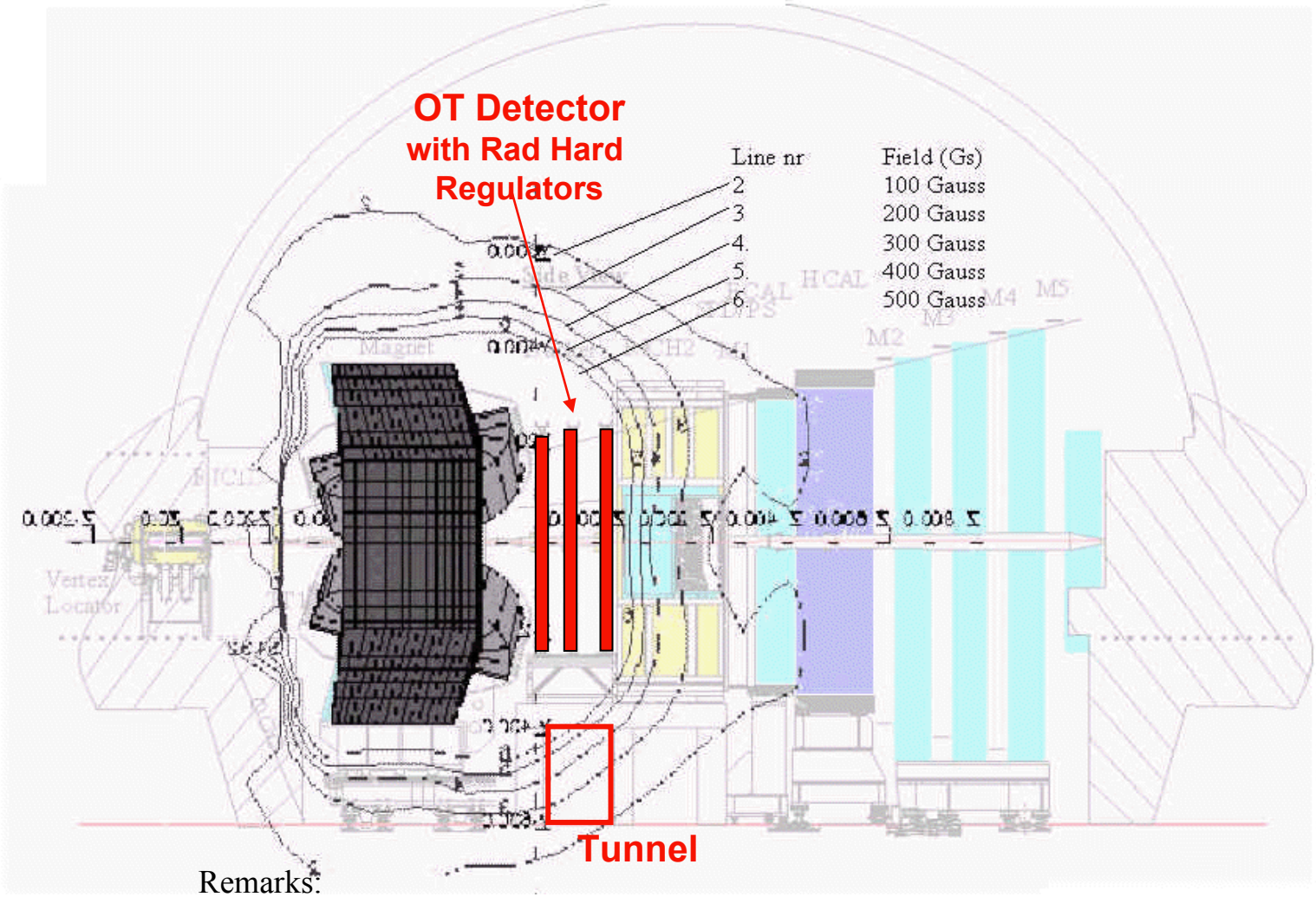
Low Voltage Power Supply Systems for the LHCb Outer Tracker

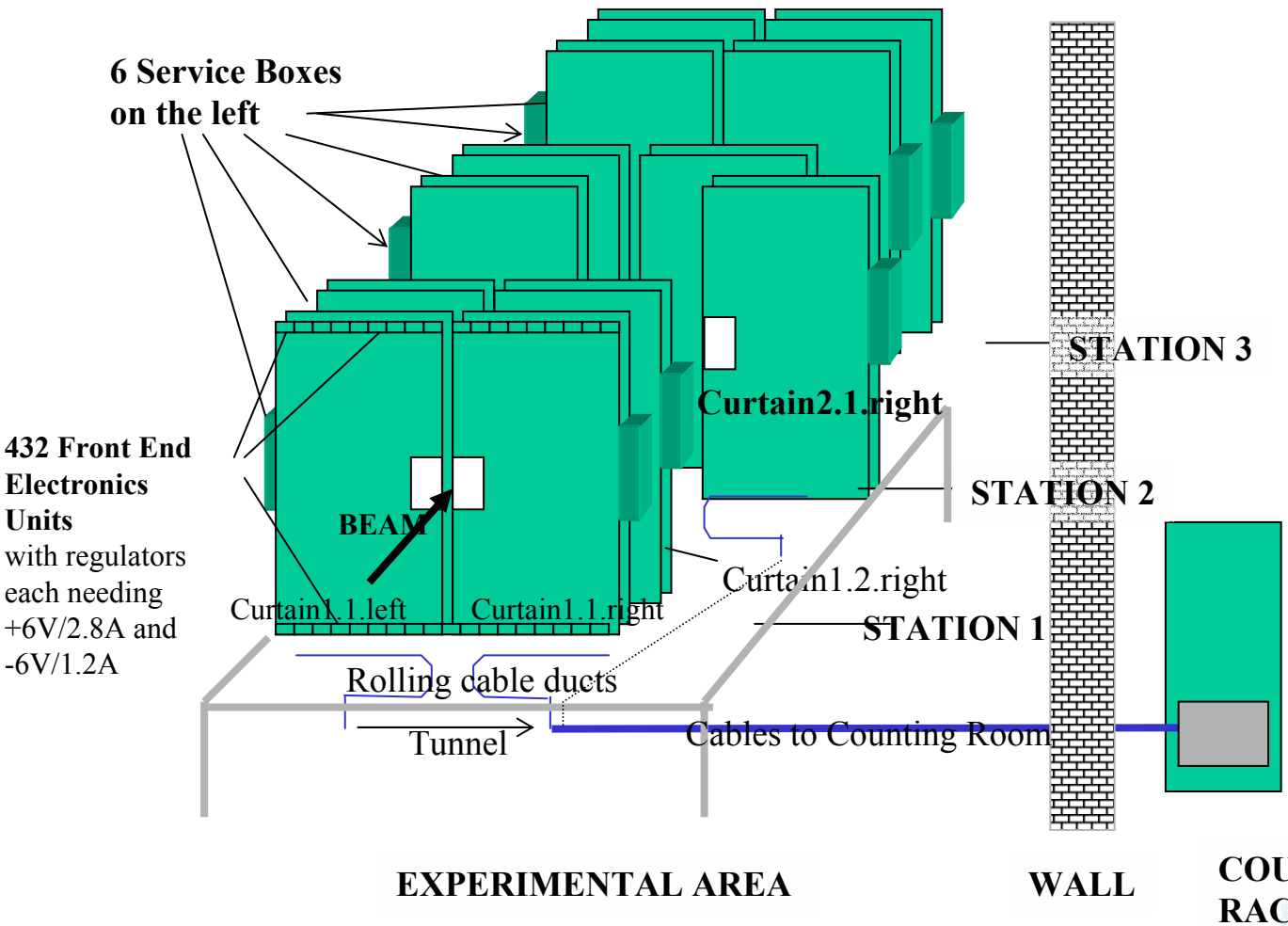
24-11-2003/T.Sluijk, A.Zwart, E. Heine

Detector view



Remarks:
Regulators always needed unless supplies on detector.
Magnetic fields are high near the Outer Tracker

Location Overview



Power distribution to the OT detector

Assumptions;

- Load of one curtain; +6V 102A, -6V 58A (954W)
- 4 curtains in one station (3.8kW)
- 3 stations in the detector (11.500kW)
- Radhard linear regulators On-Detector

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Layout constrains;

Area	Environmental constrains	Distance to load
Counting room	none	100m
Tunnel	B=50mT, 200Rad	12m
Detector		

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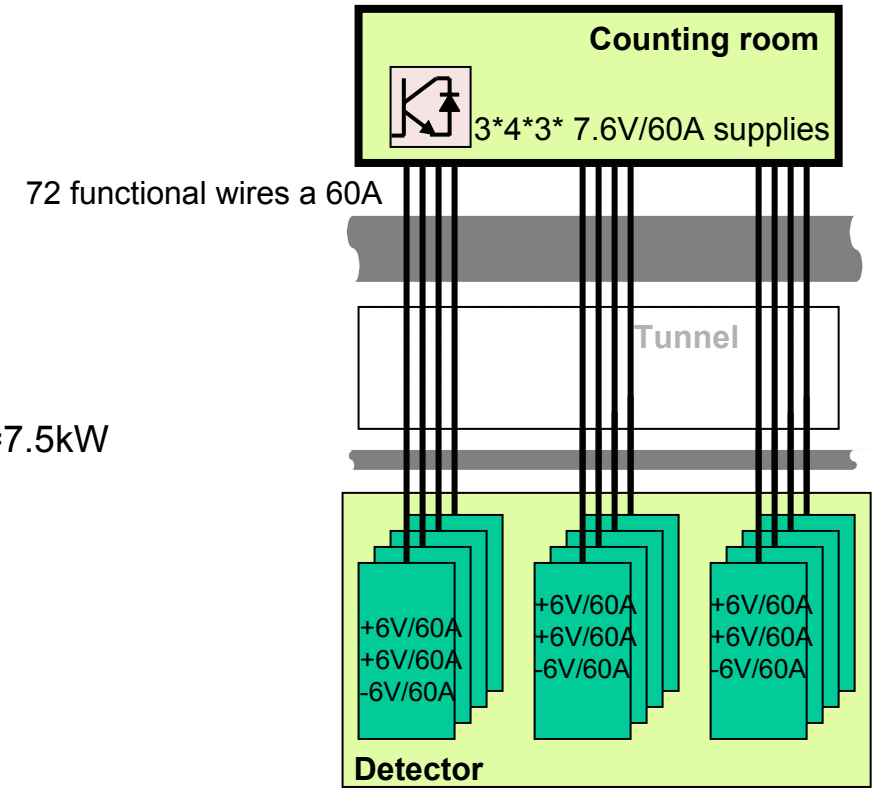
Solutions;

1) **Conventional Supplies in Counting Room**
   6V from Counting room to Detector
2) **Radiation Hard Supply (**Development , Supply split in two parts)
   High DC voltage to the tunnel,
   Conversion to low DC voltage in radation Area, then to the Detector
3) **Rectifiers Supplies** (development)
   Mains to the tunnel, rectifying to DC, to the Detector

Solution 1

Set up;
- Commercial available power supplies, located in the Counting room.
- High current cables to the Detector.

Calculation;
- Max Conductor Temp. = 85°C (IEC 92),
- 72 cables with 95 mm² copper needed,
- Total cross section (incl. isolation): 0.4m²
- Power loss = 5kWcables+2.5kWsupplies=7.5kW
- Costs: 50k€cables+19k€supplies=69k€

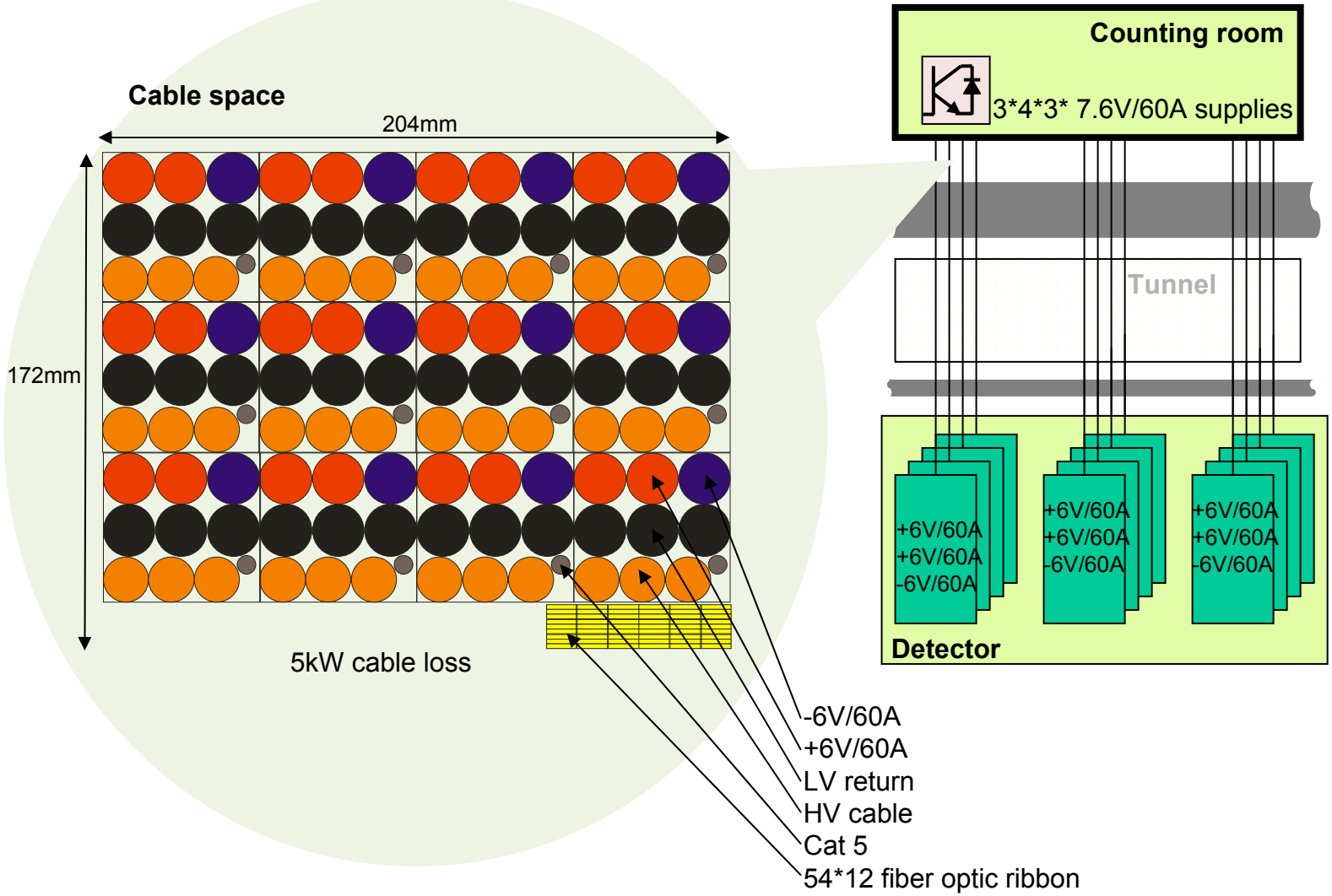


Conclusion;
- − Expensive cables
- − Low efficiency 60%
- − Difficult to install
- \+ Commercially available eg. Wiener PL500

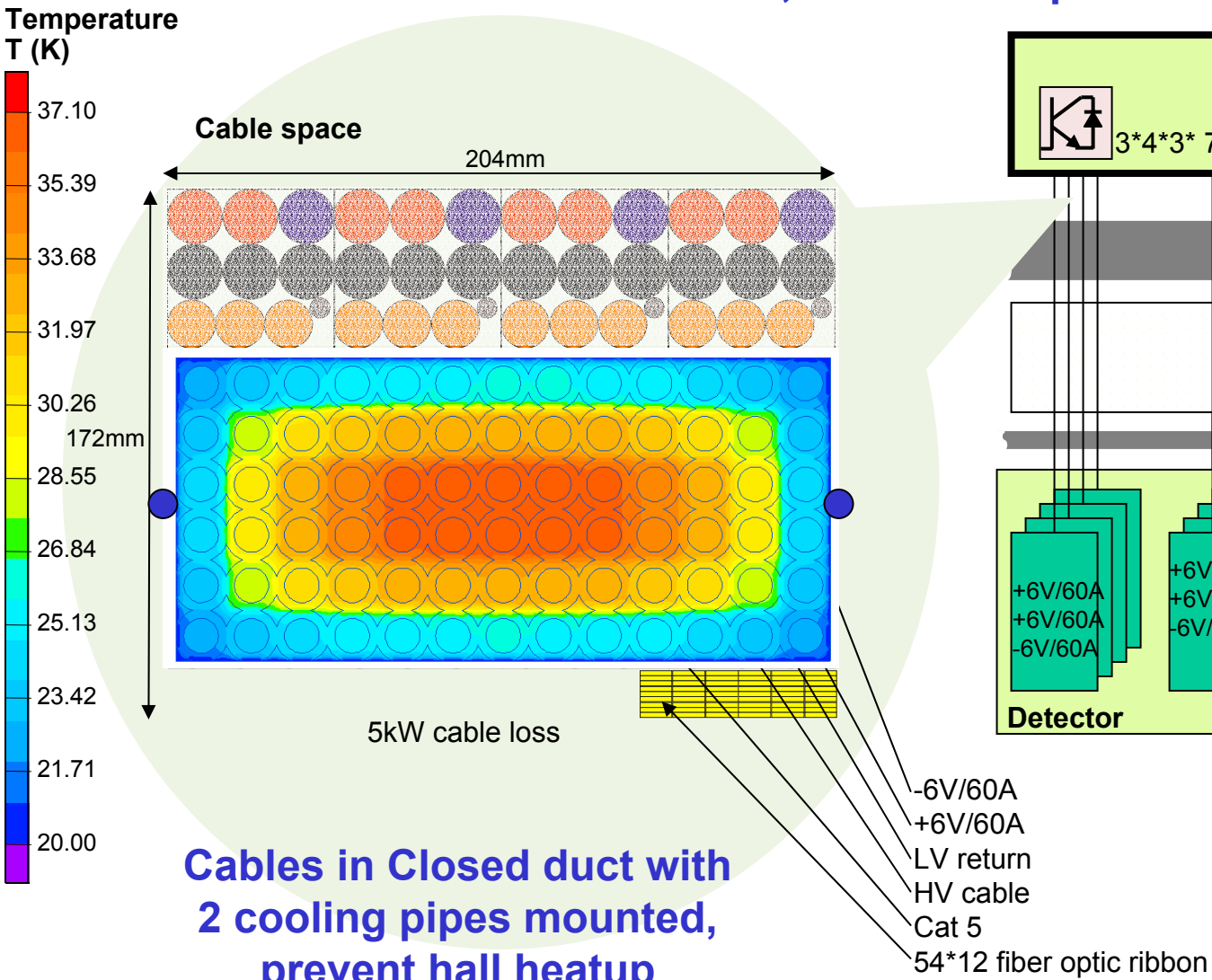
References;

Draka,"Catalogus 1", Draka Aug 2003

Solution 1, zoom in



Solution 1, Cable heatup

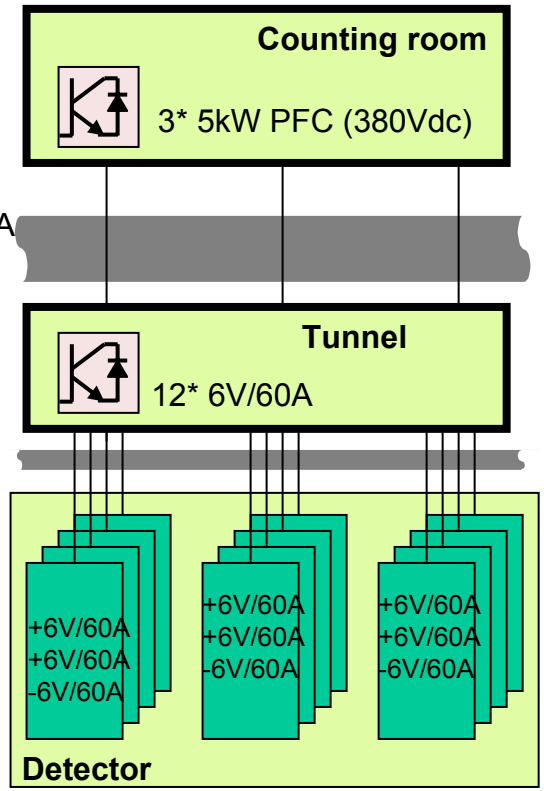


Cables in Closed duct with 2 cooling pipes mounted, prevent hall heatup ~62W/m

Solution 2

Set up;

- New designed magnetic-field- and radiation tolerant power supplies.
- Power factor corrector and all controls in the counting room (380Vdc).
- DC/DC converter located in the Tunnel (380Vdc->6Vdc)



Calculation;

- Power loss = 1.8kWcables+1.9kWdc/dc+1.5kWpfc=5.2kW
- Costs: 3.6k€cable+22k€DC/DC+16.7k€PFC=42.4k€

Conclusion;

- \- Technology not mature .Not available yet
- \- Heavy wired control system (wiener)
- \- Expensive equipment
- \+ Stable and Low noise
- \+ Efficiency 69%

References;

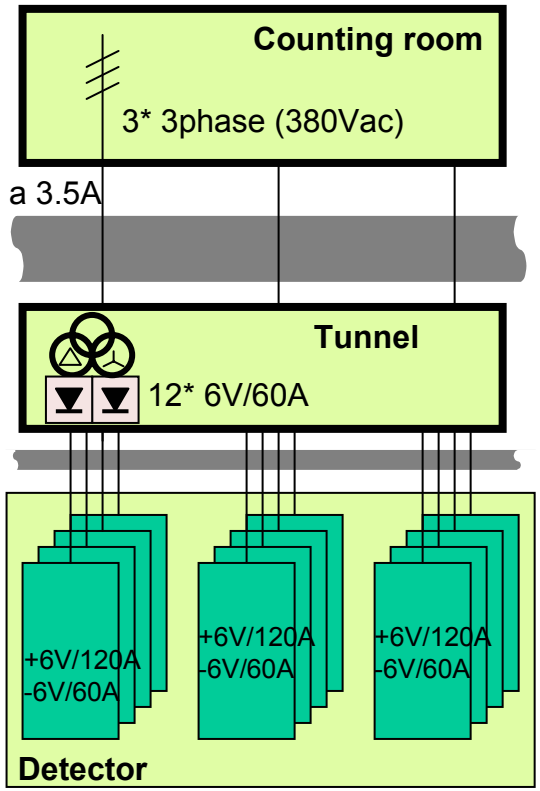
G.Grieco, "EASY: an Embedded Assembly power supply System for LHC experiments", CAEN SpA, LECC2003

"Low Voltage Power Supplies for the radiation and magnetic field area (MARATON)", Wiener

C.Rivetta, e.a., "Design considerations of low Voltage DC Power Distribution for CMS Sub-Detectors"

Solution 3

Set up;
- 3 phase AC mains to the Cavern
- In the Cavern magnetic field tolerant transformers
- From AC to DC by 6 phase full wave rectifying



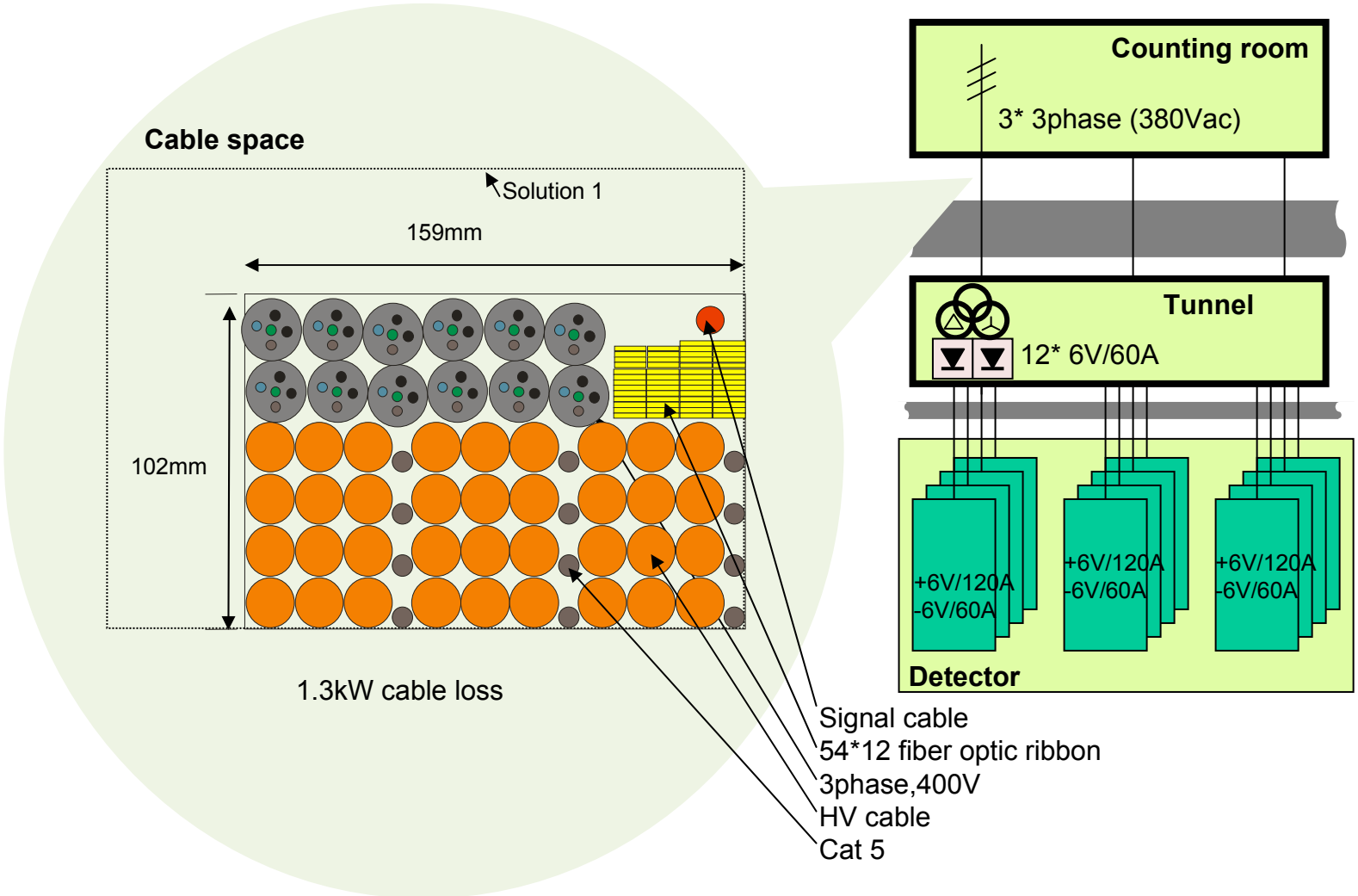
Calculation;
- Power loss: 1.3kWcables+3.4kWsupplies=4.8kW
- Costs:3664€cables+1800€central+18000€supplies=23.5k€

Conclusion;
- − 1% ripple
- − Sensitive to mains fluctuations
- \+ Robust, High reliability
- \+ Low costs
- \+ Efficiency 70%

References;

H.Koppe, e.a.,"Rectifier diodes ", Philips Application book

Solution 3, zoom in



Summary

Solution 1

Inventory;
- Power loss = 7.5kW,
- Costs = 69k€,
- 72 cables with 95 mm² Cu,
- Conductor Temp. Max 85°C,
- Outer Diameter: 17.5mm (incl. Isolation):

Conclusion;
- − Expensive cables
- − Low efficiency
- − Difficult to install
- \+ Commercial available
- \+ Supplies always reachable

Solution 2

Inventory;
- Power loss = 5.2kW
- Costs = 38k€

Conclusion;
- − Technology not mature yet
- − Heavy wired control system
- − Expensive equipment
- − Equipment in Radiation area
- \+ Efficiency 69%
- \+ Stable and Low noise

Solution 3

Inventory;
- Power loss= 4.8kW
- Costs = 23.5k€

Conclusion;
- − 1% ripple
- − Sensitive to mains fluctuations
- \+ Robust, High reliability
- \+ Low costs
- \+ Efficiency 70%