

1st Accelerators Technology Sector Workshop

Engineering Design Tools and Processes
Project Management Methodologies and Tools

Chair: Mike Lamont

Interconnecting knowledge, experience, methods,
people & data to foster learning & collaboration



ATS
Accelerators and
Technology Sector

Enhancing Technical Project Management through System Optimisation

—

Application to FCC-ee design

Davide Aguglia

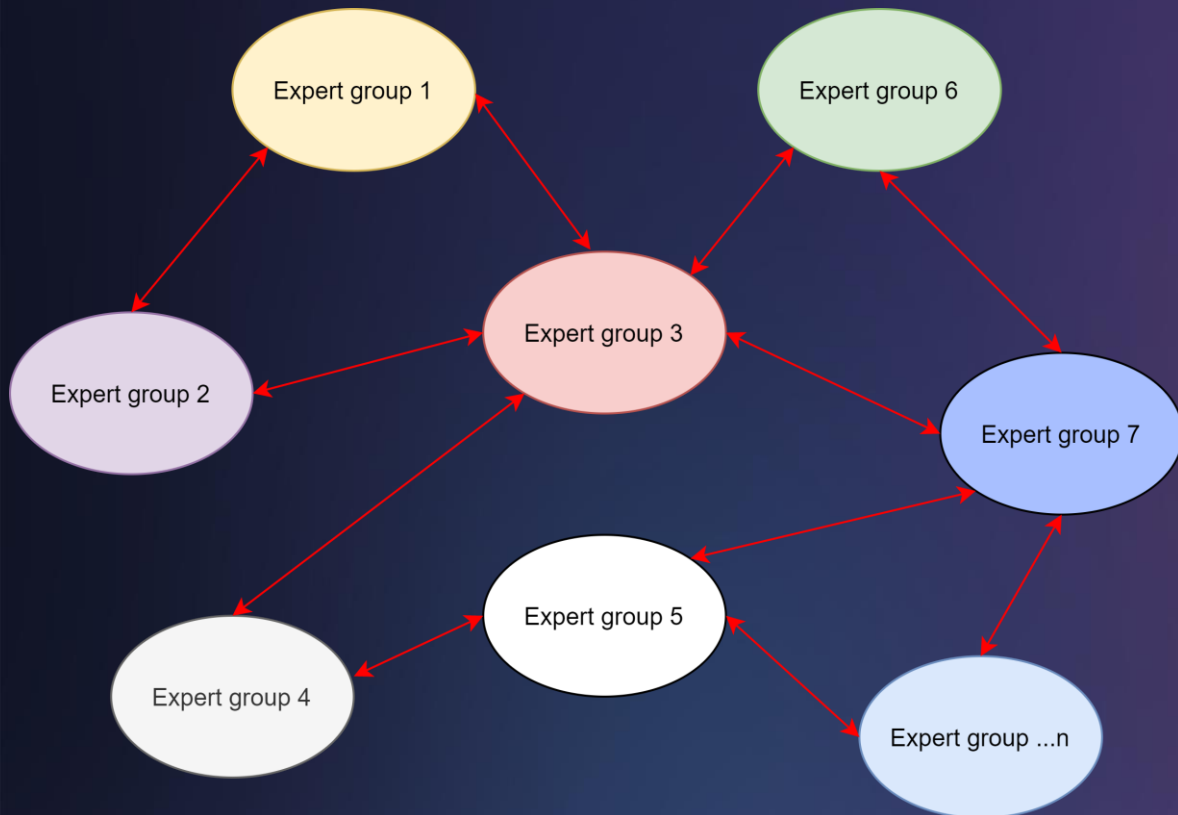


ATS
Accelerators and
Technology Sector

Content

- Groups & sub-systems interdependencies
- Gestalt: the whole is greater than the sum of its parts...
- System optimization (in a nutshell)
- Helping project management decisions
- System optimisation applied to FCC-ee design

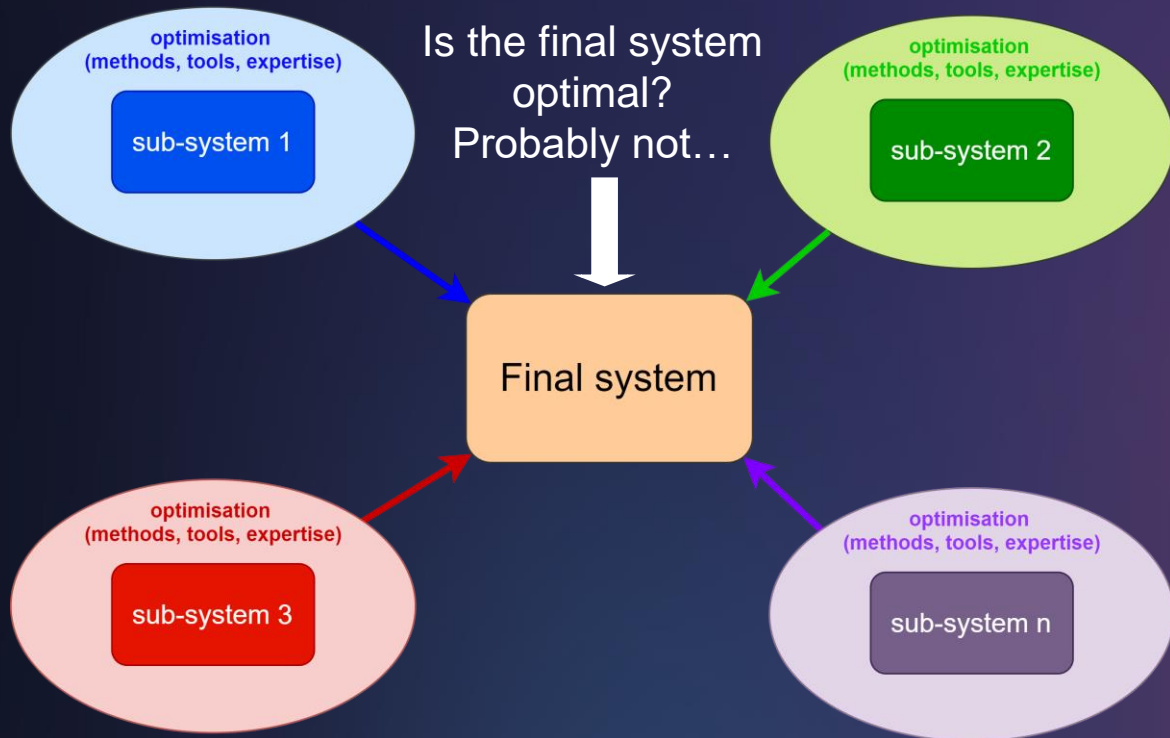
Group's & sub-systems interdependencies



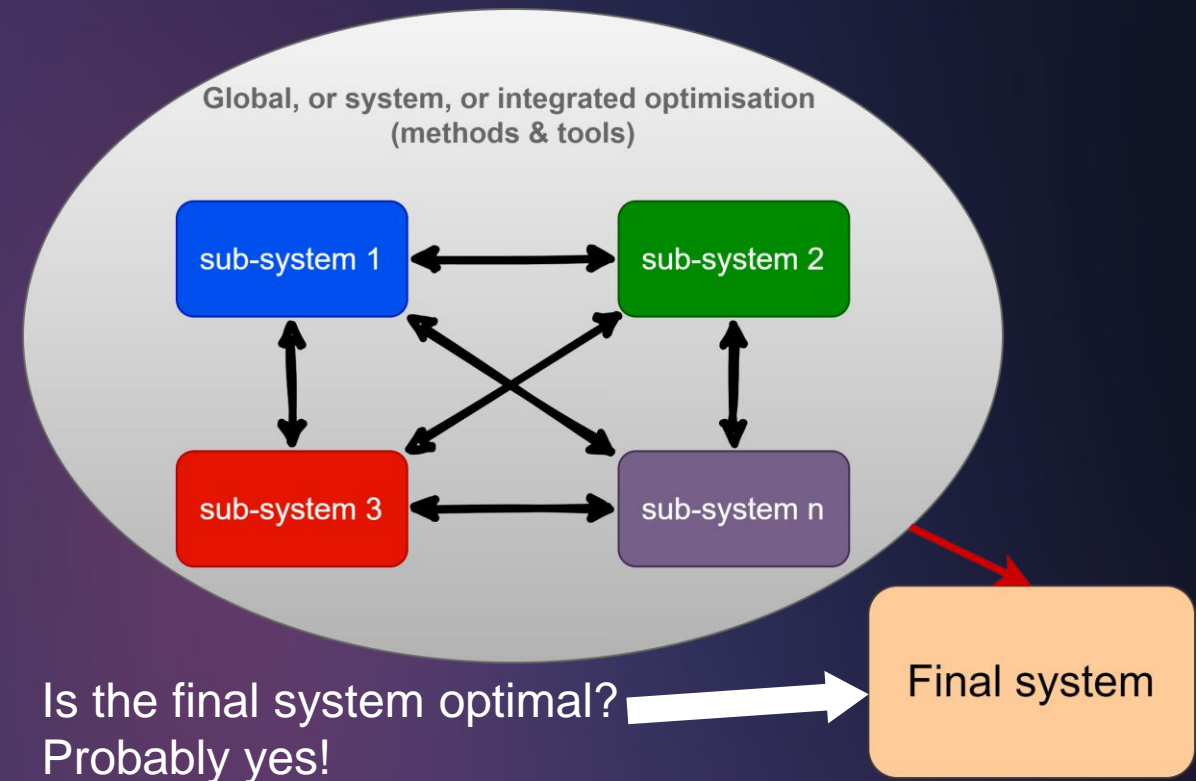
- We are organized by expert groups
 - By accelerator's sub-systems
 - Or cross group/dept. services
- Interdependencies between sub-systems need inter-group interfacing management
 - Via dedicated project meetings
 - Or direct contacts between experts in different domains
- Can we reinforce inter-group links?
...and in a more systematic way

Yes, through a holistic approach to projects

Gestalt: the whole is greater than the sum of its parts...



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!

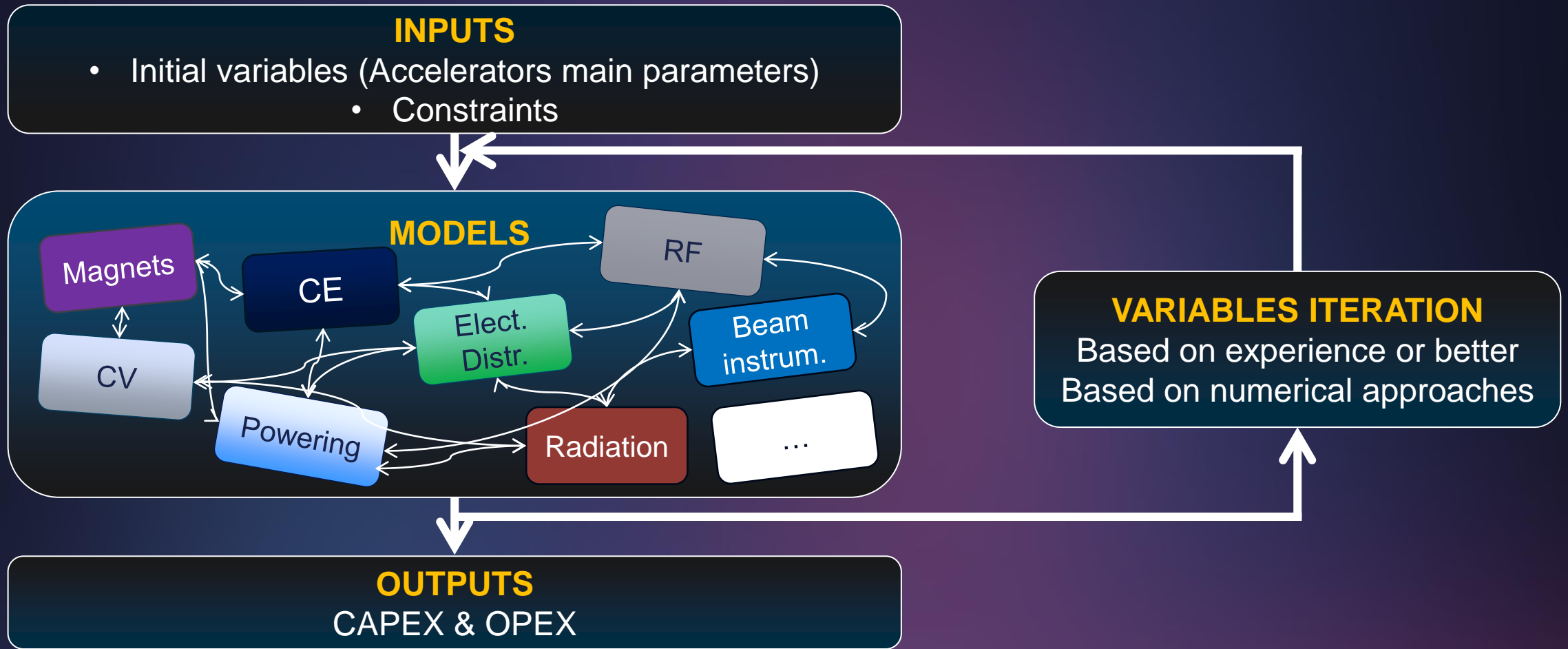
System optimization (in a nutshell)

- It all comes down to cost...
 - Buying material, paying staff, collaborations, energy consumption, redundancy, accelerator availability...
- The total cost of a system can be separated into 2 components
 - **CAPEX** – CAPital EXpenditures : Expenses for initial purchasing and/or for extending lifetime of the asset
 - **OPEX** – OPerating EXpenses : Ongoing expenses inherent to the operation of the asset
- When you want to “optimize” an engineering system, it typically means to :
 - Design a system by choosing some parameters, or variables
 - Such that it minimizes an objective/cost function of this form : $\min(J=CAPEX+\alpha\cdot OPEX)$
 - Such that some constraints are respected
 - Main constraint: the system can be built and has to work...

α is a parameter that shall be chosen by the project stakeholders

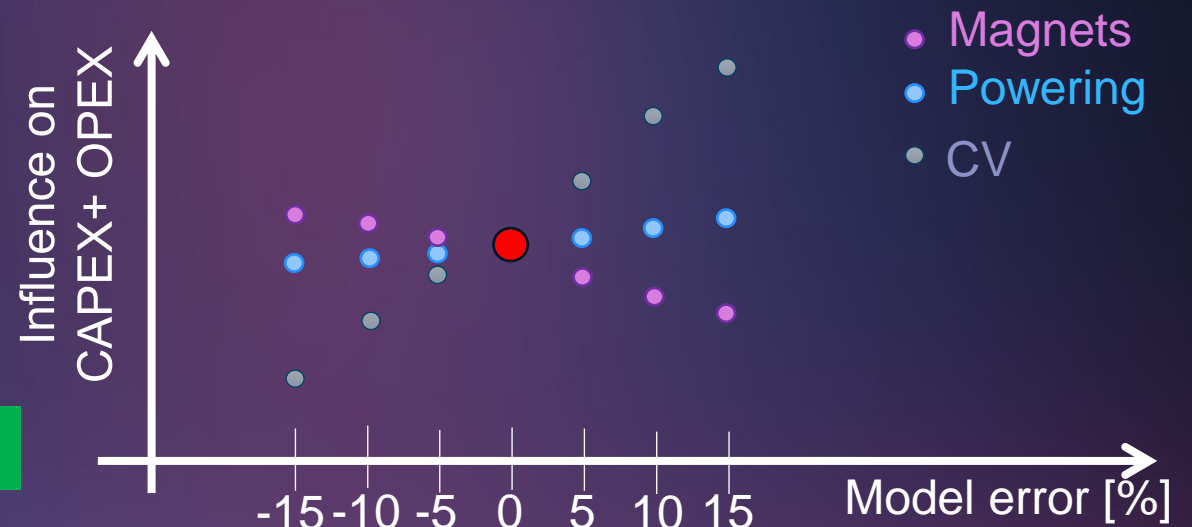
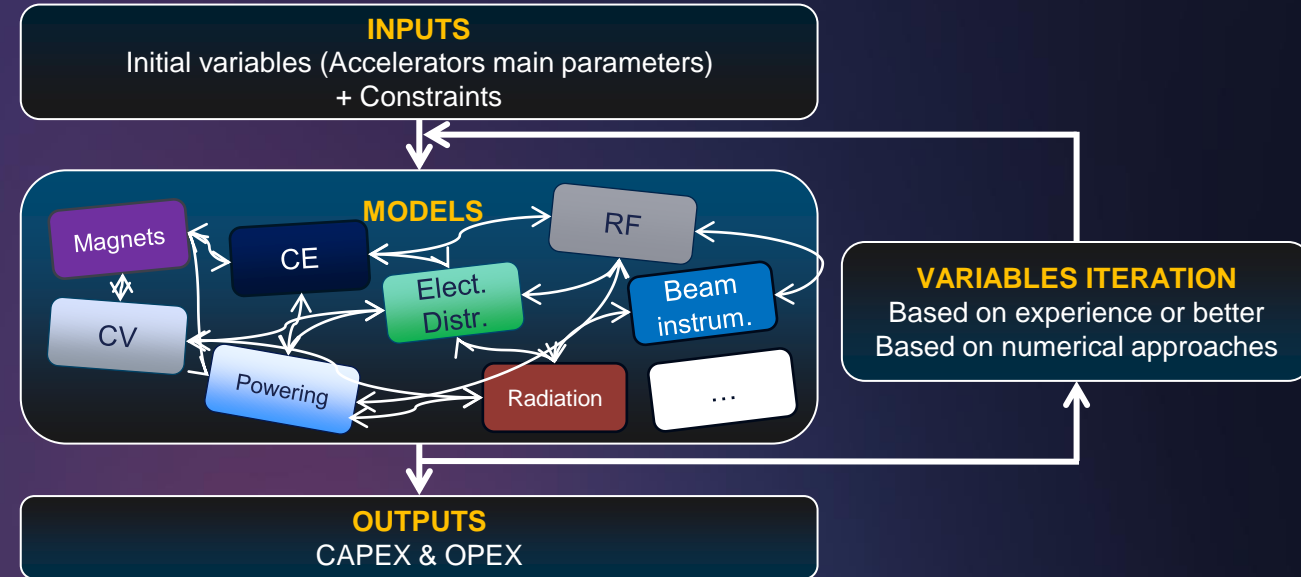
System optimization (in a nutshell)

- Need for design tools (specs changes) – global but simple optimisation tool



Helping project management decisions

- Sensitivity analyses
 - Suppose we have a rudimental tool, very unprecise models
 - Perform an optimisation
 - Now insert error on one model
 - Perform an optimisation
 - result changes? How much?
 - Repeat on another model
- Which model need more attention?
- Has the expert group the resources to improve models?



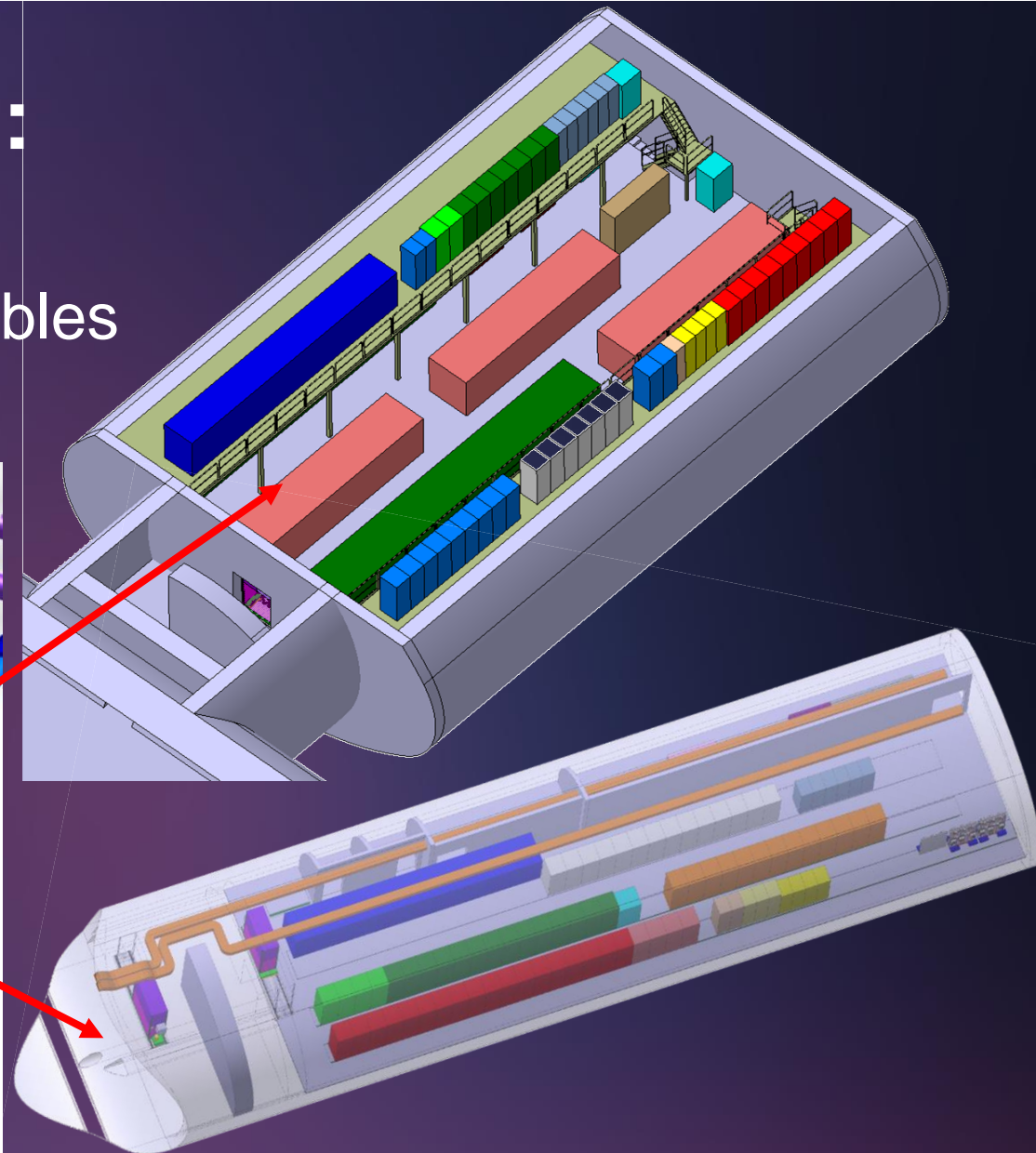
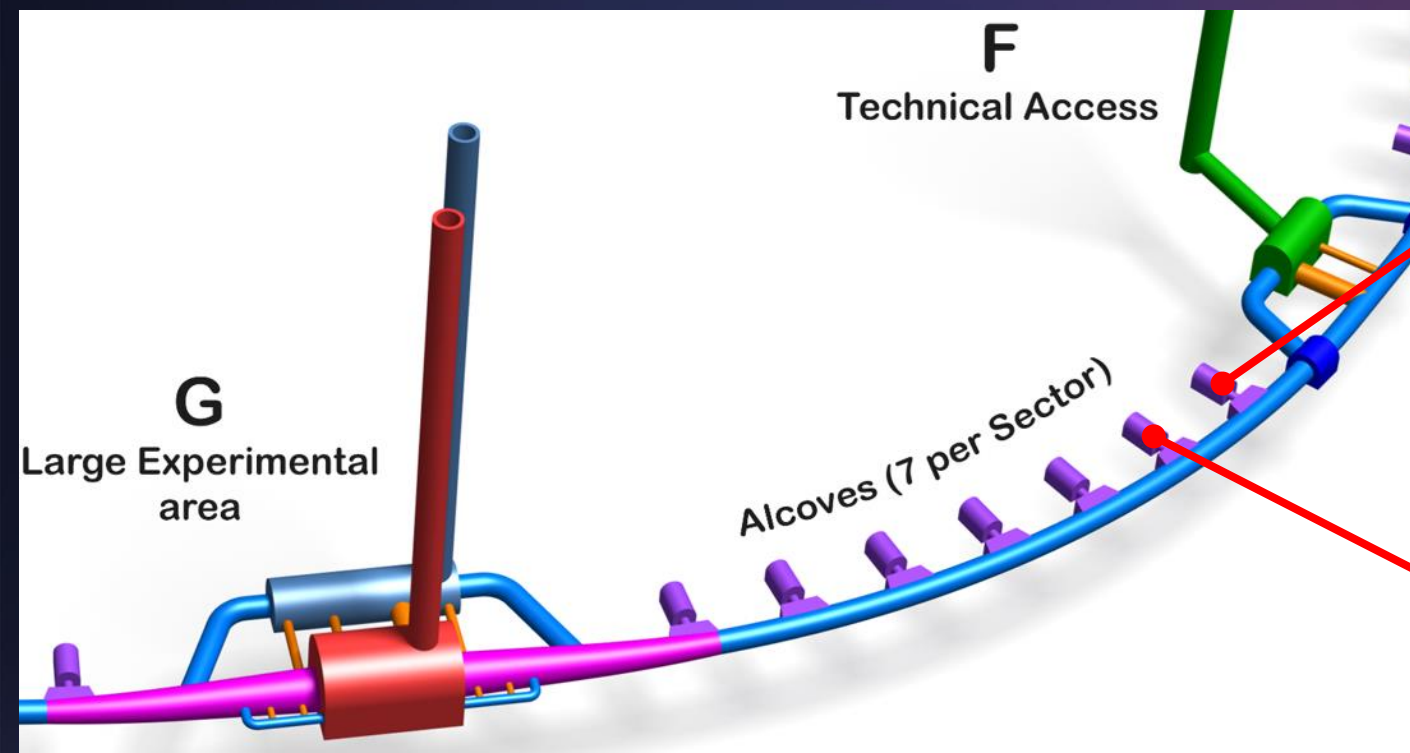
Helping priorities & Resources management!

Example – Application to FCC-ee design



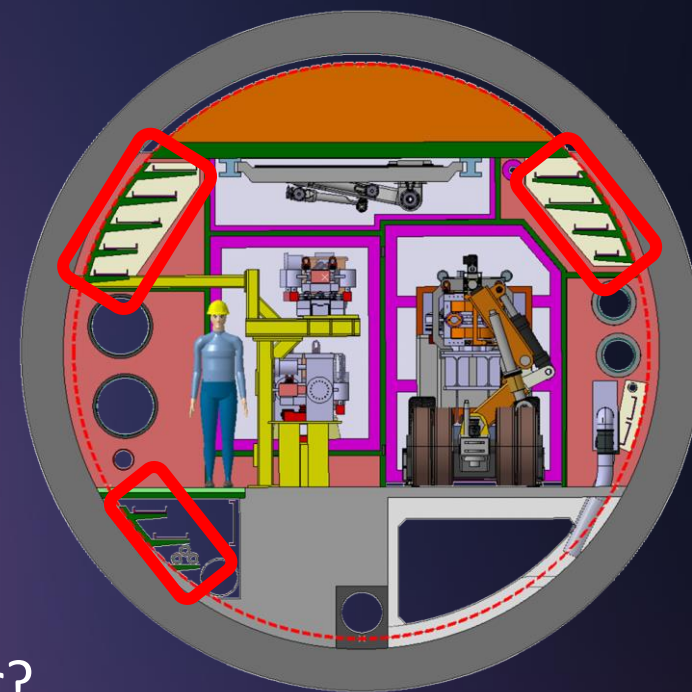
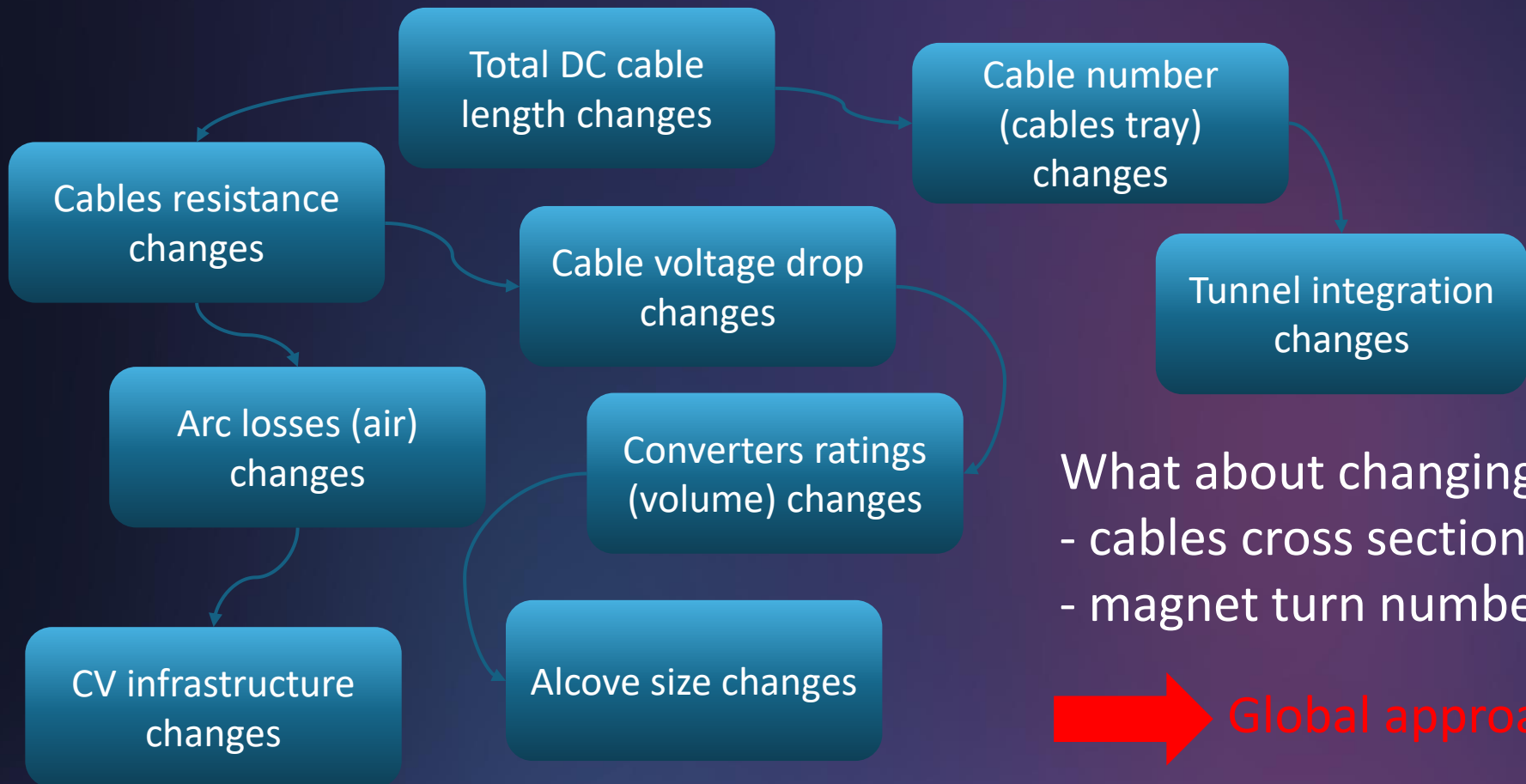
Answering a simple question: - How many alcoves?

- Magnet powering from alcoves, via DC cables
- More alcoves \equiv more cost?



What interdependencies vs alcoves number?

- If alcoves number changes, what are the impacts? (just few of them...)

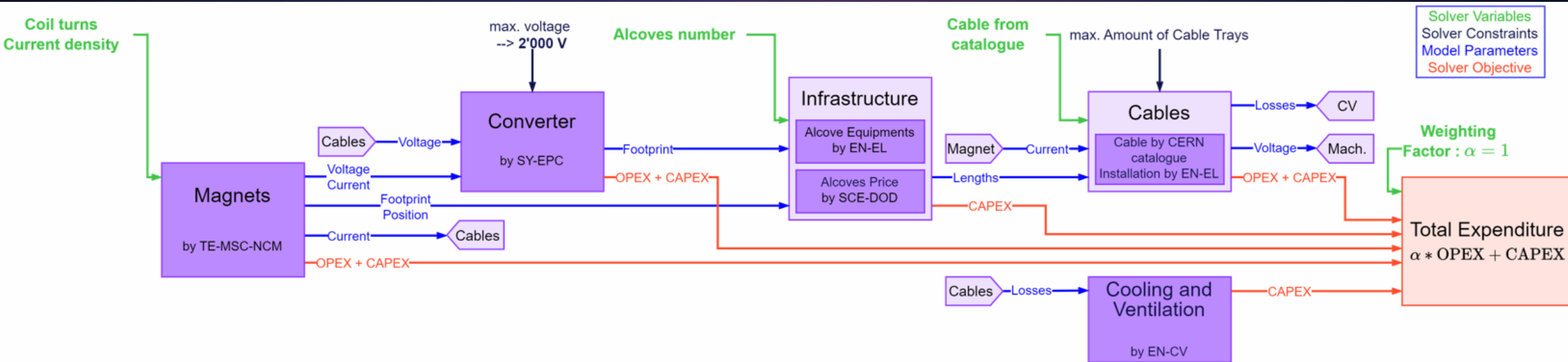


What about changing:
- cables cross section?
- magnet turn number?

Global approach necessary!

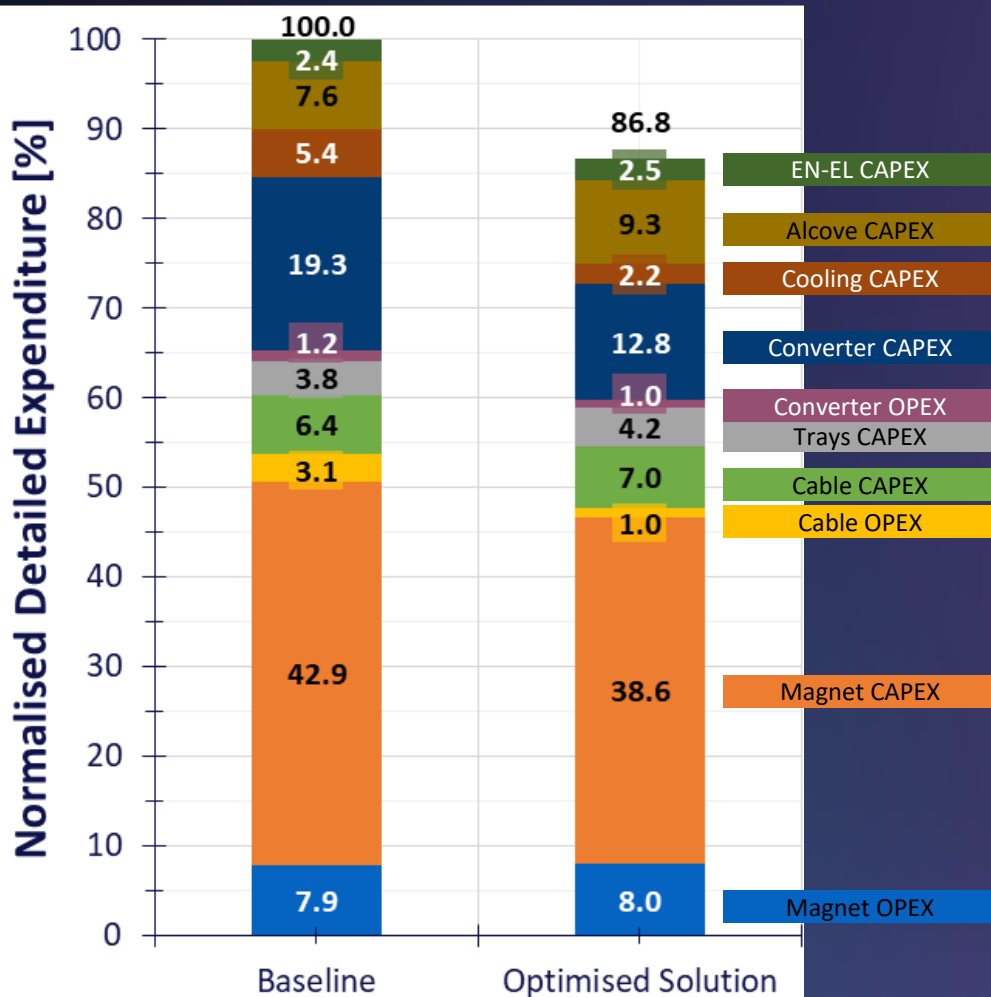
Goal: evaluate implications of alcove number selection

- Models developed by TE-MSC, EN-CV, EN-EL, EN-CV, SY-EPC & SCE-DO



- OPEX models consider losses cost over a predicted FCC-ee operation of 15 year
- Other variables such as cable trays size and usage of aluminum instead of CU in magnets are considered

CAPEX/OPEX evolution vs. alcoves number



- Preliminary results considering CAPEX + OPEX
 - 13.2% total cost reduction
 - Arc alcoves increased from 7 to 9
 - Use of aluminum instead of CU for some magnet coils
- Results with the following assumption
 - $TOTEX = \alpha * OPEX + CAPEX, \alpha = 1$
- α choice influences the accelerator sustainability!

→ top management decision, for another occasion!

Summary

- A global optimisation approach can lead to cost savings as well as helping optimising project priorities and resources allocation
- Advantages are visible even utilizing rudimental sub-systems models
- Efficiently working together is key to succeed in large projects, so...

Gestalt!

