



Offline Computing and Data Processing

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Outline



- Overview.
- Offline computing infrastructure.
- Production workflow.
 - Online.
 - Offline.
- Resources.
- Person power.

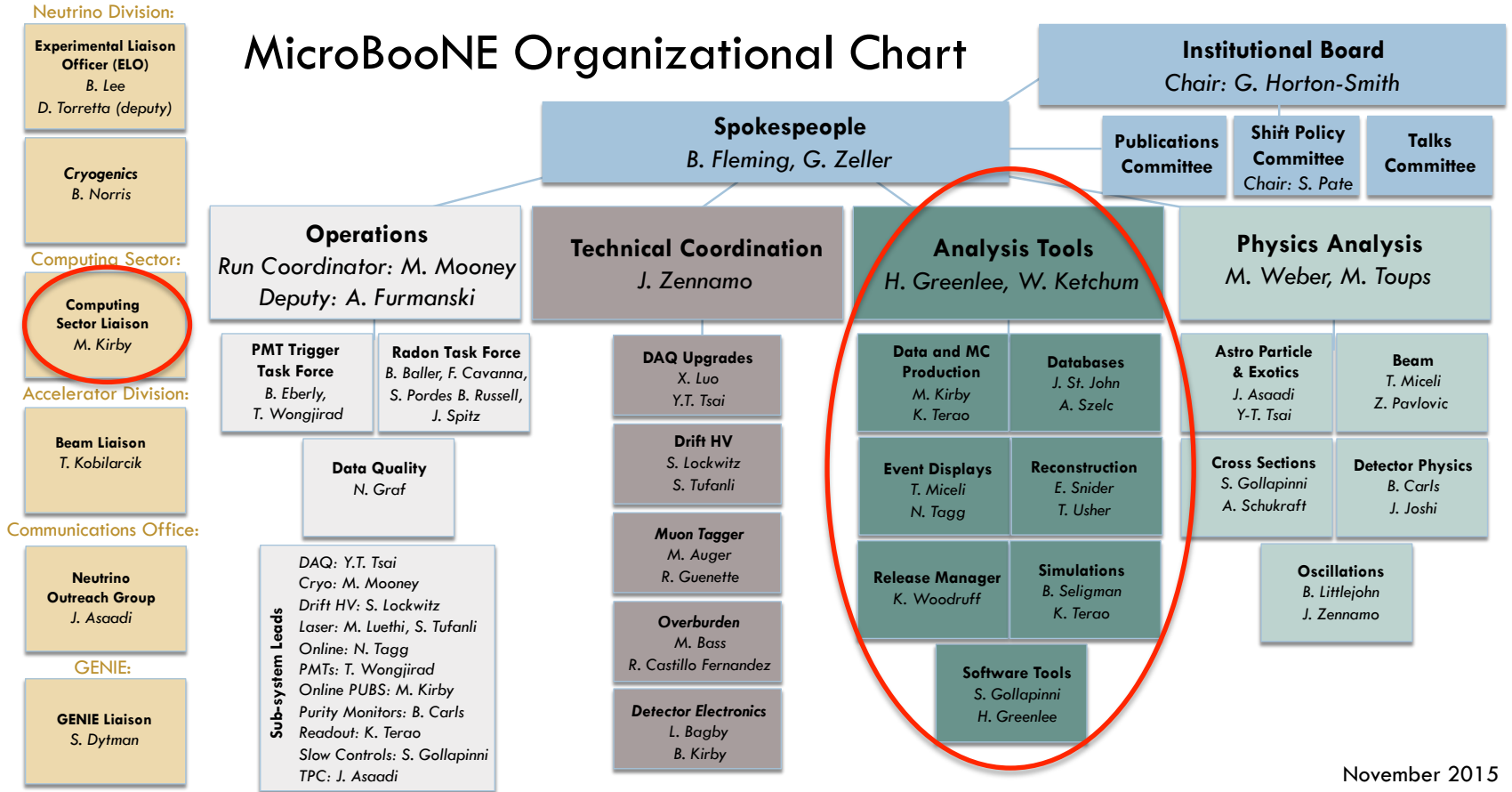
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- Offline computing infrastructure.
- Production Computing Overview.
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Organization

MicroBooNE Organizational Chart



November 2015

Offline Computing Infrastructure



- Six interactive VMs (uboonegpvm01-06).
- Bluearc disks.
 - /uboone/data (60 TB).
 - /uboone/app (3 TB).
- dCache.
 - /pnfs/uboone/persistent (non-tape-backed, 75 TB).
 - /pnfs/uboone/scratch (shared scratch).
 - /pnfs/uboone/* (*=data, mc; tape-backed).

Offline Computing Infrastructure



- FermiGrid.
 - 500 slot allocation.
- Databases.
 - Online databases (postgres, hosted at LArTF).
 - Offline database (postgres, hosted on ifdbXX).
- TSW.
 - CS docdb 5401.
 - MicroBooNE docdb 3537.

Production Computing



- Data storage.
 - Using SAM for file level metadata and file delivery.
 - Archival file storage in enstore.
 - Temporary file storage in dCache (use of bluearc disks for any production purpose is deemphasized).
 - FTS used for uploading files to enstore (dropbox located in dCache scratch area).
- Batch processing.
 - Mainly on FermiGrid.

Production Computing



- Workflow tools.
 - Larbatch (batch scripts).
 - PUBS system (includes production database).
 - Python/Postgres uB System.
- Frameworks.
 - Art/larsoft used exclusively for production computing.
 - Larlite used for algorithm development, analysis, event display (not the only event display).

Workflow Tools I - Larbatch



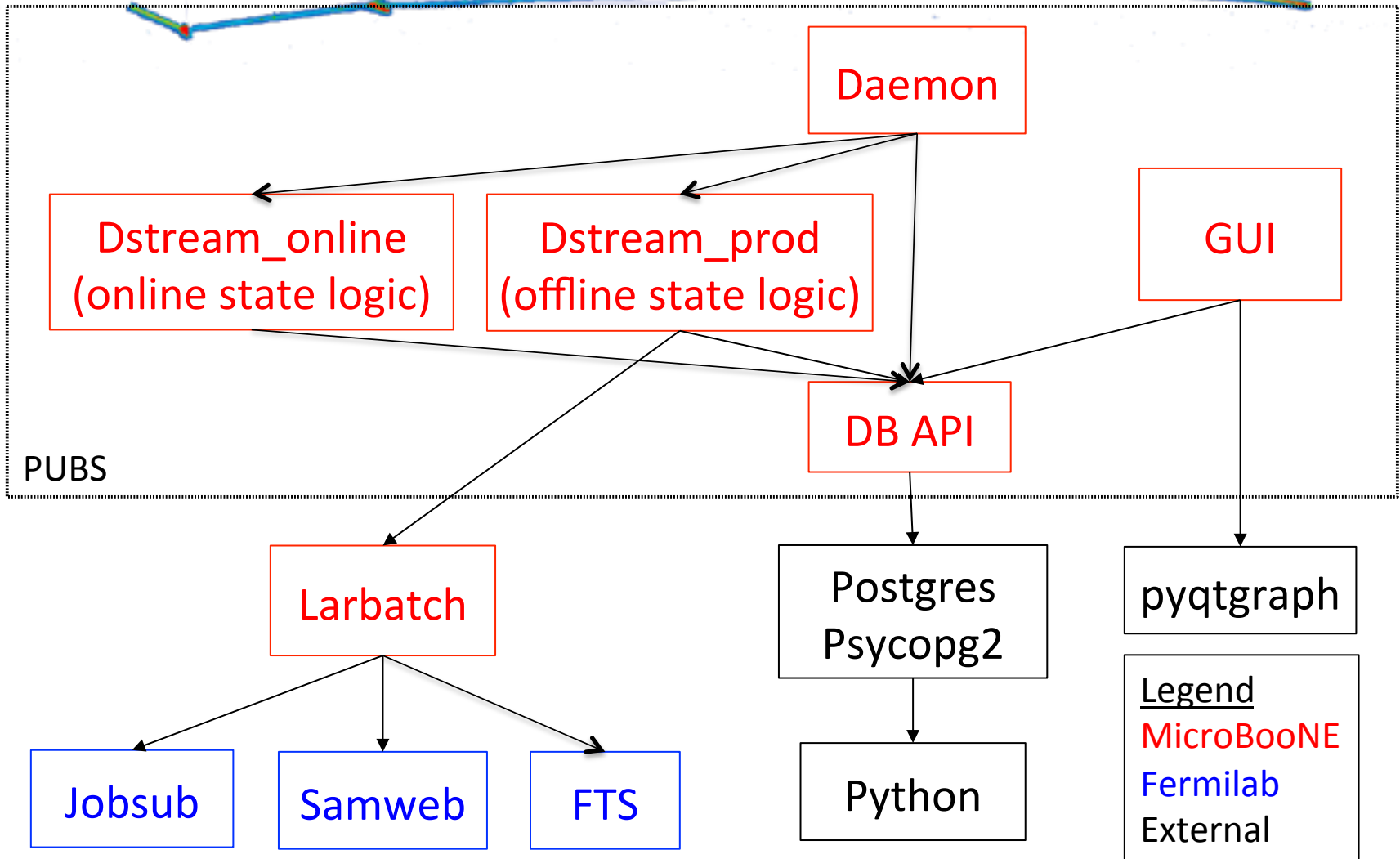
- The larbatch package contains a set of scripts for submitting and running batch jobs.
 - Multistage project configuration by XML file.
 - Includes general purpose batch worker scripts.
 - For batch jobs that run art framework program.
 - Conforms to SCD best practices for grid computing.
 - Scripts for job submission and validation.
 - Runs on top of jobsub_client.
 - Support for running on OSG and cloud.
 - Support for reading files from SAM and storing output in SAM.
 - Mostly maintained by MicroBooNE.
 - Other LAr TPC experiments are using and contributing as well.

Workflow Tools II - PUBS



- PUBS components.
 - Database (postgres).
 - Store status of data down the file (run/subrun) level.
 - Project configurations stored in DB.
 - Database python api.
 - Daemon (python).
 - Stand alone tools (python).
 - E.g. for manipulating project configurations.
 - Project scripts (python). Implement state logic.
 - Online.
 - Offline.
 - PUBS gui.
 - Borrowed from Double Chooz (author Kazu Terao).
 - Used at Fermilab by MicroBooNE.

PUBS Dependencies

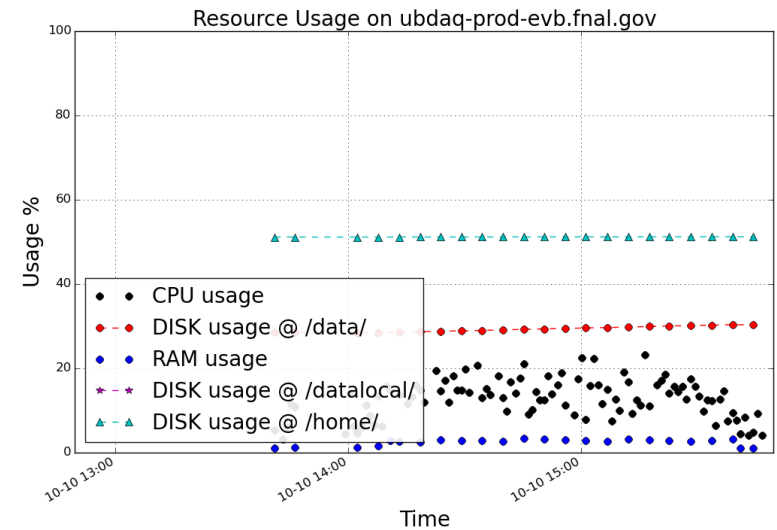
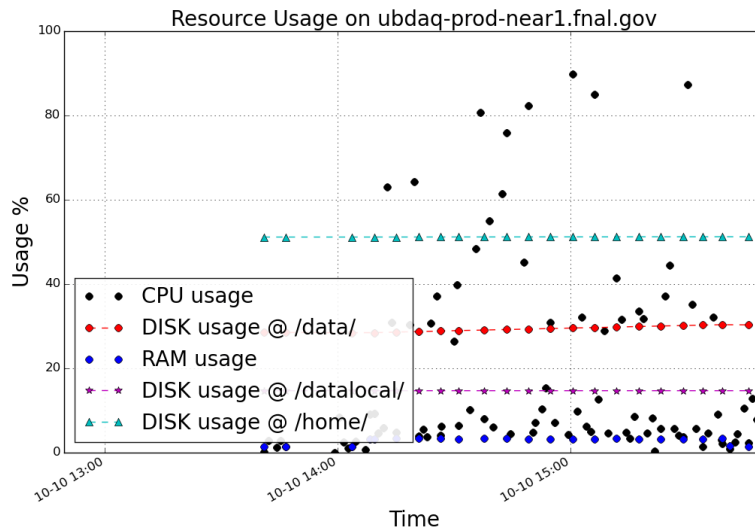


Online PUBS Data Flow



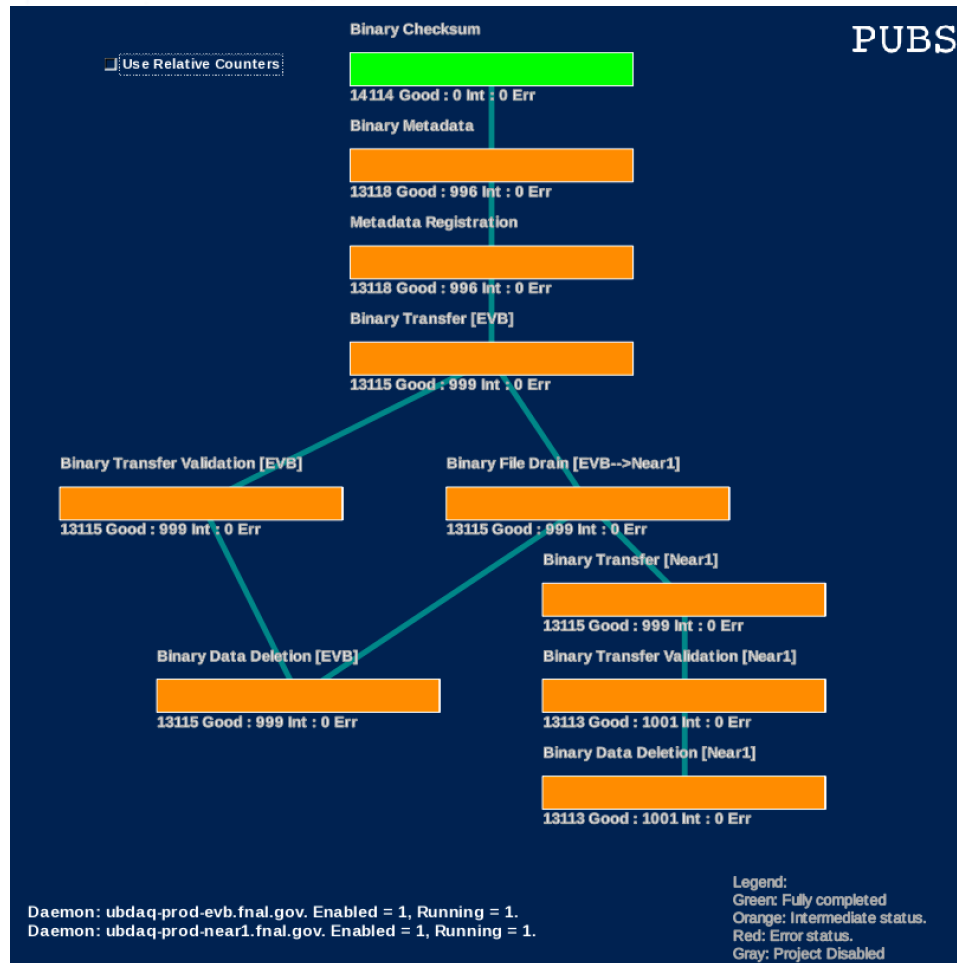
- Receive binary raw data (.ubdaq) file from DAQ system.
- Generate SAM metadata (.json file) and checksum.
- Declare file to SAM database.
- Copy file to FTS dropbox on dCache scratch.
- Verify that file has been stored to tape.
- Cleanup.

Online PUBS Resource Monitoring



- Monitored by shifters.

Online PUBS GUI



Offline PUBS Data Processing



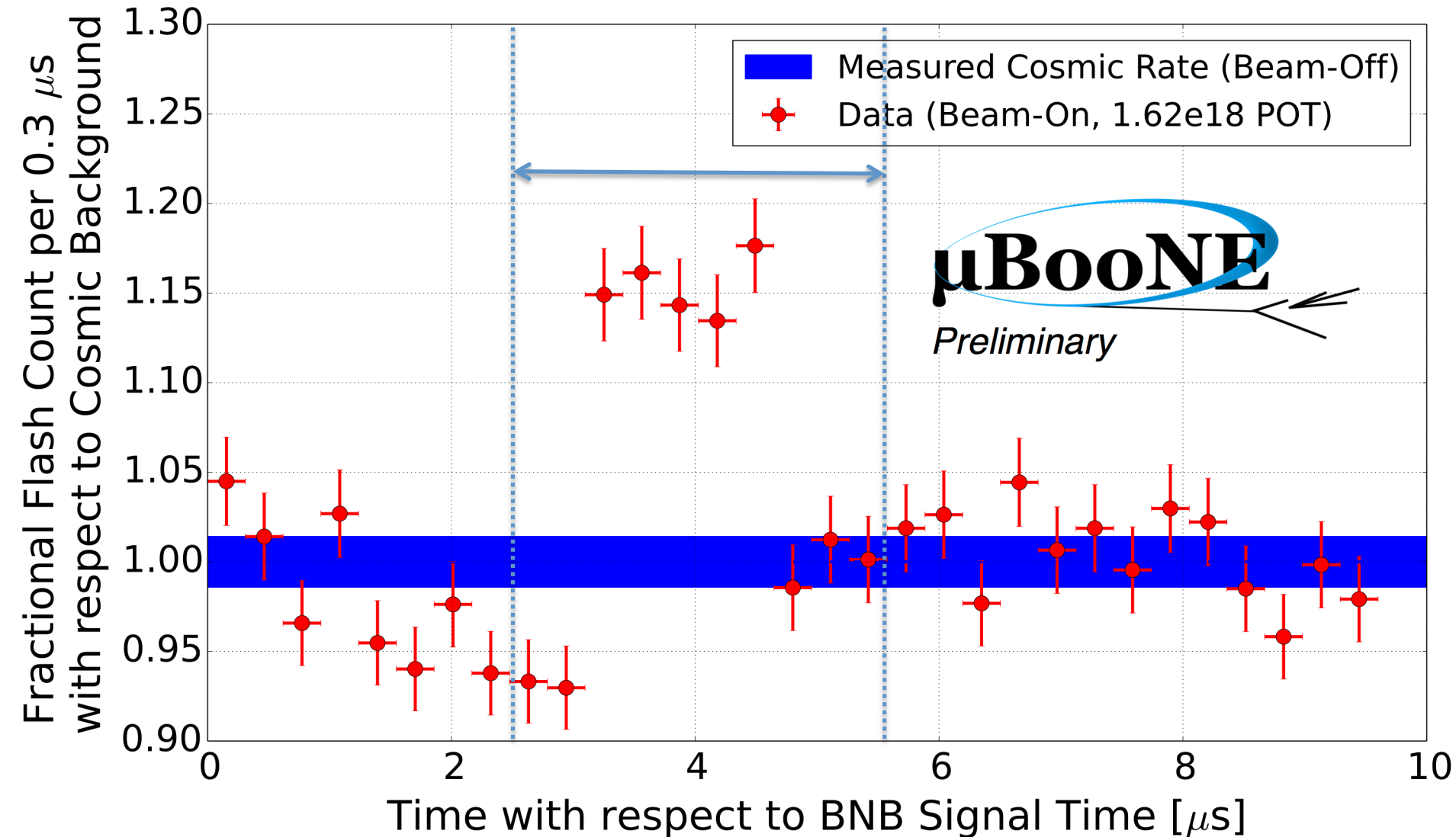
- Swizzling.
 - Convert binary raw data (.ubdaq) files to artroot format (.root) files. Declare to SAM and store.
 - Streaming and filtering.
 - Currently writing three output streams, each of $O(1\%)$ of the size of the binary raw data input.
- Reconstruction.
 - Optical reconstruction.
 - TPC reconstruction: filter waveforms, reconstruct hits, clusters, and other high level 2D and 3D objects.
- Simulation and MC production.

Swizzling In More Detail



- Read binary raw data, convert to artroot data products.
- Run optical reconstruction and flash-finding.
- Generate output streams.
 - Select events with optical flash in time with BNB beam gate (effectively, an offline trigger).
 - Randomly selected events.
 - All events, but drop TPC data (only keep optical and trigger data).

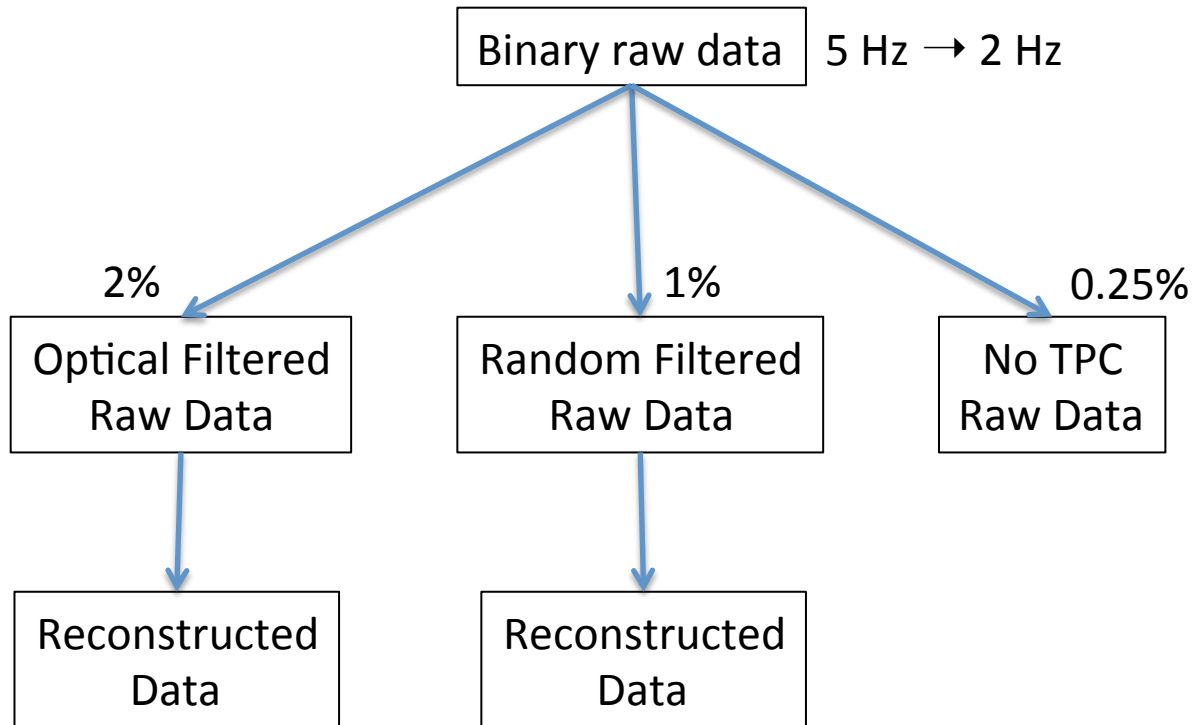
Optical Flash Timing



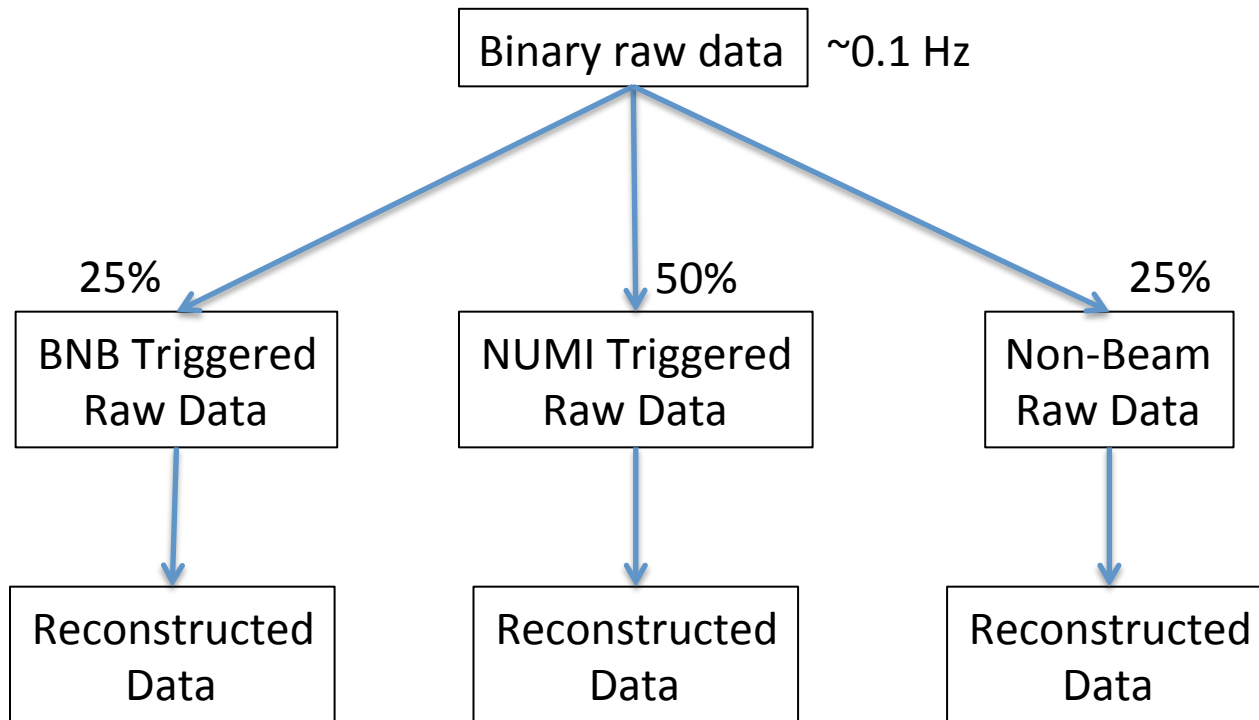
Data Processing During Commissioning Period and After

- MicroBooNE started receiving BNB beam @5 Hz on Oct. 15.
 - 5 Hz running has continued until now. Will eventually drop down to 2 Hz.
 - During a commissioning period (up to three months), MicroBooNE will collect data using an open trigger.
- Commissioning data plan.
 - Record 100% of binary raw data to enstore.
 - Establish BNB gate timing (done).
 - Swizzle and reconstruct a fraction of raw data (in production).
 - Commission PMT trigger and measure its efficiency.
- After commissioning period, collect data using PMT trigger at a reduced rate.

Current PUBS Data Flow



PMT Trigger PUBS Data Flow



Production Computing Resources



- MicroBooNE presented our FY15 and FY16 computing requests in this year's SCPMT review (Mar. 4, 2015). Updated in a special SCPMT meeting (Oct. 14, 2015).
 - Our current thinking is in line with these requests, except that in the latter SCPMT meeting we assumed there would be two weeks of 5 Hz running instead of the more than five weeks that we actually got.

BNB Raw Data Volume and Rates

FY16	5 Hz Open	2 Hz Open	2 Hz PMT
Raw Data Event Size (MB)	34	34	34
Cosmic Ray Rate (Hz)	5000	5000	5000
BNB Beam Gate (s)	1.6E-06	1.6E-06	1.60E-06
BNB Trigger Probability per Spill	1.00	1.00	0.008
BNB Rep Rate (Hz)	5.00	2.00	2.00
NUMI Rep Rate (Hz)	0.00	0.70	0.70
Trigger Rate (Hz) (BNB + NuMI)	5.00	2.70	0.050
Raw Data Rate (MB/s)	170.0	91.8	1.69
Live Time (days)	30	60	180
Beam Events	1.3E+07	1.4E+07	7.71E+05
Raw Data Volume (TB)	441	476	26

- Data volume during commissioning period is by far dominated by binary format raw data.
- PMT Trigger rate is dominated by cosmics at all beam intensities.

Data in SAM



- Binary raw data.
 - Before start of BNB data taking: 289 TB.
 - Since start of BNB data taking: 579 TB.
- Swizzled raw data (all streams): 3.04 TB.
- Reconstructed: 0.21 TB.
- MC.
 - Total: 90 TB.
 - MCC 6.1: 64 TB.

Swizzling Status



- Swizzling is not completely up to date with data-taking, since we did not start right away after the arrival of BNB beam.
 - We are swizzling new data first, then working on the backlog of early data.
 - Our DAQ system is handling the 5 Hz open trigger.
 - Copy to tape is not keeping up with data rate.
 - If 5 Hz BNB rep rate continues, we have to do something to relieve the backlog of tape copies.

CPU Time Requirement



- Swizzling: 0.2 s/ev.
 - At 5 Hz data taking, keep-up processing requires one cpu (but i/o dominated).
- Reconstructing data: 900 s/ev.
 - At 0.1 Hz data taking, keep-up processing requires 90 cpus (90 batch slots).

Production Computing Plans (Next Six Months)

- We will continue to swizzle and reconstruct our raw data during the open trigger period.
- After we commission the PMT trigger, our plan is to re-swizzle the open trigger data.
 - In order to refine the optical filter (i.e. offline trigger).
- We are planning a new MC campaign (MCC 7) to more realistically simulate the as-performing detector.

Offline Production Effort

Production Group Leaders

K. Terao (PD)

M. Kirby (FS)

PUBS Core

K. Terao (PD)

PUBS Online

K. Terao (PD)

E. Church (FS)

D. Caratelli (GS)

D. Kaleko (GS)

M. Kirby (FS)

PUBS Offline

K. Terao (PD)

Y.-T. Tsai (PD)

H. Greenlee (FS)

Legend

GS – Graduate Student

PD – Postdoc

FS – Faculty/Staff

Fermilab

Data Production

L. Jiang (PD)

MC Production

J. Mousseau (PD)

Software Releases

K. Woodruff (GS)

Larbatch

H. Greenlee (FS)

- We have had several meetings with OPOS to discuss getting help from them with our production.

Documentation



- General PUBS and online PUBS documentation available in uboone-operations redmine wiki (shifter and expert level).
 - <https://cdcvs.fnal.gov/redmine/projects/uboone-operations/wiki#Data-Management-and-PUBS>
- Offline PUBS documentation available on uboonecode redmine wiki.
 - https://cdcvs.fnal.gov/redmine/projects/uboonecode/wiki/Pubs_and_projectpy
- Larbatch tools documentation on larbatch redmine wiki.
 - <https://cdcvs.fnal.gov/redmine/projects/larbatch/wiki>

Summary



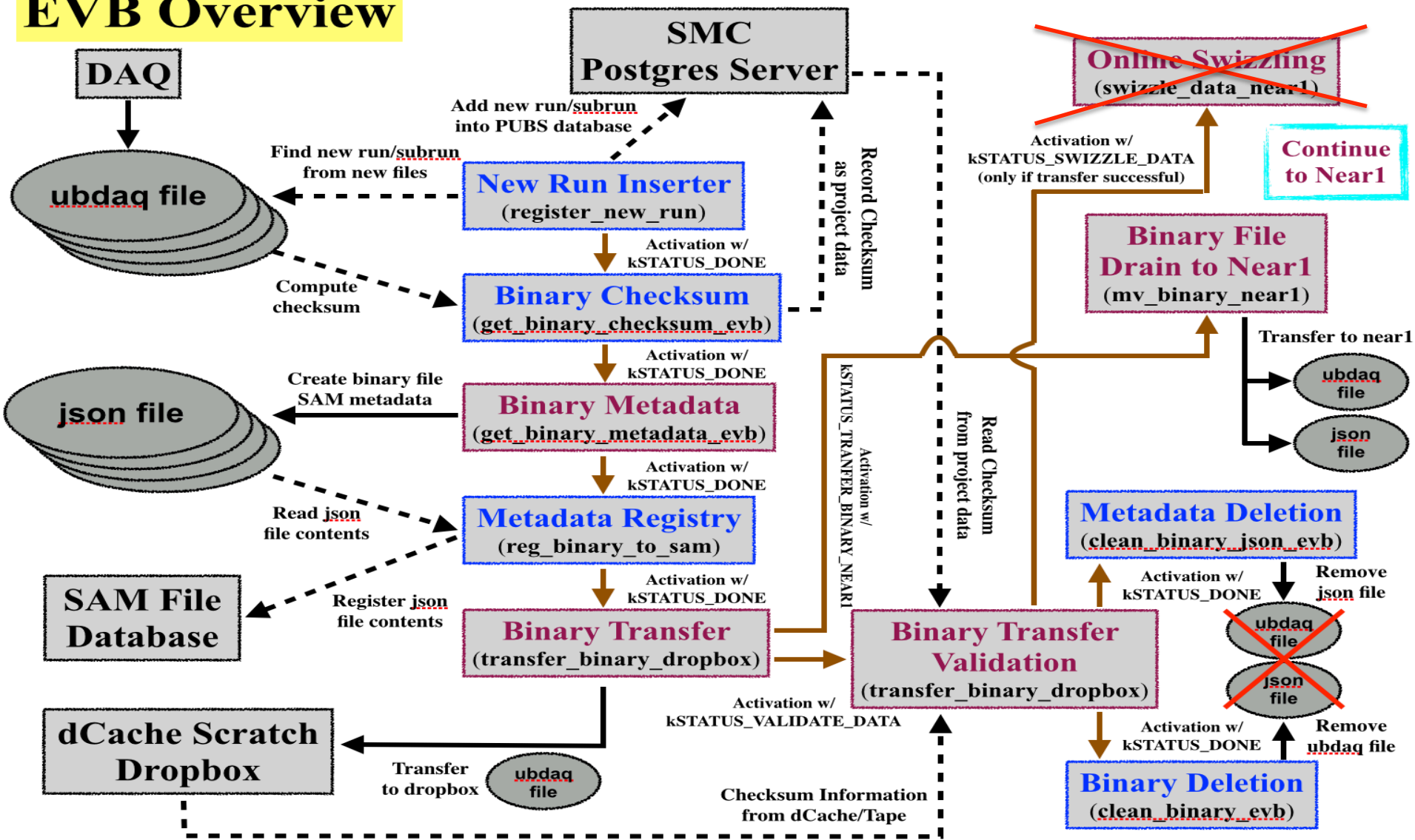
- We are currently taking data with open trigger (BNB @ 5 Hz).
 - DAQ is handling trigger rate.
 - Tape storage is having problem keeping up.
- Running swizzling and reconstruction offline w/ filtering (offline trigger) using production tools.
- We will commission PMT trigger within ~two months, which will reduce data event rate to ~0.1 Hz.



Backup

Online PUBS

EVB Overview



Enstore Tape Backlog



Summary

FTS: **OK** | SAM: **OK**

Completed files:	68559
Failed transfers:	18
All error files:	22
Waiting on tape:	25008
Other pending files:	0
New files:	0

Files waiting for tape

