MVD Services Update

Tommaso Quagli for the MVD Group
II. Physikalisches Institut, JLU Gießen

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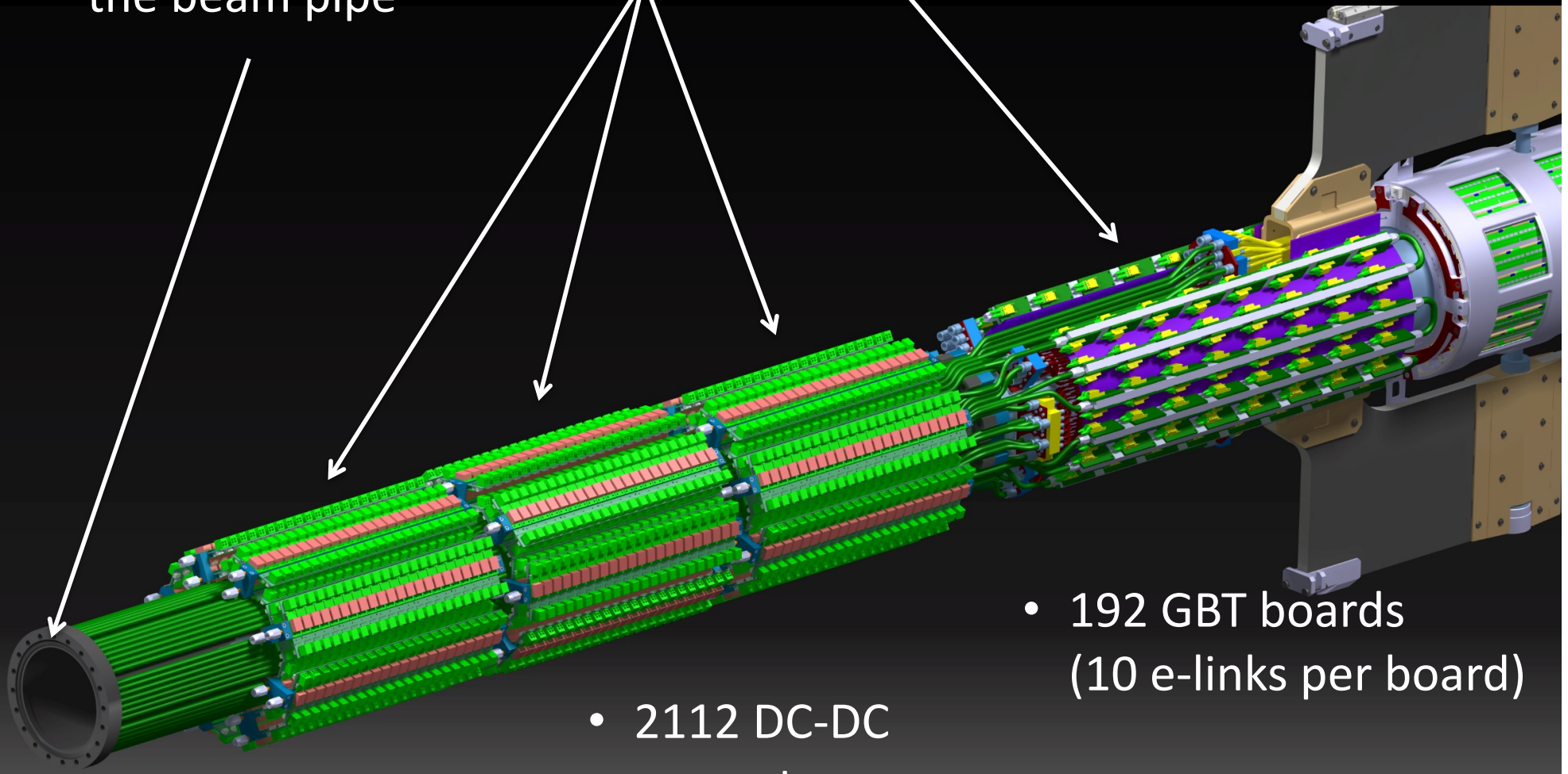
Cables for the MVD

- Extensive compilation of cable requirements in (almost) all regions between racks and detectors
- No safety factor included anywhere

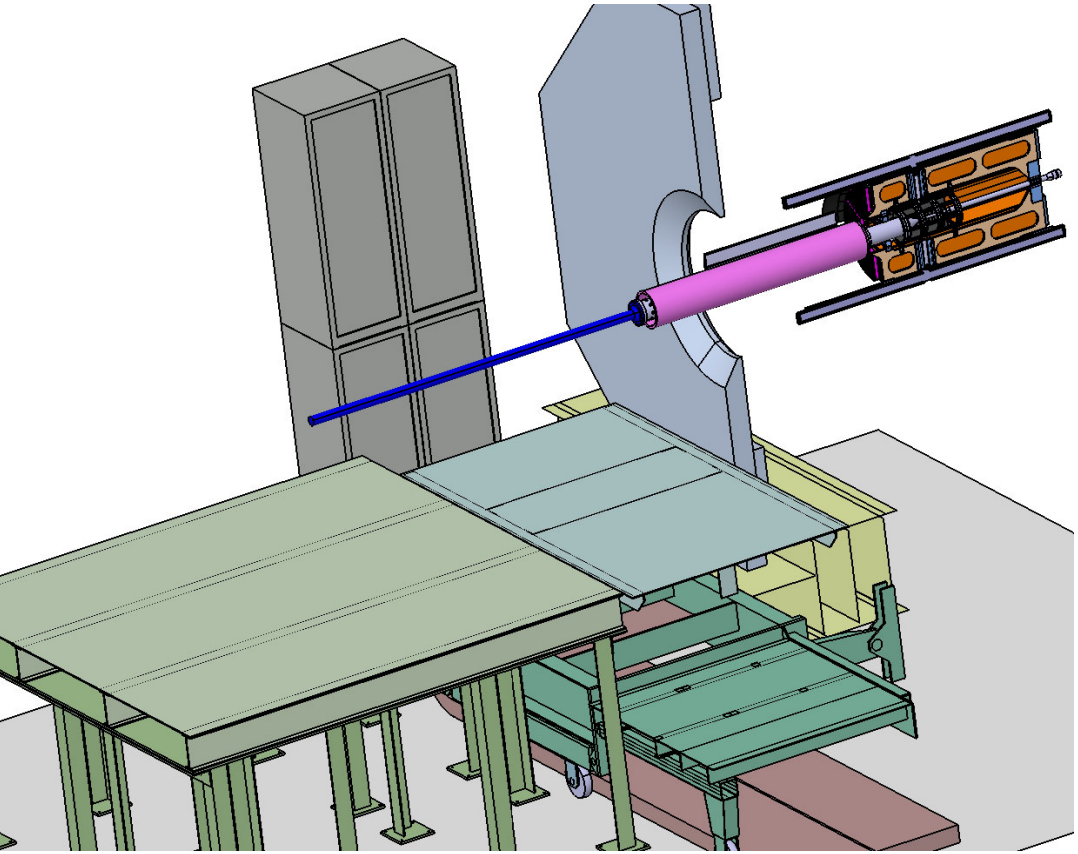
Preamble

- Mostly focussed on the DC-DC and GBT area around the beam pipe



- 192 GBT boards (10 e-links per board)
- 2112 DC-DC converters

Interaction with BEMC during installation

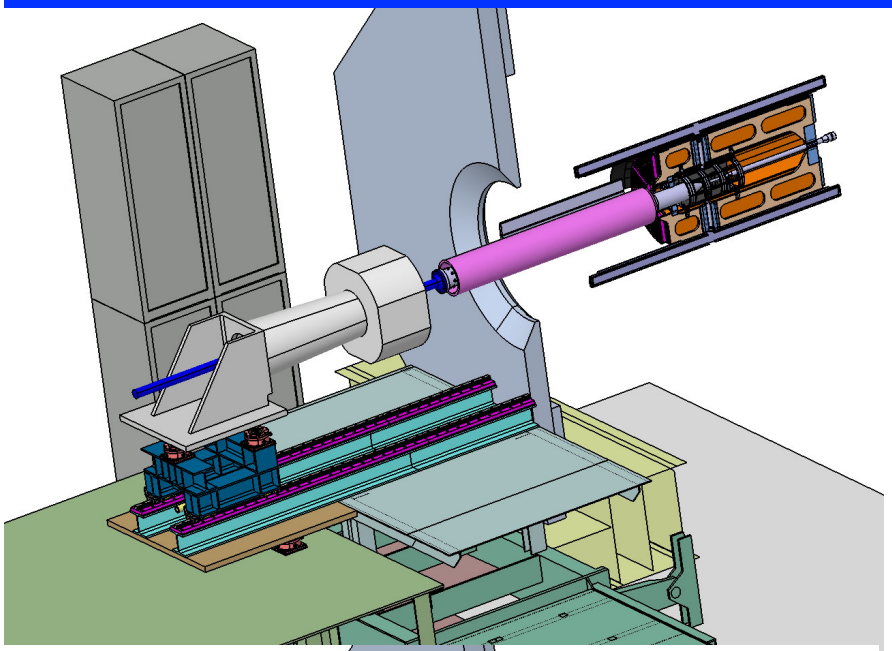


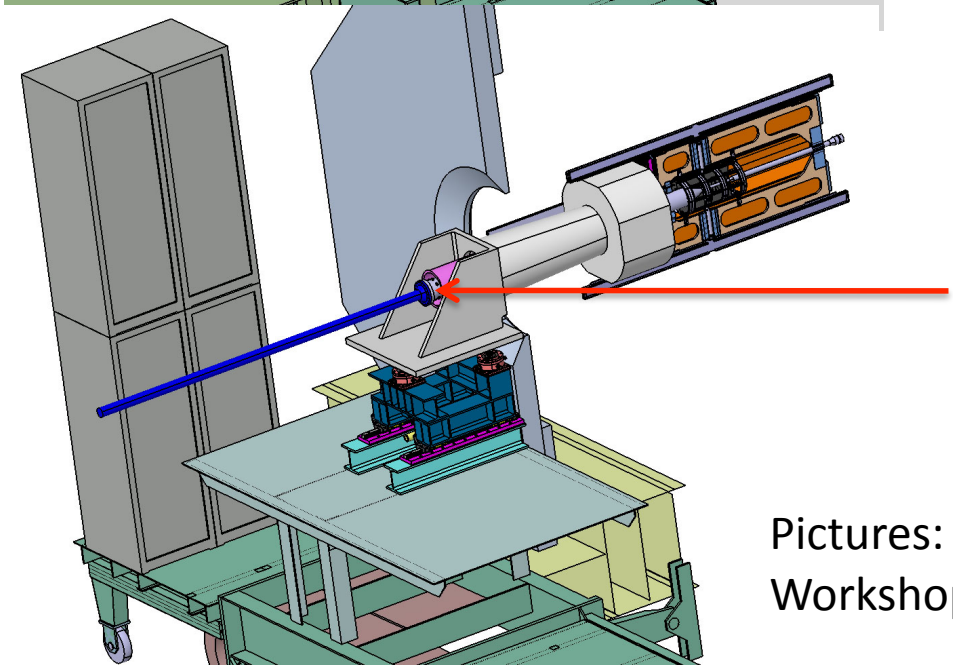
Pictures: D. Rodríguez Piñeiro, GSI Mechanical Workshop, October 2014

Cables in this region are strongly connected to the BEMC installation sequence:

- MVD assembled and tested
- MVD+STT is inserted in PANDA
- DCDC-GBT block of the MVD is completely cabled before insertion
- Support tool for Beam Pipe + Target Pipe assembly is inserted

Interaction with BEMC during installation



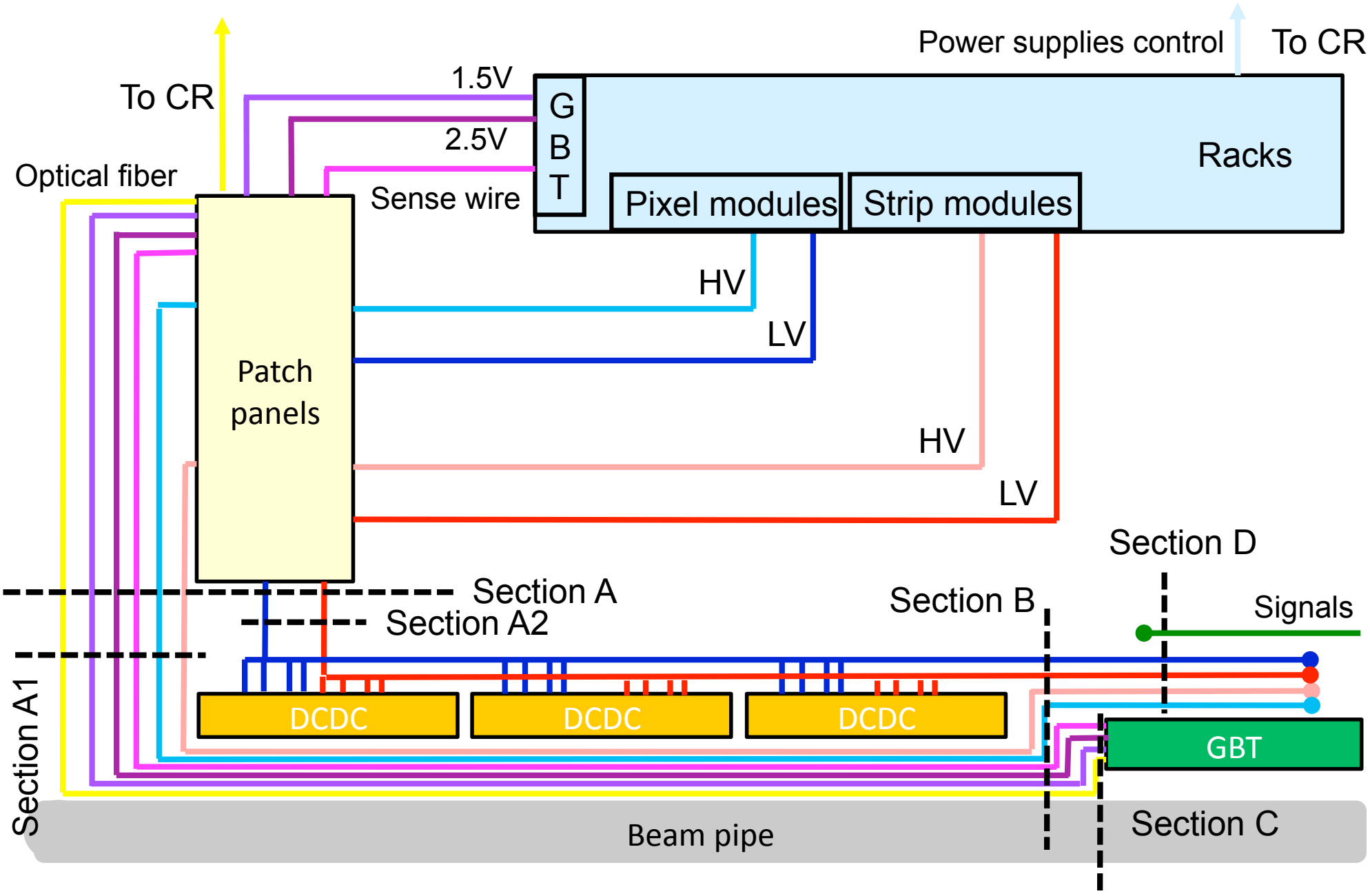


- BEMC is inserted on the support tool and slid on the MVD services
- All cables, connectors etc. must fit into the hole of the BEMC
- Long cables directly connected from MVD services to the racks are possible, but have to be supported for several meters

→ patch panels between racks and services, as close as possible to entry port of MVD services

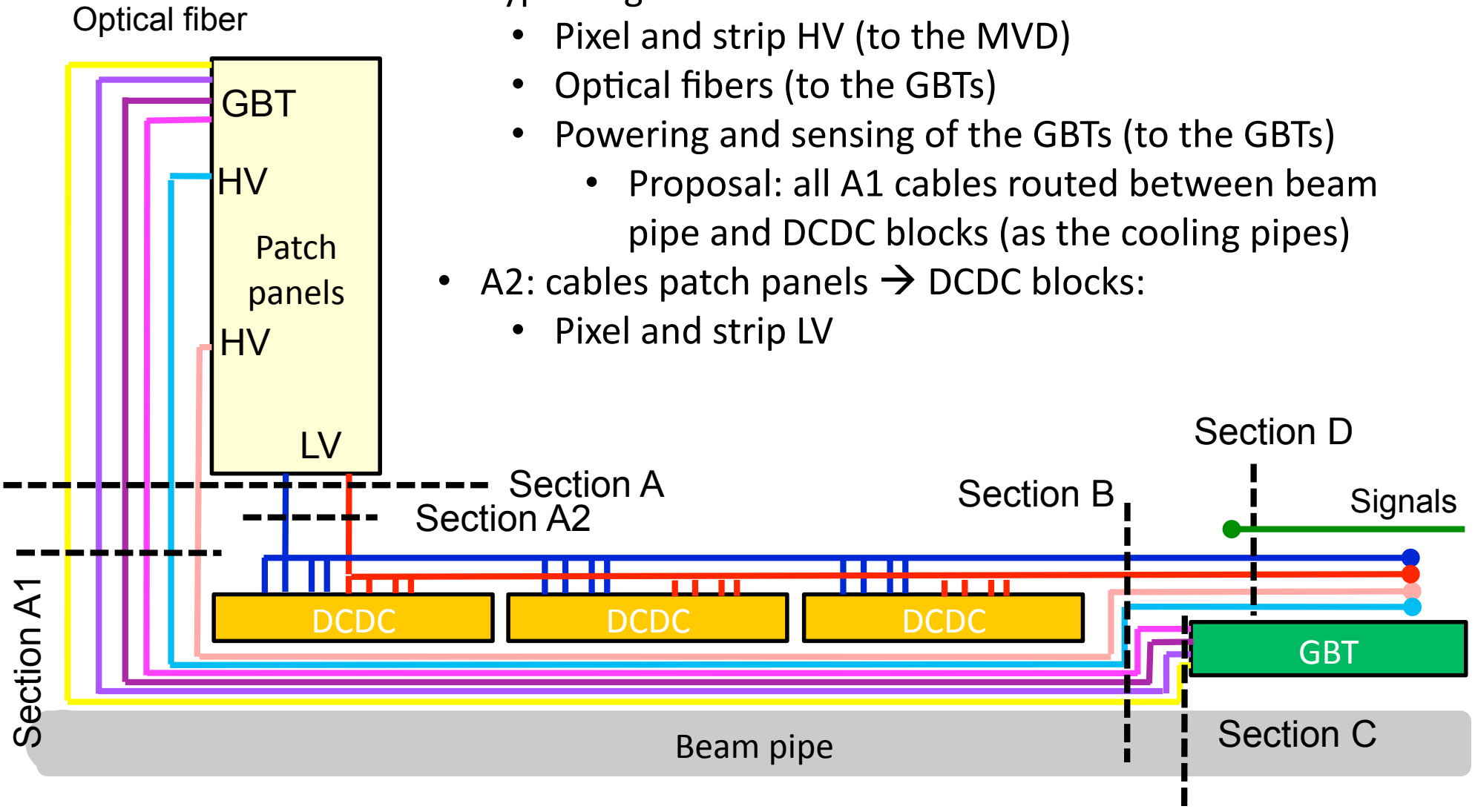
Pictures: D. Rodríguez Piñeiro, GSI Mechanical Workshop, October 2014

Racks → Patch Panels → GBT area



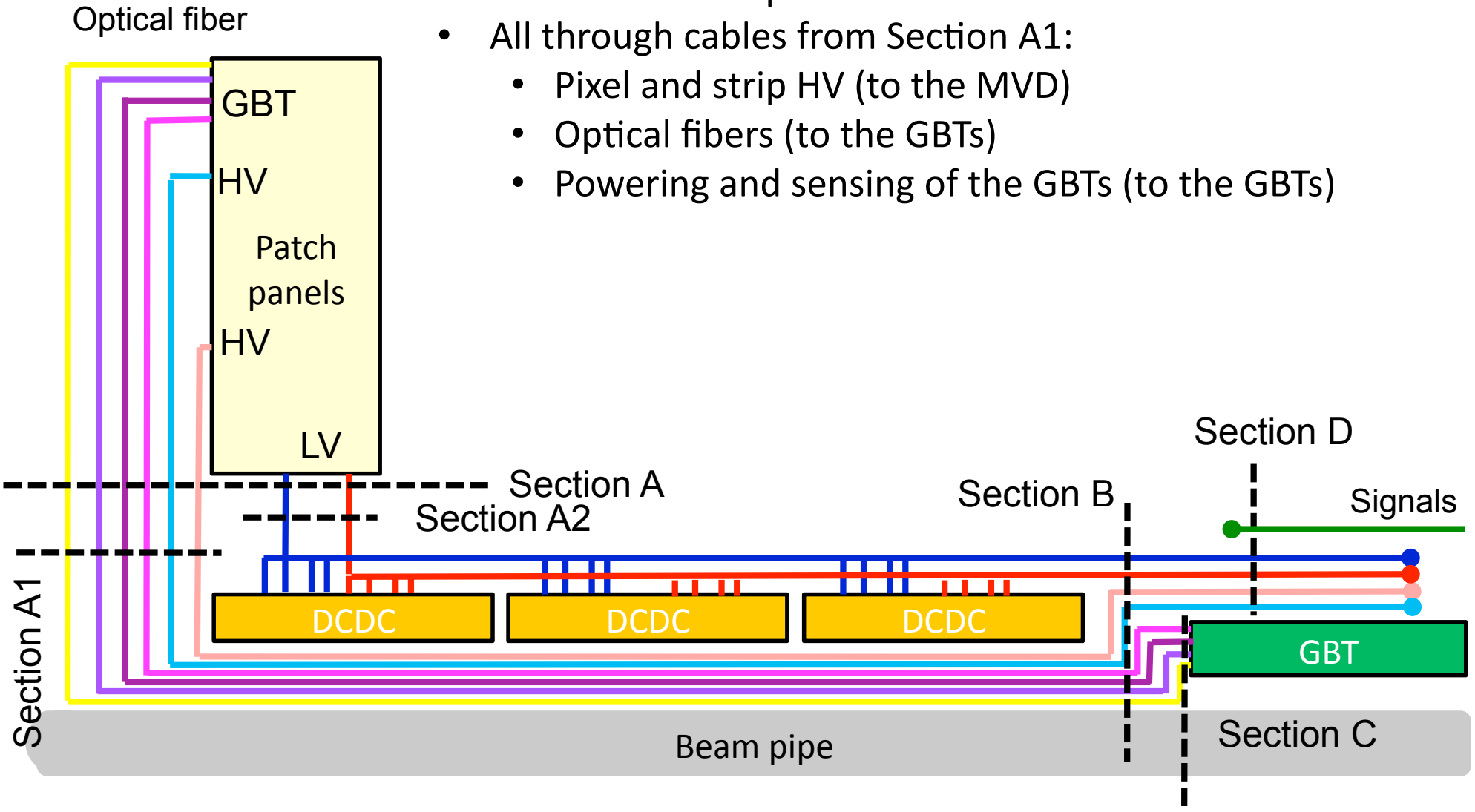
Patch Panels → GBT area

- Section A: cables exiting from patch panels
  - A1: through cables patch panels → GBT and/or MVD bypassing the three DCDC blocks
    - Pixel and strip HV (to the MVD)
    - Optical fibers (to the GBTs)
    - Powering and sensing of the GBTs (to the GBTs)
      - Proposal: all A1 cables routed between beam pipe and DCDC blocks (as the cooling pipes)
  - A2: cables patch panels → DCDC blocks:
    - Pixel and strip LV



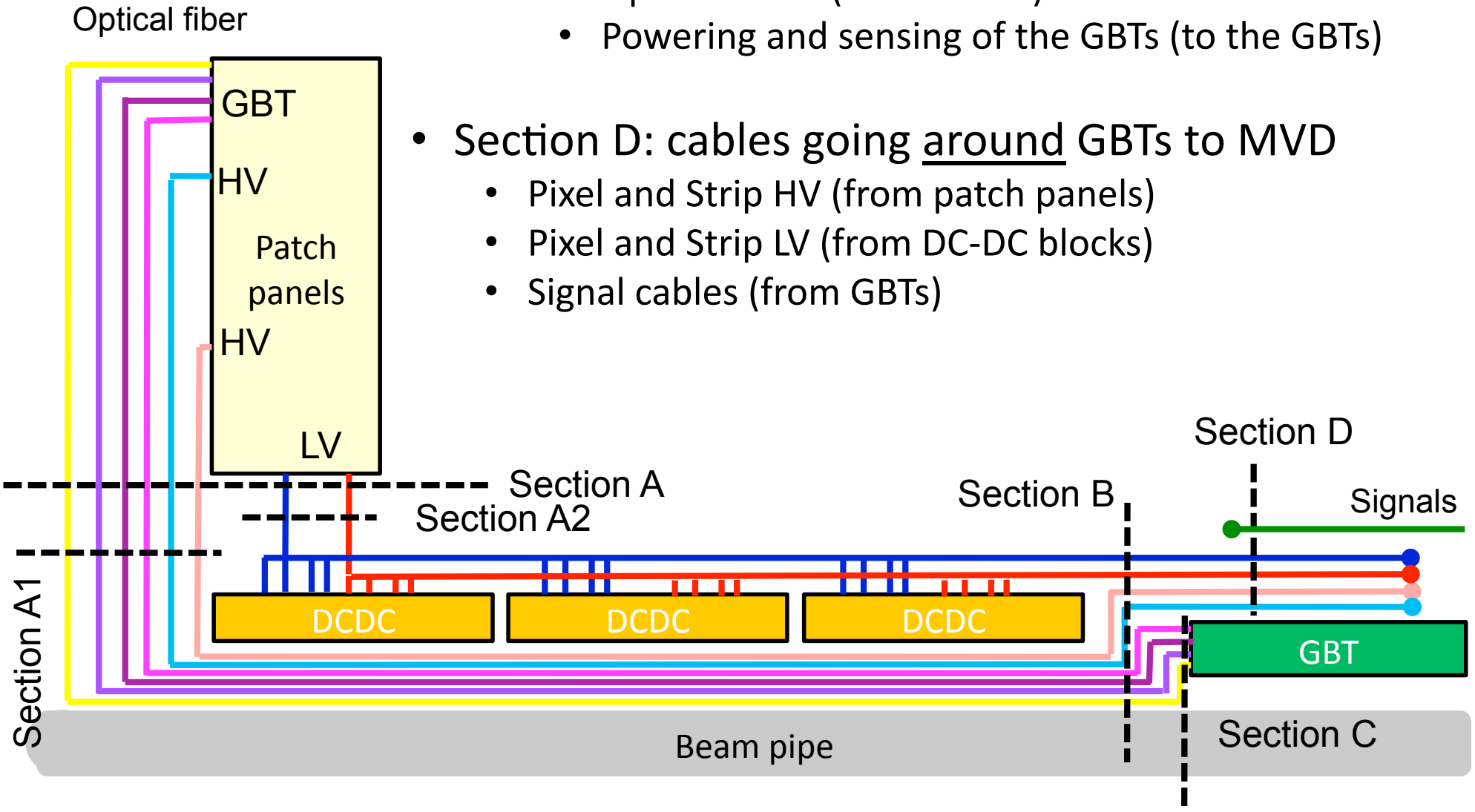
Patch Panels → GBT area

- Section B: cables between DCDCs and GBTs
  - Cables DC-DC → MVD:
    - Pixel and strip LV
  - All through cables from Section A1:
    - Pixel and strip HV (to the MVD)
    - Optical fibers (to the GBTs)
    - Powering and sensing of the GBTs (to the GBTs)



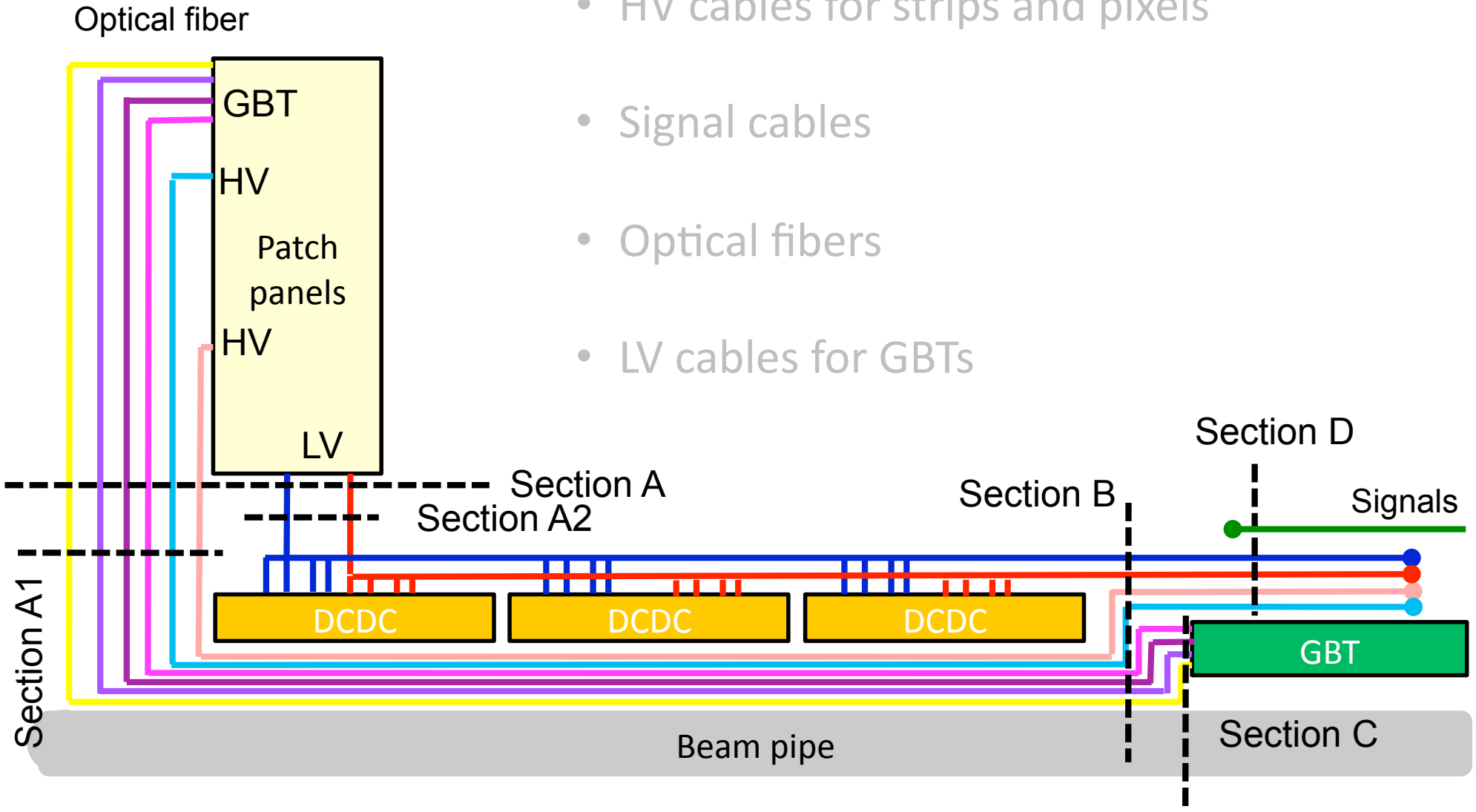
Patch Panels → GBT area

- Section C: cables entering GBTs
  - Some through cables from patch panels (A1):
    - Optical fibers (to the GBTs)
    - Powering and sensing of the GBTs (to the GBTs)
- Section D: cables going around GBTs to MVD
  - Pixel and Strip HV (from patch panels)
  - Pixel and Strip LV (from DC-DC blocks)
  - Signal cables (from GBTs)



Cables for the MVD

- LV cables for strips and pixels
- HV cables for strips and pixels
- Signal cables
- Optical fibers
- LV cables for GBTs



Powering Concept

- Each of the 472 sensors has an independent HV supply line

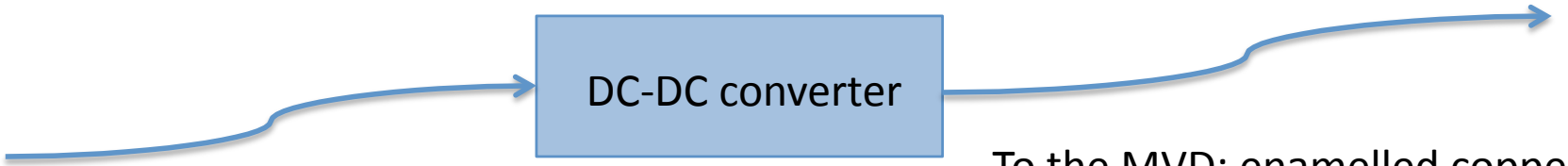
- Separated analog and digital lines for the front-ends; MDC in the strips grouped with digital part
- Each line goes to one DCDC and from there to the Primary Supply Lines (power supply channels, on racks)
- In the strips, two DC-DCs are connected to the same P.S.L.

- 608 DCDC converters are needed for pixels and 1184 for strips
  → 1200 Primary Supply Lines

DCDC Lines	1792
Primary Supply Lines	1200
HV lines	472

Low Voltage (Pixel + Strip)

- Different type of cables before and after DC-DC converters:



To the patch panels: cables with four pairs

- External diameter 7.5 mm
- Cross section 0.35 mm^2 per wire
- 300 cables
- Total cross section 16840 mm^2
- 800 mV voltage drop (round trip)

- VERY BIG cables, a better solution is needed! (see last slide)

To the MVD: enamelled copper cables

- Diameter 0.75 ÷ 1.5 mm
- 3584 wires
- Total cross section: 3284 mm^2

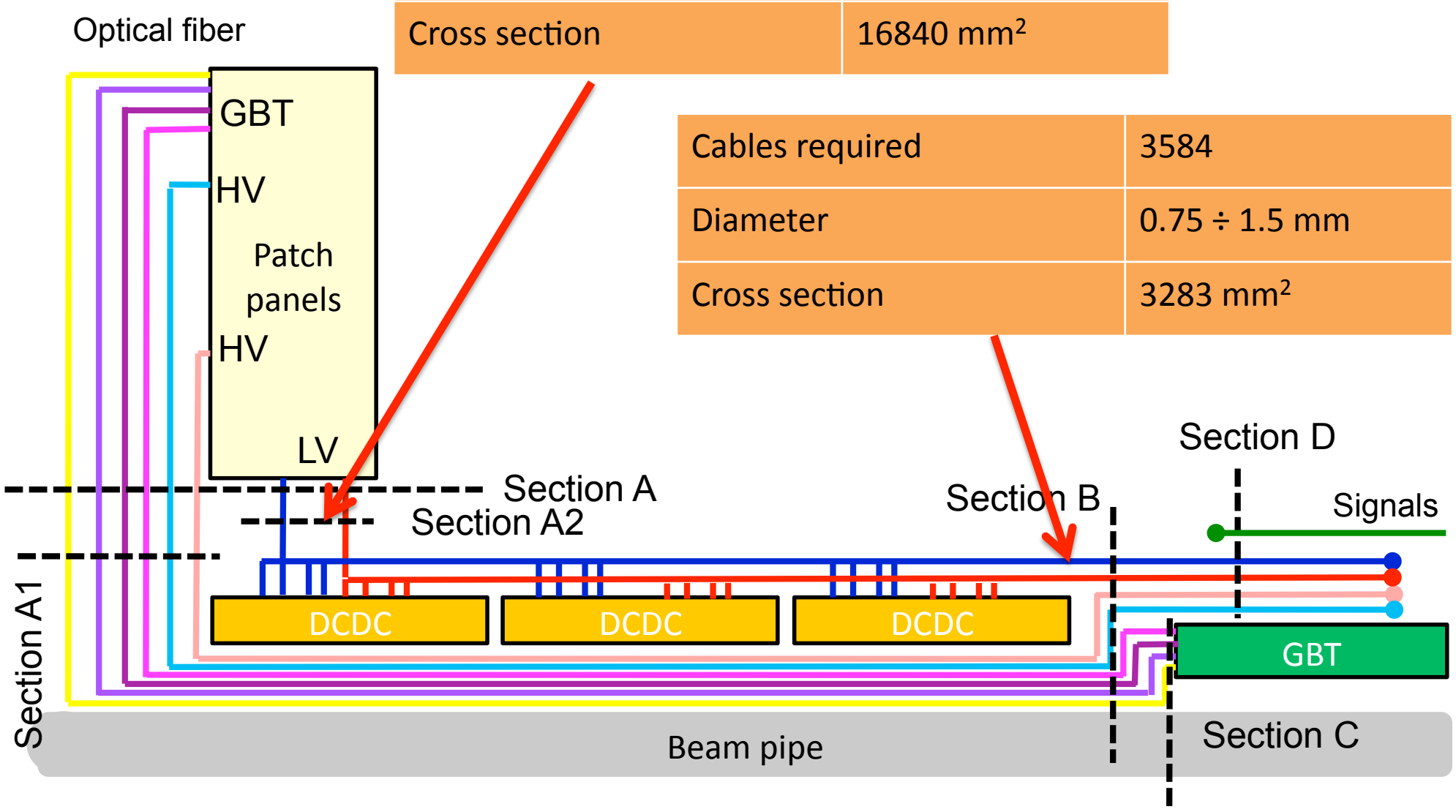
- Strips: 400 mV voltage drop (including Cu → CCA transition on-stave)
- One bundle per stave and one per disk quarter → 54 bundles
  - Cross section: 26.8 ÷ 53 mm^2

- Pixels: transition Cu → CCA and further split between GBT and MVD Total voltage drop 600 mV
- 176 bundles (one per sensor)

Low Voltage (Pixel + Strip)

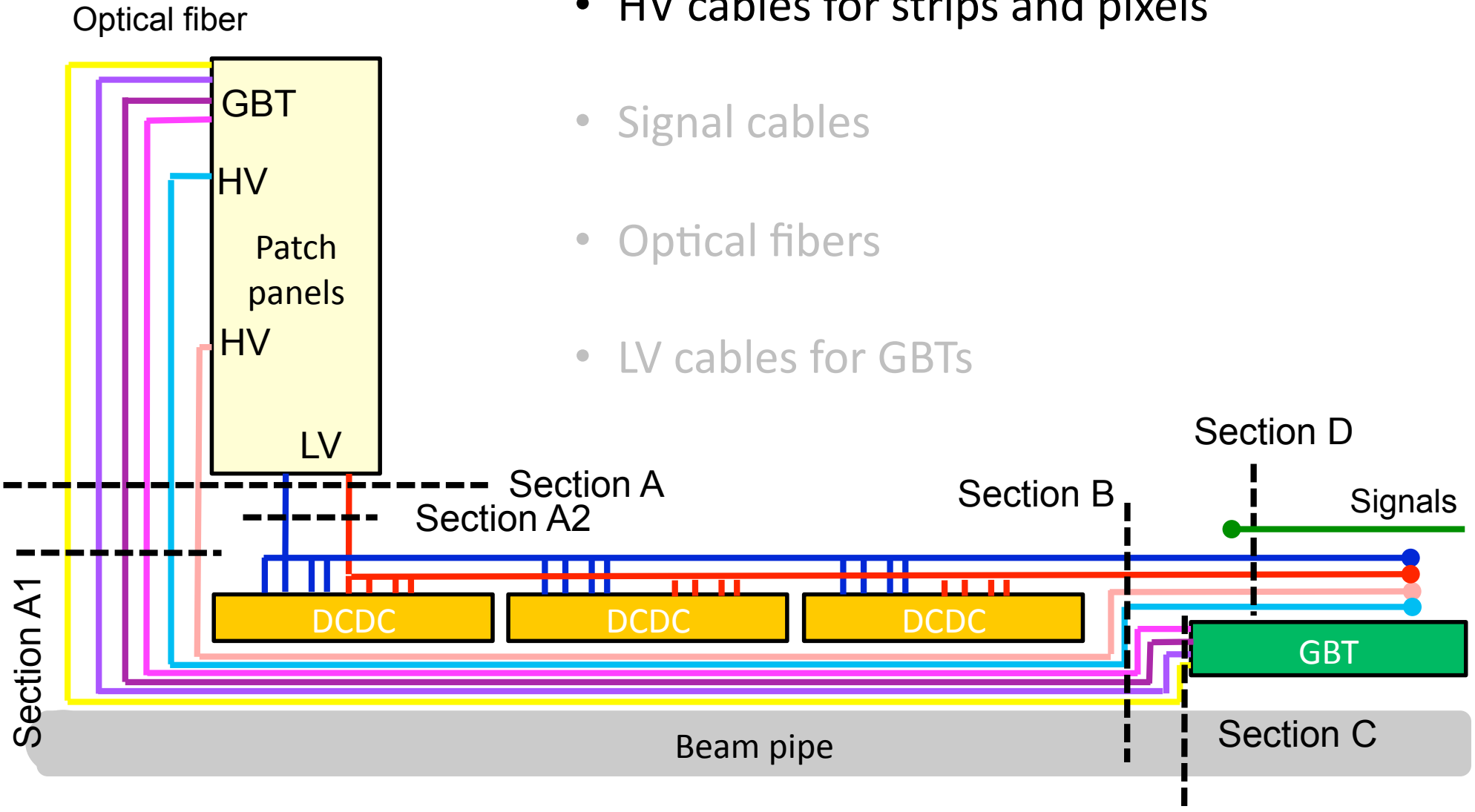
Cables required	300
Diameter	7.5 mm
Cross section	16840 mm^2

Cables required	3584
Diameter	0.75 ÷ 1.5 mm
Cross section	3283 mm^2



Cables for the MVD

- LV cables for strips and pixels
- HV cables for strips and pixels
- Signal cables
- Optical fibers
- LV cables for GBTs



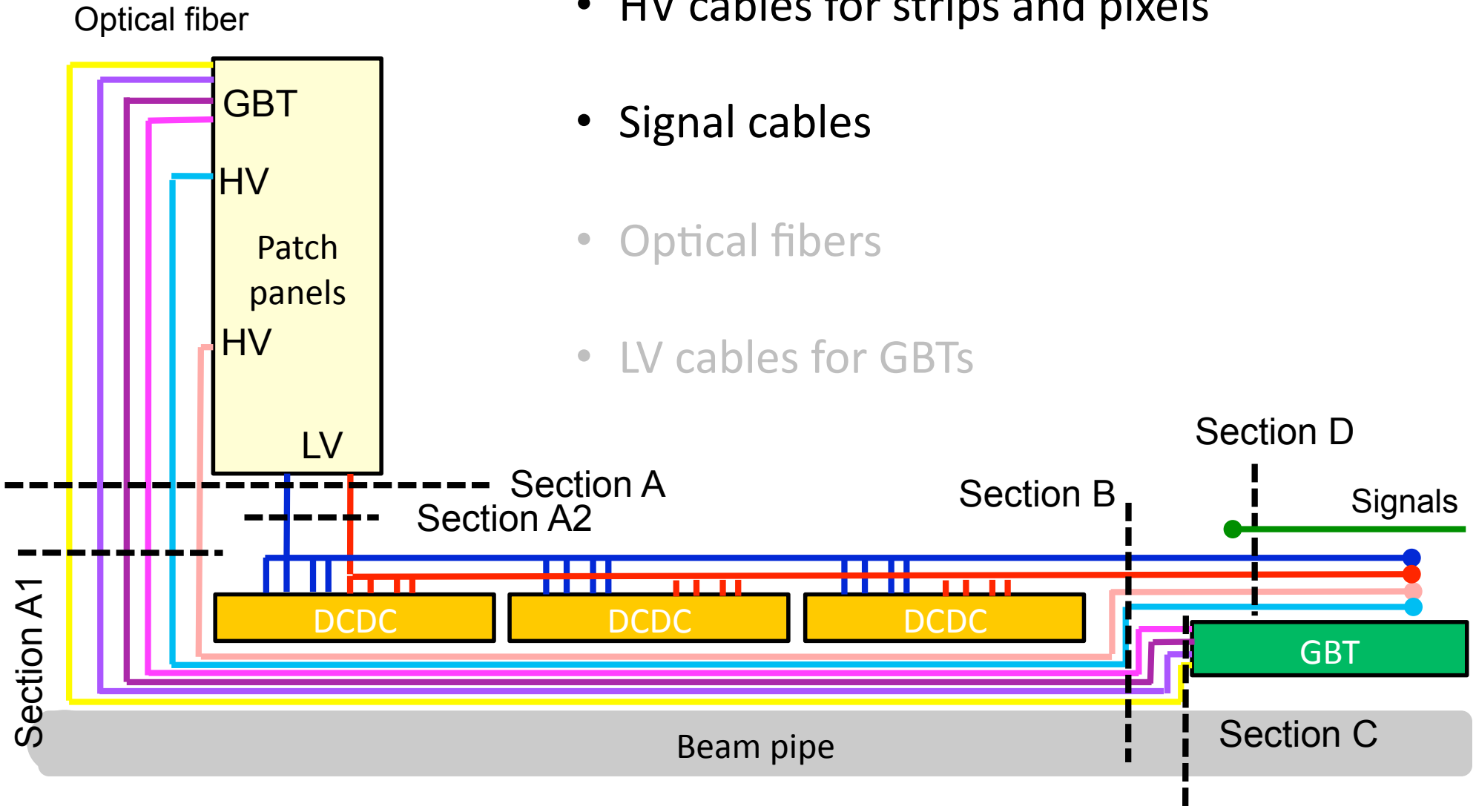
High Voltage (Pixel + Strip)

- Same type of cable from racks to patch panels and from there to MVD
- No distinction between pixels and strips
- Proposed cable 0461 11I CERN: diameter 1.3 mm with insulation

Cables required	477
Diameter	1.3 mm
Cross section	809 mm^2

Cables for the MVD

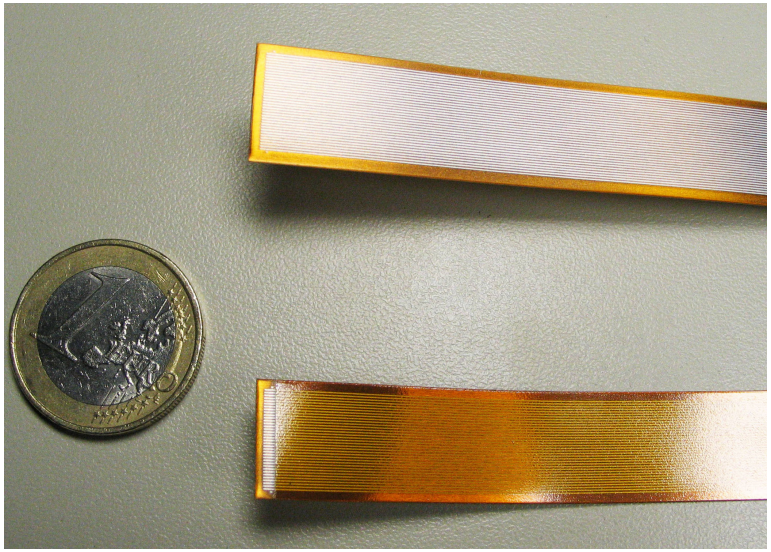
- LV cables for strips and pixels
- HV cables for strips and pixels
- Signal cables
- Optical fibers
- LV cables for GBTs



Signal cables

- Flat aluminum microstrip cables
- < 0.5 mm thick
- Pixel part: 1 cable per sensor module → 176 cables, 14 mm wide
- Strip barrel part: 1 cable per stave → 46 cables, 10 mm wide
- Strip disk part: 1 cable per disk quarter → 8 cables, 10 mm wide

Cables required	230
Cross section	1502 mm^2



Cables for the MVD

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- Signal cables
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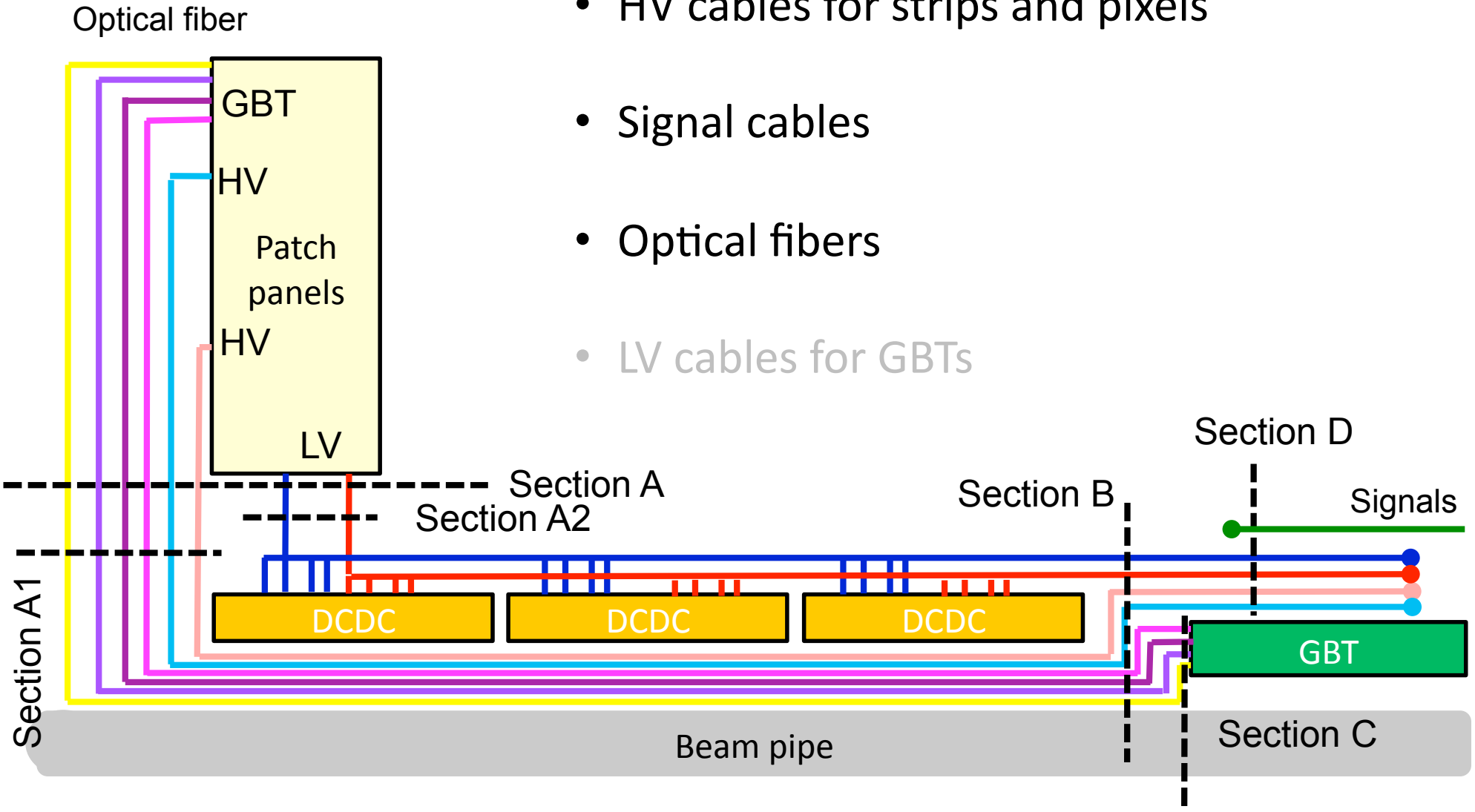

Optical fibers

- 2 fibers per GBT board
- 163 boards for pixels, 30 boards for strips
- 1 mm external diameter (with cladding)

Cables required	396
Diameter	1 mm
Cross section	396 mm^2

Cables for the MVD

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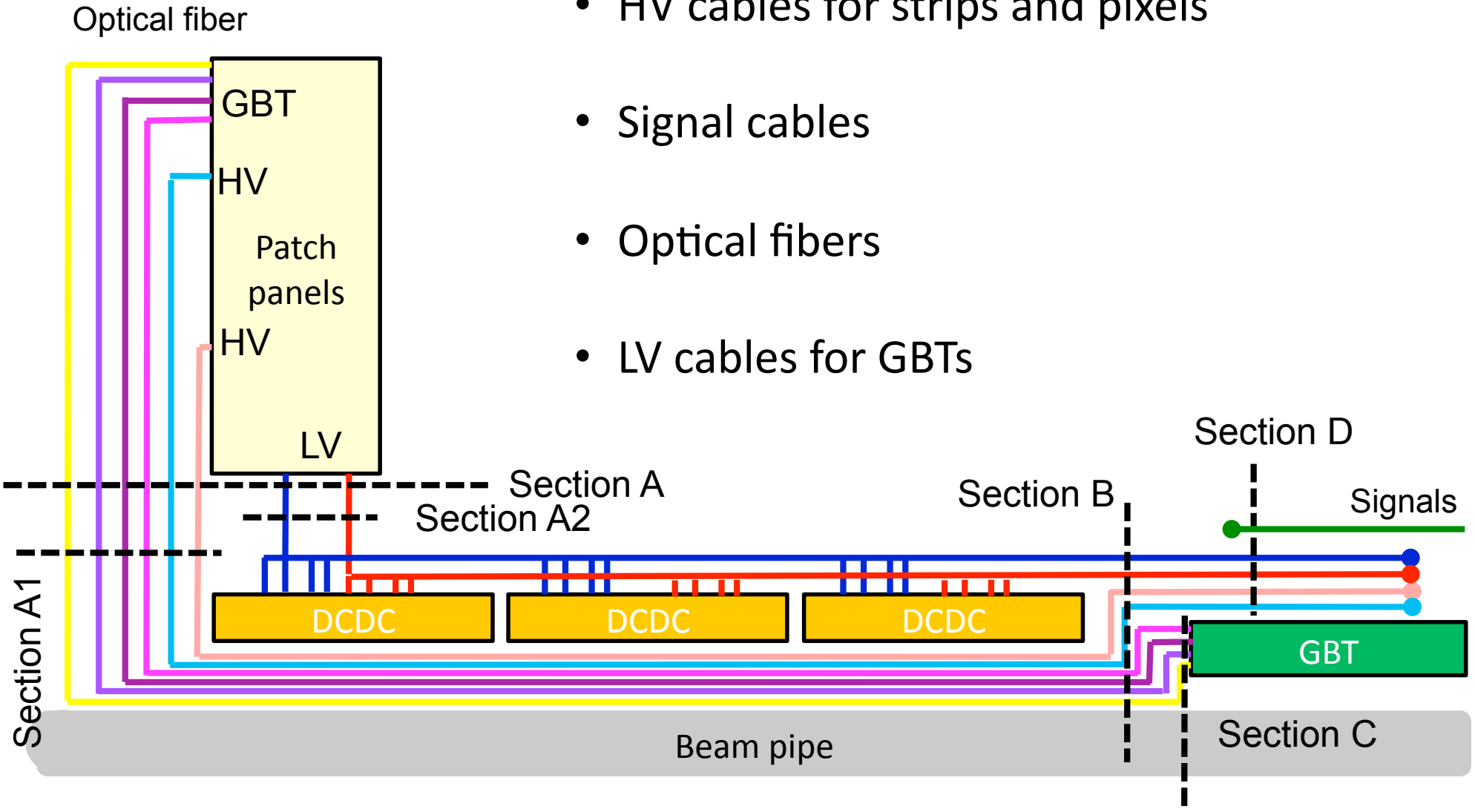
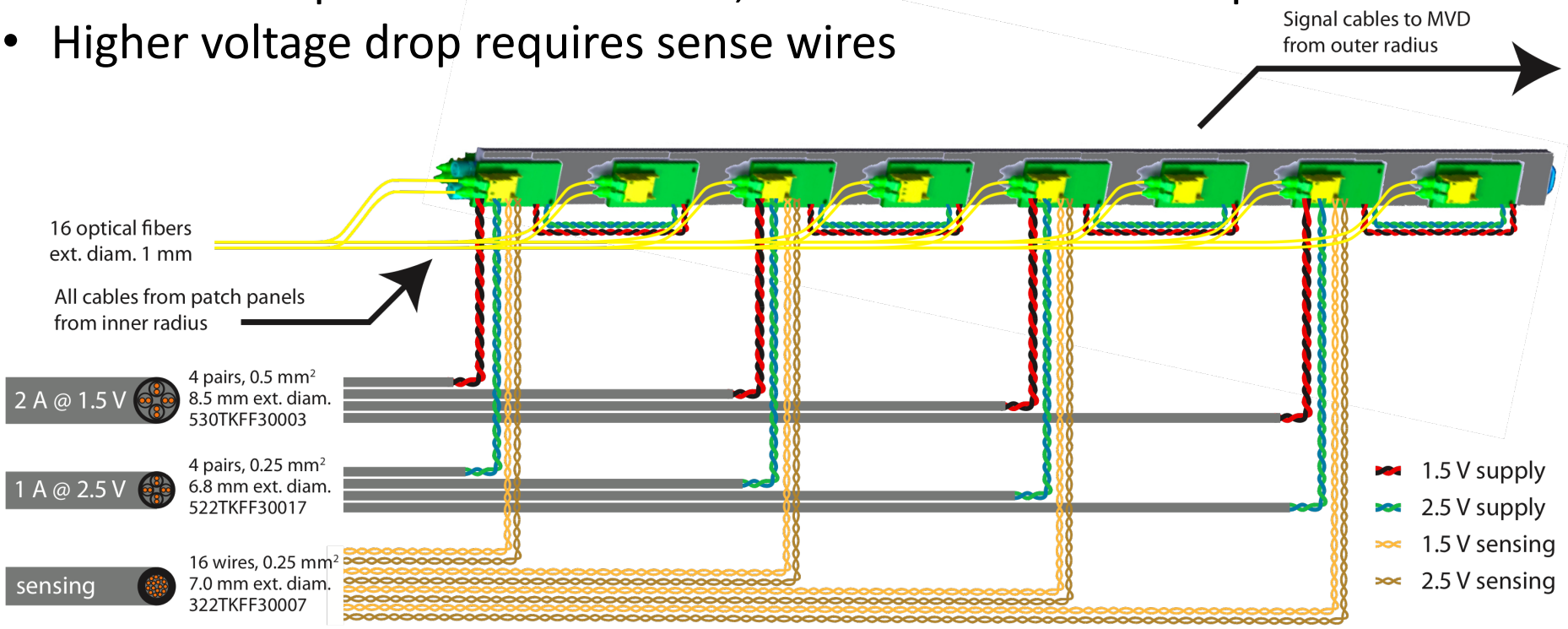
- HV cables for strips and pixels
- Signal cables
- Optical fibers
- LV cables for GBTs



GBT Powering Concept

- No DCDCs used, but direct connection to power supplies
- Each GBT requires 1.5V and 2.5 V, GBTs are connected in pairs
- Higher voltage drop requires sense wires



12 double-bars → 24 half-bars of 8 GBTs as in figure

Cables required	24+24+24 = 72
Diameter	6.8 mm, 7 mm, 8.5 mm
Cross section	4234 mm^2

Summary I

Section name	HV	Optical fibers	LV GBT		LV FEE	Signal	Total
B	477 1.3 633 809	396 1 317 396	25 8.5 1418 1805	50 7 1924 2450	3584 0.75 ÷ 1.3 2579 3284		4532 6871 8744
C		X	X	X			471 3659 4659
D	X				X	230 0.5x 10 ÷ 14 1502 1502	4291 4714 5595

Cable number
Cable diameter [mm]
Total cable section [mm^2]
Total cable section x $4/\pi$ [mm^2]

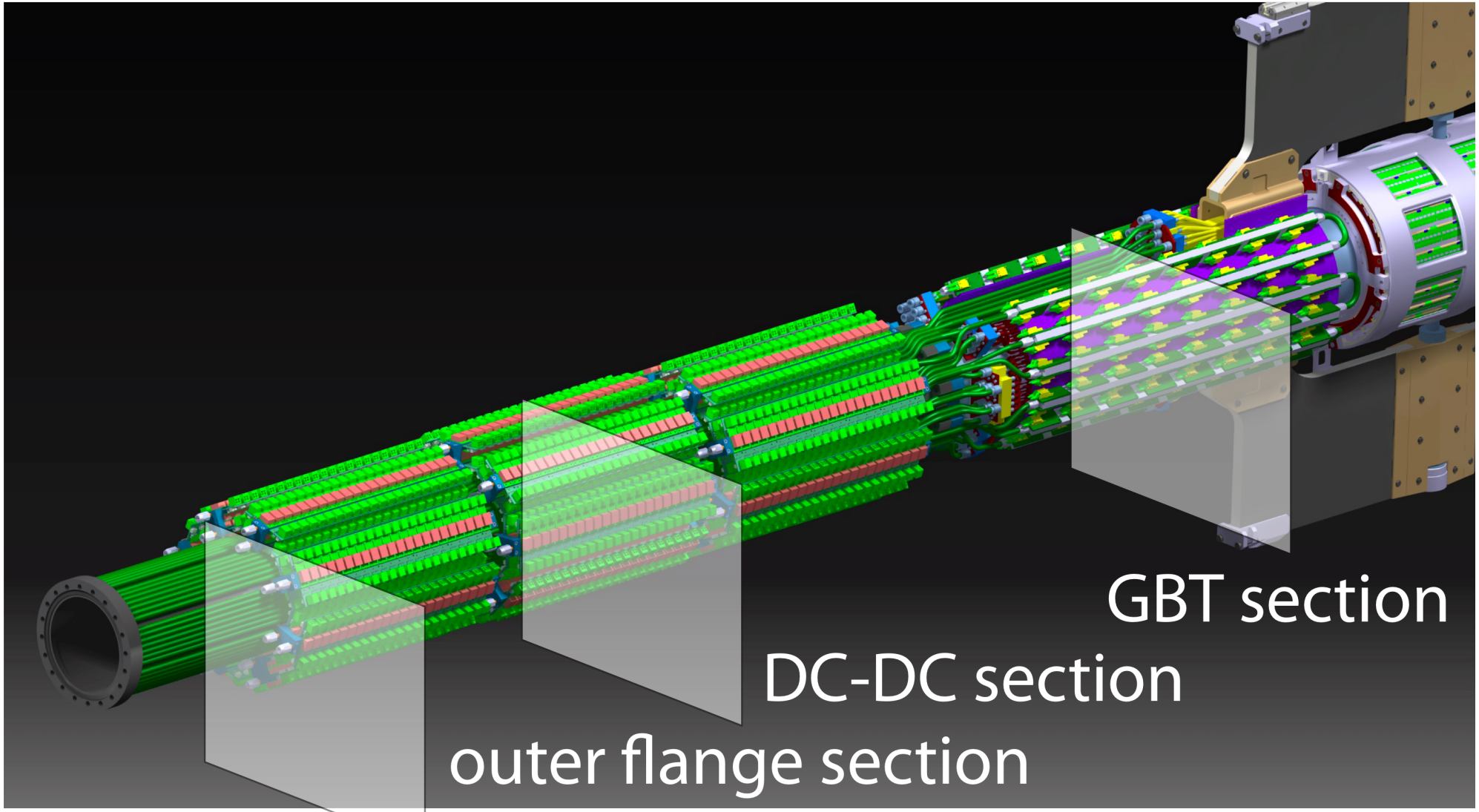
Summary II

Section name	HV	Optical fibers	LV GBT		LV FEE	Total
A1	477 1.3 633 809	396 1 317 396	25 8.5 1418 1805	50 7 1924 2450		**948** **4292** **5460**
A2					300 7.5 13226 16840	**300** **13226** **16840**
A (A1 + A2)						**1248** **17518** **22300**

Cable number
Cable diameter [mm]
Total cable section [mm^2]
Total cable section x $4/\pi$ [mm^2]

Cables from services to patch panels and from patch panels to racks

Cross sections

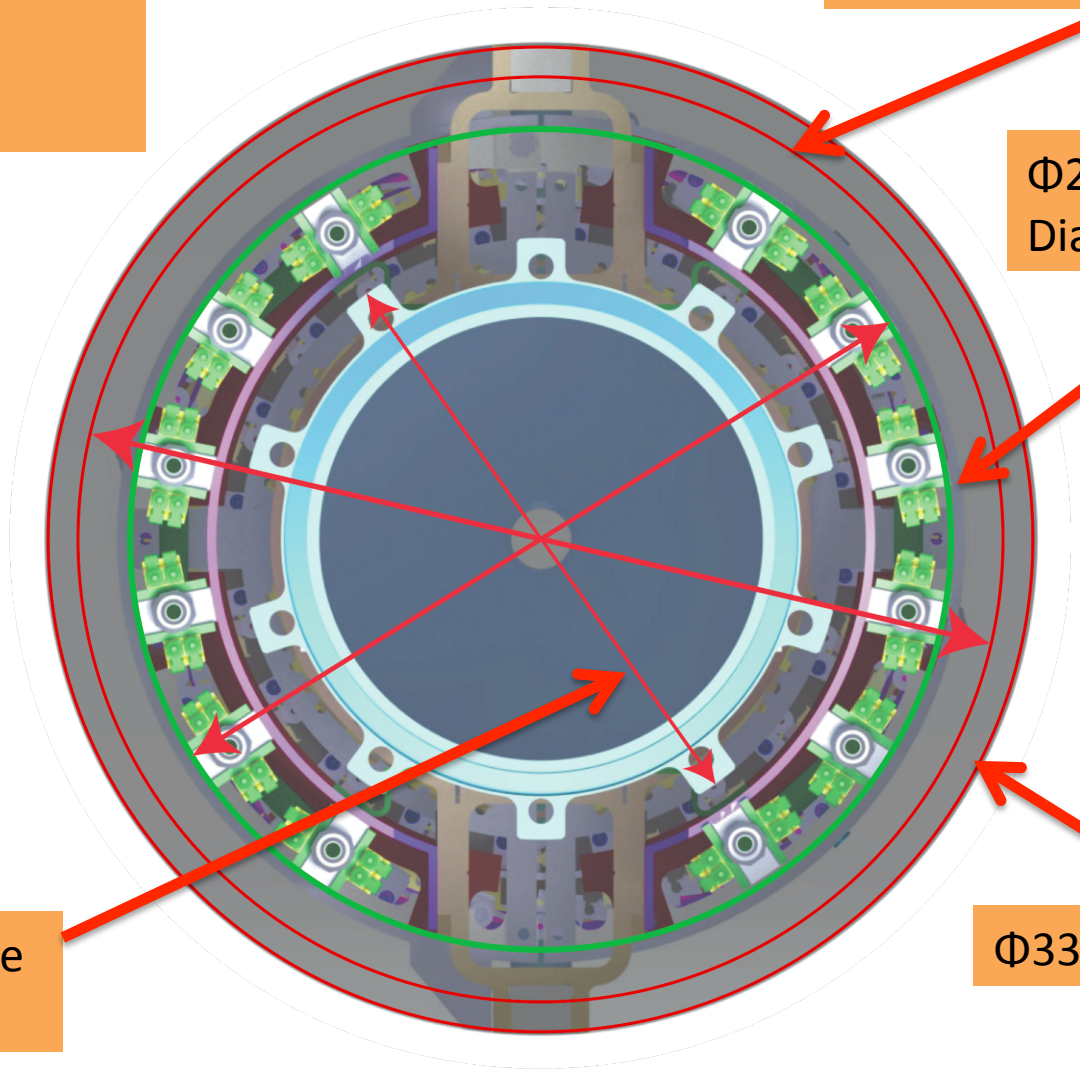


Cross sections – GBT boards

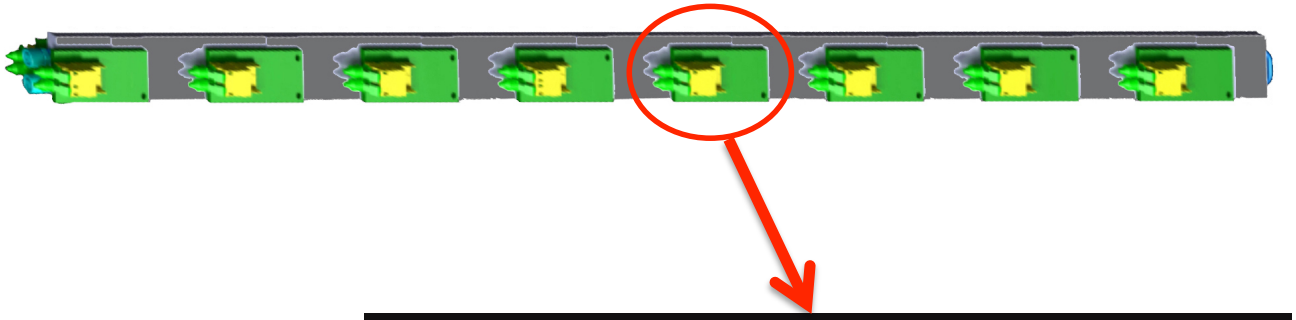
Available area for cabling Between GBT boards and MVD services limit:
~ 13000 mm^2

Cables required	4291
Raw cross section	5595 mm^2

CROSS SECTION EVALUATED WITH THE CURRENT GBT BOARD DESIGN!



Cross sections – GBT boards

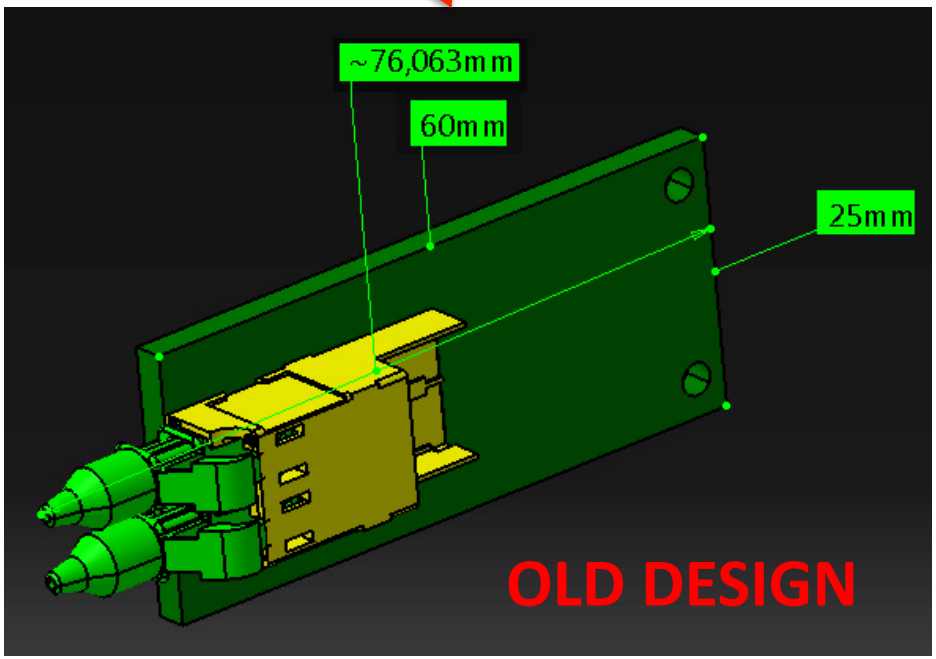


VTRx 14.5x55x10 mm^3

GBTX 17x17x1.2 mm^3

10 e-links, 3 diff. pairs each
→60 single ended lines

Necessary connectors to the MVD and eventual bundling

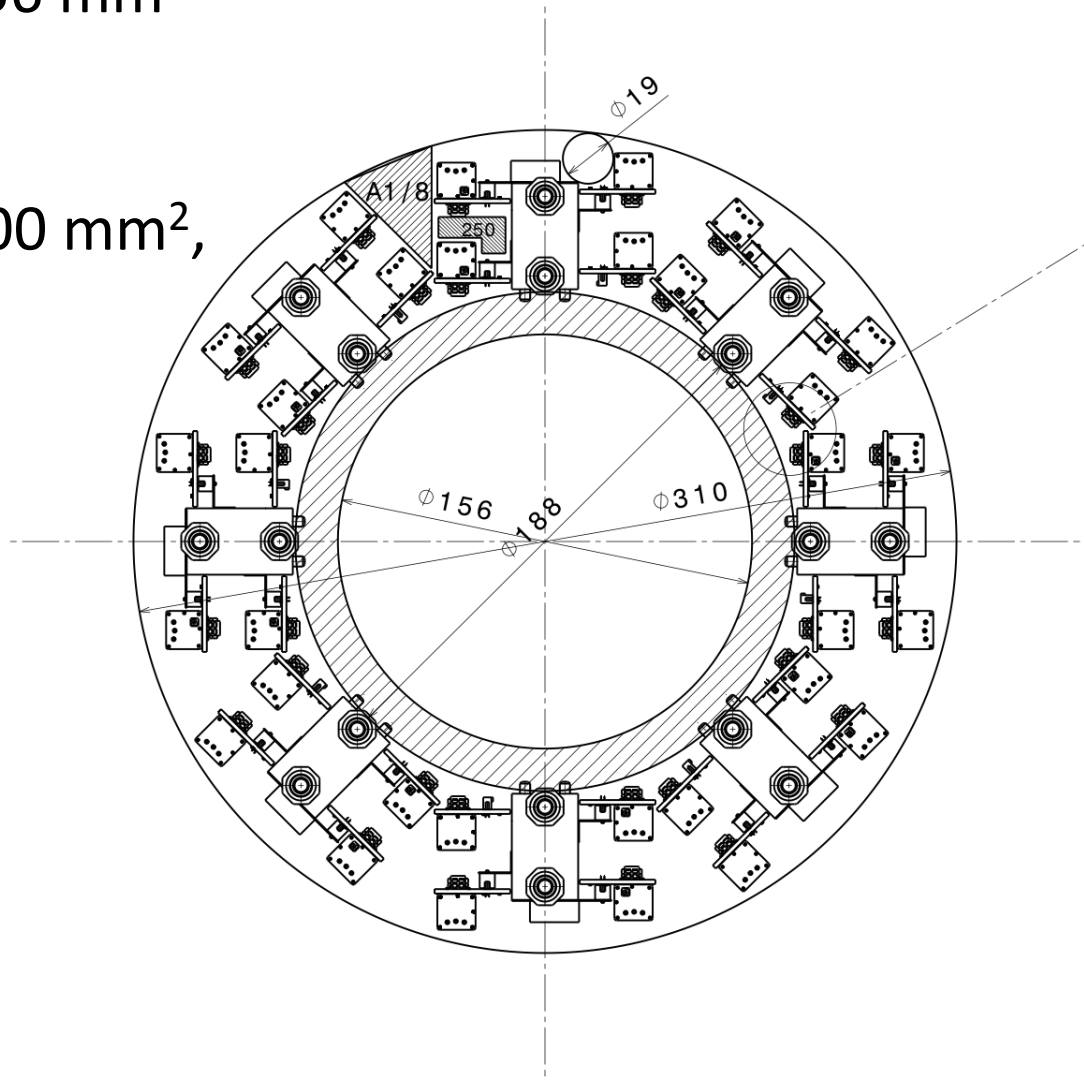


NEW DESIGN UNDER STUDY

Cross sections – DC-DC converters

- Outer beam pipe diameter: 156 mm
- MVD services limit: 310 mm

- Available cross section: ~56.000 mm^2, to be shared among cables, DC-DC staves, cooling pipes…



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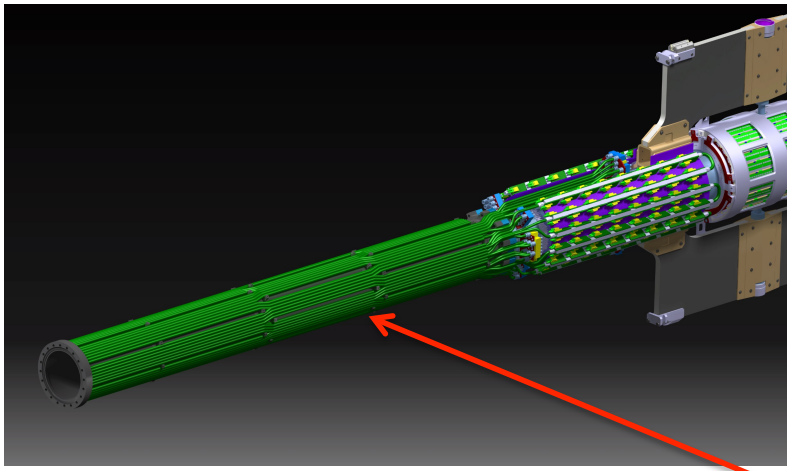
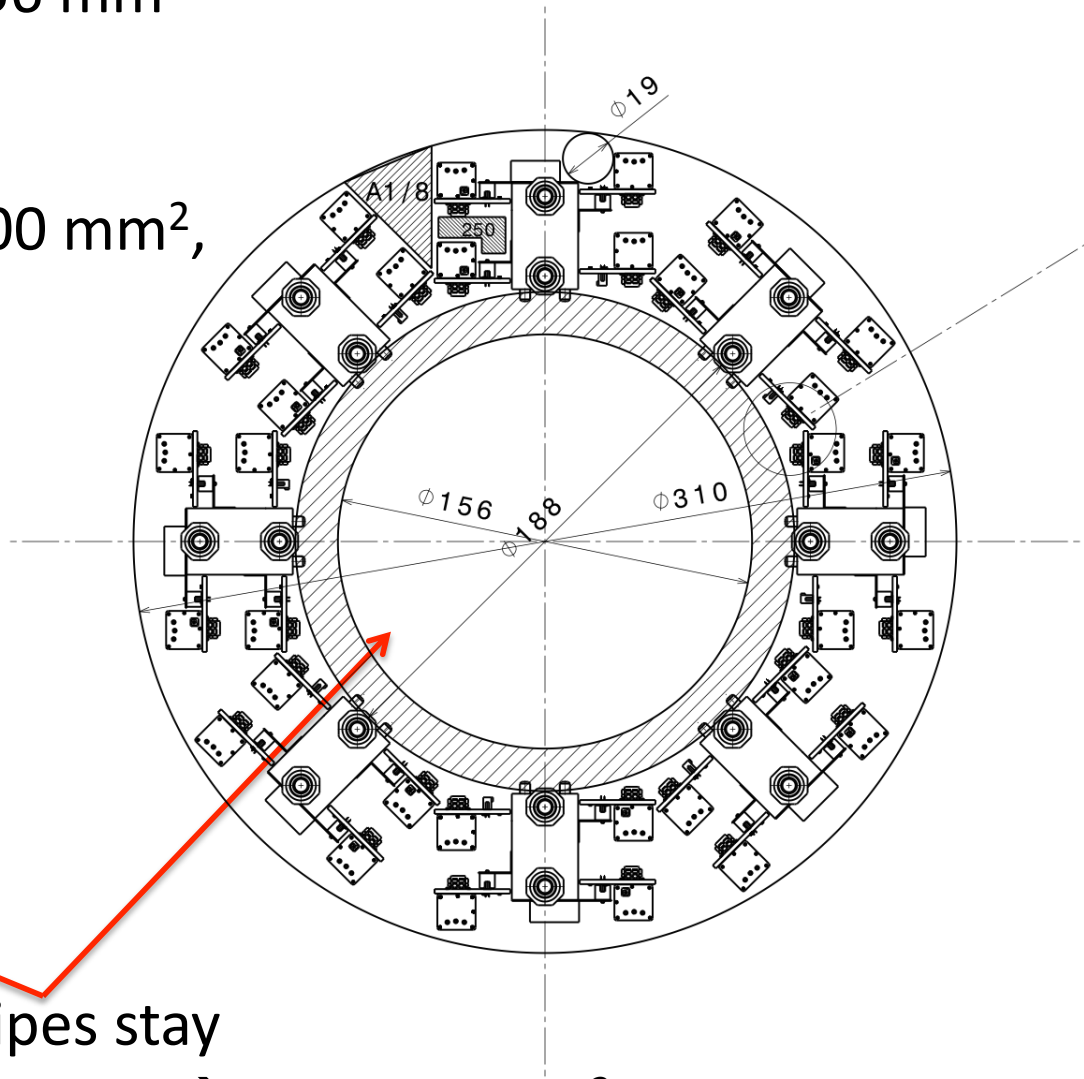




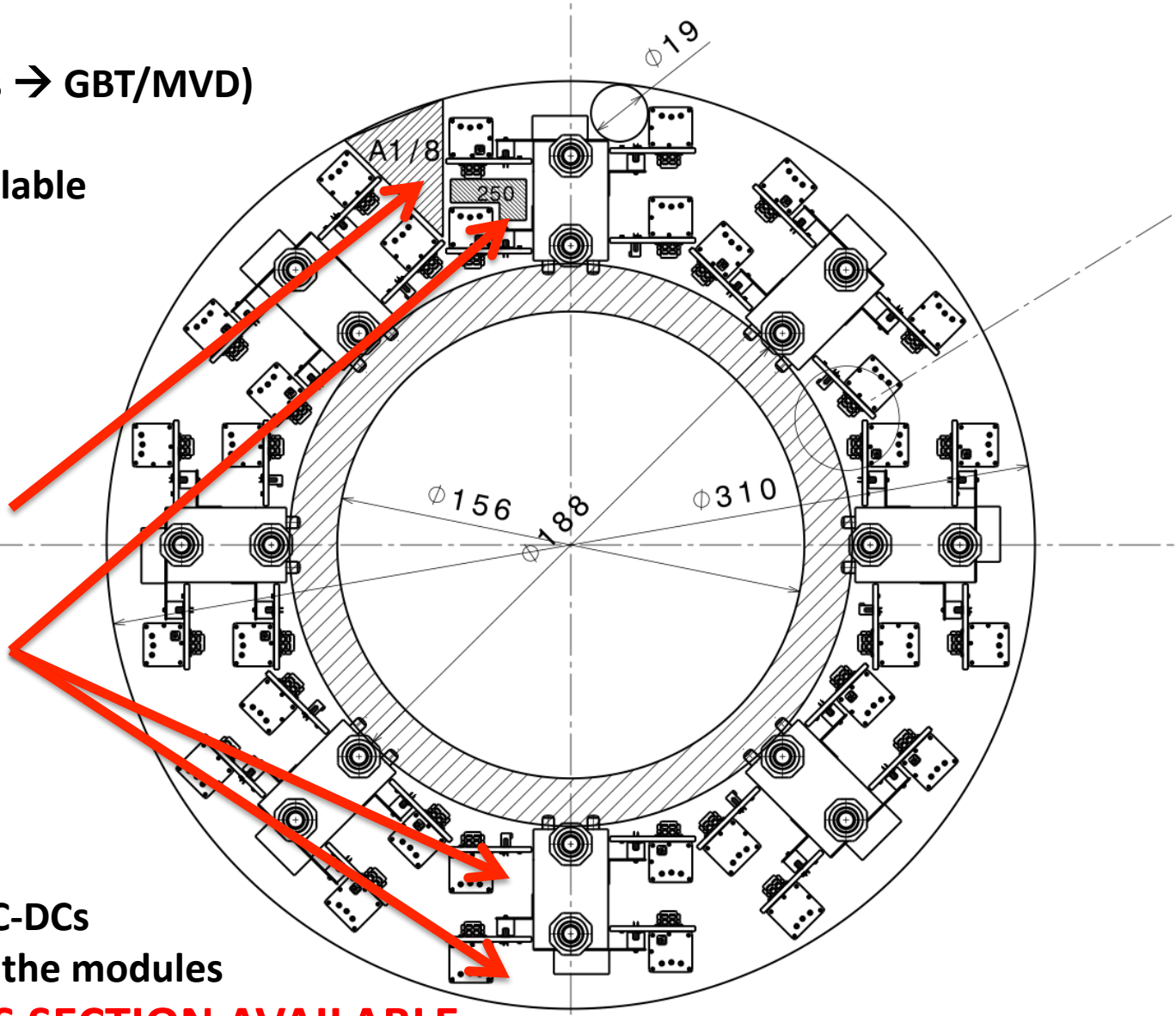
- First assumption: all cooling pipes stay in a 16 mm thick ring around the BP → ~47.000 mm² left

Cross sections – DC-DC converters

Through cables (patch panels → GBT/MVD)

8 sectors with A1/8 area available

Section name	
A1	**948 cables 5460 mm²**
A2	**300 cables 16840 mm²**
A (A1 + A2)	**1248 cables 22300 mm²**



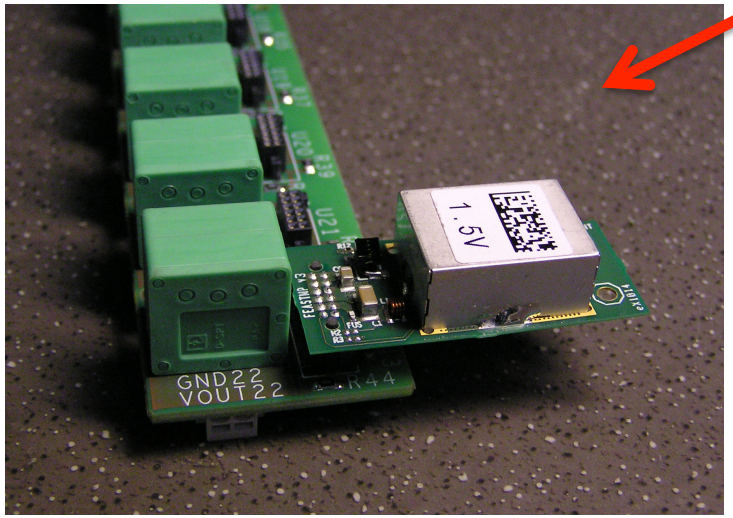
Cables from patch panels to DC-DCs
Several small sectors between the modules
ONLY HALF OF THE CROSS SECTION AVAILABLE

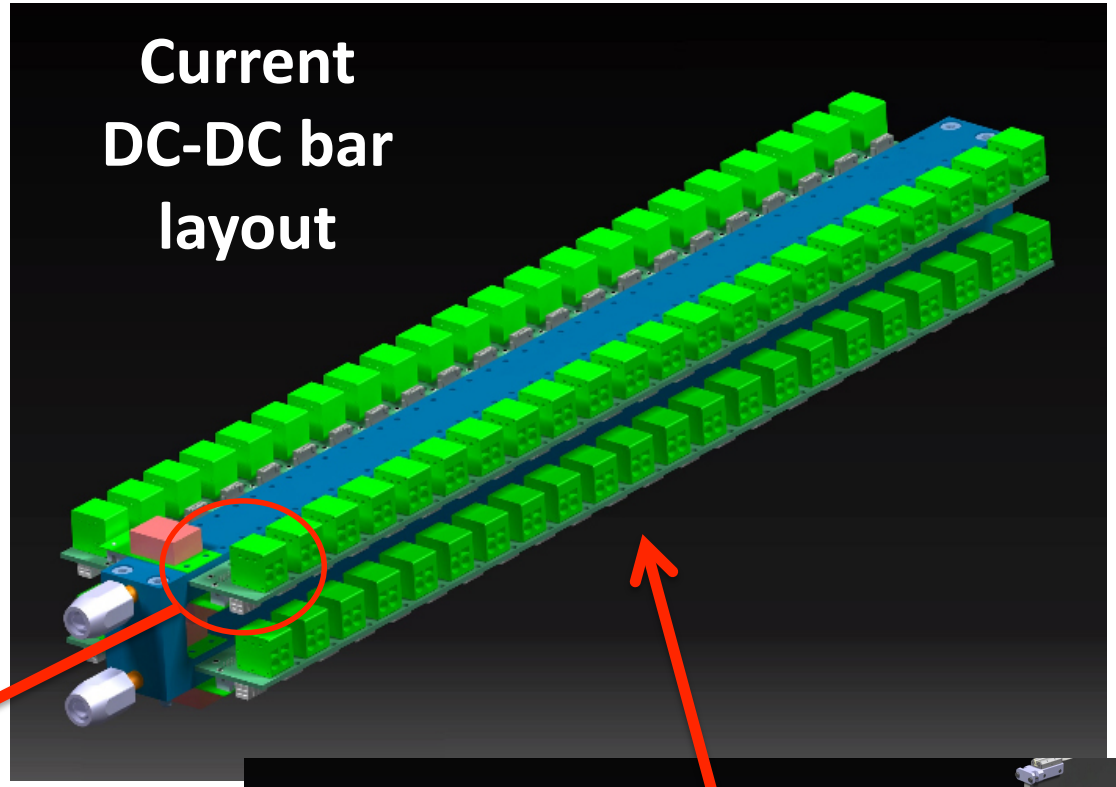
Cross sections – DC-DC converters

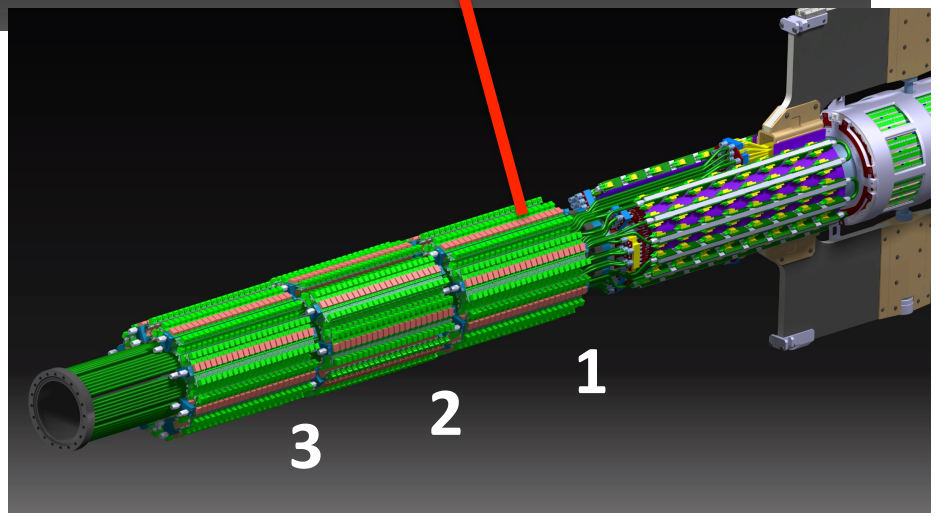
Possible modification: connector at the end of the bar for the cables to the patch panels

→ Easier installation on bar n. 3

→ Requires access to bars 1&2





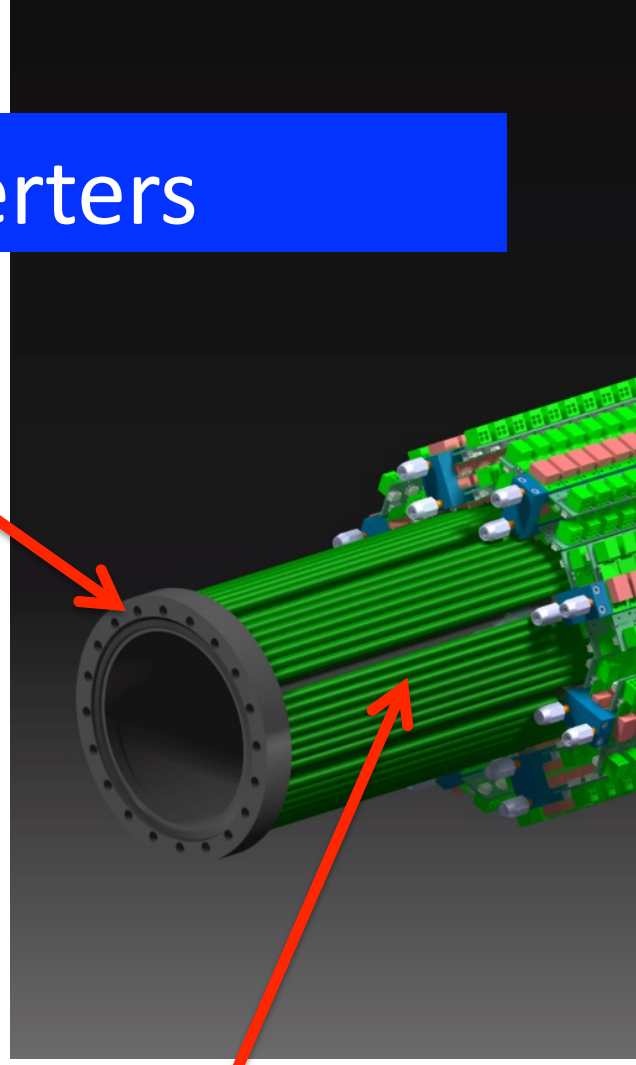


Cross sections – DC-DC converters

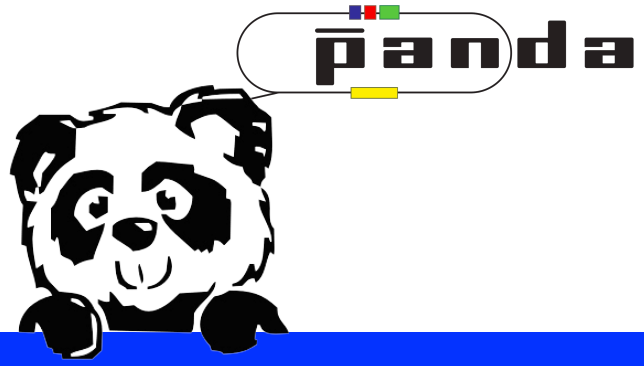
Flange diameter: 202 mm

MVD services limit: 310 mm

- Available area: ~43.500 mm^2
- Required cables:
  - 1248 cables
  - 22300 mm^2
- + cooling pipes ?



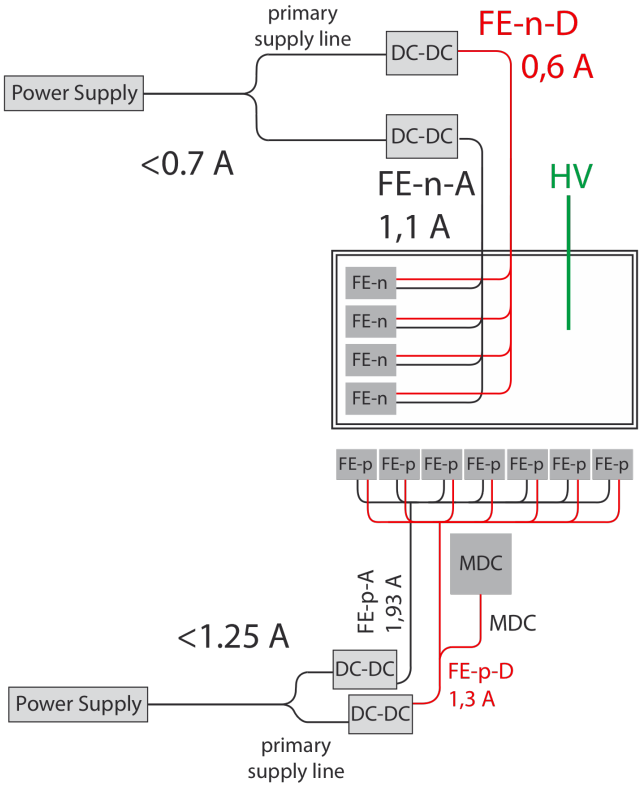
Possible location of the cooling pipes manifolds



Thank you for your attention!

Strip Powering Concept

- Each of the 296 sensors has an independent HV supply
- All PASTA chips on the same side of each sensor are connected on-stave and powered by two DC-DC converters (A+D) → total of 296 · 4 = 1184 DCDCs
- The MDC is connected on-stave to the digital line of the p-side PASTAs
  - Highest load on these lines: ~1.9 A
- The inputs of the DCDC converters are connected in pairs → total of 1184 / 2 = 592 Primary Supply Lines
  - Highest load: ~1.25 A



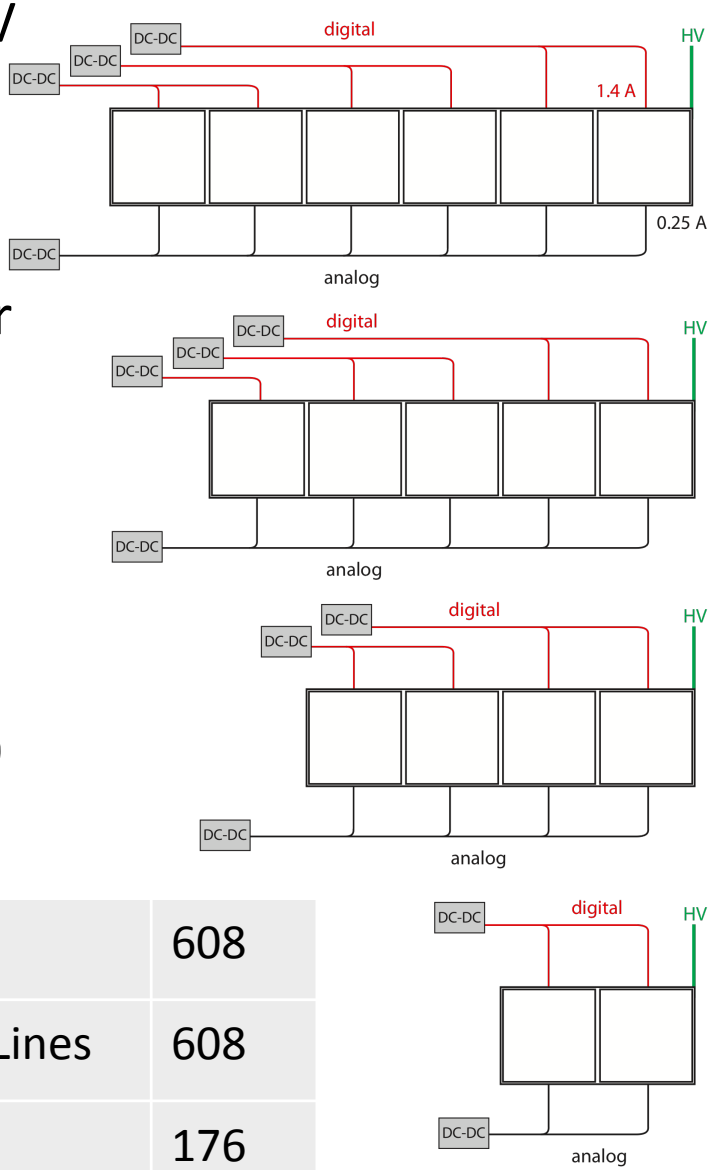
DCDC Lines	1184
Primary Supply Lines	592
HV lines	296

Pixel Powering Concept

- Each of the 176 sensors has an independent HV supply line

- Four types of sensors with 2, 4, 5, 6 ToPix
- Common analog line for all ToPix on one sensor
- One digital line serves two ToPix on the same sensor
- Each line goes to one DCDC and from there to one power supply channel

- 608 DCDC converters are needed to power 810 ToPix
  → 608 Primary Supply Lines



DCDC Lines	608
Primary Supply Lines	608
HV lines	176