



SoLID Slow Controls

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What are Slow Controls

- “Infrastructure support” systems and logging
 - Status monitoring of power, vacuum, temperatures, etc
 - Includes logging and alarms/notification services
 - Safety interlocks between systems
 - fast valve closure on vacuum problems
 - disable power on temperature/cooling failure, etc.
 - Remote control of motors, pumps, actuators, stepper motors, etc...
 - Typical meas./response time scale on the order of 1 Hz
- Examples include
 - High voltage / Low voltage power controls (R/W)
 - 'Read-only' logging of temperatures, pressures, B-field, flow rates, ...
 - Magnet/Target control systems
 - Complex control process loops: vacuum, temperature, power
 - Gas systems
 - simple “set and forget” open loop STP systems w/o recapture
 - complicated control systems running a distillation/purification system
 - Etc...

PLCs

- Programmable Logic Controllers
 - integrated hardware + firmware solutions
 - integrated systems often trade higher performance for the flexibility of 'hand-rolled' IOCs
 - modular, off-the-shelf components suitable for many common processes
 - Care needs to be taken to ensure good systems integration with the rest of the world
 - ie. built in EPICS interface very strongly encouraged
 - Allen-Bradley/Rockwell (ControlLogix, CompactLogix) PLCs in common use at JLab
 - will interface well with EPICS
 - Ideally, let's standardize on one vendor/system
- Magnet controls are good use case for PLCs

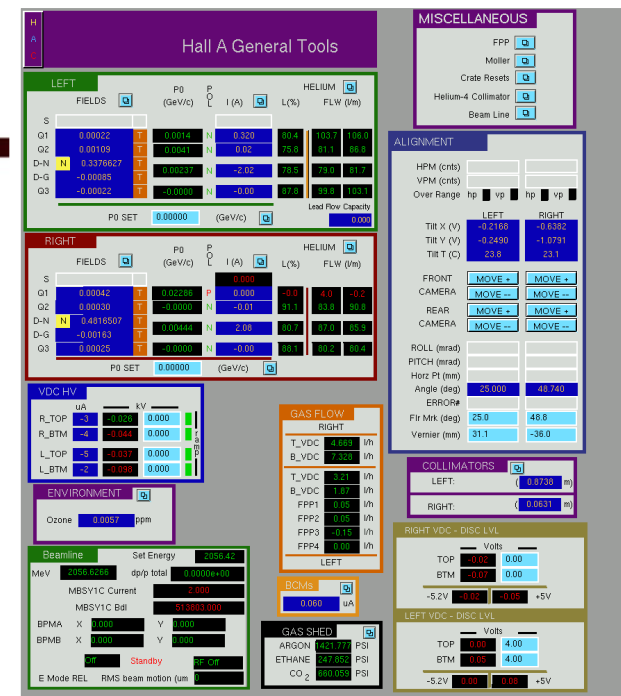


EPICS

- Experimental Physics and Industrial Control System
 - <http://www.aps.anl.gov/epics/>
 - Open source, actively developed, lots of users
 - Based on C; APIs available for Java, Python, LabView, etc...
 - Covers both input/output controllers (IOCs) that do the real work
 - ie. poll for and respond to data in real time
 - publish data for other systems to consume
 - IOCs can be single board computers running vxWorks, embedded devices that support the EPICS protocols, or 'softIOCs' which are applications that can run under conventional OSes (linux, etc)
- Main slow controls 'backend' used at JLab
 - A lot of expertise in Accel Div. that we can leverage
 - However, we need to schedule (and budget for) the developer time well in advance!
 - Archiving of slow controls data can be integrated with existing (Accel) MYA Archiver

Frontend GUIs

- EDM (MEDM) / JTABS
 - Forward-port of JLab's 6 GeV EPICS screens
 - Still developed, but dated
- Control Systems Studio
 - <http://controlsystemstudio.org/>
 - Eclipse-based toolkit designed for systems like this
 - SNS, BNL, FRIB, DESY using this system
 - JLab: Hall D (in use), Hall B (evaluating)
- Let's settle on some standards
 - Avoid LabView
 - Avoid custom/proprietary code as much as possible
 - if not possible, provide EPICS interface for integration



Hall D CSS example

The screenshot displays the TAG5C Magnet PS GUI with the following sections:

- Power Supply Control:** Includes a "TURN POWER ON" button.
- Readbacks:** Shows "Main Power ON", "Power Supply Ready", and "Remote Mode".
- Status:** A list of indicators including IOC Heartbeat, Box Heartbeat, STANDBY, NOT READY, LOCAL MODE, Fan fault, NO RESPONSE, Rx data overflow, Unexpected address, Rx data corrupted, Bad rx termination, Tx command error, Setpoint error, Polarity stuck, Polarity change, External interlock, POWER OFF, Sum interlock, DC overcurrent, DC overvoltage, Regulation module, Max current set, Phase / unbalance, Waterflow fail, Earth leakage, Thermal breaker, Overtemperature, and Panic button / doors.
- Current and Power Supply ADC:** Displays "Current Setpoint 0.000 Amps" and "Current Readback 0.000 Amps".
- Input Selection & Detailed Setpoints:** A table with columns for Input Select, Current, BDL, Setpoints, and Nominals. It lists three inputs with their respective values.
- Calculated:** Shows "Setpoint Out 0.000 Amps", "Ramp Rate 0.00 A/sec", and "Resistance 0.000 Ohms".
- Hysteresis / Tracking:** Includes "Keep On Loop" (TURN OFF, ABORT), HMAX (275.000), HMIN (4.000), Cycle Time (120.000), Cycle Rate (0.452), Tolerance (0.300), Scan Rate (Passive), and Timeout (0 Hyst Type 1).
- External Primary Interlocks:** A list of interlocks including PSS Permit, Shunt 1A, Shunt 2A, Shunt 3A, Primary 5, Primary 6, Primary 7, Primary 8, Primary 9, and Primary 10.
- Graphs:** A "STANDARDIZING OFF HYSTERESIS" graph showing Value vs. Time for MTAG5C and MTAG5CM.

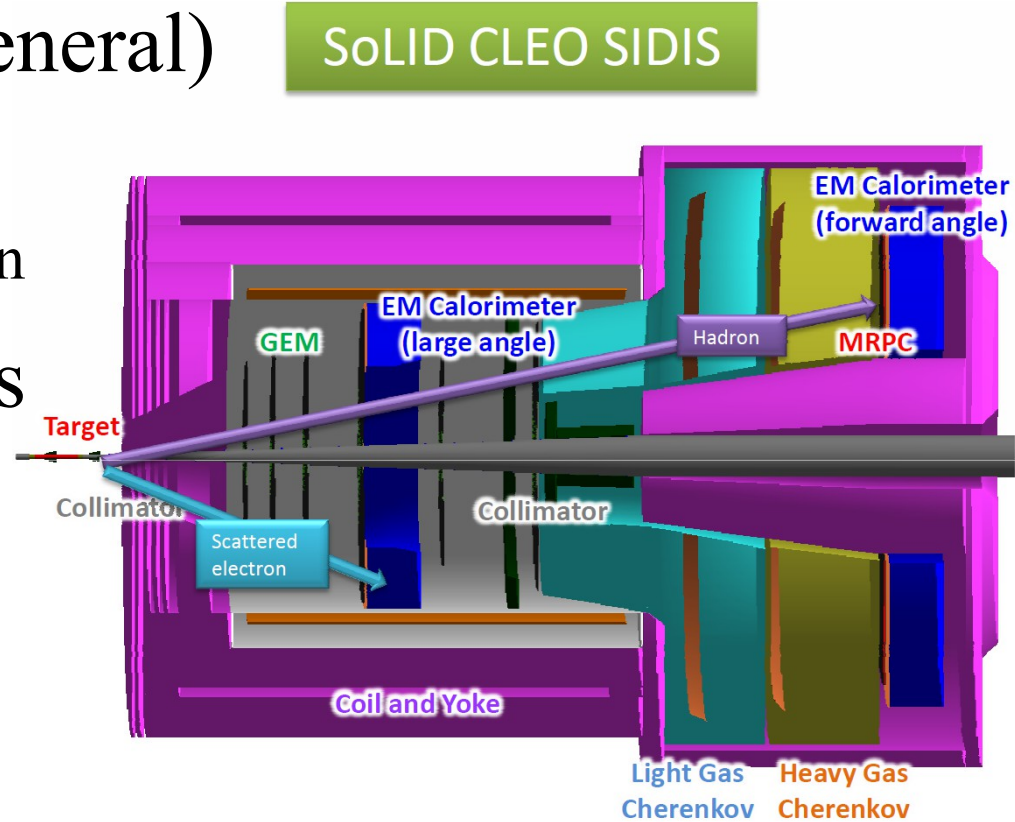
Annotations include a red circle around the "Main GUI Selector" icon in the top toolbar, labeled "Top GUI Selector", and a red arrow pointing to the "Main Action Bar" text near the graph.

The screenshot displays the ST Voltages GUI with the following sections:

- Buttons:** "Turn OFF ALL", "Bias", "LV", "SAVE/RESTORE", "ALL LV", and "ALL Bias".
- Chassis Channels:** Shows voltage and current for +5V and -5V rails.
- Preamplifier Channels:** Shows voltage and current for +3V and -3V rails.
- LV Voltages and LV Currents:** Bar charts showing voltage and current for each board.
- Bias Channels Voltages and Bias Channels Currents:** Bar charts showing voltage and current for each board.
- Bias Channel Module 1:** Shows "Menu", "OFF", "Temperature", "Voltage (V) 76.054", and "Current (mA) 0.00073".

SoLID Subsystems

- Magnet
- DAQ / Detectors (general)
 - Power (HV, LV)
 - Crate / Chassis selection
- Detector Subsystems
 - Ecal
 - LA/FASPD
 - Cherenkov
 - GEMs
 - MRPC



Magnet

- Complicated, lots of fast interlocks, high-risk, needs to be expert driven
 - Expert will pick what works best for them, hard to impose outside constraints...
 - One request:
 - Please allow for EPICS interface for easier integration into logging and DAQ systems

Detectors / Crates

- We want remote access to:
 - crate status: temperatures, fans, remote resets
- Standardize on a crate model:
 - all crates should have (at minimum) an ethernet interface on their controller
 - typically have SNMP support, etc, for monitoring/controls
 - select common (high-power spec'd) power supply module
- Wiener 60xx series in common use at JLab
(VME/VXS standard)

Detectors / High Voltage

- High Voltage hardware should be standardized
 - CAEN SYx527 system (~\$350/channel, incl crate)
 - Hall B / Hall D / Hall C
 - Built-in EPICS support, supplied controls GUI (java), other GUIs available on-site (Hall C)
 - Wiener MPOD system (Option 'B')
 - Hall D, Hall B SVT HV/LV
 - Hall B had some difficulty getting dedicated CAEN boards to work well with SVT (cooling, power, vacuum interlock related challenges)
 - SNMP-based EPICS interface exists
 - Cost ??
- Low Voltage
 - ??

Detectors – EC (Calorimeter)

- HV / LV power (previous slide)
- Fast interlocks / shutdowns?
- LED / Gain monitoring?
- Temperatures?
 - SiPM (if feasible) would likely require cooling

Detectors – LA/FASPD

- HV / LV power (previous slide)
- Fast interlocks / shutdowns?
- LED / Gain monitoring?
- Temperatures?

Detectors – Heavy Gas Cherenkov

- HV / LV power (previous slide)
- LED/Gain monitoring
- Gas flow/purity monitoring?
- Gas Temperature/Pressure regulation?
- Gas purification/recirculation systems
 - gets complicated/expensive quickly
 - pressure systems / code requirements typically mean professional engineering/designer support is mandatory
 - custom PLC/IOC design needed
 - C_4F_8O scarce, (C_4F_{10} even worse), long term options unclear...
 - All of the above gases expensive enough to need purification/distillation system on the scale needed for SoLID

Detectors – Light Gas Cherenkov

- HV / LV power (previous slide)
- LED/Gain monitoring
- Gas flow/purity monitoring?
- Gas Temperature/Pressure regulation?
- Gas purification/recirculation system?
 - CO₂ (SIDIS) can just flow (cheap, easy)
 - CO₂ + C₄F₈O (PVDIS) mixing + purification system
 - mixing is easy, purification/reuse is complicated...

Detectors – MRPC

- HV / LV power (previous slide)
- Fast interlocks / shutdowns?
- Gain monitoring
- Gas flow, purity

Detectors – GEM

- HV / LV power (previous slide)
 - “Wiener-Iseg” system used at UVa
 - Can a 'standard' system be used for production, or is this the best technical choice?
- Fast interlocks / shutdowns?
- Gas system?
 - Ar/CO₂ gas mix that just flows through is easy

Summary

- Think about and document slow control needs
 - Feed what you need/want to <brads@jlab.org>
 - I'm happy to do research and answer questions!
- Standardize, standardize, standardize
 - Avoid investing time in 'quick' solutions for local implementation. Stick with the standards – steeper learning curve, but it'll save time in the long run (build trained people as well as software).
 - Hacks and workarounds tend to become 'permanent' and unintended dependencies get baked in – good to avoid these.
- EPICS should be our common API/Protocol
- Frontend GUIs/software take time to develop
 - Can be good student projects, but needs sufficient lead time.