

PNS Status Update

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SOUTH DAKOTA MINES

An engineering, science and technology university

CALCI Consortium
Meeting

July 13, 2023

Outline

- New DD Generator
- PNS Prototyping Status
- Simulation and Analysis
- Neutron Cross Section Measurements
- Summary

New DD-Generator

- Reminder: Thermo Fischer MP320 (old) vs. Starfire n-Gen310 (new)
 - Starfire generator will have increased neutron output, lower possible pulse frequency, and comparable size

Thermo Scientific MP 320 Neutron Generator

Technical Specifications	
Neutron Yield	1.0E+08 n/s for DT, 1.0E+6 n/s for DD
Neutron Energy	14 MeV
Typical Lifetime	1,200 hours @ 1x10 ⁸ n/s
Pulse Rate	250 Hz to 20 kHz, continuous
Duty Factor	5% to 100%
Minimum Pulse Width	5 μsec tested to be 400 μsec
Pulse Rise Time	Less than 1.5 μsec
Pulse Fall Time	Less than 1.5 μsec
Maximum Accelerator Voltage	95 kV
Beam Current	60 μamps
Power Supply	Integral
Neutron Module	12.07 cm x 57.15 cm (4.75 in x 22.5 in)
Control Module	Integral, digital
Safety Features	Keylock: on/off Emergency: on/off Normal-open and normal-closed interlocks Pressure switch
Total Weight	12 kg (26.46 lb)
Remote Control	RS-232/RS-485

Starfire n-Gen310 Neutron Generator

Neutron Output	
Time-averaged Yield	10 ⁷ DD n/s max; 5x10 ⁸ DT n/s max
DD Neutron Energy	~2.5MeV (DT 14MeV option by special request)
Ion Source Type	Electrodeless RF
Pulse Options	Continuous, >50% duty factor optional
Max Neutron Flux	~1x10 ⁶ n/cm ² *s
Pulse Rate	0-1 kHz standard
Pulse Width	2-1000μs
Pulse Rise/Fall Time	< 5μs
Nominal Duty Factor	5-10%
Power and Operation	
Operating Voltage	up to 140kV
Power Requirements	Up to 100W
System Information	
Neutron Source Dimensions	3" OD x 18" L (7.6 cm OD x 46 cm L)
Neutron Source Weight	10 lbs (4.5 kg)
Supporting Hardware Dimensions	4" W x 6" H x 9" L (10 cm W x 15 cm H x 22 cm L)
Supporting Hardware Weight	4.0 lbs (1.8 kg)
Integrated cooling w/ Cowling Dimensions	3.5" OD, 22.5" length with fan
Warranty	500 operating hours, or 12 months

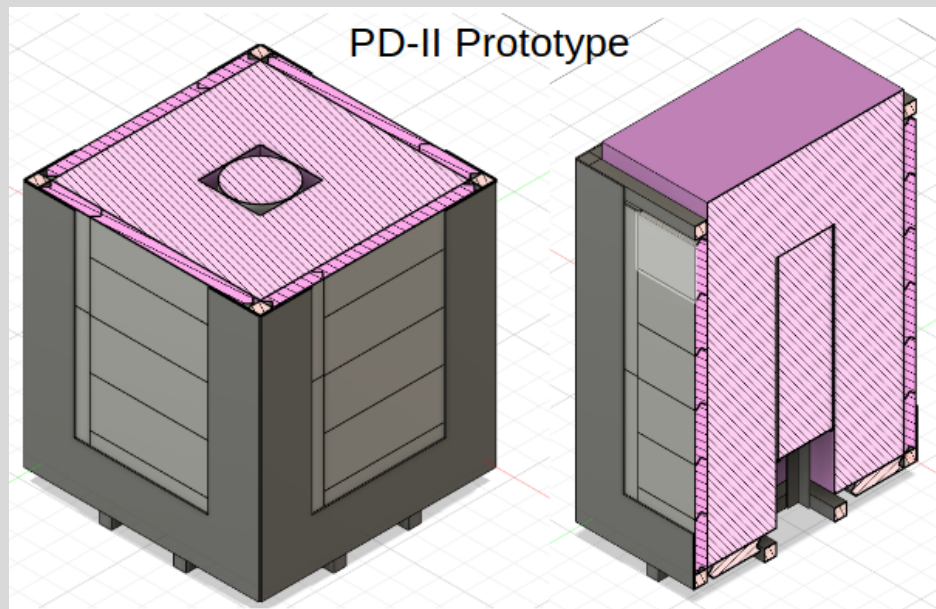
Starfire Generator

- Since the Collaboration Meeting we have received the Starfire generator, and performed a physical inspection – everything seems to look fine
 - Currently working with the safety officer at SDSMT to coordinate a safety review and first test with the new generator
 - First test will be to confirm the device is operational



ProtoDUNE-II PNS Prototype

- SD Mines will provide the final design and UC Davis will fabricate the mechanical supporting structure
 - Contractor has been found to cut the borated polyethylene to dimension for the prototype
 - Currently finalizing support structure design

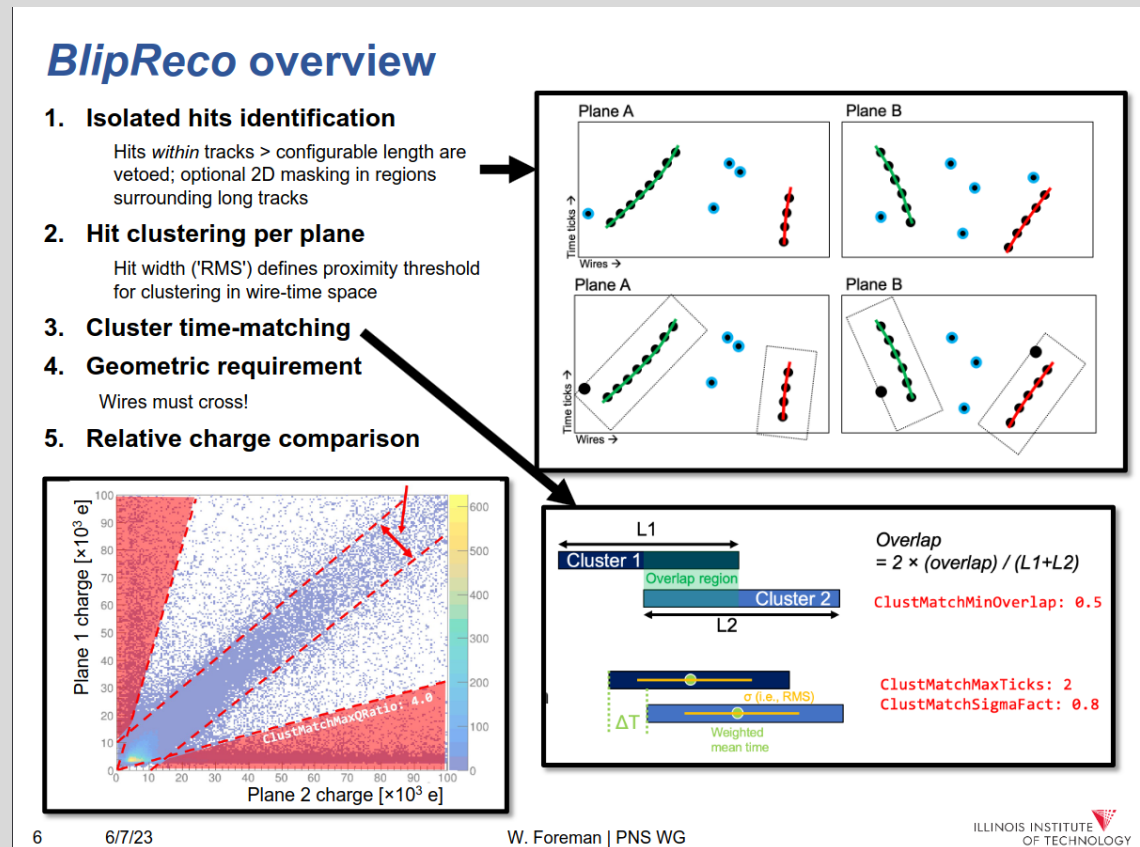


Simulation and Data Analysis

- Continuing to develop both the traditional and machine learning based approaches
- Machine Learning: Arrakis, BLIP, and HDBSCAN-PointNet (developed by Nicholas Carrera)
- Traditional: Hit clustering using DBScan algorithm, low energy specific reco techniques
 - Tools developed for 'blip' finding and reconstruction for MicroBoone will likely be made available for DUNE analysis soon

MicroBoone BlipReco Toolkit

- A comprehensive toolkit used to identify blips developed by Will Foreman
- More info in his talk at the PNS working group meeting
 - [Will's Talk](#)
- We expect these tools to be very useful for neutron capture ID



Neutron Cross Section Measurements

- ACED (LANL): Measured neutron capture cross sections at thermal energies
- ARTIE-I (LANL): Measured neutron total cross section for 20-70 keV. Paper has been published in PRC: [ARTIE-I](#)
- ARTIE-II (LANL): Measure neutron total cross section with smaller systematic uncertainties and wider energy range from 0 to 200 keV. Proposal submitted to LANL and has been accepted.
- MArEX@n-TOF (CERN): Multiple experiments planned. Measure neutron total cross section, neutron capture cross section from 0 to 500 MeV. LOI submitted to CERN (High pressure Gaseous argon target this year; Liquid argon target next year.)

Summary

- Starfire DD Generator has been received at SDSMT
 - Will perform tests following safety review
- PNS support structure design is near final
- Continuing to develop analysis algorithms
- ARTIE-I paper was published in PRC