FY2021 SBIR/STTR Solicitation

TSD High Power Targetry Topics

1) **Advanced material for accelerator production target**

Accelerator for particle production requires production targets that withstand high energy, high power pulsed beams. Targets need materials with low-Z, excellent mechanical properties, good corrosion resistance, low activation and high radiation resistance. Targetry components must survive the interaction with the high-power beam (1 to 4 MW; at a Gaussian beam profile sigma radius down to ~1.5 mm; 10 microsec pulses; ~1 Hz, with a dose up to 1 to 2 dpa). Interaction with the beam has the potential to create thermal shock, radiation damage, and high temperatures.

Develop materials such as nanocrystalline materials or high entropy alloys (HEA), or any materials that can operate in the above conditions for at least one year.

2) **Advanced material for accelerator beam windows**

Accelerator for particle production requires "beam windows" to isolate the particle beam vacuum from the target facility atmosphere (usually air). Expected increases in beam power and intensity requires advancing beam window solutions, such as the use of carbon-based materials. Beam windows must withstand the interaction with the high power beam (1 to 4 MW; at a Gaussian beam profile sigma radius down to ~1.5 mm; 10 microsec pulses; ~1 Hz), the pressure differential (2 to 4 bar), and erosion caused by oxidation at elevated temperatures on the air-side of the window. Interaction with the beam has the potential to create thermal shock, radiation damage, and high temperatures. Cooling of the beam windows is considered critical to this development. Applications for the use of such beam windows require solutions for beam apertures ranging from 2 cm to 10 cm in diameter.

Develop low-Z materials (graphite material such as glassy carbon) and/or high entropy alloys (HEA), or any materials that can survive these conditions for periods of at least one year.

3) **Advanced technology for enhanced convective cooling of high-power targets**

Accelerator for particle production requires production targets that withstand high energy, high power pulsed beams (1 to 4 MW; at a Gaussian beam profile sigma radius down to ~1.5 mm; 10 microsec pulses; ~1 Hz). Interaction with the beam has the potential to create thermal shock, radiation damage, and high temperatures. One of the largest challenges facing multi-MW targets is the removal of the time-averaged heat deposited by interaction with the beam from the target core and into the cooling medium. Future multi-MW targets may require significant compromises in physics performance due to cooling limitations. The cooling system needs to absorb up to 4 MW of beam power and needs to run in a radiation environment.

Develop high heat transfer techniques with effective heat transfer rates in the range of 10^5 W/m^2-K using fluids suitable for very high radiation environments.

4) **Advanced technology for enhanced radiative cooling of high-power targets**

Develop high emissivity surface treatments or coatings for production targets made of refractory metals (e.g. tungsten) for use in the temperature range of 1000 to 1500 C and a vacuum atmosphere.

5) Radiation resistant strain/vibration instrumentation development

Monitoring the health of a target component in situ requires strain instrumentation that can withstand the high radiation environment of a beam target. The accumulated dose of a future target component during its lifetime may exceed 10 Giga-Gray. Instrumentation that can function near to this limit is needed that can resolve strains as low as 100 nano-strain and as high as 10 milli-strain (non-concurrently). Sampling frequency is potentially as high as 4 MHz to capture the dynamic response of a high intensity beam pulse (1 to 10 microsec duration).

Develop radiation hardened transducers for measuring transient strains in the range of 10^{-7} to 10^{-2} in the frequency range of 1 kHz to 4 MHz.

6) **Radiation harden beam instrumentation and anomaly detection tool for Mega Watt Target System**

A radiation harden beam instrumentation is required for a MW-target system operation. It should work in severe radioactive environments to measure the phase space of secondary and tertiary charged particles from the target. A new algorithm will be added to detect an anomaly event of the target system by observing a spill-by-spill beam instrumentation signal. Machine Learning is a good candidate to build the new software.

7) **Accelerator robot for Mega Watt Target System**

A beam enclosure is typically long, narrow, and curved labyrinth, and often undergrounded. Besides, the enclosure is sealed by a thick metal plate and a concrete block for a radiation shielding. Therefore, no Global Positioning System (GPS) is available, and WiFi is most likely not available during a beam operation. A full autonomous robot is highly demanded. Or making a new wireless network system to communicate with the accelerator robot is required.