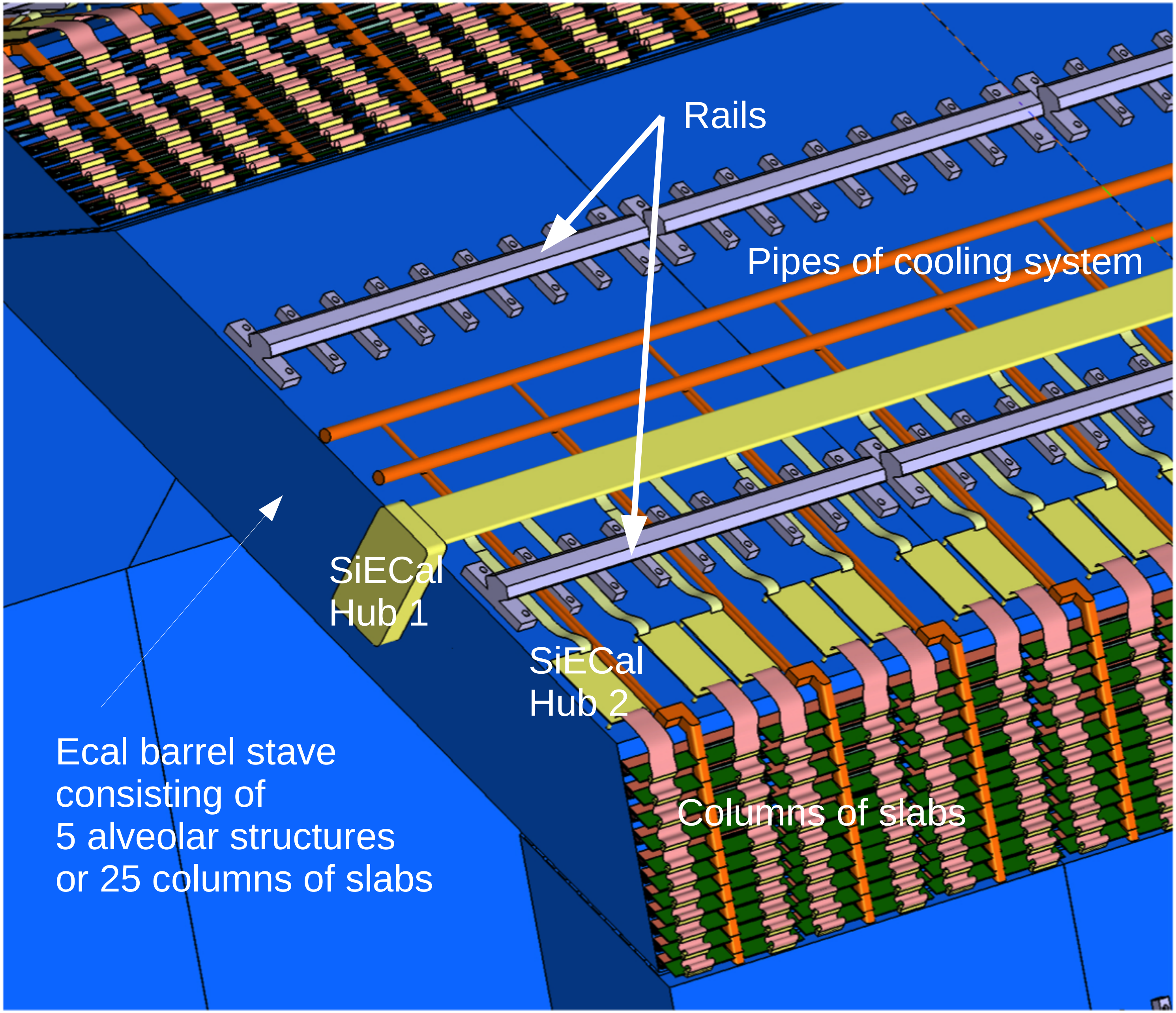
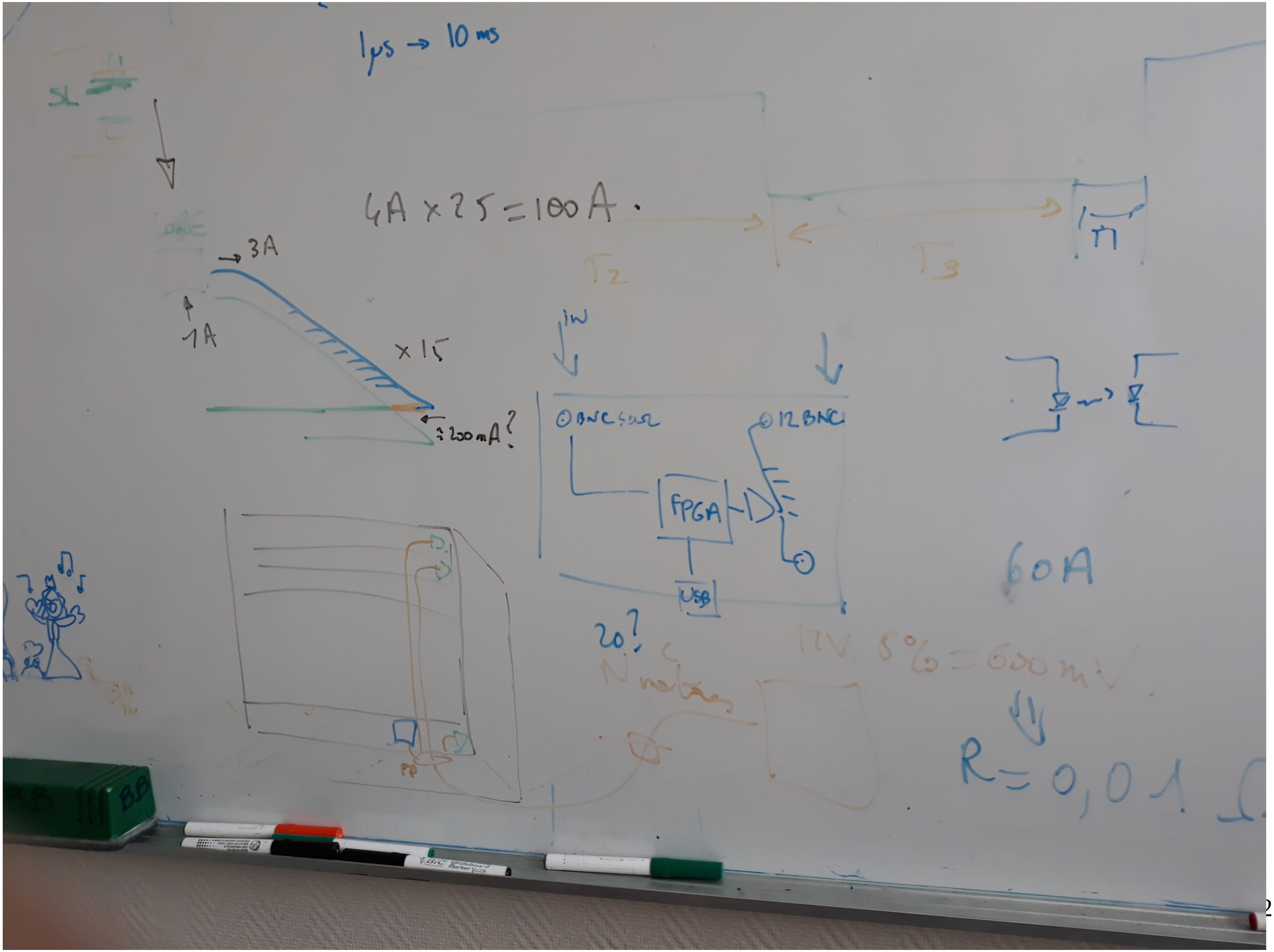
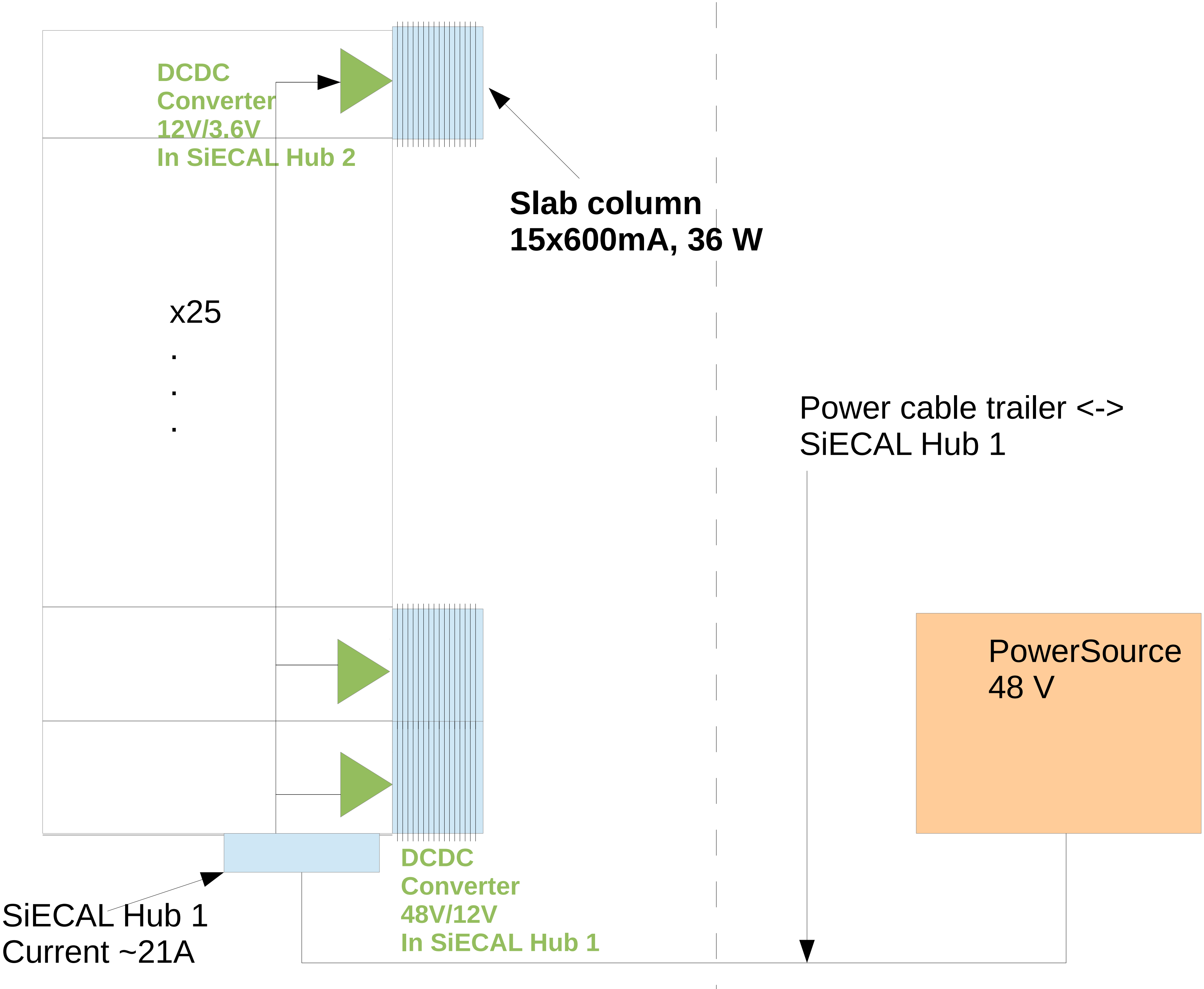

Rails
Pipes of cooling system
SiECal
Hub 1
SiECal
Hub 2
Ecal barrel stave
consisting of
5 alveolar structures
or 25 columns of slabs
Columns of slabs

Brainstorming – Dominique/Roman



Scheme of LV power supply for a stave



Scheme of LV power supply for a stave

0) Prologue: Specific Resistance of Copper rho = 0.0171 [Ohm x mm^2/m]

1a) The (continous) current consumption of a column of slabs is driven

i) by the consumption of the SL-Boards is (at approx. 4V): I_{SL} = 200 mA => 400 mA/slab

ii) by the charging current for the capacitances.
The inrush current will be limited to $I_{C,max}$ = 100mA/layer. However, at $t>t_0$ the current will drop progressively according to $I=(U_B/R)\mathrm{x}\exp(-t/RC)$ with U_B = Voltage of power source and R=Resistance to limit the inrush current, e.g for U_B = 4V, $I_{C,max}$ = 100mA => R=50Ohm

1b) In this scenario it follows that the <u>maximal</u> consumption of a slab is

Current: $I_{S,max}$ = 2x(200mA + 100mA) = 600 mA

Power: $P_{slab} = P_{SL} + P_{RC}$ = 2x(4Vx0.2A + 4Vx0.1A) = **2.4W** (again this drops as the capacitances get charged)

Power consumption of a column of slabs = 15x2.4 W = **36 W**

1c) The 4V for SL-Board and capacitance charging is provided by 12V/4V DCDC Converters that sit in Hub2. This hub hosts also the data concentrator cards and that by itself consumes around 5 W. These 5 W add to the 36 W above, leading to a total power consumption of a slab column of 41 W.

Scheme of LV power supply for a stave

1) The total power consumption of a stave 41 W (=25 columns) is about
25 x 41W =1000 W

2) These 1000W have to be provided by the main power supply of 48 W from which it follows that current drawn from the power supply is 100
1000W/48V = 21 A

These 21 A arrive at the SiECAL Hub 1

3) According to a survey on the web 21 A require a cable with a cross section of about 1.5 mm^2 maybe 2.5 mm^2 .The voltage drop per meter on such a cable at 21 A is

ΔU = (0.0171/1.5)Ohm x 21A = 0.24 Volt => ~5 Volt after 20m in case of 1.5 mm^2
with a thermal dissipation of 0.24Vx21A ~ 5W/m
ΔU = (0.0171/2.5)Ohm x 21A = 0.14 Volt => ~3 Volt after 20m in case of 2.5 mm^2
with a thermal dissipation of 0.14Vx21A ~ 3W/m
ΔU = (0.0171/4)Ohm x 21A = 0.09 Volt => ~1.8 Volt after 20m in case of 4 mm^2
with a thermal dissipation of 0.09Vx21A ~ 2W/m

Concerning the cable thickness we need to find a comprimise between material budget and thermal dissipation

=> Propose to choose 2.5 mm^2 for the time being (requires coordination with other detector components)

“External” Material budget on cables

i.e. Cables arriving at SiECAL Hub 1

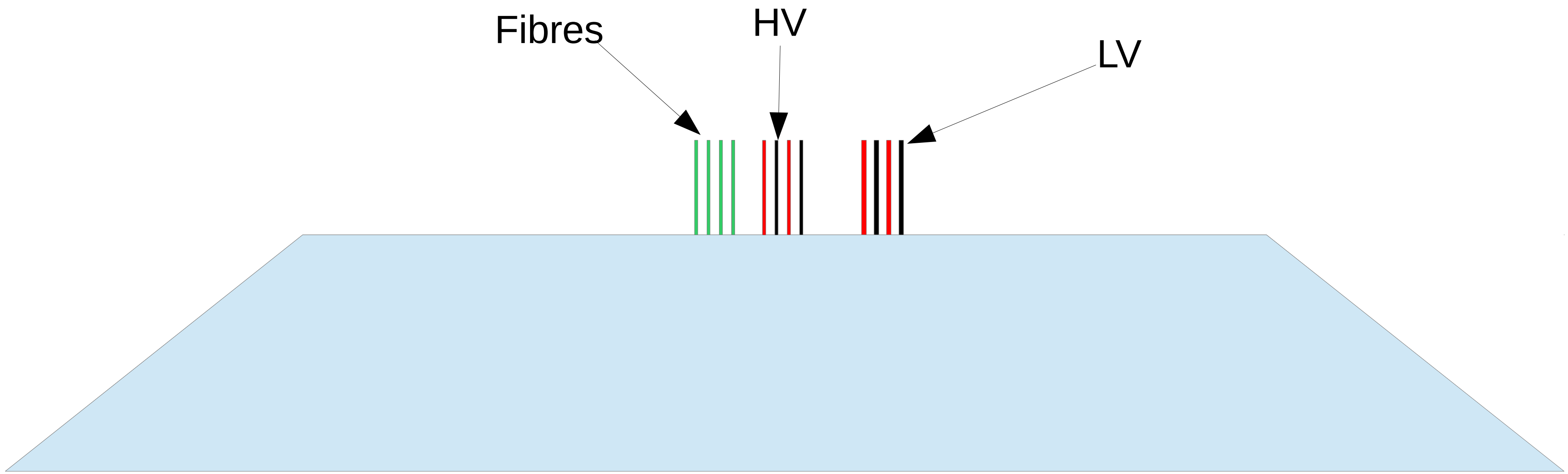
1) A copper cable of 2.5mm^2 has a diameter of about 1.8mm
   The copper cables for the LV will occupy a space of about 7.2x1.8 mm^2
   This assumes one cable for the ingoing current and another one for the return current (x2 for redundancy)

   Remark: The radiation length of copper is 14.36 mm

2) The budget added by the HV can be neglected (Current << 1A)

3) There will/may be also optical fibres for data transfer and clock distribution
   Let's assume four including redundancy
   The additional material budget is however negligible

“External” Material budget on cables – Simple Drawing



- Not to scale!!!

- To be turned into a professional drawing

Backup

http://www.learnabout-electronics.org/PSU/psu31.php

https://www.maximintegrated.com/en/app-notes/index.mvp/id/2031

Scheme of LV power supply for a stave – On DCDC Converters

... a poor man's point of view

- The advantage of a DCDC converter is that is realises the step down of the voltage **without** ohmic losses (in contrast to a “simple” linear regulator)

- From a “crash course” on DCDC converters I have learned that energy is stored in an inductor during time t_{on} and released during a time t_{off}

  The output of a (Buck) DCDC Converter is $V_{out} = V_{in} \times t_{on}/(t_{on} + t_{off})$

  The duty cycle V_{out}/V_{in} determines the average current that is drawn from the power source V_{in}

- Ay each layer the voltage 4V is available from a 12V/4V DCDC Converter. The total current of a layer is 200mA (regard SL-Boards only for simplicity)

- Therefore the average current drawn from the power source is in this case (4/12)x200mA = 66mA