# CUOF VARIOUS INFO

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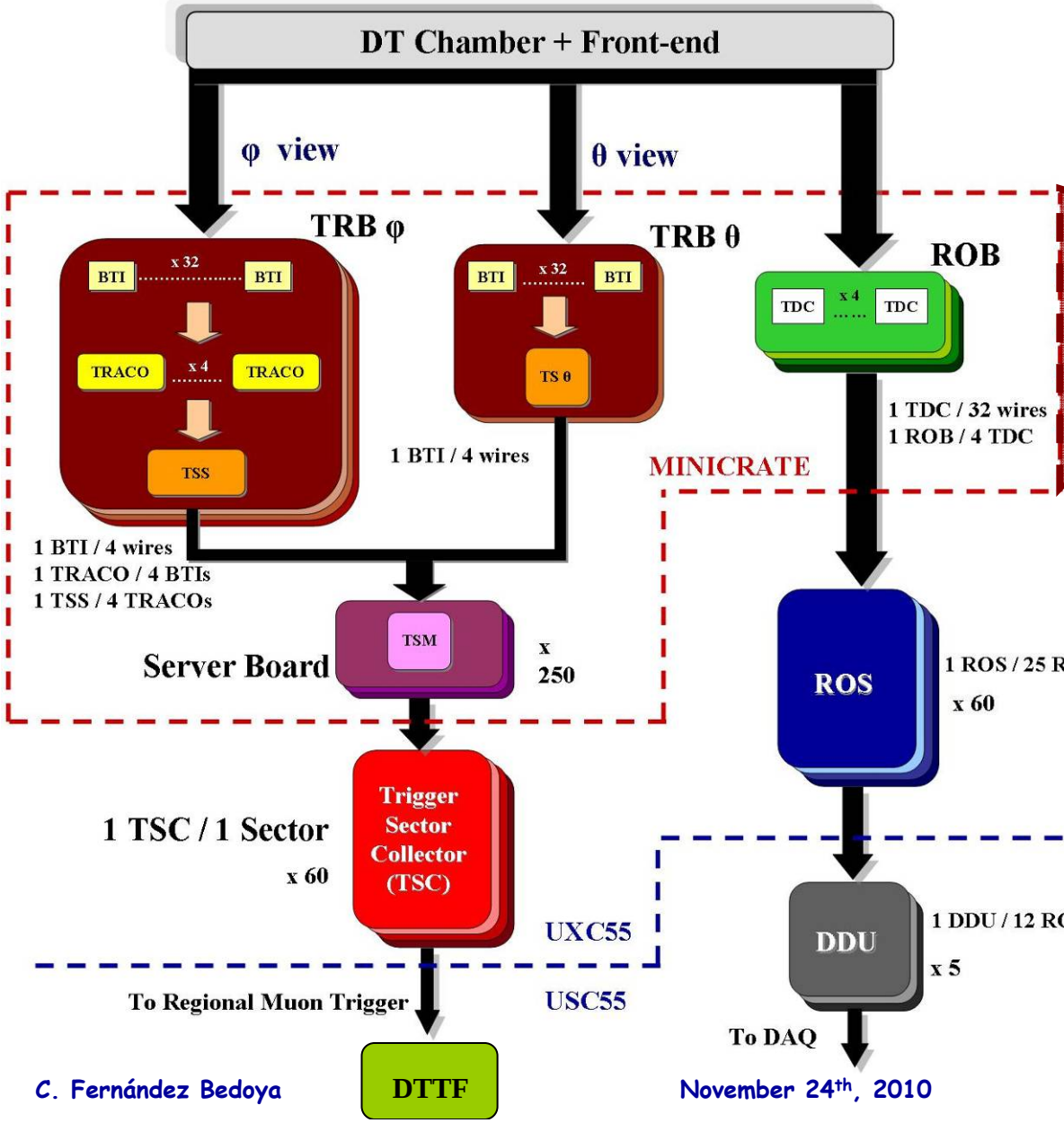
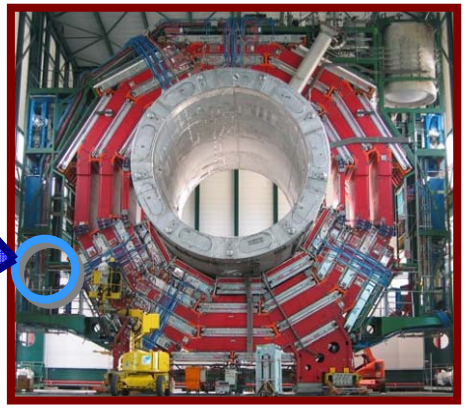
November 24th, 2010

# DT Electronics



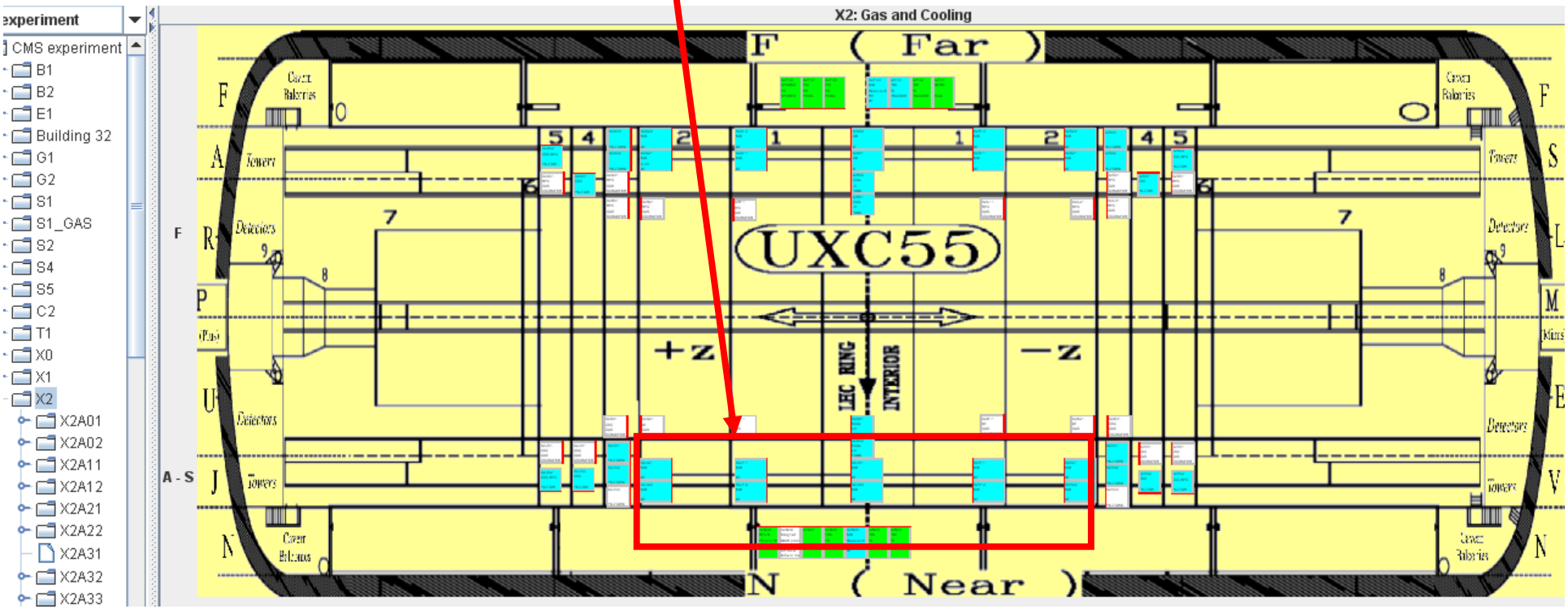
## Sector Collector

Second level of DT read-out and trigger

RACK WIZARD TOOL (read only):

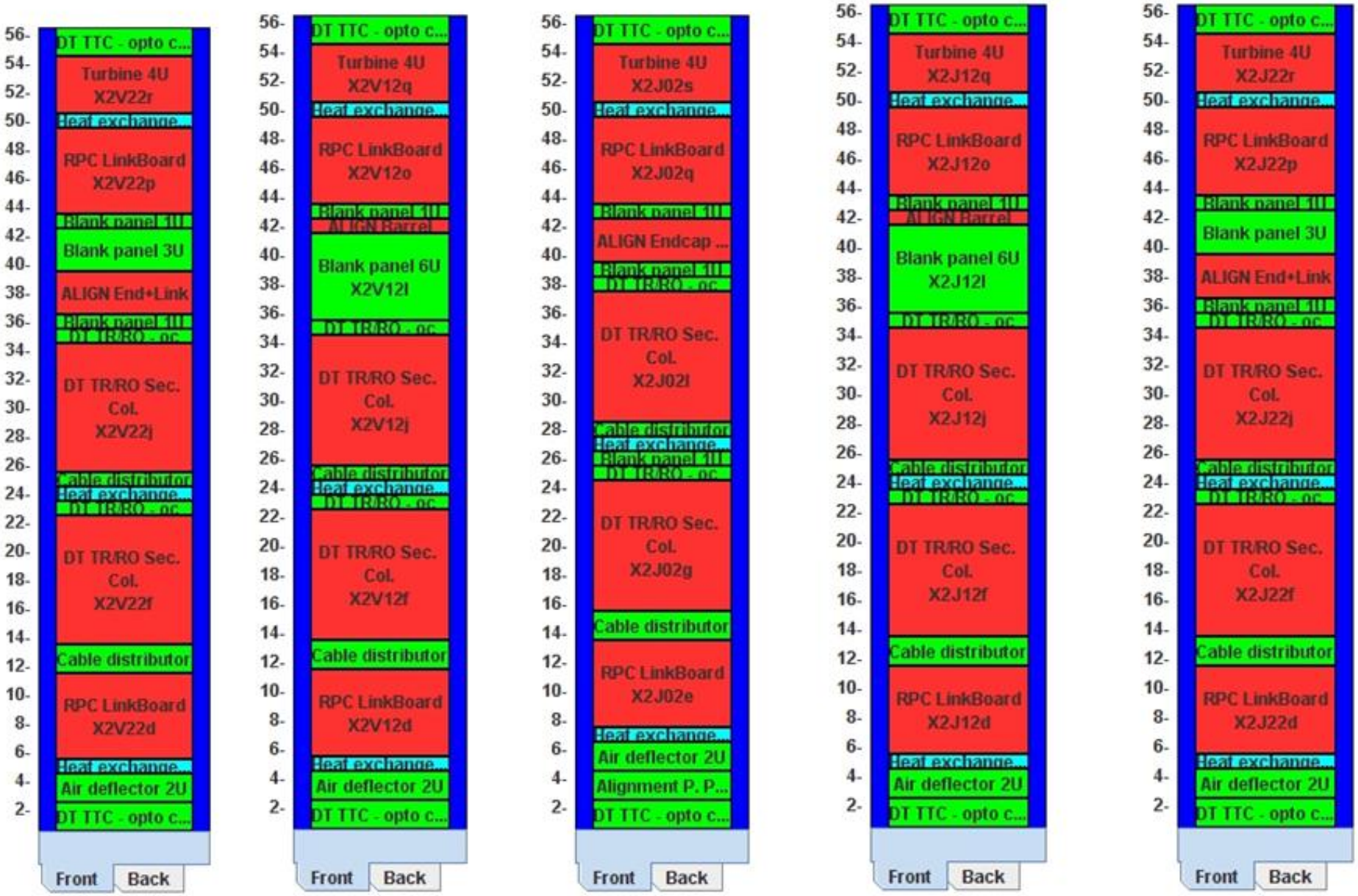
http://glege.home.cern.ch/glege/RackWizard/RackWizard.html

Sector Collector (SC) crates in UXC Level 2 near



5 racks
10 SC crates (2/wheel)

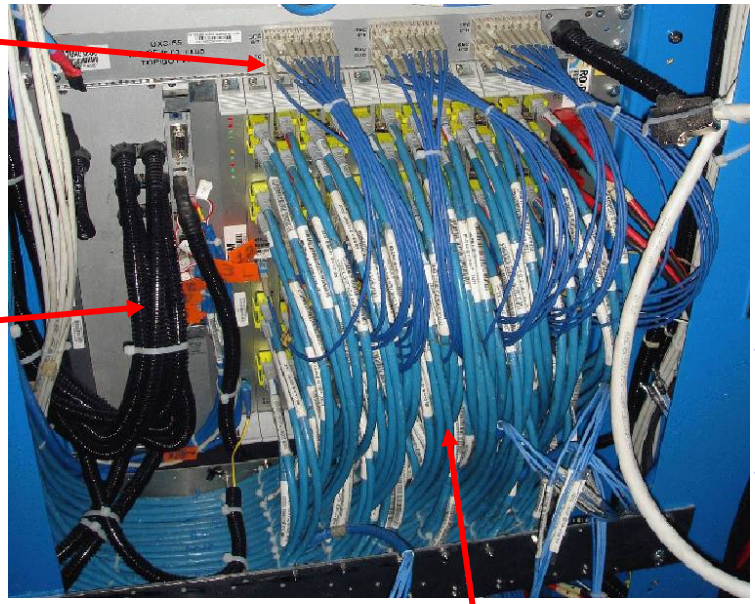
# ACK X2V22, X2V12, X2J02, X2J12, X2J22
## SC crates racks



# DT Sector Collector

-Present fibers (not to be used in the upgrade in principle)

OLD
We don´t have those tubes now



- 2 SC crates per wheel
- Located in tower racks in UXC level 2 Near
- 60 ROS and 60 TSC boards in the system (1 per sector)
- Complex electronic system
- Main elements:

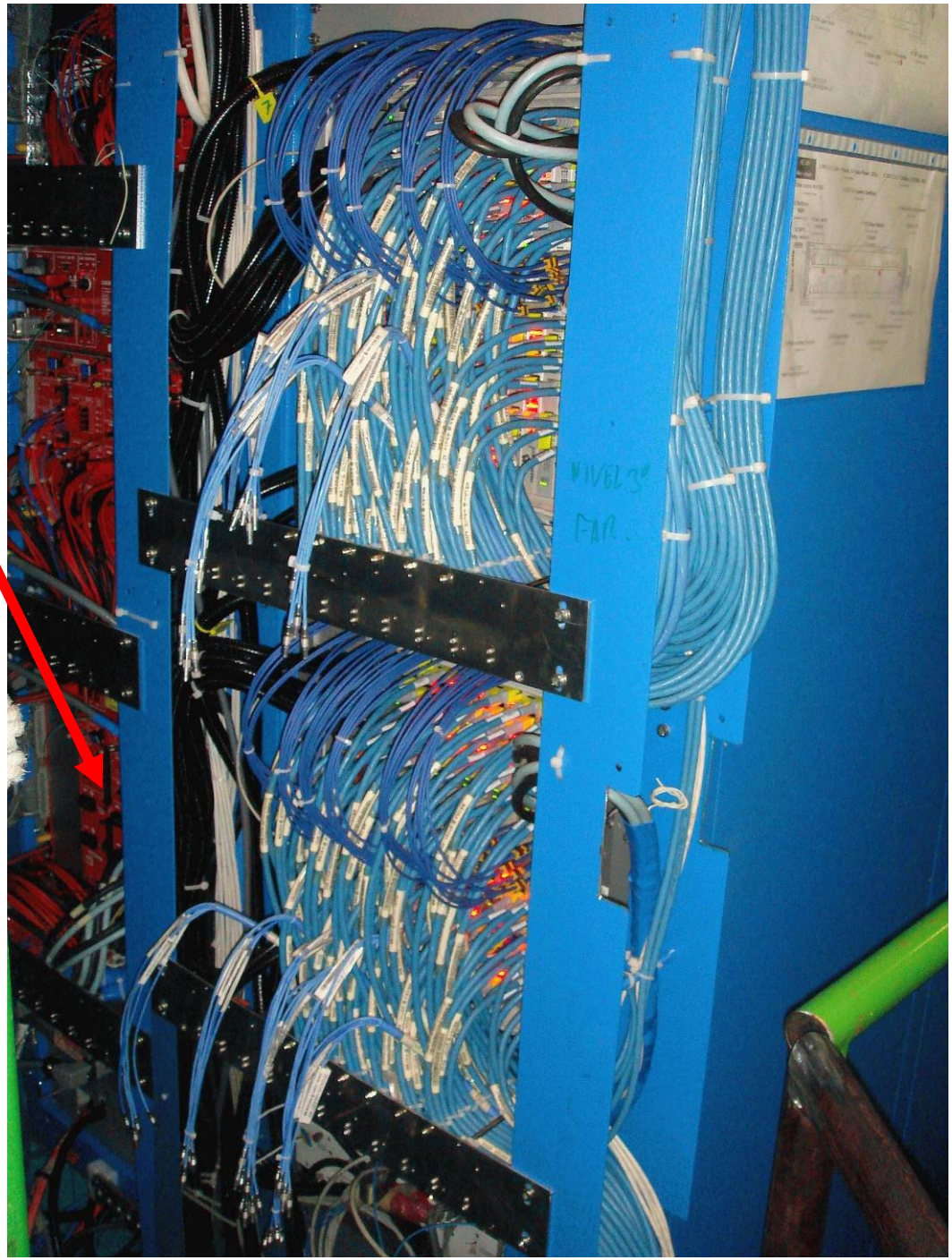
LINCO, TIM, ROS, TSC

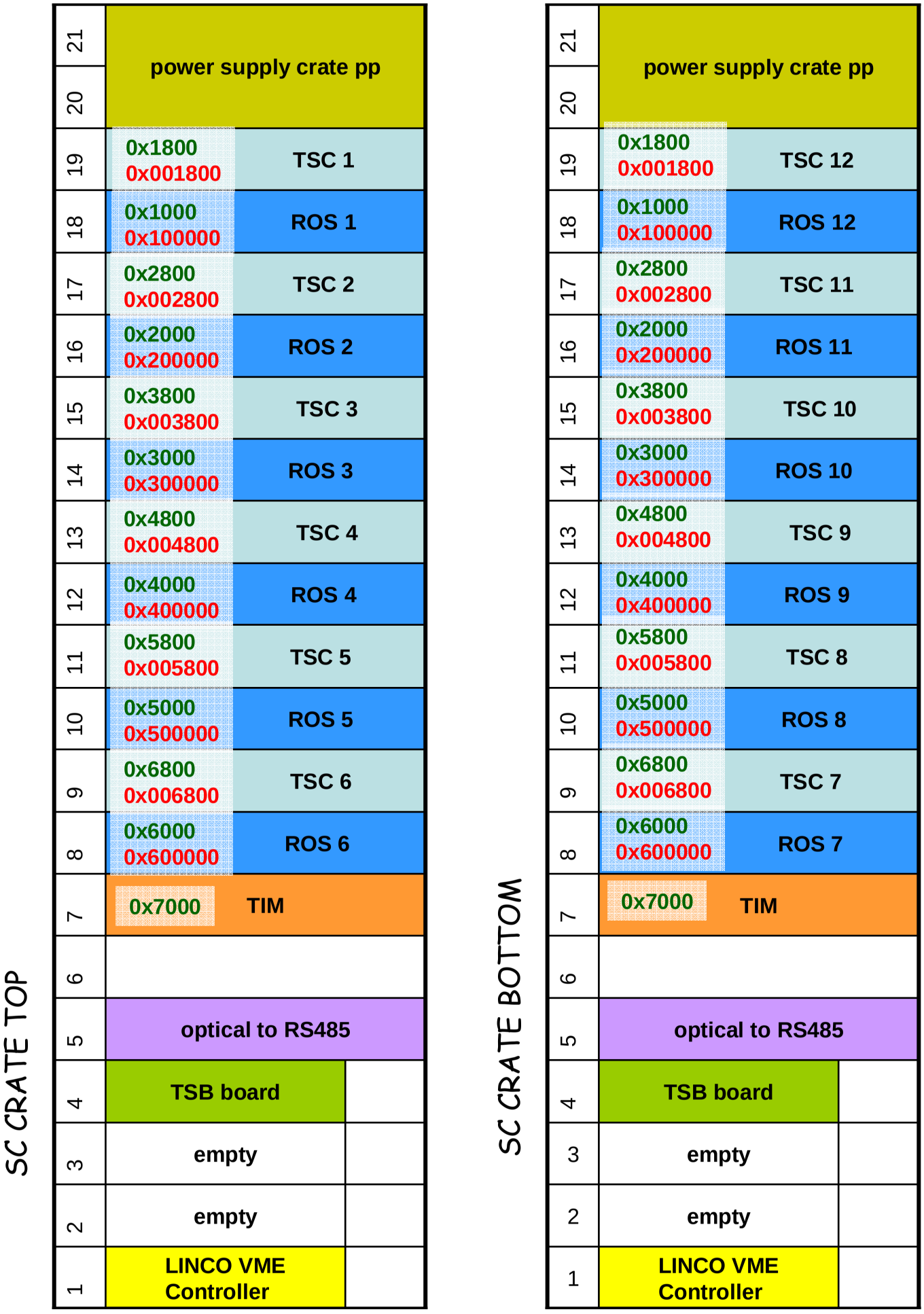
-Copper cables from Minicrates
-Up to 40 m (various lengths)
-FPT cables (very rigid)
-LVDS links

-SC CRATE POWERED from A3100 CAEN modules in the nearby rack

-A3100 5V (5.2V) output
100 A max current
At present 75 A

-Power consumption per SC crate is around 500 W
-Cooling through water (Heat Exchangers) and vertical air flow (turbines)
-Turbines are not extremely powerful (adapted to work under B field), <u>try to limit power consumption</u>




SC CRATE TOP
21
20
power supply crate pp
19
0x1800
0x001800
TSC 1
18
0x1000
0x100000
ROS 1
17
0x2800
0x002800
TSC 2
16
0x2000
0x200000
ROS 2
15
0x3800
0x003800
TSC 3
14
0x3000
0x300000
ROS 3
13
0x4800
0x004800
TSC 4
12
0x4000
0x400000
ROS 4
11
0x5800
0x005800
TSC 5
10
0x5000
0x500000
ROS 5
9
0x6800
0x006800
TSC 6
8
0x6000
0x600000
ROS 6
7
0x7000
TIM
6
5
optical to RS485
4
TSB board
3
empty
2
empty
1
LINCO VME Controller
SC CRATE BOTTOM
21
20
power supply crate pp
19
0x1800
0x001800
TSC 12
18
0x1000
0x100000
ROS 12
17
0x2800
0x002800
TSC 11
16
0x2000
0x200000
ROS 11
15
0x3800
0x003800
TSC 10
14
0x3000
0x300000
ROS 10
13
0x4800
0x004800
TSC 9
12
0x4000
0x400000
ROS 9
11
0x5800
0x005800
TSC 8
10
0x5000
0x500000
ROS 8
9
0x6800
0x006800
TSC 7
8
0x6000
0x600000
ROS 7
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0x7000
TIM
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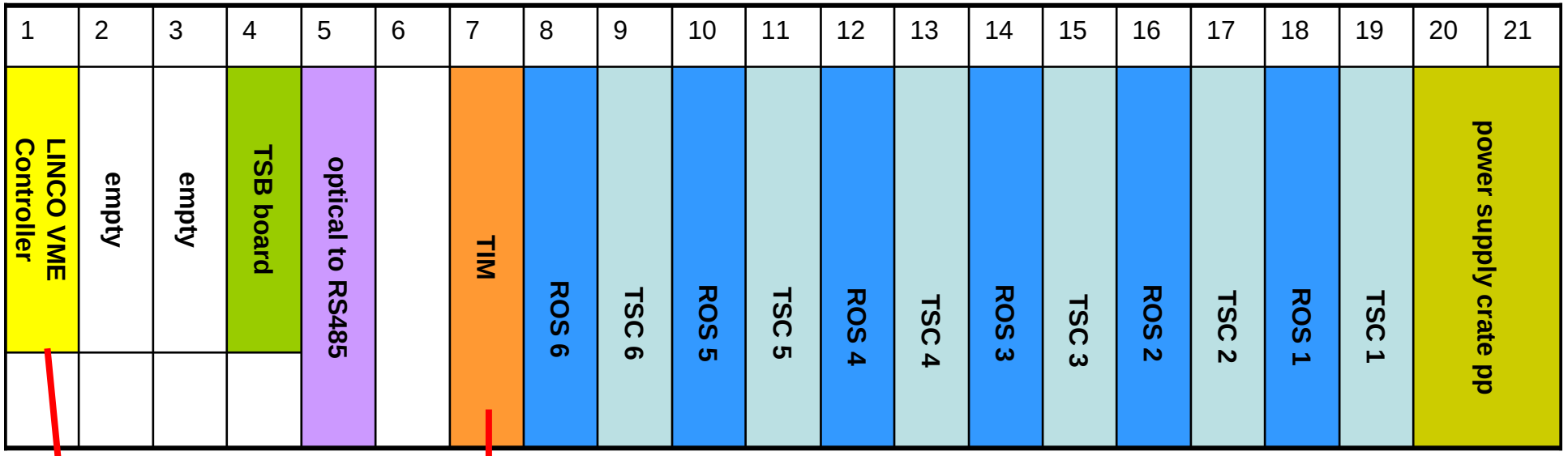
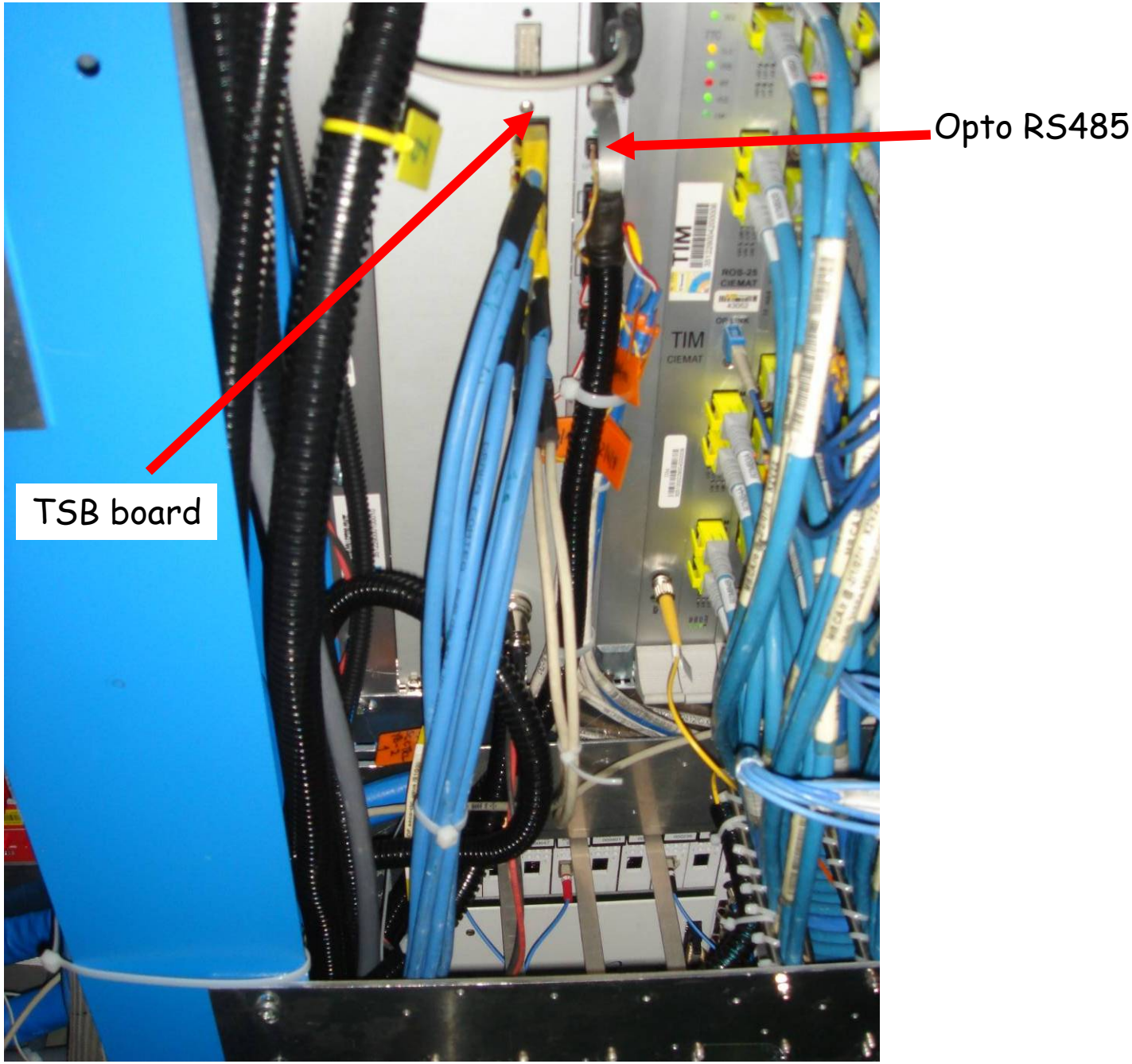
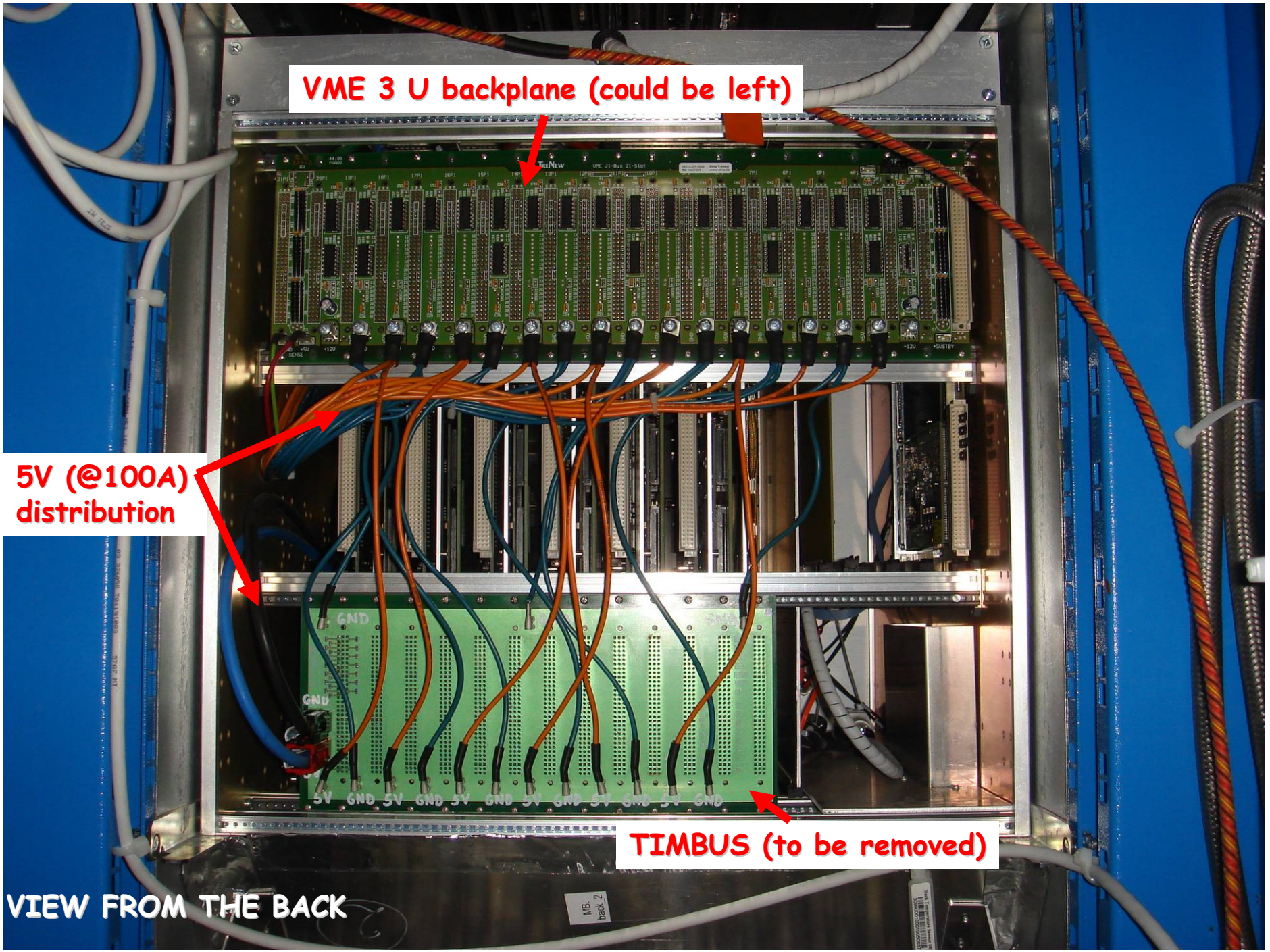
LINCO VME Controller



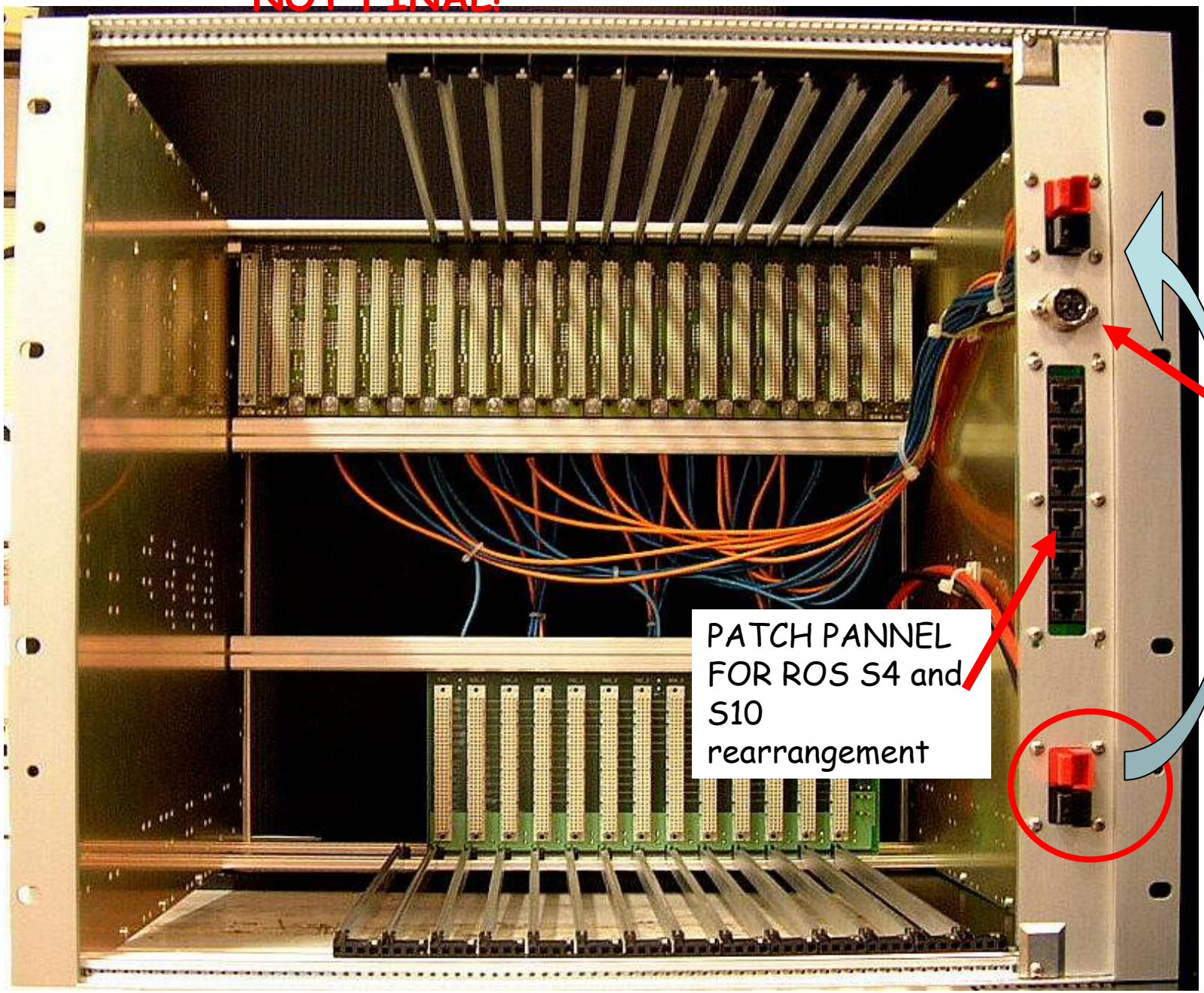

SC crate mechanics:
In principle stays, we would buy new VME crates with Power supply adapted for USC

DT TR/RO oc: In principle stays, not needed though


Opto RS485
TSB board
TIM
CIEMAT
TIM
CIEMAT


VME 3 U backplane (could be left)
5V (@100A) distribution
TIMBUS (to be removed)
VIEW FROM THE BACK

NOT FINAL!


Power connectors up here
Sensor to measure voltage drop, connected to A3100
PATCH PANNEL FOR ROS S4 and S10 rearrangement

# ROB TO ROS CONNECTIONS

| | | | SECTOR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Module offset | | ROS Channel | 1,2,3,5,6,7,8,12 | | 4 | | 9 | | 10 | | 11 | |
| 0x0 | CEROS 0 | 0 | MB1 | ROB 0 | MB1 | ROB 0 | MB1 | ROB 0 | MB1 | ROB 0 | MB1 | ROB 0 |
| | | 1 | MB1 | ROB 1 | MB1 | ROB 1 | MB1 | ROB 1 | MB1 | ROB 1 | MB1 | ROB 1 |
| | | 2 | MB1 | ROB 2 | MB1 | ROB 2 | MB1 | ROB 2 | MB1 | ROB 2 | MB1 | ROB 2 |
| | | 3 | MB1 | ROB 3 | MB1 | ROB 3 | MB1 | ROB 3 | MB1 | ROB 3 | MB1 | ROB 3 |
| | | 4 | MB1 | ROB 4 | MB1 | ROB 4 | MB1 | ROB 4 | MB1 | ROB 4 | MB1 | ROB 4 |
| | | 5 | MB1 | ROB 5 | MB1 | ROB 5 | MB1 | ROB 5 | MB1 | ROB 5 | MB1 | ROB 5 |
| 0x80 | CEROS 1 | 6 | MB2 | ROB 0 | MB2 | ROB 0 | MB2 | ROB 0 | MB2 | ROB 0 | MB2 | ROB 0 |
| | | 7 | MB2 | ROB 1 | MB2 | ROB 1 | MB2 | ROB 1 | MB2 | ROB 1 | MB2 | ROB 1 |
| | | 8 | MB2 | ROB 2 | MB2 | ROB 2 | MB2 | ROB 2 | MB2 | ROB 2 | MB2 | ROB 2 |
| | | 9 | MB2 | ROB 3 | MB2 | ROB 3 | MB2 | ROB 3 | MB2 | ROB 3 | MB2 | ROB 3 |
| | | 10 | MB2 | ROB 4 | MB2 | ROB 4 | MB2 | ROB 4 | MB2 | ROB 4 | MB2 | ROB 4 |
| | | 11 | MB2 | ROB 5 | MB2 | ROB 5 | MB2 | ROB 5 | MB2 | ROB 5 | MB2 | ROB 5 |
| 0x100 | CEROS 2 | 12 | MB3 | ROB 0 | MB3 | ROB 0 | MB3 | ROB 0 | MB3 | ROB 0 | MB3 | ROB 0 |
| | | 13 | MB3 | ROB 1 | MB3 | ROB 1 | MB3 | ROB 1 | MB3 | ROB 1 | MB3 | ROB 1 |
| | | 14 | MB3 | ROB 2 | MB3 | ROB 2 | MB3 | ROB 2 | MB3 | ROB 2 | MB3 | ROB 2 |
| | | 15 | MB3 | ROB 4 | MB3 | ROB 4 | MB3 | ROB 4 | MB3 | ROB 4 | MB3 | ROB 4 |
| | | 16 | MB3 | ROB 5 | MB3 | ROB 5 | MB3 | ROB 5 | MB3 | ROB 5 | MB3 | ROB 5 |
| | | 17 | MB3 | ROB 6 | MB3 | ROB 6 | MB3 | ROB 6 | MB3 | ROB 6 | MB3 | ROB 6 |
| 0x180 | CEROS 3 | 18 | MB4 | ROB 0 | MB4-4 (3) | ROB 2 | MB4 | ROB 0 | MB4-10 (11) | ROB 0 | MB4 | ROB 0 |
| | | 19 | MB4 | ROB 1 | MB4-4 (3) | ROB 3 | MB4 | ROB 1 | MB4-10 (11) | ROB 1 | MB4 | ROB 1 |
| | | 20 | MB4 | ROB 2 | MB4-4 (3) | ROB 4 | MB4 | ROB 2 | MB4-10 (11) | ROB 2 | MB4 | ROB 2 |
| | | 21 | MB4 | ROB 3 | MB4-4 (5) | ROB 2 | MB4-4 (5) | ROB 0 | MB4-10 (9) | ROB 0 | MB4-4 (3) | ROB 0 |
| | | 22 | MB4 | ROB 4 | MB4-4 (5) | ROB 3 | MB4-4 (5) | ROB 1 | MB4-10 (9) | ROB 1 | MB4-4 (3) | ROB 1 |
| | | 23 | MB4 | ROB 5 | MB4-4 (5) | ROB 4 | MB4-10 (9) | ROB 3 | MB4-10 (9) | ROB 2 | MB4-10 (11) | ROB 3 |
| 0x280 | CEROS 4 | 24 | MB3 | ROB 3 | MB3 | ROB 3 | MB3 | ROB 3 | MB3 | ROB 3 | MB3 | ROB 3 |
| | | 25 | SC | | SC | | SC | | SC | | SC | |

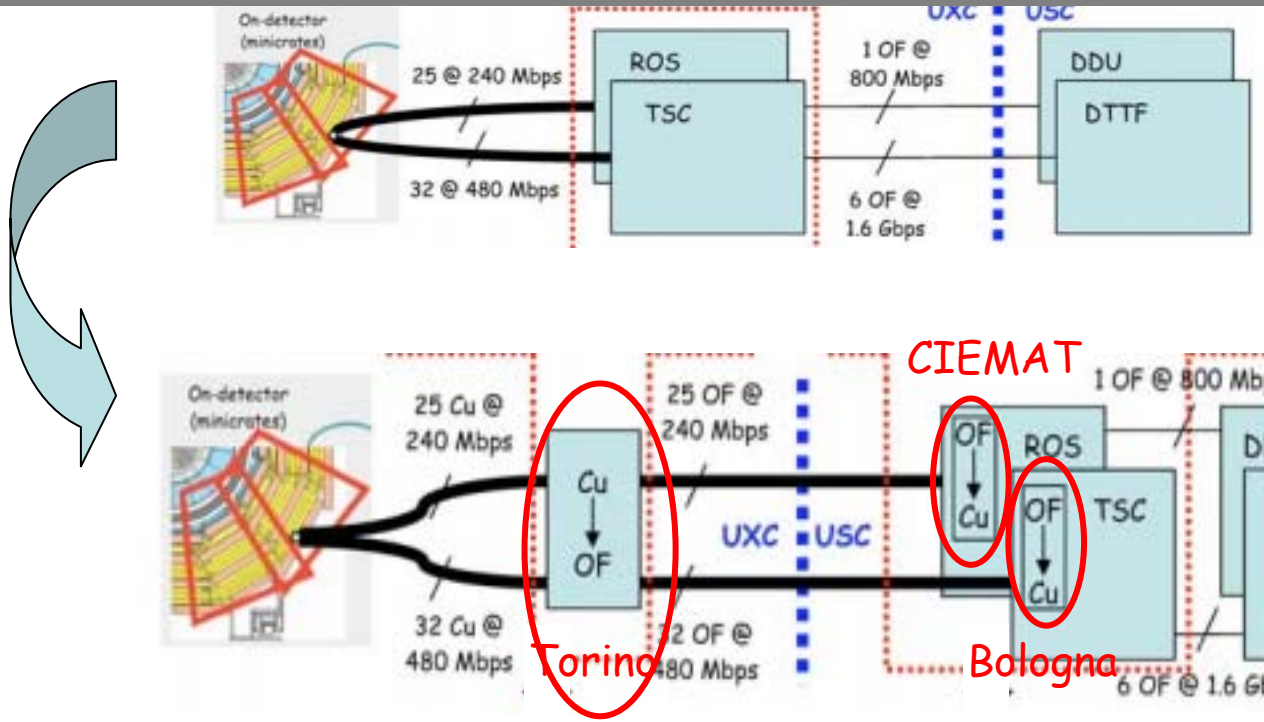
| | |
|---|---|
| MB4-4 (3) | Stands for MB4 chamber of Sector 4 closest to Sector 3. |
| MB4-4 (5) | Stands for MB4 chamber of Sector 4 closest to Sector 5. |
| MB4-10 (11) | Stands for MB4 chamber of Sector 10 closest to Sector 11. |
| MB4-10 (9) | Stands for MB4 chamber of Sector 10 closest to Sector 11. |

# Proposed Upgrade

-Relocation of DT SC electronics in the USC counting room
-Make a "simple" copper to OF conversion at SC level
-Modify input mezzanines of ROS and TSC

**MAKE AN ANALOGUE TRANSDUCER (NO SAMPLING; NO SERIALIZATION; NO MERGING)**
**L1A LATENCY HAS TO BE KEEPT MINIMAL!!**

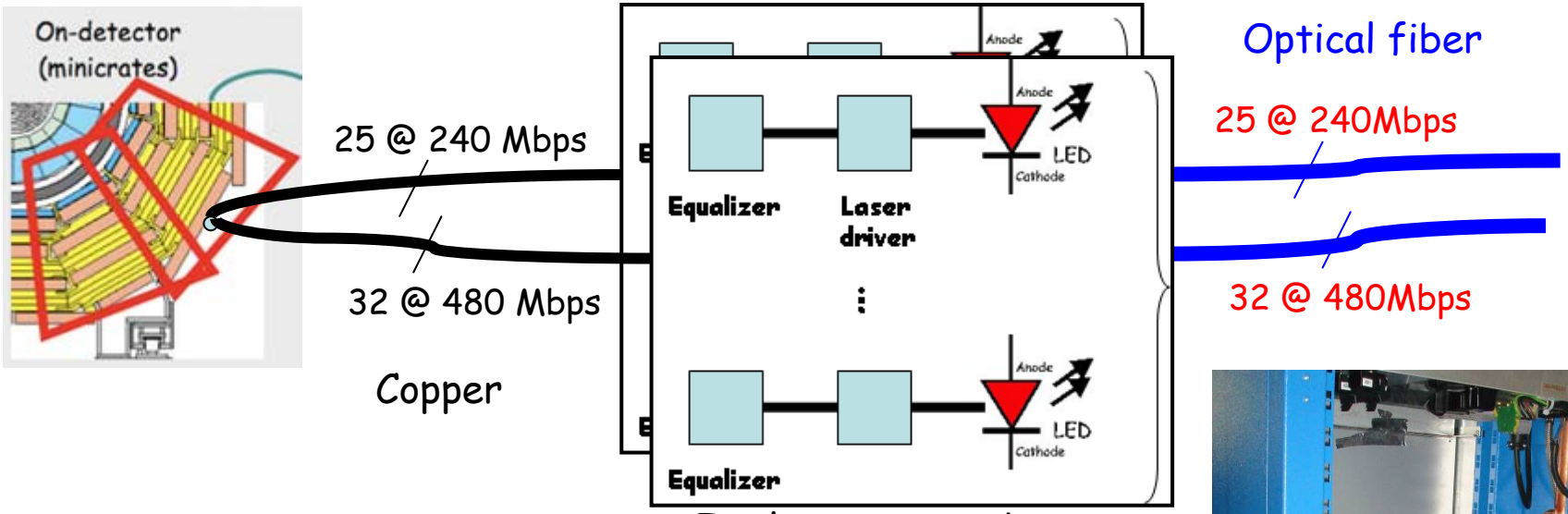
Low impact modifications: compatible with present system and with possible future upgrades



# Cu to OF conversion

Present proposal is to make a 1 to 1 channel Cu-OF

(Present links are copper based which length cannot be increased without compromising its reliability)




- Plus few components for bias setting (DAC) and monitoring.
- OF could be extracted from the back of the SC crate
- VME interface at tower rack may not be needed
- Power can be extracted from present power supplies

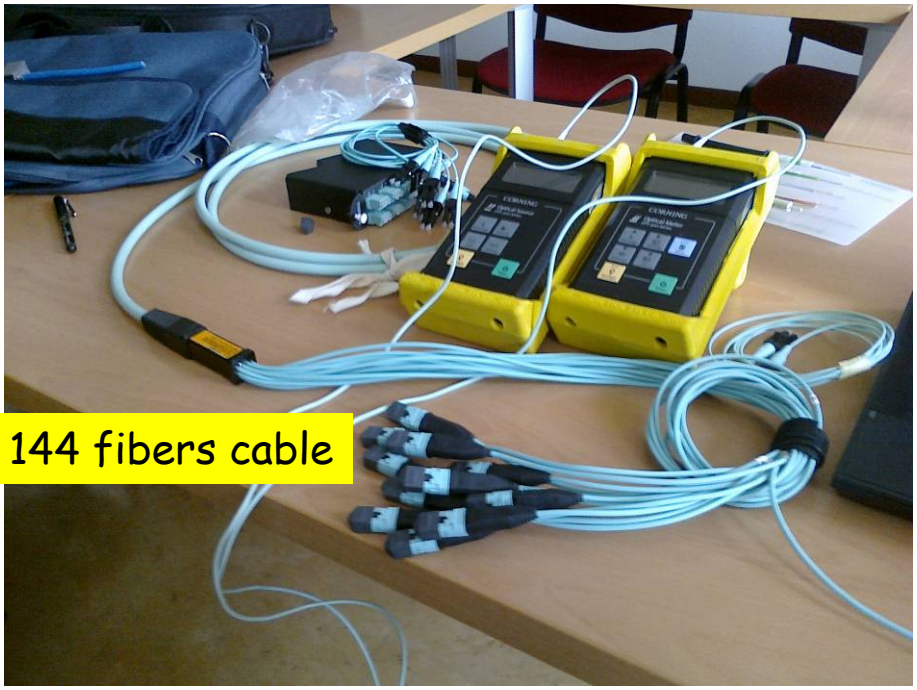
# Installation of fibers

Number of links between Minicrates and SC electronics

| | Per Sector | Per Wheel | Total |
|---|---|---|---|
| **ROB to ROS** | 25 | 300 | 1500 |
| **SB to TSC** | 32/40* | 400 | 2000 |
| **Total** | 57/65 | 700 | 3500 |

*(S4 and S10 have 5 DT chambers each instead of 4)

Large number of fibers



144 fibers cable

4 of these cables per SC crate
(40 cables in total, large number of spare fibers)

Total cross section needed around 100 $cm^2$

One possibility that looks promising:
MTP of 12 channels each. Cables of 12 MTP ribbons (144 OF/cable).

## •PER SECTOR

| | | |
|---|---|---|
| ROS | 3 MTP/sector = 36 links | 11 spares (44%) |
| TSC-32 | 3 MTP/sector = 36 links | 4 spares (16%) |
| TSC-40 | 4 MTP/sector = 48 links | 8 spares (32%) |

## •PER SECTOR COLLECTOR CRATE

Assuming cables of 12 ribbons (and separating completely RO and TRG):

| | | | |
|---|---|---|---|
| ROS | 3 MTP * 6 ROS = 18 MTP ribbons | 2 of 144-cables = 24 MTP | 6 spares (33%) |
| TSC | 3 MTP * 5 TRG-32 + 4 MTP * 1 TRG-40 = 19 MTP ribbons | 2 of 144-cables = 24 MTP | 5 spares (26%) |

TOTAL ROS+TRG => 4 cables-144 / SC crate

## •PER WHEEL

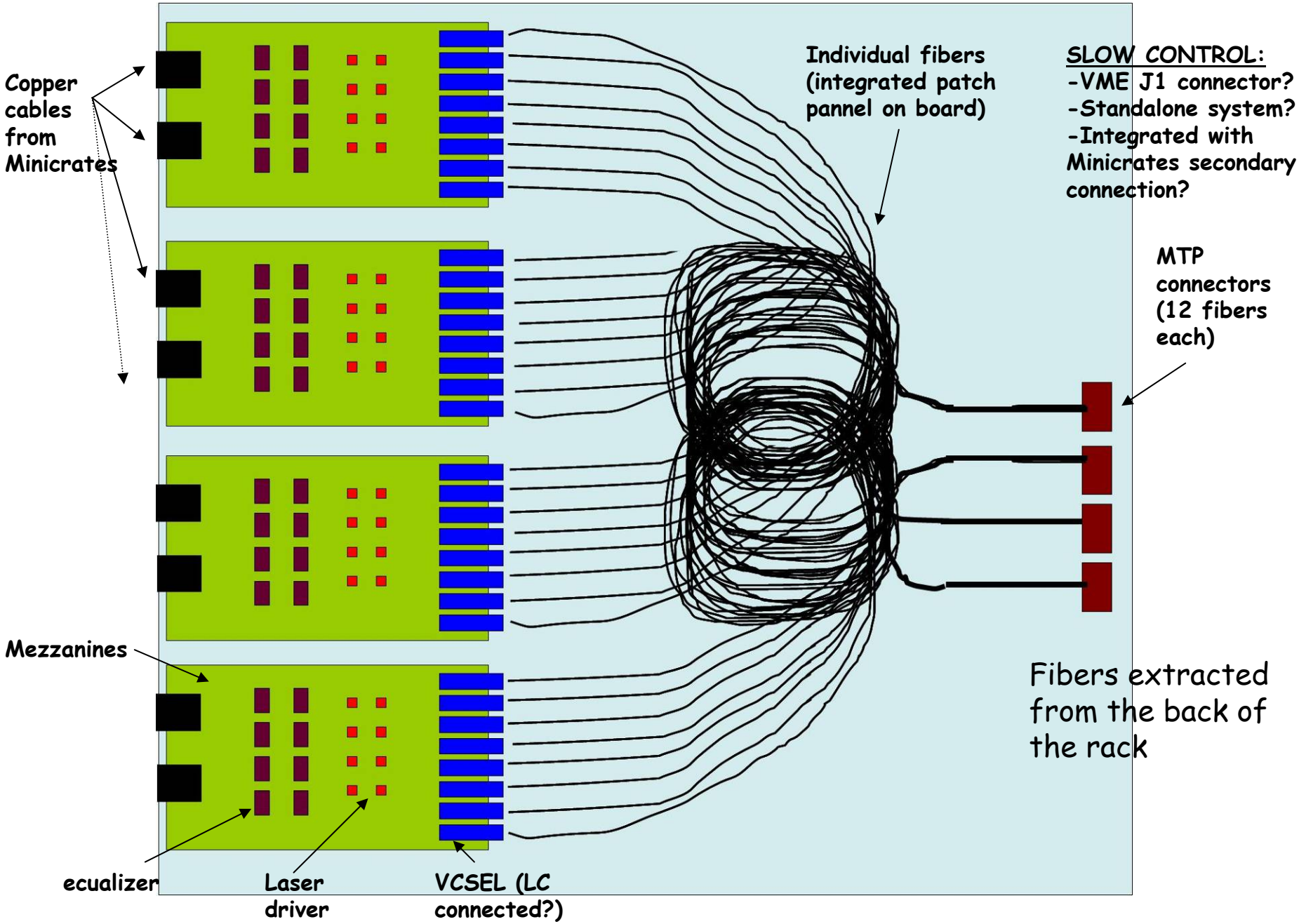
TOTAL ROS => 4 cables-144 / WHEEL
TOTAL TRG => 4 cables-144 / WHEEL
TOTAL ROS+TRG => 8 cables-144 / WHEEL

## •TOTAL

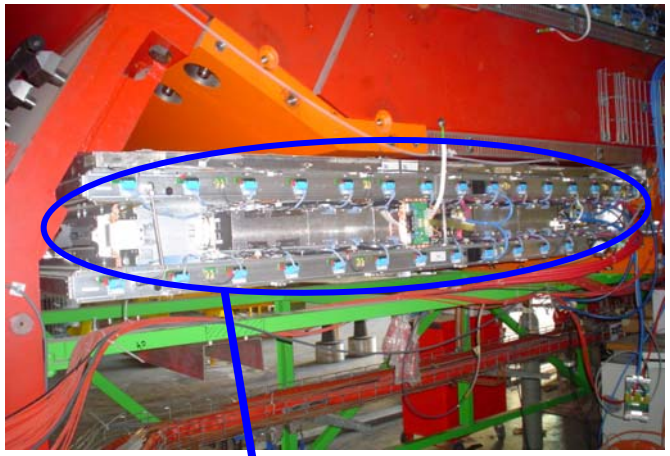
TOTAL ROS => 20 cables-144
TOTAL TRG => 20 cables-144
TOTAL ROS+TRG => **40 cables-144**

My proposal for a CUOF board (for a TSC-32 links):

9U format VME

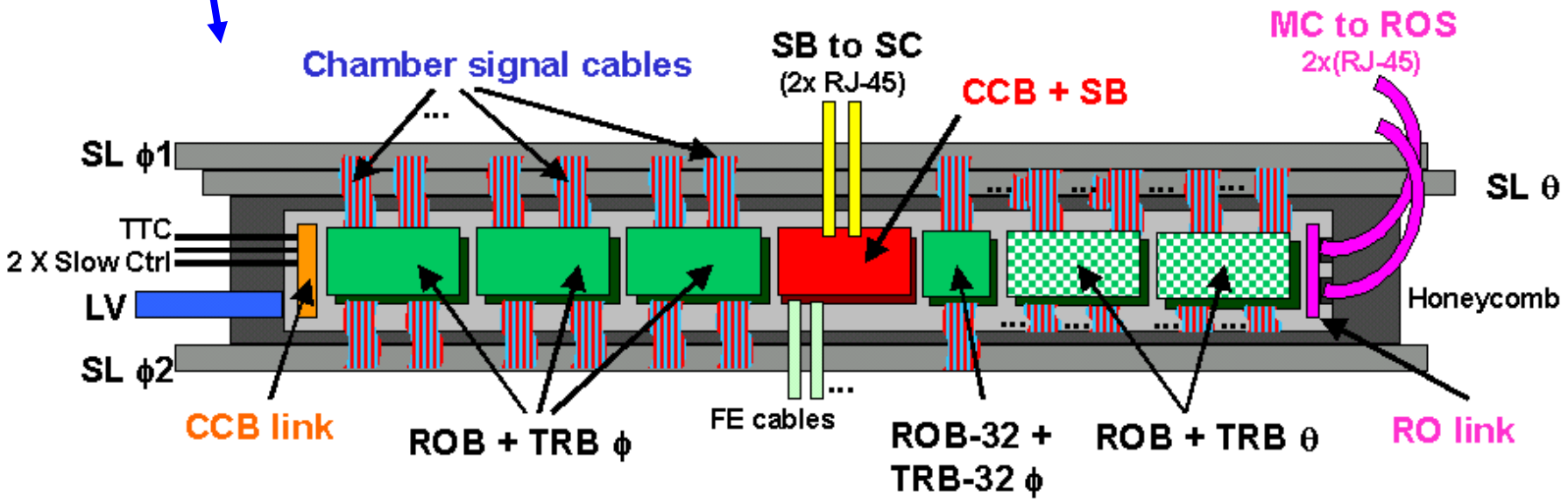


# Minicrate



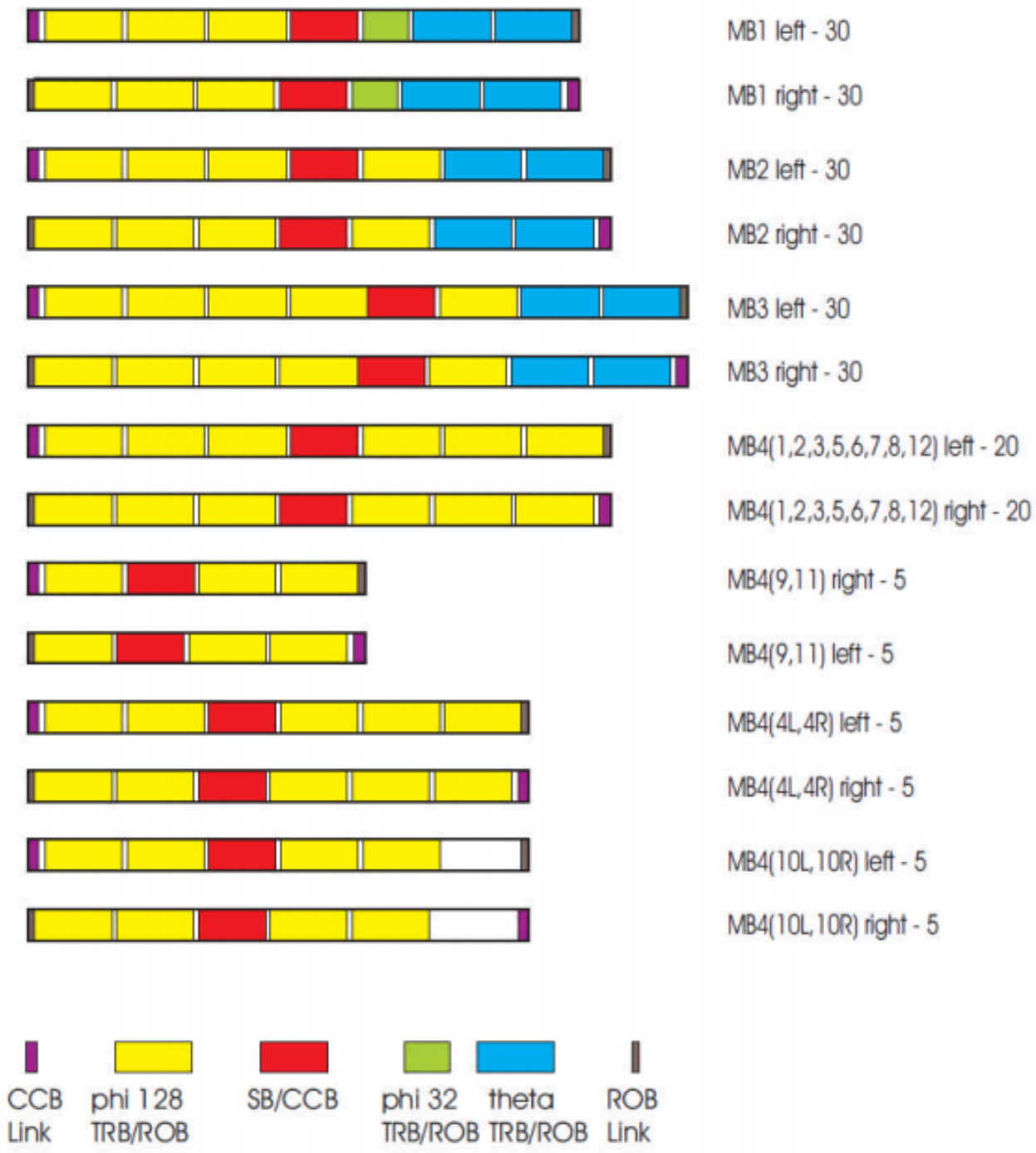
**Attached to the DT Chambers it contains the first level read-out, trigger and full chamber control electronics.**

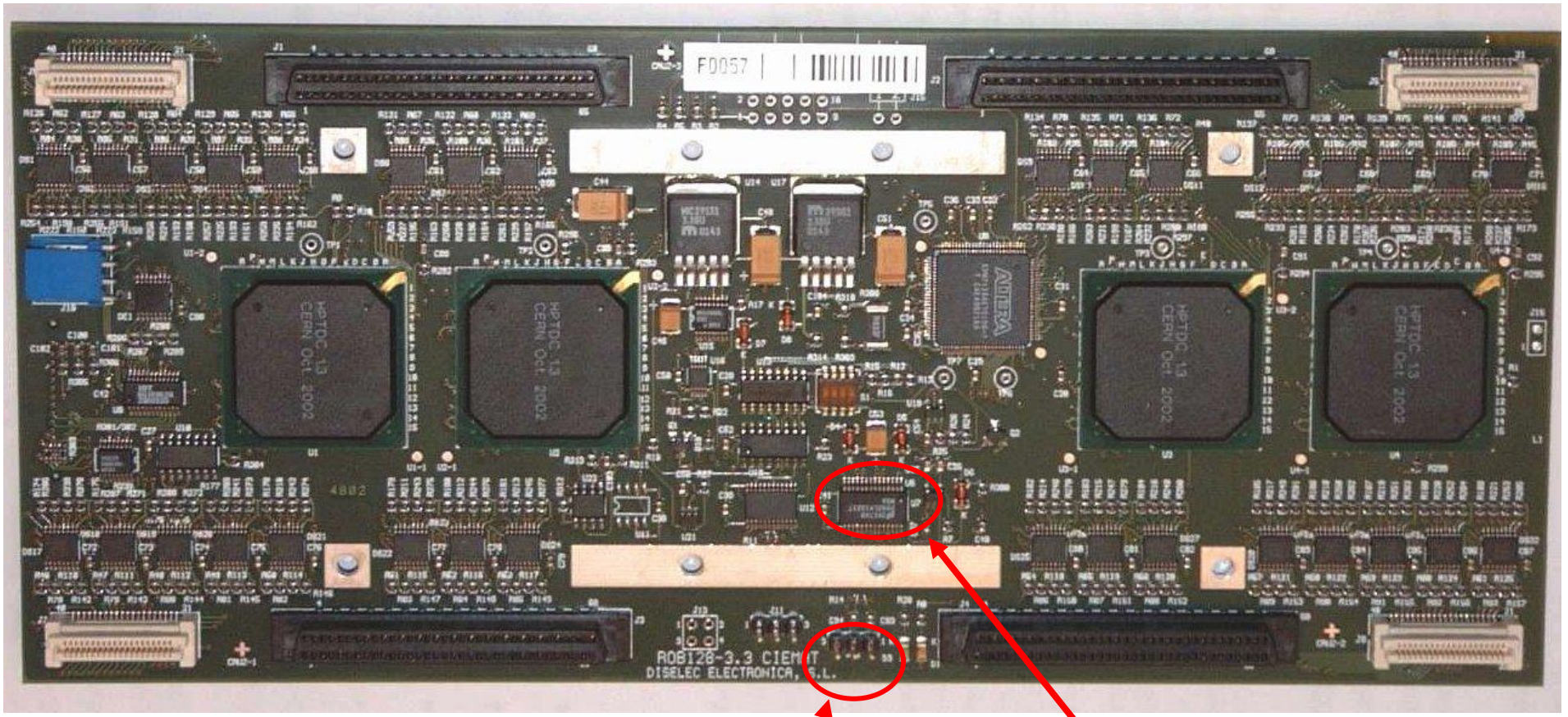
- **CCB: Full chamber control and monitoring: configures, sets thresholds, reads temperatures, etc.**
- **CCBlink: Connects the CCB to the external DT DCS system.**
- **TRB: Searches track segments and performs bunch identification.**
- **SB: Performs track selection and transmits to TSC.**
- **ROB: Time digitalization of signals coming from the chambers.**
- **ROLINK: Collects outputs from ROBs and sends it to the ROS.**




**New Minicrate firmware means new CCB firmware.**

# MINICRATE TYPES





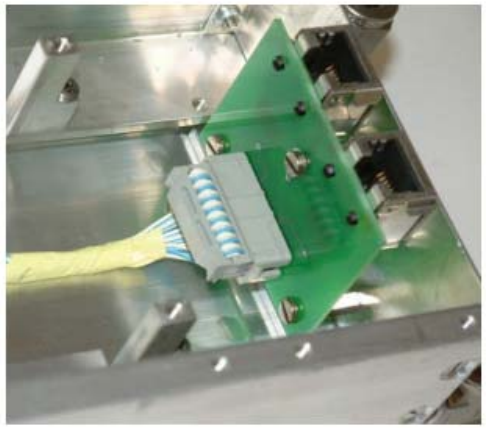
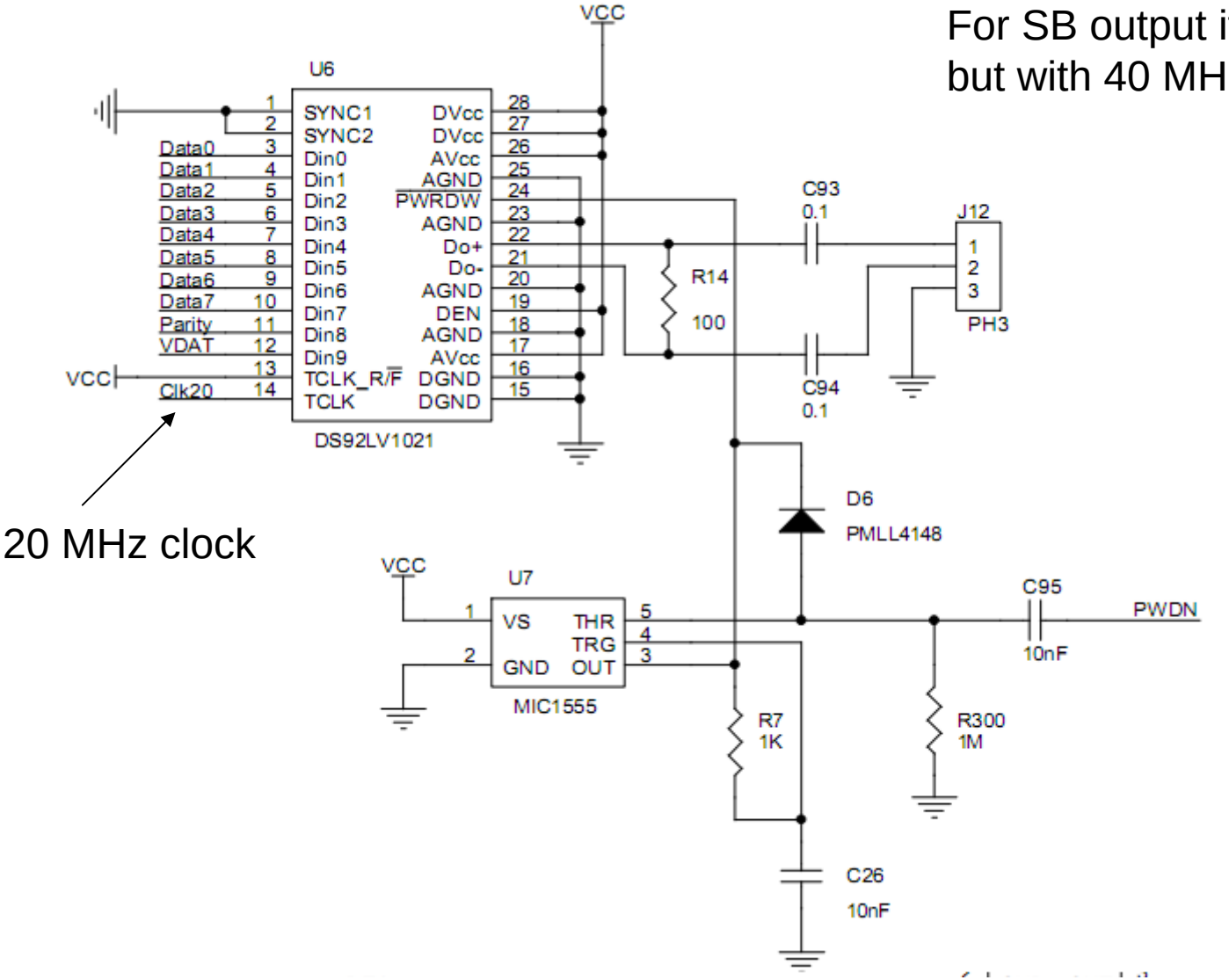



**Figura 4.20:** Imagen de la tarjeta ROLINK instalada en el Minicrate.

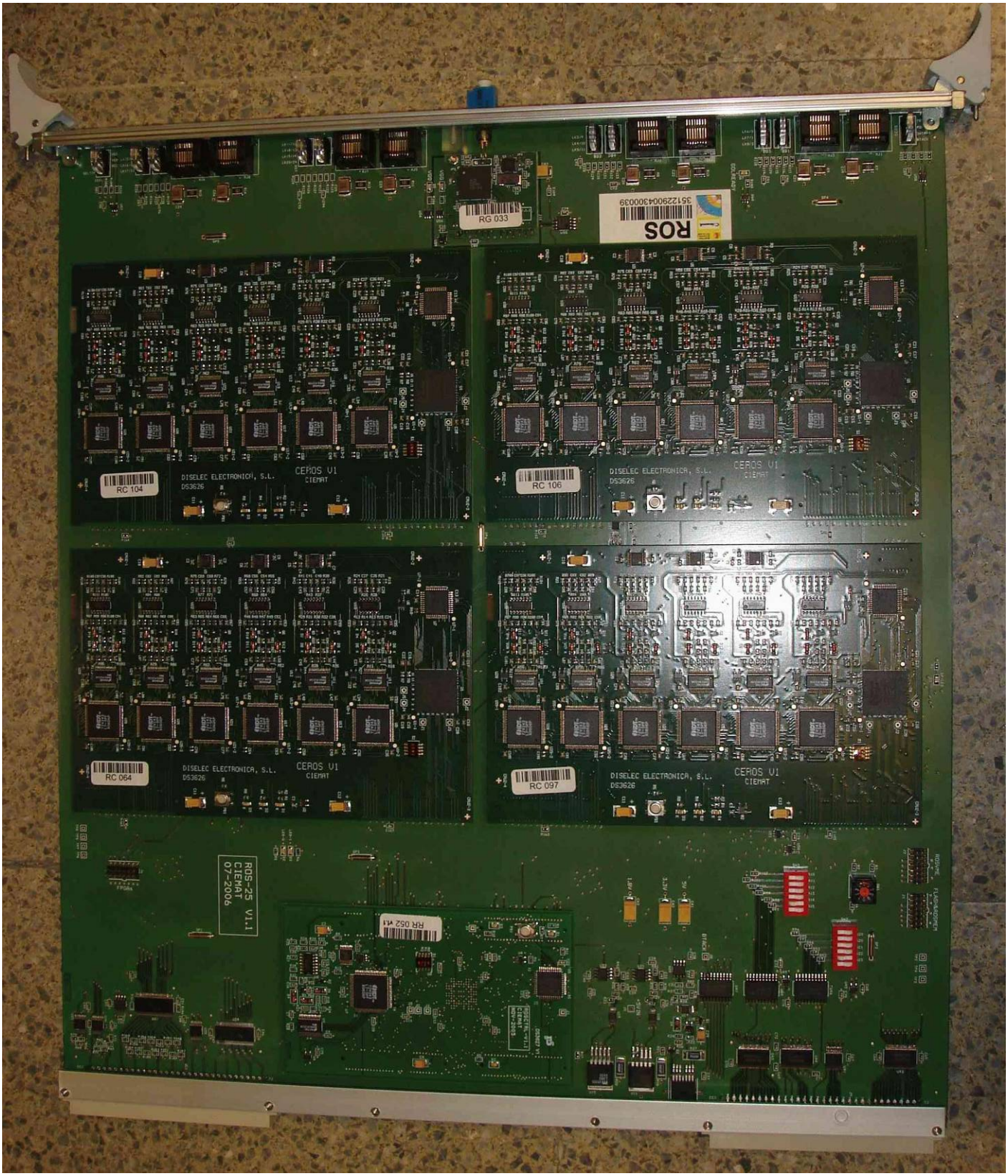
# PRESENT ROB OUTPUT

For SB output it may be similar but with 40 MHz sampling clock

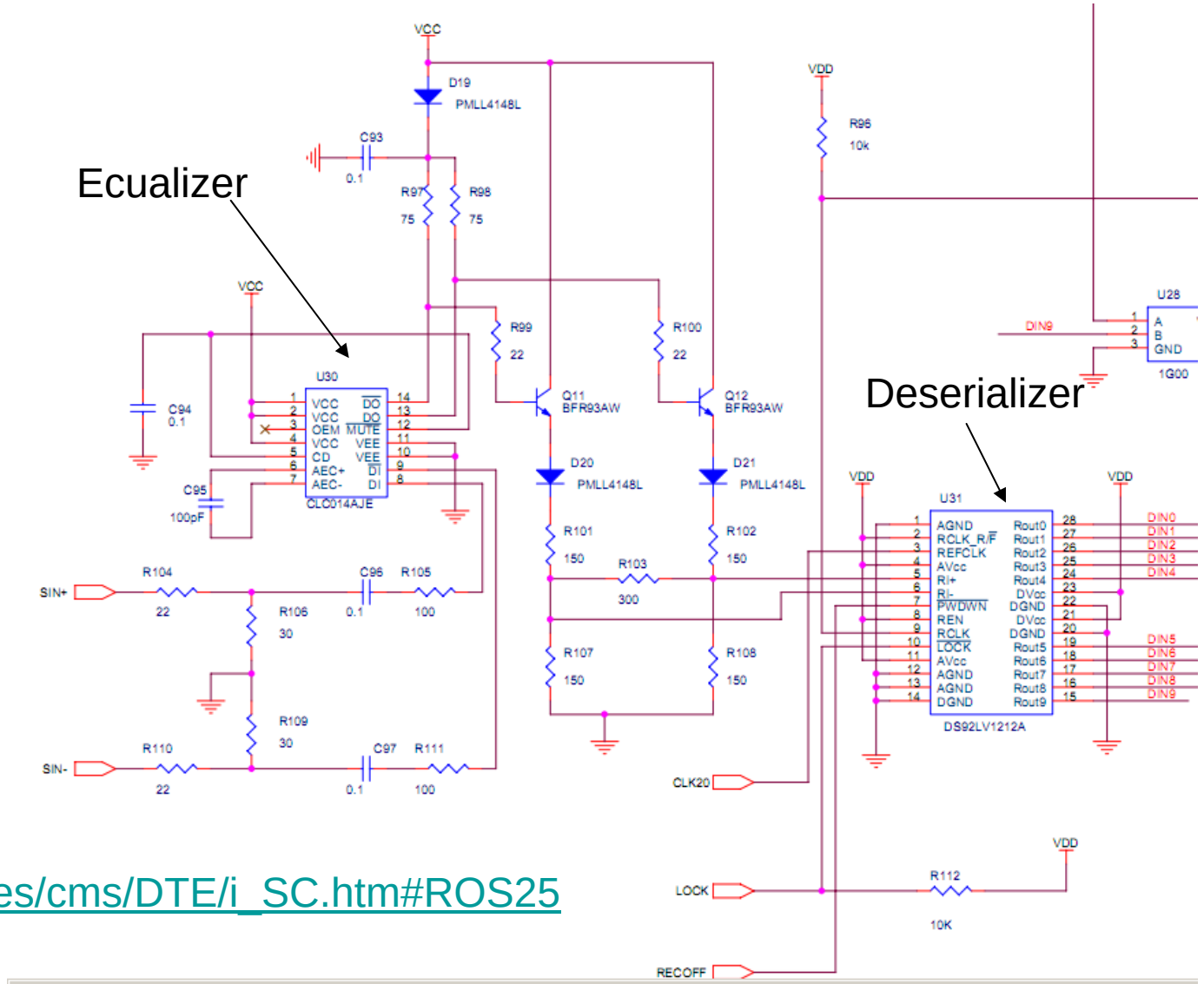



20 MHz clock

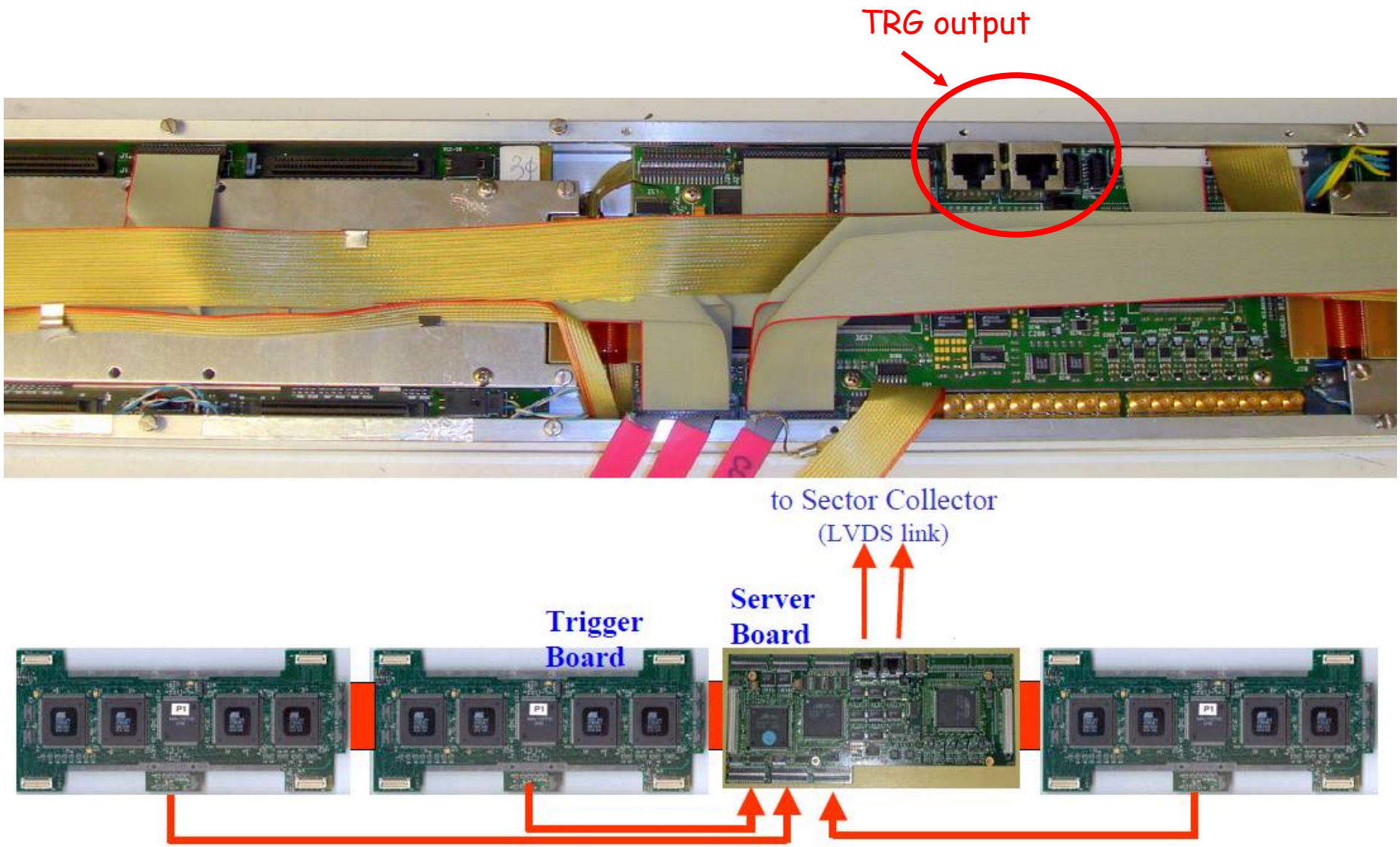
http://wwwae.ciemat.es/cms/DTE/idoc.htm#ROB
(ROB schematics)


RG 033
ROS
RC 104
DISELEC ELECTRONICA, S.L.
DS3626
CEROS V1
CIEMAT
RC 106
DISELEC ELECTRONICA, S.L.
DS3626
CEROS V1
CIEMAT
RC 064
DISELEC ELECTRONICA, S.L.
DS3626
CEROS V1
CIEMAT
RC 097
DISELEC ELECTRONICA, S.L.
DS3626
CEROS V1
CIEMAT
ROS-25 V1.1
CIEMAT
07-2006

# PRESENT ROS INPUT

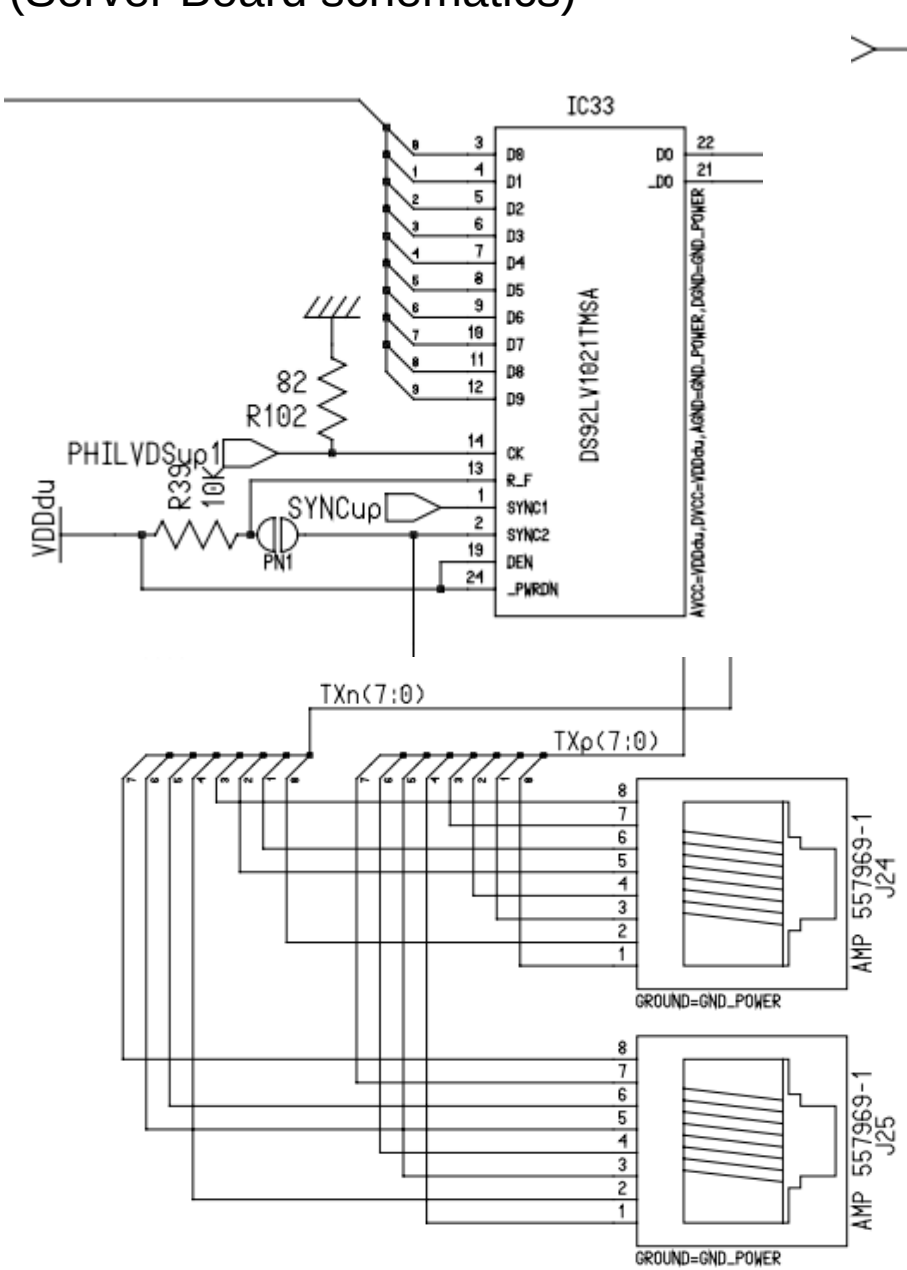


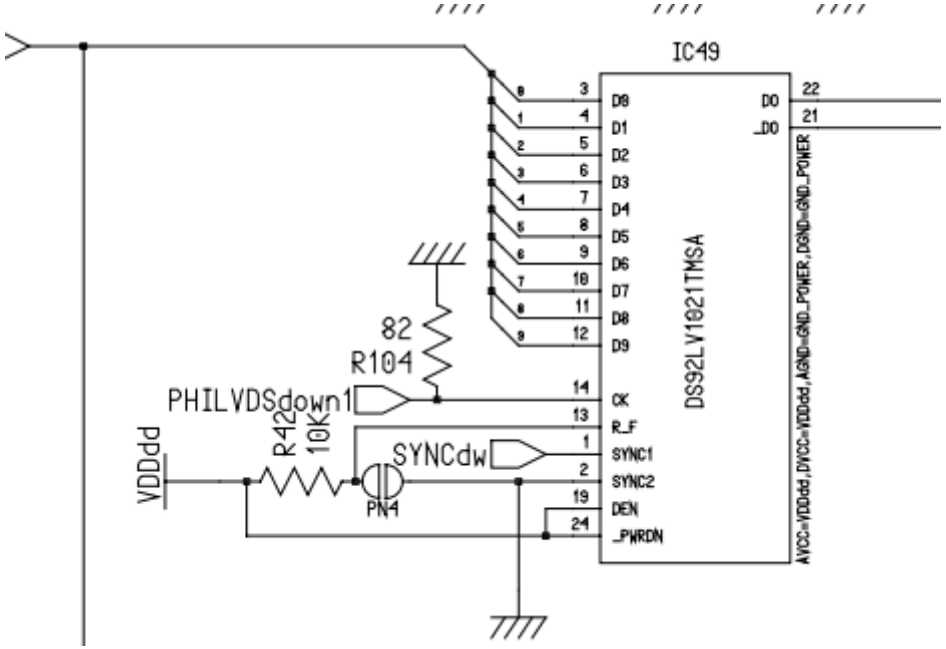

http://wwwae.ciemat.es/cms/DTE/i_SC.htm#ROS25
(ROS schematics)


TRG output
to Sector Collector
(LVDS link)
Server
Board
Trigger
Board

http://www.pd.infn.it/~caste/software.htm

(Server Board schematics)




Trigger out put from the Minicrates
(8 LVDS links/Minicrate)

TSC board in SC crate

## CU-OF REQUISITES SUMMARY:

-B field ~ 0.04 Tesla
-Neutron fluence ~ 4 $10^{10}$ $cm^{-2}$
-Charged particle fluence ~ $10^{8}$ $cm^{-2}$
-Integrated dose 0.4 Gy
-Power supply 5.2 V (max A3100 output 8V, but to be verified with other electronics in SC crate)
-Power consumption < 1kW per rack (the lower the better)
-Vertical air flow

-In principle, not TTC (Timing Trigger and Control) interface needed, but you tell me.
-Slow Control: up to you, to be discussed with INFN Padova (F. Gonella, A. Triossi, S. Ventura and M. Bellato)

# DT SC consolidation: Plan

PRESENT PLAN

1. Fibers installation (2012-2013?):
   - -Requires long access time
   - -Needs to be done simultaneously for all the fibers

2. Scaled installation at any time (winter shutdowns). Minimal unit is half a wheel.
   - -Modification of TSC and ROS input mezzanines
   - -Relocation of SC electronics in USC

3. New DTTF by 2016 (?)

Estimated cost 800 k€ (+600k€ if ROS and TSC are totally redesigned)

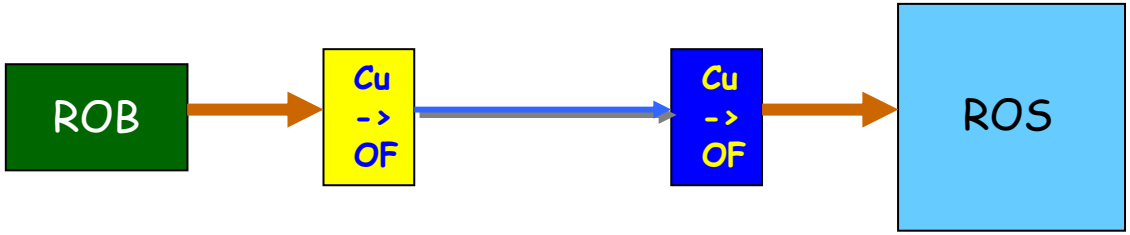
# First tests

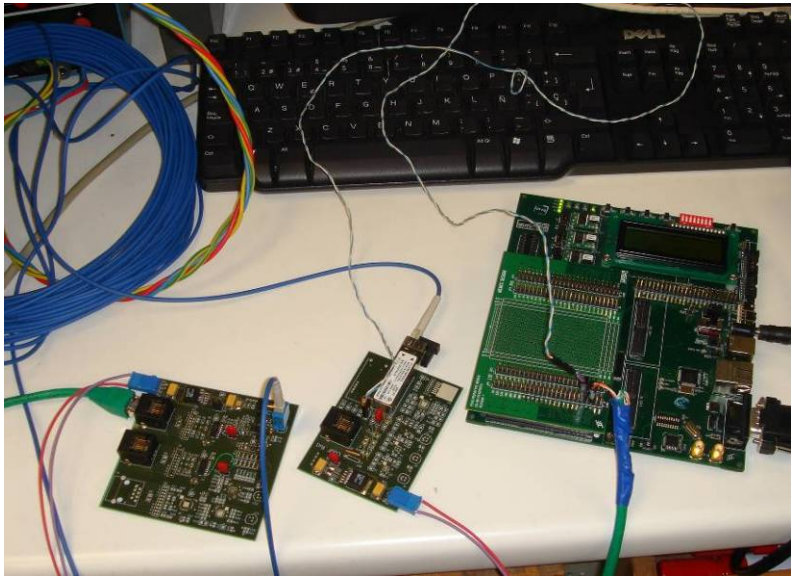
-Two prototype boards to perform Cu-to-OF and OF-to-Cu conversion have been developed at Ciemat.

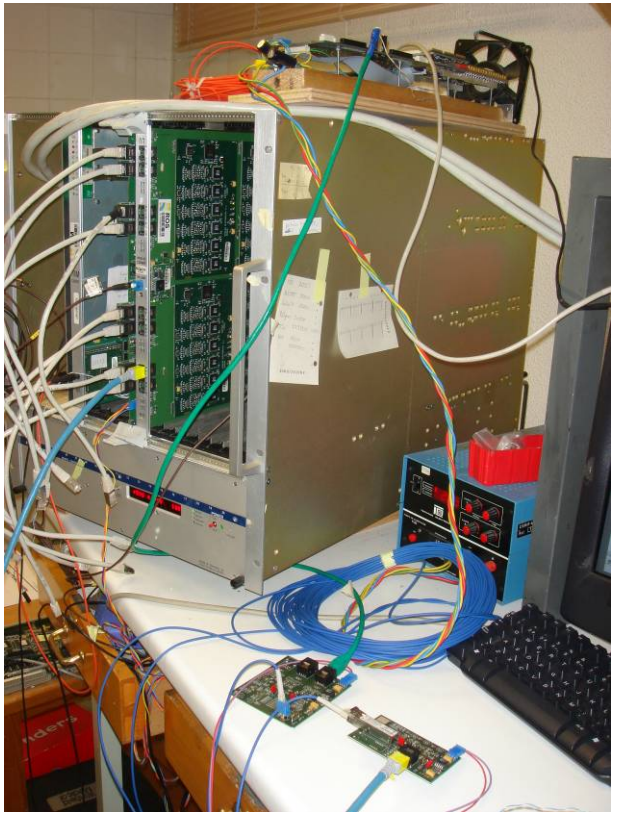
-With these boards we intend to qualify different devices at the market.

-First tests are positive both in standalone and in the integrated chain with ROB and ROS

-More studies are ongoing mainly in the reliability of the link





# DT SC Consolidation: Motivation

Proposed upgrade is not motivated by the physics performance but by the fact that aging and other risks may jeopardize detector operation and contribute to an accelerated degradation

**Magnetic fields (40 mT) => tangential turbines**
SC crate power consumption (aprox 1 kW) is already marginal for CMS cooling system in the cavern. Temperature of some boards reach 45°C.
Turbines aging will lead to accelerated aging of the system and increased failure rate.

**Radiation doses 0.2 Gy per year (charged particle fluxes 20 $cm^{-2}$ $s^{-1}$)**
SC boards include large amount of logic, sensitive to SEU. Higher L => higher SEU rate.
Important constrain for future upgrades.

**Limited access tighten to LHC technical stops and radiation protection issues**
In case of failure, it can take easily one week until access to the cavern is granted.
Impact of failures in the detector can be VERY LARGE:

| Part failing | Affected region | %DT affected |
|---|---|---|
| LINCO | Half a wheel in trigger and read-out | 10% |
| TIM | Half a wheel in trigger and read-out | 10% |
| ROS | 1 Sector in the readout | 1.7% |
| TSC | 1 Sector in the trigger | 1.7% |

# DT SC Consolidation: Motivation

We think this modification is a necessary change to allow future modifications that are forced to happen in a tight LHC schedule and happen simultaneously with a system that is already working

-Compatibility between present and future systems is very advisable (if not mandatory)

-LHC shutdowns tight considerably any change in UXC (i.e. installing fibers, replacing modules in UXC, etc) Development of a new system in UXC has to be planned to match this shutdowns.

-In order to commission an new system we are not going to have as much time as we have now, plus we may have less manpower

-A 1 to 1 channel conversion allow us to have in USC exactly what we have in UXC without adding extra L1A latency (serialization, etc), so it gives a lot of flexibility for future improvements

-For phase 2 the plan is not decided yet, but we should aim to minimize artificial frontiers if not needed (i.e. multiplexing in same link different type of information), having in USC what you have in the detector opens yourself to basically all the approaches you can think of.

-Very likely, time will determine what is more convenient and we can only foresee how to make the system more reliable until the best option to change appears without adding more limitations