The Online Calibration Framework

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1 Introduction

The Online Calibration Framework will be designed to ensure that all sub-systems of the detector take the necessary calibration data for each of the approximately one million channels that will form the upgraded DØ detector. This calibration data will form the basis of every physics measurement made by DØ in Run 2. The Calibration Framework is a software package that will control the calibration tasks. It will be required to initiate each of the sub-detectors calibration tasks, return the results, and notify the user of any errors that occurred during the calibration task. In addition, the framework will be required to compare the results with previous calibration runs, provide standard plots, and store the results in the online calibration database. In some cases the detector calibration tasks will adjust the parameters that will be down-loaded to the detector at the beginning of each run. If this occurs, the Framework will be required to adjust all relevant database entries and down-load files.

This document will describe the design requirements and preliminary design of the Calibration Framework. It will then describe the calibration data that each of the sub-detectors will be collecting. The requirements of the Online Database will then be described including a description of any additional data that will be stored in the database (e.g. Beginning/End–of–run records, triggers settings, hardware settings, luminosity information and environment monitoring). Finally, the schedule for the completion of this project will be given.

2 Calibration Framework

It will be assumed for the purpose of designing the framework that it is only concerned with collecting the appropriate calibration data. This Framework will not be required to act as an interface to to the calibration database and a second utility will have to be written to do this. The Calibration Framework will be required to complete the following tasks:

- **Receive a message from a user and perform the requested task.**
  - Need to determine list of allowable messages. A preliminary set of tasks has been decided on and these are:
    1. Run a calibration task for one of the sub-detectors
    2. Check the status of any/all of the running Calibration tasks
    3. Check the Calibration history
    4. Terminate/Pause a given calibration task
    5. Terminate the Calibration server and all of its currently running tasks.
  - Choice of format of messages (Standard DØ Online message format?)
  - Who (or from where) is allowed to request messages.
  - Queue with priority system for messages
- **Start and monitor calibration tasks for each of the sub-detector systems**
  - Request control of appropriate detector systems from COOR
  - Keep track of status of calibration task
  - Receive Calibration record from sub-detector task.
  - Ensure that task is completed in an appropriate length of time
- **Place Calibration Records in Calibration Database**
  - Compare Calibration record with standard reference numbers
  - Notify user if record conforms with standards and provide calibration plots for checks
  - Request permission to update database.
  - Update Database
- **Calibration Frequency**
  - Check the time between calibrations, if the time is excessive send alarm

- **Control Systems**
  - The Framwork will be accessed via a GUI interface
  - A set of tools that keep track of the status of all tasks
  - The ability to cancel jobs (including all jobs and the server itself)
  - Elegant error handling in the event of failure in external systems.

An example of a possible design for a generic sub-detector calibration task is given in Fig. 1

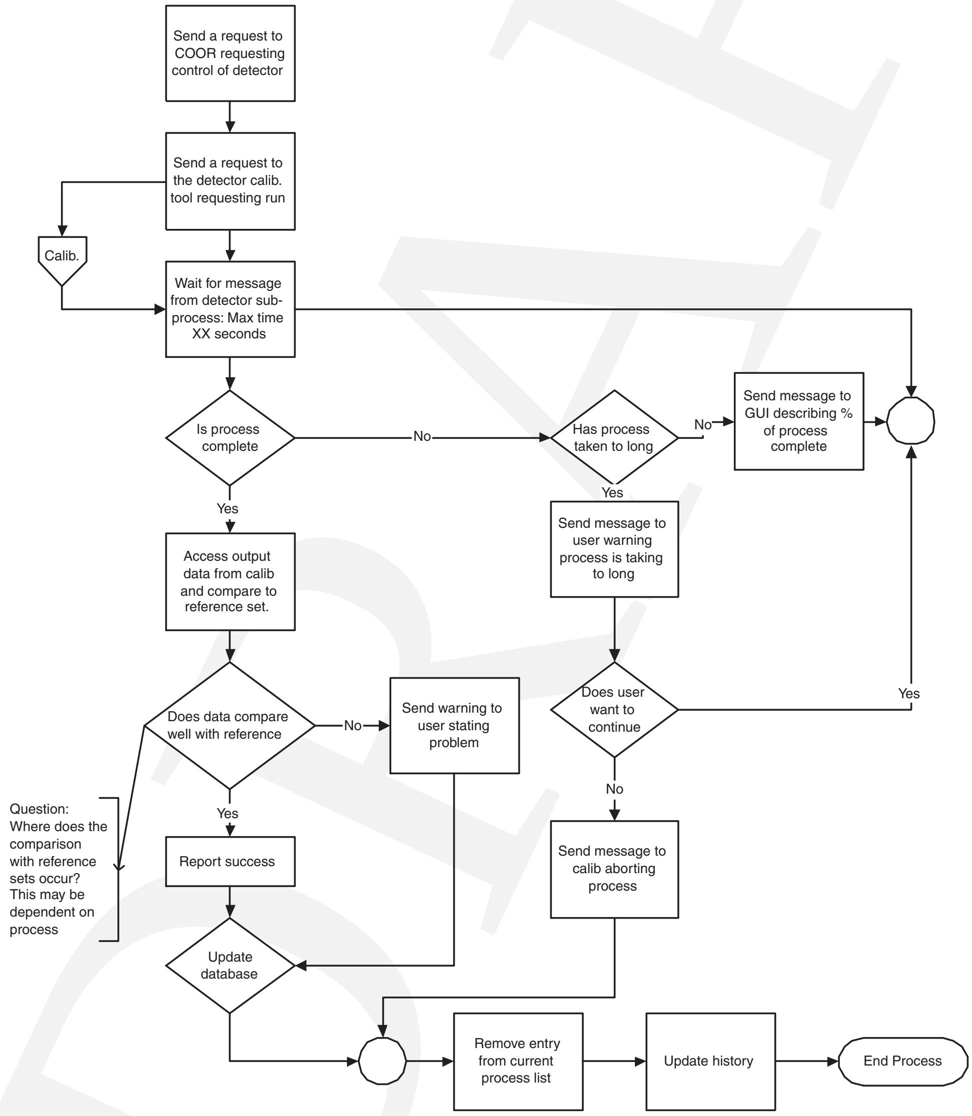

Figure 1: Design for a generic sub-detecor calibration task.

Some decisions have been made relating to the design of the framework; it will be required to use the ACE package for all communications, and will be based on the THREAD_UTIL package. In addition it will make use of the standard DØ database access tools when these become available.

3 Sub-Detector Calibrations

Each of DØ's sub-detectors will require a calibration tool that measures the necessary calibration constants for that detector. The tool will be required to issue the commands required to run the hardware required by the calibration task, collect the data, analyze the data, provide the resulting calibration constants and report any errors in the calibration.

The requirements of the detector calibration tools will vary depending on the use that the calibration information will be used for.

The sub-detectors that will require calibration tools are: the calorimeter, the silicon tracker, the central fiber tracker, the muon system, the pre-shower detectors (central and forward), the forward proton detector, and the luminosity monitors (unsure if this detector plans on having calibration runs).

The following sections will describe the current requirements for the calibration tasks of each of the sub-detectors.

3.1 Calorimeter

The calorimeter's calibration tool will be based on the Run I tool which already exists. This tool needs to be updated for the new calorimeter electronics and software standards that will be used in Run II. The task is required to:

- **Take five minutes to complete**
- **Measure the pedestals or gains (pulsers) for the 47800$\times$2 channels**
  The following data sets will be collected by the calibration task:
  PEDESTALS:

  1. mean (32 bit floating point number to be used off-line)
  2. mean (16 bit adc count to be down-loaded to trigger)
  3. sigma (rms) (32 bit floating point number to be used off-line)
  4. zero suppression limits (16 bit adc count to be down-loaded to trigger, also used to turn off noisy channels)
  5. error flag (bit pattern describing errors that occurred during the pedestal measurement)

6. 10 monitoring histograms are stored per run to examine the status of bad channels and monitor a select group of good channels for calorimeter performance (dynamic size: 200-300 words per histogram)

PULSERS (GAINS):

1. mean (32 bit floating point number to be used off-line)

2. sigma (rms) (32 bit floating point number to be used off-line)

3. error flag (bit pattern describing errors that occurred during the pedestal measurement)

4. 10 monitoring histograms are stored per run to examine the status of bad channels and monitor a select group of good channels for calorimeter performance (dynamic size: 200-300 words per histogram)

- **Using the data collected during the pedestal run update the zero-supression information to be downloaded to the calorimeter.**

3.2 Muon

The muon calibration process is required to measure the following with a period of approximately one week.

Calibration Parameters (updated about once/week)

Parameter	card	bytes	# cards	param/card	# params
PDT t-zeros	PTD FEB	2	300	24	7200
PDT pad gains (A only)	PTD FEB	2	72	48	3456
PTD time-to distance	PDT CB	2	94	10	940
MDT t-zeros	MDC	2	268	192	51456
scint t-zeros	SFE	2	130	48	6240
total					69292

This information will be used to monitor the muon system and update the muon down-load parameters as required (updated infrequently in general, but more frequently during commissioning or with changes in accelerator parameters). These parameters are:

Parameter	card	bytes	# cards	param/card	# params
PDT wire thresholds	PTD CB	1	94	1	94
PDT pad thresholds (A only)	PTD CB	1	18	1	18
PDT wire gate	PTD CB	1	94	1	94
PDT pad gate (A only)	PTD CB	1	18	1	18
PDT trigger gate	PTD CB	1	94	1	94
PDT channel masks (16-bit)	PTD CB	2	94	6	564
MTD threshold	MDC	1	268	1	268
MTD gate width	MDC	1	268	1	268
MTD gate delay	MDC	1	268	1	268
MTD channel masks (16-bit)	MDC	2	268	12	3216
MTD pipeline delay	MDRC	1	30	1	30
MTD pipeline length	MDRC	1	30	1	30
MDT timing adjust	MDRC	1	30	1	30
MDT address table	MDRC	1	30	16	480
MDT reserved	MDRC	2	30	3	90
Scint threshold	SFE	1	130	48	6240
Scint timing gate width	SFE	1	130	3	390
Scint timing gate delay	SFE	1	130	3	390
Scint analog gate width	SFE	?	130	3	390
Scint analog gate delay	SFE	?	130	3	390
Scint enable masks (16-bit)	SFE	2	130	4	520
total					13882

3.3 Silicon Tracker

The silicon tracker task will be required to collect pedestal and gain information every two days. It is assumed that this information will be used to determine a set of zero-suppression thresholds to be down-loaded to the detector and that these thresholds will be updated approximately once every three months once stable operations have been achieved.

The calibration data to be collected for all 792756 channels is:

- PEDESTALS
  1. mean (32 bit floating point number)
  2. sigma (rms, 32 bit floating point number)
  3. zero suppression level (8 bit number per chip, down-loaded to chip)
- GAINS
  1. mean (32 bit floating point number)
  2. sigma (rms, 32 bit floating point number)

3. 3rd moment (not sure if needed need to wait for burn-in tests)

In addition a list of dead and noisy channels will be kept.

3.4 Central Fiber Tracker and Preshower Detectors

The calibration of the fiber tracker and the preshower detectors is expected to be similar to that required by the Silicon tracker. i.e. The data stored after each calibration run will be:

- PEDESTALS
  1. mean (32 bit floating point number)
  2. sigma (rms, 32 bit floating point number)
  3. zero suppression level (8 bit number per chip, down-loaded to chip)
- GAINS
  1. mean (32 bit floating point number)
  2. sigma (rms, 32 bit floating point number)
  3. 3rd moment (not sure if needed need to wait for burn-in tests)

In addition a list of dead and noisy channels will be kept.

3.4.1 Characterization Information

Before Run II commences the VLPC system will have been fully characterized. The information collected will be stored in the Online (Offline) Calibration Database. This information is:

- VLPC's (15 kchips)
  1. VLPC Identifier
  2. Date of Test
  3. Run number of test
  4. Bias during test
  5. Gain
  6. RMS of Gain
  7. Efficiency
  8. RMS of Efficiency
  9. Threshold
  10. RMS of threshold
  11. Break Voltage

3.4.2 Front End Electronics

The CFT, CPS, and FPS will require the following information to be downbloaded to the electronics boards at initialization time.

- FE ELECTRONIC'S DATA: AXIAL (80 boards)

  1. The 64 identifiers of the VLPC chips read out by the board
  2. 8 VLPC bias values
  3. 7 thresholds for CFT MCM chips
  4. 2 thresholds for axial CPS MCM chips (2 per chip)
  5. 8 thresholds for SVX chips (1 per chip)

- FE ELECTRONIC'S DATA: STEREO CFT (75 boards)

  1. The 64 identifiers of the VLPC chips read out by the board
  2. 8 VLPC bias values
  3. 8 thresholds for CFT MCM chips
  4. 8 thresholds for SVX chips (1 per chip)

- FE ELECTRONIC'S DATA: STEREO CPS & FPS (42 boards)

  1. The 64 identifiers of the VLPC chips read out by the board
  2. 8 VLPC bias values
  3. 16*2 thresholds for MCM chips
  4. 16 thresholds for SVX chips (1 per chip)

3.5 Forward Proton Detector

No information at this time.

3.6 Luminosity

No information at this time.

4 Online Database

5 Schedule

This is a preliminary draft of a schedule for the implementation of the Calibration Framework. The schedule is not complete and I have left out dates for some goals as I am unsure of when they happen. The schedule will be updated.

Calibration Framework Tasks

Milestone	Data
Define Message Class	30 June 1998
Send/Receive Messages	31 July 1998
Operating Queues	31 July 1998
Prototype Database Created	31 August 1998
Enter/Extract Info from database	31 August 1998
Setup multi-thread process	30 September 1998
Implement calibration history	30 September 1998
Implement multiple queues	30 September 1998
Implement Job status queries	31 October 1998
Implement cancel job facility	31 October 1998
Implement server shutdown procedure	31 October 1998
These goals are without dates	
Send detector allocation request to COOR (response)	
Implement GUI Interface	
Integrate Calorimeter Calibration Task	
Integrate muon calibration task when detector available	
Calibration Framework test with SVX 10% project	
Online Calibration database Design 1	
Complete Calibration Framework	1 January 2000

6 Conclusions

This document is intended to elicit responses from the collaboration on the proposed Online Calibration Framework. Please contact me with any comments, especially with additional information that can be included in this document.