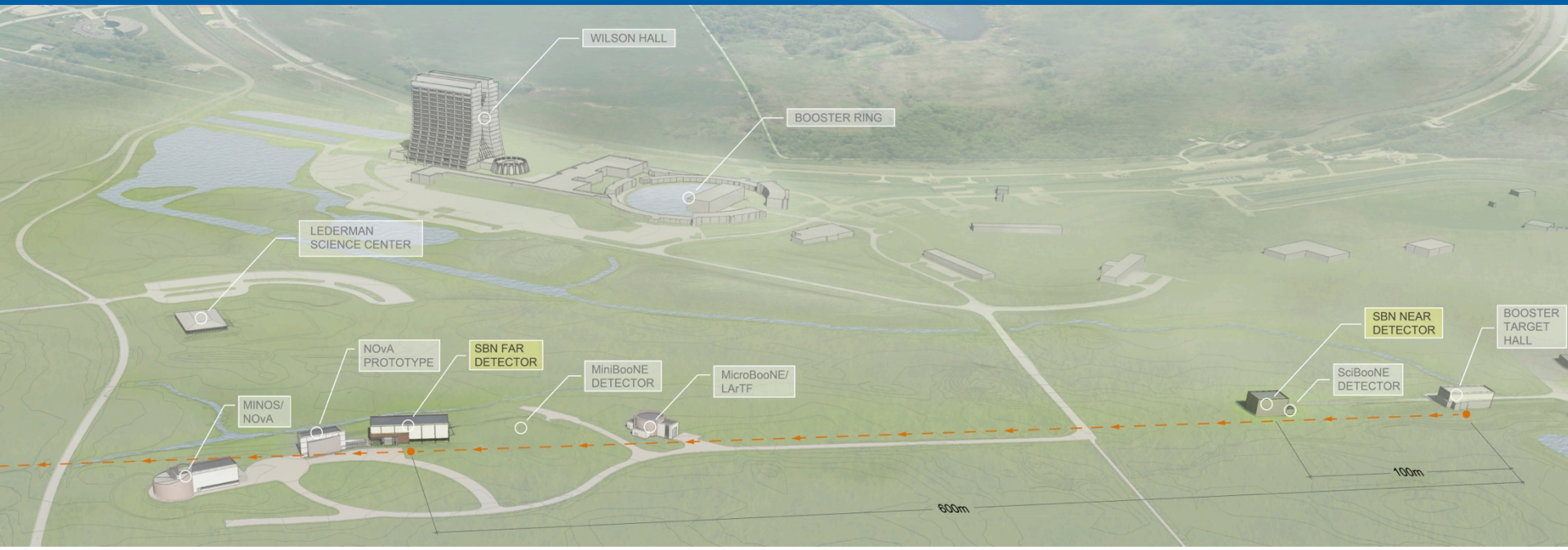


SBND DAQ Status/Overview

Eric Church

SBN Director's Progress Review

16 December 2015

Outline

- Status and things that are new since September Review
  - People, documents, work
  - Schedule
- Reminder of DAQ components
  - Subsystems
- Timing and Trigger

WBS2.7 Management

- Eric Church and Georgia Karagiorgi are co-L2 managers
  - Georgia's emphasis will be infrastructural hardware, trigger
  - Eric's is software and DAQ coding systems, DAQ hardware
- Wes Ketchum (FNAL SCD) is L3 for DAQ Software Design And Implementation
  - Brings strong DAQ coding expertise and high-level understanding of the highly relevant, complex DAQ from MicroBooNE
  - *Can imagine even breaking this further into databases and readout*
- Sowjanya Gollapini (KSU) is L3 for Detector Controls (SlowMonCon)
  - Strong expertise and wide knowledge of what to monitor and how to unify it into a complex, but shifter-usable system from MicroBooNE.

WBS 2.7 FNAL Personnel

- Linda Bagby (still, at least at some level)
  - Racks, power, guidance
- Wes Ketchum, Kurt Biery's artdaq team
  - DAQ coding, Run Control, databases
- Bill Badgett and Geoff Savage
  - Software and hardware
- Helpful FNAL computing service
  - MicroBooNE has had wonderful experience with these teams
    - Networking
    - SLA admin support, network card configuring

Estimated Labor (post-docs, etc)

- 1-2 Teststand Installation/Operation WBS 2.7.6 (have 1-2 identified)
- 3 DAQ coding experts WBS 2.7.7 (have 1-2)
  - Starting with 2016 Teststand at DAB
  - These people run the meetings and coordinate the work for 2 years
- 2 Laser + CRT people to lead the systems integration at FNAL in 2018 WBS2.7.3
- 1 warm electronics person to integrate with DAQ, starting 2016
  - NIM logic expert WBS2.7.3
- 2 Slowmon experts WBS2.7.4 (have 1)
- 1-2 database experts WBS 2.7.7
- 1 online monitoring expert WBS 2.7.7
- 3-4 students for installation for 2 months WBS2.7.3,9
- Installation and Commissioning WBS2.7.9 needs thought/bodies
  - And 2.7.6 too – testing on teststand with assembled detector: wirebias on, masking channels, noise tests…

Requirements / Documentation / BoEs

- *Evolving* Trigger Requirements Document: docdb 690
  - with inputs from LDS, TPC Readout, CRT, Laser
- Proposed Trigger + Timing System Document: docdb 723
- SBND DAQ Implementation Strategy: docdb 679
- DAB Testspace and WR comments: docdb 680
- GPS and WR possibilities: docdb 658

- CRT with DAQ description: docdb 532
- Power Supplies/Infrastructure: docdb 607

- BoE docdbs: Laser-DAQ (575), CRT-DAQ (576), DAQ Procurement (438)

DUNE + SBN DAQ Meeting, 20-November

- https://indico.fnal.gov/conferenceDisplay.py?confId=10599

- Many of us were at this nice meeting in November
  - The conversation and idea-sharing were quite useful
    - e.g., The WA105 talk bits on White Rabbit

    - Presentations from Leslie on Nevis Hardware
    - me on the MicroBooNE experience
    - Kurt on artDAQ
    - Wes on collected SBND,MicroBooNE,Icarus Data rates and Requirements
      - Reprised at this Review

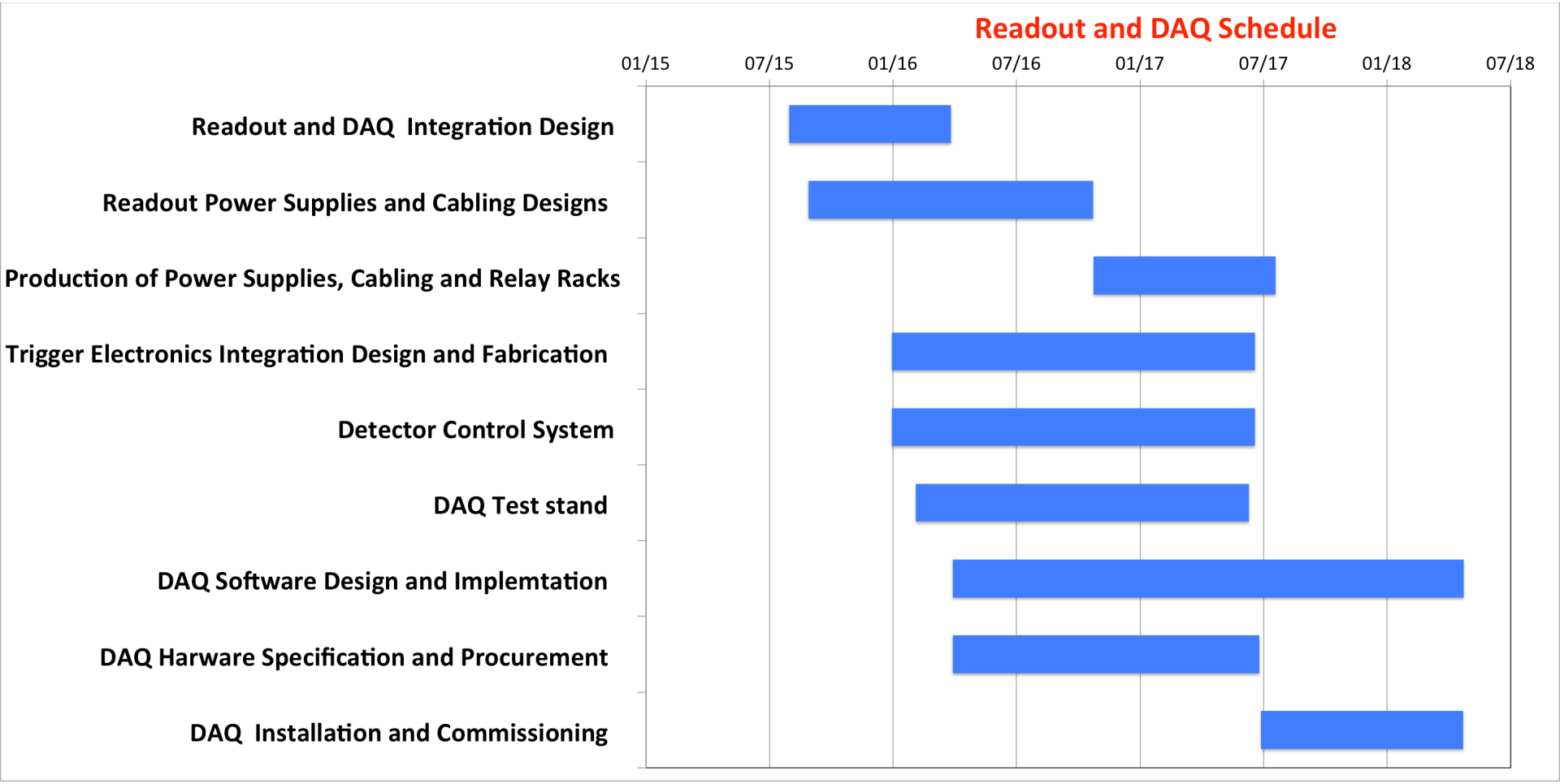
Procurements for Teststand

- Goal: a Vertical cryo Teststand at DAB to readout electronics and test DAQ: late summer, 2016

- Assembly has begun at PNNL
  - Pulser, Scope
  - KVM
  - Server (en route)
  - White Rabbit Starter Kit (January, 2016)
  - GPS (January, 2016)

- We will build out a teststand in late summer at DAB
  - Nevis crates
  - More servers
  - BNL chimney – starting with Warm Interface Boards
  - Dewar /motherboard, eventually

DAQ schedule



DC Power Supplies 1

per Linda Bagby

- HV Drift
  - Heinzinger PNChp
  - (-150kV/1mA)

- TPC Readout Crates
  - Wiener PL506
  - (+12V/20A per crate)
  - Requires interface engineering

DC Power Supplies 2

- TPC Wire Bias/Electron Diverter
  - Wiener MPOD Mini
  - 16 channels (+/-1.5kV)

- TPC Field Adjust/Pick Off Monitor
  - Keithley 2410 Source Meter
  - Source: 1.1kV/1A
  - Meter resolution: 100nV/1pA

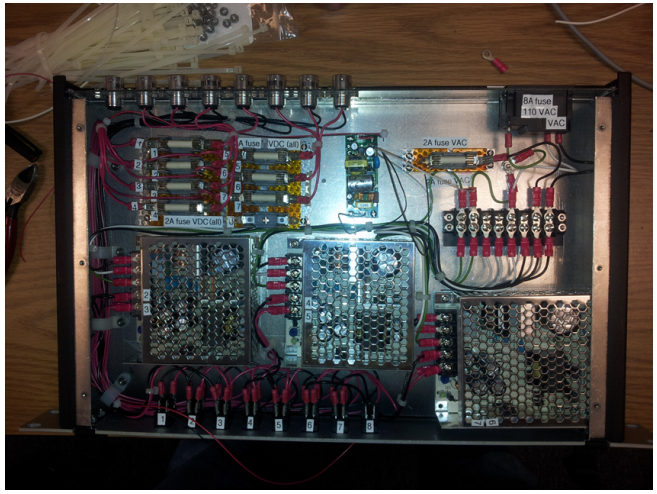
DC Power Supplies 3

- TPC Cold Electronics
  - 4 channels of +12V/27A
    - +12V/~4.5A/WIB (Warm Int'f Bd)
    - 6/WIBs/Feedthroughs
    - 4 Feedthroughs
  - Options
    - Wiener MPOD
    - Wiener PL506
    - Investigating linear supply options

DC Power Supplies 4

- Laser System (4 racks)
  - uBooNE design
    - Custom designed chassis
      - 5V/10A
      - 12V/4.2A
      - 15V/5A
      - 9V/550mA
    - SEDR guidance will be followed.

    (Safety Engineering Design Review)



- Cosmic Ray Tagger
  - Wiener PL512 (12 channels)
    - 5V/10A per channel (7 ch req.)
    - Each channel fans out to 18 FEMs
    - 5V/2.5A per cable, 28 cables
    - Requires interface engineering

DAQ Components

- Fragment generators from detector subsystems -> EventBuilder
  - DAQ's most important job!
- A (lightweight) RunControl
- RunConfiguration database
- Online/nearline Monitoring
- Slow Monitor and Control/Alarming and database
- Channel Map database

Online

Offline

- Data management of files out to SAM (tape/dcache)
- Data Quality Management processe
- Data Processing

Data Rates

- 11,000 wires, 2 bytes/sample, 2 MHz, 1.28ms drift, 3 frames, 1/5 **compression**, 10 Hz beam
  - This is the open trigger rate (no LDS trigger) and ignoring LDS data itself
  - Huffman encoding, ala MicroBooNE
  - Ignoring supernova (continuous) data here

    - **500 MB/sec (with ε LDS added, but strobe not included)**

- Must be able to take 15 Hz in sustained bursts => 750 MB/sec
- Trigger req document says we want to swallow even more (in short bursts!)
- The LDS will bring this down to below 10 MB/sec

Infrastructure

- Servers (“sebs”, in the DAQ parlance)
- Racks
- Cables/fibers
  - Trunk lines and distribution of fibers
  - Copper  fiber boxes
  - Rangers for distribution of USB, etc
- 3 Pulsers
- 3 Oscilloscopes
- 6 UPSes for temporary (~5min) backup power
- 6 Switched and unswitched power distribution units (PDUs)
- GPS + WR clock+trigger distribution
- NIM crates for BNB (1D&1F) II Strobe, sundry logic

MicroBooNE Servers

We imagine a similar SBND Server room

Laser

- 1 server controls one laser and writes out a small (10's of bytes) struct holding power/pointing information per pulse, which becomes a fragment and goes to assembler

- The laser firing is the trigger in Laser Run Mode: it generates a lemo signal into the trigger board.

- This triggering mode is analogous to LED-Flasher run mode and Wire Calibration mode
  - Namely, these modes drive the trigger themselves. We do not care what the LDS activity is. We just want to read out per pulse.

Cosmic Ray Tagger (CRT)

- The cosmic ray tagger readout is described in internal documents
- Readout consists of 7 servers, each with one data-acquiring NIC connected by cat5 cable to 16-18 daisy-chained FEBs. Each server reads out one wall's worth of FEBs.
- They are networked to an 8th server on the CRT private network. The 8th server does the work to assemble the CRT event fragment and stamp that fragment's time wrt some GPS master time and an (Resistive Wall Monitor) RWM finetime, and ships it to assembler.
- One CRT network switch that knows only about these 8 machines. The 8th machine also on internal DAQ network.
- Data rate is ~8 MBytes/sec

Light (Photon) Detection System (LDS/PDS)

- Defer to the LDS experts for details
  - Information presented here is under development, requiring additional input from light readout system

- From the DAQ p.o.v. it's another asynchronous-fragment-producing system.

LDS is not integrally connected to the TPC as in MicroBooNE. Requires synch'ing by DAQ.

- Trigger and Timing
  - Requires a BNB pulse in + anything else in with which to determine a coincidence/veto with PMT || light-bar activity
  - Must produce a pulse out with sub-ms delay to Trigger Board upon coincidence, and a trigger word to encode the trigger conditions
  - LDS may derive its clock from Nevis's 16 MHz clock – not decided
    - But not so terribly meaningful to DAQ

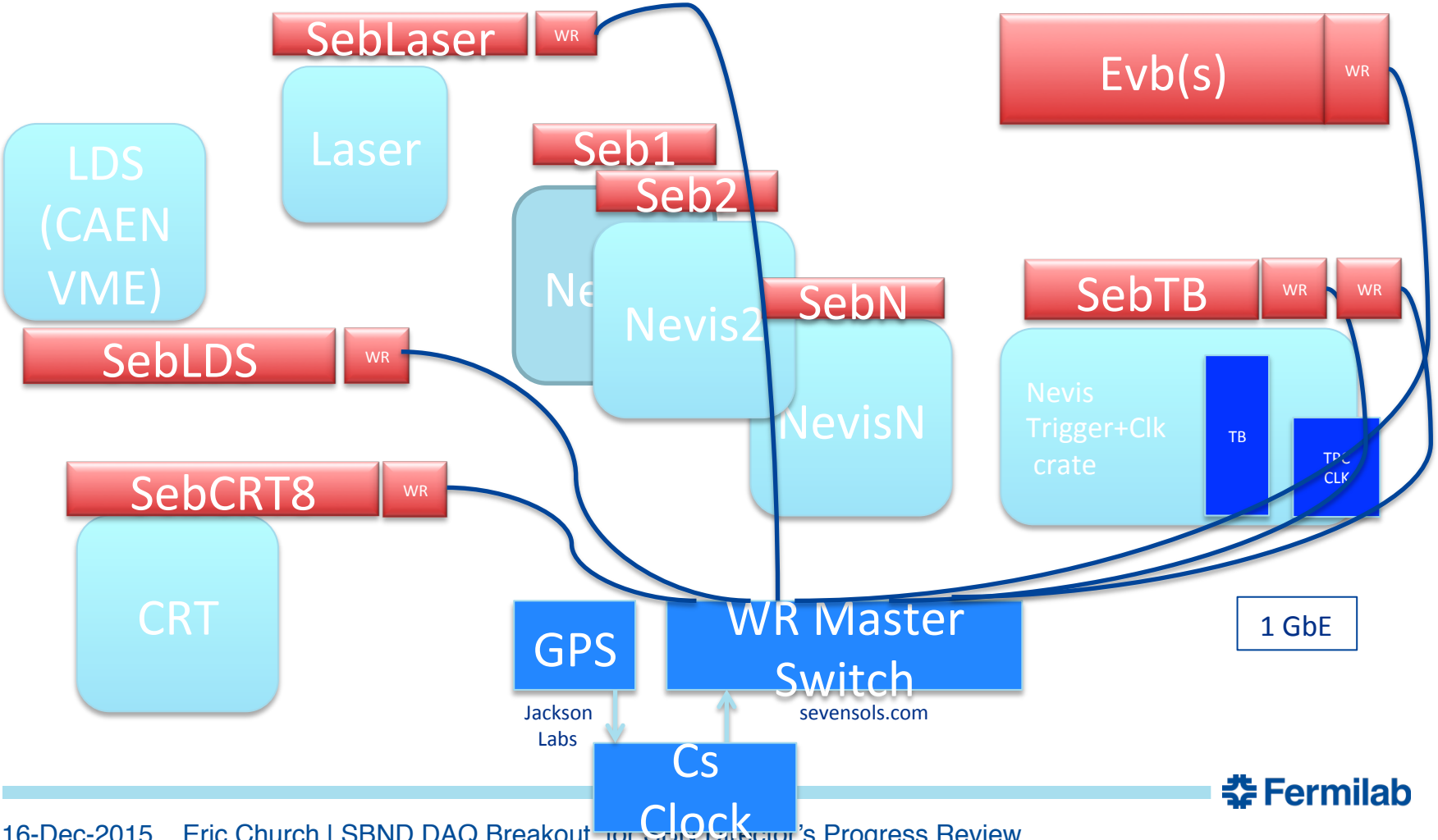
Timing and Trigger Distribution System

- New document holds Trigger Requirements
  - We have had discussion with subsystems
    - This discussion still ongoing
  - There are plenty of open questions in that document in red.
    - Mostly to do with the LDS
      - What inputs are needed besides BNB?
      - ~~How do we require it to buffer up its activity, so that a trigger may ask for it?~~
      - …
      - In fact, with the following WR Timing and Trigger system we don't have to fret about details of the LDS DAQ quite yet. It asynchronously sends its fragment to the event builder.

White Rabbit Timing and Control at SBND

www.ohwr.org
whiterabbitsolutions.com

"WR" box => SPEC PCIe card
with a DIO FMC attached



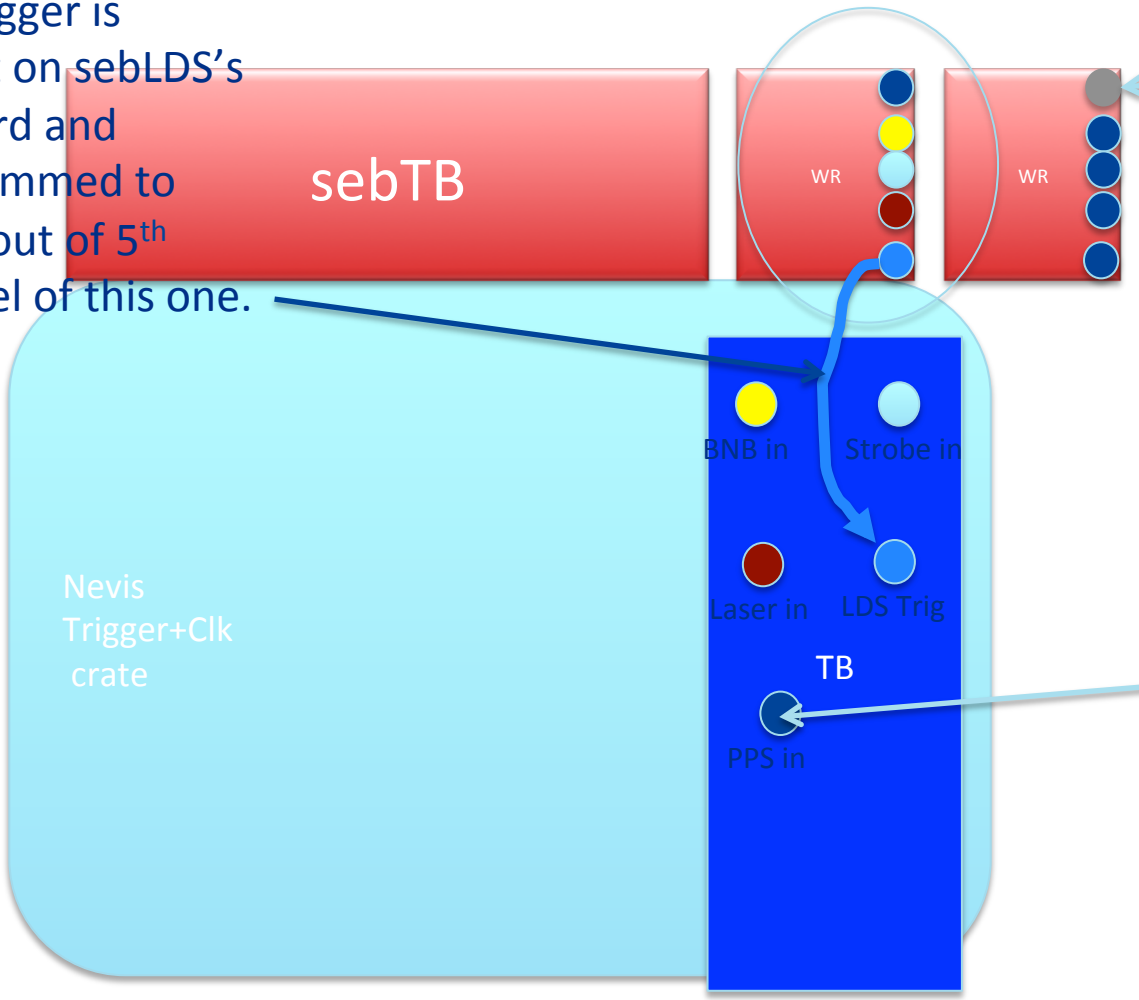
LDS Timing informing Trigger Board, to readout TPC

- A Beams Division IRM box is provided in server room at detector.
  - One extracts BNB's $1D and $1F with proper timing and puts them in coincidence
  - Much NIM logic between IRM and Trigger Board inputs is required to ensure no BNB signal is missed due to a strobe
  - Must also hold off multiple LDS triggers that come too close in time

- Copies of these signals go into sebTB's WR DIO channels and into TB LEMO sockets.
- LDS sends its fragments to the event builder; it is not triggered by TB

Trigger Board and sebTB

LDS trigger is output on sebLDS's WR card and programmed to come out of 5th channel of this one.



RWM

ExtraWR card for other inputs, like RWM, Calib, Flasher…

These are LEMOs-in except top ● which is an output, fed to input on TB.

The PPS into the TB latches the TPC 16 MHz clock. Will read that out and ship it with TB fragment.

Event Builder

- From the DAQ's perspective the question is how to assemble the fragments from the subsystems into built Events

- A scheme that ensures that each subsystem produces a sequenceID that identifies its fragments, along with White Rabbit timing, allows this.
  - All fragments of the same sequenceID are built into one Event.

- sequenceID currently receiving a lot of discussion. I imagine we will hear a proposal soon at an upcoming meeting. This is an early thing to mock up at a teststand.
  - No show-stoppers seen
  - 1 or 2 discussed ideas seem feasible

SBND Readout/DAQ Meetings

- Bi-weekly Readout/DAQ meetings.
  - Meeting is not strictly for just WBS2.7
    - though we are due for a discussion of WBS2.7-qua-2.7
      - tasks linkages and timelines at an upcoming meeting, Feb 4.
  - This meeting is sometimes the forum for Electronics discussions
  - May go to weekly meetings in Spring, 2016