# E961(COUPP) Video, Trigger, & DAQ for 60 Kg [1.5.]

## Goal - make the world's most boring movie

Photograph a well illuminated, sensitive, bubble chamber at ~100Hz with VGA resolution (480X640) BW cameras.

Declare a trigger when an image changes (>5 pixels with $|\Delta|>15/256$ adc counts)
Combine & manage triggers from cameras, pressure controller, operator
Request a chamber compression for each trigger.

Record trigger data - 10 300kb bit map images/camera + state and other data ~10Mb/trigger. Analyze events as taken for monitoring purposes.

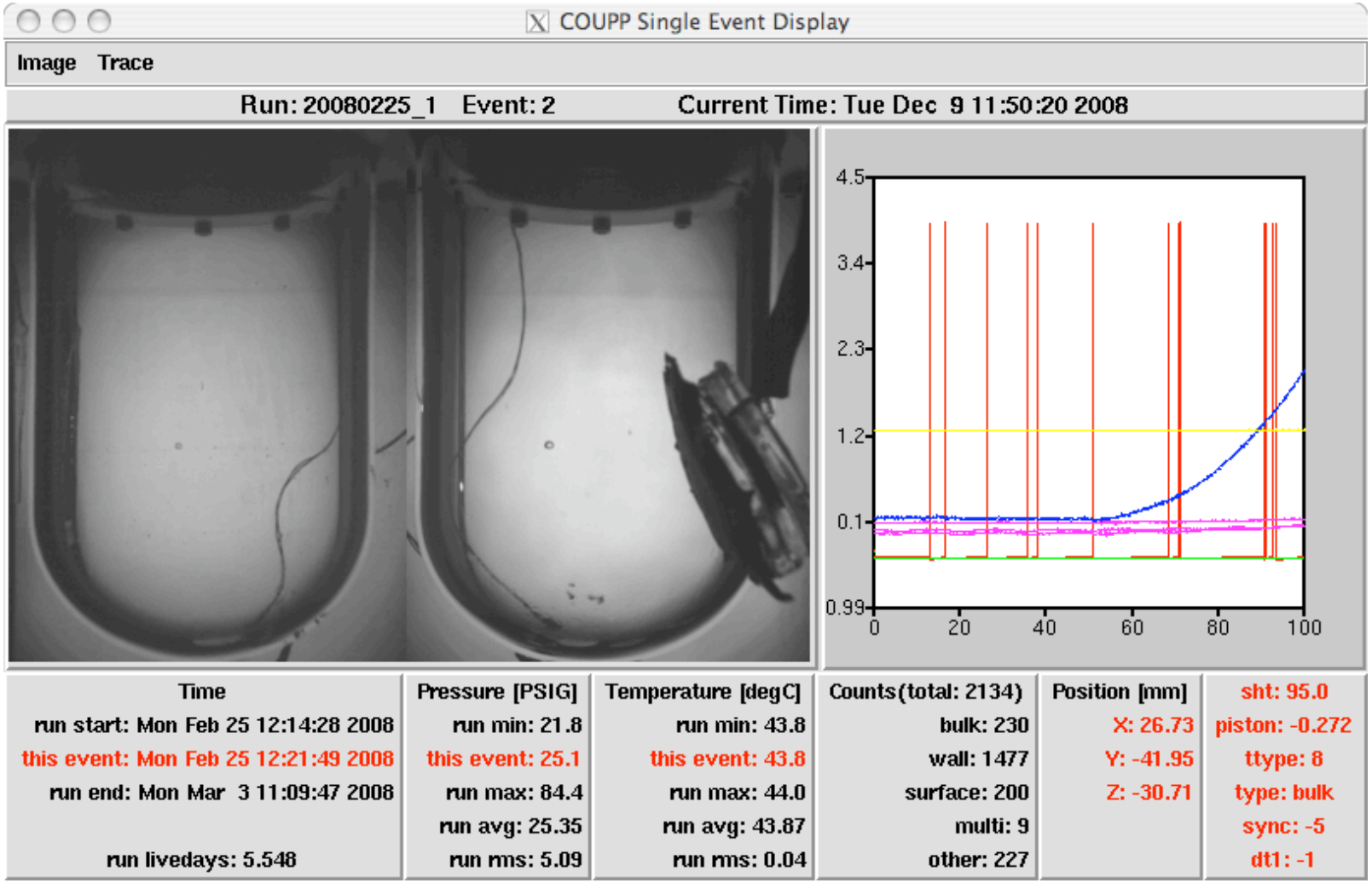
DAQ Parameters

| | | |
|---|---|---|
| Trigger rate | 100-5000/day | {high rate for source testing} |
| Trigger deadtime | 30 seconds | {chamber recompression settling time} |
| time resolution | ~10 msec | {time between images} |

Provide a user interface for monitoring, control and DAQ

Robust, stand alone, remote operations via the network. Gracefully survive power and network outages without treks to the North Woods.

# An Event




Steve Brice's Single Event Display prototype

Please ignore the UFO - the speaker to test the acoustic sensors broke free

# Parts and Players

## Components

Lighting - LED array + diffuser in compression fluid
Cameras - Basler Excite (Linux onboard) image difference video trigger
Logic - power cameras and lighting combine all trigger sources master camera clock
PLC - control pressure cycle, handle state data (P, T, etc.)
Muon tagger - 12 PMTs 5 Hz/tube, DAQ TBD
Computer - Linux servers for data, network …
Labview - waveforms and user interface

## Team

Lighting - Martin Hu (Coupp/AD)
Cameras - Dan Broemmelsiek (Coupp/AD)
psc (Coupp/CD)
Logic - Rick Kwarciany (CD) ,
Greg Deuerling (CD)
PLC - Rich Schmitt et.al. (PPD)
Computer- psc (Coupp/CD),
Jason Ormes(CD)
Software - Dan Broemmelsiek (Coupp/AD)
Andrew Sonnenschein (Coupp/PPD)
Coordination - psc (Coupp/CD)

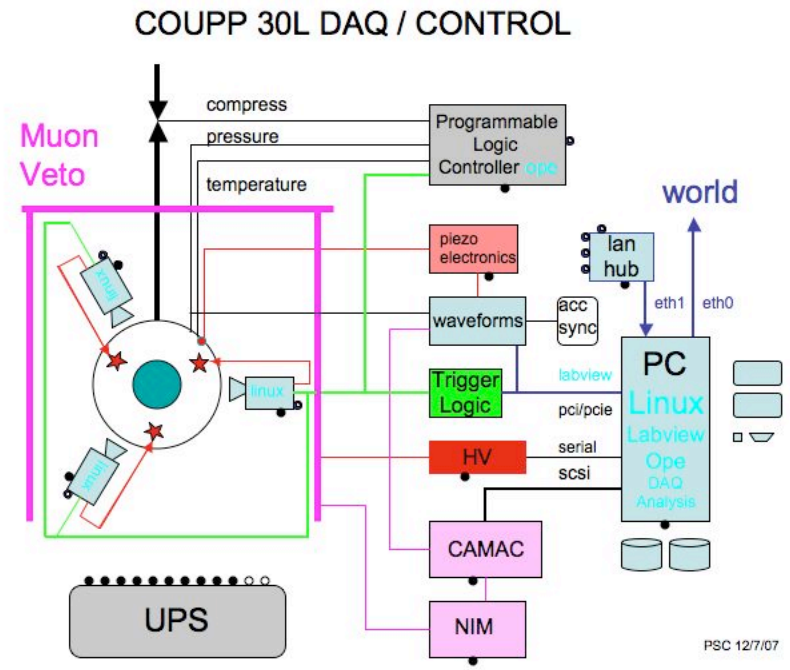



Figure from Conceptual Design [526-v1] 12/6/2007. Details have changed; concepts and basic design has not.

# WBS 1.5 Data Acquisition and Handling

| WBS | Activity name | days | Start | Finish | Manager |
|---|---|---|---|---|---|
| 1.5 | DATA ACQUISTIONS AND HANDLING | 335 | 6/10/08 | 9/22 | Cooper |
| 1.5.1 | Documentation | 291 | 6/10/08 | 7/22 | Cooper |
| 1.5.2 | VIDEO AND ILLUMINATION Hardware | 16 | 4/7 | 4/28 | Hu |
| 1.5.3 | DAQ Hardware | 36 | 4/28 | 6/16 | Broemmelsiek |
| 1.5.4 | DAQ Software | 55 | 4/22 | 7/7 | Broemmelsiek |
| 1.5.5 | DAQ system bench test | 5 | 5/25 | 5/29 | Broemmelsiek |
| 1.5.6 | Full DAQ System at NUMI | 0 | 7/7 | 7/7 | Cooper |
| 1.5.7 | Data Archiving | 10 | 9/9 | 9/22 | Cooper |

## 1.5.1 Documentation

| Projects-doc-# | Title | Author(s) | Last Updated |
|---|---|---|---|
| 526-v1 | COUPP 30 Liter Chamber DAQ Monitoring & Control Overview | Peter Cooper | 04 May 2009 |
| 527-v1 | E961(COUPP) Video, Trigger, & DAQ for 60 Kg | Peter Cooper | 04 May 2009 |
| 529-v1 | COUPP Camera Trigger Interface Controller Module Requirements | Richard Kwarciany | 04 May 2009 |
| 528-v1 | CTIC User Manual | Richard Kwarciany | 04 May 2009 |

## Work

CLIM (LED PS and flasher) User's Manual
Software documentation and User's Manual await software development

## 1.5.2 VIDEO and Illumination

## Next talk - Martin Hu

# 1.5.3 DAQ Hardware - Cameras

## Achievements

Acquisition — 5 camera bought previously - need 2
Camera now obsoleted by Basler

Prototyping — images/optics identical to old cameras
model video triggers work
trigger line software tested

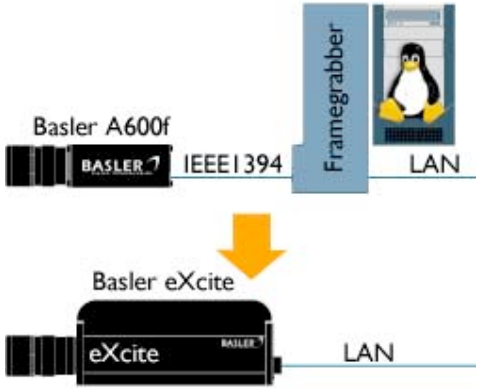
Networking — Basler client/server model under test
NFS has been tested and works too

Mount — Design completed
fabrication done

Testing Software — Bubbles seen with test software @ D0
Coding V1.0 now

## Work

System Integration
[Martin's Talk]

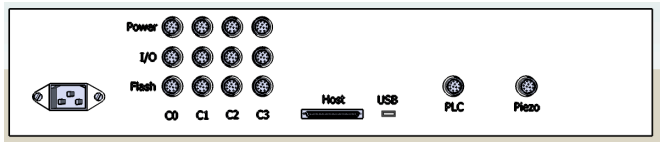
# 1.5.3 DAQ Hardware - Trigger

## Modules

CTIC Coupp Trigger Interface Controller
CLIM LED Power supply


## Achievements

Design completed and reviewed October 08
Boards done
Assembly 2 CTIC + 2 CLIM, 2 more CLIM
Testing done




## Work

Integration with Labview, cameras & DAQ @FCC [1.5.5]
Installation on 60Kg @D0 / NUMI [1.5.6]

# 1.5.3 DAQ Hardware - Cosmic Tagger

## Achievements

Prototype — Sten Hansen has built and is testing Crockcroft-Walton PMT bases with onboard 40MHz digitizers Which readout via USB/LAN for coupp2l. Achieved specs are more than adequate (noise, buffer depth, …)

Design — He is redesigning for the coupp30l muon tagger PMTs Different HV and base pinout, same DAQ

Software — Jeter Hall (CDMS) has a working Labview VI for these bases

## Work

Hardware — Fabricate and test Coupp30l bases

Software — Adapt Jeter's code

Integration — put the system together [1.5.6]

# 1.5.3 DAQ Hardware - Computers

## Achievements

Prototype 4 large systems installed December 2007
8 2GHz CPUs, 1.5Tb disk, 4Gb memory
2 ethernets, 12 Fans, rack mount
(I ain't going to the North Woods in January!)
COUPP server, Teststand, 30l, 2l

Software FNAL Scientific Linux
v5.2 for camera development platform

Labview made to work

Hardware Labview PXI crate,
basic interface module for CTIC & pressure trace

## Work

Reinstall PLC database (OPE) after v5.2 upgrade
Acquire 4 2 channel NI scope cards for piezo's
Integration with cameras and trigger/power supply [1.5.5]

# 1.5.4 DAQ Software Labview and other Programing

## Components

Camera — Image difference trigger
coordinate triggers and data with rest of DAQ
(~500 lines C++)

Labview — Trace DAQ for piezos and pressure
Event building (files in a directory)
Monitoring and control
based on coupp1l experience &
Mike Crisler's new Labview VI for coupp2l

Linux — near realtime event analysis
system, shell, network, storage and archiving

## Goals [1.5.6]

Basic V1.0 functionality for engineering test @D0
Higher level coding for final DAQ/control system @NUMI

## Challenge - schedule risk

Integrating DAQ rarely goes as planned

# DAQ Integration

## 1.5.5 DAQ system bench test

Coupp12 computer, CTIC, 2 cameras and NI hardware are now in a rack on FCC3. Active hardware/software integration work is in progress

### Goal

Drop a penny in front of a camera and get both a trigger and an event.

## 1.5.6 Full DAQ system at NUMI

Move system first to D0 then NUMI. Complete integration with PLC, chamber pressure and piezo traces. Advance higher levels of software functionality.

### Goal

Ready to take engineering data

## 1.5.7 Data Archiving

Adapt coupp1l near-online data analysis and archiving (enstore@FCC) systems.

### Goal

Ready to take and look at physics data.

# Design Criteria and Scalability

## Design Criteria

Mainly conventional commerical technologies

Minimum number of components (CTIC instead of NIM and power bricks)

We want a 1 rack, low power (with UPS), system for remote underground operations.

Overkill wherever possible. No stress on DAQ system parameters

The approach to bandwidth saturation of firewire for the dumb Basler cameraa lead us to the smart cameras.

## What about a bigger Chamber?

We might need up to 8 cameras for a big chamber.

So? Add 6 more cameras to the LAN we have now - same software

Daisy chain 2 or 3 CTICs for trigger managment,
Add more LED power if necessary
Add Labview cards for more Cosmic and acoustic signals

and the present system will do this job.

# Questions ?