An Overview of
The Nuclear Physics SBIR/STTR Program :

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Outline

- How the SBIR/STTR Program operates in the DOE Office of Science
- How the Nuclear Physics (NP) mission influences Topic development and selection of proposals.
  - Advance technologies unique to NP
  - Develop software tools and hardware to advance NP MIEs and projects
- Other mechanisms to foster connections between the NP community and small businesses
  - The annual NP SBIR STTR Exchange meeting
  - Other efforts
- Conclusions

The Three SBIR/STTR Phases

Phase I: Feasibility, Proof of Concept

- Award Amount: $150,000 (guideline), $225,000 (max.)
- Project Duration: 6-12 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

Phase III: Commercialization

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

Not implemented by DOE, instead -

Modified from a slide originally from M. Oliver, SBIR/STTR Office

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Not implemented by DOE, instead -

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 an innovation towards commercialization.**
- Award Amount: $1,000,000
- Project Duration: 2 years

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Annual SBIR/STTR funding percentages FY15 and out-years

- In FY2015, all Federal agencies with an extramural research budget greater than $100M contributed 2.9% of that budget to the SBIR portion of the program.
- If the agency has greater than $1B in extramural R/R&D, then 0.4% of that budget went to the STTR program.
- These values have risen steadily since the 2011 reauthorization.

%	FY15	FY16	FY17	FY18	FY19	FY20	FY21
SBIR	2.9	3.0	3.2	3.2	3.2	3.2	3.2
STTR	0.40	0.45	0.45	0.45	0.45	0.45	0.45
Total	3.30	3.45	3.65	3.65	3.65	3.65	3.65

- The SBIR/STTR program was reauthorized in 2016 through FY 2022 at the same percentage set aside as established in FY 2017.

Current SBIR/STTR Award funding levels and requirements on Research Institution participation

Phase I

Grant	Max award ($k)	Small Business (Level of Effort)	Research Institution (Level of Effort)
SBIR	150	Min 66%	Optional
STTR	150	Min 40%	Min 30%

Phase II

Grant	Max award ($k)	Small Business (Level of Effort)	Research Institution (Level of Effort)
SBIR	1000	Min 50%	Optional
STTR	1000	Min 40%	Min 30%

Phase I Funding Opportunity Announcements Participating DOE Programs (FY 2018)

Phase I Release 1

- Office of Advanced Scientific Computing Research (ASCR)
- Office of Basic Energy Sciences (BES)
- Office of Biological and Environmental Research (BER)
- **Office of Nuclear Physics (NP)**

Phase I Release 2

- Office of Defense Nuclear Nonproliferation (NA)
- Office of Electricity Delivery and Energy Reliability (OE)
- Office of Energy Efficiency and Renewable Energy (EERE)
- Office of Environmental Management (EM)
- Office of Fossil Energy (FE)
- Office of Fusion Energy Sciences (FES)
- Office of High Energy Physics (HEP)
- Office of Nuclear Energy (NE)

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Operation of the DOE SBIR and STTR Programs

- DOE Program Office
  - Develop Topics
  - Identify Reviewers (Scientific Peer Review)
  - Recommend Awardees
  - Manage Projects

Technical Expertise Leveraged Throughout DOE

- DOE Chicago Office
  - Negotiate Grants
  - Issue New and Continuation Awards
  - Grant Closeout

Single Grants Office for Awardees

- DOE SBIR/STTR Programs Office
  - Develop Funding Opportunity Announcements
  - Administer Review and Selection Process
  - Ensure Compliance with SBIR/STTR Legislation
  - Conduct Outreach

Single Administrative Office for Applicants

- NP recommends what R&D gets funded, but is otherwise freed of much of the administration of those funds.

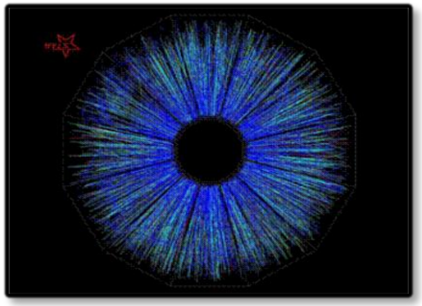
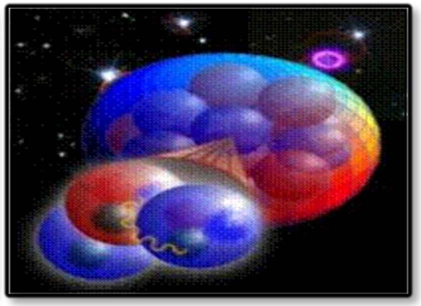
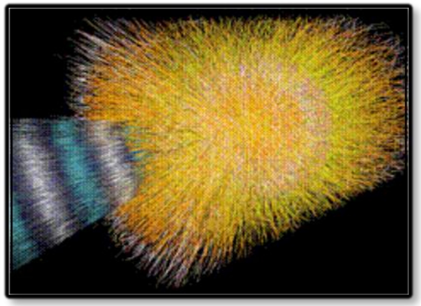
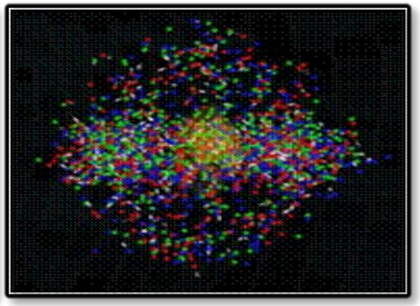
Slide courtesy M. Oliver SBIR/STTR Office

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

DOE Isotope Program Mission

The **mission** of the DOE Isotope Program is threefold:

- Produce and/or distribute radioactive and stable isotopes that are in short supply, associated byproducts, surplus materials and related isotope services.
- Maintain the infrastructure required to produce and supply isotope products and related services..

Isotope Production Facility (LANL)

Brookhaven Linac Isotope Producer

- Conduct R&D on new and improved isotope production and processing techniques which can make available new isotopes for research and applications.

This can relate to the SBIR Isotope Topic

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How the NP Mission translates into programs

- NP's major physics 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

NP SBIR/STTR Topics for FY 2018 support these programs

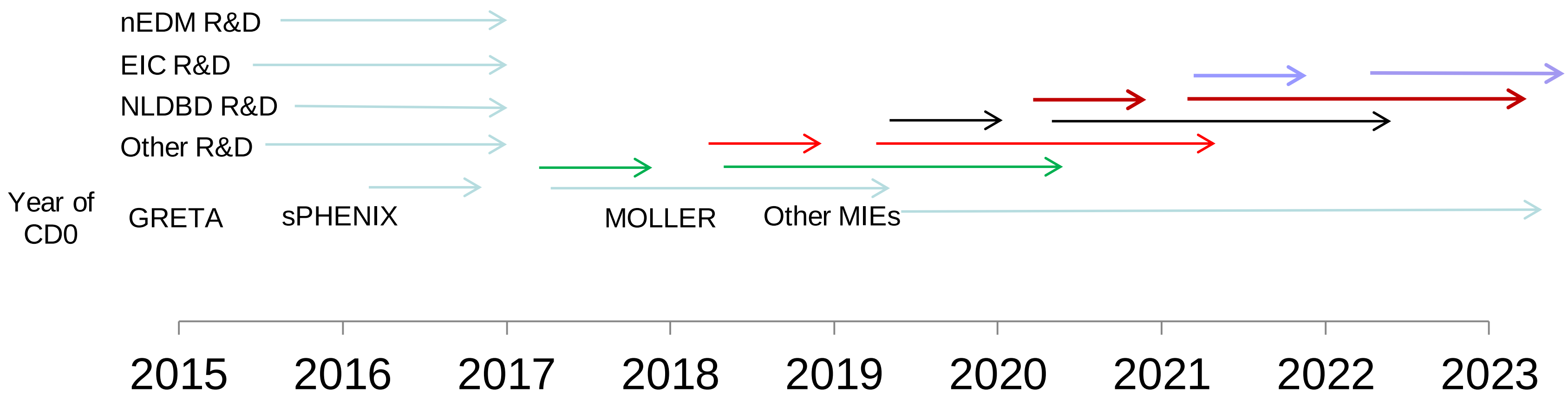
- Software and Data Management
- Electronics Design and Fabrication
- Accelerator Technology
- Instrumentation, Detection Systems and Techniques
- Isotope Science and Technology

- Once again there was a considerable amount of subtopic revision from FY17 to FY18.
- Funding Notes: There is no fixed set aside for each topic. Proposals from all 5 topics compete with each other and highly ranked applications determined to have the most impact are funded.

NP yearly SBIR/STTR topic development process

- Start with last year's published topic document and make initial revisions based on a year-round observation of needs by Program Managers and NP community input as well as,
- Request input for each topic from subject matter experts within the NP community,
- Collect and implement all inputs on existing subtopics. Add and/or delete subtopics as necessary,
- Review HEP and BES Topic narratives to insure we don't unnecessarily duplicate-fund the same companies,
- Submit the revised topics to the DOE SBIR/STTR office which publishes them in mid-July
- The solicitation is published as a Funding Opportunity Announcement (FOA) around the middle of August (in FY18 - middle of October)
- Letters of Intent to submit a proposal are due the day after Labor Day
  - In FY18 – day before Halloween
- Proposals are due around the middle of October (in FY18 - 4th of December)

Topic definition process (cont.)



- Bottom-up: NP community (Facilities, etc.)
- Match Facility AIP and CE activities and mid-term upgrade plans to 3 year SBIR/STTR funding cycle. Same for universities or other collaborations working on detectors.
- Annually, have SMEs justify each subtopic they wish retained.
- Coordinate with BES and HEP 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.

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

NP Topic introductions reflect our community and mission emphasis

- 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

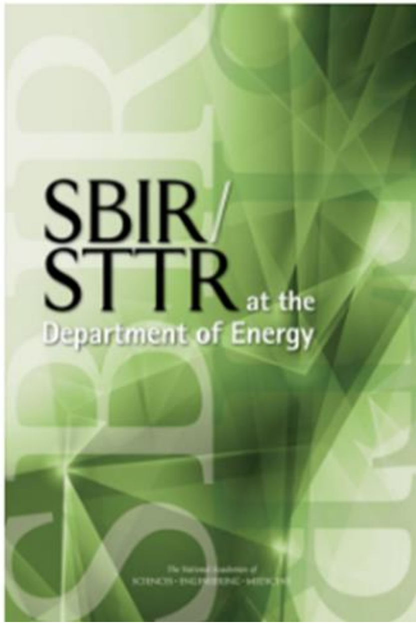
- A proposal based on merely incremental improvements or little innovation will be considered non-responsive unless context is supplied that convincingly shows its potential for significant impact or value to the DOE Nuclear Physics Program.

- 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 subtopics below refer to 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.

Recommendations from the DOE Phase II SBIR/STTR NAS assessment also influence our Topics

- Previous study
  - DOE SBIR/STTR Assessment report issued December 2016
  - https://www.nap.edu/catalog/23406/sbirsttr-at-the-department-of-energy
  - Report was one year late; was due to Congress December 31, 2015
- Next study
  - Task order for next study issued July 2017
  - Report due to Congress December 31, 2019 (Report due every 4 years)



Slide courtesy of Manny Oliver – SBIR/STTR Office

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 products from a finished (Phase II or Phase II sequential) grant more attractive is to have them start from a sufficiently high Technical Readiness Level (TRL).
  - TRL 4-6 is generally where they should start to achieve this goal. In some cases, TRL 3 may be acceptable.
- Often we get proposals at TRL 1-2 and it is these that don't tie in well to the NP strategic priorities.
  - And, they won't have hardware that can be rapidly purchased and deployed to fulfill the NP community's needs.
- DOE TRLs are in DOE Order DOE G 413.3-4A and are in the following slide.

DOE Technical Readiness Levels (TRL) serve as a guide for developing our Topics*

System Operations	**TRL 9**	Actual system operated over the full range of expected mission conditions.	The technology is in its final form and operated under the full range of operating mission conditions.
System Commissioning	**TRL 8**	Actual system completed and qualified through test and demonstration.	The technology has been proven to work in its final form and under expected conditions.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment.
Technology Demonstration	**TRL 6**	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system.
Technology Development	**TRL 5**	Laboratory scale, similar system validation in relevant environment	The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.
Technology Development	**TRL 4**	Component and/or system validation in laboratory environment	TRL 4-6 represent the bridge from scientific research to engineering.
Research to Prove Feasibility	**TRL 3**	Analytical and experimental critical function and/or characteristic proof of concept	At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants.
Basic Technology Research	**TRL 2**	Technology concept and/or application formulated	The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research.
	TRL 1	Basic principles observed and reported	Scientific research begins to be translated into applied R&D.

* TRL description excerpts

NP Funding – historical and out-year projections

K$	FY15	FY16	FY17	FY18* (PR)	FY18* (1QCR)		
SBIR	12,967	14,040	15,354	12,968	3,800		
STTR	1,789	2,106	2,173	1,793	550		
Total	**14,756**	**16,146**	**17,527**	**14,761**	**4,350**		

*Projection based FY18 President's Request

- FY17 funding was sufficient to fund 24 Ph I SBIR plus 3 Ph I STTR grants, and 14 Ph II grants
  - Success rate was ~19%, relative to the number of proposals received.

The NP SBIR/STTR Exchange Meeting is Unique in the Office of Science

- NP seeks to effectively assess the performance of NP supported SBIR/STTR projects in contributing to the NP mission and goals. Started in FY2010, the Exchange Meeting is designed to serve that purpose as well as:
  - To **provide a platform** for small businesses to present the status of NP-supported Phase II grant work to the NP community and Federal Program Managers
  - To offer an opportunity to **exchange information** regarding the **companies' capabilities** and the technical needs of the NP programs
  - To **strengthen the ties** of the SBIR/STTR businesses **with the community** and enhance the possibilities for commercialization
- Typically, 60-80 participants attend the two day meeting

NP SBIR/STTR Program Changes started in FY17

- We wish to better connecting businesses to the NP community.
- To do this, we provided the link to the SBIR/STTR Office awards page to all reviewers, as well as Lab managers and Center points of contact.
- Implemented Phase I project kickoff meetings by request. Specifically reached out to PIs who were new to the NP SBIR/STTR Program.
- The SBIR Office is implementing a Phase I Principal Investigator Meeting, to be held in June each year. The objectives are-
  - In person meetings with DOE program managers and DOE Commercialization Assistance providers
  - Presentations relating to Phase II and Commercialization
  - Small business networking

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 other than nuclear science

- Three years of funding is equivalent to that of a large research effort
  - With input from 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 meeting
  - This in turn enhances opportunities for commercialization

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DOE Technical Readiness Levels (TRL)

Technology Development	**TRL 4**	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste[2]. Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. **TRL 4-6 represent the bridge from scientific research to engineering.** TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.
Research to Prove Feasibility	**TRL 3**	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants.[1] Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
Basic Technology Research	**TRL 2**	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
	TRL 1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.

Backups

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TRLs 5-9

System Operatios	**TRL 9**	Actual system operated over the full range of expected mission conditions.	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	**TRL 8**	Actual system completed and qualified through test and demonstration.	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning[1]. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.
Technology Demonstration	**TRL 6**	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants.[1] Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.
Technology Development	**TRL 5**	Laboratory scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants[1] and actual waste[2]. Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.