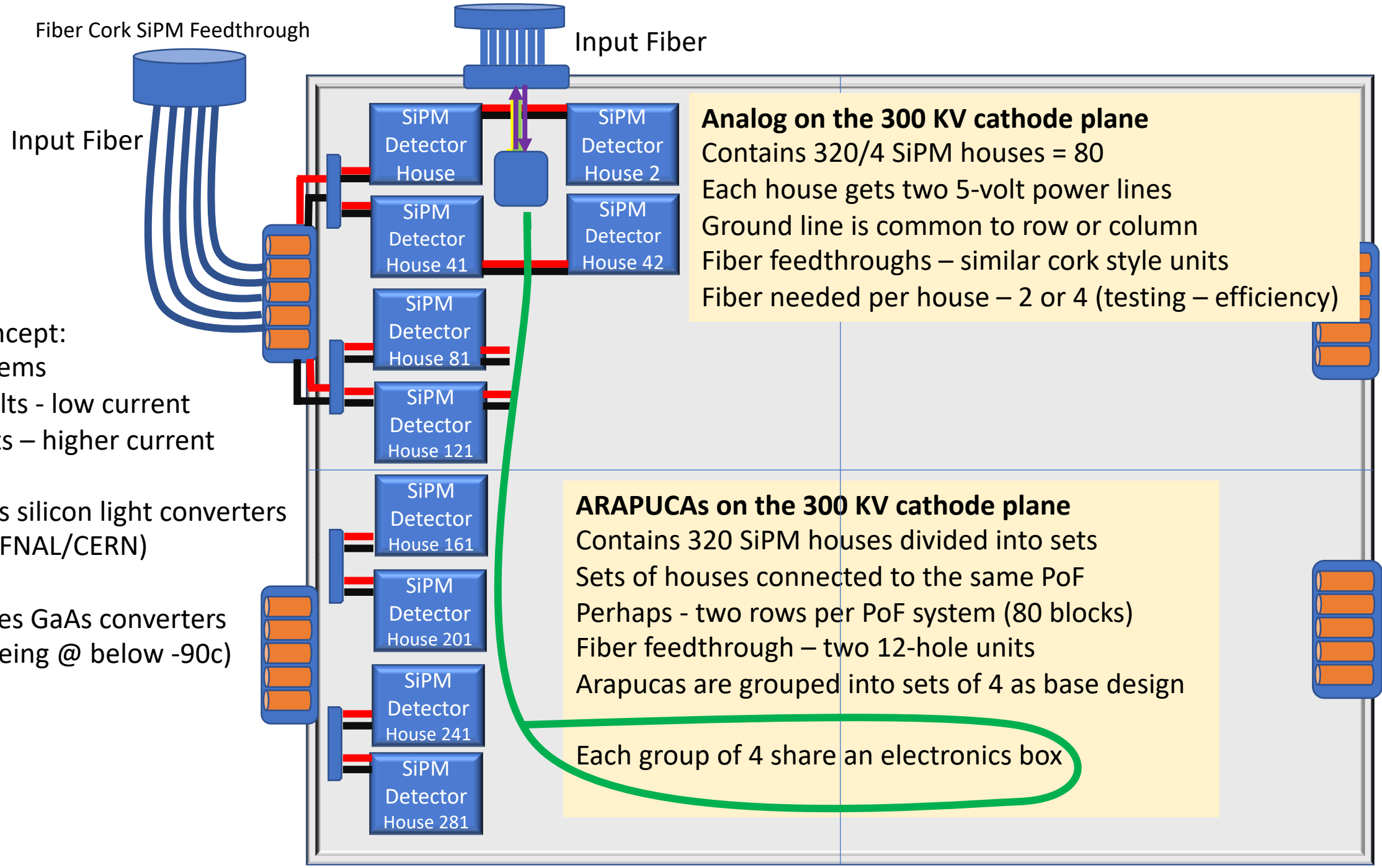
Power - Analog

VD-PD

W. Pellico

Analog Power/Arapuca – Assumptions

- Analog Transmitters:
  - Bias Current – est. 10-20 ma
  - Voltage – est. **5 volts**
  - Peak current 80 ma
  - Signal rate: 1 Hz
- Calibration pulse power
  - Op amp based/BJT - ramp
  - Peak current 90 ma
  - Voltage **5 volts**
  - Signal rate ?
- Electronics
  - Summing Op amp
    - 30 ma
    - **3 – 5 volts**
  - Tigger chip –
    - Buffer Amp Chip - fanout
    - <5 ma
    - 5 Volts
- SiPMs
  - Bias Voltage
    - **48-50 Volts**
  - Current (~5ua/SiPM)

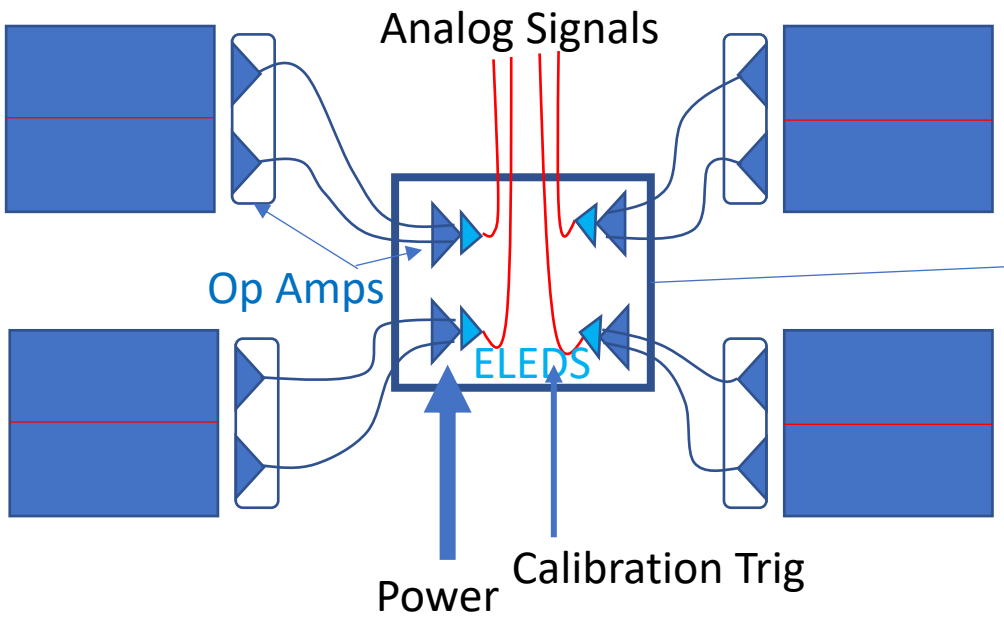


Base PoF Concept:
Two PoF systems
One @ 48 volts - low current
One @ 5 volts – higher current

The 48 V uses silicon light converters
(as tested at FNAL/CERN)

The 5 volt uses GaAs converters
(tested at Boeing @ below -90c)

Electronics Box



- Each Arapuca transmits two analog signals to the electronics box
- A summing amp combines both analog signals
- An analog transmitter, Tx (and conditioning electronics) transmits
- A calibration circuit (receives an ext. trig and plays a ramp into Tx)

This configuration will require 320 ELEDS/Cables - Verses 640 if each channel has a analog transmitter
Power for the op amps near the Arapuca may come from SiPM power units
Power for op amps and transmitters in the electronic box will come from power voltage fanout

PoF System/Hardware

- ***Cathode SiPMs***
  - 320 ARAPUCAs
  - Divided into sectors (4 – 6)
  - 48 Volts +/- 80 mv
  - 50 ma (DC) / Sector (assuming 5ua/SiPM)
  - Some storage capacitance at housing units

  Tested power (FNAL/CERN)

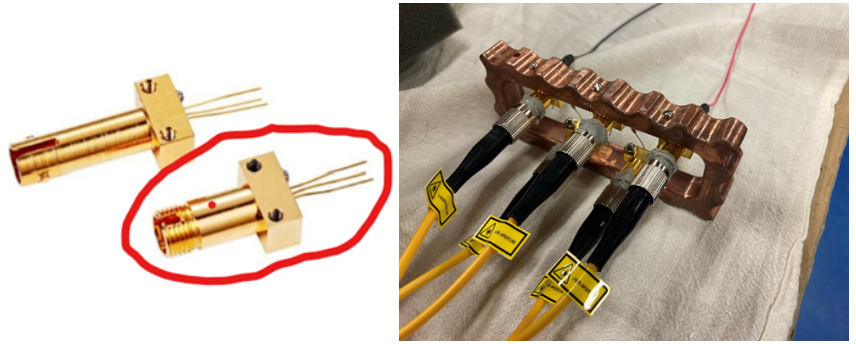
  Certified 48 v

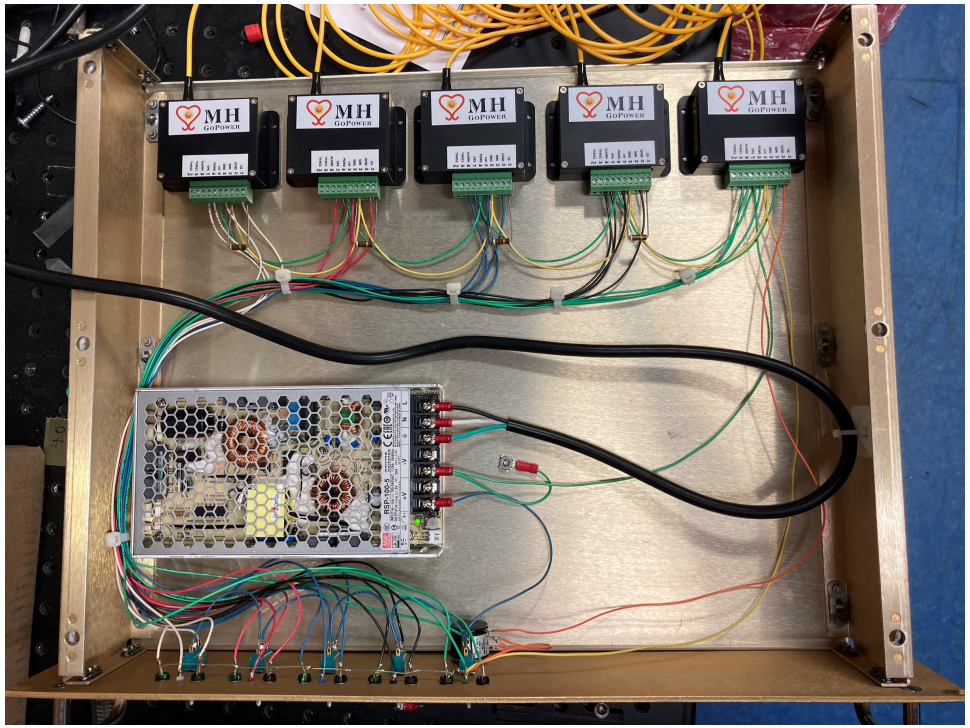
  Certified short-term stability

  Verified power vs load

  <u>Need to verify long term viability</u>

  <u>Test DC-DC converter to handle load variations</u>





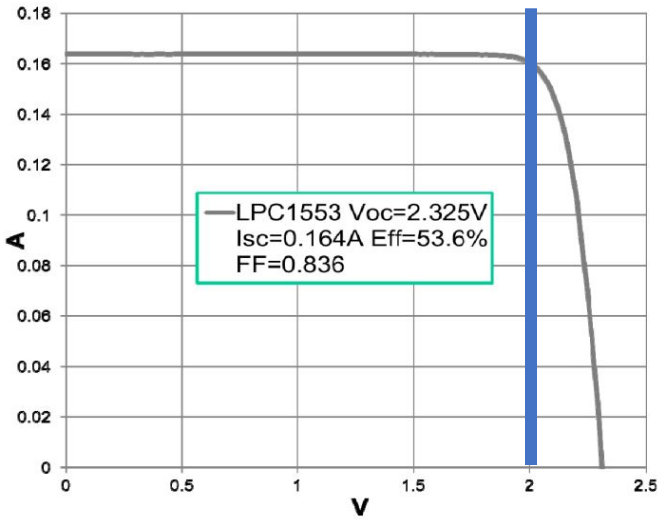
PoF Electronics Box

- Two Higher Current / Lower Voltage Options

1. Like Arapuca PoF – Silicon based but larger
   - Testing for past five months -
2. GaAs Units: More efficient in cold –

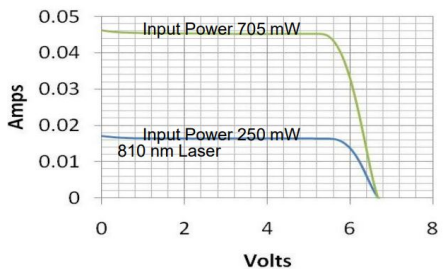
- No electron carrier ‘freeze-out’
- Devices are at least 50% efficient and often reach over 60% when tested warm.
- Lower voltage but higher current (off the shelf).
  - Vendor recommends higher power units for testing
  - Can run up to 4 Watts

Typical Laser Power Converter I-V Characteristics

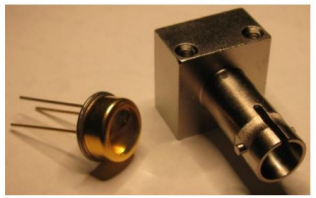


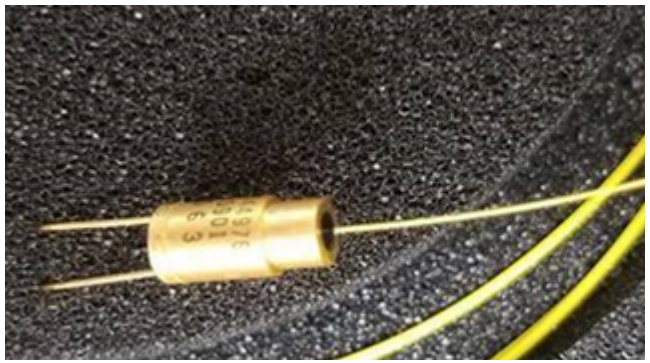
Temperature Coefficients for Dual Junction PV Laser Power Converter		
600mW Illumination		
I_{sc}	-1.04E-04	A/ºC
V_{oc}	-2.87E-03	V/ºC
P_{max}	-6.55E-04	W/ºC
Efficiency	-0.11	%/ºC Abs
V_{pmax}	-2.80E-03	V/ºC

I-V Data versus Input power



6V LPC Package





Analog Power Estimates

- Arapuca
  - <1ma (all SiPMs)
  - 48 volts
    - Power per Arapuca = 48*1ma=.048W
  - Op amp (two)
    - 10 – 30 ma @5 volt
    - Power = .1 W - .3 W
  - SiPM total: 320ma@48 Volts ~100 mW
  - Op amps: 320* .1 = **32 W** or **96 W**
- **TOTAL = 100mW + 32W = 32.1W**

- Electronics Box
  - 4 Transmitters
    - 200 mW bias (10ma@5V*4)
    - .Tx Power 1.6 W (80ma @5V)*4
  - Op amp summer
    - 4 op amps
      - 5 V @ 10 ma *4 = .2 W
  - Calibration chip/trigger
    - .01 amps @ 5 volts= .05 W/Box
    - .085 amps @3.3 volts= .28 W/Box
- **Cathode TOTAL = .2 W+ 1.6W .28 W = 166 W**
- **FC TOTAL = 400 W (Shared electronics box)**
- **4 PoF fiber per Electronics box – conservative**