

A visualization of a particle detector, likely a calorimeter, showing a central impact point with concentric rings of energy deposition. The image is dark with a blue and white glow emanating from the center, surrounded by a dashed white circle.

FCC power requirements Methodology for data collection

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EN-EL

Acknowledgements: Davide Bozzini

FCC week, 14 April 2016

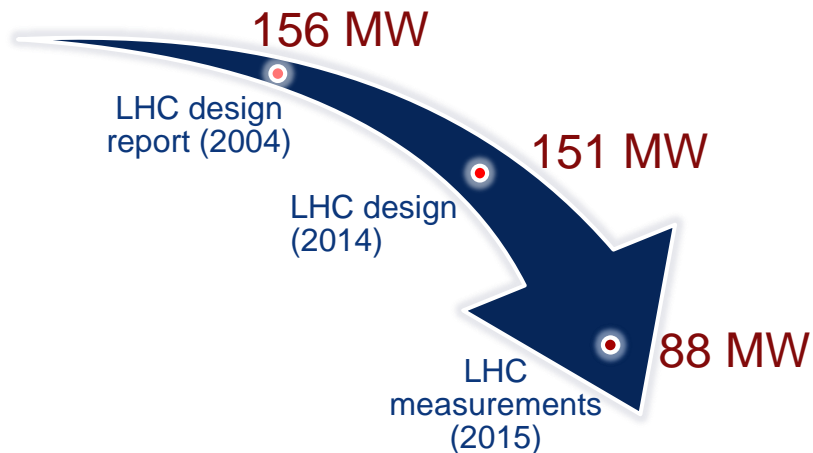


Goal

Optimize power requirement data collection procedure to create FCC power profile

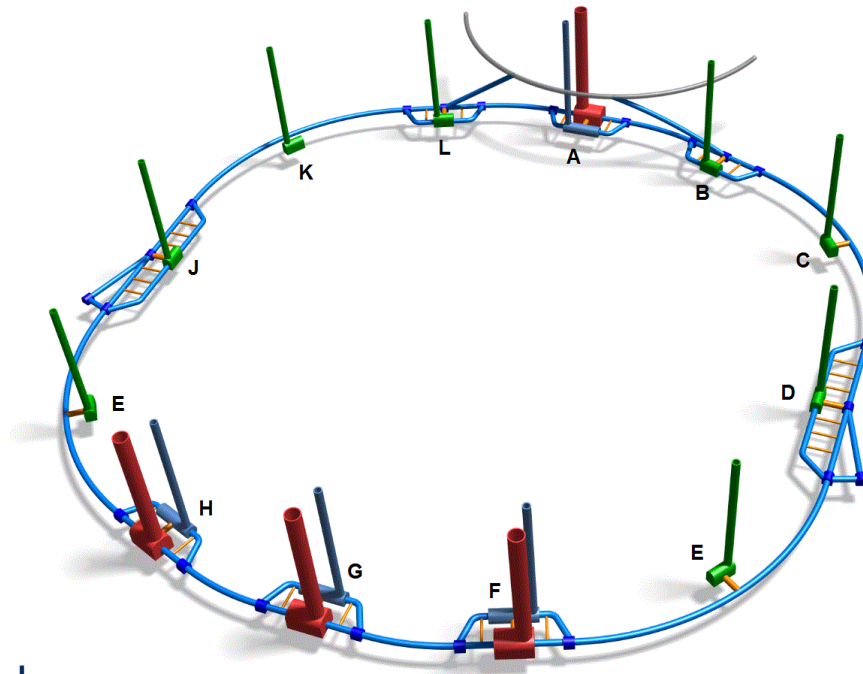


Lessons learnt from LHC design:



- ✓ In detail study of steady state and peak power consumption
- ✓ Definition of individual systems & operational processes

Machine versions



FCChh

- Hadron-hadron collider
- 100 TeV



Similar operation with LHC
Power consumption data
(scale up?)

FCCee

- Electron-electron collider
- 4 operation points:
91, 160, 240 and 350 GeV



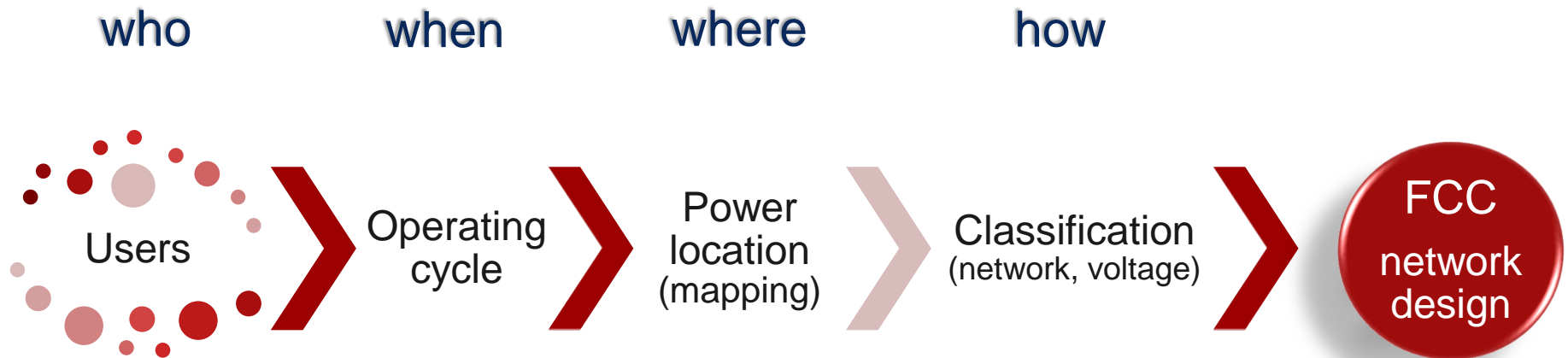
No power consumption
data from similar machine

Methodology



Method

Identification, classification & geographical location of power requirements



Parameters



Users

Magnets & Power converters

Power converters, warm and superconducting magnets

RF system

Accelerating cavity system

Cryogenics

Compressors & refrigerators

Cooling

Pumping stations, cooling towers, chillers etc.

Ventilation

Underground & surface premises ventilation

Experiments

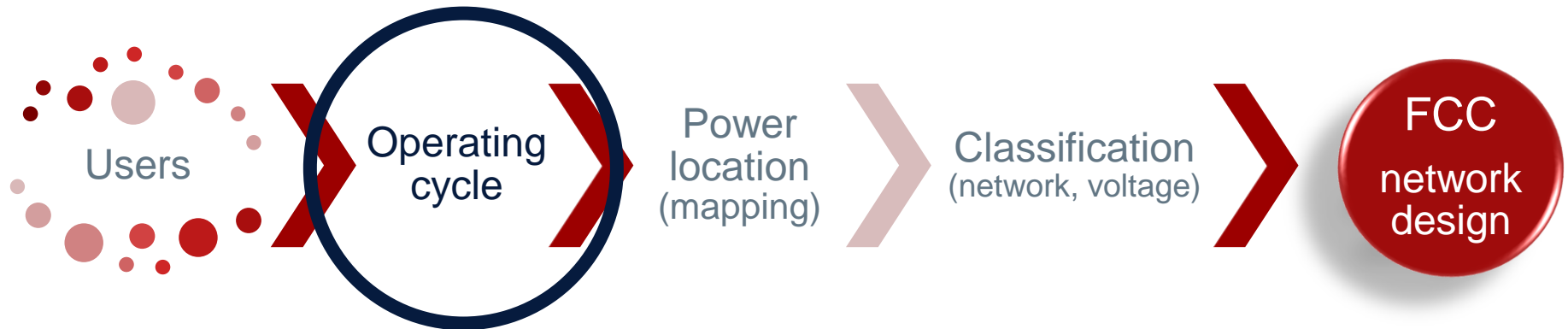
Four experimental detectors

General Services

Loads dedicated to the technical infrastructure & specific systems
(smoke extraction, lighting, elevators, vacuum etc.)



Parameters

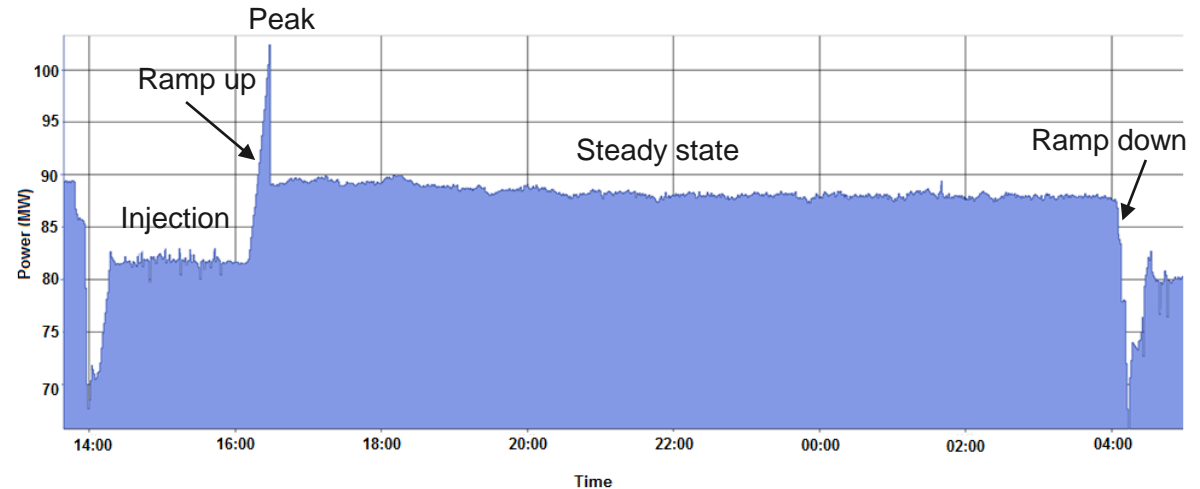


Machine operating cycle

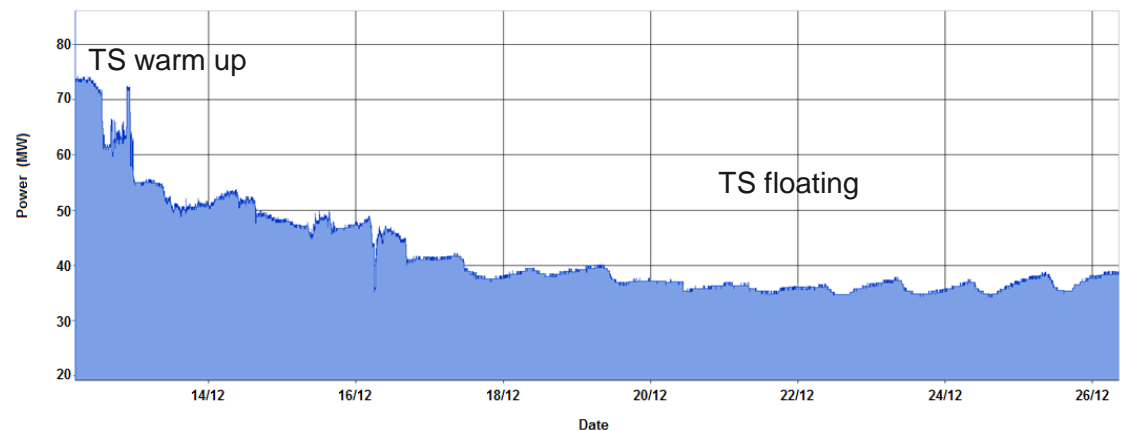
Injection
Ramp up
Peak
Steady state
Ramp down



Physics run



TS warm up
Tech. stop (TS)
Warm up (to 300 K)
Long Shutdown (LS)
Cool down



Machine operating cycle

LS 1

Cool down 2

Tech. stop 3, 10

Injection 4, 9

Ramp up 5

Peak 6

Steady state 7

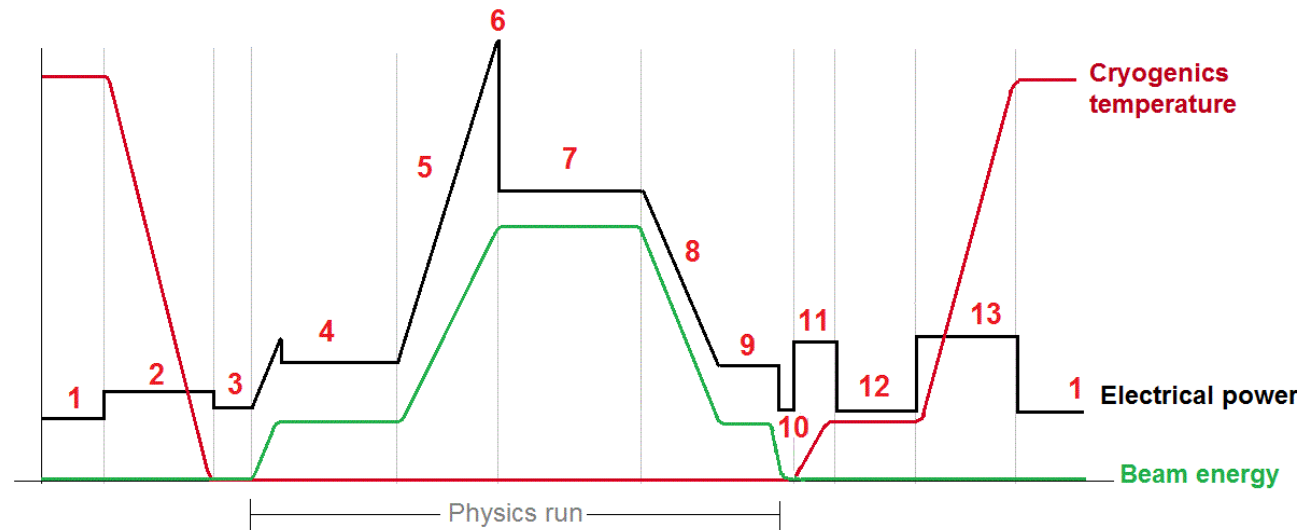
Ramp down 8

TS warm up 11

TS floating 12

Warm up to 300K 13

Qualitative representation



Parameters



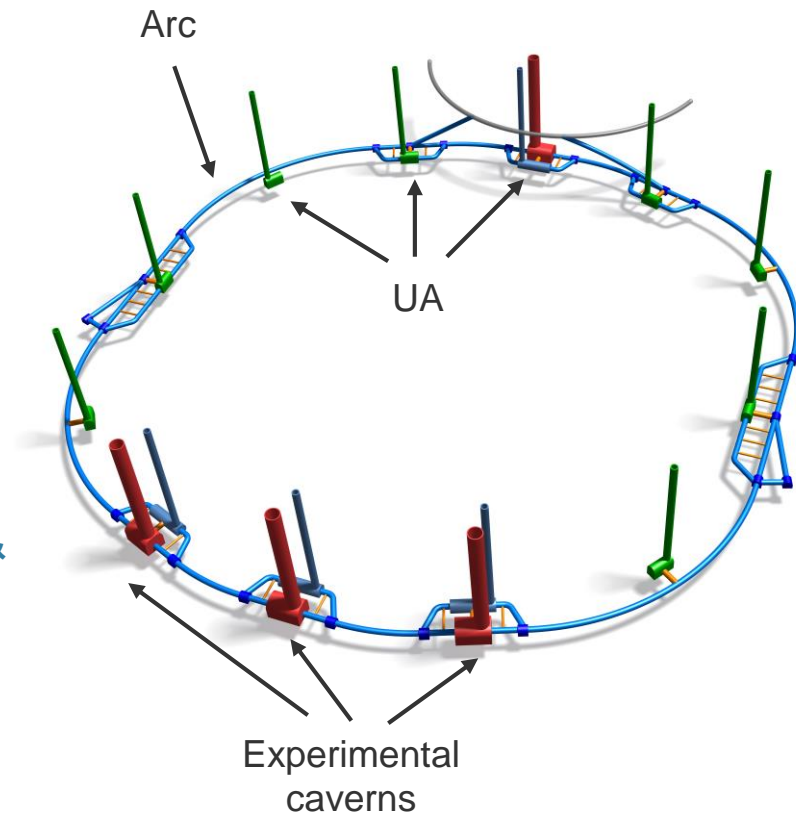
Power mapping

Surface

Surface electrical equipment
(part of cooling & ventilation equipment,
cryogenic compressors etc.)

Underground

- Experimental caverns
Caverns housing experimental detectors
- UA (underground areas)
Bypass caverns housing power converters &
other electrical equipment
- Arcs
Tunnel areas between points housing
different types of magnets



Parameters



Classification (network design)

Network types

- **Machine network**
Accelerator and experiments related load
(cryogenic & cooling equipment, RF, power converters, ventilation etc)
- **General services network**
Technical infrastructure network
(smoke extraction, lighting, elevators, vacuum etc)
- **Secured network**
Supported by diesel generators
(safety-related loads)
- **Uninterrupted network**
Supported by UPS and batteries
(cryogenic instrumentation, PC control system etc.)



Voltage level (IEC standard)

Low voltage 50-400 V

Distribution network 3.3-36 kV

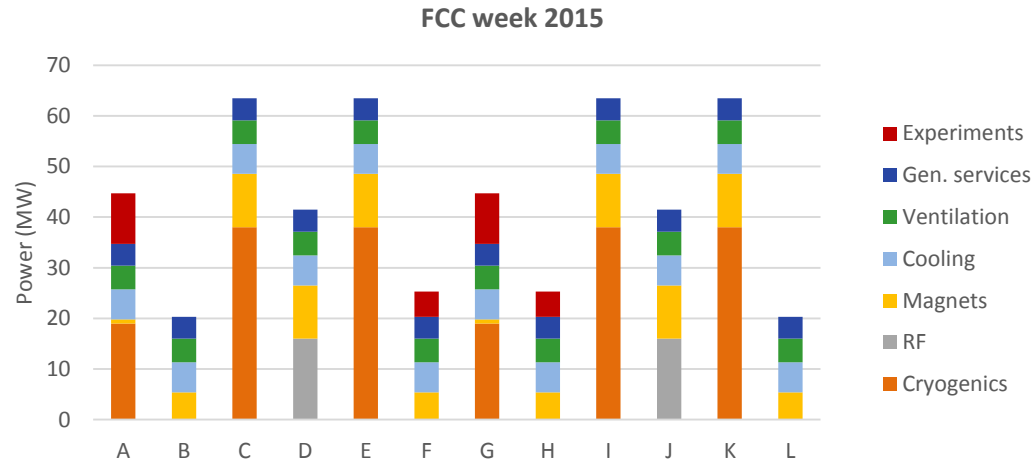
Transmission network 50-400 kV

Power estimation & Power data collection status



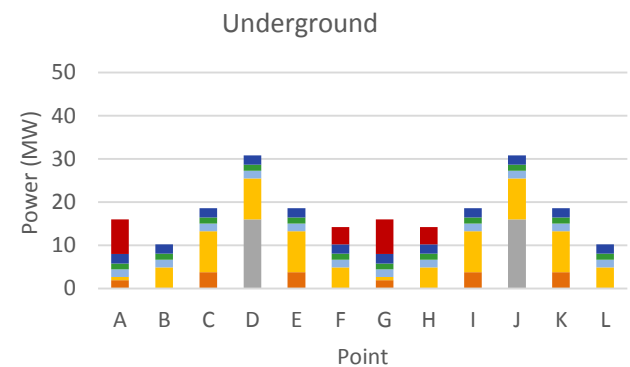
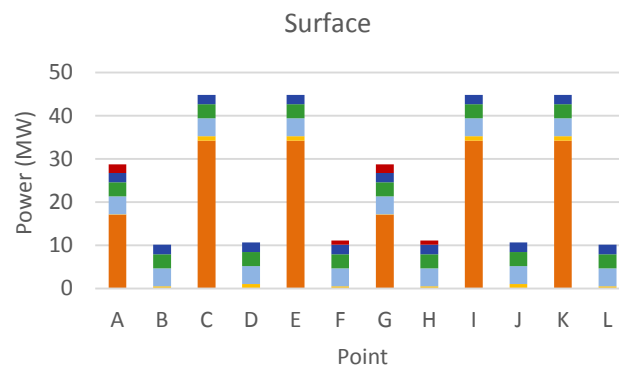
FCC_{hh}: Average power estimation

Power requirements FCC week 2015

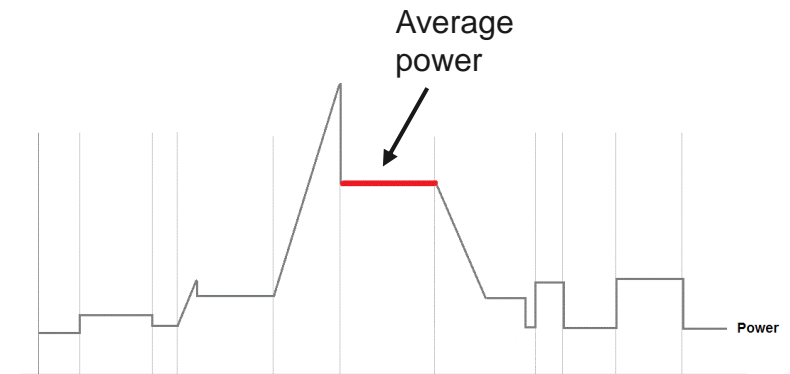
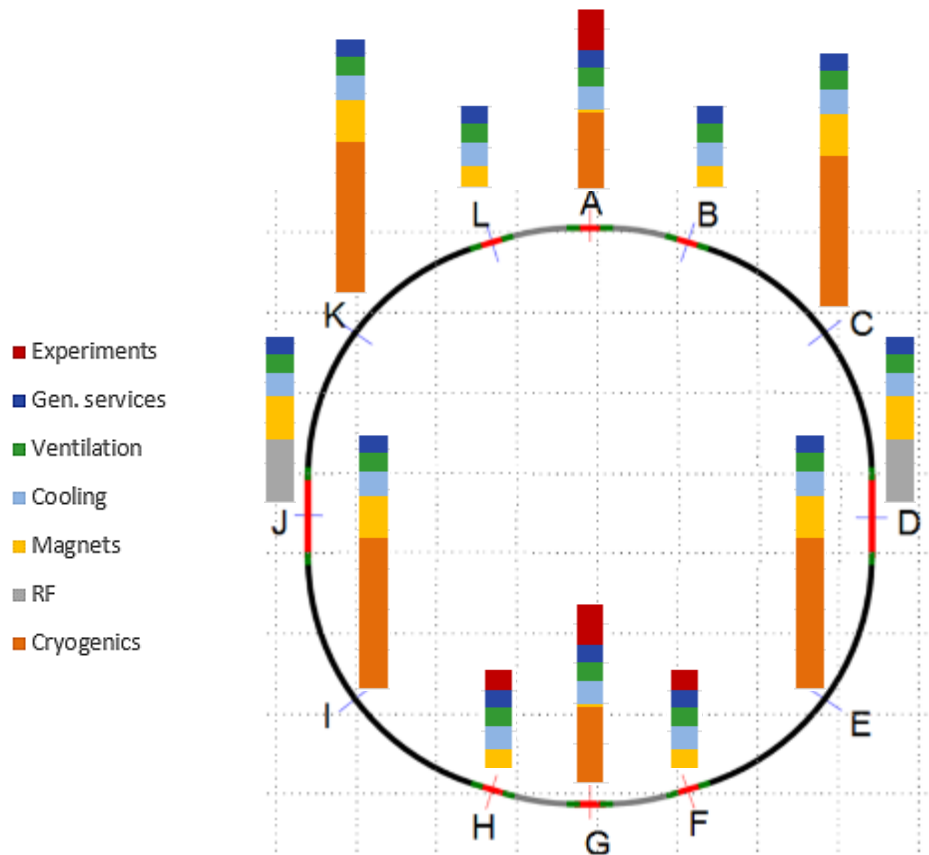


Assumptions

USER	Surface (%)	Underground (%)
Cryogenics	90	10
RF	0	100
Magn.& PC	10	90
Cooling	70	30
Ventilation	70	30
Gen. services	50	50
Experiments	20	80

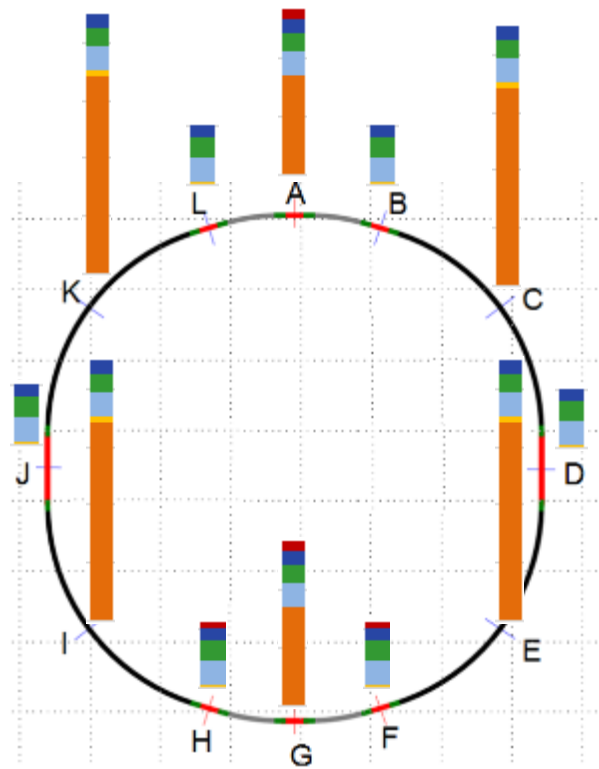


FCC_{hh}: Power mapping

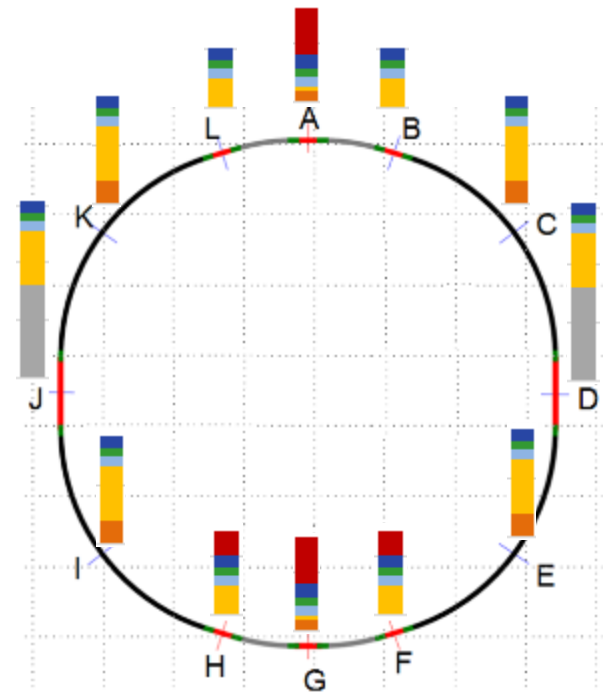


Average power distribution

FCC_{hh}: Power mapping



Surface distribution



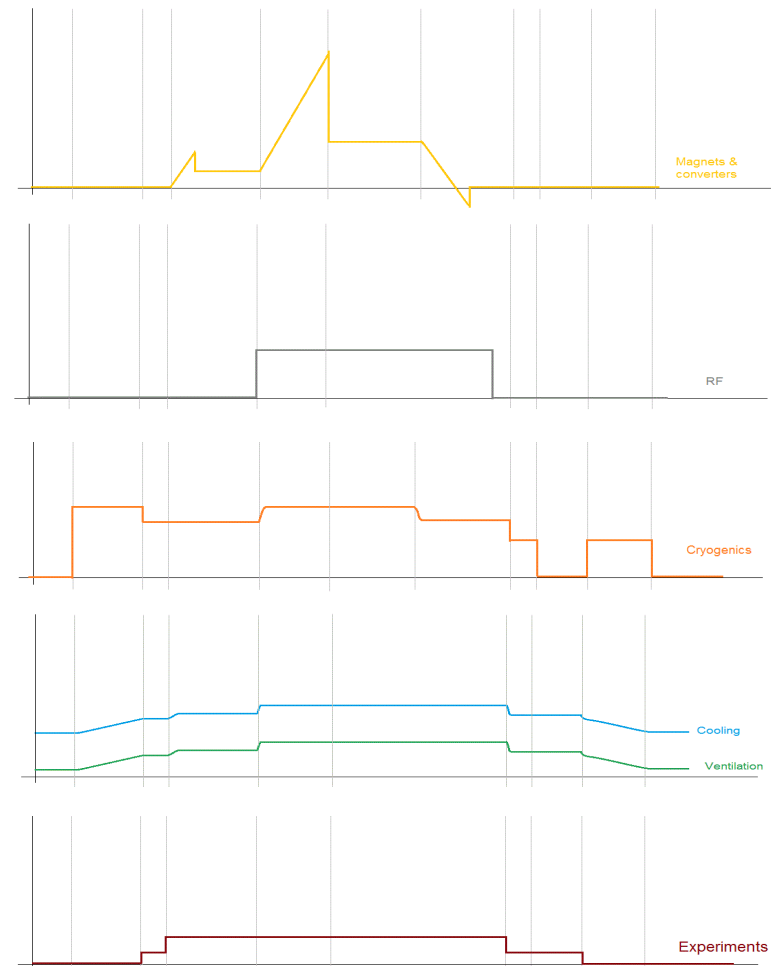
Underground distribution

- Experiments
- Gen. services
- Ventilation
- Cooling
- Magnets
- RF
- Cryogenics

FCC_{hh}: users power profile

Assumptions

- **Magnets & Converters**
Peak in ramp up to injection level
& in ramp up to nominal energy
Negative peak in ramp down
- **RF acceleration system**
Consumption expected only during accelerating phase
- **Cryogenics**
Variable power requirements according to cryogenic temperature of magnets
- **Cooling & ventilation**
Steady consumption during physics run
Low consumption during TS
Dependant from ambient temperature
- **Experiments**
Consumption during physics run
Limited consumption during TS

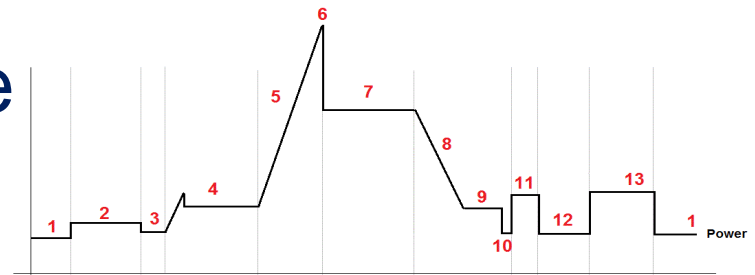


FCC_{hh}: users power profile

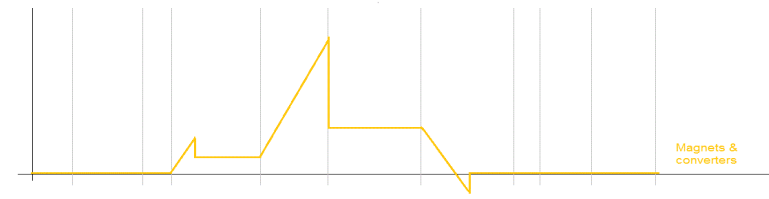
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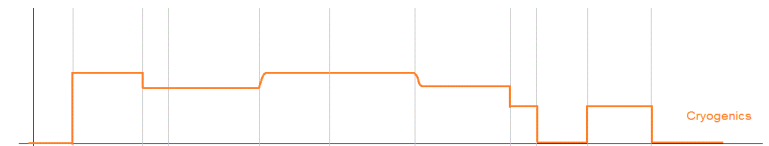
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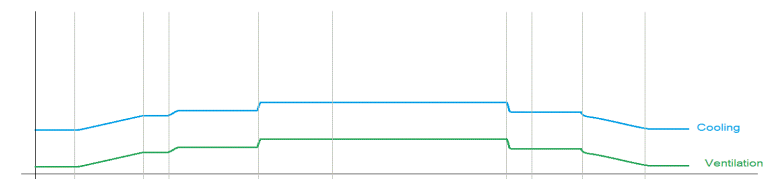
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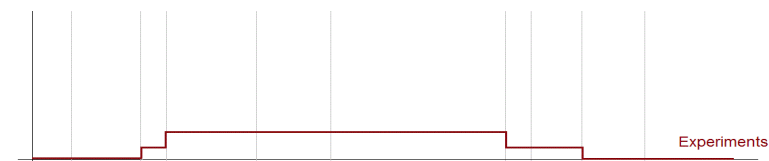
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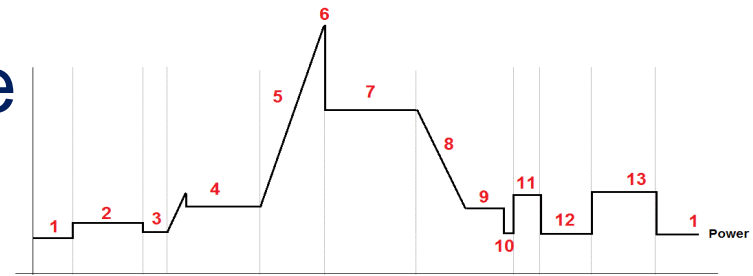


FCC_{hh}: users power profile

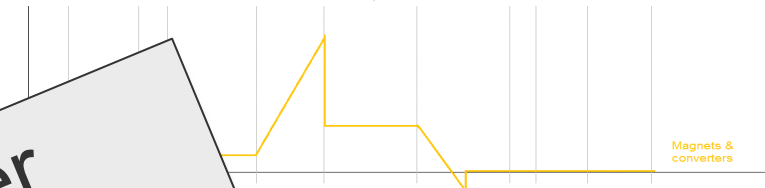
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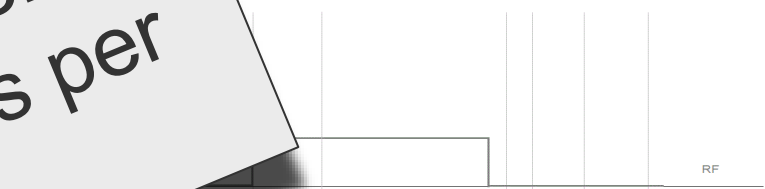
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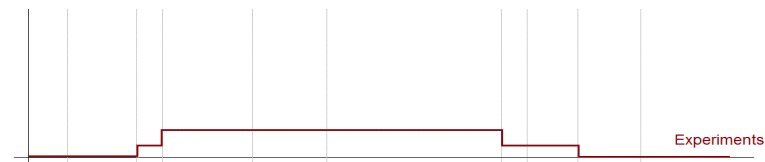
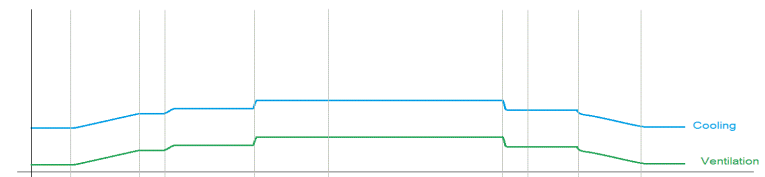
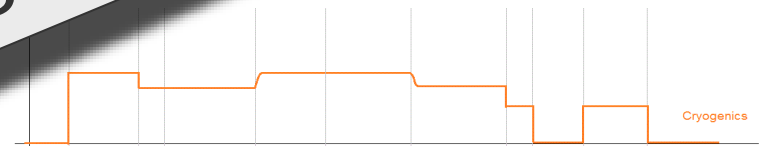
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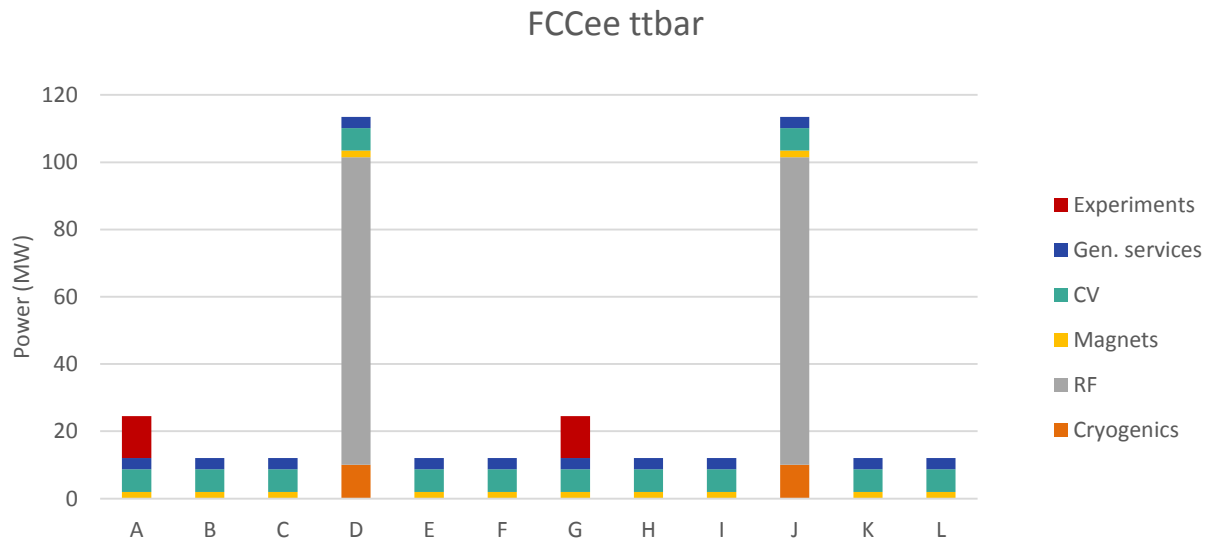
Need power requirements per phase

FCC_{ee}: Average power estimation

Power requirements

FCC week 2015 estimated by machine designer

- Rough estimations for 4 operational versions: 91-350 GeV
- Higher power requirements: 350 GeV machine version (ttbar)



Power inputs collection status

- Currently in initial phase of the method
 - Future steps strongly depending on users
 - Data without margins
 - Voltage level & network type classification
 - Power data for all system versions for each user
 - Study normal & degraded operating scenarios
- ✓ Conceptual design report:
End of 2018



Future steps



- Study & comparison of electrical layouts
- Verify feasibility of operating scenarios
- Modelling of transmission & distribution network



ENGINEERING
DEPARTMENT

Thank you for your attention !

Any questions



Spare slides

Summary table (FCC week 2015)

Items	LHC Steady State Power [MW]	FCC-hh Steady State Power [MW]	Comment
Magnet Circuits	20	86.4	Wall-plug, worked out estimate
RF	18	32	Rough estimate
Cryogenics	32	190	To be revisited/refined
Cooling	20	71	Power in cooling water
Ventilation	14	56	Rough, 4 x LHC
Other Machine	2.5	10	Rough, 4 x LHC
General services	13	52	Rough, 4 x LHC
Experiments	22	30	(10 + 10 + 5 + 5)
Total	147.5	527.4	

Power mapping

- Source
- Point

