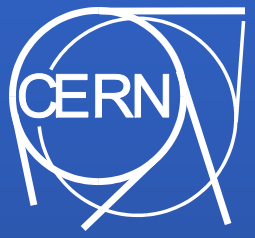


CRYOGENICS @ CERN with UNICOS

M. Pezzetti AT_ECR_CE

27 June 2005

Accelerator Technology Department

ECR

Cryogenics for Experiments

Design, construction, operation & maintenance of cryogenic systems for experiments

1. Construction & commissioning of the cryogenic systems for CERN detectors
2. Operation & maintenance of cryogenic facilities for experiments using superconducting magnets & liquefied gases, and for LHC components tests
3. Management of the industrial support contract for maintenance & operation of cryogenic systems
4. CERN-wide support to low-temperature developments & tests at the Central Cryogenic Laboratory
5. CERN-wide service for supply of cryogenic fluids on site

Giorgio PASSARDI Group Leader

Dimitri DELIKARIS Deputy (Planning, operation, safety, industrial contracts)
Friedrich HAUG Deputy (Projects)

Secretariat:
P. BACCHERETTI (AT-ADM) ☎78409 252/1-042

TECHNICAL SUPPORT

Cryolab
T. NIINIKOSKI
A. BOLLET
L. DUFAY
A. VACCA
H. VIGIER

Mechanics & Installation
O. PIROTTE
E. COUSSY
J. ESCOURROU
H. GJERMANDSEN
C. JOUVE
E. MATTELON
J. METSELAAR

Equipment Controls
M. PEZZETTI
P. ALLIOD
C. BATAILT
R. BAUD
Y. DROUYER
R. GUYON
D. LEGRAND
A. PARK
J.M. QUETSCH
O. *PAVLOV*

EXPERIMENTS

ATLAS + TOTEM Cryogenics
G. PASSARDI
Magnets:
N. DELRUELLE
F. HAUG
R. PENGO
LAr Calorimeters:
J. BREMER
C. FABRE
G. VANDONI
M. CHALIFOUR (EP)
G. CUCCURU
S. JUNKER
F. RODRIGUEZ

CMS Cryogenics
G. PERINIC
T. DUPONT

Operation + COMPASS + CAST Cryogenics
K. BARTH
R. CHANUT
R. CONSENTINO
C. DELPECH
L. STEWART

STAFF MEMBERS
ASSOCIATES, FELLOWS, STUDENTS, VIA

JANUARY 2005

ECR_CE_Section

Providing technical support for the activities of the AT_ECR group working within the engineering process control systems, the electrical design, installation, instrumentation calibration and commissioning

ECRCE control system

- Elaboration architecture according to project requirements :
  - **Instrumentation**
  - **Control system (PLC – I/O)**
  - **Supervision systems SCADA**
  - **Long Term Data Archiving (Oracle Data Base storage)**

  (Industrial component based, solution adapted to the size/type of the application)

- Material ordering, Reception and conformity verification, installation and Commissioning @ CERN

Project LHC Experiments

LHC Point 1

- ATLAS Magnets 20 kW GHe @ 60 K Thermal Shield cryoplant
- ATLAS Magnets 6 kW LHe @ 4.5 K Main cryoplant
- ATLAS Proximity cryogenics for toroidal magnets
- ATLAS Proximity cryogenics central solenoid

- ATLAS ANRS LN2 cryoplant for LAr calorimeters
- ATLAS LAr + LN2 Proximity cryogenics systems

LHC Point 5

- CMS Magnet 1.5 kW LHe cryoplant
- CMS Magnet Proximity cryogenics
- TOTEM cooling system

ECR UNICOS systems total :

~ 7500 I/O Signals

Support to operation

- Technical support to 11 Helium Cryoplants, CERN wide, operated under ECR group's responsibility (for physics and test benches)

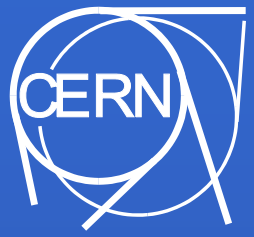
- Implementation of Long Term Data Archiving system
  - "in house system " (DEC system)
  - "IMS" (ABB system)
  - "UNICOS standard TIMBER" (Oracle Data Base storage**)**

- ECR CE total systems :

  → ~8000 I/O (ABB) + ~ 7000 I/O (Schneider)

UNICOS standard

- Provide a common control system for the LHC cryogenics
  - Components, tools and methodology
  - Based on industrial components: PLC and SCADA
- Define a standard hardware & generic software architecture
- Produce complete documentation for maintenance, operation and users
  - Cryogenics operators and experts



UNICOS Advantages for Process Control

Language: Common vocabulary for technical communication

Methodology: Structured Application
Preliminary analysis

Documentation: Logic, Devices and Data Base

Update: Follow-up of modifications
Easy to Upgrade thanks to structure

Programming Tools: Use Embedded Object function

Standard: Operation
Programming

Full Package for Control System

Who Does What

Specification: CERN, External Institutes, Air Liquide, Linde, …

User Application: CERN create and maintain documentation

Hardware:
- PLC, Supervision system
- Network : Rely ON CERN IT infrastructure
- Cabling

Maintenance:
- User Application
- System

How do we proceed?

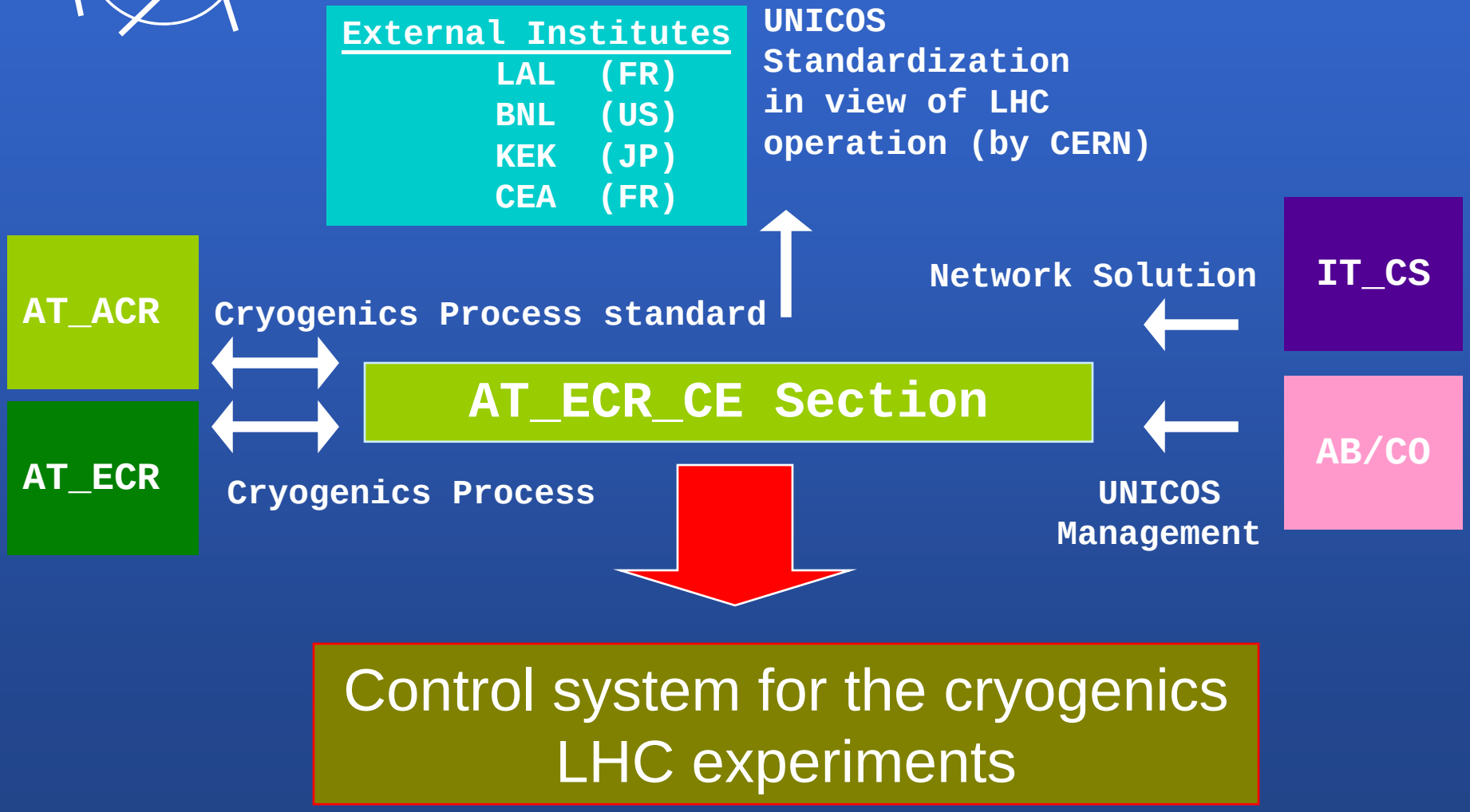
- Analysis of Functional Logic
- Generation of UNICOS Specification

  (Including Logic and Data-Base description)

- Generation of controls Data-Base
- Production code PLC – SCADA supervision

- Installation, Reception and Commissioning
- Consolidation and maintenance of the applications

CONTROL PROJECT COORDINATOR TASK



Technical Specifications

3 Documents to produce related of the 3 Control Layers:

- Process Logic description

  Object Structure

  User Application Description in UNICOS Language

- Field description

  Fully Parameters Description of Each Field

- Data Base Description

  List of Input and Output Objects

I/O Objects

Microsoft Excel - CMS_ST_compres_Quantum_Database_V08

File Edit View Insert Format Tools Data Window Help

B2 = QSC1H

	A	B	C	D	E	F	G	H	I	J	K	L
1	Type	Analog Input										
2	Equipment	QSC1H										
3	Location	C										
4	Implementation		Quantum									
5	Help											
6						Help						
7		0	1	2	3	4	5	6	7	8	9	10	11
8		QUANTUM CHANNEL	ELECTRICAL DIAGRAM	NAME	DESCRIPTION	INSTANCE TYPE	UNIT	RANGE MAX	RANGE MIN	DEAD BAND (%)	FILTER PERIOD	BOARD FILTER	TYPE
9					Spare		%	100.0	0.0	0.025	1	2	F
10			AI1.1	1IT150	C01 Current	GREEN_ANALOG_INPUT	A	info cern	info cern	0.025%	1	2	F
11			AI1.2	1GT120	C01 position 1CV120	GREEN_ANALOG_INPUT	%	100	0	0.025%	1	2	F
12			AI1.3	1PT110	C01 Inlet pressure	GREEN_ANALOG_INPUT	bara	6	0	0.025%	1	2	F
13			AI1.4	1PT123	C01 outlet pressure	GREEN_ANALOG_INPUT	bara	10	0	0.025%	1	2	F
14			AI1.5	1PT625	C01 oil pressure	GREEN_ANALOG_INPUT	bara	10	0	0.025%	1	2	F
15			AI1.6	1PTD615	clogging 1F618/9	GREEN_ANALOG_INPUT	bar	1,2	0	0.025%	1	2	F
16			AI1.7	1TT620	C01 inlet oil temp.	GREEN_ANALOG_INPUT	°C	+150	0	0.025%	1	2	F
17			AI1.8	1TT123	C01 outlet temp.	GREEN_ANALOG_INPUT	°C	+150	0	0.025%	1	2	F
18			AI2.1	1FT539	C01 out. water flow	GREEN_ANALOG_INPUT	m3/h	10	0	0.025%	1	2	F
19			AI2.2	1TT539	C01out. water temp.	GREEN_ANALOG_INPUT	°C	+100	0	0.025%	1	2	F
20			AI2.3	1TT151	C01 stator A temp.	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F
21			AI2.4	1TT152	C01stator B temp.	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F
22			AI2.5	1TT153	C01 stator C temp.	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F
23			AI2.6	1TT154	C01 fr. bearing temp.	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F
24			AI2.7	1TT155	C01 re. bearing temp	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F
25			AI2.8	2IT150	C02 current	GREEN_ANALOG_INPUT	A	info cern	info cern	0.025%	1	2	F
26			AI3.1	2GT120	C02 position 2CV120	GREEN_ANALOG_INPUT	%	100	0	0.025%	1	2	F
27			AI3.2	2PT110	C02 inlet pressure	GREEN_ANALOG_INPUT	bara	22	0	0.025%	1	2	F
28			AI3.3	2PT123	C02 outlet pressure	GREEN_ANALOG_INPUT	bara	22	0	0.025%	1	2	F
29			AI3.4	2PT625	C02 oil pressure	GREEN_ANALOG_INPUT	bara	22	0	0.025%	1	2	F
30			AI3.5	2PTD615	clogging 2F618/9	GREEN_ANALOG_INPUT	bar	1.2	0	0.025%	1	2	F
31			AI3.6	2TT620	C02 inlet oil temp.	GREEN_ANALOG_INPUT	°C	+150	0	0.025%	1	2	F
32			AI3.7	2TT123	C02 outlet temp.	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F
33			AI3.8	2FT539	C02 out. water flow	GREEN_ANALOG_INPUT	m3/h	10	0	0.025%	1	2	F
34			AI4.1	2TT539	C02 out. water temp.	GREEN_ANALOG_INPUT	°C	+100	0	0.025%	1	2	F
35			AI4.2	2TT151	C02 stator A temp.	GREEN_ANALOG_INPUT	°C	150	0	0.025%	1	2	F

Analog Input

Analog Output

Digital Input

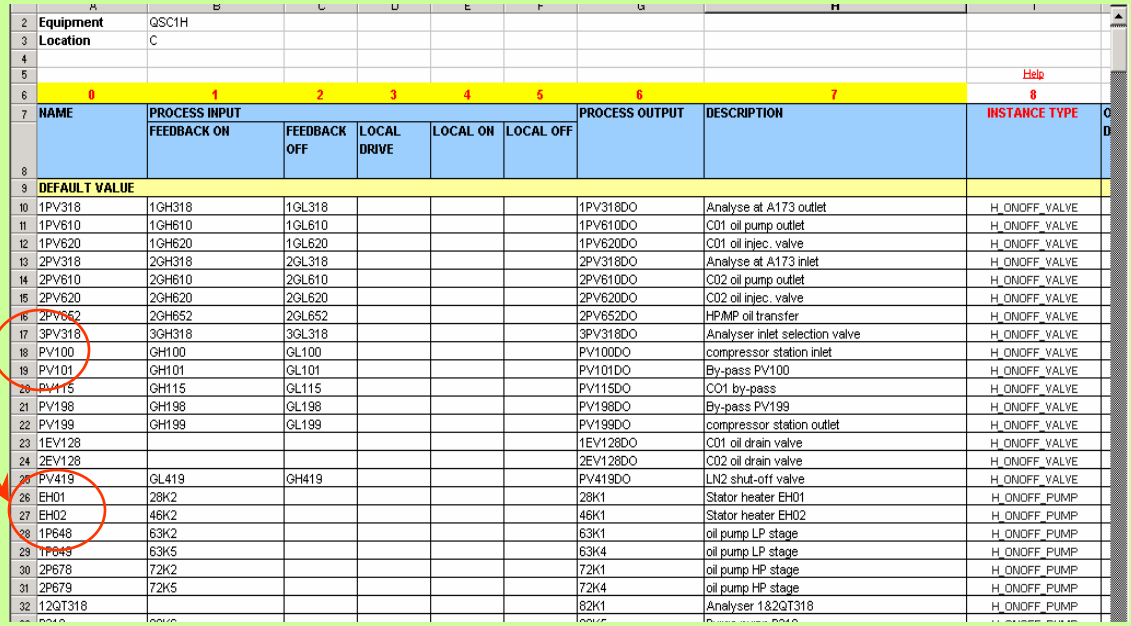
Digital Output

I/O Devices

Field Objects

pressure valve

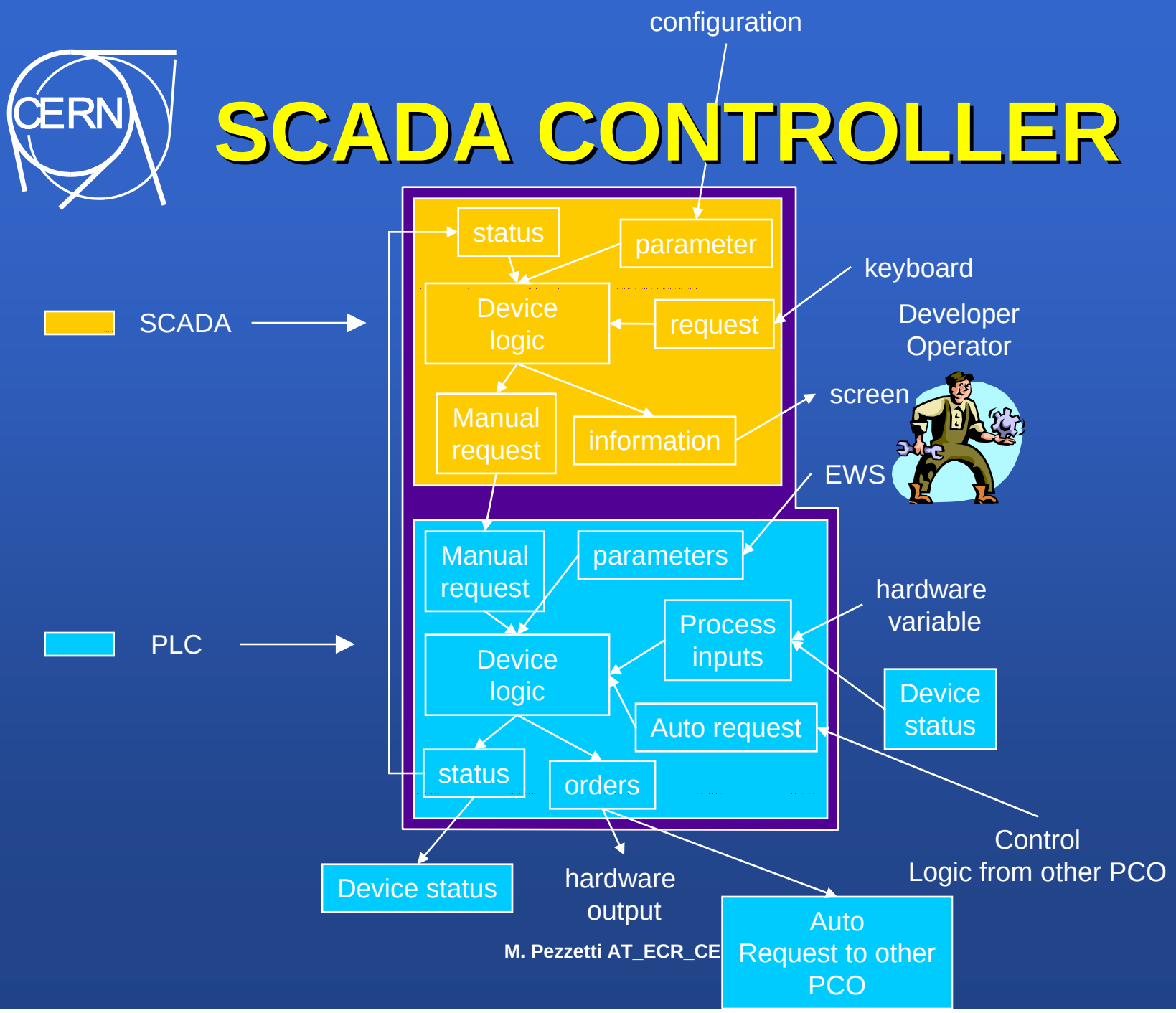
Heater



	A	B	C	D	E	F	G	H	I
2	Equipment	QSC1H							
3	Location	C							
4									
5									Help
6	0	1	2	3	4	5	6	7	8
7	NAME	PROCESS INPUT					PROCESS OUTPUT	DESCRIPTION	INSTANCE TYPE
8		FEEDBACK ON	FEEDBACK OFF	LOCAL DRIVE	LOCAL ON	LOCAL OFF			
9	DEFAULT VALUE								
10	1PV318	1GH318	1GL318				1PV318DO	Analyse at A173 outlet	H_ONOFF_VALVE
11	1PV610	1GH610	1GL610				1PV610DO	C01 oil pump outlet	H_ONOFF_VALVE
12	1PV620	1GH620	1GL620				1PV620DO	C01 oil injec. valve	H_ONOFF_VALVE
13	2PV318	2GH318	2GL318				2PV318DO	Analyse at A173 inlet	H_ONOFF_VALVE
14	2PV610	2GH610	2GL610				2PV610DO	C02 oil pump outlet	H_ONOFF_VALVE
15	2PV620	2GH620	2GL620				2PV620DO	C02 oil injec. valve	H_ONOFF_VALVE
16	2PV652	2GH652	2GL652				2PV652DO	HP/MP oil transfer	H_ONOFF_VALVE
17	3PV318	3GH318	3GL318				3PV318DO	Analyser inlet selection valve	H_ONOFF_VALVE
18	PV100	GH100	GL100				PV100DO	compressor station inlet	H_ONOFF_VALVE
19	PV101	GH101	GL101				PV101DO	By-pass PV100	H_ONOFF_VALVE
20	PV115	GH115	GL115				PV115DO	C01 by-pass	H_ONOFF_VALVE
21	PV198	GH198	GL198				PV198DO	By-pass PV199	H_ONOFF_VALVE
22	PV199	GH199	GL199				PV199DO	compressor station outlet	H_ONOFF_VALVE
23	1EV128						1EV128DO	C01 oil drain valve	H_ONOFF_VALVE
24	2EV128						2EV128DO	C02 oil drain valve	H_ONOFF_VALVE
25	PV419	GL419	GH419				PV419DO	LN2 shut-off valve	H_ONOFF_VALVE
26	EH01	28K2					28K1	Stator heater EH01	H_ONOFF_PUMP
27	EH02	46K2					46K1	Stator heater EH02	H_ONOFF_PUMP
28	1P648	63K2					63K1	oil pump LP stage	H_ONOFF_PUMP
29	1P649	63K5					63K4	oil pump LP stage	H_ONOFF_PUMP
30	2P678	72K2					72K1	oil pump HP stage	H_ONOFF_PUMP
31	2P679	72K5					72K4	oil pump HP stage	H_ONOFF_PUMP
32	12QT318						82K1	Analyser 1&2QT318	H_ONOFF_PUMP

Field Devices

SCADA CONTROLLER



N_TOF I/O estimations

6 CV valves
1 HE heater
3 PV valves
3 TT, 2 PT, 1 FT, 1 LT
+ Magnet

Total I/O : [20 AI; 10 AO; 10 DI; 10 DO]
+ Magnet

N_TOF Control cost estimations

Total I/O : [20 AI; 10 AO; 10 DI; 10 DO]

PLC and I/O Schneider Electric

- 1 Rack TSX RKY12 Rack Embase 12 POSITIONS 335,33 €
- 1 TSX PSY 3610MModule Alimentation 24Vdc 410,65 €
- 1 TSX PS7 5634MProcesseur 5302,00 €
- 2 TSX AEY 1600Module Entrées AI (16) 1796,00 €
- 1 TSX ASY800Module Sorties AO (8) 933,08 €
- 1 TSX DEY 32D2KModule Entrées DI (32) 359,22 €
- 1 TSX DSY 16T2Module Sorties DO (16) 241,28 €

TOTAL 9400 €

SUPERVISION SYSTEM

- 3 CERN PC 6000 €
- PVSS and Unity CERN Licence (no charges) TOTAL 6000 €

N_TOF Elec. cost estimations

ELECTRICAL COST

- Racks
- Alimentation 24 V
- Alimentation 230 V
- I/O Terminal Field
- General Cabling
- ManPower
- Documentation

TOTAL 100 000 €

N_TOF Cost estimations

ELECTRICAL COST + CONTROL COST **TOTAL 120 000 €**

Very Rough Estimate
(depend on physical location, distance between points, responsability interface, etc)