

# High-Output Pulsed Power Source

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DOE SBIR Award DE-SC0021548

DOE NP SBIR/STTR Exchange Meeting, August 14, 2024

- Founded in 2004
- ~50 employees and growing
- 30,000 ft<sup>2</sup> headquarters in Santa Monica, CA



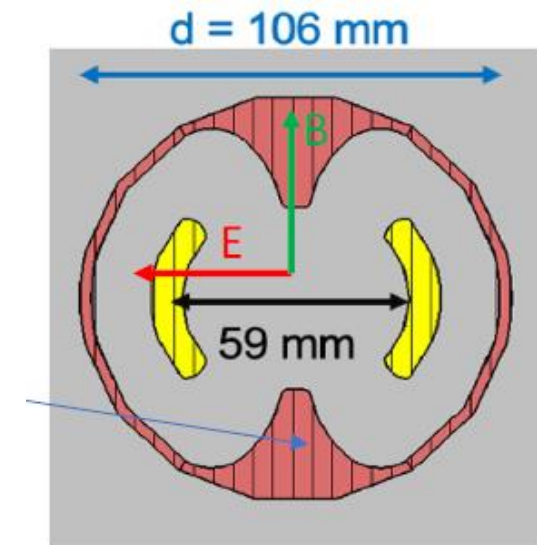
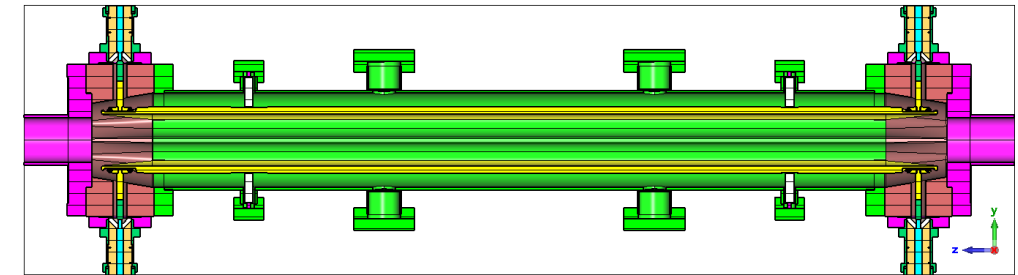
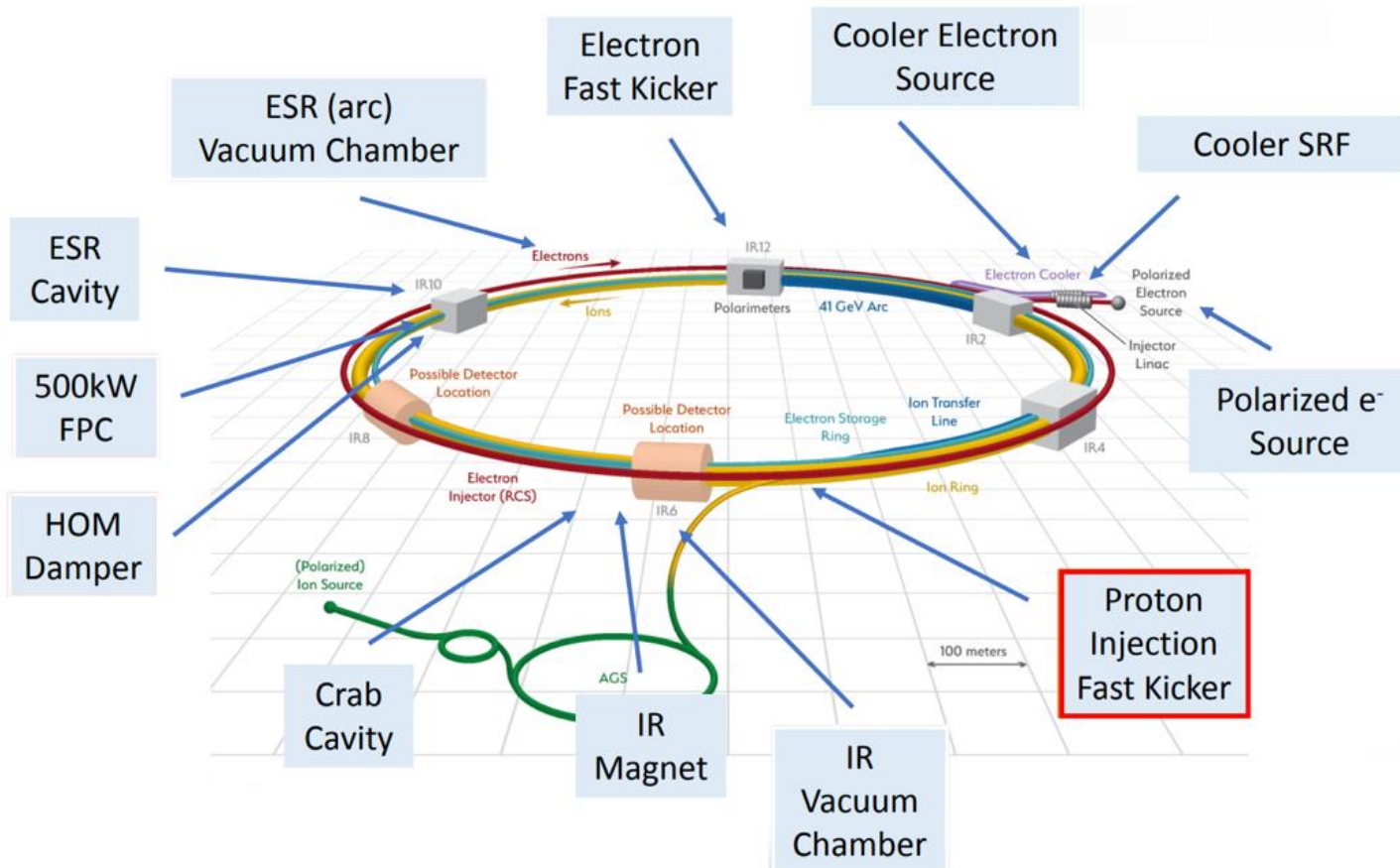
- Accelerator R&D, design, engineering, manufacturing and testing all under one roof in a dynamic, small-business setting



- Multiple CNC milling and turning centers, > \$3 million investment
- Dedicated “clean shop” for RF and UHV machining
- Full-suite of inspection equipment, including CMM
- 10 highly-skilled machinists
- ISO 9001 compliant quality system



- Brookhaven National Laboratory has recently been selected as the site for the Electron-Ion Collider (EIC). The EIC will consist of two intersecting accelerators, one producing an intense beam of electrons, the other a high-energy beam of protons or heavier atomic nuclei, which are steered into head-on collisions. One of the sections of the EIC beamline will require a hadron injection kicker system ( $\sim 20$  kickers)
- The injection kicker system for EIC will be required to support single bunch transfers with a bunching frequency of 24.6 MHz

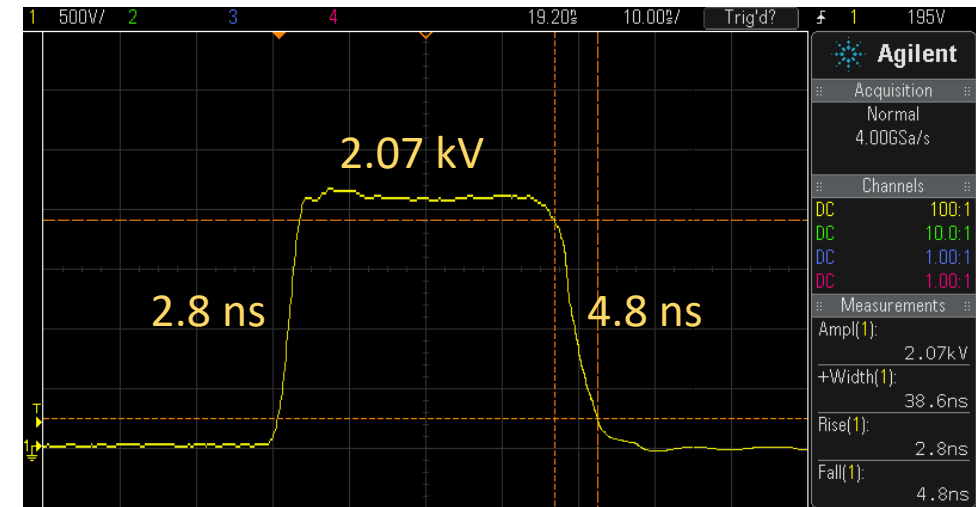


Parameter	Value	Achievements in RadiaBeam's Phase I
Peak Voltage / Current / Power	+/-50 kV / 1 kA / 50 MW	+5.8 kV / 116 A / 673 kW
Average power per channel	Up to 200 W	<3 W
Load Impedance	50 Ohm	50 Ohm
Pulse Width	40 ns including transition times	~40 ns
Rise/fall times	<10 ns each, <20 ns combined	<b>3.0ns / 3.6 ns</b>
Repetition rate	20 Hz normal operation, up to 100 Hz for lifetime test	Tested at 100 Hz for several hours

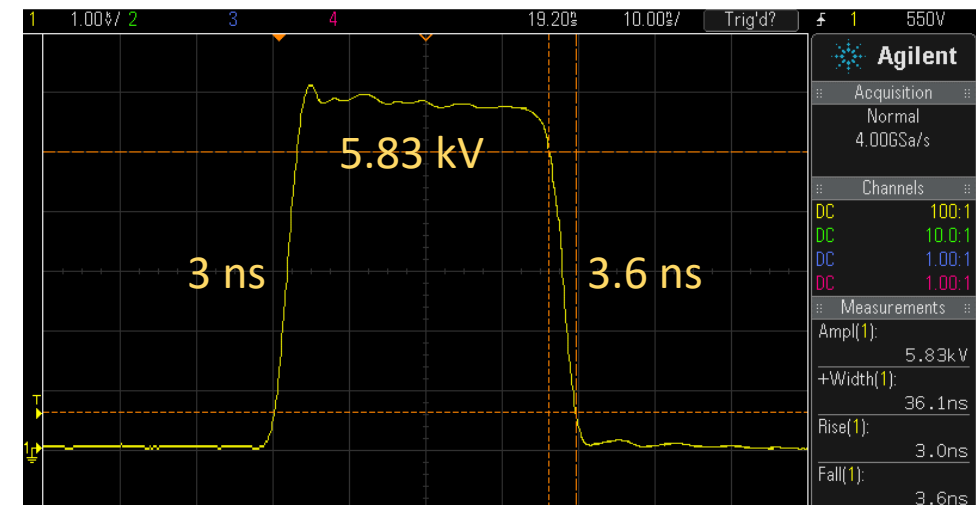
- 3x2 Marx cell configuration in each module: 2 kV / 116 A
- 3 x 2 kV / 116 A modules + PCB-based combiner



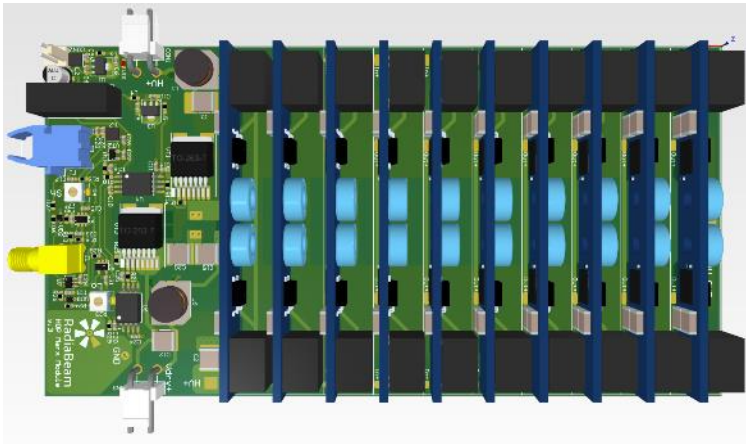
Single 2 kV / 116 A modules output waveform (16.6 Ohm)



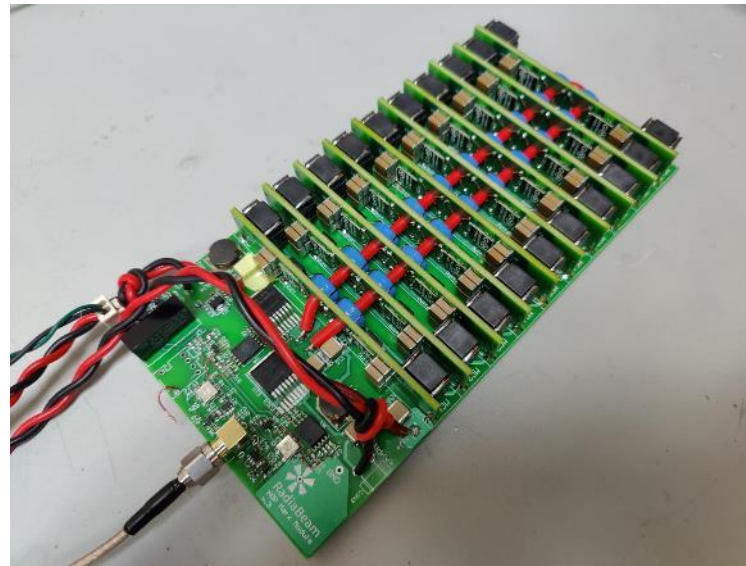
3 x 2 kV modules output waveform (5.83 kV / 116 A / 50 Ohm)



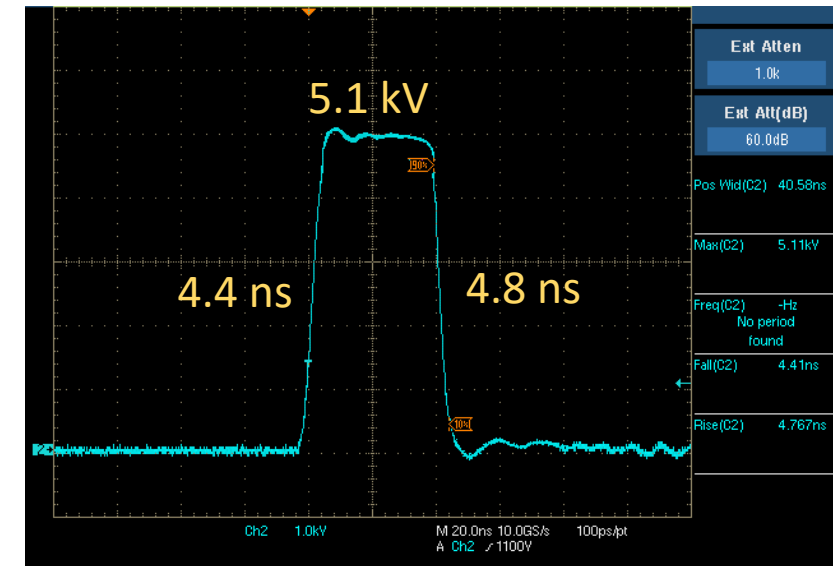
- 2 kV / 116 A -> 5 kV / 167 A
- Major module redesign: improved pulse parameters; compactness; ease of assembly
- 3x2 cells -> 10x2 cells; added protective diodes
- Driver improvements



3D design

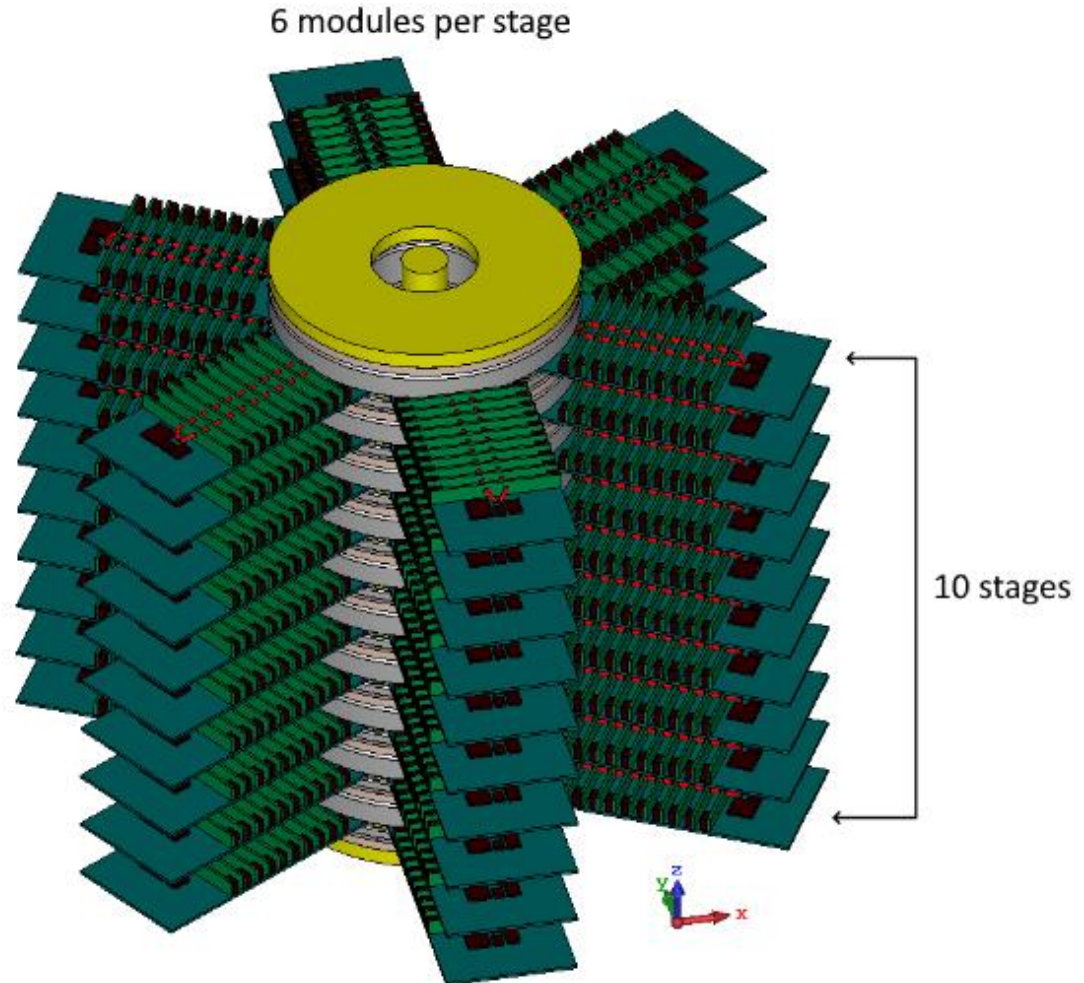
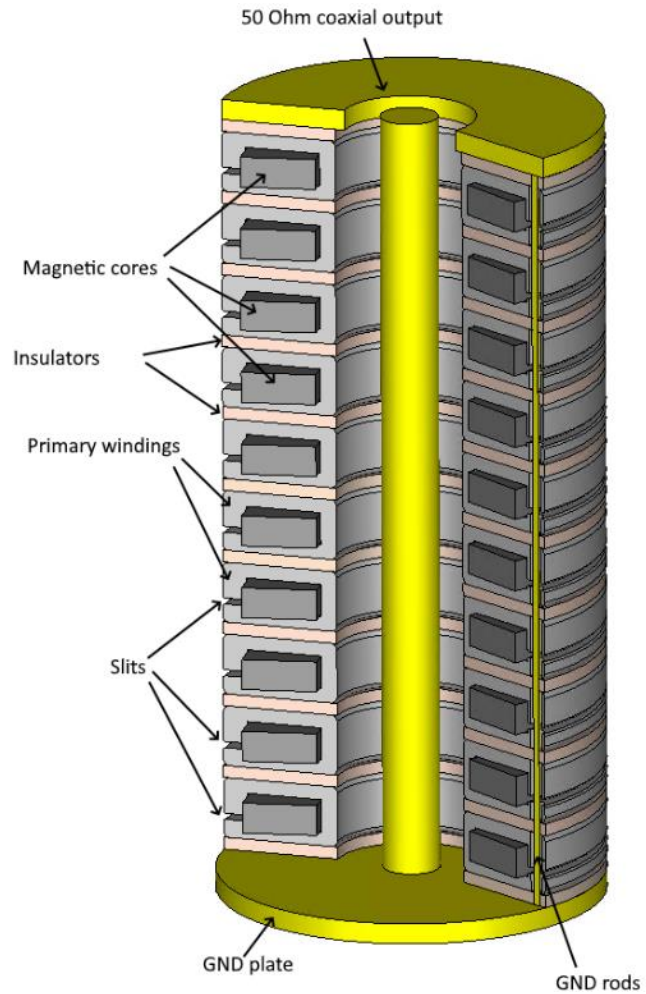


Assembled module



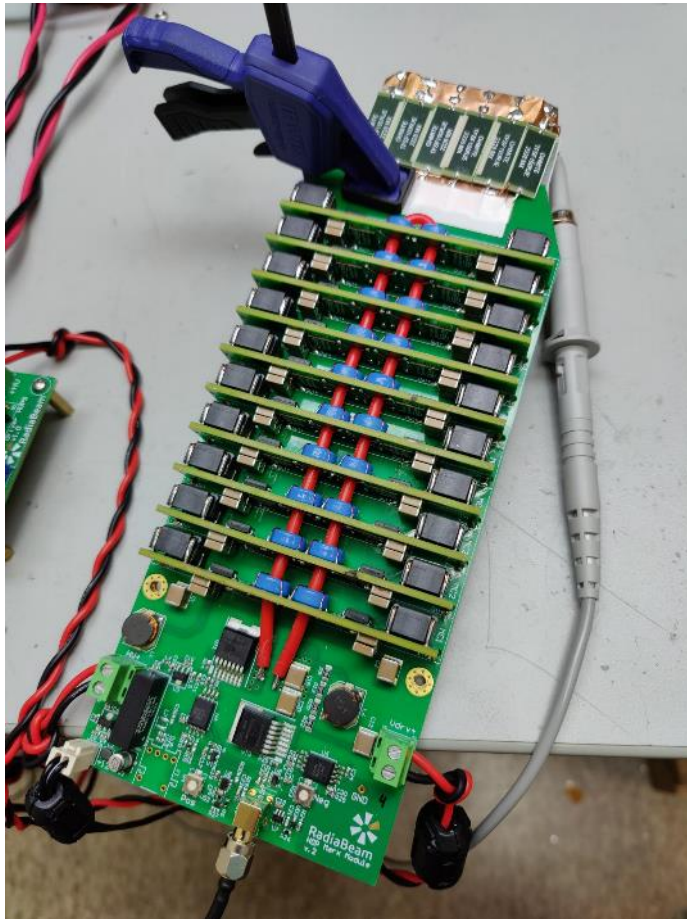
Measured 5.1 kV / 166 A (30 Ohm)

- 5 kV / 167 A modules
- 6 modules per stage = 1 kA; 10 stages = 50 kV – 50 Ohm equivalent

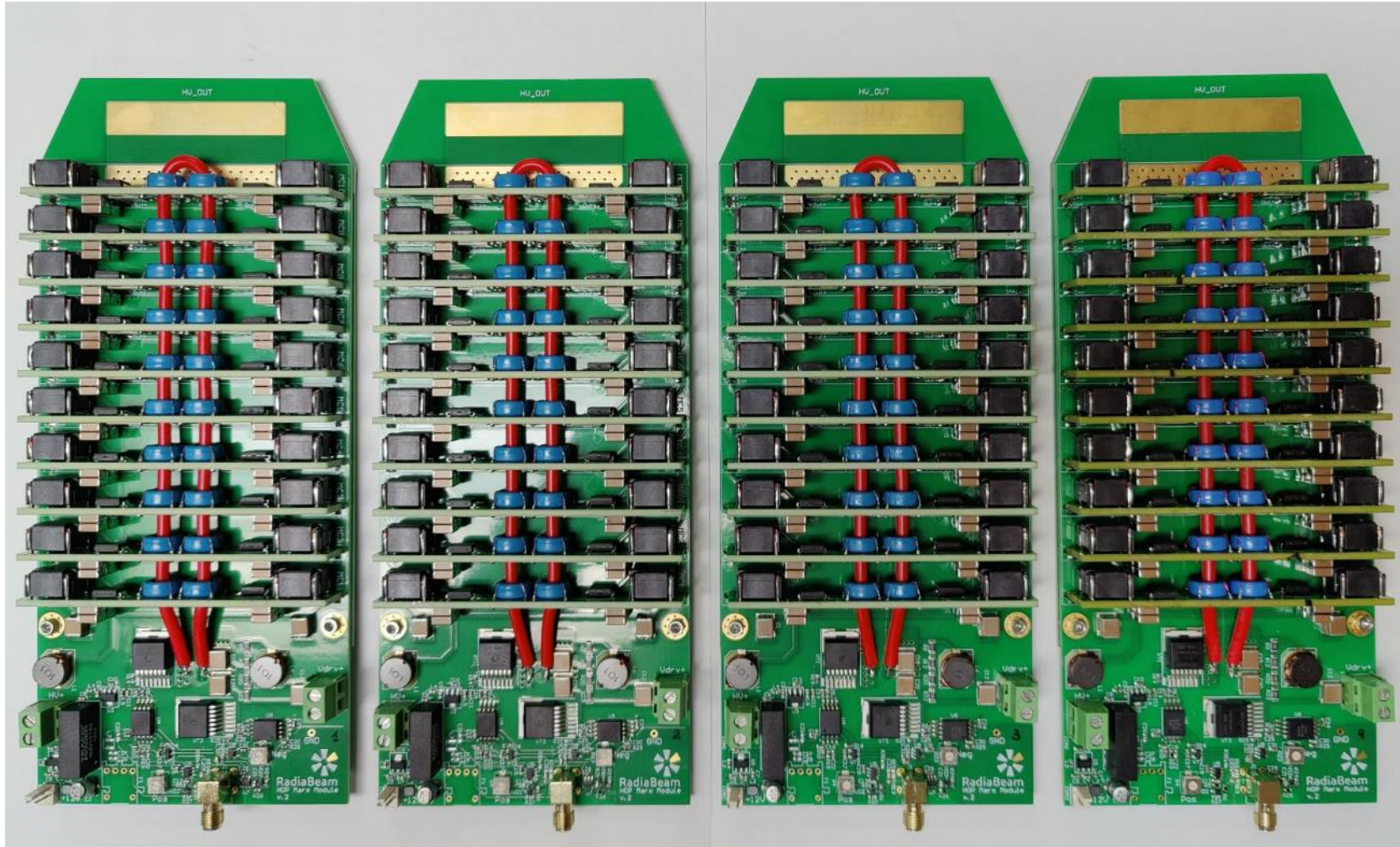




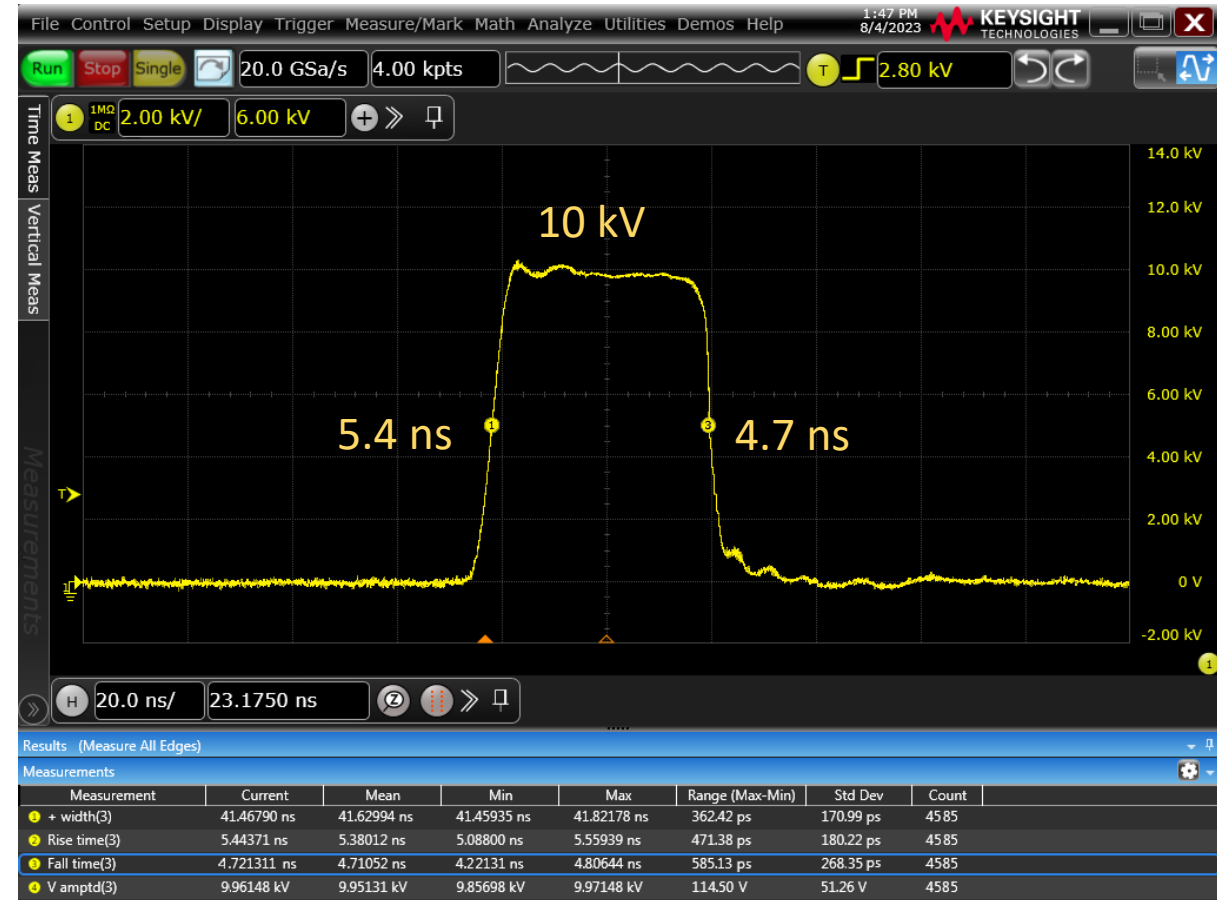
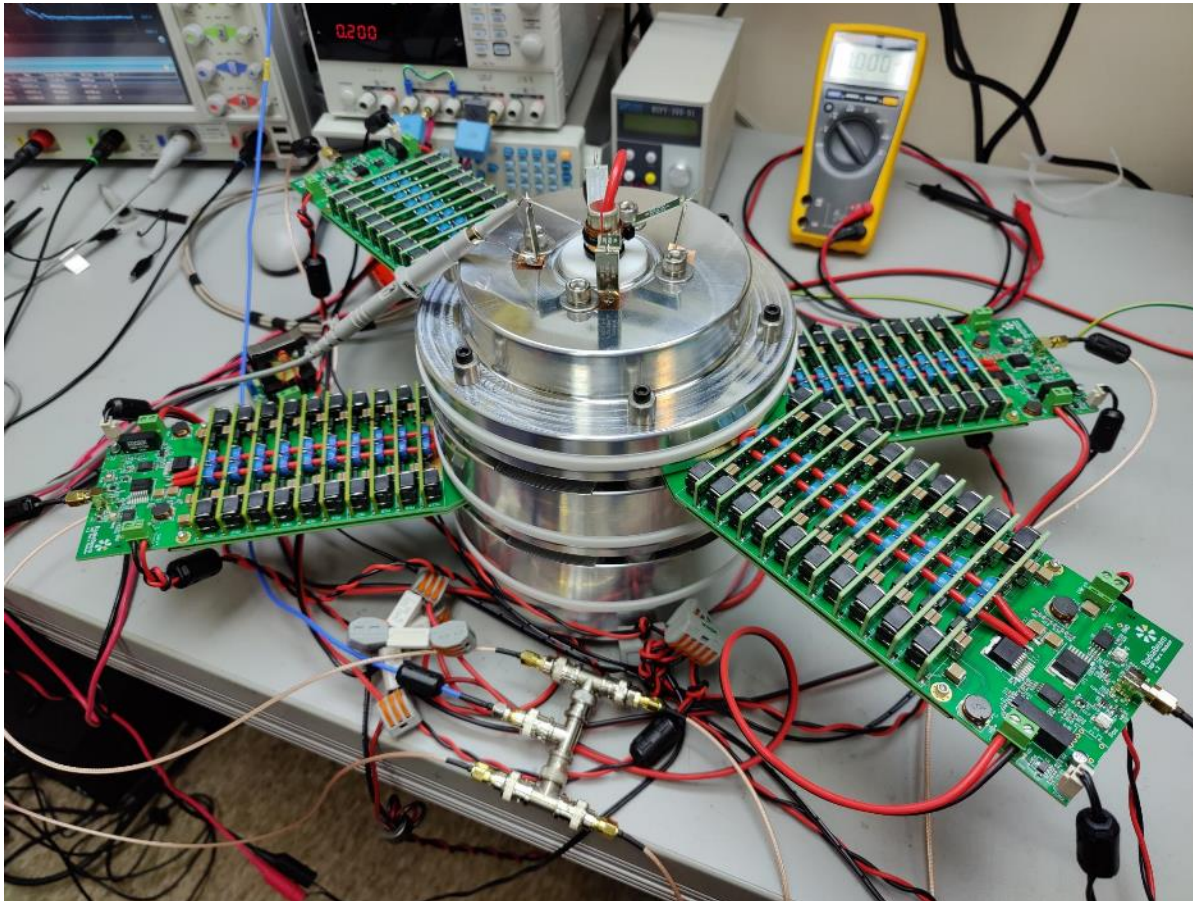
- 5 kV /166 A modules
- 10x2 Marx cells configuration – 30 Ohm load
- Rearranged + and GND terminals for easy connection to the IA



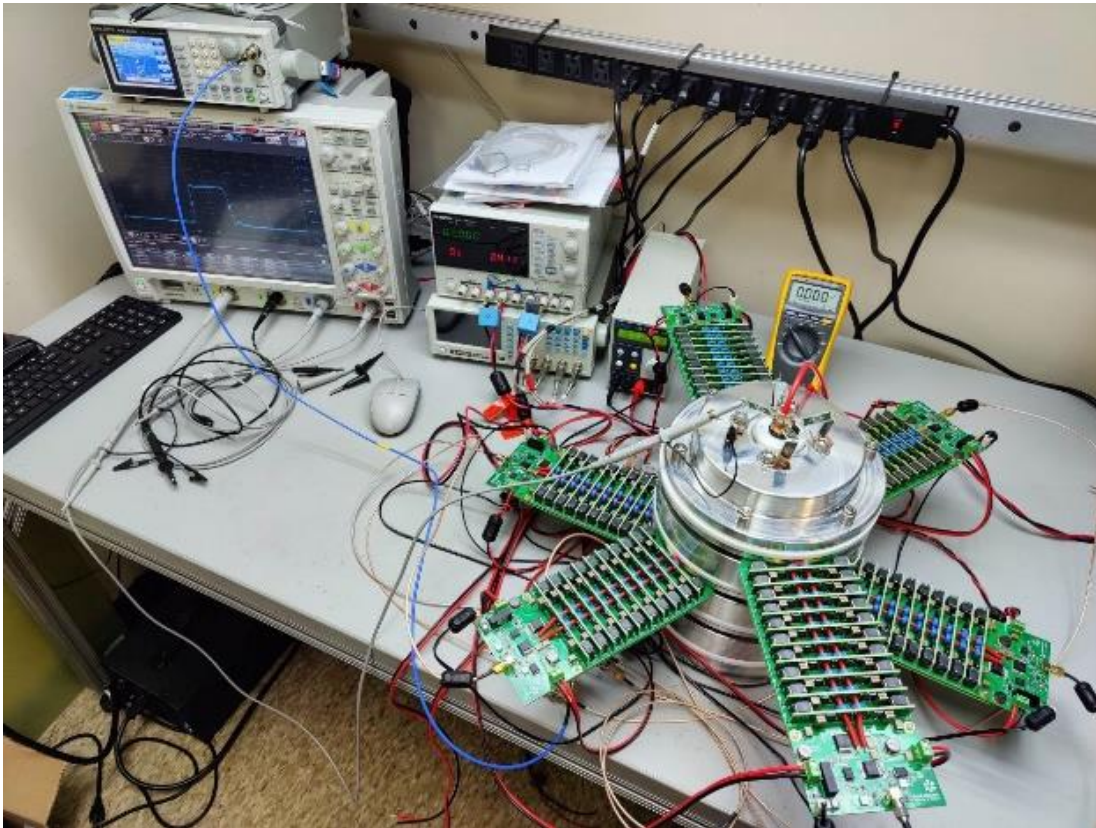
- 5 kV /166 A modules
- 10x2 Marx cells configuration – 30 Ohm load

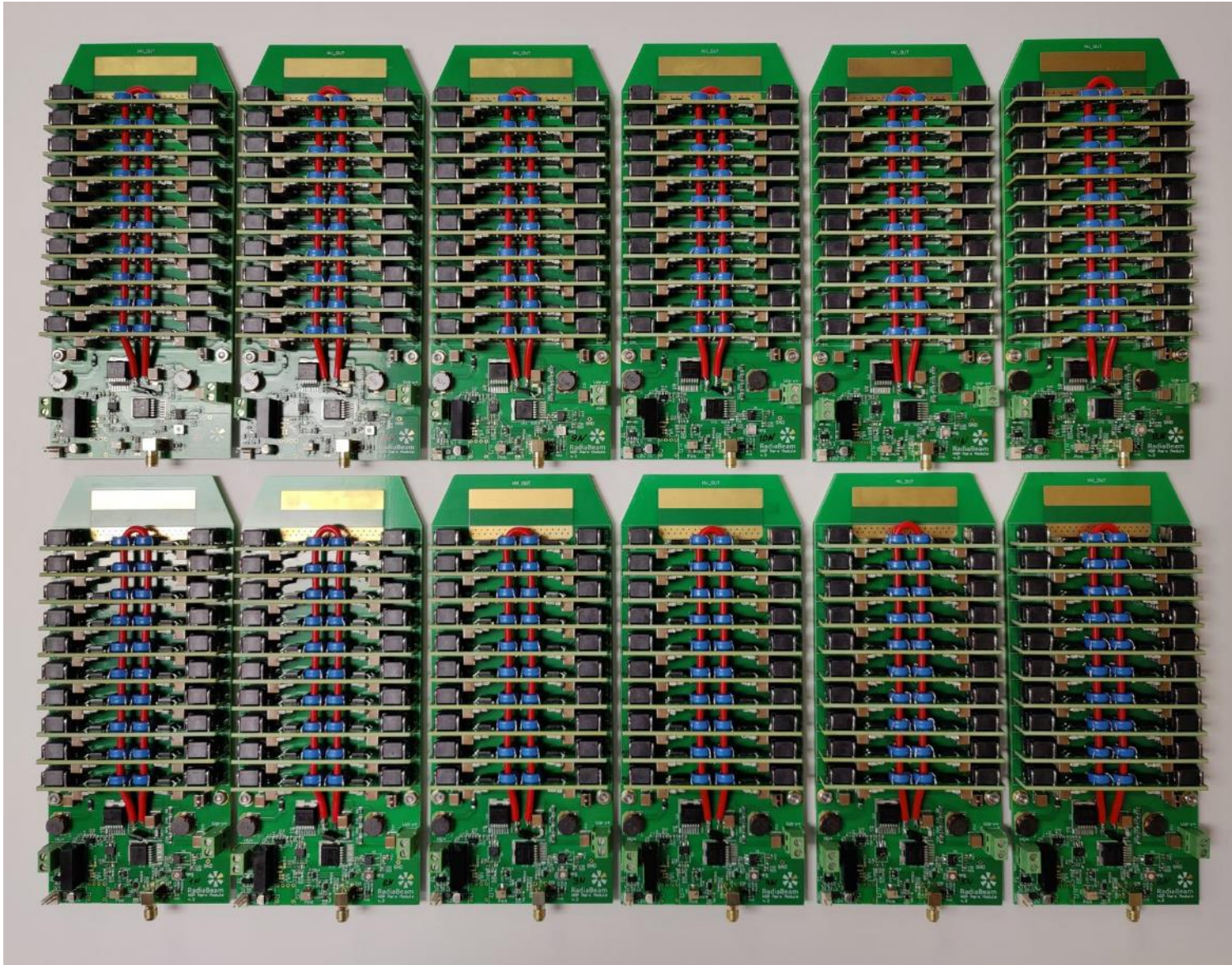


- 4 x 5 kV /166 A modules
- 2x2 Inductive adder configuration – 30 Ohm load

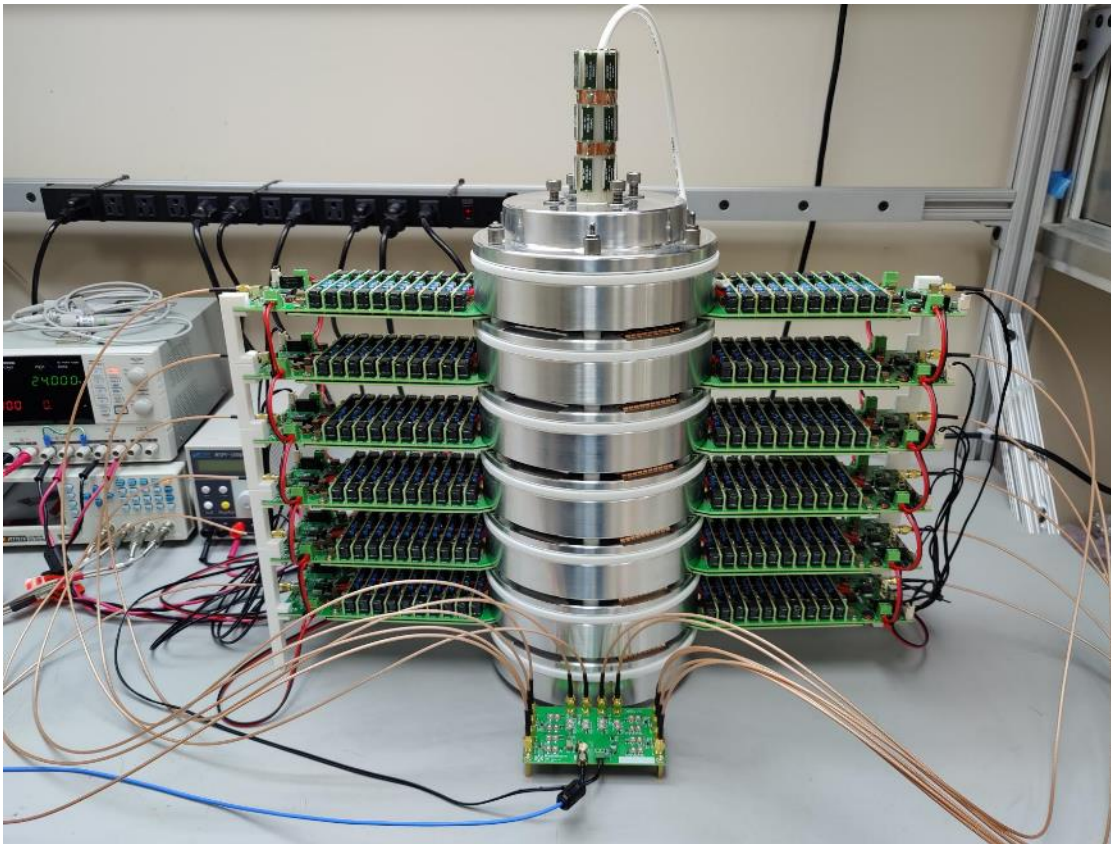


- 6 x 5 kV /166 A modules
- 3x2 Inductive adder configuration – 45 Ohm load





- 6 x 5 kV /166 A modules
- 6x2 Inductive adder configuration – 85 Ohm load



- Updated requirements from BNL HSR injector line:
  - 25 kV, 500 A
  - 35-40 ns pulse length
  - <8ns rise/fall,
  - 1 Hz operation
- 12 modules tested in 6 x 2 configuration;
  - 25 kV, 330 A achieved
  - 4.3 ns rise, 8 ns fall time
- Combine more modules in parallel:
  - test up to 30 kV, 600A in 6 x 4 modules operation,
  - so far 50% of this goal is achieved
- General modules revision
- Building positive and negative polarities channels
- Tests at BNL (TBD)