Implementation of ATLAS Phase-1 Upgrade Components for LAr Calorimetry & TDAQ Systems

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ATLAS Experiment

- Largest collaboration at CERN

- Tests predictions of the Standard Model and looks for new interactions and new particles (like the Higgs)

HL-LHC: 2026

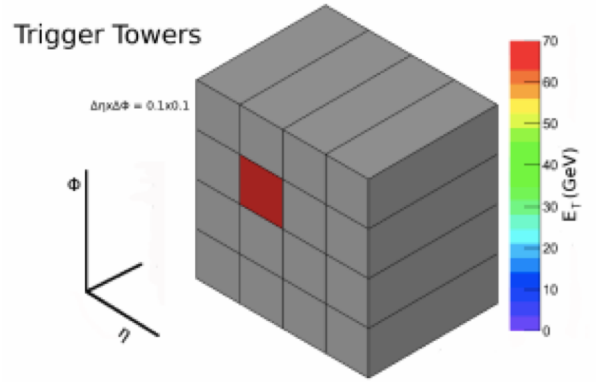
- Higher luminosity, up to 200 interactions per bunch crossing and instantaneous luminosities of 5-7.5 x 10^{34} cm^{-2} s^{-1}

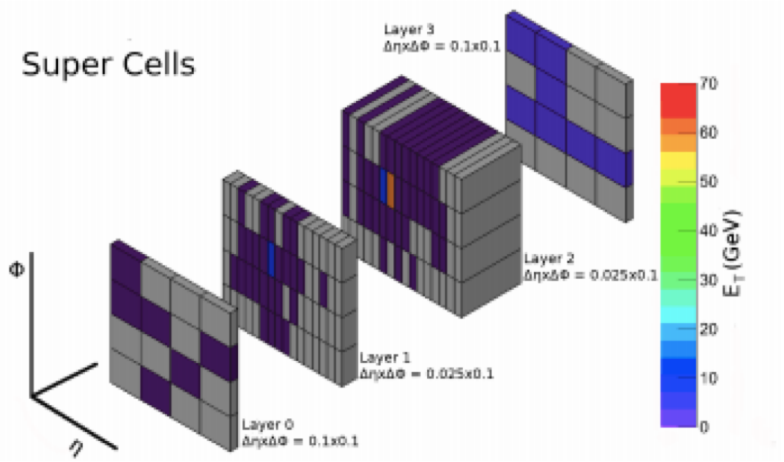
- Increase data points by an order of magnitude

- Investigate high energy and statistically rare events to better understand physics beyond the Standard Model

Lar Phase-1 Upgrades

Increased Granularity (Supercells)



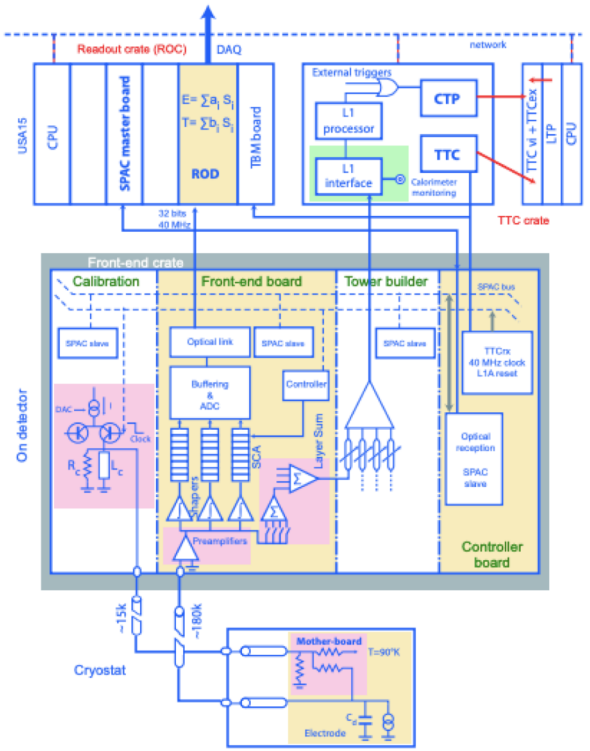


- Allow for lower trigger thresholds with the same accuracy

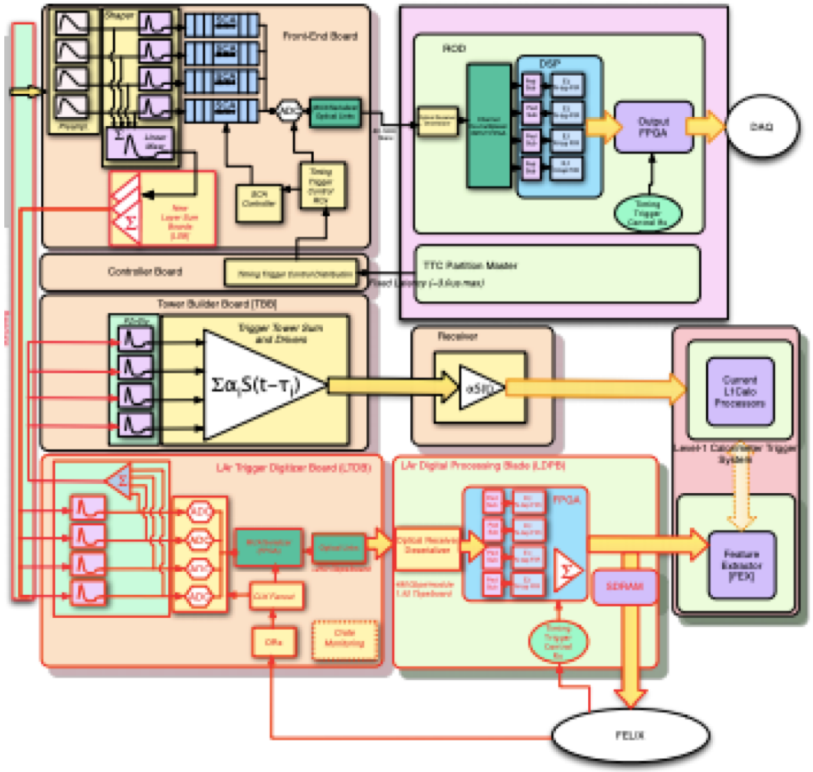
- Allow for deployment of more advanced algorithms that produce data that are more easily understood

Lar Phase-1 Upgrades

Updated Front End Readout Electronics

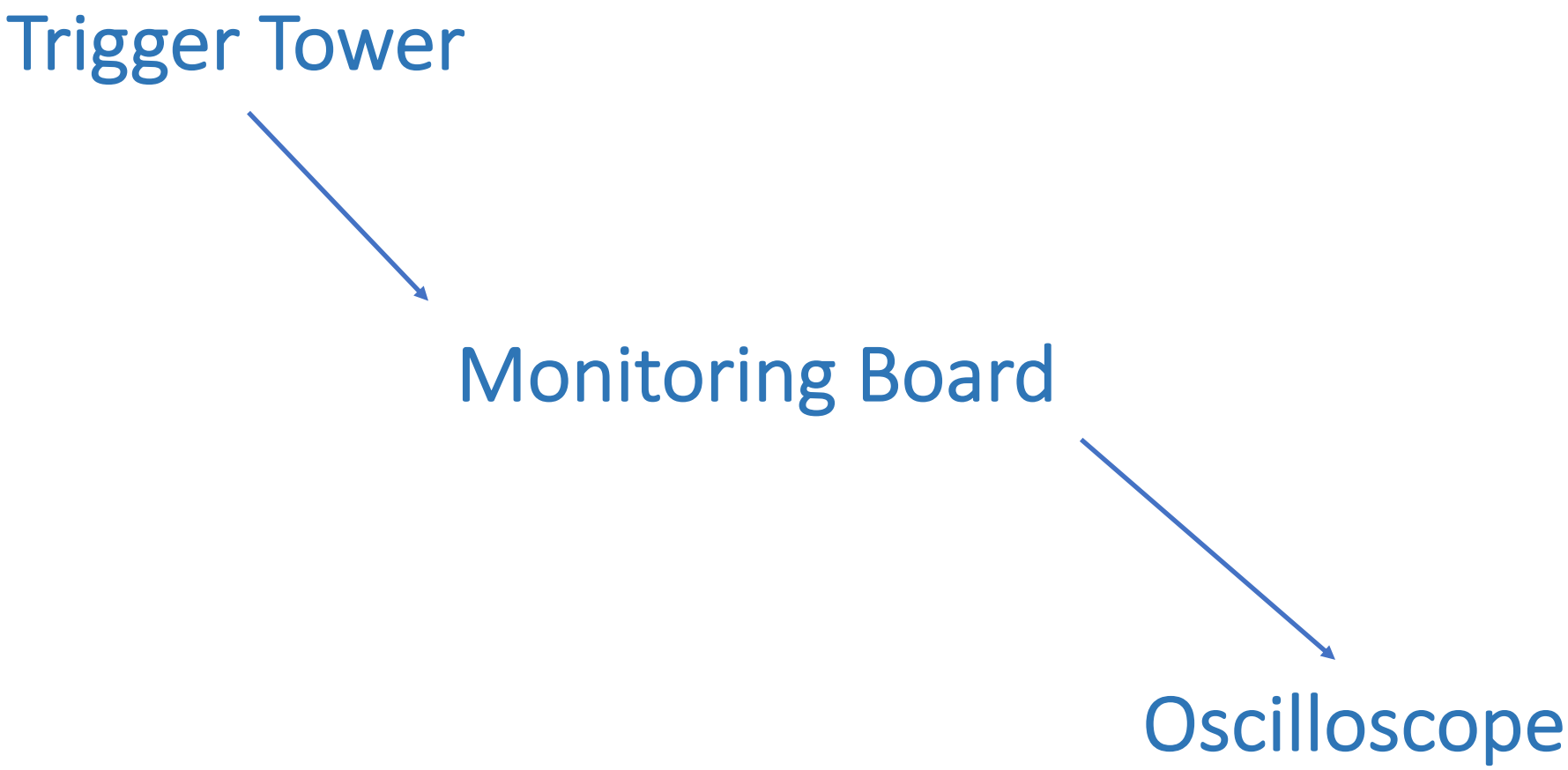


Legacy

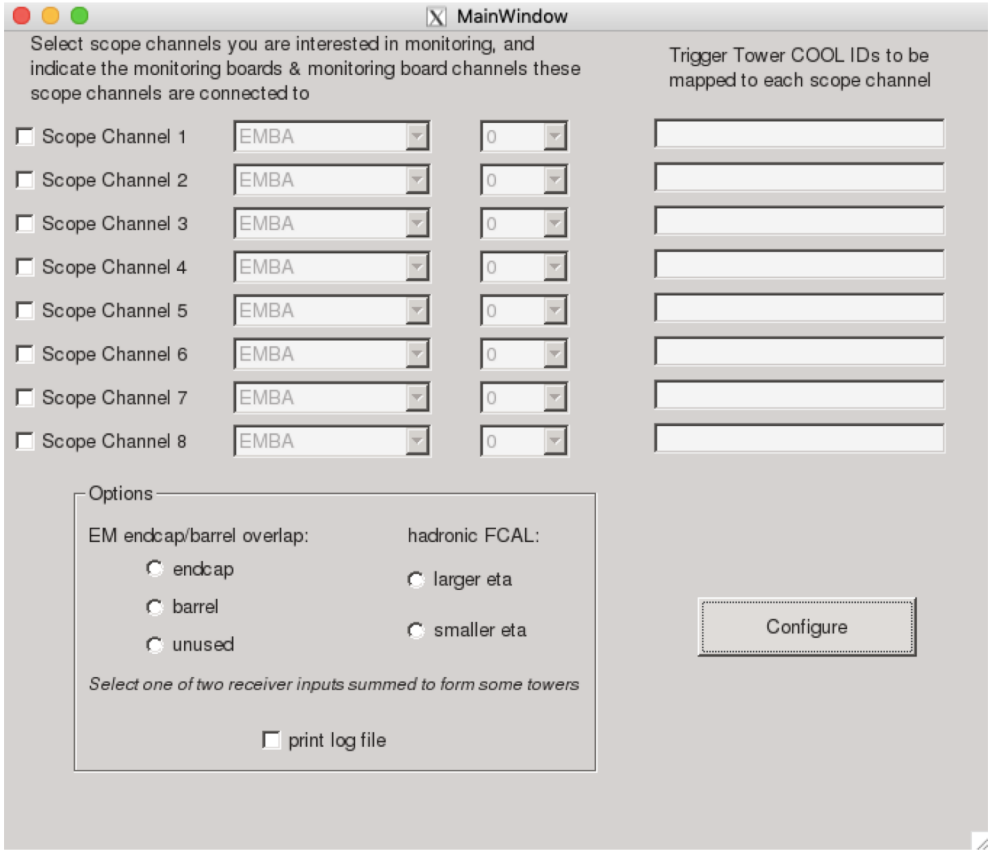


Updated

Monitoring Board Configuration



Monitoring Board Configuration



Trigger Timing Control (TTC)

Legacy System

- **ROD Busy**
  - Collect Busy from ROD crates
  - Transmit the OR to the LTP
  - Produce Statistics on the Busy
- **LTP** (Local Trigger processor)
  - Receives TTC signals from CTP/LTPI/LTP chain
  - Can be a local generator of these signals
  - Transmits them to the TTCvi
  - Receives Busy and transmits it to the CTP/LTPI/LTP chain
- **TTCvi**
  - Generates the 2 channels (A & B) used for transmission of the TTC information.
- **TTCex**
  - Encodes the 2 channels on one signal and converts it to optical (up to 10 outputs)

Trigger Timing Control (TTC)

ATLAS Local Trigger Interface (ALTI)

- **Performs all the functions of the four boards in the legacy system in a single board**

- **Less boards/connections means less opportunities for hardware to fail**

- **Added functionality:**
  - **Snapshot memory**
  - **Phase shift programming**
  - **TTC signal analyzer (can monitor its own signal)**
  - **Mini Central Trigger Processing (can be its own master)**

- ***Completely backwards compatible with the current system***

ALTi Power Measurement Procedure

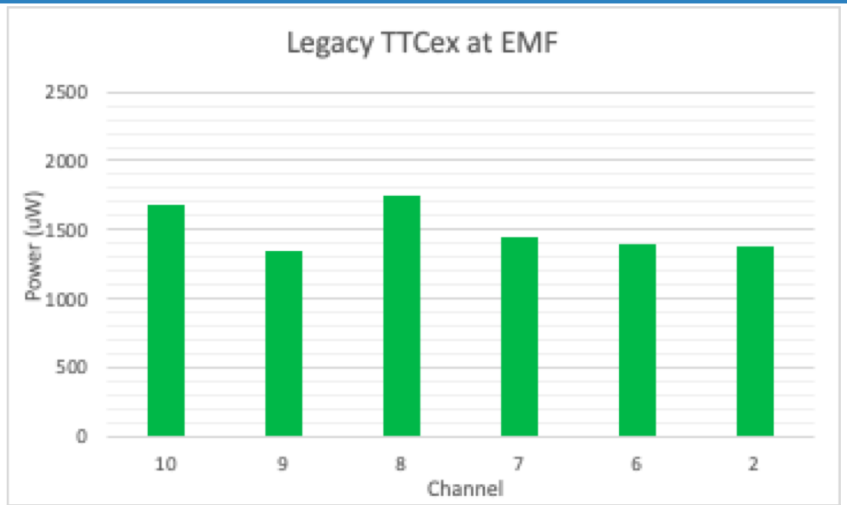
- Measured optical power from legacy TTCex transmitters at EMF and P1 as a baseline

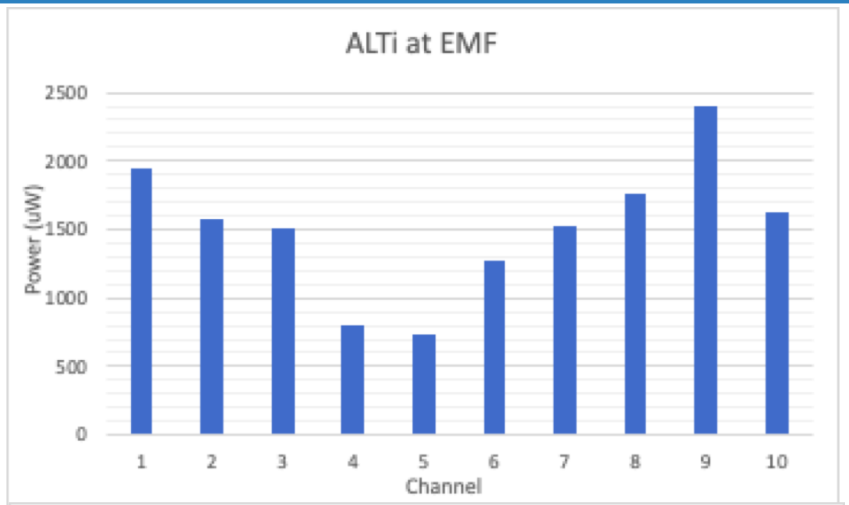
- Measured optical power from all 10 ALTi transmitters at EMF and P1
  - with individual transmitters turned on and with all 12 transmitters turned on

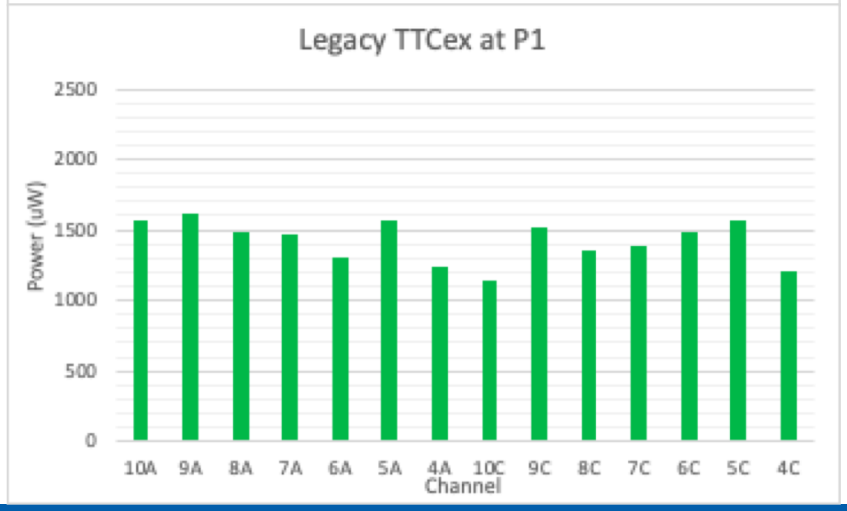
- Measured optical power from TTCex directly before front end crate (FEC) at EMF
  - after signal travels through an attenuator and fiber that mimics P1 set up

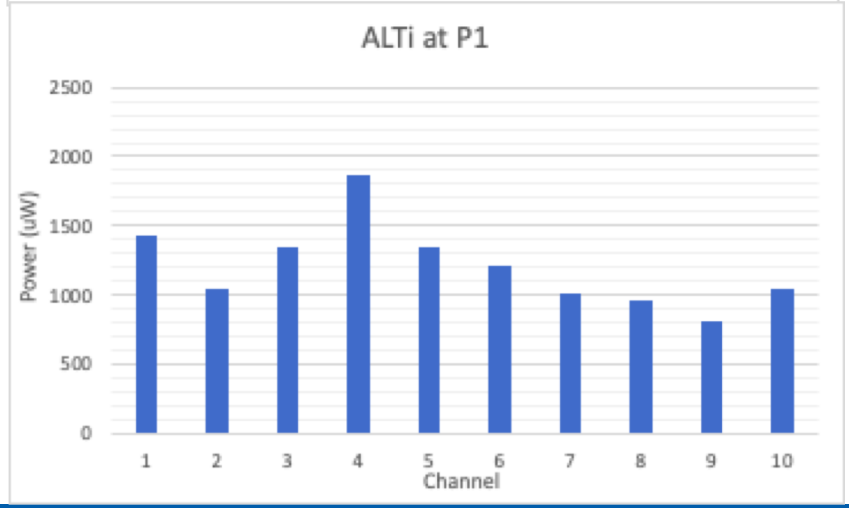
- Measured optical power from ALTi directly before FEC at EMF

Results – power from transmitter

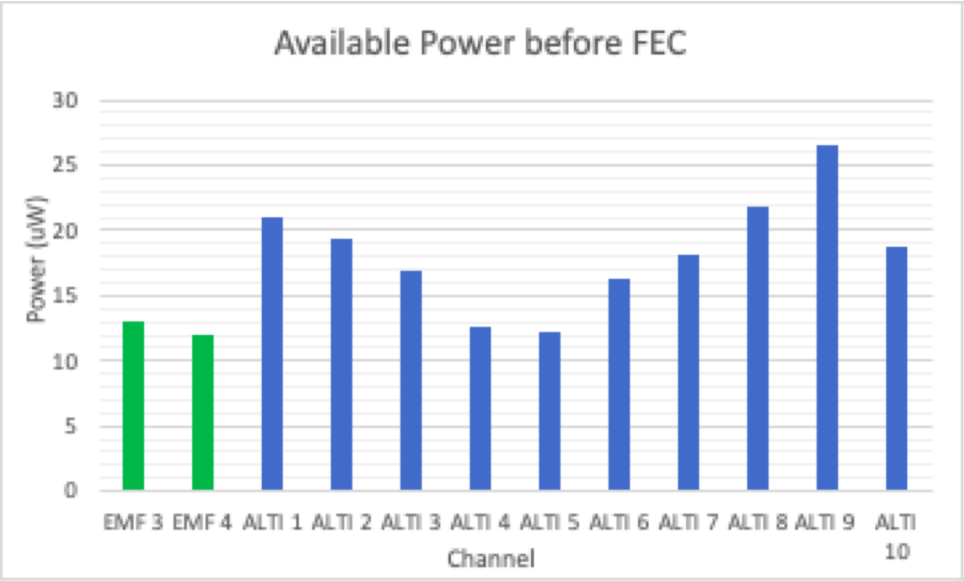


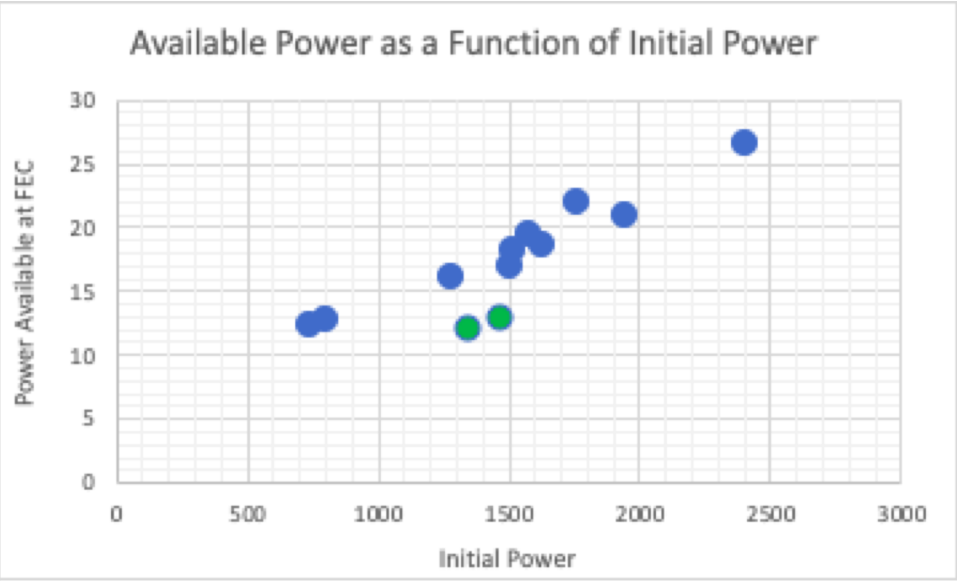




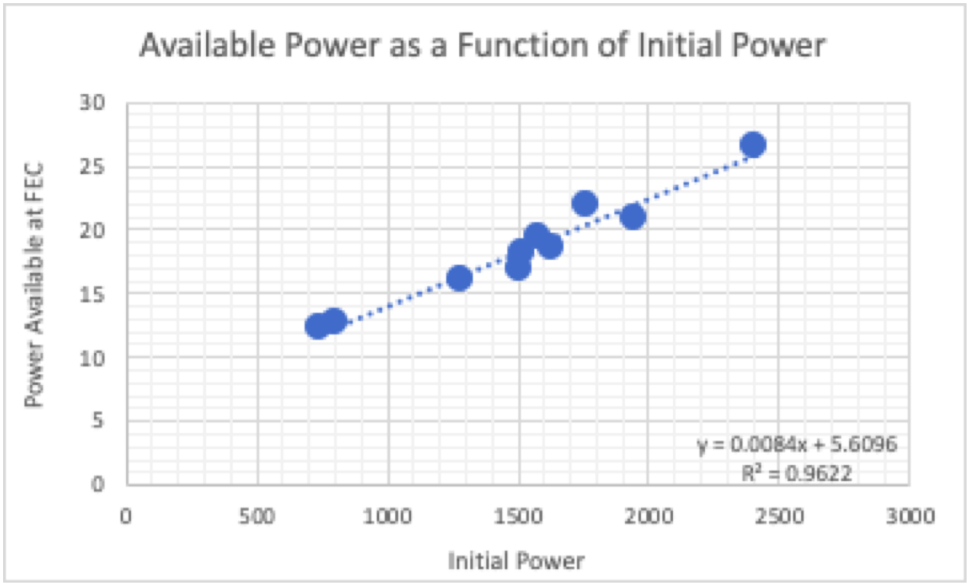


Results – power before FEC at EMF





Results – predicted power before FEC at P1



Predicted Available Power at P1

P1 channel	Estimated Available Power
ALTI 1	17.60816
ALTI 2	14.4212
ALTI 3	16.97144
ALTI 4	21.29576
ALTI 5	16.90928
ALTI 6	15.7904
ALTI 7	14.07008
ALTI 8	13.724
ALTI 9	12.40856
ALTI 10	14.40272

Conclusions

- There is far greater variation in optical power across transmitters in the ALTi boards than there is across transmitters in the legacy TTCex system

- Optical power output from ALTi transmitters follows a pattern that is not the same at EMF and at P1 (likely due to different cooling methods), which is important to consider when moving hardware from the testbed to USA15

- ALTi transmitters that produce about 50% of the power produced by the legacy system preserve power better through fibers/splitters/attenuators and deliver comparable power to FECs

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Questions?

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