

# Planning of Interventions With the Atlas Expert System

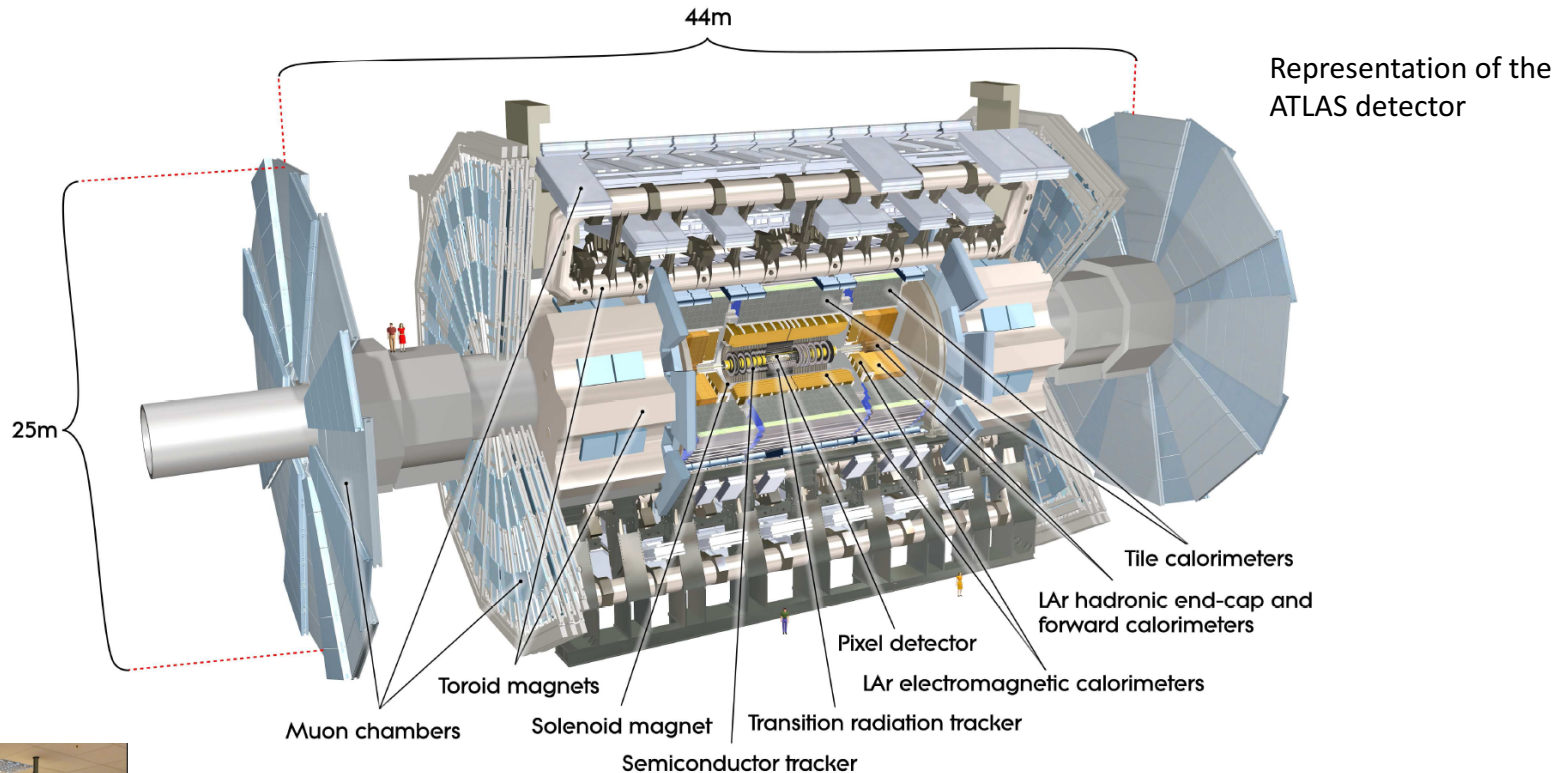
ICALEPCS 2019



VNIVERSITAT  
ID VALÈNCIA

**Ignacio Asensi**

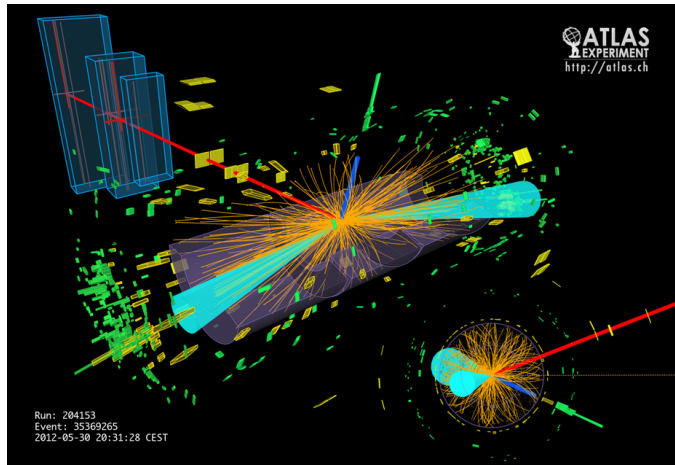
University of Valencia



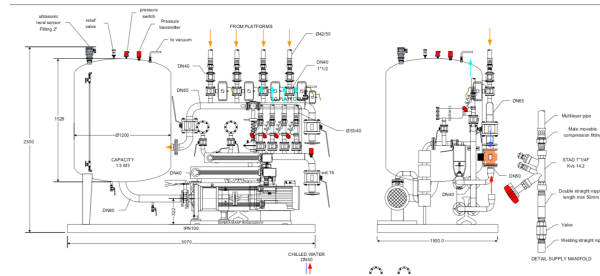
Control room

- ATLAS is a general-purpose particle physics experiment at the LHC
- Its major components are
  - Magnet, Muon, Inner detector, Calorimeters
  - Many others like computing, Control and Safety systems
- Confident knowledge on many systems of the detector is critical for maintenance, upgrade operations control and monitoring

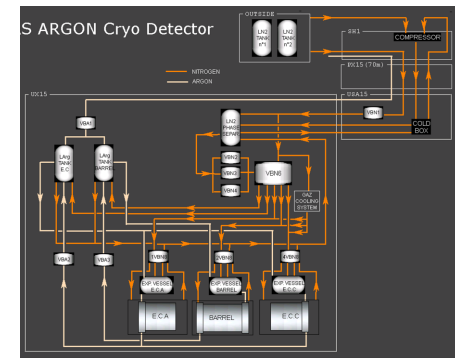
# What is ATLAS?



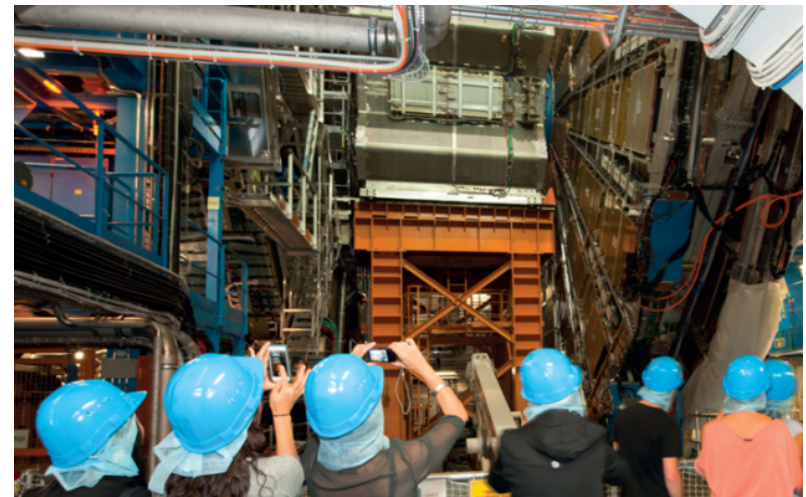
A physicist thinks this is ATLAS



An engineer thinks this is ATLAS



A safety person thinks this is ATLAS



General public

## ATLAS is...

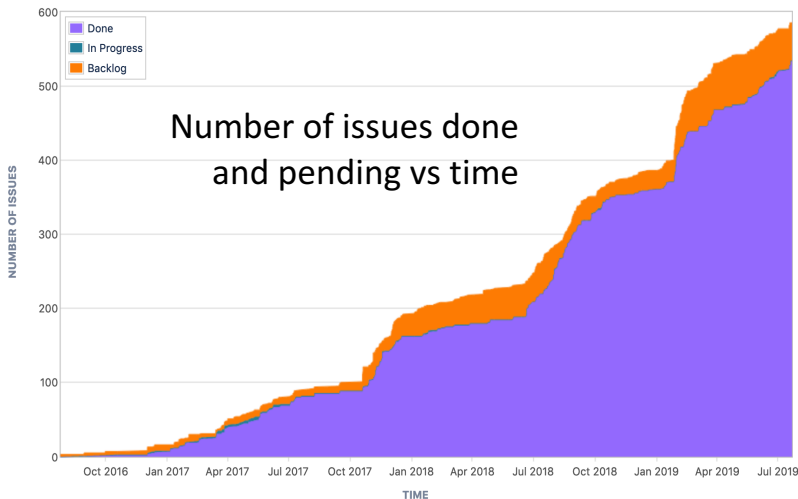
- Database
- User Interface
- Questions
- Answers
- Decisions

action airdryer alarm board compressedairsystem  
 compressor computer coolingloop coolingstation  
 coolingsystem crate cryostat delayedaction  
 digitalinput dsu electricalcabinet elevator gascentral  
 gassensor gassystem group heater  
 interlock iacs lighting magnet minimax pipe plc  
 plcmodule pneumaticcontroller pneumaticvalve  
 powersupply rack smokecentral  
 smokesensor sniffermodule sniffertiroir  
 subdetector switchboard sys  
 thermalscreen transformer ups vacuumumpump vacuumvalve  
 ventilationsystem vesselwatersystem zone

## Tasks!

<https://its.cern.ch/jira/projects/ATLASTCES/issues>

Database

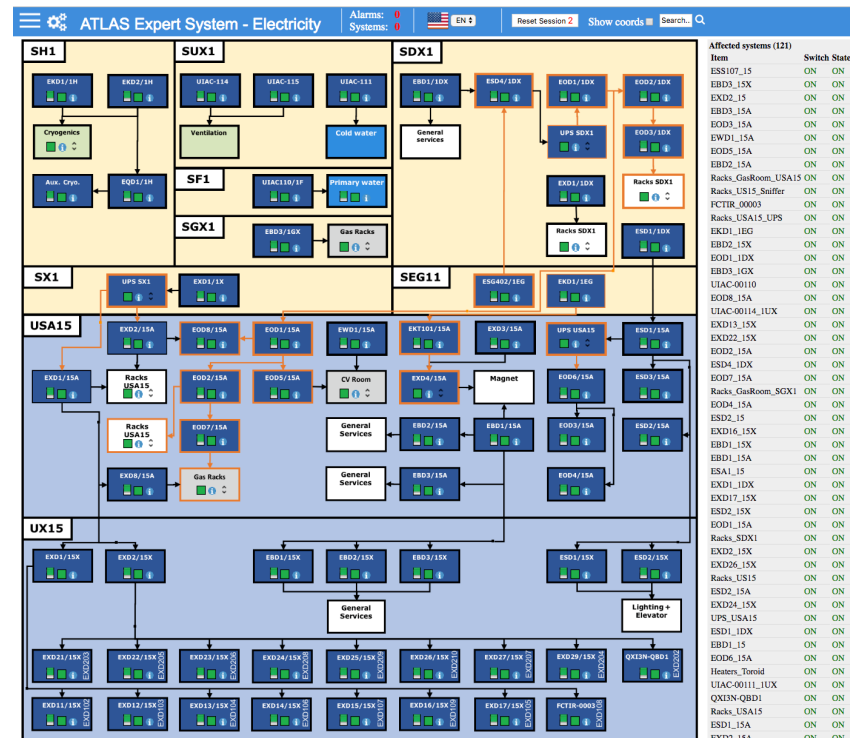
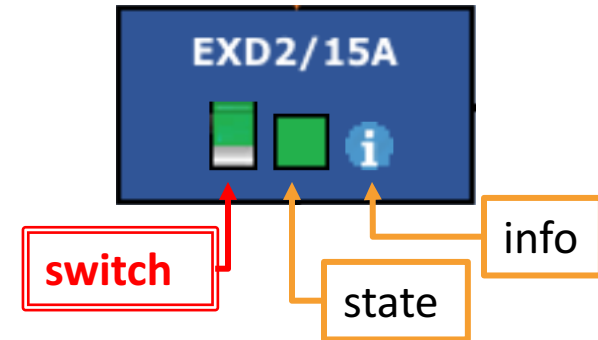


What happens if EXD1 trips??  
 What happens if the TRT cooling loop 3 stops?  
 What happens if fire detection system loses power?  
 What happens if....

Questions

## Using graphical interface

- Individual systems can be found by locations, types or groups
- Systems can be switch off and alarms be triggered
- Systems are represented as boxes with up to 3 icons (switch, state, info)
- When there is an interaction, the inference engine determines the consequences and displays the new scenario





# Descriptions



Electricity	Cryogenics	Gas	Magnet	Racks	Water	Safety
Electricity	Electricity	Gas Summary	Cryogenics SH1	Racks SR1	Water Distribution	Access System
Electricity 18kV	Cryogenics Distribution	Gas Racks	Cryogenics USA15	Racks SDX1	Water SF1	Elevators
Diesel Electricity	Cryogenics SH1	Gas CSC	Cryogenics UX15	Racks USA15	Water SPS	Smoke Centrals
UPS SDX1	Cryogenics USA15	Gas MDT	Magnet Cryogenics	Racks US15	Water SUX1	Flammable Gas Centrals
UPS SX1	Cryogenics Racks USA15	Gas RPC	Magnet Vacuum	Racks UX15	Water SH1	Sniffer Racks
UPS USA15	LAR Heater Racks	Gas TGC	Magnet Electricity	Access System	Water SU1	Firemen Boxes
UPS US15	Cryogenics UX15	Gas TRT		Smoke Centrals	Water USA15	DSS Racks
Racks SR1	Cryogenics ANRS	Gas TFC		Flammable Gas Centrals	Water US15	DSU
Racks SDX1	Cryogenics Argon			Sniffer Racks	Backup Chiller	Minimax
Racks USA15	Cryogenics Argon PLC13			Firemen Boxes	<b>Cooling</b>	
Racks US15	Cryogenics Argon PLC14			Lighting	Water Distribution	
Racks UX15	Cryogenics Argon PLC15			DSS Racks	CV Room	
Lighting	Cryogenics Argon PLC16			Gas Racks	Cooling US15	<b>DSS</b>
Magnet Electricity	Magnet Cryogenics			CV Room	Cooling UX15	DSS Racks
				Cooling US15	Cooling TRT	DSU
				Muon Cooling Loops	Muon Cooling Loops	DSS Alarms
				Cryogenics Racks USA15	Detector Cooling	Inhibit Request
				LAR Heater Racks	Evaporative Cooling	
				Minimax	Thermosyphon	
					IBL Cooling	

## Menu

[Advanced](#)

[Unfold](#)

> Simulations

Dashboard

Search

> Systems

> Electricity

∨ Sub-Detectors

Cooling TRT

IBL

Pixel

SCT

TRT

LAR

Tile

RPC

MDT

**CSC**

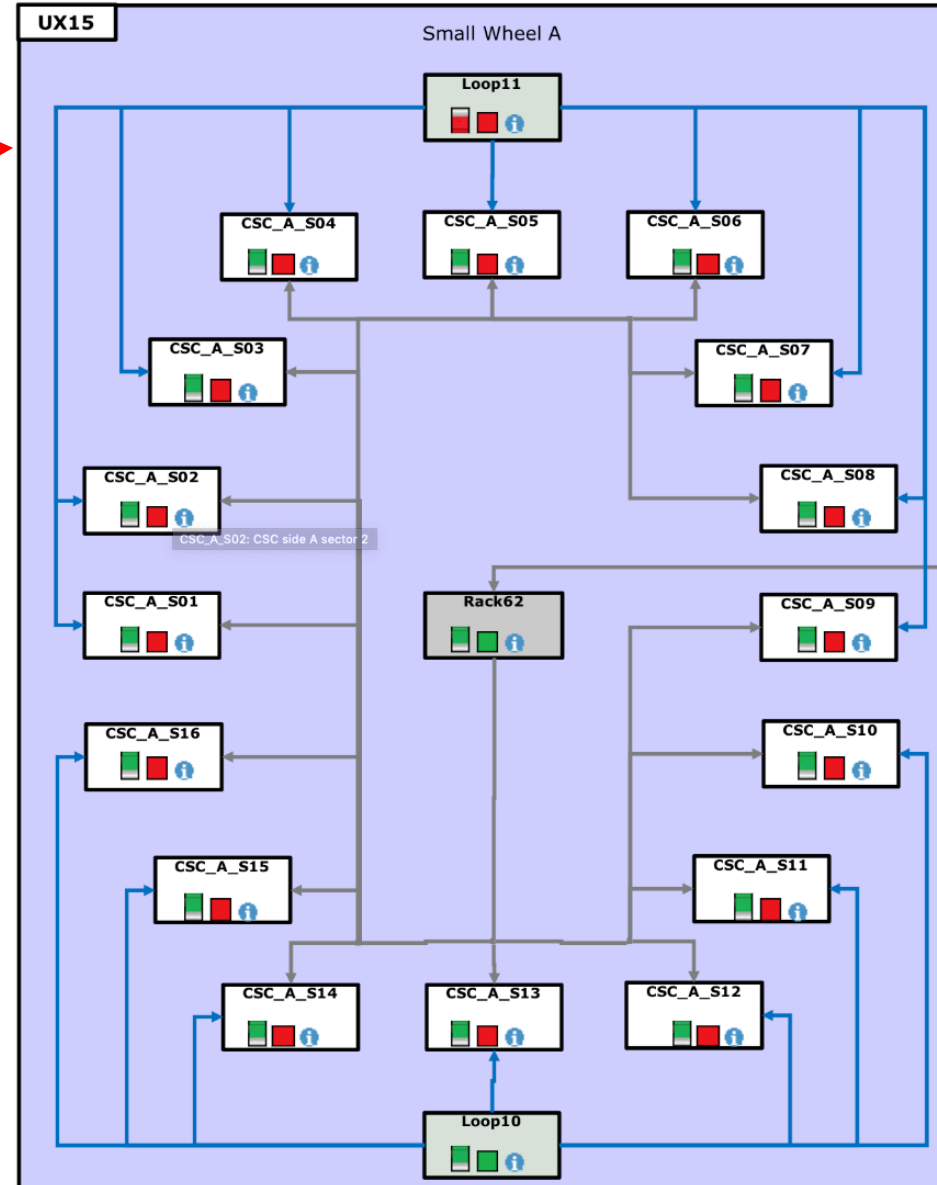
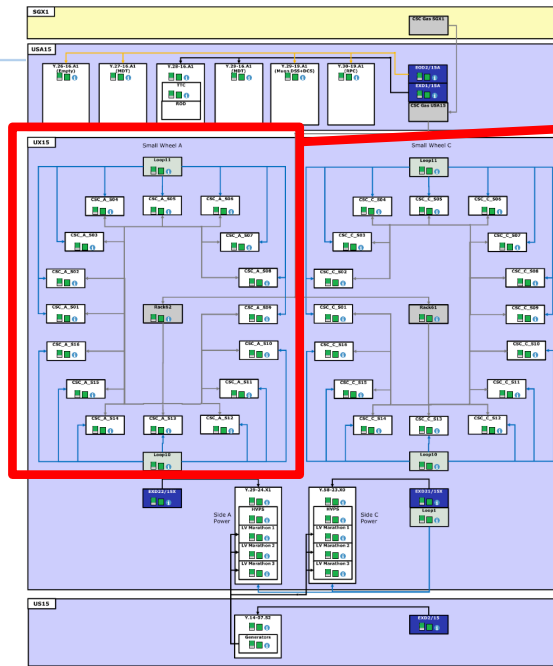
TGC

FTK

> Locations

> Help

Inhibit Request

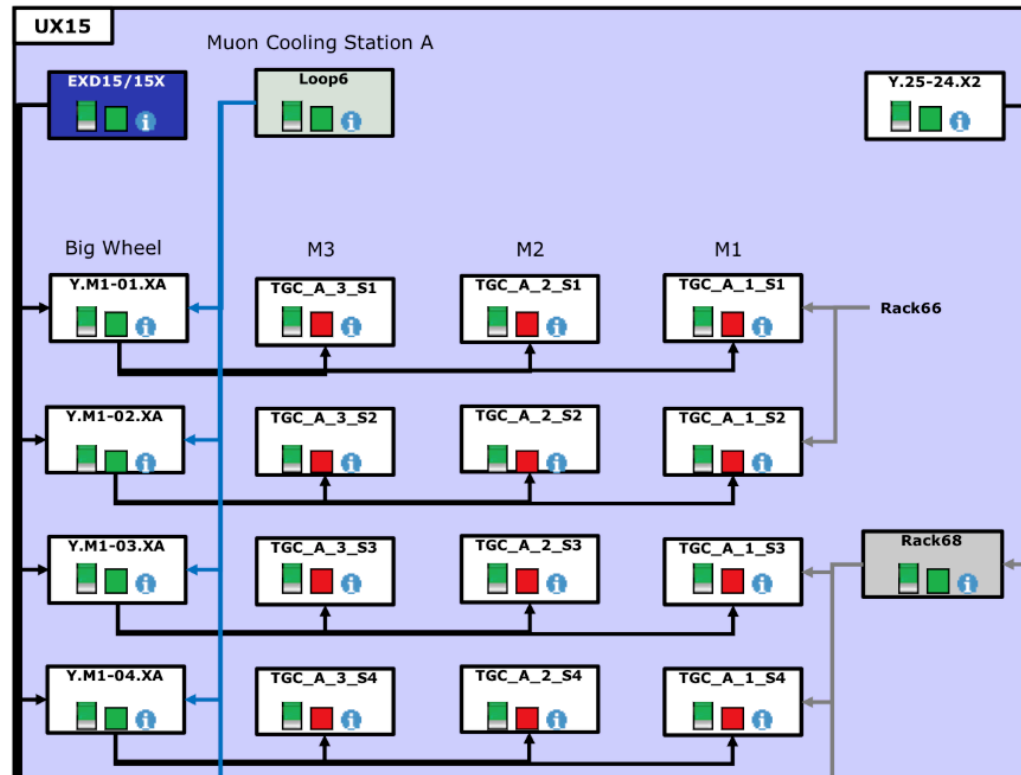
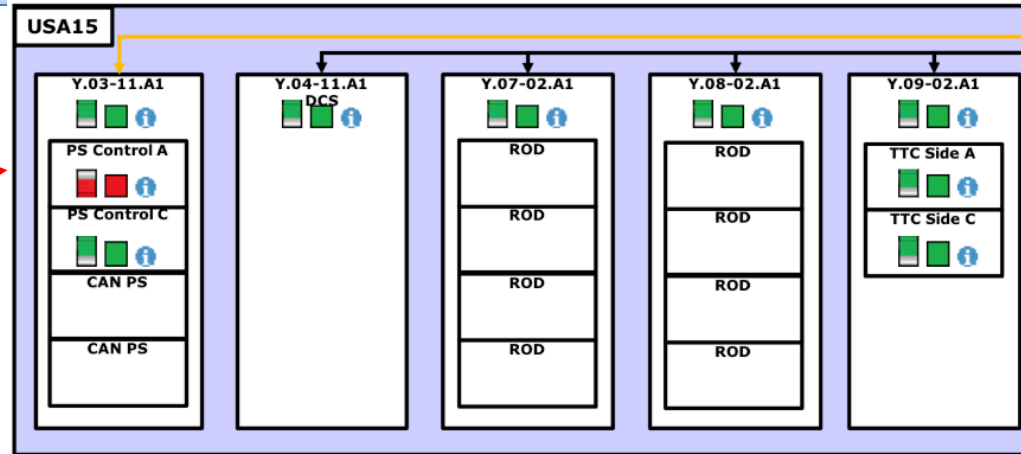


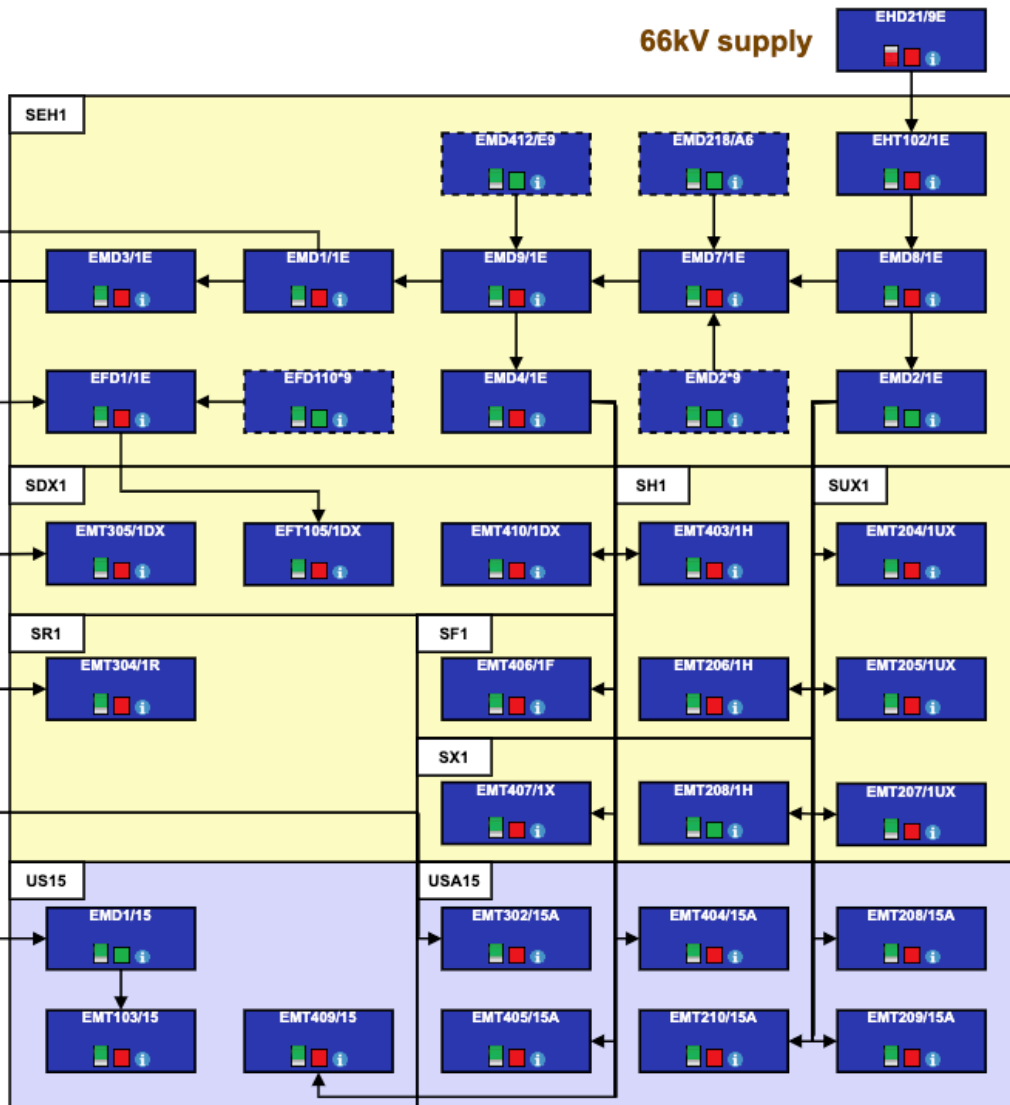
## Menu

Advanced

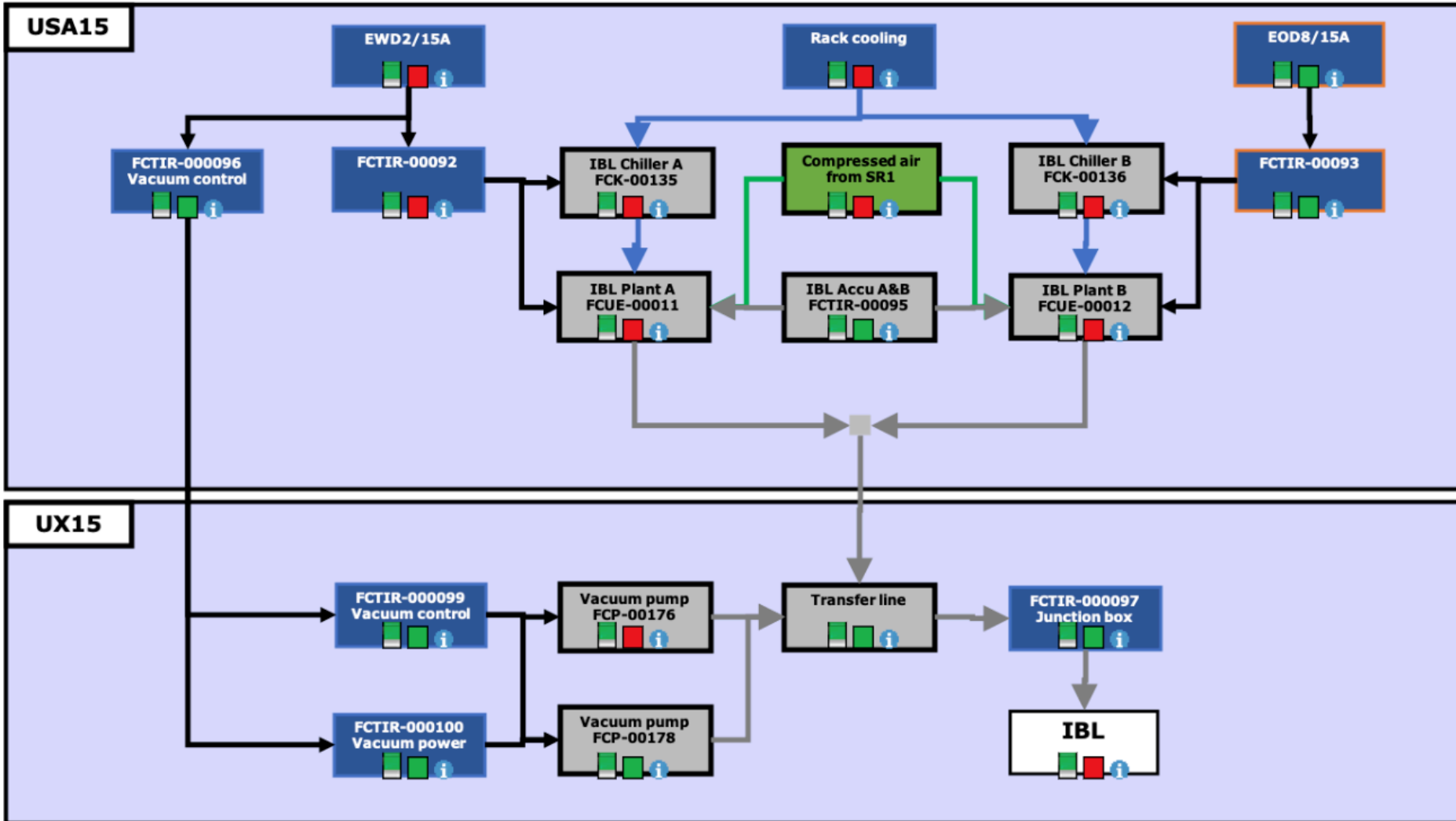
Unfold

- > Simulations
- Dashboard
- Search
- > Systems
- > Electricity
- ∨ Sub-Detectors
  - Cooling TRT
  - IBL
  - Pixel
  - SCT
  - TRT
  - LAr
  - Tile
  - RPC
  - MDT
  - CSC
  - TGC
  - FTK
- > Locations
- > Help
- Inhibit Request





- Quickly understanding of events
- Consequences of a power cut in a main line
- Minimize impact in subsystems



Summary CSV	
Search...	
Actions	364
AirDryer	2
Alarms	525
CompressedAirSystem	1
Compressor	2
CoolingLoop	10
CoolingStation	7
CoolingSystem	1
Crate	48
DigitalInput	116
DSU	4
Elevator	2
GasCentral	3
GasSensor	10
GasSystem	23
Group	29
Heater	6
Interlock	3
Lighting	17
Minimax	9
PneumaticController	3
PneumaticValve	34
PowerSupply	21
Rack	39
SmokeSensor	158
SubDetector	390
Switchboard	30
sys	13
VentilationSystem	4
Vessel	4
WaterSystem	11
Zone	1

ATLAS Expert System - Dashboard
Alarms: 525 Systems: 3921

Search Object

**Commands (1)** CSV

1- EHD21_9E	off
-------------	-----

**Important elements affected** CSV

MDT_Subdetector
TGC_subdetector
TRT_Subdetector

**Summary** CSV

Actions	364
Alarms	525
GasSystem	23

**Alarms (525)** CSV

AL_AL3_CO2_USA15L1_CVRoom
AL_AL3_CO2_USA15L2_GasRoom
AL_AL3_CO2_USA15L3_CVArea

**DSS inhibits (0)** CSV

No DSS elements inhibited

**Actions (364)** CSV

O_COL_BeamPipe_VJA_CoolingSwitch
O_COL_BeamPipe_VJC_CoolingSwitch
O_COL_IBL_CO2_PlantA_Stop_FCTIR00092

Impacted elements:

**GasSystem (23)** CSV

HGXGDIS001-CR301101		
HCXGDIS001-CR301102		
HV_6536		

**SubDetector (390)** CSV

MDT_BIR_2C_15		
MDT_BMG_2C_14		
MDT_BOS_4C_10		

**Crate (48)** CSV

LAr_ROD_EMB_C_2		
LAr_ROD_EMB_C_3		
LAr_ROD_EMB_C_4		

**DigitalInput (116)** CSV

DI_FG_UX15_BigWheelCTrench_Y1519A2		
DI_INF_Power_USA15_ESS01_UPSFailure		
DI_Smoke_TIL_Y0616A1		

**SmokeSensor (158)** CSV

SFDEI-13543		
SFDEI-13544		
SFDEI-13545		

**Group (29)** CSV

LAr_EMEC_A		
LAr_EMEC_C		
Racks_US15		

**Lighting (17)** CSV

EBL211_15A		
EBL222_15X		
ESL103_15X		

**GasSensor (10)** CSV

SGDGA-01156		
SGDGA-01157		
SGDGA-01314		

**Rack (39)** CSV

Y.03-02.D1		
Y.03-02.D2		
Y.16-21.A2		

**GasCentral (3)** CSV

SGGAZ-00153		
SGGAZ-00158		
SGGAZ-00178		

**PneumaticValve (34)** CSV

PVA4_TRT		
PVA5_Cables		
PVA8_Pumps		

**Switchboard (30)** CSV

EBD2_15X		
ESJ1_1CX		
ESJ1_15X		

**Minimax (9)** CSV

Y.29-15.S2_Minimax		
Y.36-25.X2_Minimax		
Y.57-05.X0_Minimax		

**WaterSystem (11)** CSV

FDM_00221		
MOT_9800		
SUX1_Ventilation		

**CoolingStation (7)** CSV

FCM_00135		
FCUE_00012		
FCUM_00004		

**PowerSupply (21)** CSV

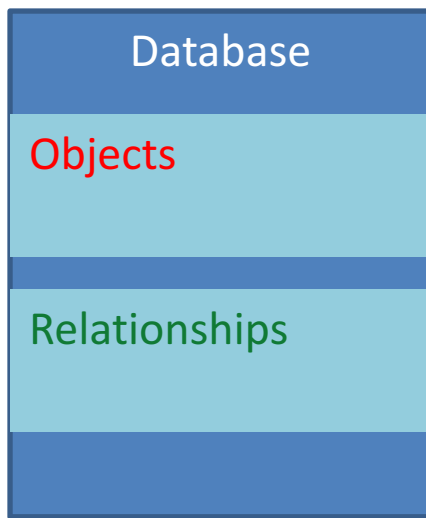
LAr_LVPS_FEC_A10		
LAr_LVPS_FEC_A11		
LAr_LVPS_FEC_A13		

**Vessel (4)** CSV

Manifold_M3_1		
Manifold_M3_2		
Manifold_M5_1		

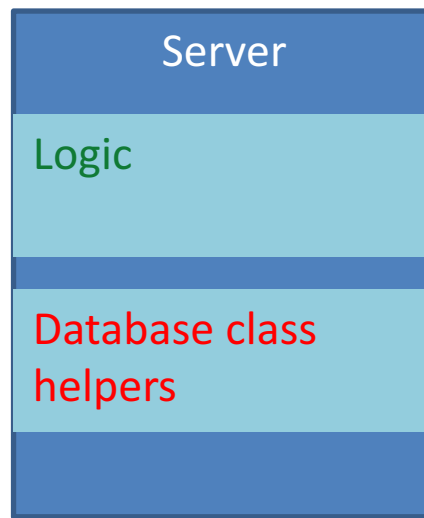
**sys (13)** CSV

FCTIR_00092		
Magnet_Toroid_CL		
Magnet_UPS_2		



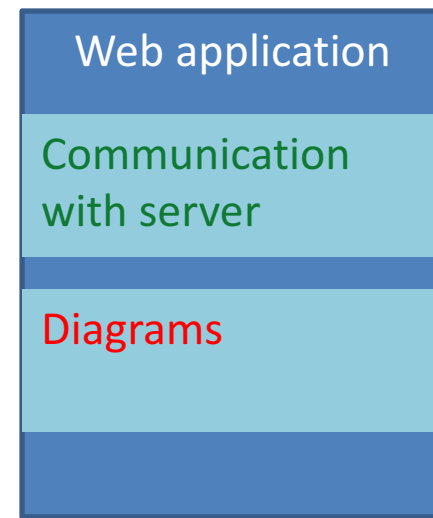
## Model

- Maintenance of simulation state
- Store and retrieve data



## Controller

- Respond to user input
- Interpret user request with data from model



## View

- User interaction
- Scenario rendering

General  
ATLAS specific

- The ATLAS Expert System by ATLAS Technical coordination is a diagnostic tool for the maintenance of the experiment.
- Description of critical systems like electricity, gas, detectors and others is reaching the desired granularity.
- The Expert System has been proven useful evaluating the impact of interventions.
- Simulations have been compared with actual intervention outcomes during LS2.
- The portability to other detectors is possible.
- Future plans include the ability to search the causes of current state in the simulations

Thank you for your attention