



EPC - Overall optimization of magnet powering

SY-FCC workshop

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- **Objectives**
- **Need for global optimization**
- **Today's status**
- **Missing items**

Objectives – Powering all magnets (collider+boost.)

- **Our deliverables are:**

- Defining locations and volume of each power converter for CE integration → important for pre-TDR
- Provide a cost estimate of all power converters → important for FS & pre-TDR era

- **To achieve this → need defining powering needs & circuits configuration**

- **“Powering needs” means:**

- Voltage & currents → no. of power converters per magnet team (number of magnets)
- Guarantee a minimum “precision”
- Min. availability → Deciding level of redundancy & reliability
- Etc.

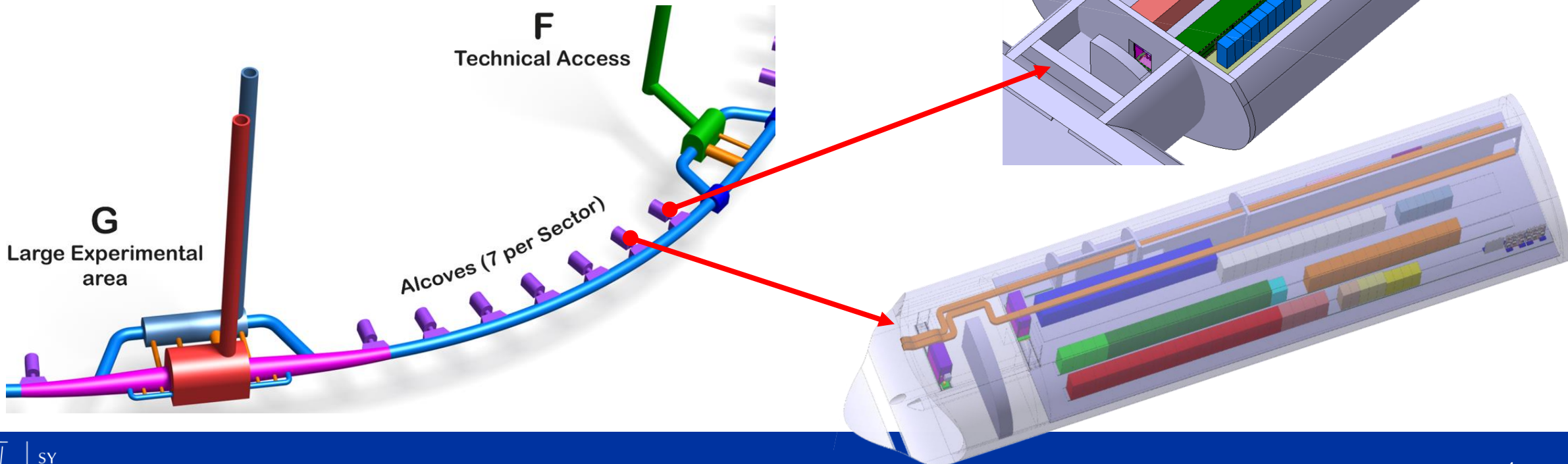
- **“Circuits configuration/layout” means:**

- Defining power converter's locations
- Defining max cable distance
- Deciding if magnets can be put in series or not
- Checking if putting trim converters can be convenient
- Etc.

All this minimizing CAPEX & OPEX

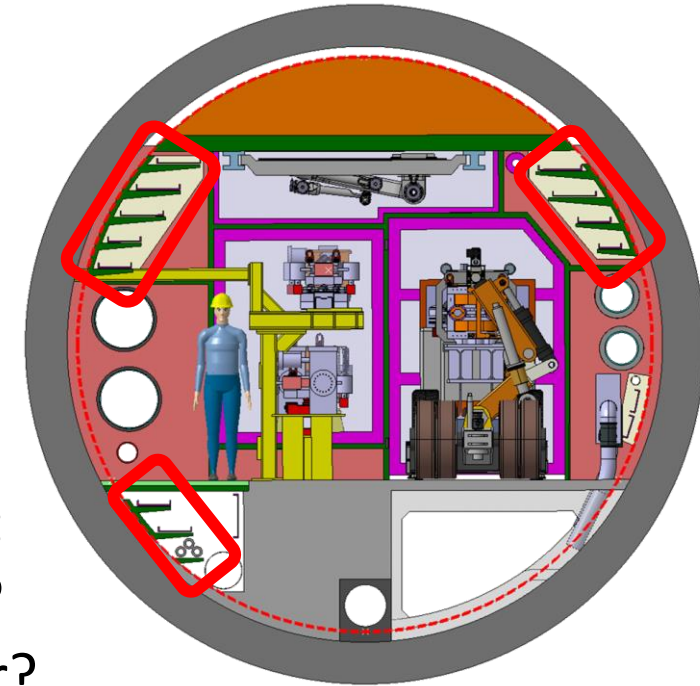
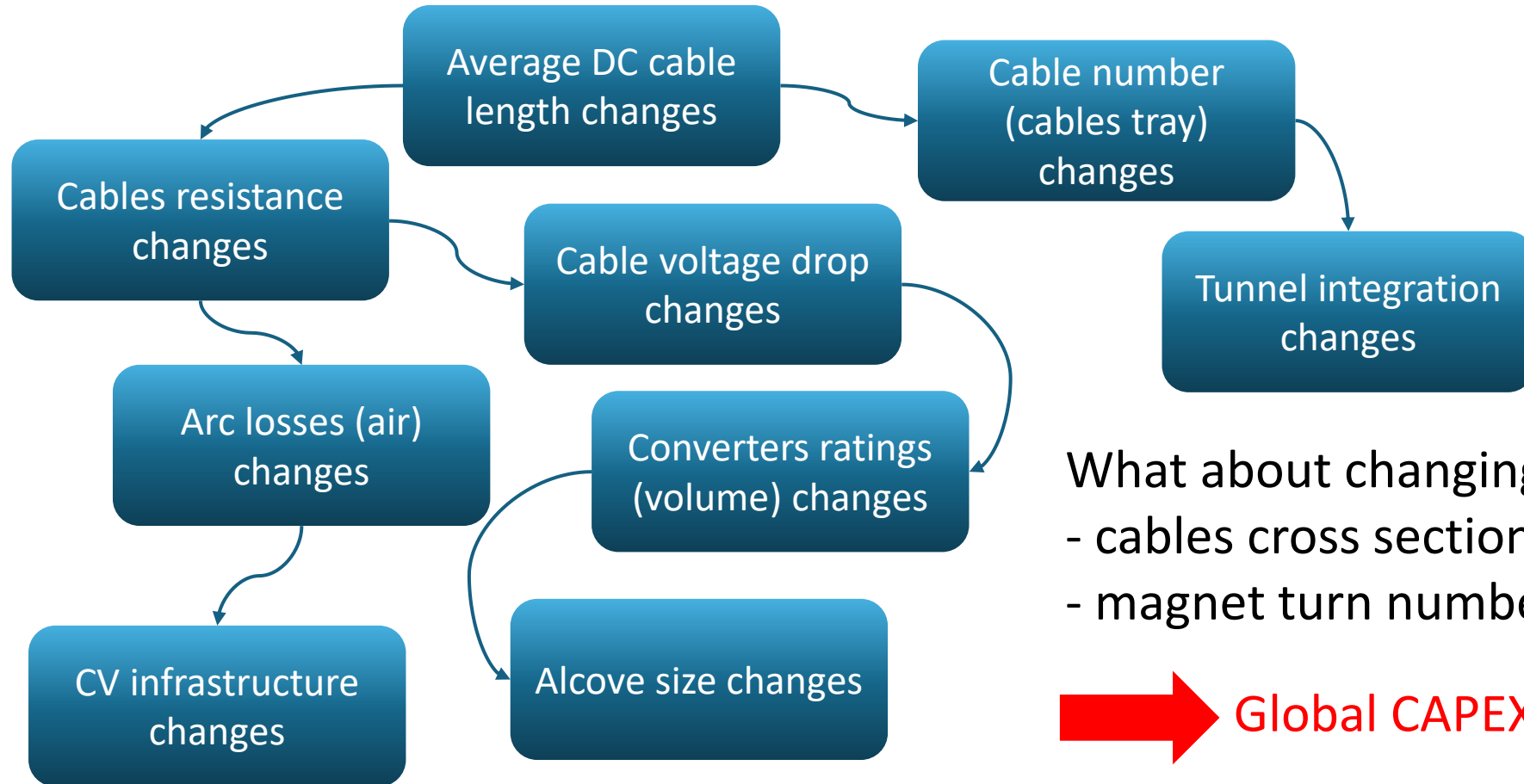
Objectives – Powering all magnets (collider+boost.)

- One of the first questions we tried to answer
 - Where to place power converters? (alcoves vs. near access points vs. under beamline)
 - Why 7 alcoves / arc? Is it a “good” number?
 - What is the cables volume in the tunnel to power all magnets?



Absolute need for a global optimization approach

- Addressing the question regarding converters placement or number of alcoves

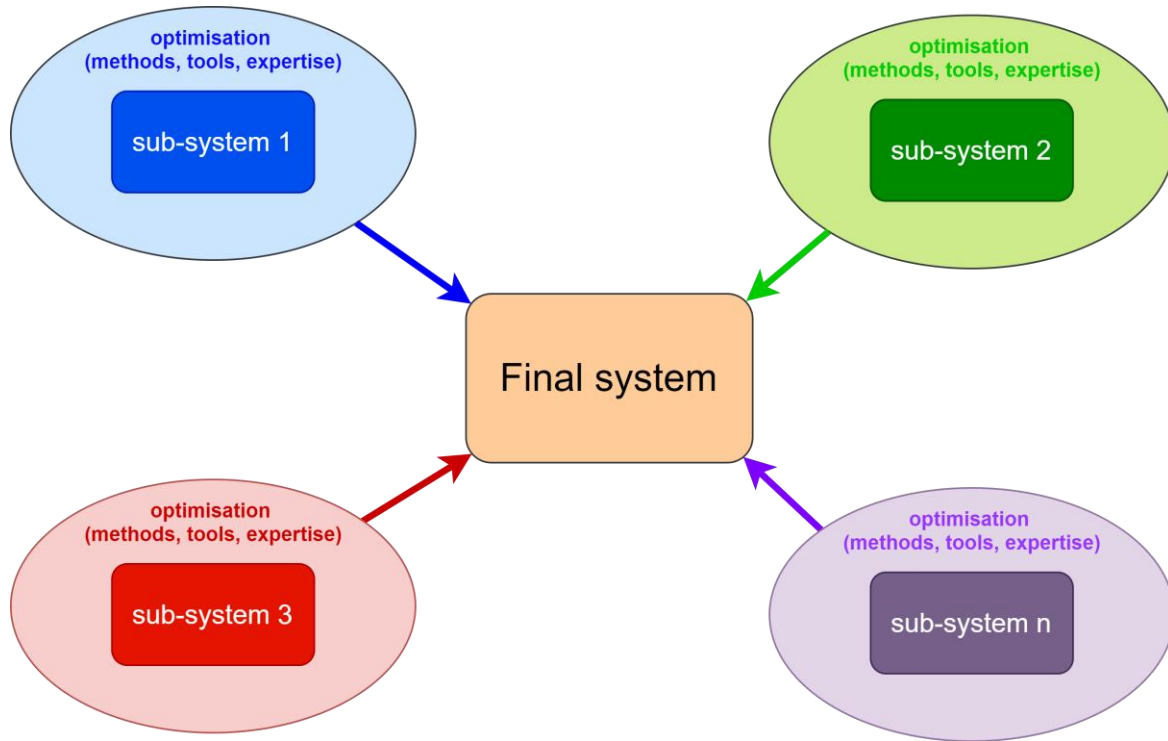


What about changing:
- cables cross section?
- magnet turn number?

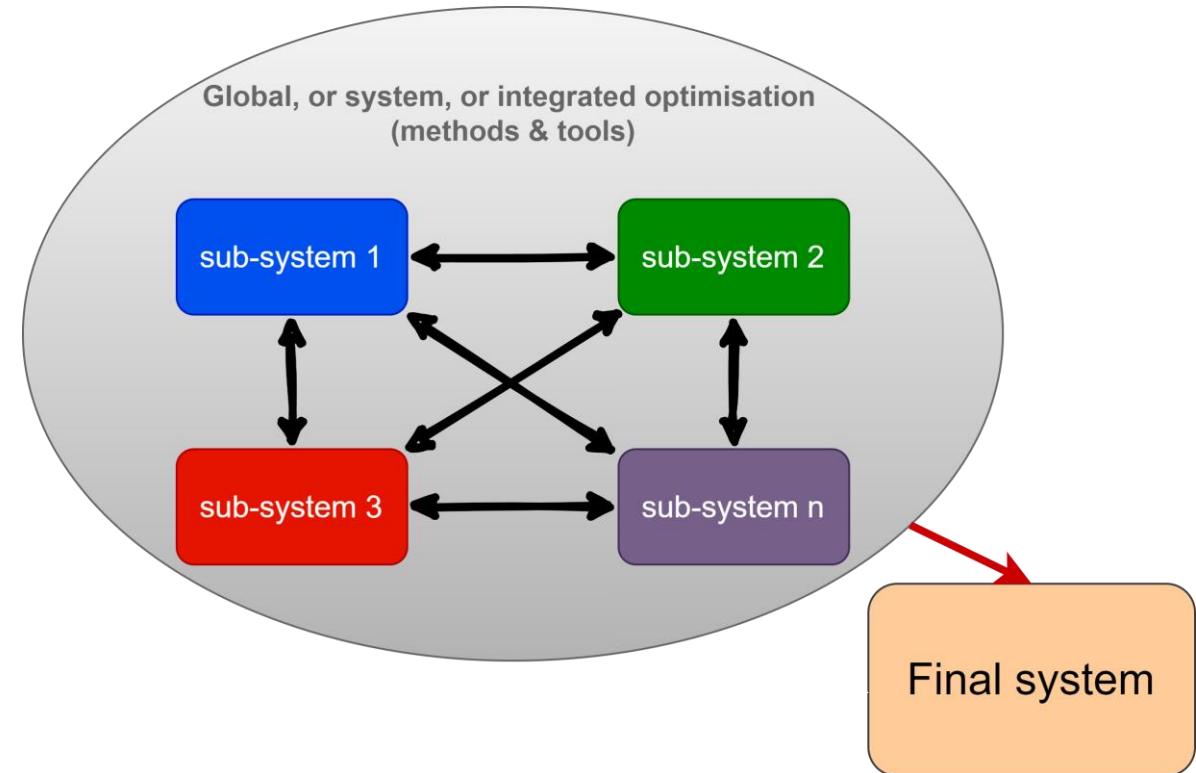
➔ Global CAPEX-OPEX optim. necessary!

Absolute need for a global optimization approach

- Changing the way we approach projects: organization by equipment groups but...



Even with accurate sub-system models, the final system is not optimised



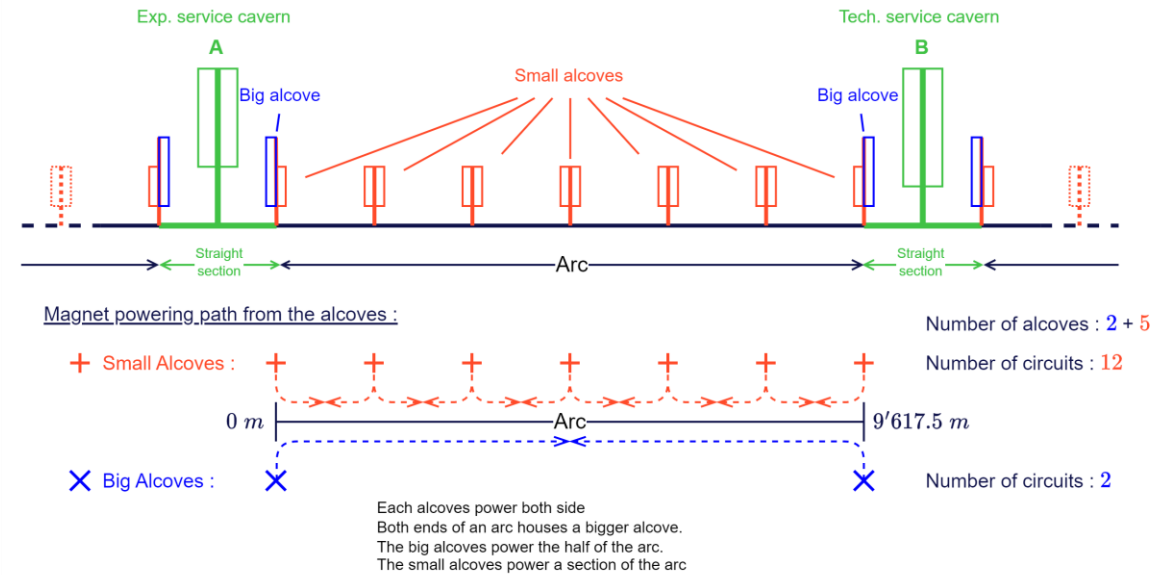
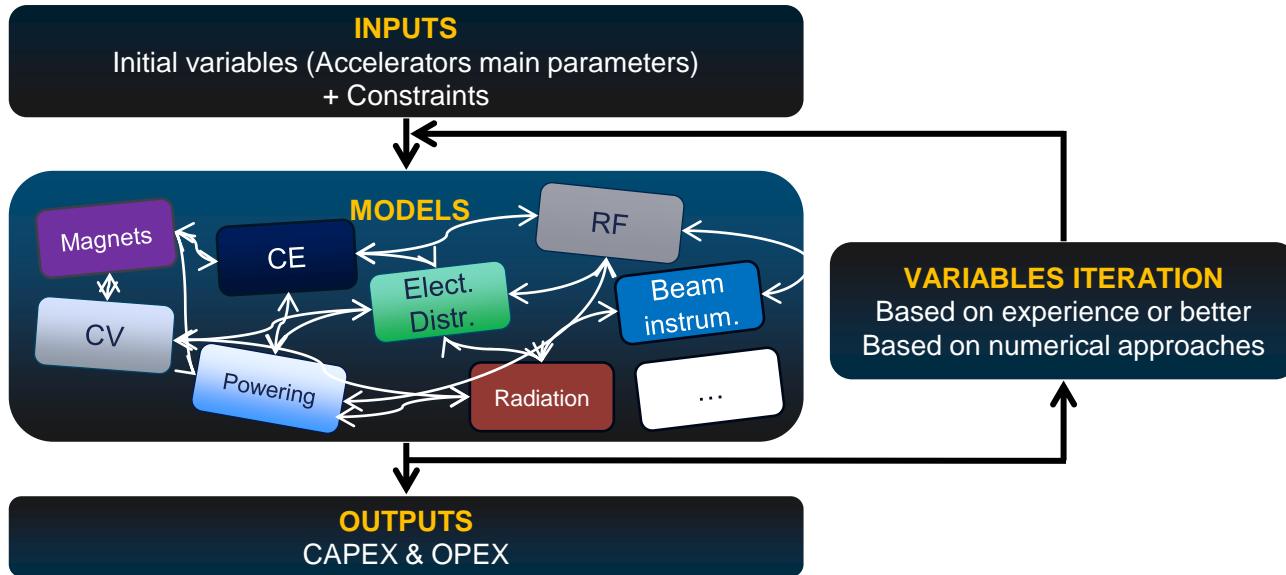
Even with inaccurate sub-system models, the final system is much closer to an optimised solution!

Today's status

- We know where to place power converters
- Magnet functions probably fixed for collider?
- Global design tool exists and is heavily used
 - Gathered CAPEX&OPEX models form MSC, CV, SCE, EPC

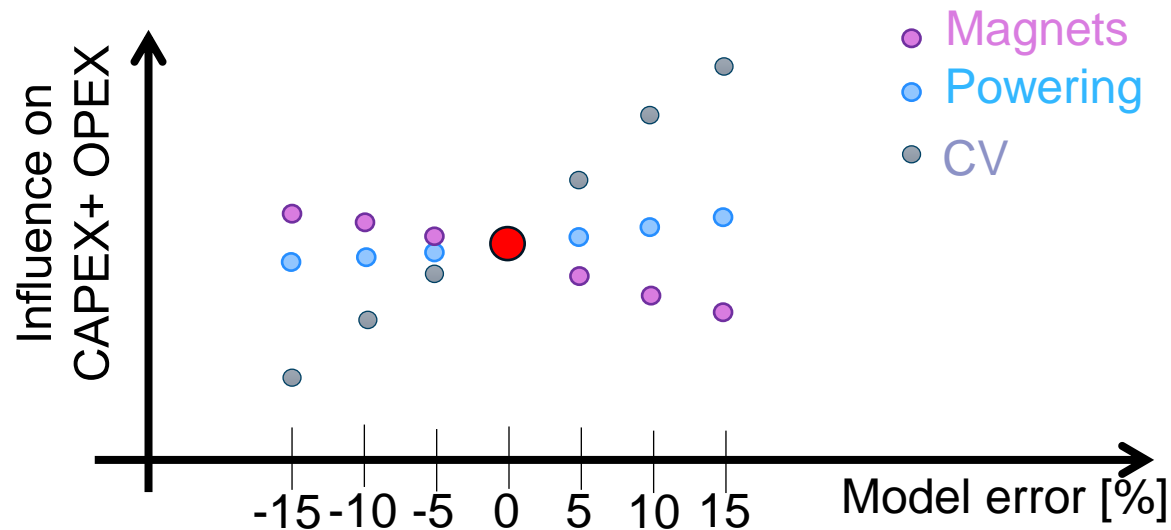
Collider's Functions		Collider's Magnets		Magnets powering emplacement					
		N° main Coil	N° aux. Coil		Big Alcoves	Small Alcoves			
Dipole		Dipoles	2 840	5 680	×				
Focusing Quadrupole		Quadrupoles	2 840	5 680	×				
Defocusing Quadrupole		Sextupoles	2 824	8 472		+			
Sextupole Fam. 1		↓ Sextupoles per beam line : 1 128 double + 284 single					+		
Sextupole Fam. 2..3..4..									+
Sextupole Fam. 8									+
Dipole Tapering									+
Quadrupole Tapering									
Horizontal Correction									
Vertical Correction									
Skew Quadrupole									

		Big Alcoves	Small Alcoves
Collider	Dipoles	×	
	Quadrupoles	×	
	Sextupoles		+
	Horizontal Correctors		+
	Vertical Correctors		+
	Skew Quadrupoles		+
Booster	Dipoles	×	
	Quadrupoles	×	
	Sextupoles	×	
	Horizontal Correctors		+
	Vertical Correctors		+
	Quadrupole Correctors		+

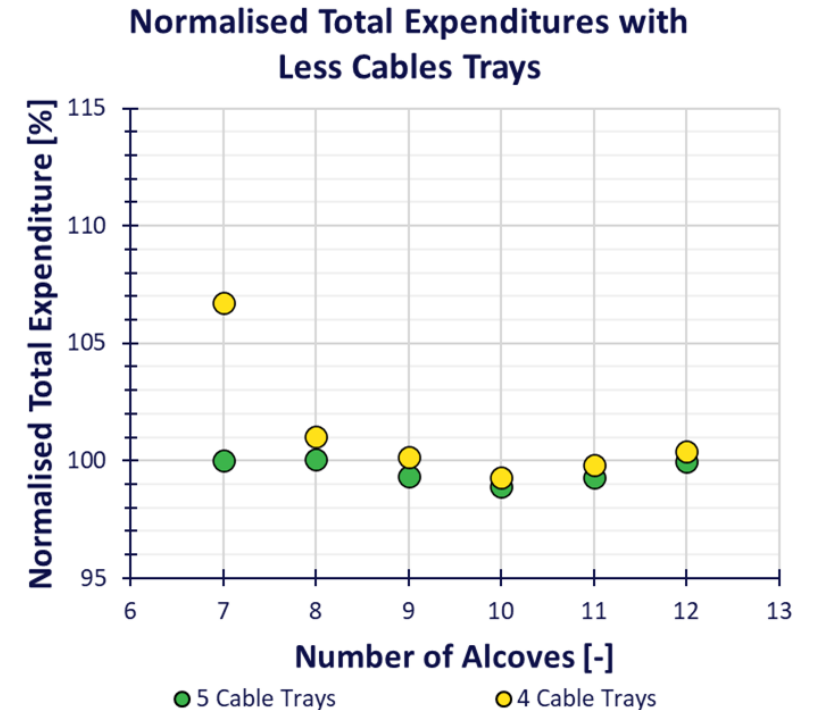


Today's status

- Design tool used to optimize CAPEX & OPEX against several variables
- Used to perform sensitivity analyses & provide a roadmap



- Optimised for min. CAPEX & OPEX for different alcoves number
- Results very sensitive to available cable trays number...



FS status & missing items

- **For the Feasibility Studies report**

- Cost estimate will be updated from mid-term review – powering feasible

- **Recent changes on booster specs**

- More circuits: Tapering for Dipoles and Quads, correctors for Quads, skew Quads
- Waiting for new specs of all these new circuits (maybe in Oct. 2024 more data for skew & corrector quads)
- We recently received new specs for booster sextupoles
- Recent change in booster cycle definition (more frequent injections → more losses)
- + addition of straight section magnet (we just have numbers, specs guessed by EPC), with some EPC assumptions on new magnet specs, gives additional 30 MW power consumption in booster...

Pre-TDR & missing items

- **Circuits definition/layout needs**

- Fixing granularity for tapering and tuning
- Fixing beam controllability
- Defining minimum level of availability
- Defining precision needs

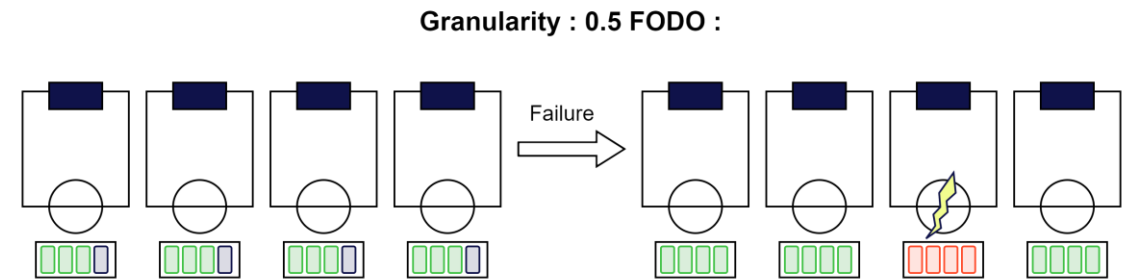
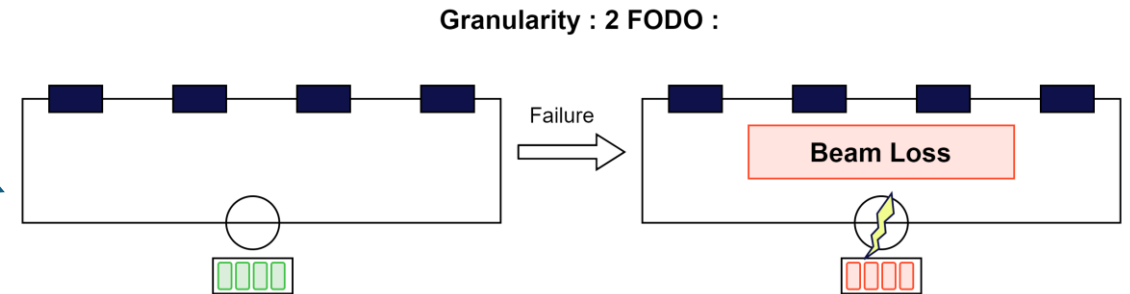
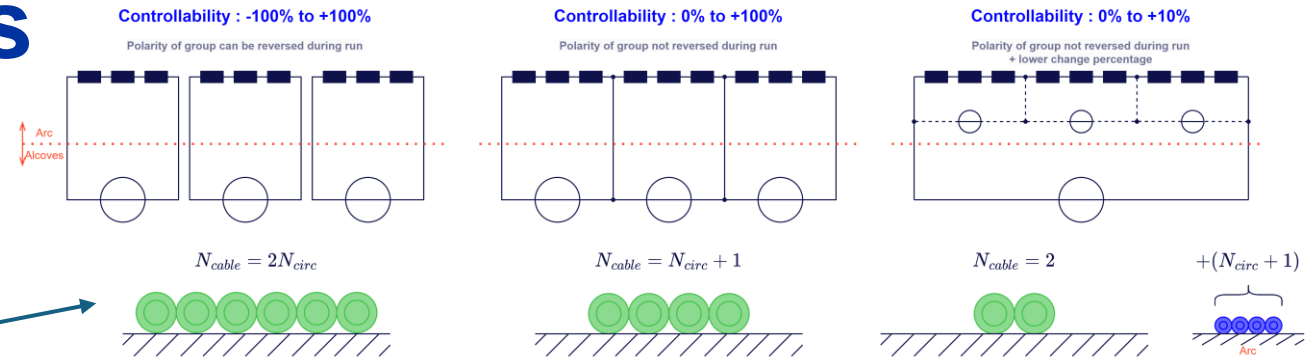
- **Same for FCChh!**

- We have only addressed volumes requirements for energy storage → need all magnet's specs

All the above cannot be provided in 2027, too late for EPC!

- **Work inside EPC**

- Improve CAPEX & OPEX models for converters – pre-designs needed



Pre-TDR & missing items

- **Everything related to pre-injector → no mandate or resources**
- **Sustainability → under resourced**
- **Environmental impact → under resourced**



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