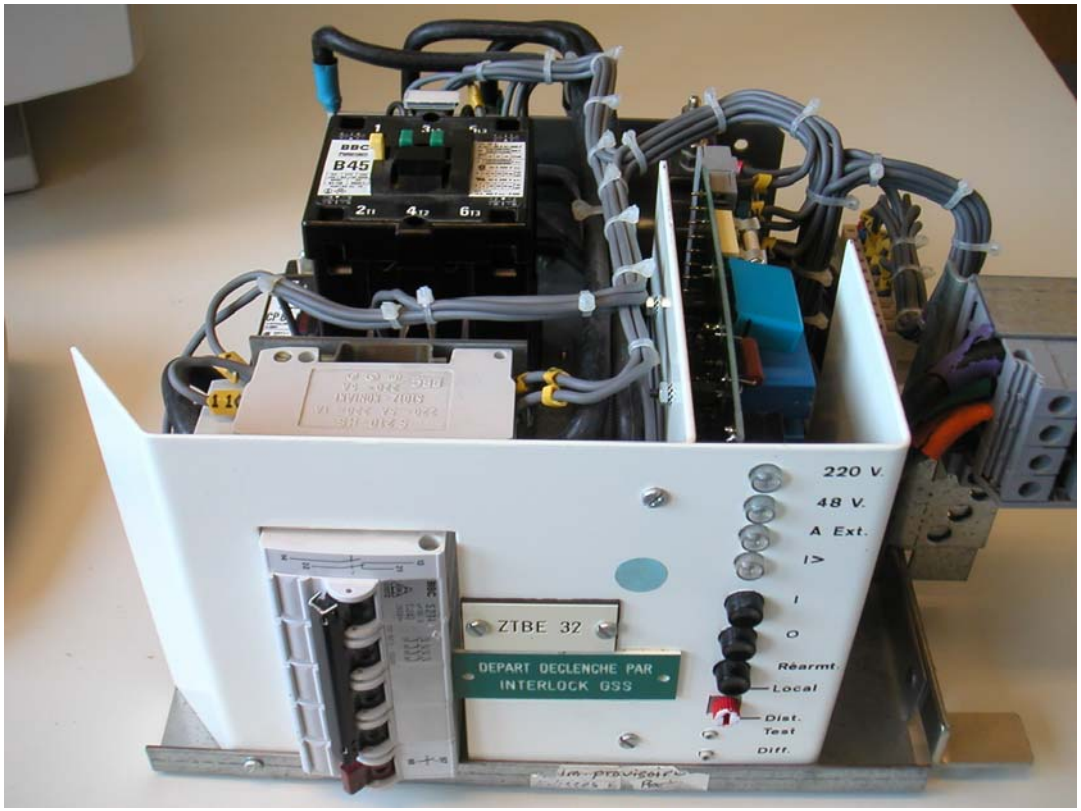
Supervision of the LV electrical distribution for ALICE and LHCb

- Switchboards and Feeders
  - Description
  - Location
  - Quantities
  - Constraints
- Monitoring and Control
  - Available signals
  - Requirements
- Data Concentrator
  - I/O quantities
  - Cabling switchboards to concentrator.
  - PLC systems
- Interface to ENS and DCS
  - Protocols
- Conclusions.

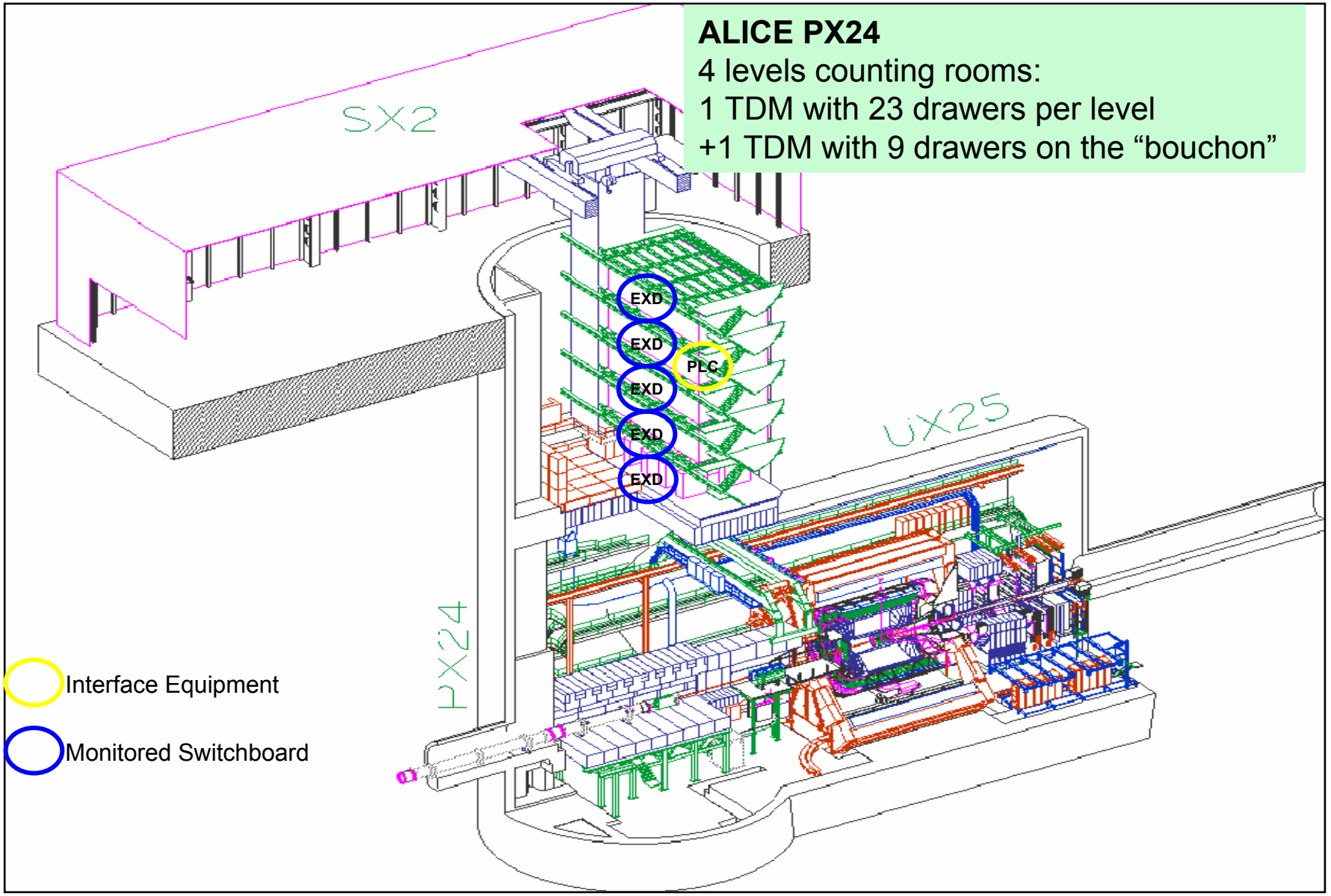
Switchboards and Feeders description

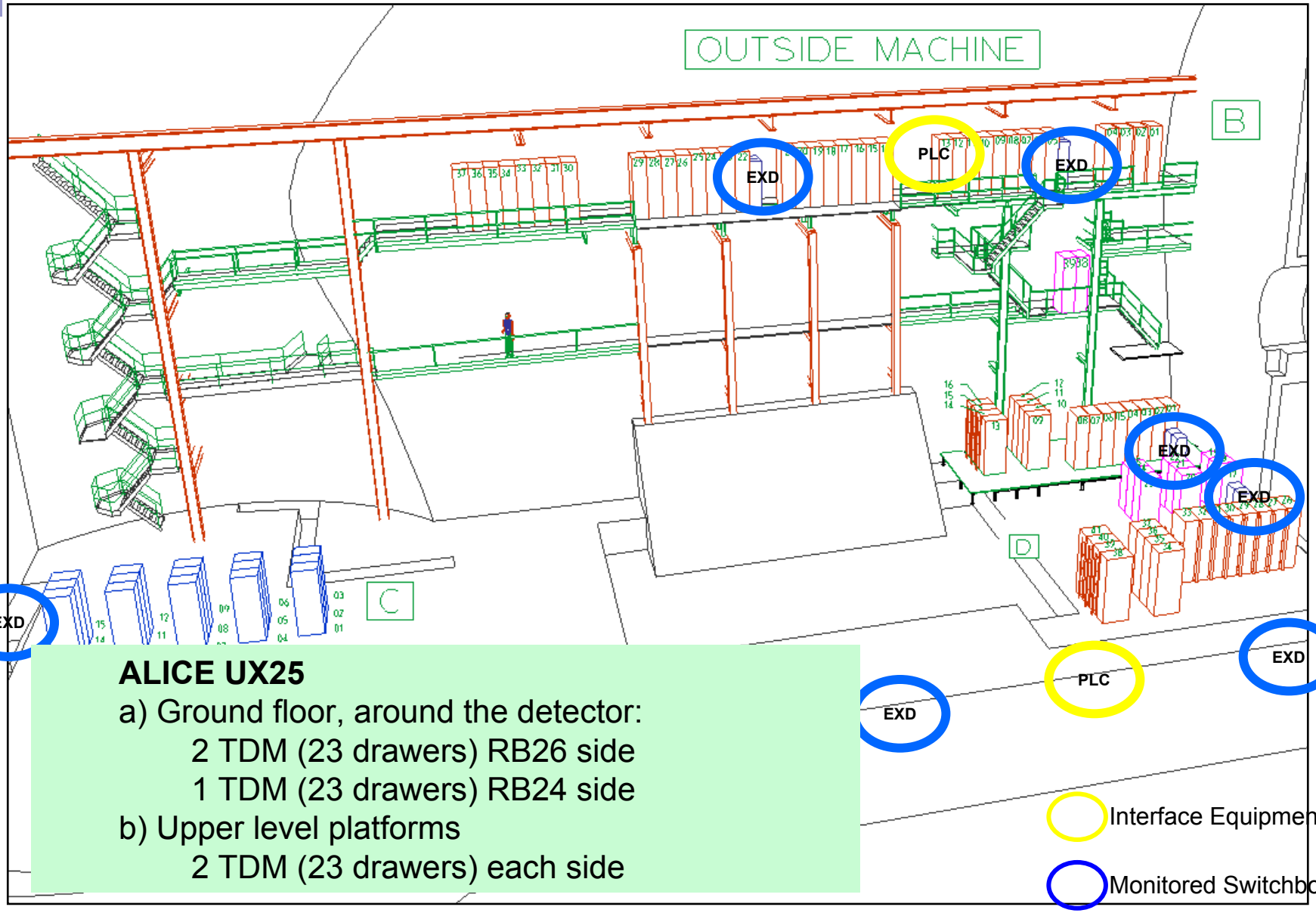
- Switchboards
  - TDM from HAZEMEYER recuperated from LEP experiments
    - 400V (3 Ph + N)
    - 250/400A bus-bars with incomer interrupter
    - Simple (9 slots) or double (23 slots) columns
- Feeders
    - ZTBE type removable drawers
    - 32A (20kVA) and 63A (40kVA) ratings
    - Circuit Breaker for protection
    - Contactor for Open/Close circuit
    - External interlock
    - Local/Remote control

TDM switchboards and ZTBE drawers



ALICE PX24
4 levels counting rooms:
1 TDM with 23 drawers per level
+1 TDM with 9 drawers on the “bouchon”





ALICE UX25

a) Ground floor, around the detector:

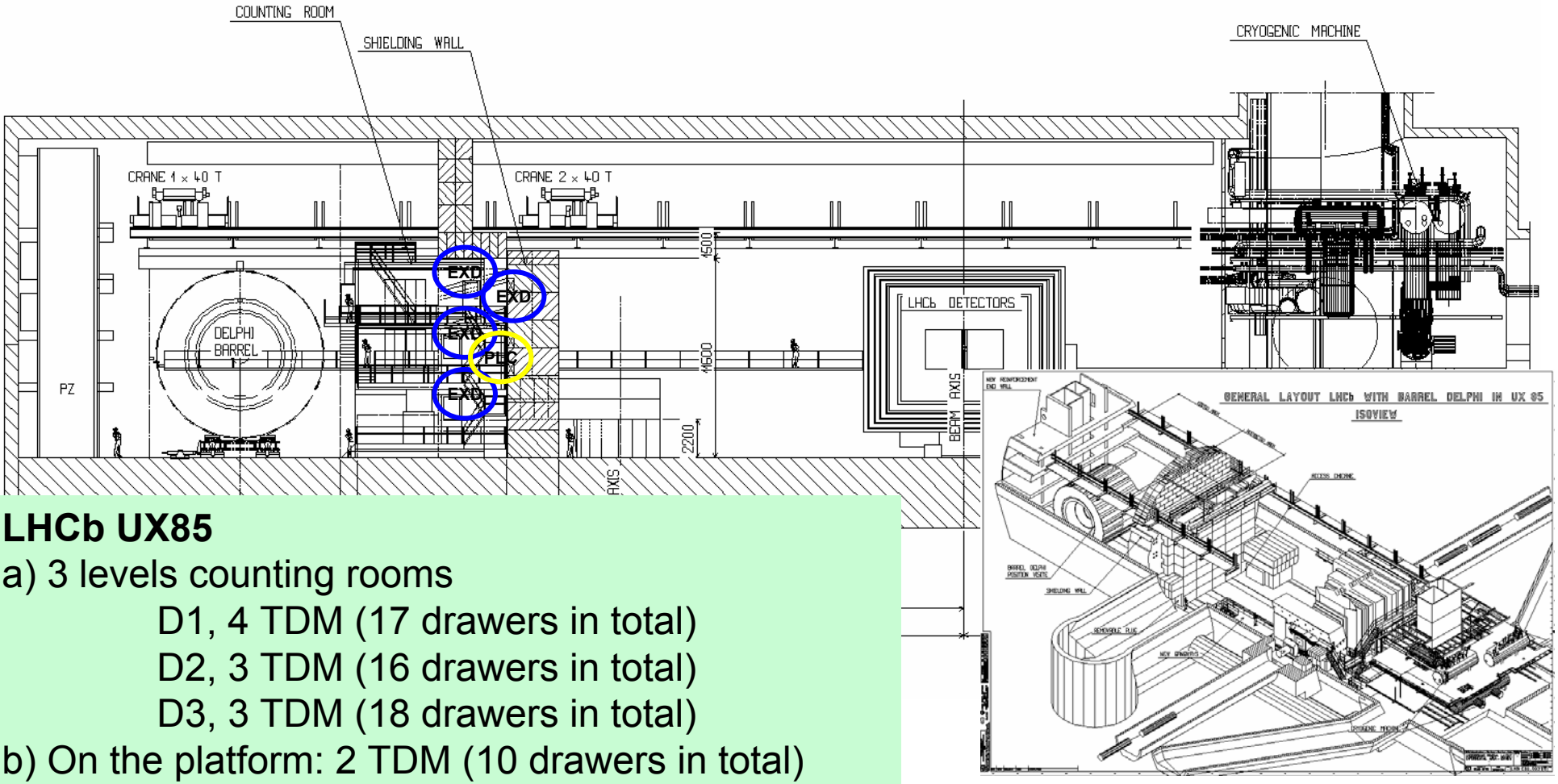
2 TDM (23 drawers) RB26 side

1 TDM (23 drawers) RB24 side

b) Upper level platforms

2 TDM (23 drawers) each side

GENERAL LAYOUT LHCb WITH BARREL DELPHI IN UX 85
ELEVATION



LHCb UX85

a) 3 levels counting rooms

D1, 4 TDM (17 drawers in total)

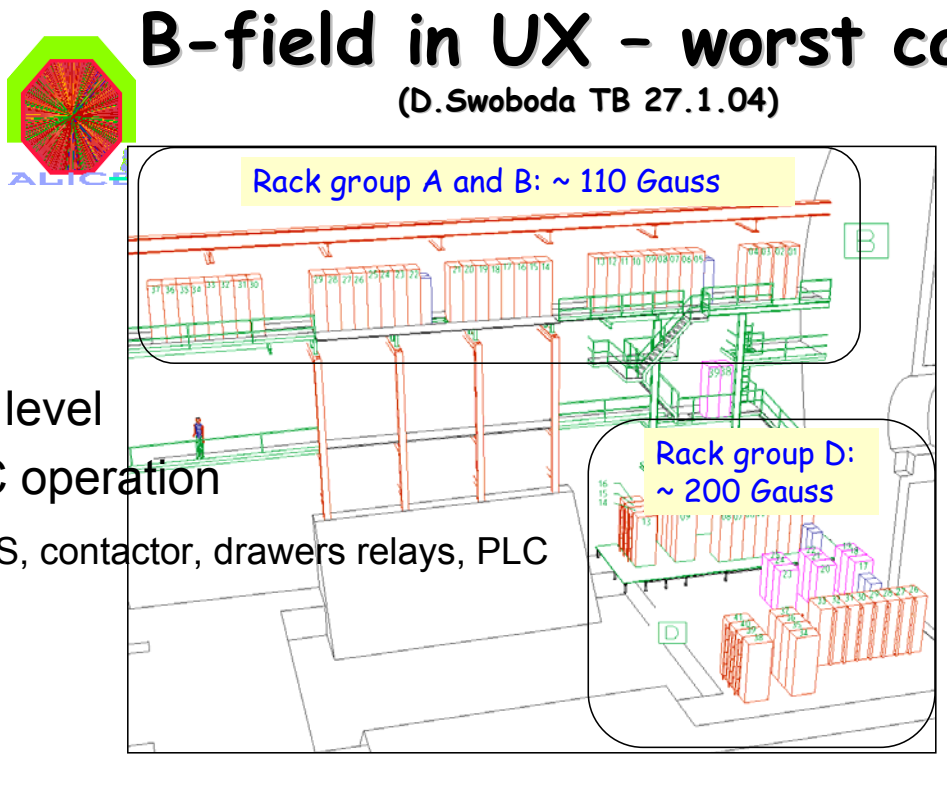
D2, 3 TDM (16 drawers in total)

D3, 3 TDM (18 drawers in total)

b) On the platform: 2 TDM (10 drawers in total)

Radiation, Magnetic field and Access Constraints

- ALICE
  - PX24
    - No radiation constraint
    - Accessible area
  - UX25
    - Radiation considered low level
    - Inaccessibility during LHC operation
    - Magnetic field (CT, VT, DIRIS, contactor, drawers relays, PLC relays)
      - To be verified
- LHCb
  - UX85 Good Side
    - No radiation constraint
    - Accessible area



Available Signals

- Switchboards
  - States
    - Input breaker status (Opened and Closed)
  - Measures
    - Bus Bars voltages (3 phases to N)
    - Input Phases and Neutral current
- Drawers
  - States
    - Contactor Position (Opened and Closed)
    - Breaker Position (Opened) after drawer modification.
    - Local/Remote switch (Local and Remote)
    - Electrical trip (SD)
    - External Interlock (Activated)
  - Controls
    - Open Contactor, Close Contactor, Reset external interlock

Requirement for Monitoring and Control

- TS/EL, via ENS SCADA
  - Switchboards out of voltage
  - Protection trips activated
    - ➔Alarms to TCR and E065 contract intervention
  - Power measurements
    - Power balance, Neutral current
- Experiments, via DCS SCADA
  - Drawers status
    - Open/Close, External interlocks (Rack over temperature)
  - Remote Control (switch on/off in sequence)

Signals Quantities (ALICE)

- UX25: 7 switchboards of 23 drawers = 161 drawers
- PX24: 4 switchboards of 23 drawers = 92 drawers and 1 switchboard of 9 drawers
- Total 262 drawers

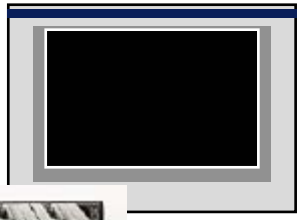
ALICE	Switchboards	States	Inputs	Feeders	States	Controls	Inputs	Outputs	Total
UX25	7	2	14	23	8	4	1302	644	1946
PX24	4	2	8	23	8	4	744	368	1112
EOD	1	2	2	23	8	4	186	92	278
Bouchon	1	2	2	9	8	4	74	36	110
							2306	**1140**	**3446**

Signals Quantities (LHCb)

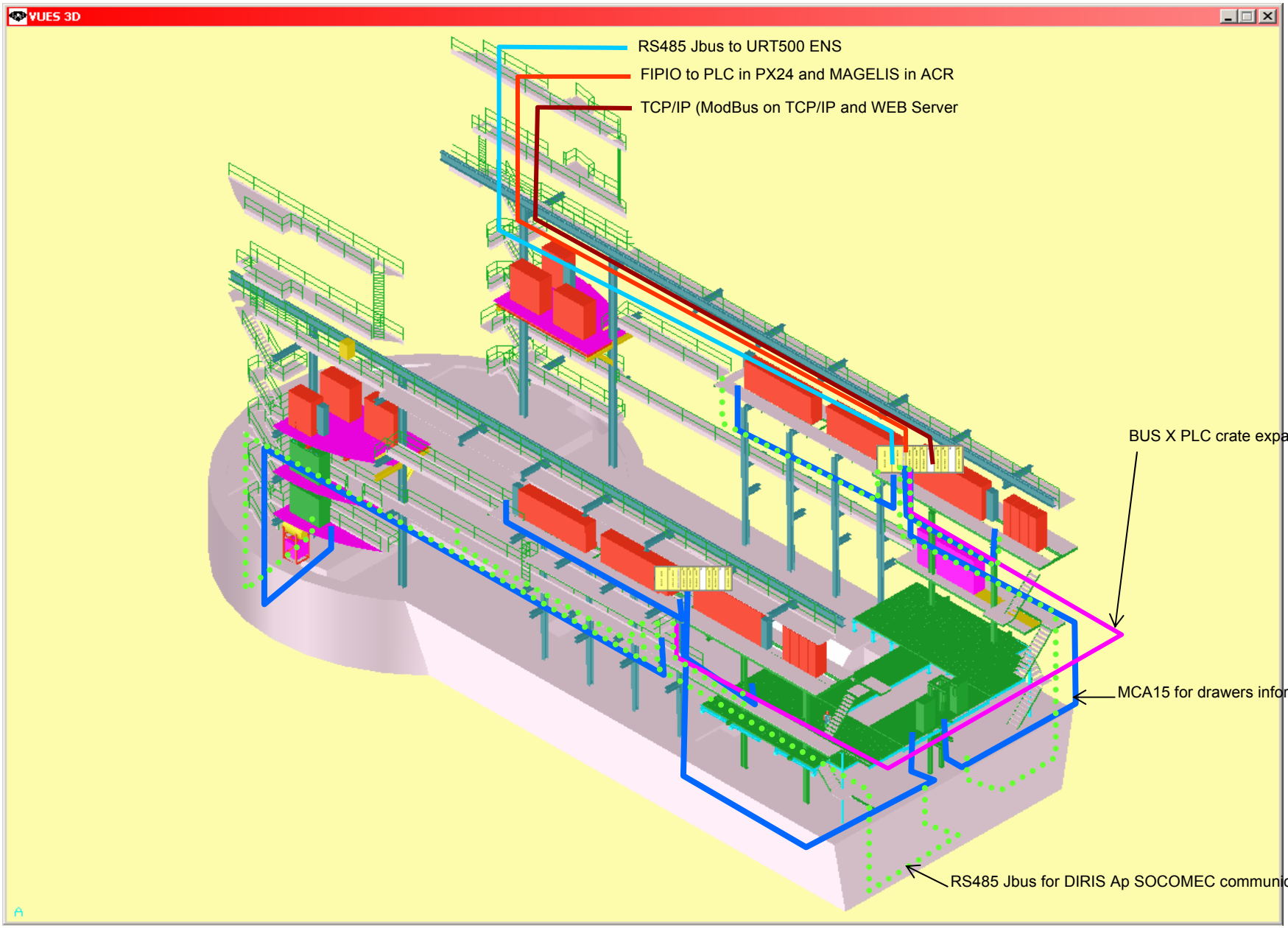
- D1: 4 switchboards, 17 drawers
- D2: 3 switchboards, 16 drawers
- D3: 4 switchboards, 18 drawers
- Supply to Cavern: 2 switchboards, 10 drawers
- Total 61 drawers

LHCb	Switchboards	States	Inputs	Feeders	States	Controls	Inputs	Outputs	Total
D1	4	2	8	17	8	4	144	68	212
D2	3	2	6	16	8	4	134	64	198
D3	4	2	8	18	8	4	152	72	224
Cavern	2	2	4	10	8	4	84	40	124
							514	**244**	**758**

PLC PREMIUM + DIRIS SOCOMEC



- PLC PREMIUM as Main Concentrator
  - PLC boards for digitals I/O and DIRIS for measurements
    - 64 bits input boards (24VDC polarisation)
    - 64 bits output boards with external TeleFast relays
  - Modular crates, 24 drawers max each.
  - Measures by DIRIS Ap placed in switchboards
    - Full measurement
      - Voltage Ur, Us, Ut
      - Currents Ir, Is, It, In, maximum current
      - Active & reactive Power, maximum power
      - On/Off incomer interface
      - Saves 2 MCA15 cables per switchboard
    - Local display
- PREMIUM limited to 2048 I/O
  - ALICE: Two PLC sets in UX25 and PX24
  - LHCb: one PLC set in UX85

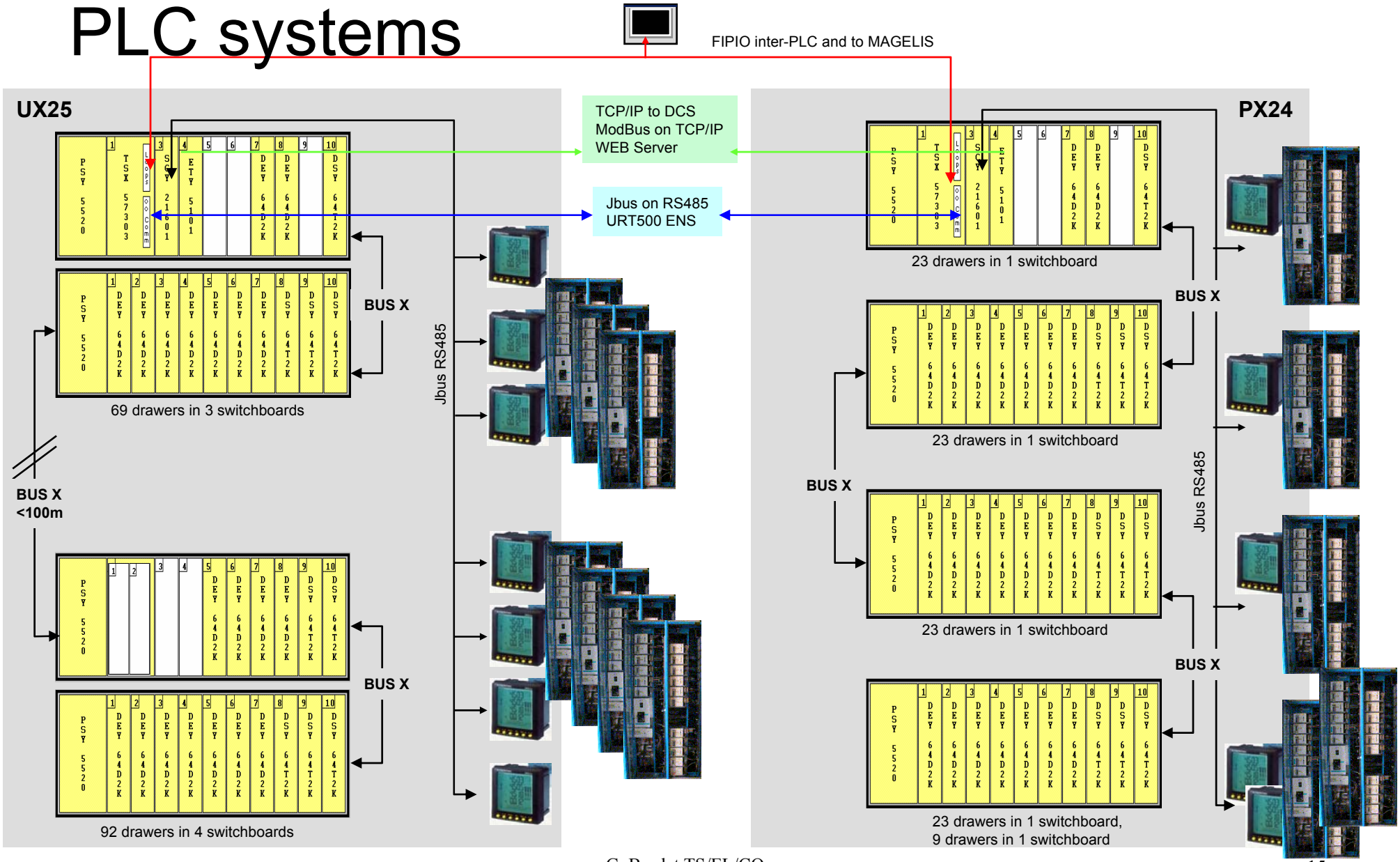

VUES 3D
RS485 Jbus to URT500 ENS
FIPIO to PLC in PX24 and MAGELIS in ACR
TCP/IP (ModBus on TCP/IP and WEB Server
BUS X PLC crate expansion
MCA15 for drawers information
RS485 Jbus for DIRIS Ap SOCOMEC communication

Cabling Feeders to PLC (ALICE & LHCb)

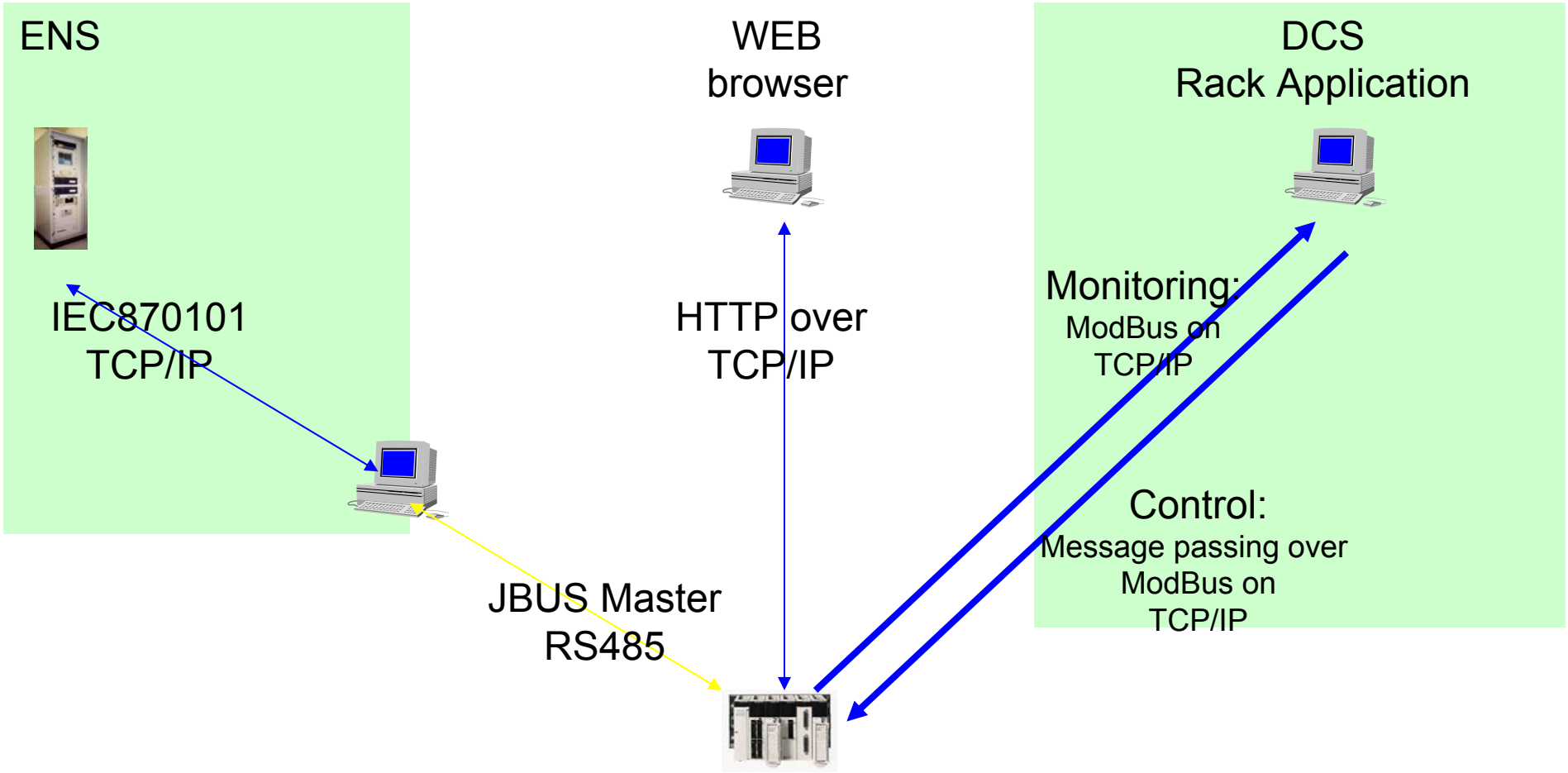
Area	Switchboards	Feeders	Cables (nb)	Length (m)	Total (m)
US25	2	23	46	10	460
US25	2	23	46	15	690
US25	2	23	46	25	1150
US25	1	23	23	50	1150
US25			**161**		**3450**
Level 1	1	23	23	15	345
Level 2	1	23	23	10	230
Level 3	1	23	23	15	345
Level 4	1	23	23	20	460
Bouchon	1	9	9	25	225
PX24			**101**		**1605**
			262	**cables**	**5055**

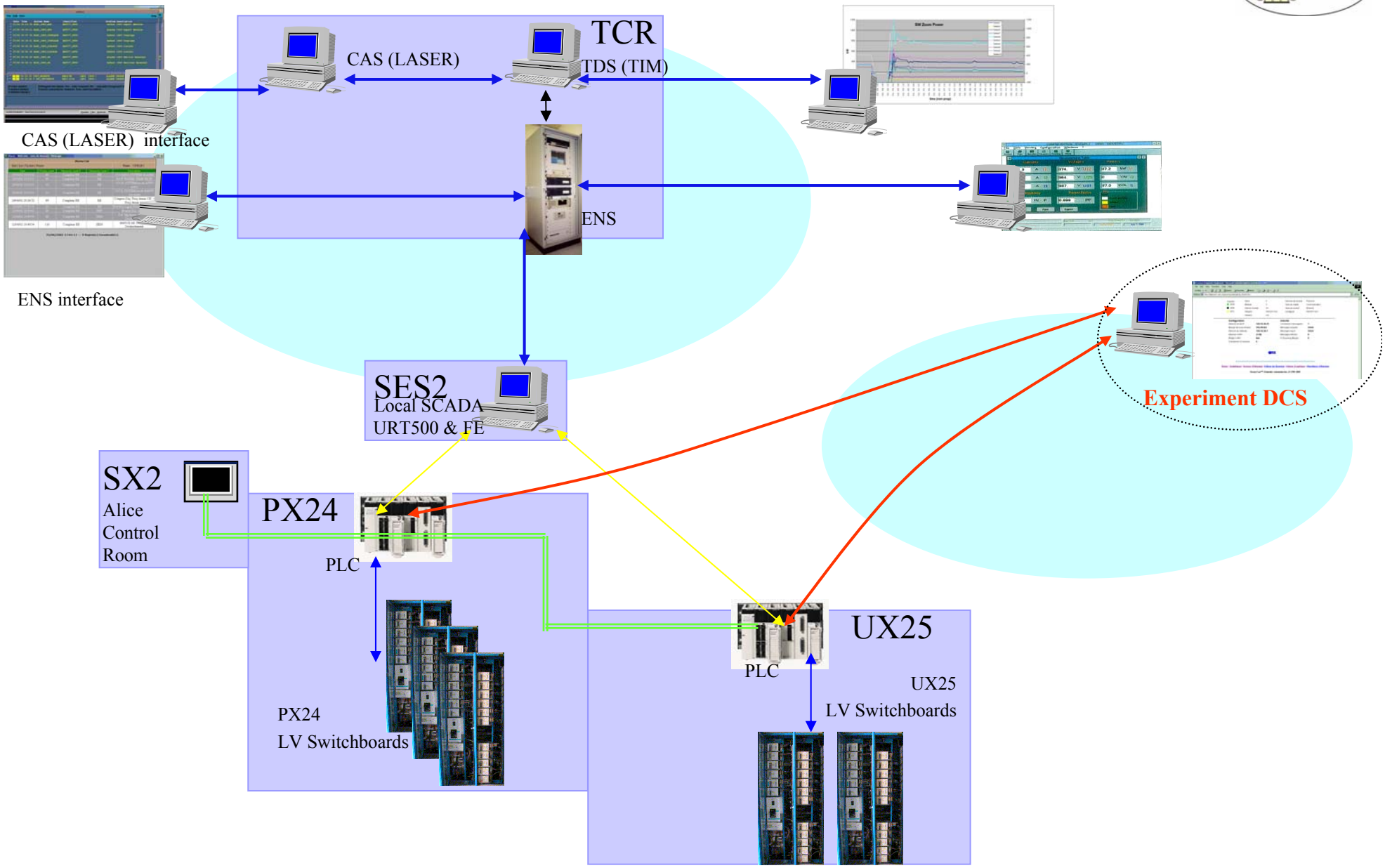
LHCb	Feeders (nb)	Length (m)	Total (m)
D1	17	15	255
D2	16	15	240
D3	18	15	270
Cavern	10	15	150
	61	**cables**	**915**

PLC systems


FIPIO inter-PLC and to MAGELIS
UX25
TCP/IP to DCS
ModBus on TCP/IP
WEB Server
Jbus on RS485
URT500 ENS
BUS X
69 drawers in 3 switchboards
Jbus RS485
BUS X
<100m
BUS X
92 drawers in 4 switchboards
PX24
23 drawers in 1 switchboard
BUS X
23 drawers in 1 switchboard
Jbus RS485
BUS X
23 drawers in 1 switchboard
BUS X
23 drawers in 1 switchboard,
9 drawers in 1 switchboard

PROTOCOLS


ENS
WEB
browser
DCS
Rack Application
IEC870101
TCP/IP
HTTP over
TCP/IP
Monitoring:
ModBus on
TCP/IP
Control:
Message passing over
ModBus on
TCP/IP
JBUS Master
RS485


CAS (LASER) interface
TCR
CAS (LASER)
TDS (TIM)
ENS
ENS interface
SES2
Local SCADA
URT500 & FE
Experiment DCS
SX2
Alice
Control
Room
PX24
PLC
PX24
LV Switchboards
UX25
PLC
UX25
LV Switchboards

Conclusions

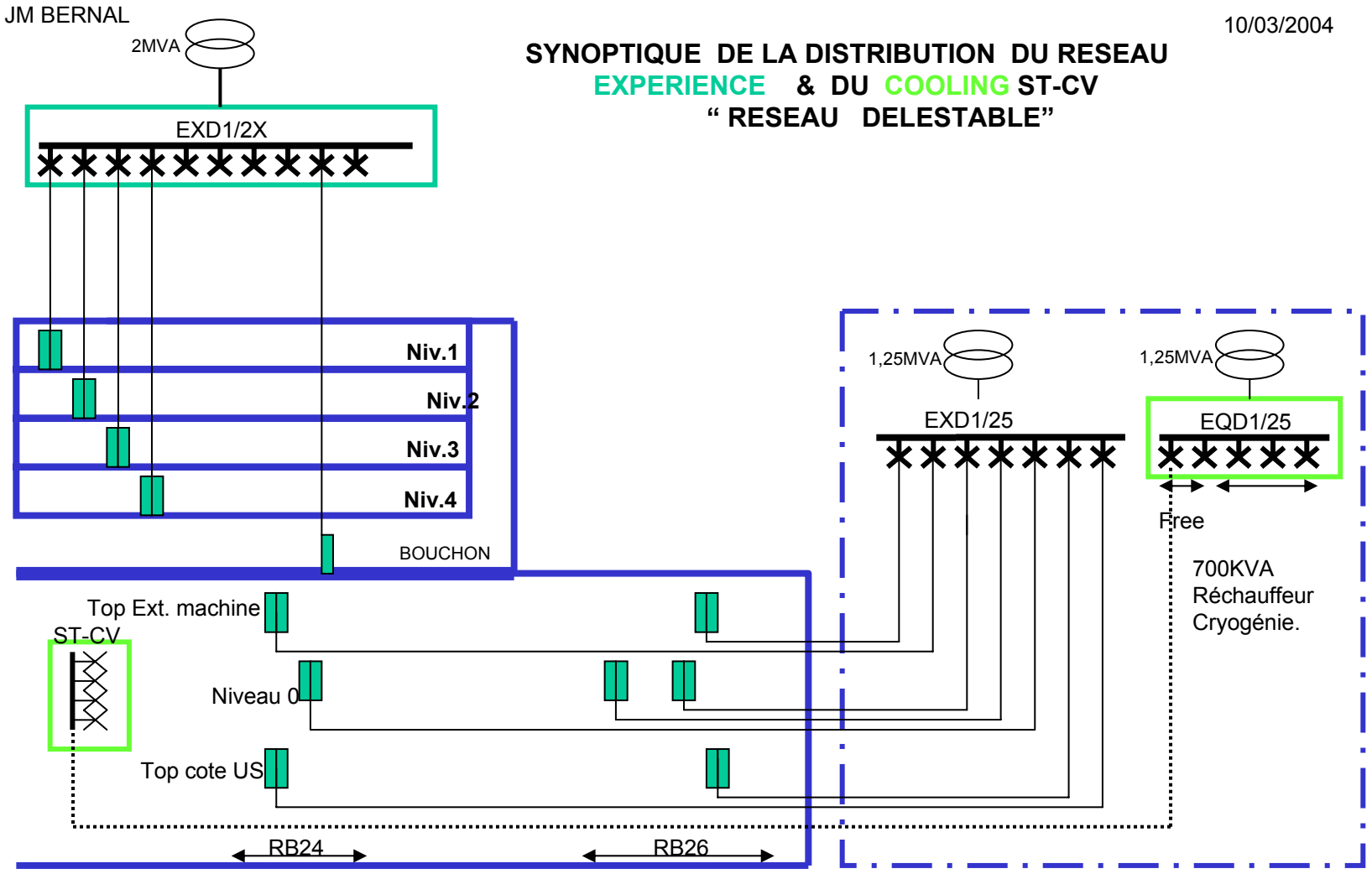
- Drawers impose cable/connector type
- Quantity of I/O's
- PREMIUM PLC (digital I/O), DIRIS Ap (measures)
- To be tested: Magnetic field effects on drawers
- Integration to ENS in standard manner
- Supervised and Controlled by DCS

Thanks for your attention!

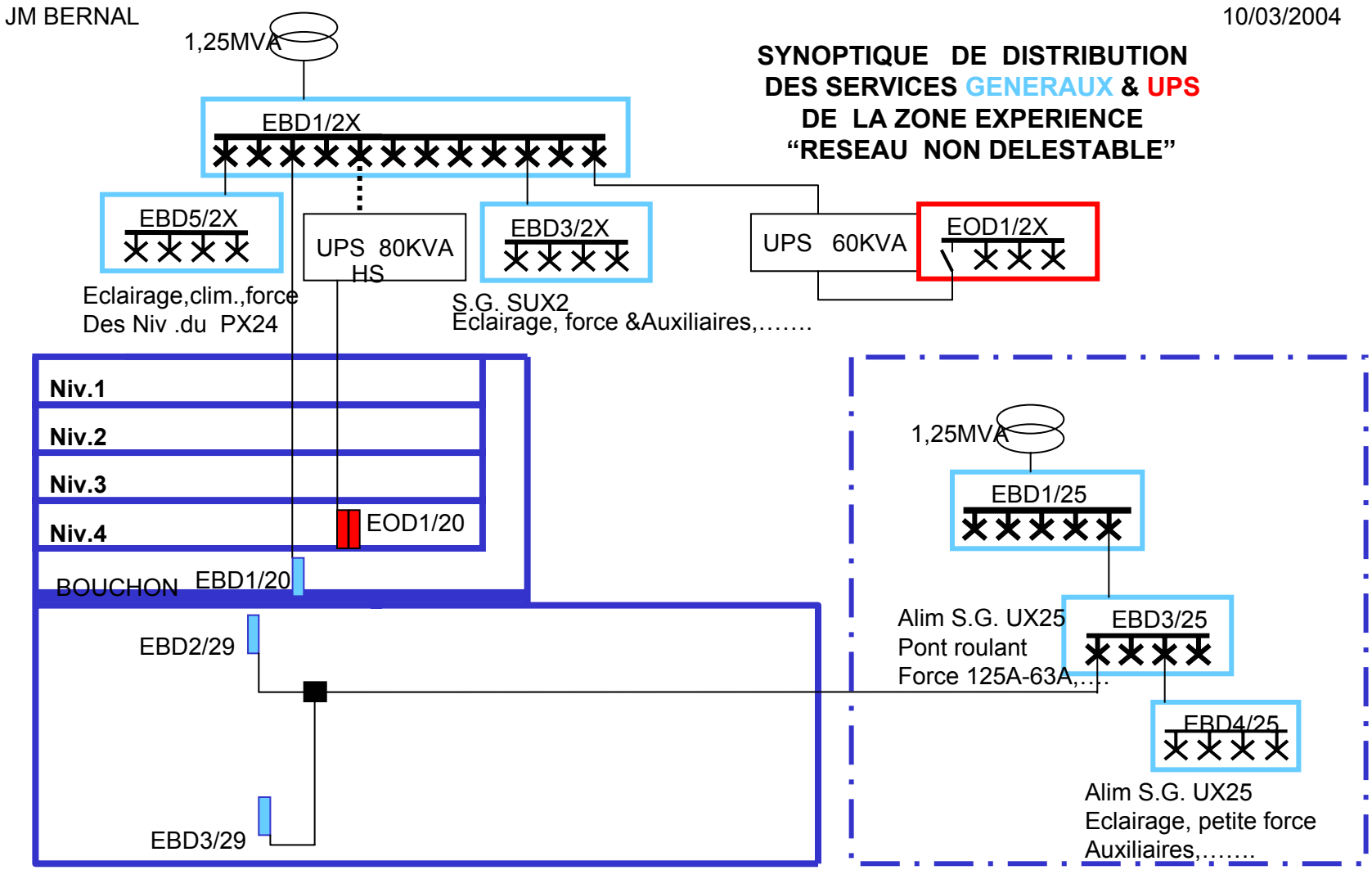
- References
  - EDMS
    - ALICE: EDMS 445556
    - LHCb: EDMS 460918
    - PROTOCOL DCS: EDMS 452784
  - WEB
    - TS Department ➔ EL Group ➔ Projects
      - http://ts-dep.web.cern.ch/ts-dep/groups/el/elprojects.htm
- Questions?

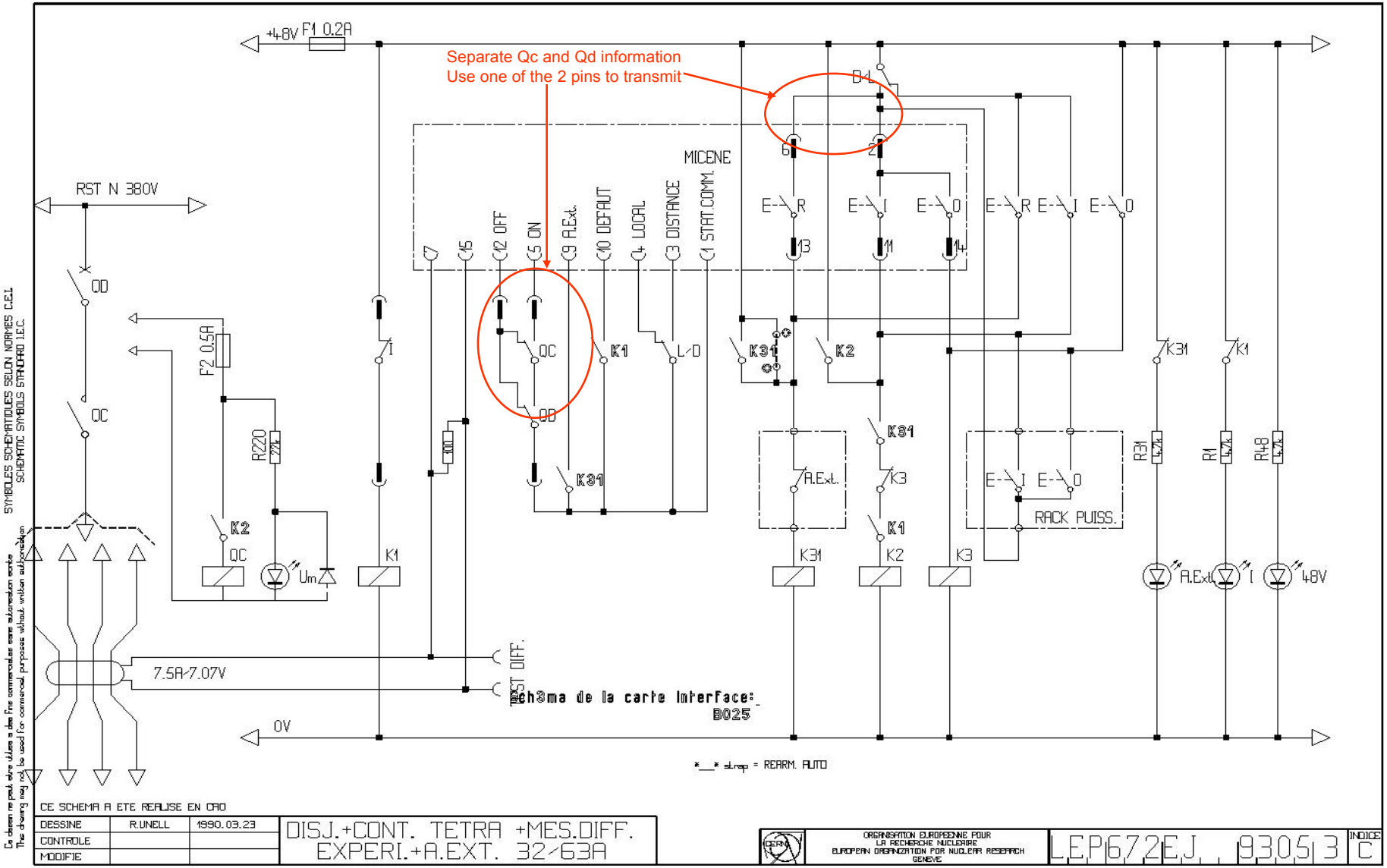
Annexes

ALICE Racks Supply



ALICE General Services





Schema of drawer (before modification for breaker state)

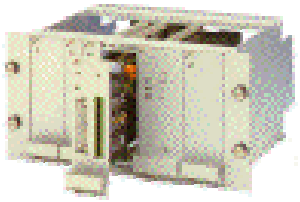
Considered Interfaces

- CIT8.4, CIT8.4A, CIT1.32P HAZEMEYER
- PLC PREMIUM and distributed I/O's on FIPIO
- PLC SIEMENS
  - S7-300 centralised
  - S7-300 distributed
  - S7-400
- PLC PREMIUM and CIT 8.4A HAZEMEYER
- PLC PREMIUM and DIRIS Ap SOCOMEC

PLC PREMIUM and distributed FIPIO

- PLC PREMIUM as Main Concentrator
  - TBX
    - TBX 16 inputs
    - TBX 16 outputs
    - TBX Analogues + converters
- + Modularity
- - Incompatibility with analogue signals imposes analogu converters.

PLC PREMIUM and CIT HAZEMEYER



- PLC PREMIUM as Main Concentrator
  - CIT1.32P Concentrator per switchboard
    - 1 x CIT 8.4MX per drawer (states and controls)
    - 1 x CIT 8.4MX per switchboard (states and measures)
- 12 sets (7+4+1 switchboards).
  - 274 CIT8.4MX, 12 CIT1.32P
- 1 x PLC PREMIUM SCHNEIDER + MAGELIS
  - Interface Cost: (plus crates, cables, cabling, program).
- + Modularity et compatibility with analogue signals.
- - CIT Quantity and HAZEMEYER contract.

PLC SIEMENS

- 32 bits inputs boards
- 16 bits outputs boards, common by 4
- Prices for digital I/O (no measures).

PLC PREMIUM + CIT HAZEMEYER

- PLC PREMIUM as Main Concentrator
  - PLC boards for digitals I/O and CIT for measurements
- 1 x CIT1.32P Concentrator for measurements
  - 64 bits input boards (24VDC polarisation)
  - 64 bits output boards with external TeleFast relays
  - CIT8.4A (spare) versus CIT8MX (contract)
    - 1 module per switchboard
      - Voltage Ur, Us, Ut
      - Currents Ir, Is, It, In
      - Active Power Pr, Ps, Pt included