FUTURE CIRCULAR COLLIDER

ALCOVES: REQUIREMENTS, INTEGRATION AND CABLING CONCEPT

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FCC week 2023

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- Electrical distribution of the alcoves
- Layout of the alcoves
- Cabling concept of the tunnel and alcoves
- Conclusion and next steps

Alcoves concept

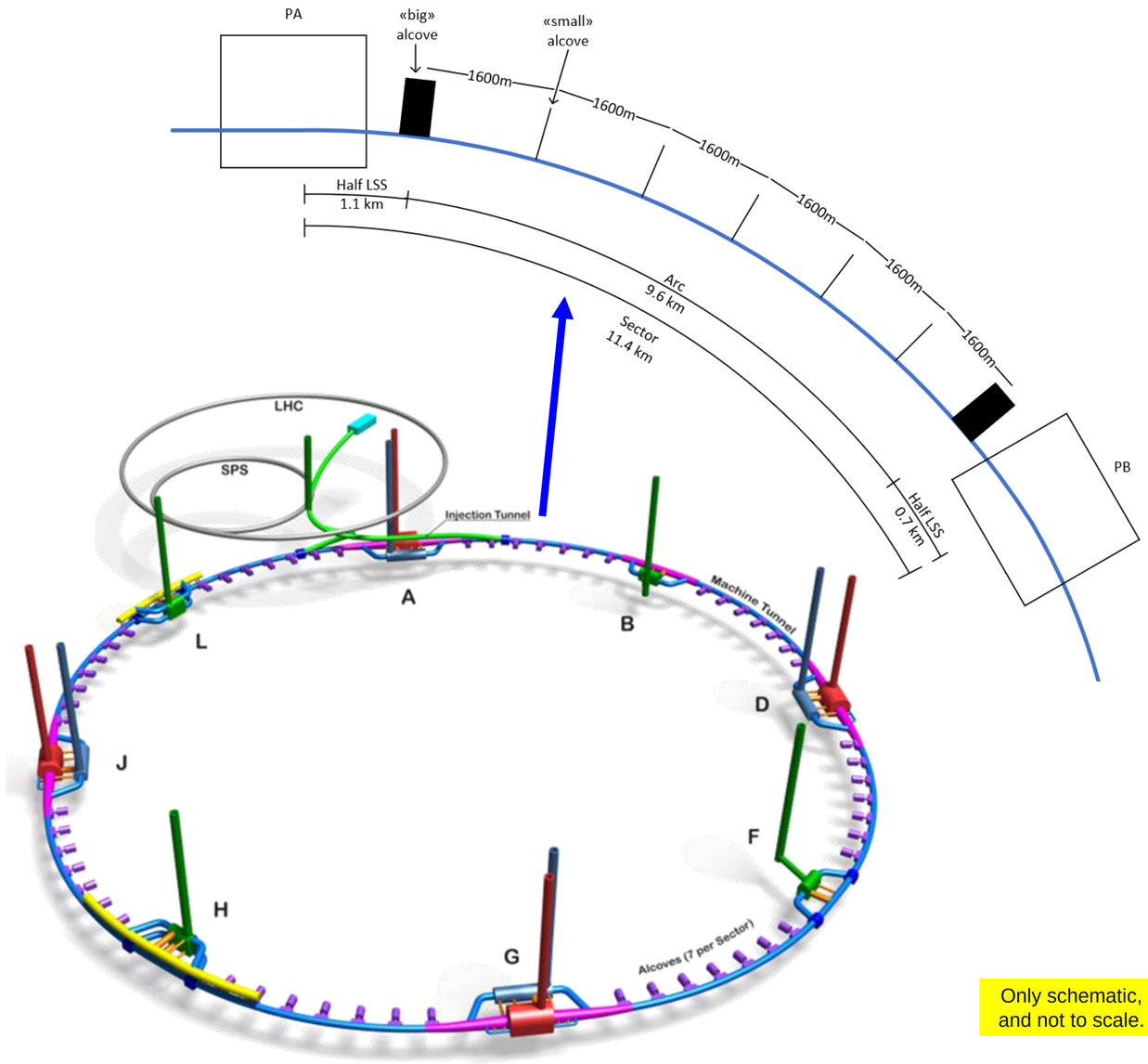
Accelerator of 91km: 1 alcove every **1,6km** (based on LHC repartition, that seems coherent for the machine)

Total of **56 alcoves** all around the machine, **7 by sector**

Role of an alcove: host the converters for the magnets of the machine and all the equipment that need to be protected from the radiations present in the tunnel (including power centers) Also serve as escape road and parking area for the transport

Two types of alcoves:

- **“big” alcoves**, that are at the end of the straight sections of each point and host the main converters for the magnets (for dipoles and quadrupoles)
- **“small” alcoves**, that are all along the arc, cover the distribution on 800m each side and host the other converters (for sextupoles)



Only schematic, and not to scale.

Alcoves concept

At a first instance, same distribution scheme as LHC for the power

Main systems supplied in each sector:

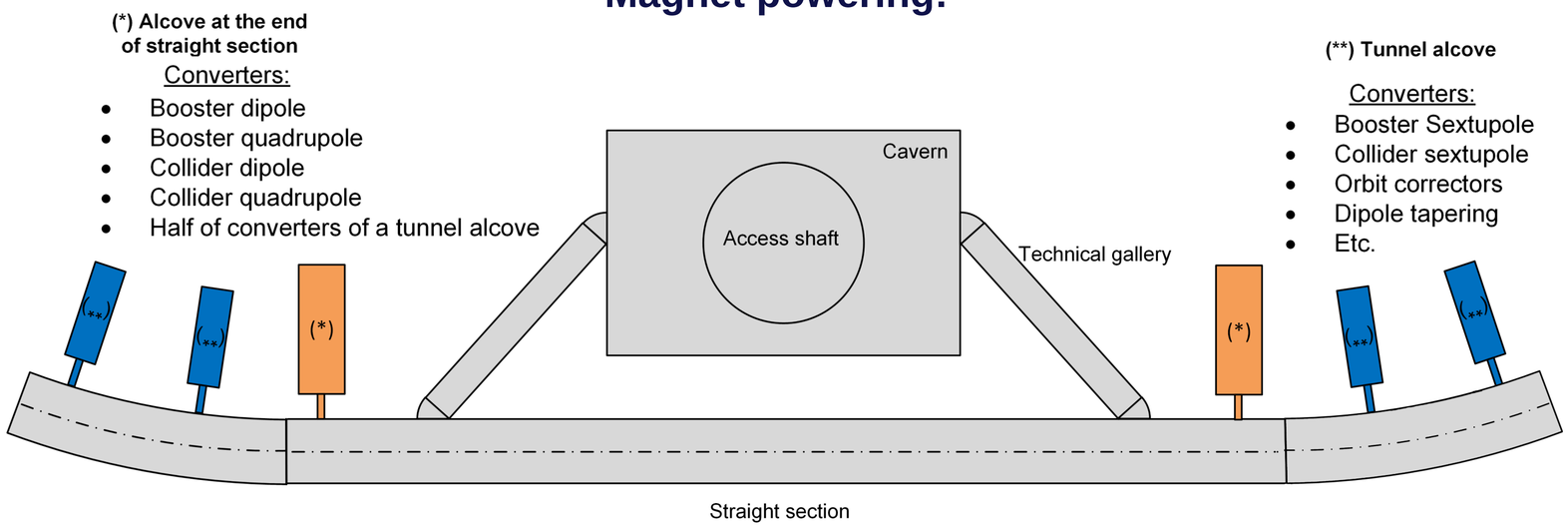
- **Lighting** (normal and emergency)
- **Power outlets** for general services and accelerator systems
- **UPS power outlets** for specific/critical accelerator systems (as vacuum, machine protection systems)
- **Magnets** (by converters)
- **Safety and control systems**

Main identified users requiring power in the alcoves:

- Power converters (EPC)
- Cryogenics (Cryo)
- Cooling and ventilation (CV)
- Transport
- Vacuum

- Other users' racks (safety, control…)

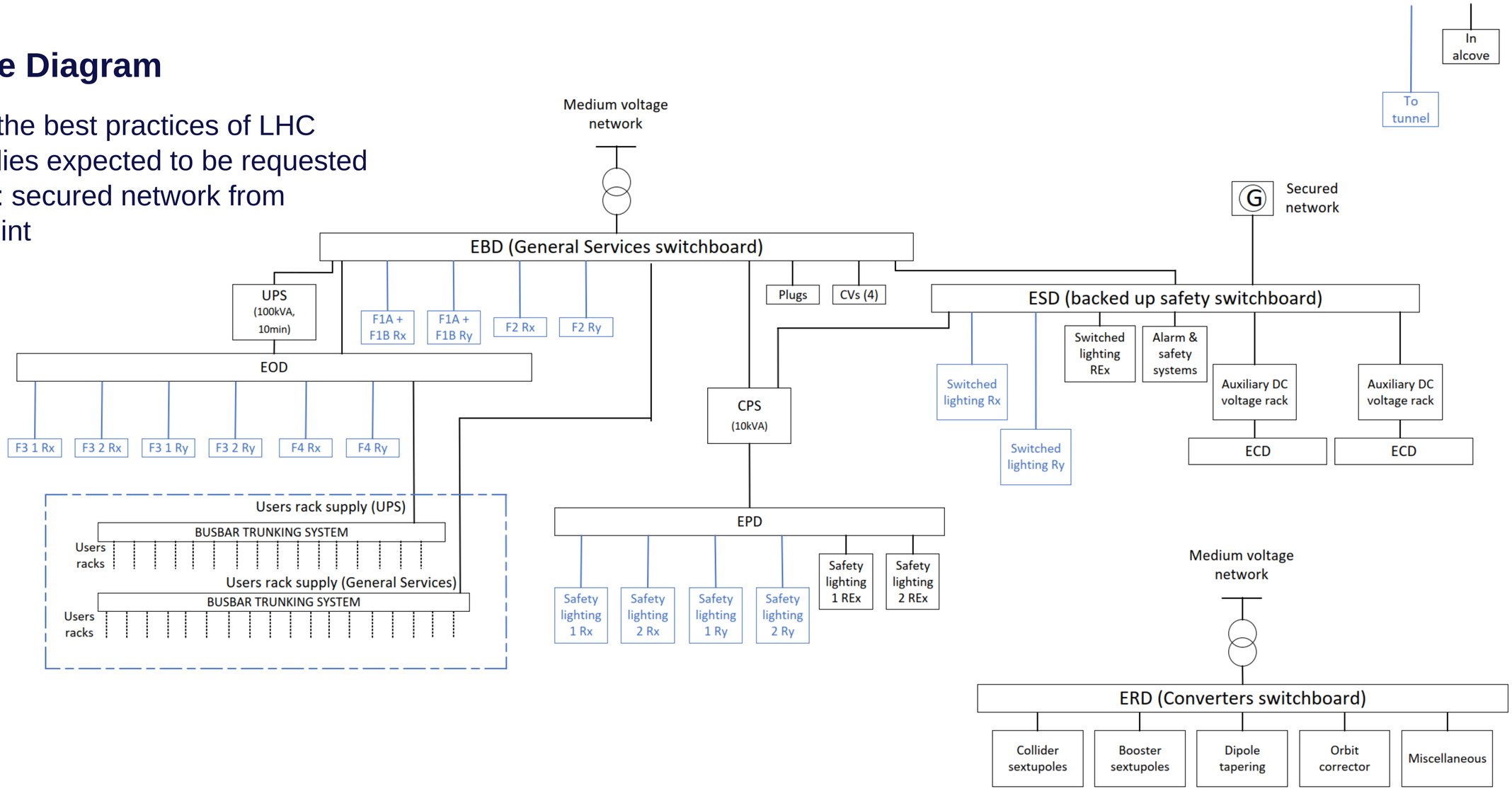
Magnet powering:



Electrical distribution of the alcoves

Single Line Diagram

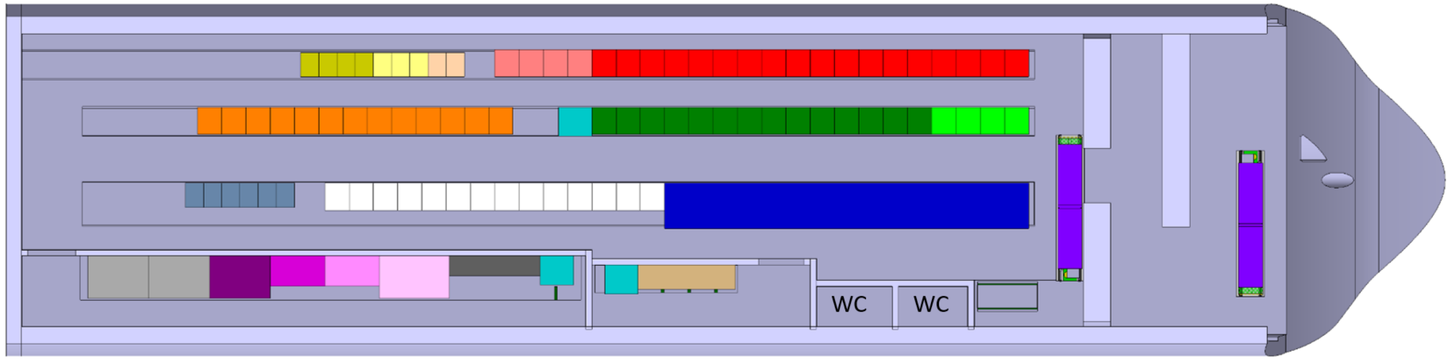
- Based on the best practices of LHC
- UPS supplies expected to be requested
- Challenge: secured network from surface point



Layout of the “small” alcoves

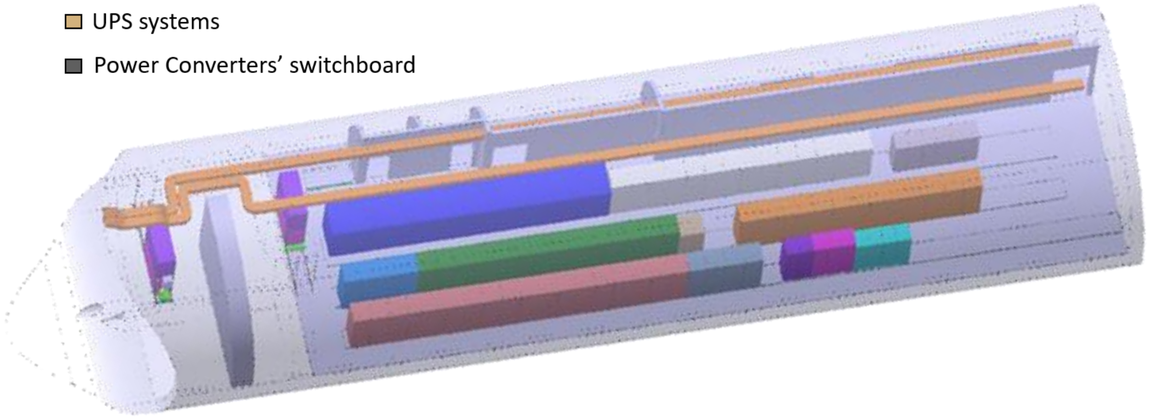
Only for electrical and power converters equipment:

Equipment	Number	Total footprint (width x depth cm)	Require access at back and front?
MV cubicles general	3	180x100 *(60x100 each)*	Yes
630 kVA transformer general	1	200x140	Yes
LV power center	1	400x140	Yes
UPS systems	2	320x80 *(160x80 each)*	Yes
CPS system	2	120x80 *(60x80 each)*	Yes
Control & fibre optic racks	3	180x80 *(60x80 each)*	Yes
MV cubicles for Power Converters	3	180x100 *(60x100 each)*	Yes
800 kVA transformer for Power Converters	1	230x150	Yes
Power Converters’ switchboard	1	300x65	No
Miscellaneous	14	1120x90 *(80x90 each)*	Yes
Orbit corrector	4	320x90 *(80x90 each)*	No
Dipole tapering	4	320x90 *(80x90 each)*	No
Booster sextupoles	14	1120x90 *(80x90 each)*	No
Collider sextupoles	18	1440x90 *(80x90 each)*	No



- User Racks
- Booster Racks
- Alarm , Light and Spare Racks
- Control and Fibre Optic Racks
- CPS System
- Orbit Racks
- Collider Racks
- Miscellaneous Racks
- Control Cubicle
- Air Handling Unit
- Cryo Racks
- Dipole tapering Racks
- UPS systems
- Power Converters’ switchboard
- LV power centre
- 630 kVA transformer general
- MV cubicles general
- MV cubicles for Power Converters
- 800 kVA transformer for Power Converters

300m² reserved for each alcove



Layout of the “small” alcoves

Other equipment than electrical may need to be in the alcoves and can take a lot of space

Example: **fire detection**

Generalized fire detection base on aspirating smoke detection (ASD) technology.
SPS example:

From T. Ladzinski (EN-AA), for Safety Systems in the FCC Arcs

This would require:

- ~15 tubes/alcove
- 1 ASD per tube
- 1 CIE (central) of Fire Detection/alcove

→ Heavy for the space occupation of the alcove

Layout of the “big” alcoves

Half of a classic alcove: it covers the first 800m of the arc
+
Converters for the magnets in series of half of the arc

For FCC-ee:

Converter type	Basic ratings	Required space
Collider dipole magnet circuit 2 converters per access point	950 kW – 250 V – 3.8 kA	≈45 m2
Collider quad magnet circuit 4 converters per access point 2 x QF + 2 x QD	750 kW – 1500 V – 500 A	≈104 m2
Booster dipole magnet circuit 2 converters per access point	1500 kW – 400 V – 3.8 kA	≈52 m2
Booster quad magnet circuit 4 converters per access point 2 x QF + 2 x QD	1000 kW – 2000 V – 500 A	≈120 m2

Integration, with the other equipment required in these alcoves, needs to be done

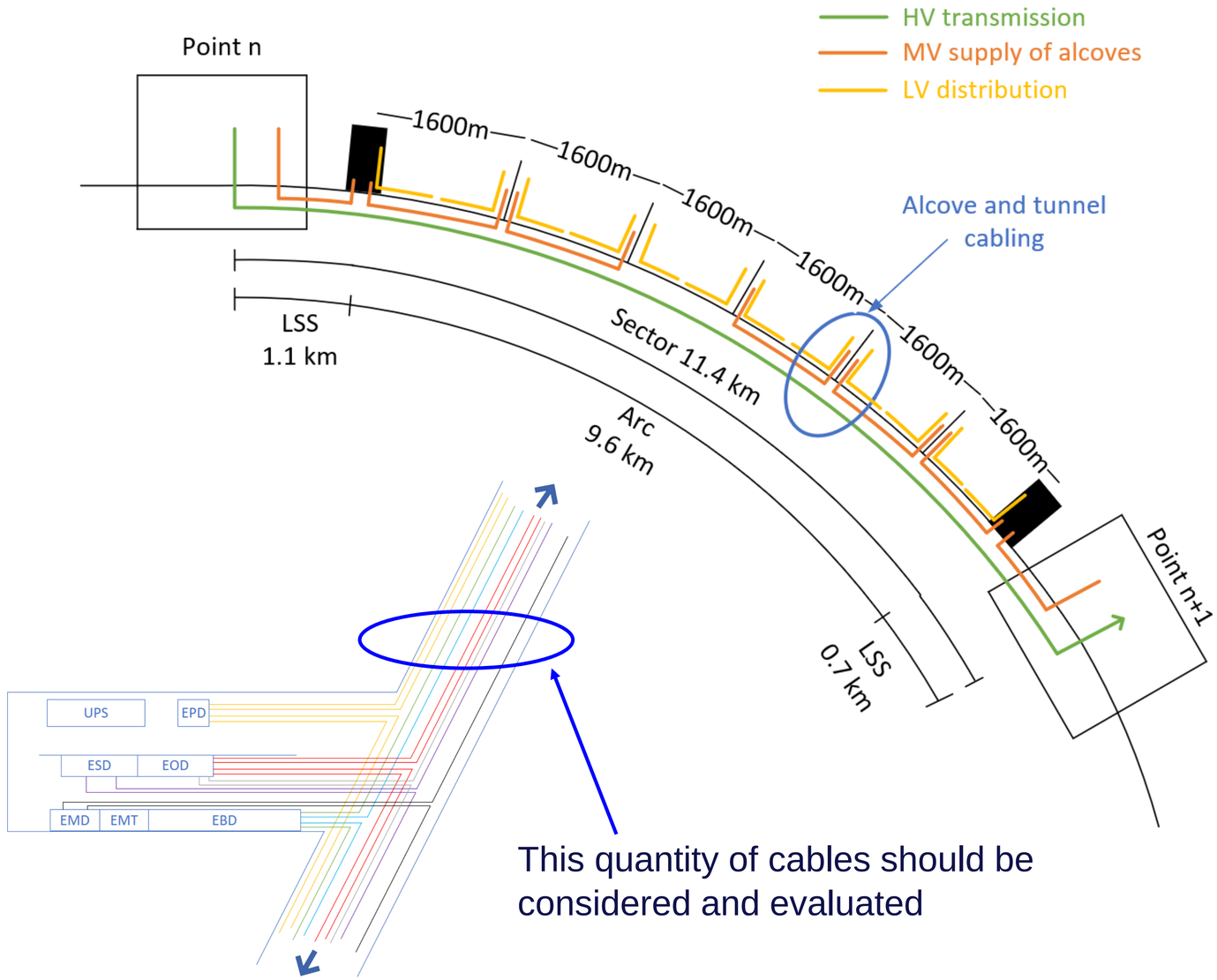
But space dedicated to these alcoves is already reserved by civil engineering (**900m²**)

Cabling concept of the tunnel and alcoves

General concept

- Each point supplies the alcoves of half arc in MV, with the possibility to re-supply the second half
- Each alcove serves the 1,6km around it, 800m on both sides, with UPS supplies, general services, control cables
- In principle, the control and communication interconnections among alcoves should be in Optical Fiber
- Analysis ongoing to merge Power Converters and other electrical loads under the same network

Based on LHC, only for power supplies, lighting and power outlets:



Cabling concept of the tunnel and alcoves

Cables listing

Collecting cables needs from **users**, some start to be known, with preliminary design concepts:

User	Load		Cable type	Diameter per cable (mm)	Quantity of cables per alcove
Vacuum	Colliders + booster	ion pumps	1x 0,63(HV) + 2x 0,25 mm2 Cu	10,7	36
		NEG (power)	3x 2,5 mm2 Cu	13	64
		Penning	3-axis 0,8/8,4 mm Cu	10,3	24
		Pirani	1x 4x1 mm2 Cu	6,5	24
		BA power	6x 2x0,75 mm2 Cu	14,5	12
		BA collector	3-axis 0,5/5,7 mm Cu	7	12
		Sector valve	6x 2x0,75 mm2 Cu	14,5	12
		Profibus	2x 1x0,35 mm2 Cu	8	2
Safety	Sector doors		13x 2x0,5 mm2 Cu	17	1
	Fire doors	magnet	2x1,5 mm2 Cu	10,5	5
		position contacts	1x 2x1 mm2 Cu	5	5
		flashing lights	4x1,5 mm2 Cu	10,5	5
	Call points	break-the-glass	1x 2x1 mm2 Cu	5	4
		telephones	1x 4x0,6 mm2 Cu	7,4	4
	Evacuation	voice alarm	2x2,5 mm2 Cu	13	
Magnets powering	DC cables				
Other users	?				

For more details, presentation on Thursday 8th June at 9:42am “Powering of magnet concept and requirements”

Not yet developed

Powering cables

based on LHC distribution in the tunnel & estimation of needs of the FCC

Name	Cable type	Diameter per cable (mm)	Quantity of cables per alcove
Standard lighting	5x16 mm2 Cu	29,5	2
Sa			4
Power out			2
Power outlets on UPS	3x 1x240 + 1x120 mm2 Cu	3x27 + 1x21	4
HV transmission loop	?	?	?
MV supply for alcove	3x 1x400 + 1x120 mm2 Cu	3x50 + 1x21	4
Secured network supply	?	?	?
A.U. (emergency electrical stops link)	14x 2x1 mm2 Cu	20,5	2

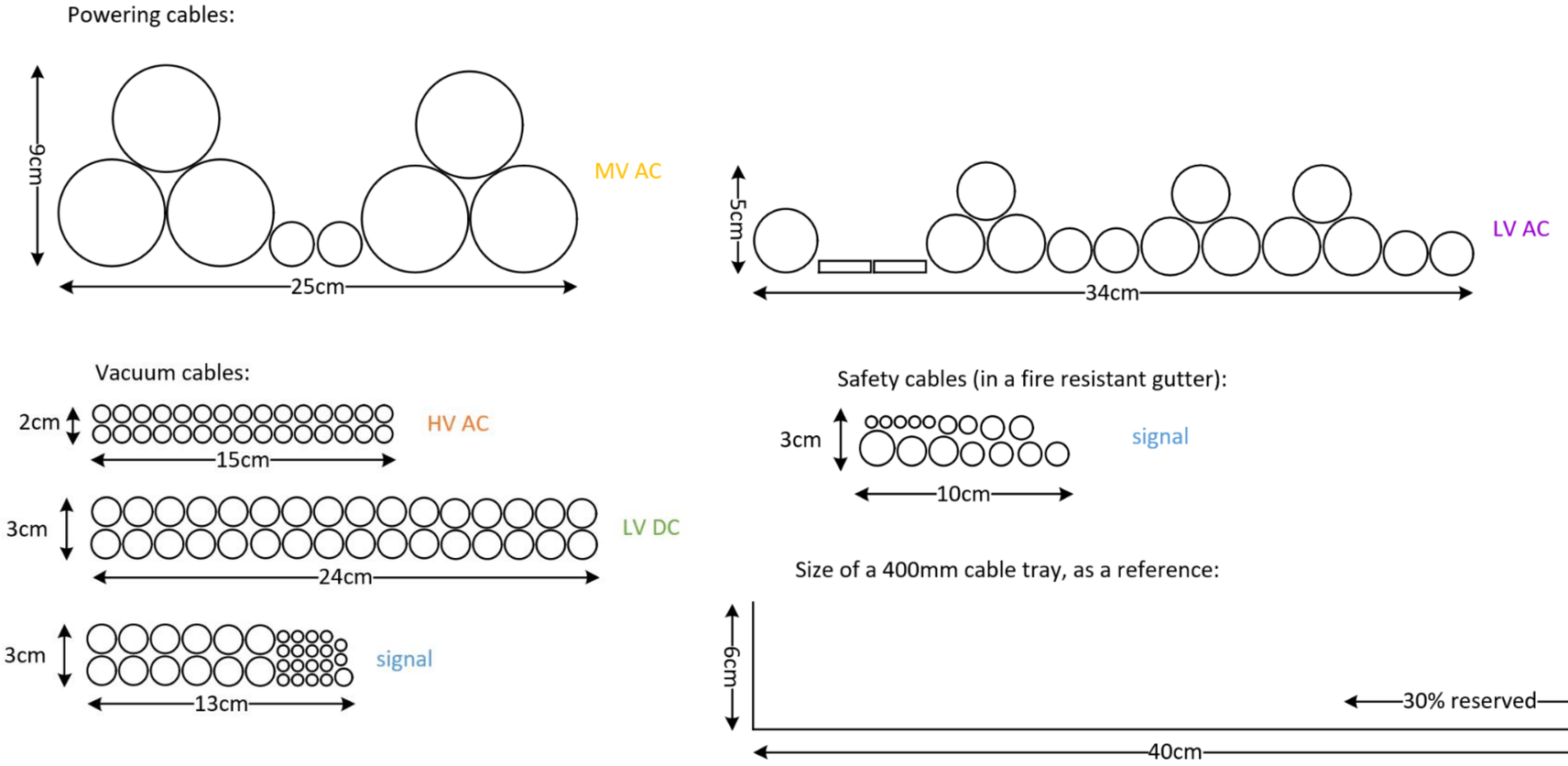
For HV transmission loop: voltage level to be defined first, for more details, presentation on Thursday 8th June at 9:06am “Electrical distribution concept and layout”

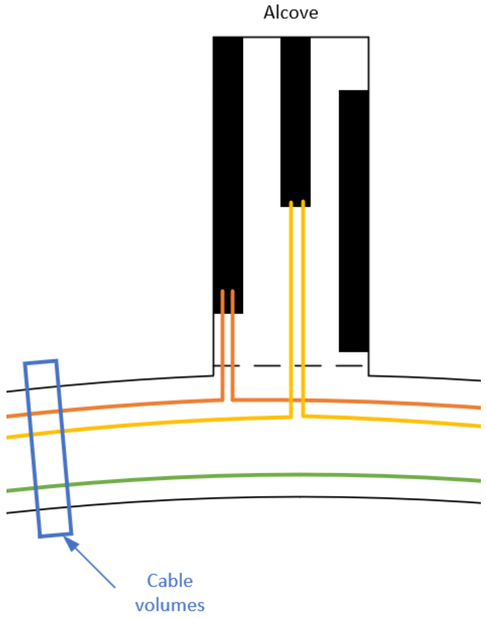
To be studied

Cabling concept of the tunnel and alcoves

Cables volumes

Cables going out of the alcove to the tunnel on one side (covering 800m)





Already not negligeable volume of cables and:
+ Optical Fiber to evaluate
+ DC cabling
+ more to come from other users…

Conclusion and next steps

Today

- Concept of the alcoves and their recurrence is **defined** and fixed for the civil engineering (spaces reserved)
- Electrical distribution and layout of the alcoves in the arc **well developed**

- Electrical distribution concept of the tunnel **well developed**

- **Document released** on the preliminary study of the technical requirements for the alcoves: https://edms.cern.ch/ui/#!master/navigator/document?P:100891083:101222647:subDocs

In the future

- Characteristics of the first alcoves at the end of the straight sections **still to be detailed**
- Iterations to update the integration of alcoves, especially for the big ones **still to be performed**

- **Development** of the needs of fibre optics and users' cables
- Definition of cable trays in the tunnel and update of integration **still to be performed**

- The optimization of the split between general services and converters supply **will be analyzed**

Thank you for your attention