



# Infrastructure and Operation Overview

Volker Mertens, CERN

*on behalf of the FCC Infrastructure & Operation Working Group  
and the collaborating partners*

FCC Week 2016  
Rome, 11-15 April 2016



# Infrastructure and Operation topics

- Geology & civil engineering
- Integration
- Electricity distribution
- Cryogenics
- Cooling & ventilation
- Transport & handling
- Installation
- Planning & coordination
- Survey & alignment
- Controls
- Computing
- Communications & networks
- General safety
- Access control
- Radiation protection
- Environmental protection
- Power/energy consumption
- Energy efficiency
- Operation & maintenance concepts
- Availability & reliability
- ...

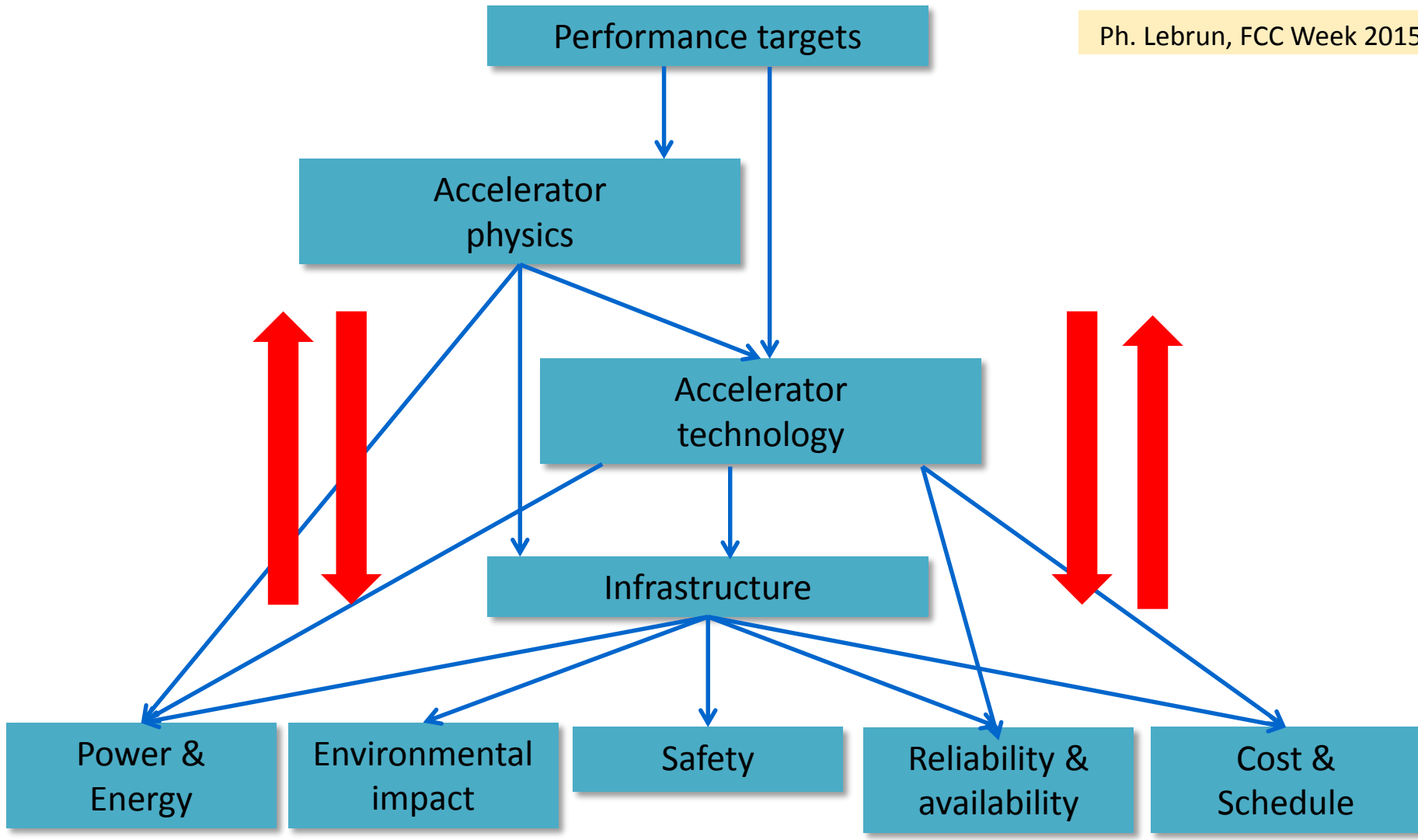
<https://fcc.web.cern.ch/Documents/Organisation/WBS.pdf>



# Design roadmap

- Waterfall vs concurrent engineering -

Ph. Lebrun, FCC Week 2015



# Session overview

Infrastructure and Operation overview (V. Mertens, 10')  
 Civil engineering (John A. Osborne, 20')

**Monday**

Time	Day	Topic	Speaker
08:00-09:00	Monday	Registration	
09:00-10:00	Monday	Infrastructure and Operation overview	V. Mertens
10:00-11:00	Monday	Civil engineering	John A. Osborne
11:00-12:00	Monday	Cryogenics	Jaroslav Polinski (TU Wroclaw)
12:00-13:00	Monday	Lunch	
13:00-14:00	Monday	Implementation, Electricity, Cooling and Ventilation	Philippe Lebrun (CERN)
14:00-15:00	Monday	Coffee Break	
15:00-16:00	Monday	Safety, Availability, Controls	Ralf Trant (CERN)

**Friday**

Summary of parallel Infrastructure and Operation sessions  
 (V. Mertens, 15')

11:00

**Cryogenics**

*Jaroslav Polinski (TU Wroclaw)*

12:00

**Thursday**

**Room:  
Costantino**

13:00

14:00

**Implementation,  
Electricity, Cooling  
and Ventilation**

*Philippe Lebrun (CERN)*

15:00

**Coffee Break**

*Winter Garden, Crowne Plaza*

16:00

**Safety, Availability,  
Controls**

*Ralf Trant (CERN)*

Thursday, 10:30-12:10

## Cryogenics – chair: Jaroslaw Polinski / TU Wroclaw

- Cryogenics overview (Laurent Tavian)
- Ne-He cycle refrigeration above 40 K (Steffen Klöppel / TU Dresden)
- Innovative He cycle (François Millet, CEA Grenoble)
- Cool-down and warm-up studies of a FCC sector, Hugo Correia Rodrigues
- Impact of high design pressures on heat inleaks, Pawel Duda / TU Wroclaw

- General parameters (linked to choice of magnet parameters  $T_{cm}$ ,  $T_{bs}$ )
- Baseline layout (# plants, sites)
- System architecture (surface, underground, distribution)
- Use of modern high-efficiency equipment and cryogenes
- Electrical power needs
- Considerations concerning the He inventory and cool-down logistics

Items (being) worked on

## Implementation, Electricity, Cooling and Ventilation – chair: Philippe Lebrun

Thursday, 13:30-15:00

- FCC civil engineering – tunnel optimisation (Charles Cook)
- Large scale metrology for the FCC work package (Mark Jones)
- Design considerations for the FCC electrical network architecture (Davide Bozzini)
- FCC electrical power requirements –
- methodology for data collection and geographical mapping (Maria Mylona)
- Cooling plants and ventilation systems (Mauro Nonis)

Items  
(being)  
worked on

- Footprint review June 2015 → pre-fixing of some parameters
- Comparative risk analysis intersecting/non-intersecting variants
- Construction methods and estimate of CE work progress
- Optimisation of transfer lines, access locations and surface structures
- Tunnel options (single vs double), size of safe zone, tunnel diameters
- Number, size and equipment of shafts, conc. design of underground structures
- Collection of heat loads → conceptual design of cooling and ventilation systems
- Collection of power requirements → conceptual design of electrical distribution
- Collection of alignment requirements, definition of survey infrastructure and techniques
- Coarse planning for construction, installation and commissioning started

Thursday, 15:30-17:00

## **Safety, Availability, Controls** – chair: Ralf Trant

FCC collaboration “Fire safety” (Saverio La Mendola)

Conventional safety (André Henriques)

Radiation protection (Markus Widorski)

First results from availability studies (Andrea Apollonia)

Controls architecture challenges for beam dump kickers (Pieter van Trappen)

- Fire and evacuation studies
- Recommendations on safe zone, cross connections, lifts, ventilation schemes
- First studies on lifts and cranes, and personnel transport equipment
- Dose rate studies for tunnels and experimental zones
- Studies about radiation impact on electronics in the tunnel („R2E“)
- Reliability and availability studies (benchmarking on LHC, extrapolation to FCC)
- First studies for ultra-high reliability control and trigger systems

Items (being)  
worked on

## Cryogenics

- [TU Wroclaw](#) – Design pressure impact of the FCC-hh cryogenic distribution system and superconducting magnet cryostats on the heat inleaks at different temperature levels
- [CEA Grenoble](#) – New architectures and technologies for innovative helium refrigeration above 4.5 K and in superfluid helium at 1.8 K and 1.6 K including magnetic refrigeration
- [TU Dresden](#) – Ne-He cycle producing large refrigeration capacity above 40 K for the cooling of the FCC beam screens, thermal shields and HTS current leads

## Safety

- [ESS](#) – Ignition probabilities of materials and equipment; intervention procedures for classified accelerator areas
- [FNAL](#) – Tunnel fire dynamics and egress studies based on a broad range of different US underground installations
- [JRC Jülich Research Centre](#) (University of Wuppertal) – Optimisation of Computational Fluid Dynamics tools for fire safety related calculations
- [Lund University](#) – Fire and egress scenarios typical for accelerator facilities and their special geometries, including fire testing and virtual reality
- [MAX IV](#) – Knowledge transfer on fire statistics for physics laboratories



## Reliability, availability

- [TU Tampere](#) – RAMS design methods and tools to be applied to particle accelerators
- [TU Delft](#) – RAMS modeling of LHC cryogenic system
- [Univ. Stuttgart](#) – Reliability engineering training

Plus direct or indirect support from industrial and informal support from institutional partners (referenced in the respective presentations).

„Infrastructure and operation“ is very active.

Many points have been addressed over the past 12 months, with substantial progress.  
Lots of „concurrent“ and iterative activities.

Much detailed work to continue, and still to come.

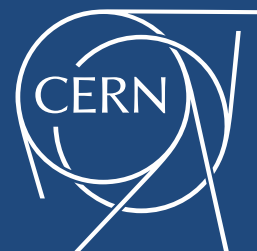
Need to continue narrow-down process and produce reference designs  
(structures, system layouts/designs, address new issues „from the list“).  
Pre-requisite: machine design and technology choices.

Many „firsts“ for a scientific instrument (e.g. size, volumes, precision, logistics, ...).

Need to apply modern (and future) solutions and methods  
(e.g. „redundancy by design“, remote diagnostics/interventions, automatisisation, ...).

Technological progress is expected to help in many ways – be open for new approaches.

**Looking forward to interesting presentations and stimulating discussions.**



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