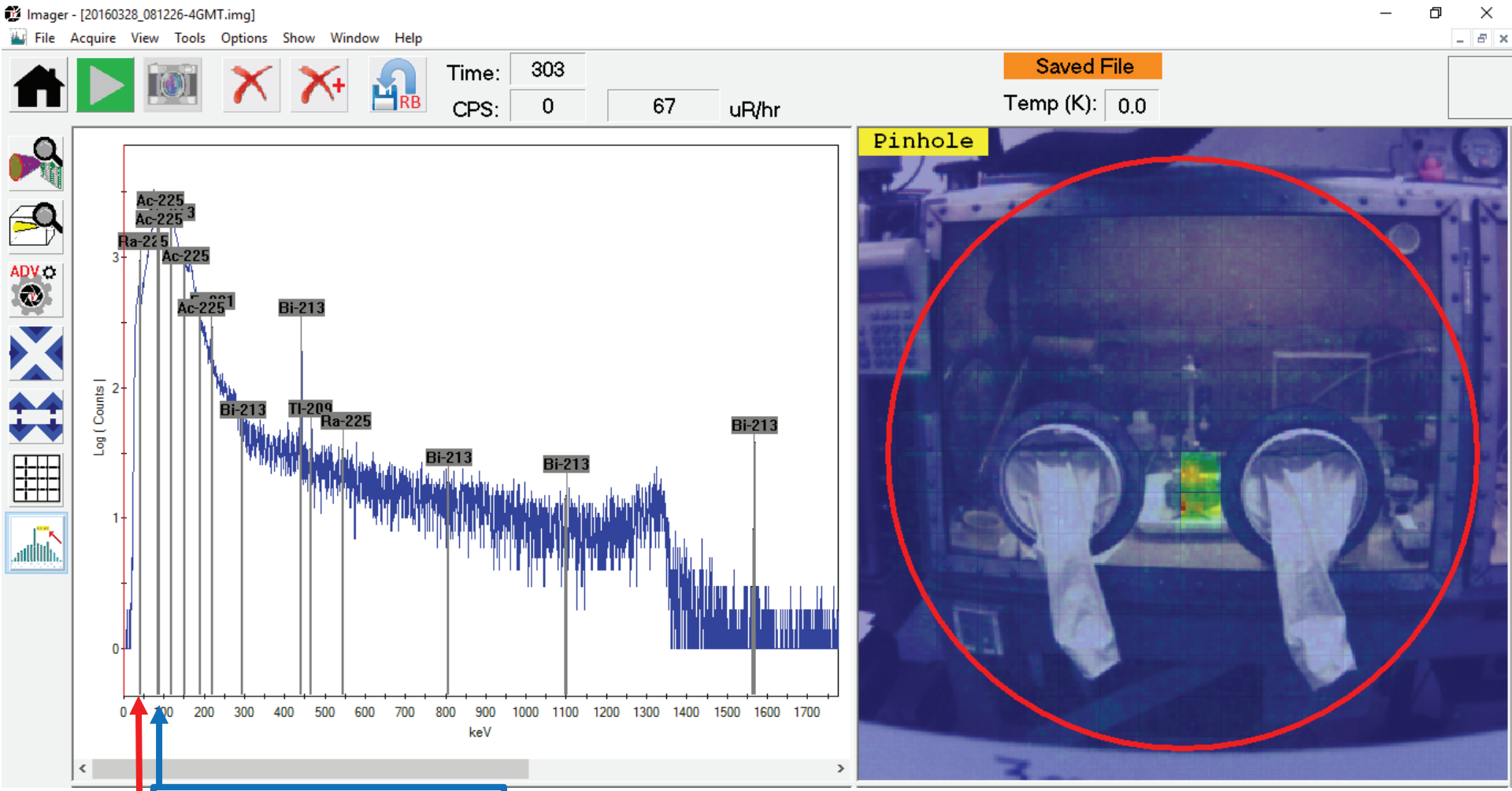
- In FY18 PHDs Co made sizeable sales of their radioisotope imagers to several National Labs
  - Based on HPGe



Slide courtesy Ethan Hull

Commercialization Highlight -2 (cont)

- Imager at work – detecting position of Ac-225 and Ra-225 in a separation column



Slide courtesy Ethan Hull

Conclusions

- NP uses the Congressionally-mandated SBIR/STTR Program –
  - To fund R&D that benefits the NP community
  - To build and sustain a US-based commercial infrastructure that serves society in areas beyond nuclear science

- NP's set aside for the SBIR/STTR Program over five years is equivalent to that for a major item of equipment like a detector
  - With input from NP Program Managers and the community, the NP SBIR/STTR program uses those funds for R&D that advances our core technologies as well as new initiatives

- NP uniquely fosters the connection between the NP community and the small businesses that serve it through an annual exchange meeting
- Program Managers from other Federal agencies (e.g. NSF, NIH) invited
  - This in turn provides opportunities for funding by those agencies and an introduction into new science and technology sectors