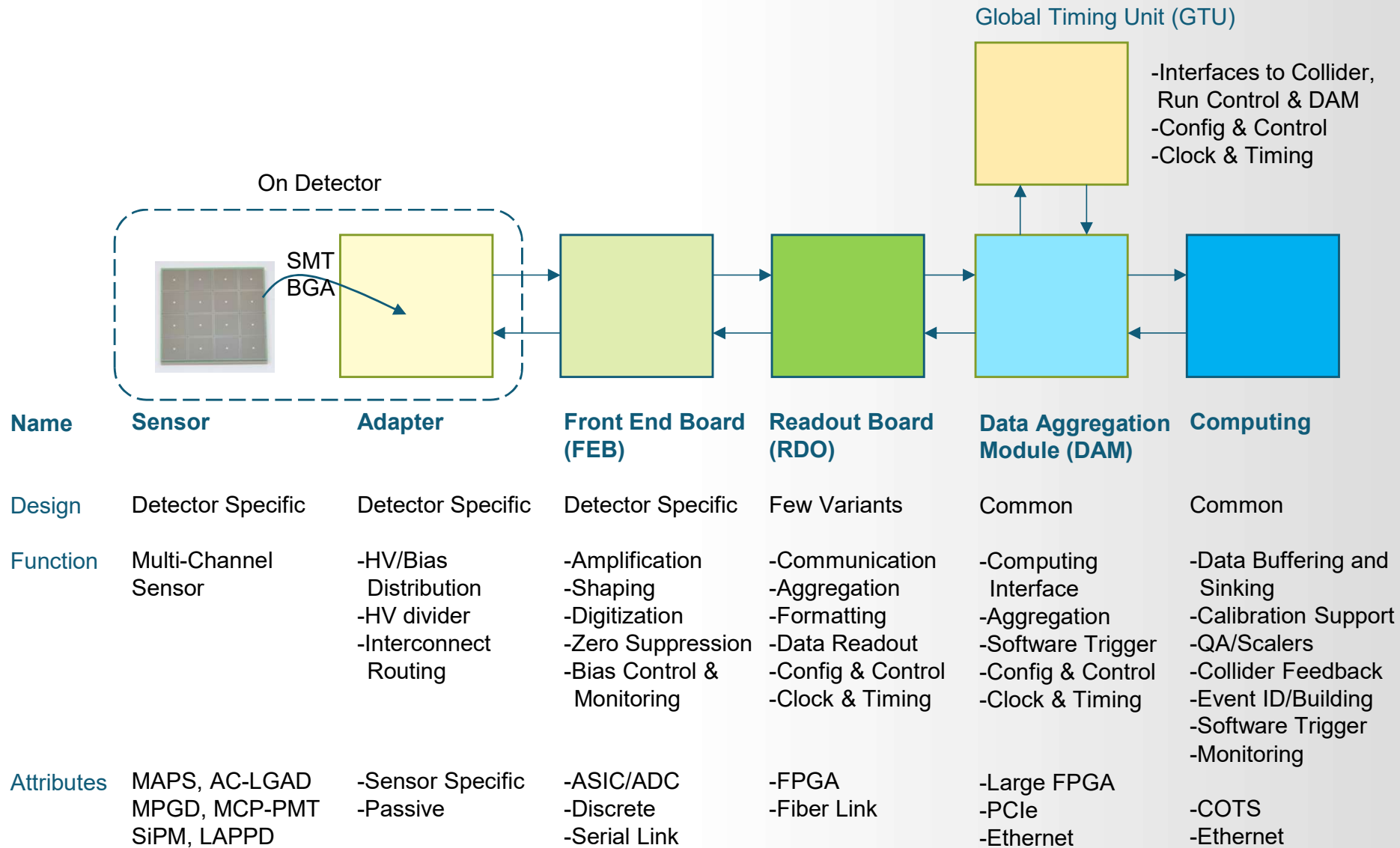


Integration of End-of-Stave Card with ePIC DAQ: FLX expectations (ePIC RDO)

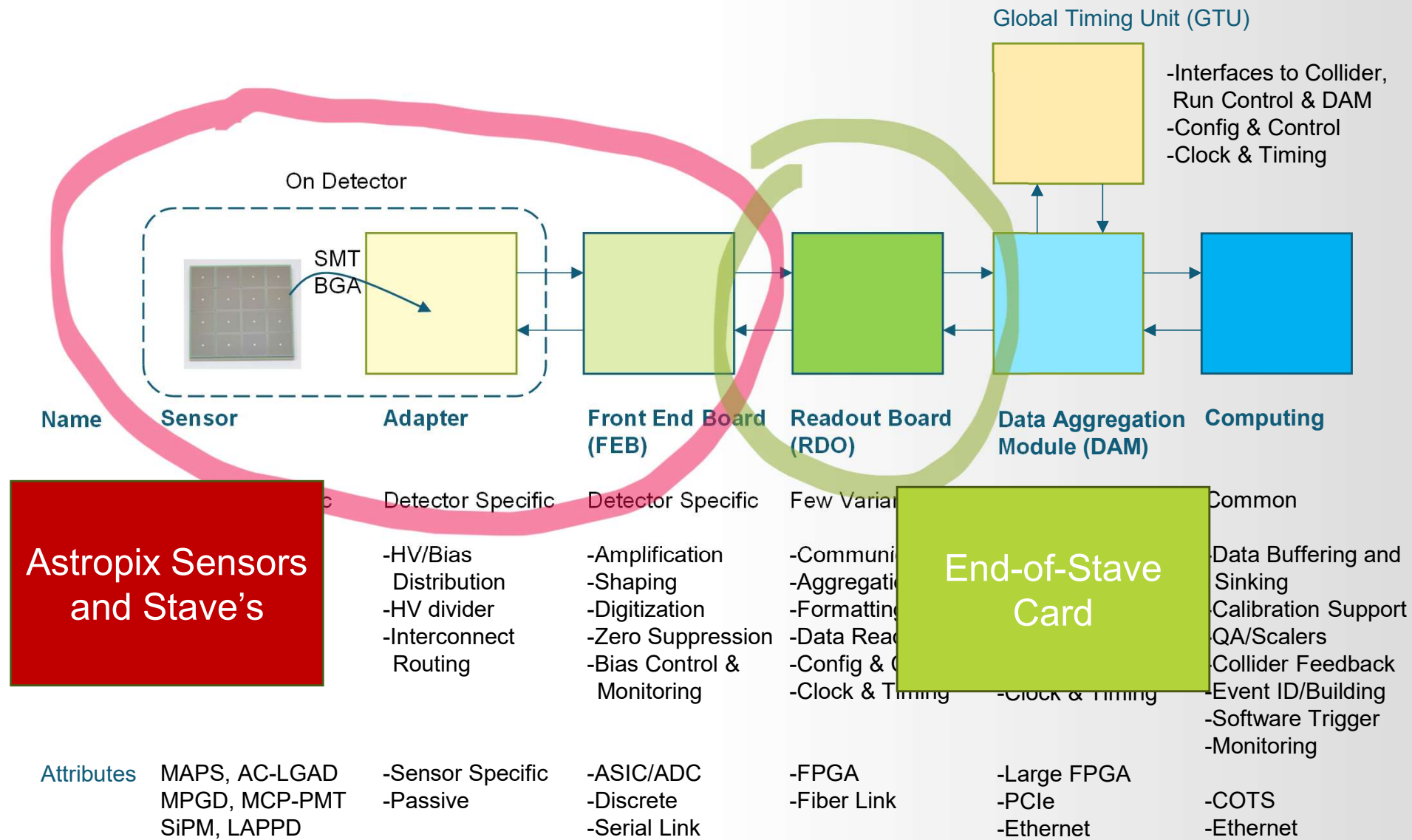
Electronics and DAQ WG Conveners:

Fernando Barbosa, Jeff Landgraf, Jin Huang

ePIC Readout Chain



ePIC Readout Chain



Astropix Sensors and Stave's

End-of-Stave Card

Streaming in ePIC

ePIC DAQ

Definition of streaming is “No L0 trigger”

- No system wide deadtime in normal operation
 - Detectors **will** have minimum double hit times for channels or modules, as well as throughput limitations.
- Collaboration should have the full ability to make data selection cuts on the widest possible criteria
 - Full flexibility for event selection
 - As full flexibility for data selection as possible
 - As full background characterization as possible
- But subject to an overall throughput budget of ~100Gb/sec

ePIC Streaming will include

- Capabilities for software triggering
- Capabilities for hardware triggering
- Capability for flow control
- Zero suppression & aggregation within data packets

ePIC Computing

Definition of streaming is “Process data as it arrives”

- Physics event selection and tagging
- Fast Analysis (~3 weeks not months or years) using automation of calibration and reconstruction.
 - Fast understanding of operations needs
 - Fast understanding of calibration
 - Fast publication
- Distributed analysis
- Efficient use of diverse architectures (eg. Support for GPU)
- Efficient use of diverse software (eg. AI)
- Incorporate worldwide computing facility contributions

Overlap between DAQ and computing

- Automation of Calibrations
- QA and monitoring
- Consistent schemes and language for managing data and metadata
- Event Selection and Tagging

Streaming in ePIC

ePIC DAQ

Definition of streaming is “No L0 trigger”

- No system wide deadtime in normal operation
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ePIC Streaming will include

- Capabilities for software triggering
- Capabilities for hardware triggering
- Capability for flow control
- Zero suppression & aggregation within data path

Expectations for RDO (with respect to detector readout):

- Use clock synchronized to (multiple of) EIC bunch crossing clock
- Identify times with global Bunch Number
- Provide information to define times with respect to global Bunch Number in data
- Mark begin/end of time frames (under GTU direction)
- Pass user/commands (including potential trigger information) to next stage
- Support FEB sensor/ASIC requirements
 - Accept trigger commands needed by Sensors/ASICS (charge injection, LED etc...)
 - Provide Clocks
 - Aggregate and package serial data from FEB

Overlap

- Automation
- QA and monitoring
- Consistent schemes and language for managing data and metadata
- Event Selection and Tagging

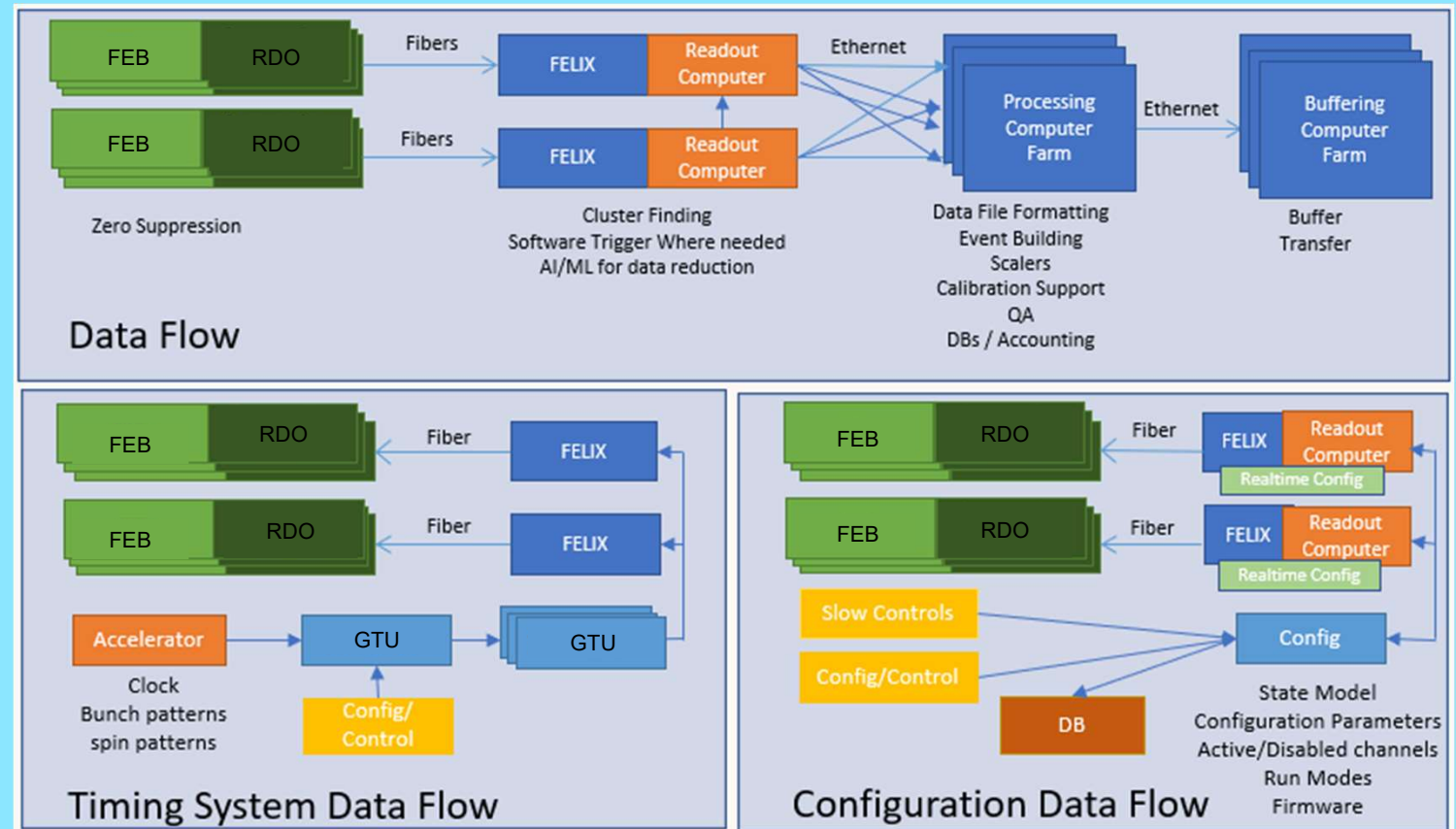
RDO not expected to:

- Buffer data for triggering

Optical Protocol Requirements

The High-Level Optical Protocol

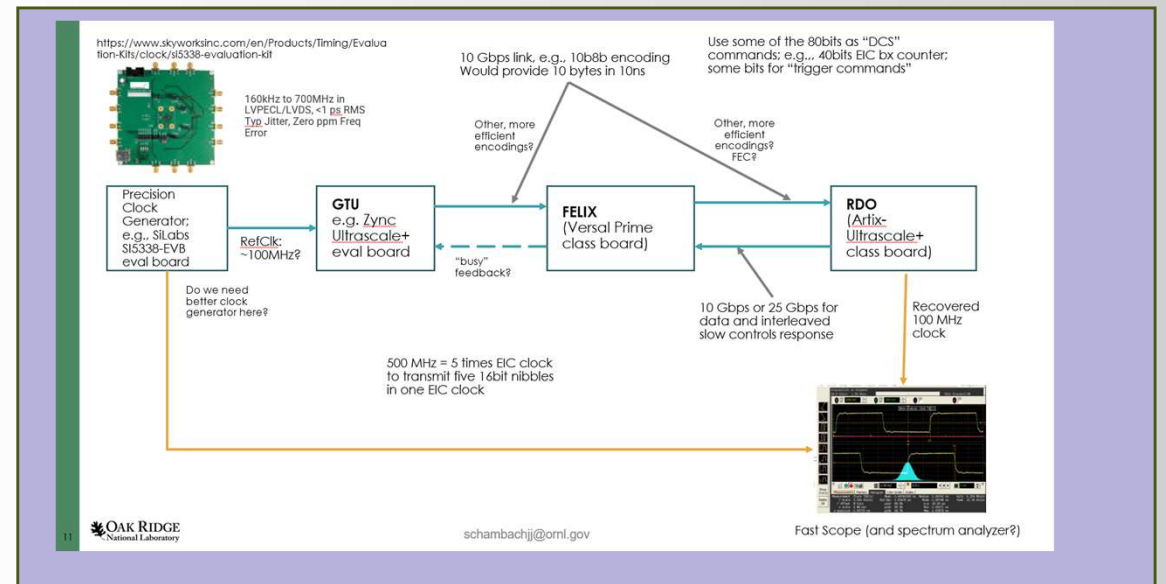
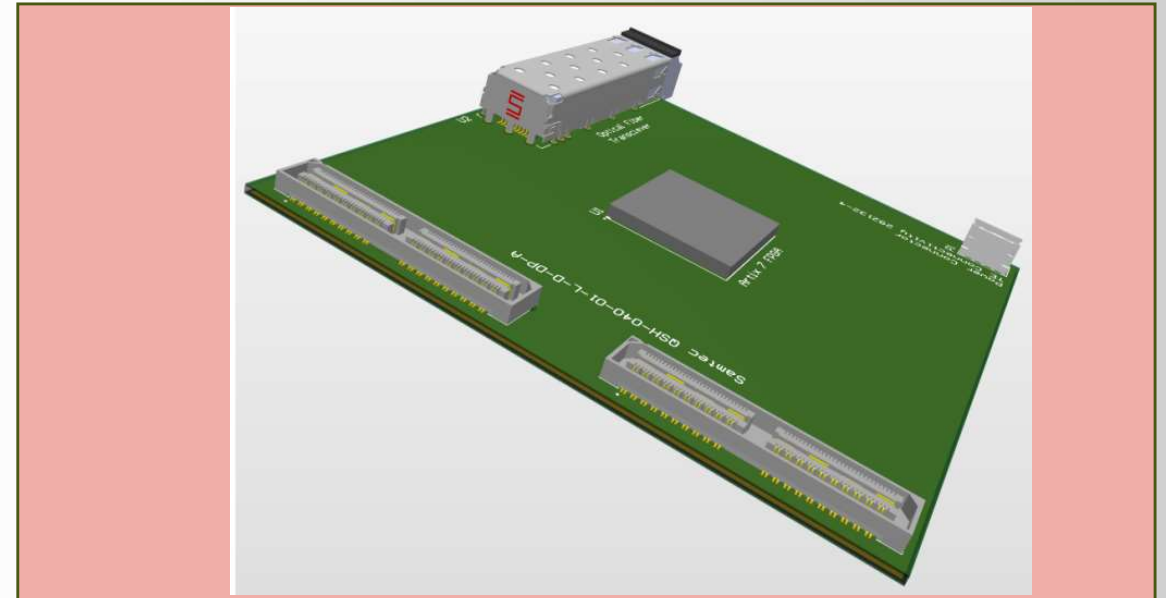
- Defines the information content of the data flow between the GTU, RDO, and DAM boards
- Optical Protocol Requirements
 - Timing
 - $\leq 5\text{ps}$ Resolution for hi-res Detectors
 - $\leq 100\text{ps}$ for All detectors
 - Phase stability on power cycle
 - Configuration of RDO firmware and ASIC parameters
 - Mode for configuring RDO
 - Mode for ASIC configuration passthrough
 - Real-Time Command / Control
 - Define bunch crossing counter
 - Define time frames
 - Trigger Information
 - Mark or initiate calibration events
 - Potential debug or fallback triggered modes
 - Formatting information
 - Flow Control
 - RDOs need to mark potential dropped data
 - Need the capability of applying global busy
 - Slow Control Monitoring from ASICs/FEBs (e.g. Temperature monitoring)
 - Data Transfer ($\geq 10\text{Gb/s}$ per RDO)



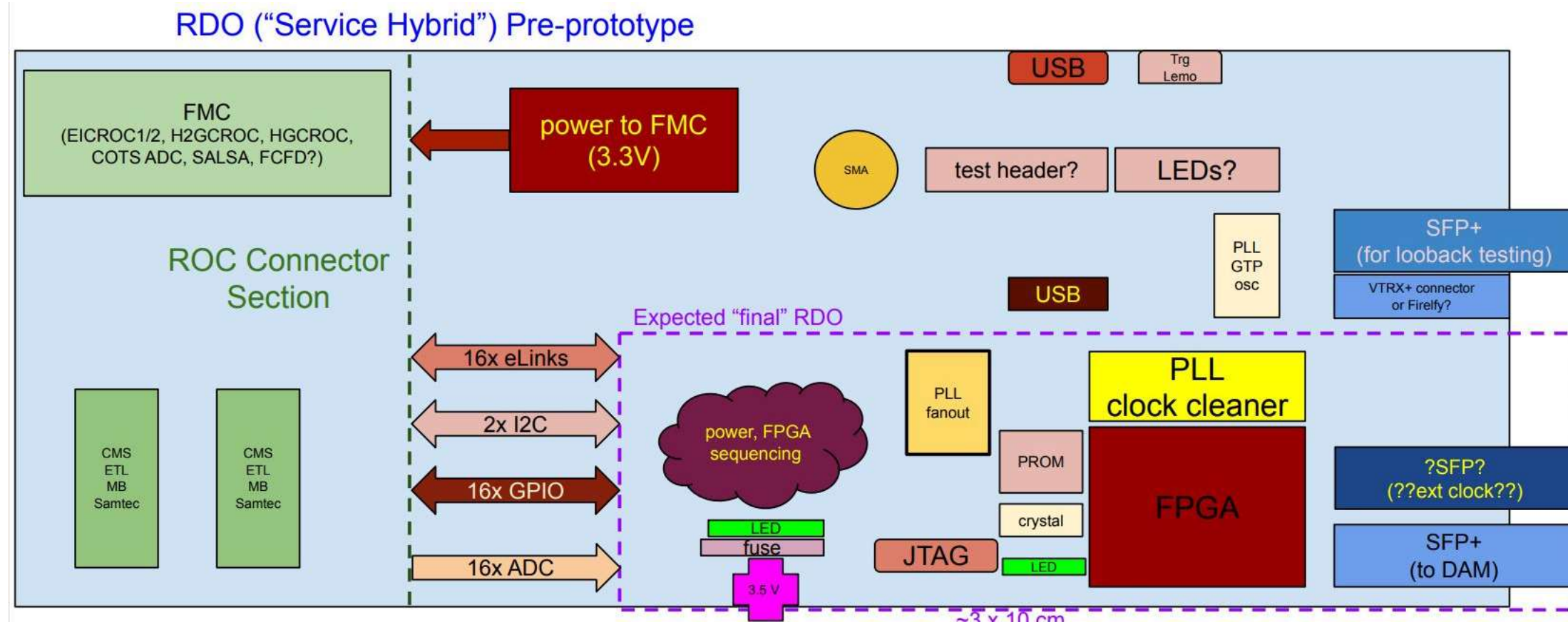
System Component Status: RDO and GTU

The hardware development of the RDO and GTU is currently focused on the development of the low-level timing protocol for achieving the 5ps time resolution requirement. We prefer using a reconstructed clock to avoid extra fiber

- Study the underlying timing protocol for GTU->DAM link and DAM->RDO link using dev-kits & FELIX 182
- Specify the information protocol
 - Details of time frame
 - Details of flow control
 - Implementation of software triggering
- Data volume studies need to be extended to the channel level in to study detailed rates needed by components
- Mocked up physical characteristics
 - Assume Artix Ultrascale+,
 - 2.5 x 2.5 inches for common components + connector space
 - 2-5 Watts power



RDO, pre-prototype

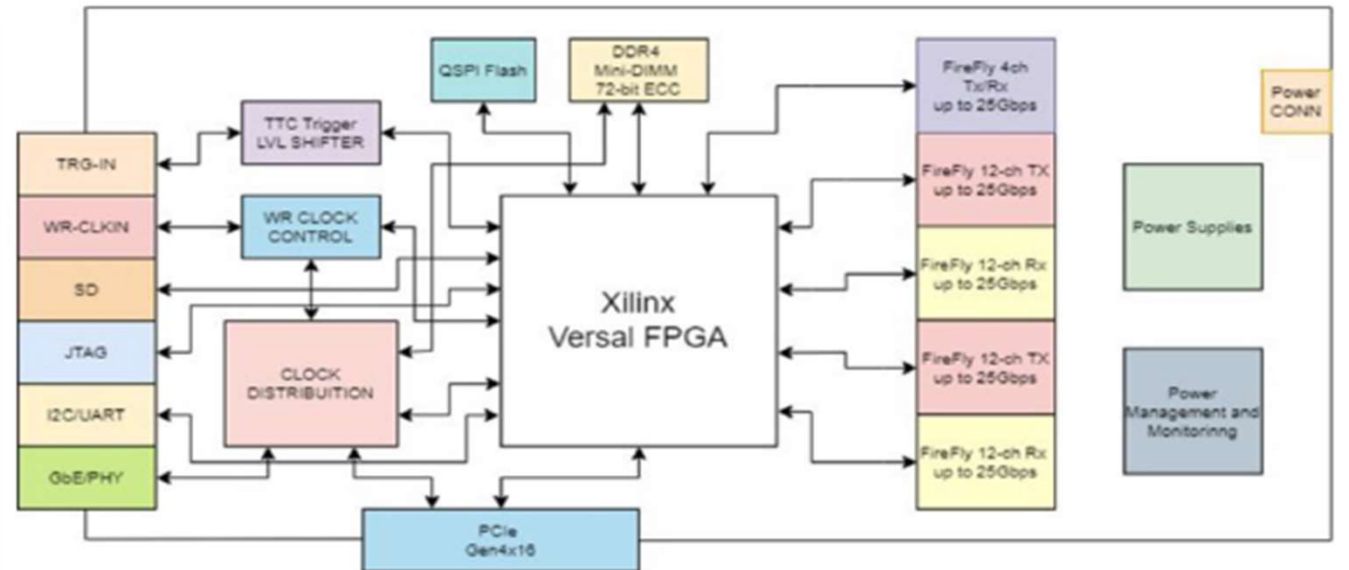
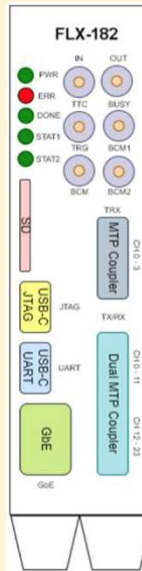


- Working on the schematics
- Fully assembled boards are expected in the summer of 2024

System Component Status: DAM

DAM Candidate

- We have FELIX FLX-182 in hand and are evaluating
- Expect to use upcoming FLX-155
 - Additional LTI interfaces
 - 48 ports
- Discussing need/desire for additional modifications
 - Direct link to Si5345
 - Direct links to versal XPIO pins
- Current Expectation for Imaging Calorimeter is:
 - ~230 RDO
 - 5 DAM



Questions:?