# SoLID Slow Controls

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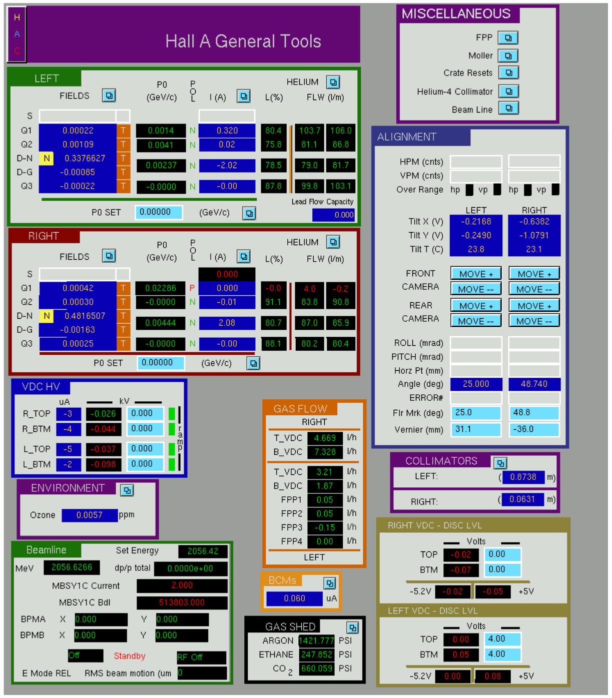
# What are Slow Controls

- “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 *without* recapture
    - complicated control systems running a distillation/purification system
  - Etc...

# EPICS

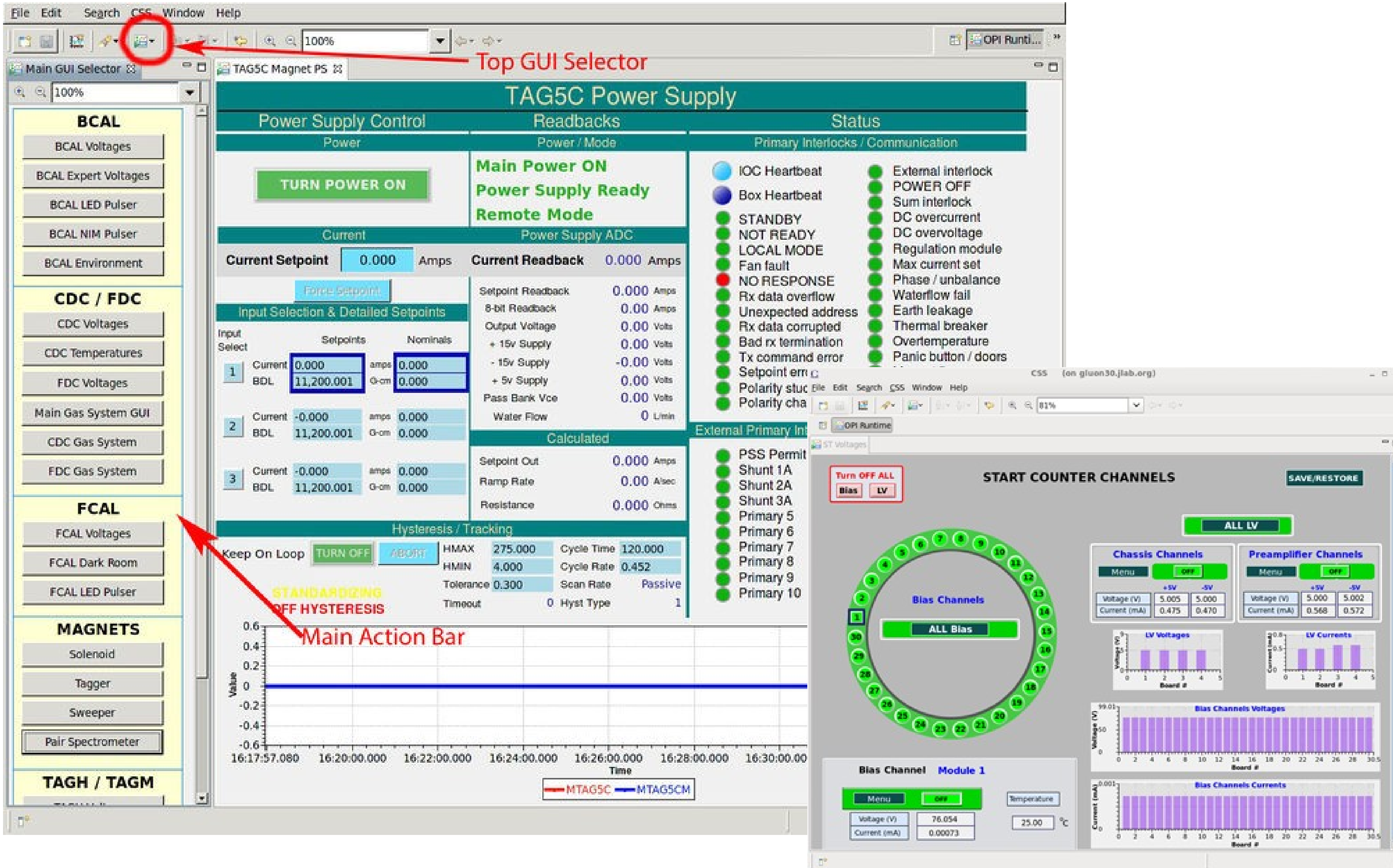
- Experimental Physics and Industrial Control System
  - http://www.aps.anl.gov/epics/
    - Open source, actively developed, lots of users
    - Based on C; APIs available for Java, Python, LabView, etc...
  - Covers both input/output controllers (IOCs) that do the real work
    - *ie*. poll for and respond to data in real time
    - publish data for other systems to consume
    - IOCs can be single board computers running vxWorks, embedded devices that supprt 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 ours
    - SNS, BNL, FRIB, DESY using this system
    - JLab:  Hall D (in use), Hall B (evaluating), Hall C (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



# 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
    - Hall B / Hall D / Hall C
    - Built-in EPICS support, supplied controls GUI (java), other GUIs available on-site (Hall C)
    - A7030 is new high density board (48 ch for significantly lower $/channel)
      - NOTE: 1 mA max. current/chan – check your device first!
  - 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
  - *NOTE: Existing/"legacy" Lecroy HV will **NOT** be used*
- Low Voltage
  - ??

# Detectors – General

- HV / LV controls, Temperature, Pressure GUIs with EPICS compatible logging
  - Go with a standard as described and this will be 'easy'. Recommended systems have control, monitoring and alarm loops already implemented, no IOC/PLC development needed.
- "Flow-through" / open-loop gas systems (GEM, LGC)
  - Solved problem with pre-existing GUIs. Go with a standard MFC, etc.
- Recirculating / variable pressure / distillation gas systems will be expensive and will require significant dedicated designer time. (HGC, MRPC)
  - Design must come first, then we can talk about slow controls (but keep the general 'standards' principles in mind!)
- LED Gain monitoring ("on/off") remote controls are straight forward
- Automated motion / positioning systems are more complicated
  - custom IOC/PLC development, fail-safe design and interlocks, etc.
- Fast interlocks (msec level) that cross system boundaries need to be identified at design stage.

# Detectors – Heavy Gas Cherenkov

- HV / LV power (previous slide)
- LED/Gain monitoring
- Gas flow/purity monitoring?
- Gas Temperature/Pressure regulation?
- Gas purification/recirculation (ie. Hall B)
  - gets complicated/expensive quickly
  - pressure systems / code requirements typically mean professional engineering/designer support is mandatory
    - custom PLC/IOC design needed
  - $C_4F_{10}$ seems viable for now (single supplier only?), long term options unclear...
    - Gas expensive enough to need purification/distillation system on this scale
    - Need to watch environmental regulations for these gasses too…
      - (Hall B can take advantage of grandfathering, SoLID can't)

# Detectors – MRPC

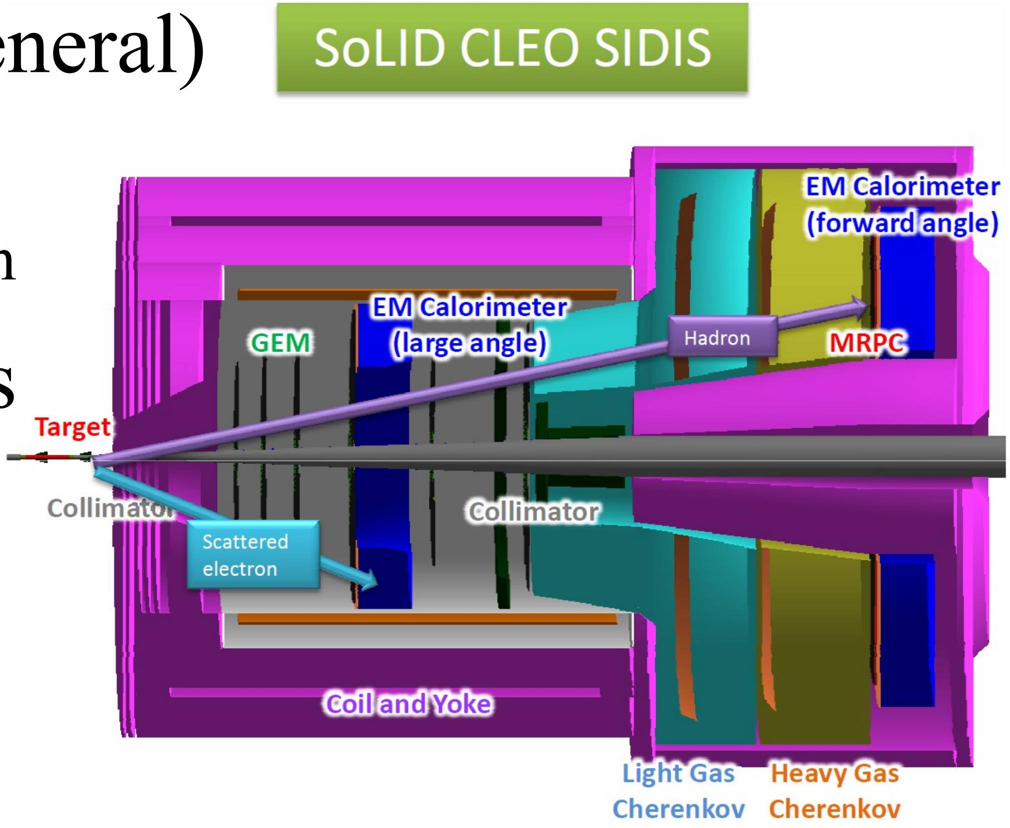
- HV / LV power (previous slide)
- Fast interlocks / shutdowns?
- Gas system
  - 5% SF6 + 95% R134 + 5% Isobutane
  - Will likely need capture/recirculation system
  - Phenix HBD / STAR MRPC gas system suggested as a model (need some details)

# Summary

- Think about and document slow control needs
  - Feed your requirements/design specs to <brads@jlab.org>
    - I'm happy to support research and answer questions
  - Design deadlines (end of 2016?) will arrive quickly. The devil is in the details.
- 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.
  - Proper hardware selection will minimize custom IOC/PLC development.
- EPICS should be our common API/Protocol
- Frontend GUIs/software take time to develop
  - Can be good student projects, but needs sufficient lead time.

# SoLID Subsystems

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



# Detectors – GEM

- HV / LV power (previous slide)
  - Wiener-Iseg SHQ 126L (6 kV, 1 mA) used at UVa
    - Has RS232/CAN interface
- Fast interlocks / shutdowns
  - Trip HV if gas flow is interrupted
- Gas system
  - 75% $CO_2$ / 25% Ar gas mix (simple flow through)
  - Remote monitoring / control required

# Detectors – Light Gas Cherenkov

- HV / LV power (previous slide)
- LED/Gain monitoring
- Gas system:
  - $CO_2$ (SIDIS) can just flow (cheap, easy)
- ~~Gas flow/purity monitoring?~~
- ~~Gas purification/recirculation system?~~
  - ~~$CO_2$ (SIDIS) can just flow (cheap, easy)~~
  - ~~$CO_2 + C_4F_8O$ (PVDIS) mixing + purification system~~
    - ~~mixing is easy, purification/reuse is complicated…~~
  - ~~Integration with HGC gas system likely important, but distillation of a CO2 mix may require significant modifications of a “Hall B” system~~

**Not Needed**

# Detectors – LA/FASPD

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

# 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