



DUNE Collaboration Meeting

W Pellico

Power over Fiber

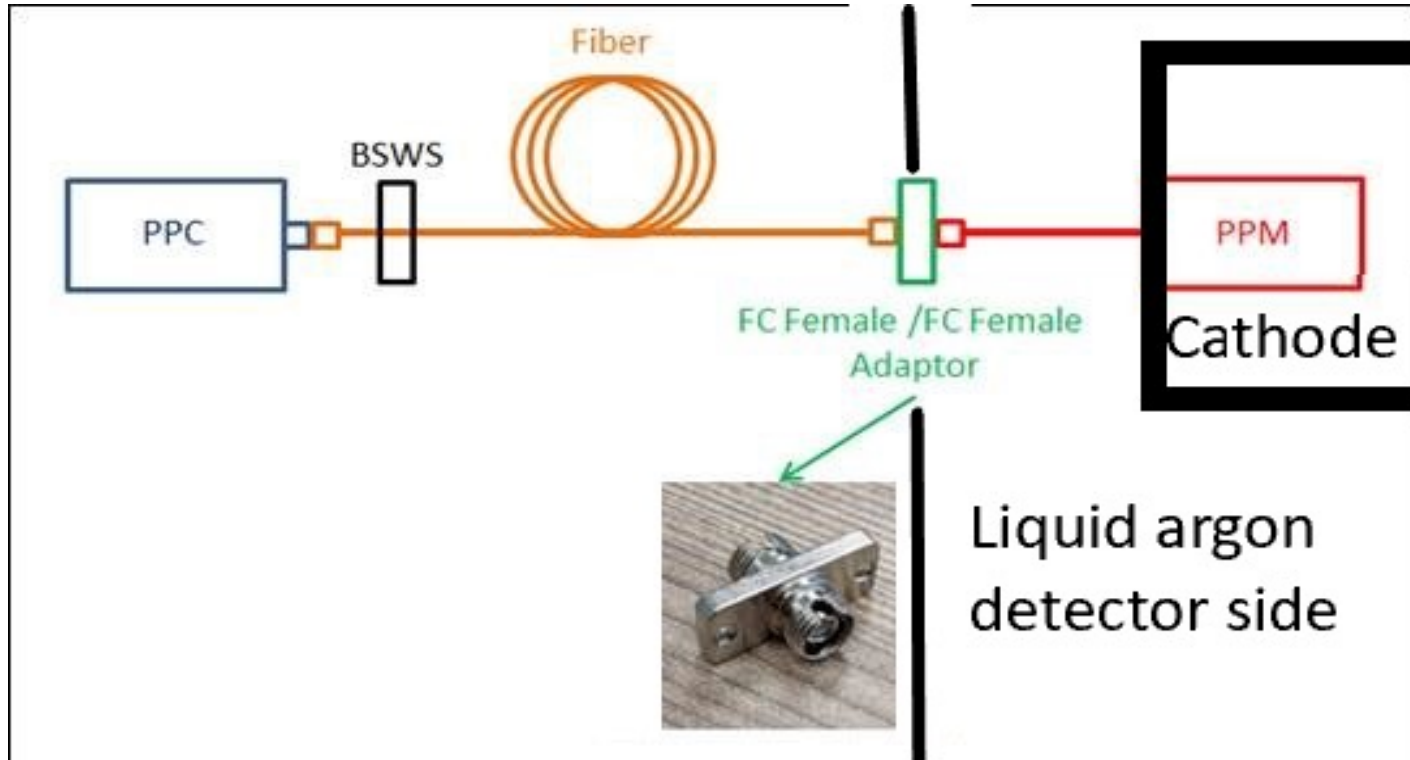
20-5-2021

Outline

- Power over Fiber (PoF) is relatively new technology
- Used for systems requiring isolation
 - Cell Towers
 - Transformer Yards
 - Low Noise Experimental Systems (isolation from noise)
 - Floating diagnostics systems safe from ground faults
- Rapidly developing technology that is aligned with solar systems
- Increasing used in military systems
 - Used with fiber or open-air laser system to power drones
 - Used to power remote sensors

DUNE

- Electronics on HV cathode is like many HV systems
 - Provides isolation
 - Low noise
 - Few components

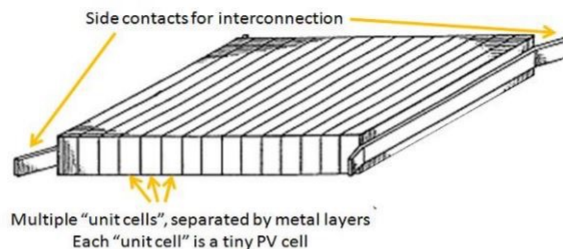
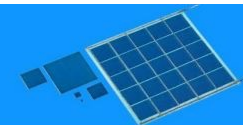


What are we doing – PoF R&D

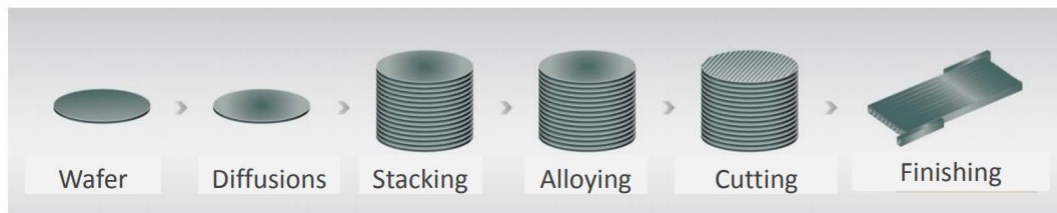
- 1. Can we meet power needs of SiPMs?**
- 2. Can we meet power needs of data pipeline electronics?**
 1. Analog systems look to require less power.
 2. Digital system – more power, possibly more voltage levels, higher current
- 3. Can we demonstrate/ensure system viability?**
 1. System redundancy
 2. System modeling
 3. Manufacturing process modification
- 4. Looking at vendor capabilities and options**
 1. Two vendors are working with us but in a limited way
- 5. Looking at universities**
 1. Several have shown interest – discussing roles/work

PV cell - PoF

Core Technology – MIH[®] VMJ PV Cell

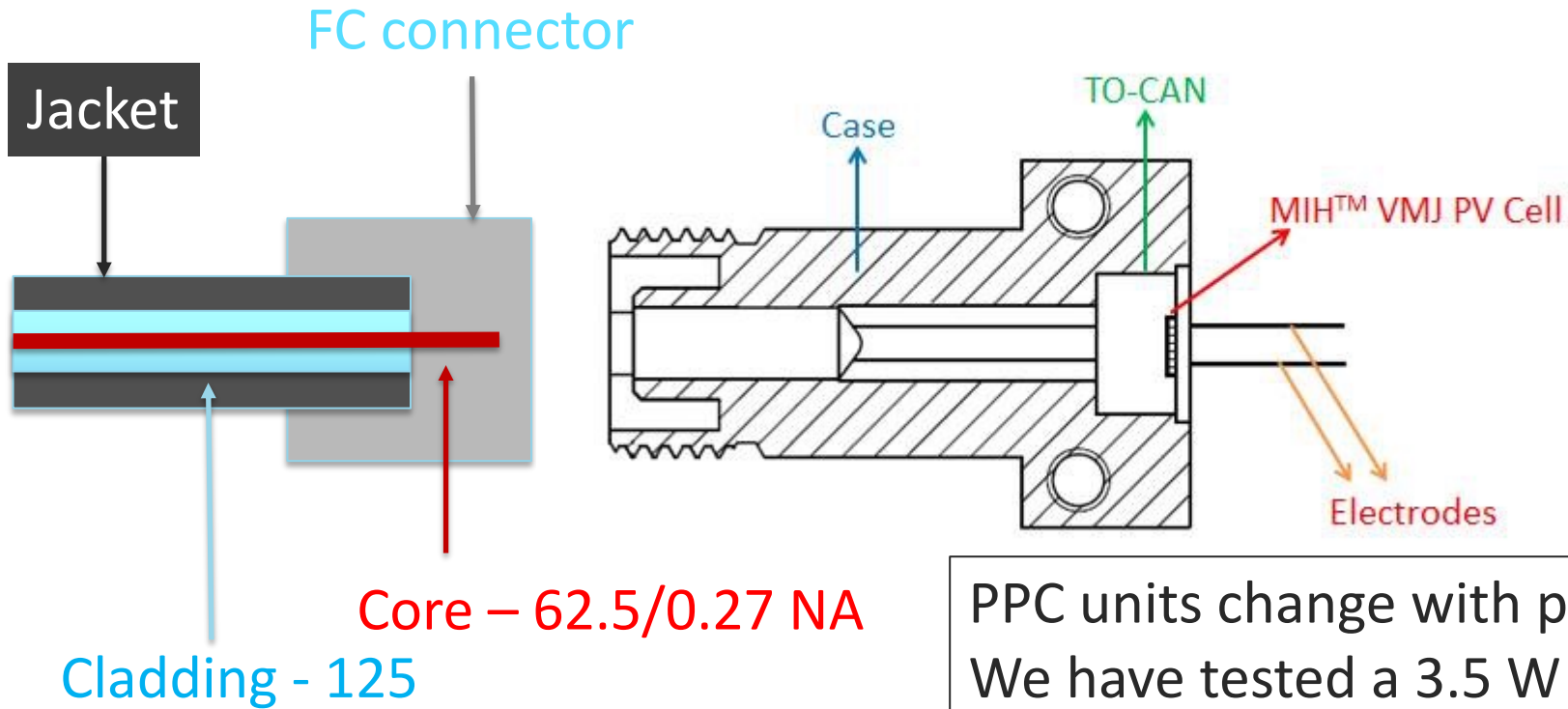


- Proprietary and patented silicon based **Vertical Multi-Junction (VMJ)** PV cell
- High power conversion efficiency ~40% with 9xx nm laser
- Customization – Voltage (up to 150V) 、 Size (1mm ~ 50mm)



The process is somewhat typical of semiconductor device manufacturing. This is a multistep process which uniquely designed for each voltage/current device. Higher power devices tend to have more layers with greater spacing. The process has more complexity for rare earth materials verses crystalline Silicon cells.

Fiber and Power converter unit



PPC units change with power
We have tested a 3.5 W and 12 W unit

Jacket material testing.

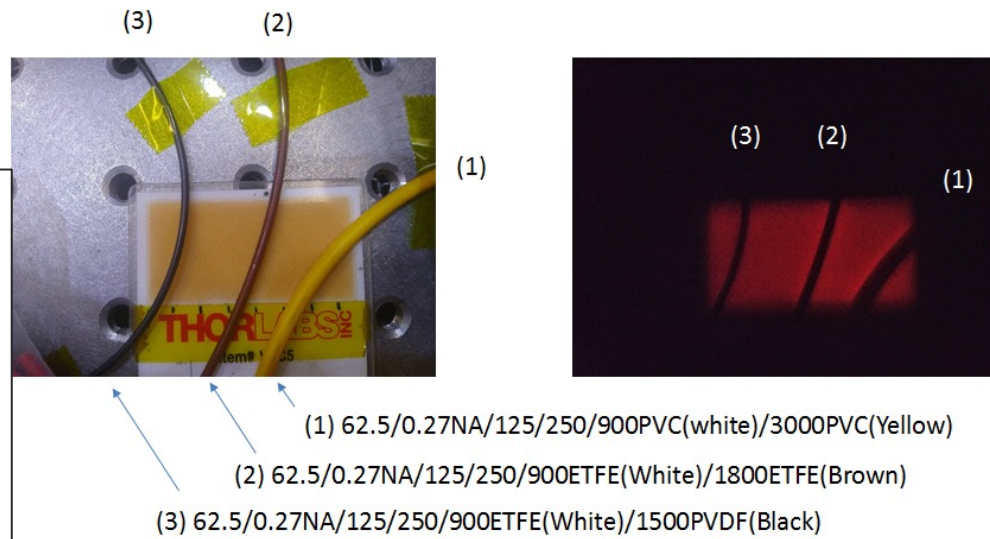
Cryo properties

Light leakage (running watts of light power)

Connector Style – FC has been dependable, but attention needs to be paid to connection.

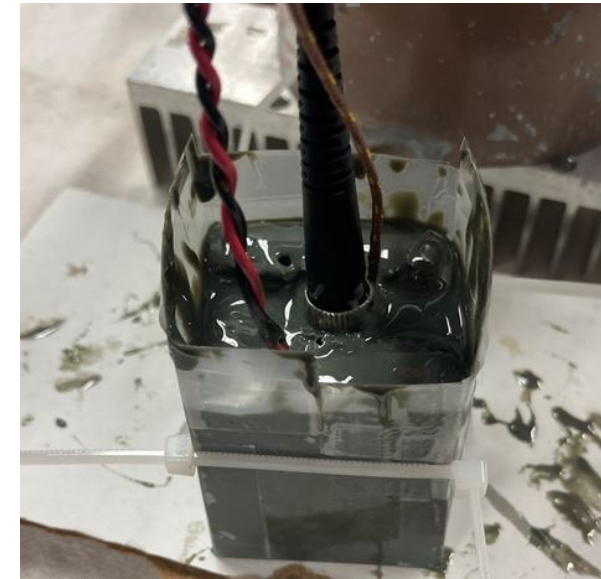
Cryo Testing

1. Fiber Jacket Material
 1. ETFE, PVC, PVDF
2. PPC Units: series and parallel
3. PPC efficiency
4. PPC stability
5. PPC heat loss – point sources
6. PPC potted units
7. Power converters/regulators
 1. Efficiency
8. Epoxy materials – Thermal/electrical properties
9. GaAs – building voltage specific units (+ tunable laser)



Present
Test

Next



Voltage – PoF System – R&D

1. PPC Output Voltage: By adjusting PV cell junction number, PPC output voltage can be set to the target voltage level.
2. PPC Efficiency: The efficiency is also related to the heat and bubble issues. The PV cell material and laser wavelength pretty much decide the efficiency, there's little room for improvement. Elevating the PV cell temperature shall be able to improve the efficiency, and this is the direction for efficiency improvement for silicon devices.
3. PPC Reliability: There're two different epoxies used in the PPC, and epoxies are organic which would be the weakest link for PPC reliability.
4. GaAs PPC units are better suited for low temperatures.
 1. Units from a vendor with FC connector being built for testing.
 2. Can be built for desired voltage – reducing the need for power converters.