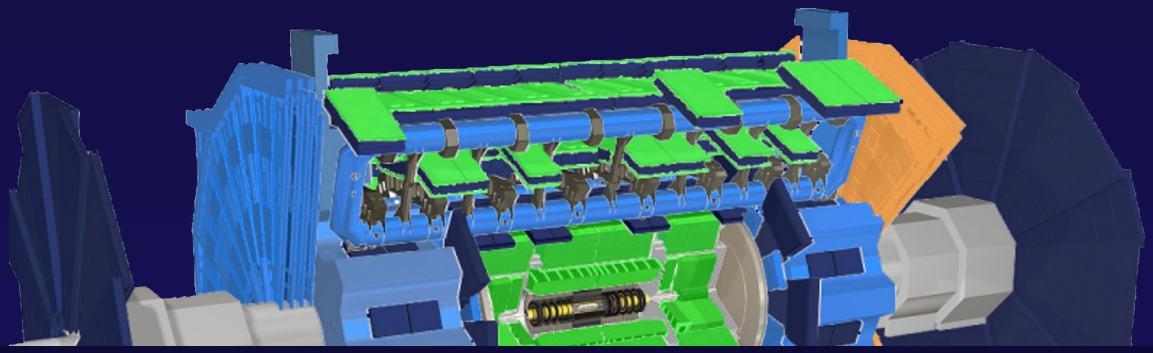
Shift Training: **Detector Control System**

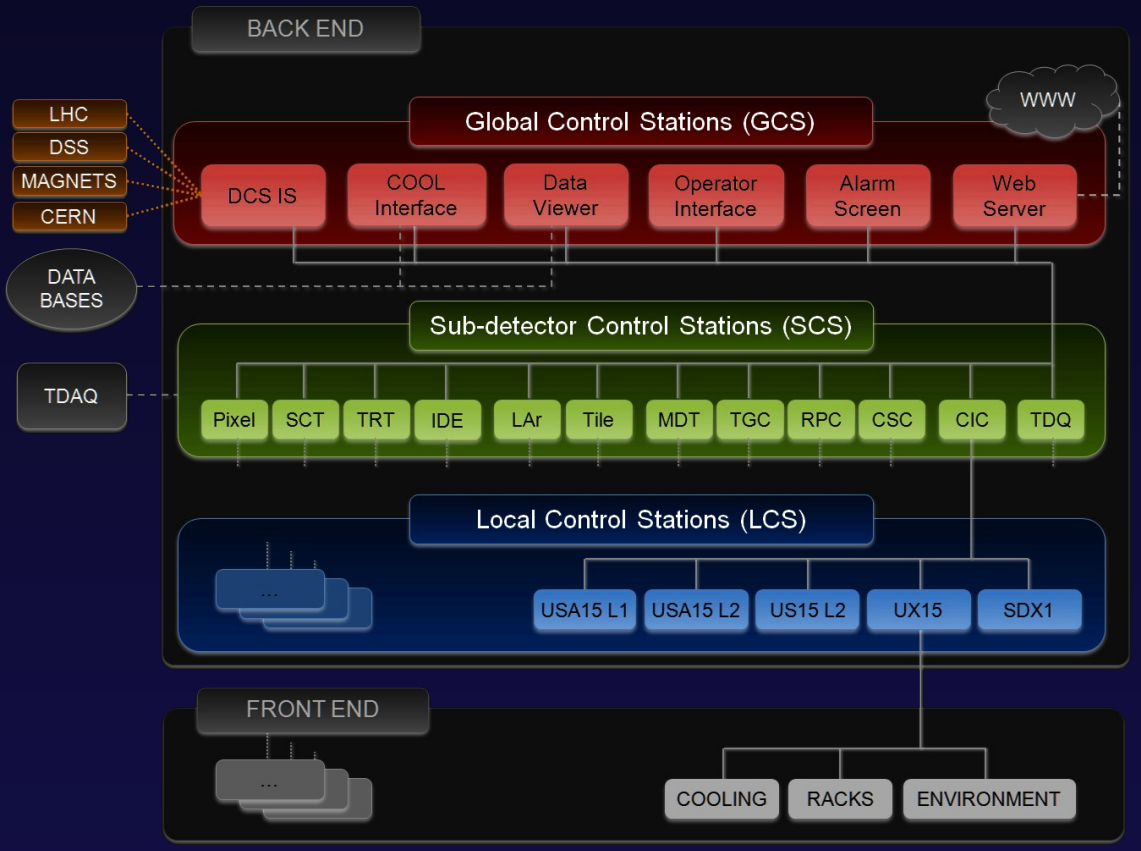
Stefan Schlenker, CERN
for ATLAS DCS



ATLAS DCS Overview

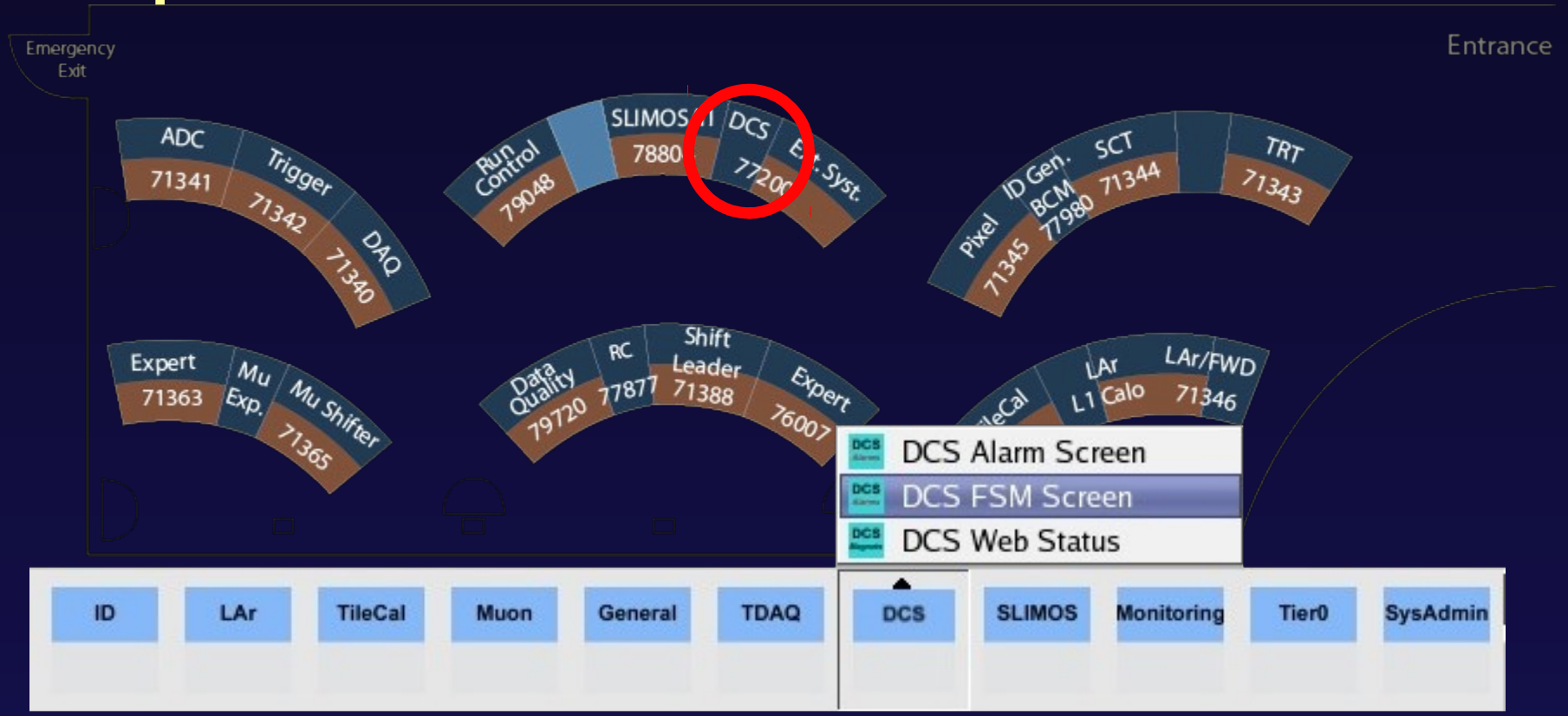
Function & Architecture

- Monitor and control detector operation
- Total >10^7 parameters distributed over >130 LCS (rack servers)
- Archiving of selected parameters to Oracle database
- Interfaced with DAQ/RunControl
- Links to external controls systems (LHC, Infrastructure)
- Remote access: direct and via web applications



System	Component	# Servers (# Appl.)	# Archived Parameters	Total # Parameters	# FSM Objects
Inner Detector	Pixel	11(12)	57k	1'086k	9.1k
	Silicon strips	11(11)	106k	1'265k	14.7k
	Transit. radiation	11(11)	69k	123k	13k
	Services	7(8)	16k	494k	3.7k
Calorimeters	Liquid Argon	13(13)	27k	910k	8.3k
	Tile	5(5)	51k	719k	2.4k
Muon Spectrometer	Drift tubes	29(29)	214k	3'229k	19.2k
	Cathode strip	2(2)	1.3k	109k	0.6k
	Resistive plate	7(7)	139k	1'597k	2.5k
	Thin gap	7(7)	81k	1'225k	10k
	Services	2(2)	0.7k	55k	0.04k
Forward detectors		4(4)	4.9k	194k	0.9k
Common Services	Counting rooms	7(7)	23k	568k	4.7k
	Trigger & DAQ	2(2)	11k	386k	1.3k
	External+safety	4(6)	8.0k	144k	0.4k
	Global services	9(13)	1.2k	222k	0.4k
Total		**131(139)**	**809k**	**12.3M**	**91.2k**

Operation in ACR

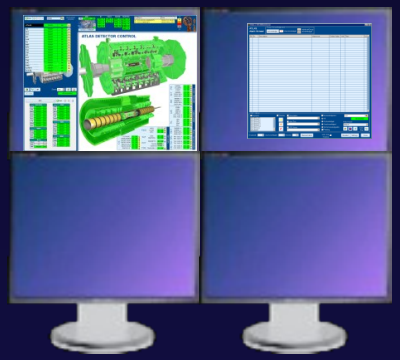


Interfaces

- Finite State Machine (FSM) and Alarm Screens

Desk Details

DCS Desk `pc-atlas-cr-dcs`



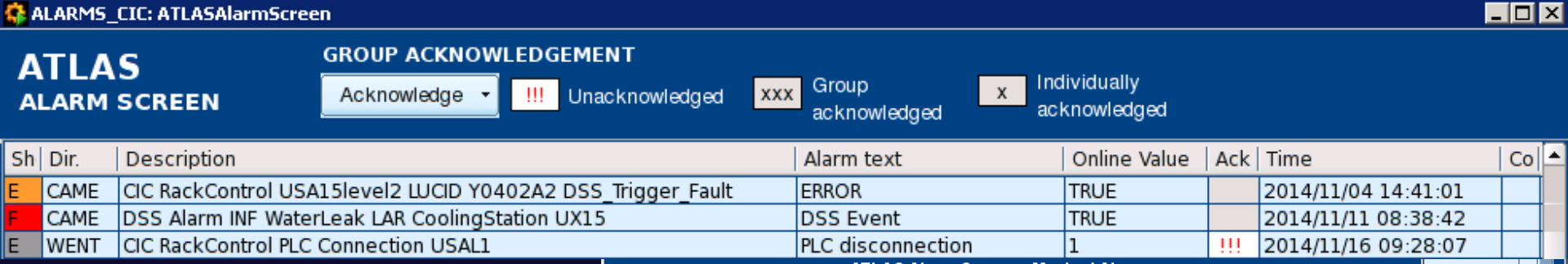
Shifter Desk `pc-atlas-cr-*`

ACR Stations

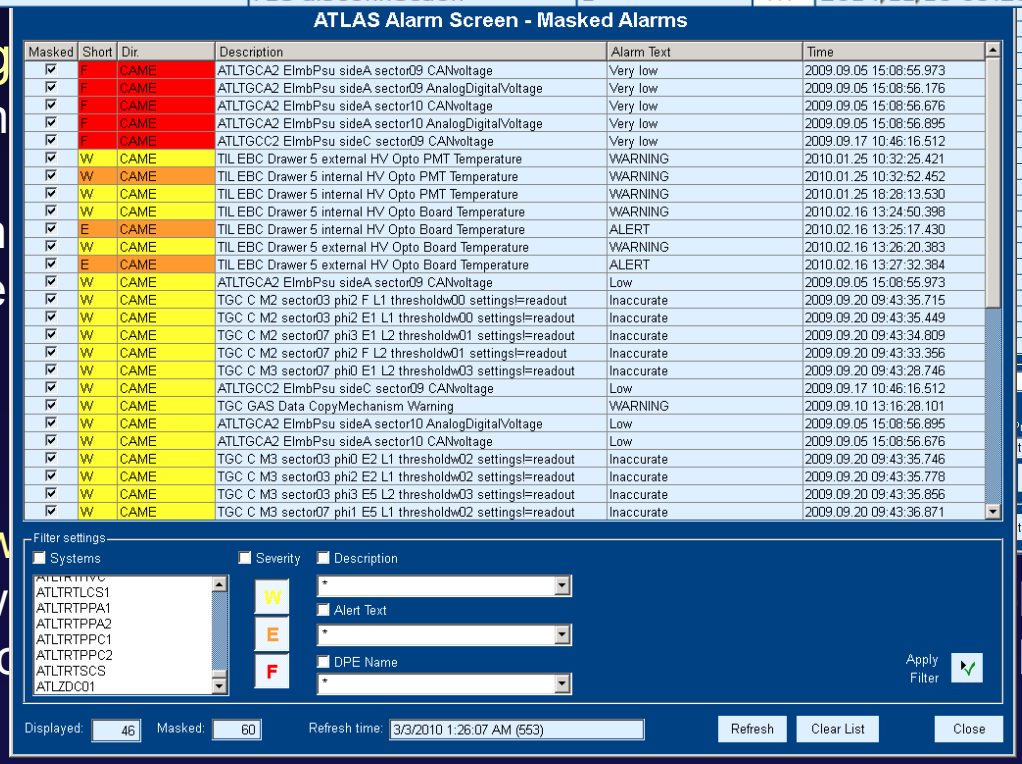
- DCS desk: Global FSM for Control, FSM ownership, global Alarms
- Shift Leader desk: Global FSM for Monitoring and LHC interaction (handshake), global Alarms
- System Shifter desks: FSM and Alarms for respective system group (ID, CAL, MUON)

Be aware:

- All desks: limited # of UIs!! Counts per system, alarm if close to limit



- Options for each alarm (rig
  - Mask alarm on UI level un
    the alarm condition goes
  - Insert alarm to ELOG with
  - Display trend plot of value
  - Alarm help on TWiki
- Acknowledgement:
  - Only for some alarms
  - Operator needs to acknow
    (left-click on "!!!"), otherw
  - Unacknowledged, but resc
- Summary alert:
  - Single alarm entry hiding several alerts of same type (accessible via "Details")
- Filters:
  - Different sets of filters exist, e.g. sub-detectors
  - Use always "Default" unless you know what you are doing, always revert back



Finite State Machine (FSM)

State machine hierarchy

- Detector hardware represented by FSM objects, hierarchically structured

State&Command propagation

- State model for devices (ON,OFF,…) and logical objects (READY, NOT_READY,…)
- Propagation upwards (using programmed logic for parent depending on child states)
- Commands propagated downwards

Status

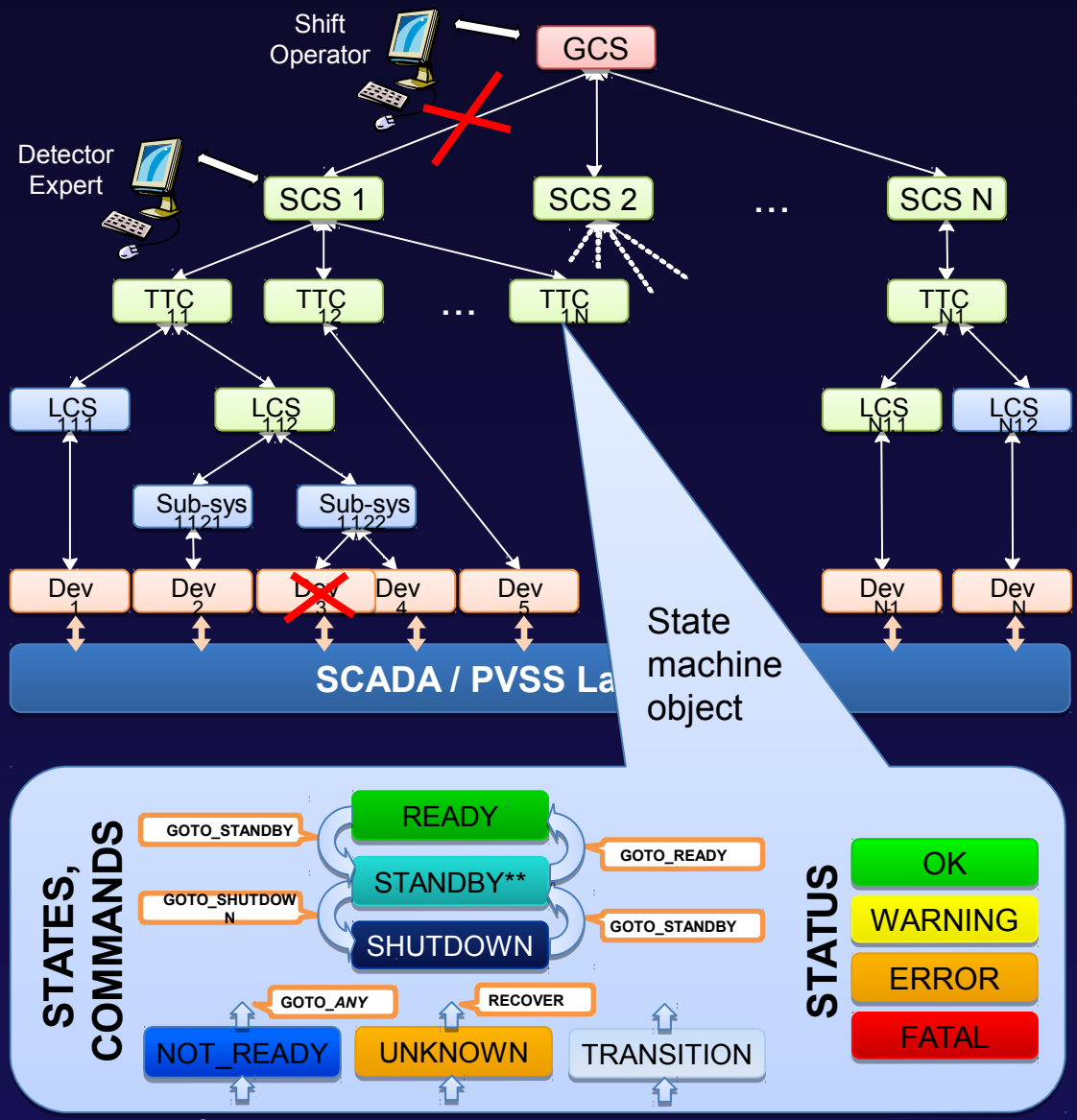
- Error handling upwards

Object operations

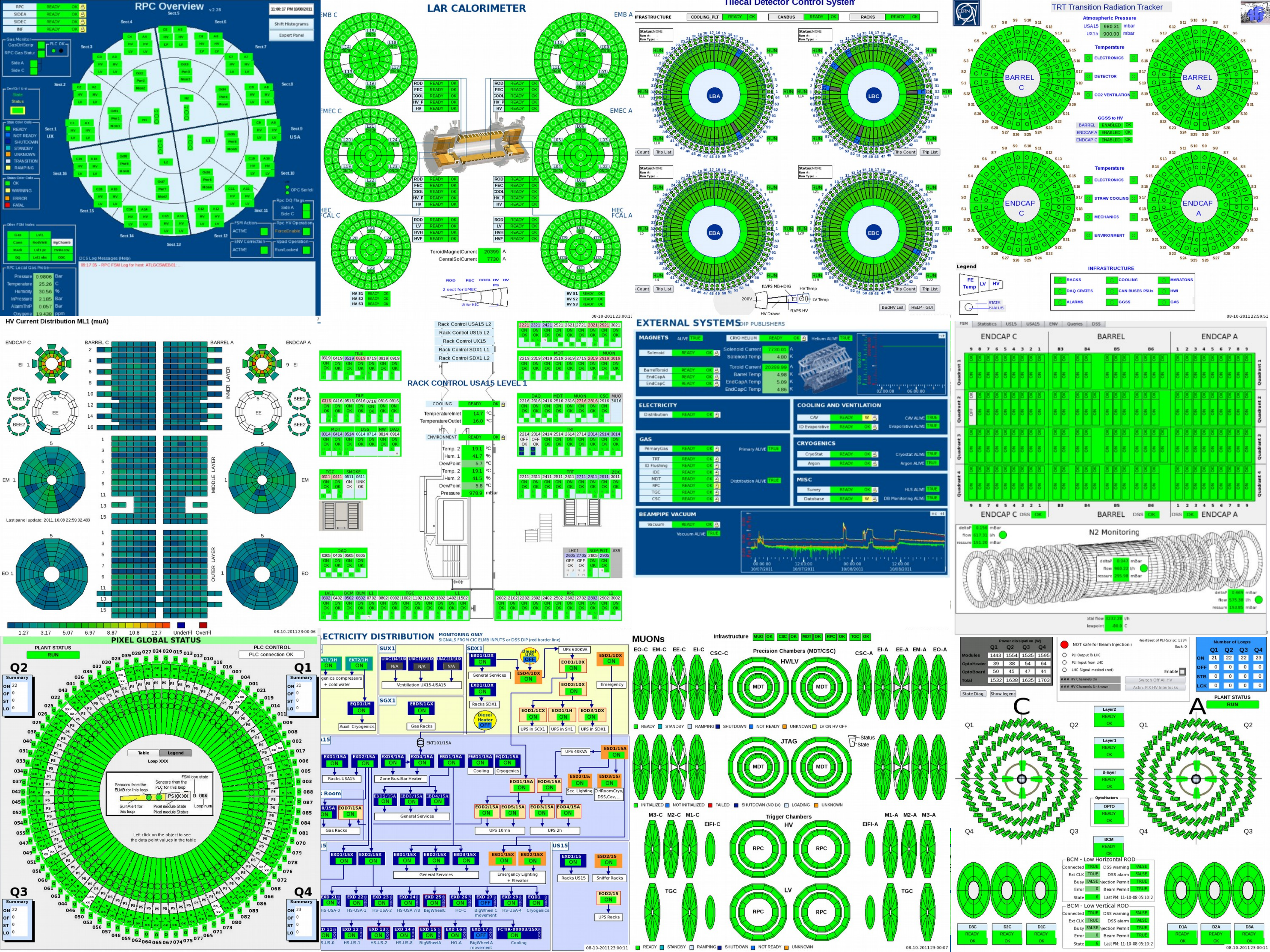
- Commands
- Enable/disable (low level)
- Take/release/include/exclude (high level)
- Access control for all operations

User Interface

- Browsing and object operation…



**only mandatory for relevant sub-detectors


RPC Overview
LAR CALORIMETER
Tilecal Detector Control System
TRT Transition Radiation Tracker
HV Current Distribution ML1 (muA)
RACK CONTROL USA15 LEVEL 1
EXTERNAL SYSTEMS
N2 Monitoring
PIXEL GLOBAL STATUS
ELECTRICITY DISTRIBUTION
MUONs
Precision Chambers (MDT/CSC)
Trigger Chambers
PLANT STATUS

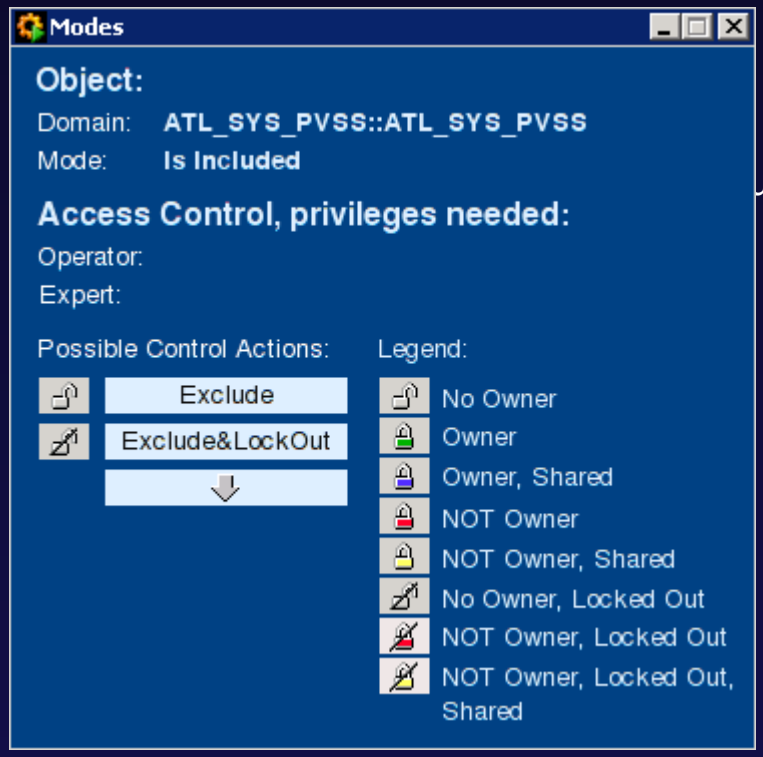
FSM Screen: Partitioning Modes

High level objects:

Padlocks:

- No control, Free
- Exclusive, Owner
- Shared, Owner
- Exclusive, NOT Owner
- Shared, NOT Owner
- No control, Locked Out
- No control, Included

Change mode with left-click on padlock:



Padlock background = tree completeness:

- Tree complete
- Excluded children (!)
- Disabled children

Low level objects:

Checkboxes:

- Enabled, Controllable
- Disabled, Controllable
- Enabled, Not controllable (either free or not owned + exclusive sub-tree)
- Disabled, Not controllable

Change mode with left-click on checkbox:

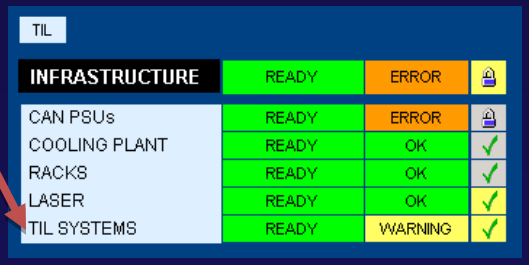
Access Control

Aim: prevent accidental actions

- Username, Password: CERN account
- Shifters get DCS:<sub-det>:operator privileges for shift, thus could:
  - Mask/acknowledge alarms
  - Operate FSM objects:
    - Enable/disable
    - Take/release/include/exclude (if owner)
    - Commands
- Please use FSM actions only after request by an expert or if stated explicitly in sub-system instructions!
- Shift Leader roles/privileges:
  - DCS:<sub-det>:operator for all sub-dets, but not in sub-domains (e.g. LARHV) as fallback solution
  - Additionally BIS operator (see Beams training)

DCS Back-End Monitoring

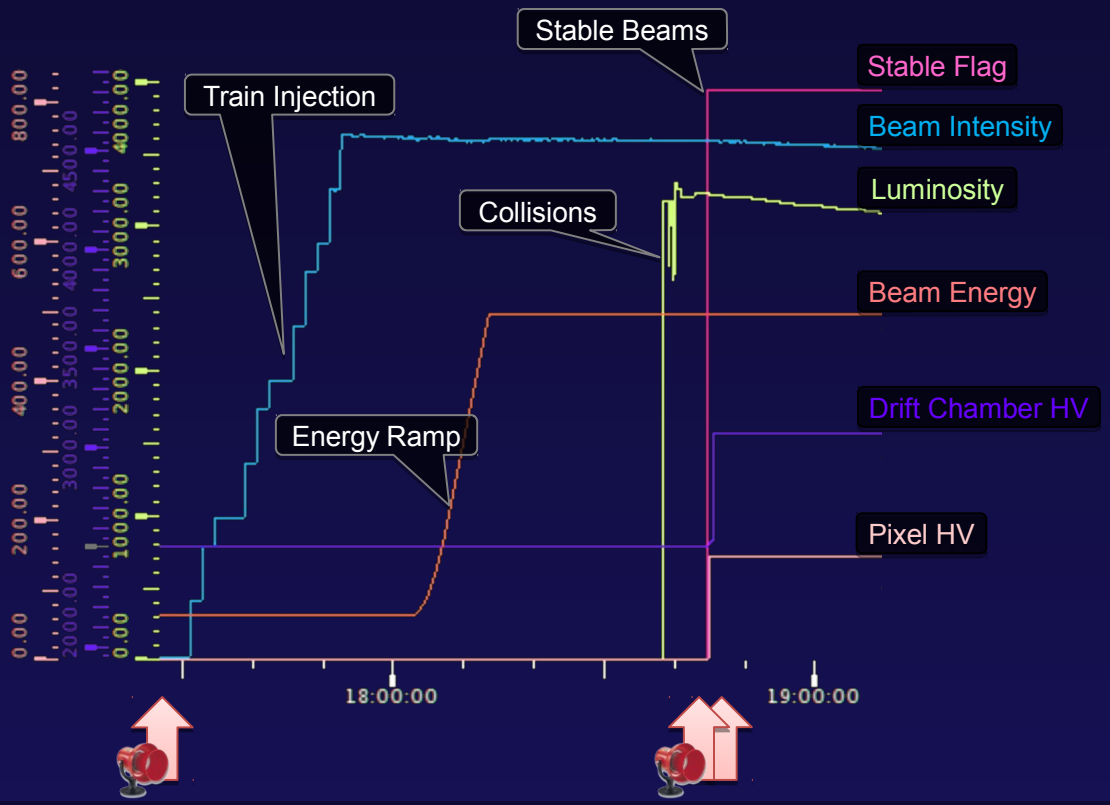
- Monitor state of DCS back-end itself (processes, machines, …)
- Accessible on FSM screen
  - Global: “DCS BE”
  - Sub-det: “XYZ SYSTEMS”
- Control over running panels from within ACR, possibility to monitor and kill (emergency only!) user interfaces by shift leaders
- Follow up of problems only by DCS experts (sub-detector or central)

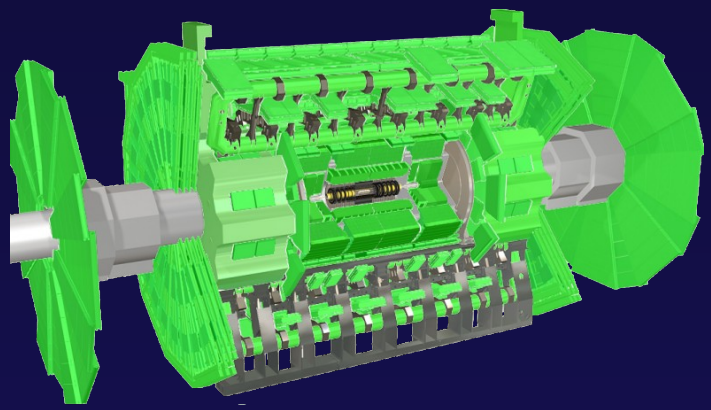


LHC Interaction

Synchronization of DCS with LHC operation and run control

- Detector safety requires lower voltage levels during unstable beam conditions (beam injection, adjust, STANDBY =
- State change STANDBY [READY automated (atm except IBL/Pixel), synchronization with DAQ run control, should take max. 5 minutes
- Audible notifications from DCS for important beam events
- Beam backgrounds and luminosity monitored via DCS (LHC FSM tree)

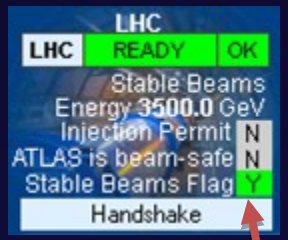


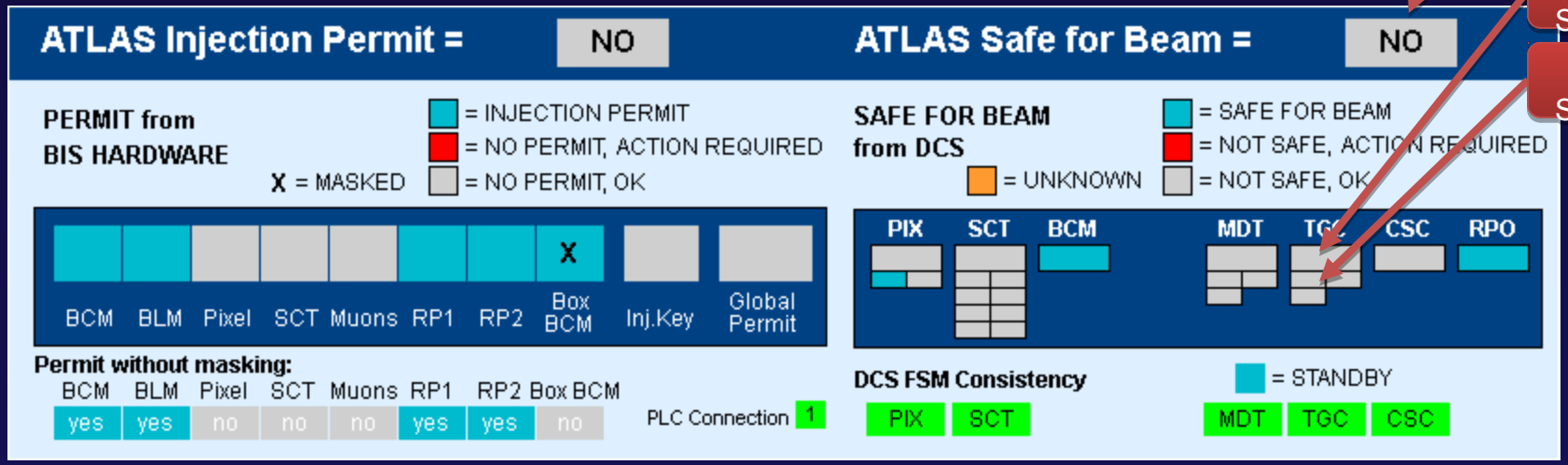


Beam Interaction – Details

Hardware permits vs. Software “safe for beam”

- Hardware permits (left widgets) sometime generated via DCS
- Software flags (right widgets) evaluate total sub-detector condition independent of FSM configuration
- FSM states to x-check consistency
- Right-click on widgets to get history (if archived)





Global Software Flag

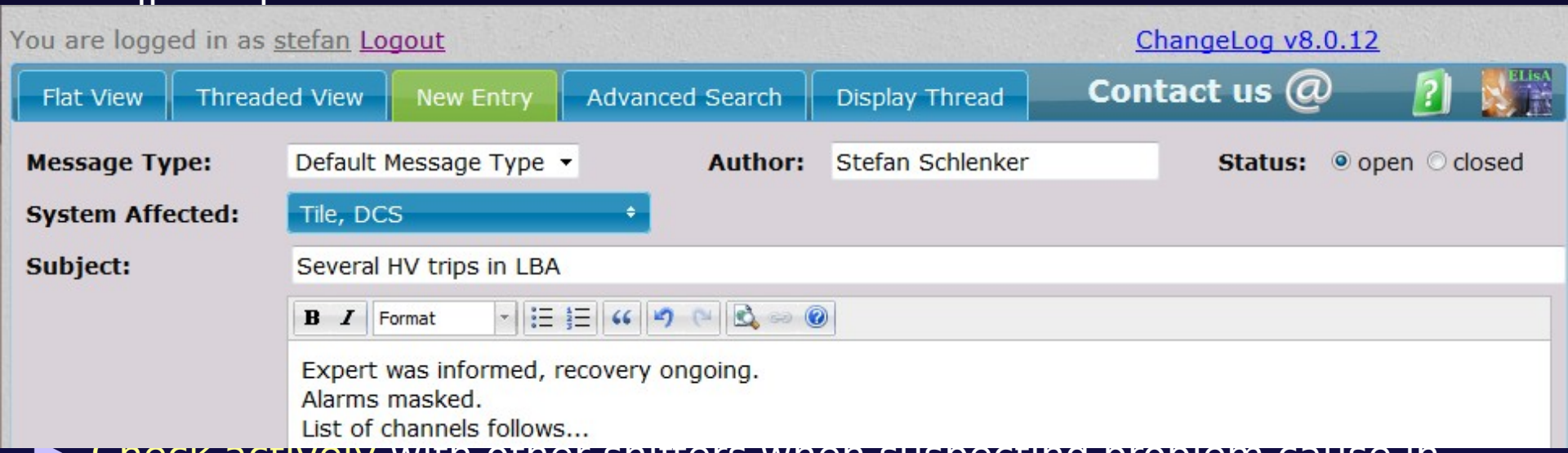
SCS Software Flag

LCS Software Flag

Shifter Tasks

Preparation

- Check respective system documentation
- In particular inform yourself about current problems and solutions, on-



- Check actively with other shifters when suspecting problem cause in other systems,
- Inform shift leader about possible efficiency
- Report to ELOG:
  - Message Type = Default
  - System affected: DCS + sub-detector

System assignment (2015)

Desk	System Identifiers
ID	PIX, SCT, TRT, IDE
CALO+FWD	LAR, TIL, FWD, LCD, ZDC, RPO
MUON	MDT, CSC, RPC, TGC, MUO
DQ	LHC, LUM
SLIMOS	CIC, EXT, SAF, GCS
SHIFT LEADER	TDQ, GCS

Shifter Tasks: Alarms

FATAL — Fatal failure, immediate attention required. Call.

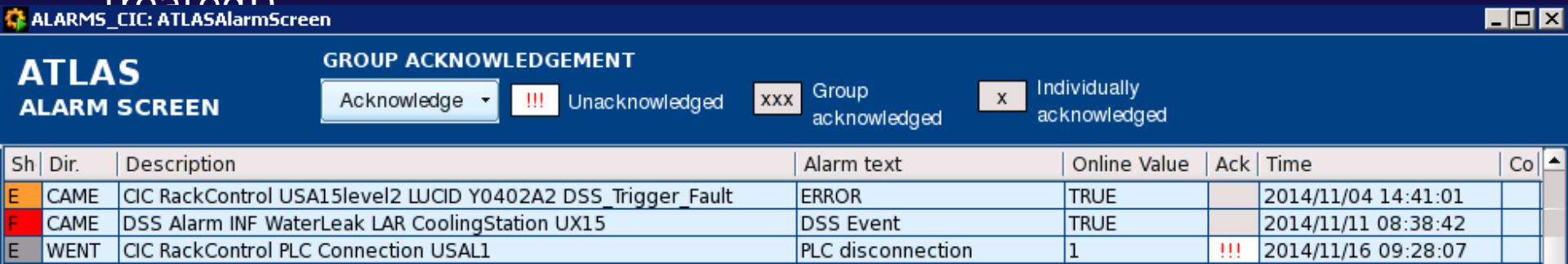
ERROR — Failure condition which might prevent taking good data. Call.

WARNING — Minor problem. Upcoming failure which might be avoidable. Elog/maybe call.

Aim: Get / Keep alarm screen empty!

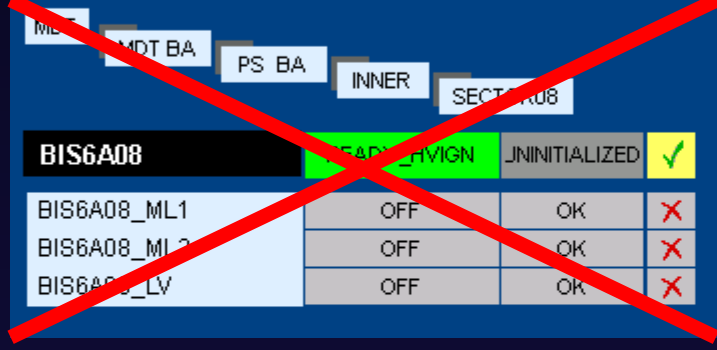
Procedure:

- Follow up according to severity
- Try to understand alarms, check documentation (= system shifters instructions and right-click alarm help) for specific procedures
- If problem cannot be fixed, contact system expert
- If alarm condition cannot be removed on short timescale (<~30min), *mask* alarm in agreement with expert or following specific instructions
- If (masked) alarm condition cannot be removed on long timescale (>1week), expert is responsible to *deactivate* alarm or change alarm limits until problem is solved
- Acknowledgeable alarms: *acknowledge* after informing expert
- Report to ELOG what has been done, including details (list of alarms treated!)



Shifter Tasks: FSM

Aim: Get / Keep FSM READY / STANDBY OK



Procedure:

- Beginning of shift: check for tree being incomplete no objects shou show (excluded sub-trees), in case they do contact expert
- Understand problems (*State*!=READY, *Status*!=OK)
  - Navigate down to object causing the problem, check on respective panel
  - Check documentation for specific procedures
- If problem cannot be fixed, contact system expert
- If problem cannot be solved on short timescale (<~30min), *Disable or Exclude* only affected FSM object in agreement with expert or following specific instructions
  - Use with caution since this object will not receive global FSM commands nor will report further state/status changes, do not disable all children objects and leave parent enabled

  Note: Exclude/Include can only be done on DCS desk, Disable/Enable on all FSM screens
- Interventions on monitored trees should be done by handing over ownership from DCS desk to experts (*Exclude*), then *Include* sub-tree


END