

Future Circular Collider

Understand the Present to Master the Future

Johannes Gutleber



Scope of FCC

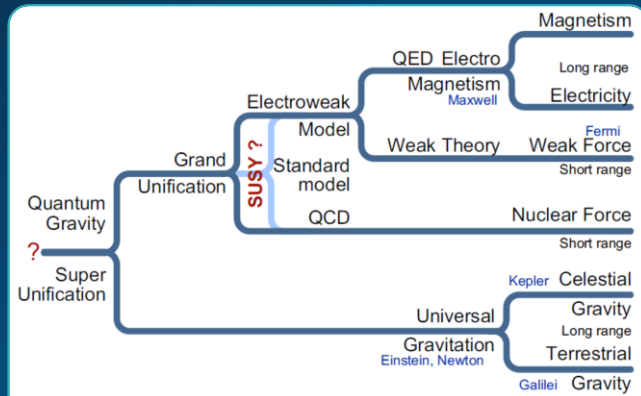
European strategy update on particle physics
“to **propose** an ambitious **post-LHC accelerator project**
at CERN by the time of the next strategy update”

CERN should undertake **design studies** for accelerator
projects **in a global context**

International collaborations to be **set up during 2014**
are **at the core** of the study!



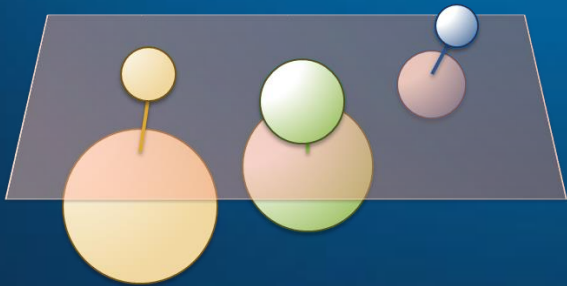
Driving Forces



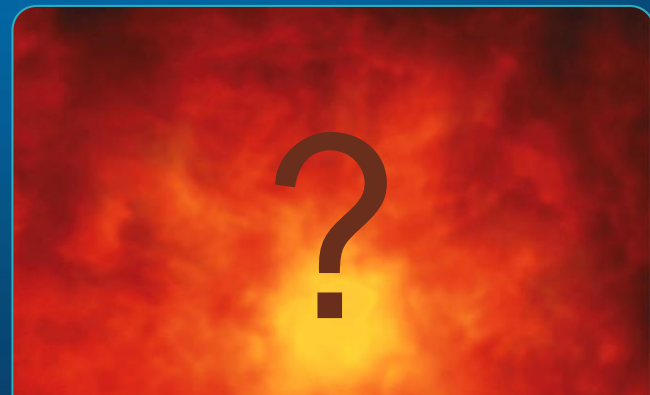
What are the fundamental laws that govern nature?



What is dark matter?



Do supersymmetric particles exist?



What are the smallest constituents of matter?

Scope of the Study

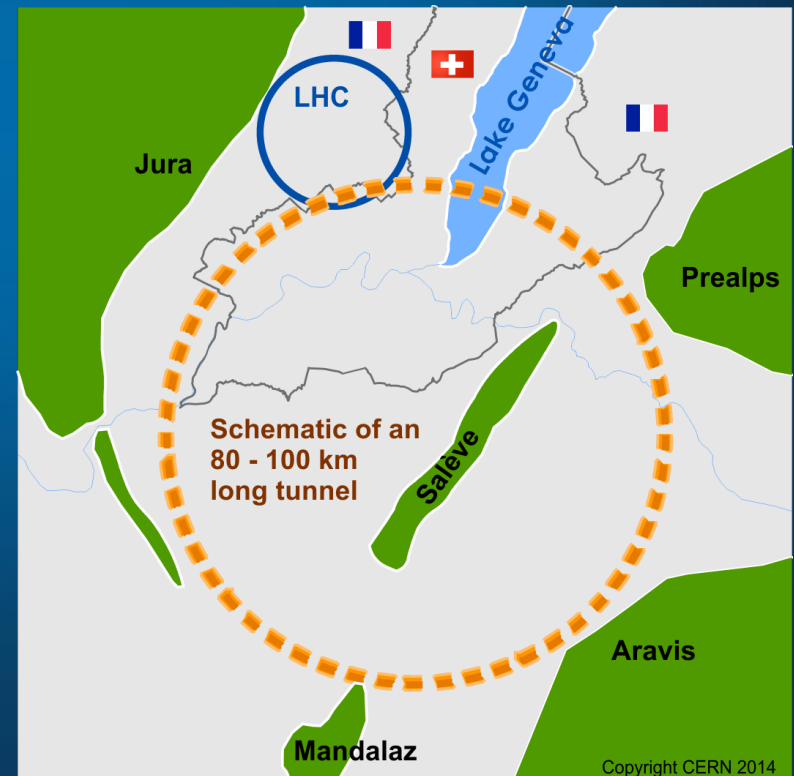
Hadron collider (pp, ions)

Lepton collider (e^+e^-)

Infrastructure determined by hadron collider

@ 15 T = 100 TeV in 100 km

@ 20 T = 100 TeV in 80 km



FCC and OpenLab

FCC has **long-term view**

- conceptual study until 2017
- recommendations for projects 2025 - 2035

FCC provides a **study case**

FCC provides framework to establish world-wide collaborations to

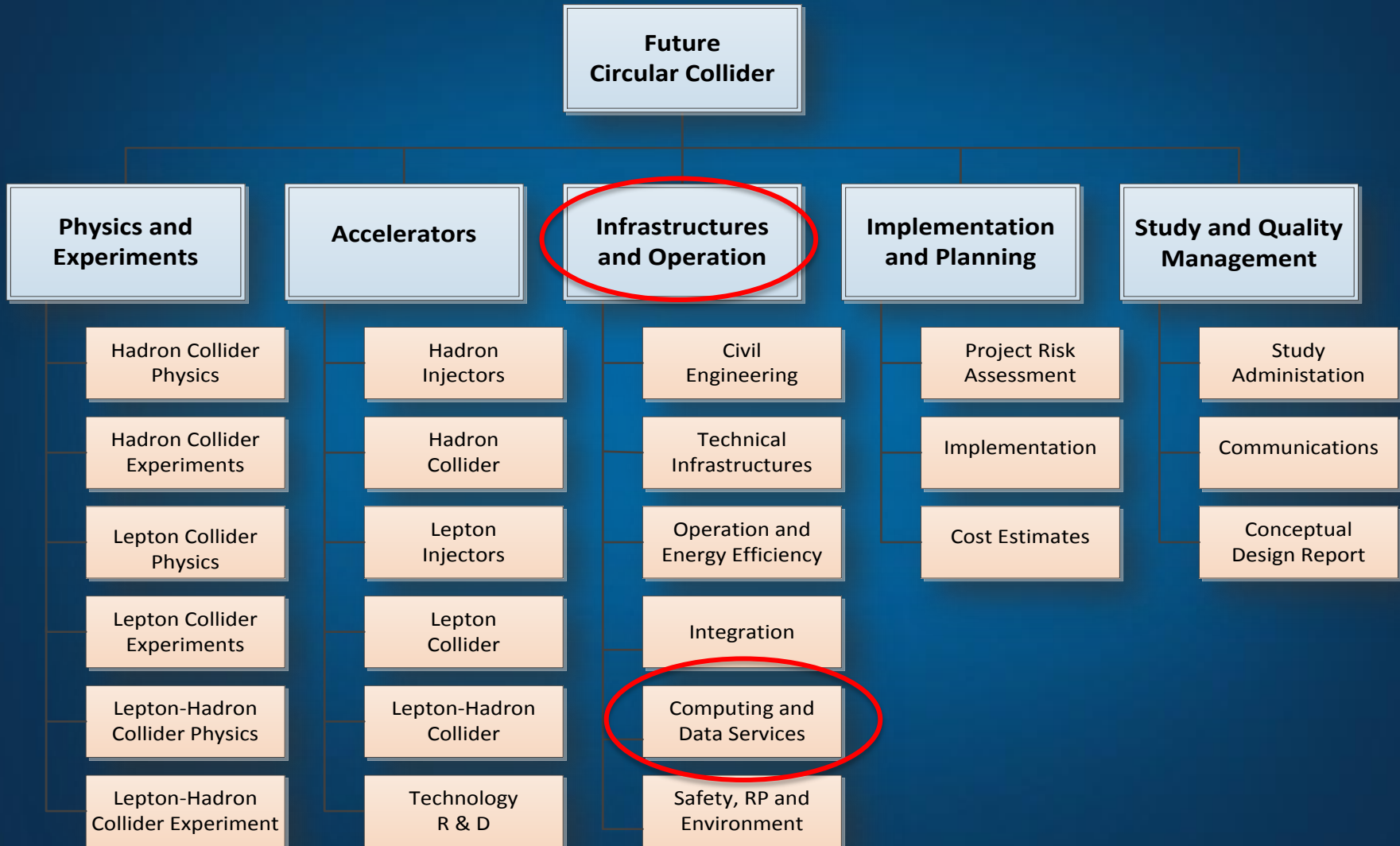
- **understand** of emerging technologies
- **learn using** emerging technologies
- **assess long-term fitness** of technologies
- **identify long-term strategic partnerships**

FCC **identifies** future R&D needs

Study Preparation Team

| Study coordination M. Benedikt , F. Zimmermann | | | | | |
|--|---------------------------------------|---|--|---|--|
| Hadron collider D. Schulte | Hadron injectors B. Goddard | e+ e- collider and injectors J. Wenninger | Infrastructure, cost estimates P. Lebrun | Technology | Physics and experiments |
| e ⁻ p option Integration aspects O. Brüning | | | | High Field Magnets L. Bottura | Hadrons A. Ball , F. Gianotti , M. Mangano |
| | | | | Superconducting RF E. Jensen | |
| Operation aspects, energy efficiency, safety, environment P. Collier | | | | Cryogenics L. Tavian | e ⁻ p M. Klein |
| | | | | Specific Technologies JM. Jimenez | |
| Planning (Implementation roadmap, financial planning, reporting) J. Gutleber , F. Sonnemann | | | | | |

Work Breakdown Structure



Computing and Data Services

Computing

End-user environments, **software performance**, world-wide infrastructures, ownership and cost models

Networks & Data
Transmission

On-site and off-site needs and constraints, embedded and safety-relevant systems

Data and Storage

Volume estimates, future trends,
adequate end-user access needs and concepts

Data Analytics

Decades long data usage, ownership and licensing, format standardization, integrity, storage evolution/obsolescence

Archive & Availability

Technology outlook, infrastructure management and provisioning, application workflows, SCADA, DBs, data analytics, Gigascale modelling

Platforms & Tools

Security

Cyber-security, regulatory aspects, contributions to risk management database

Study Case

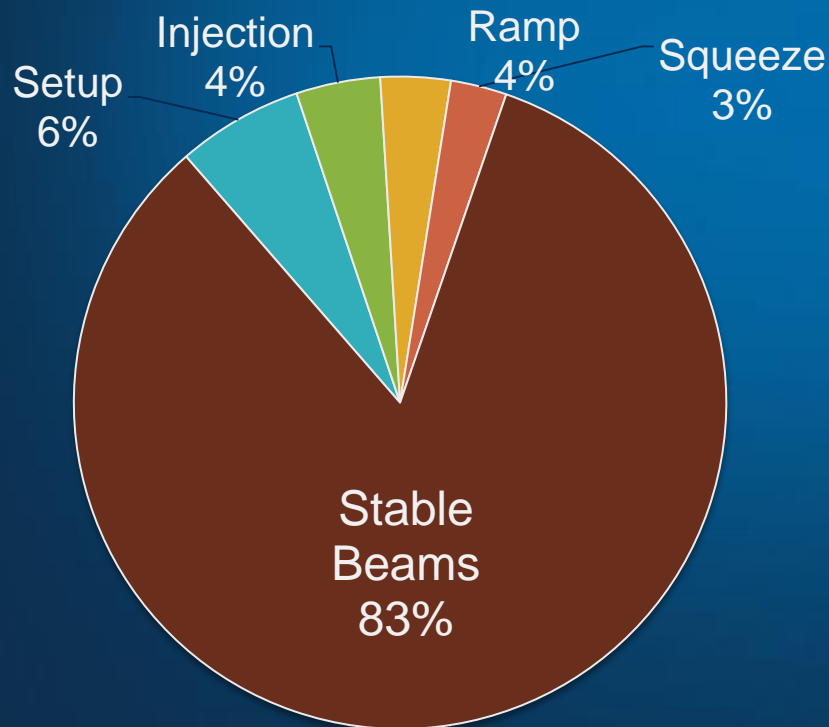
Achieve high availability and operation efficiency

- Early warning and co-scheduling of preventive interventions
- Develop availability improving modifications based on observations
- Establish a model of an accelerator for
 - Confirmation of expected behaviour in face of faults
 - Operator training
 - Design of upgrades and future colliders

LHC Availability

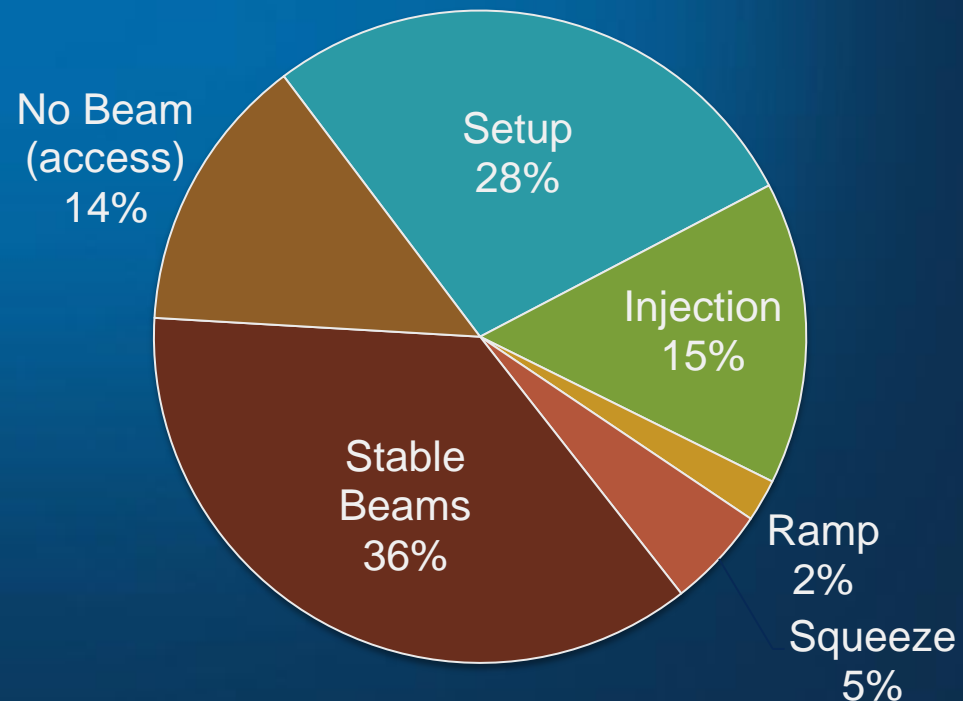
Estimated

- 10 hour physics coasts
- No faults, or down time

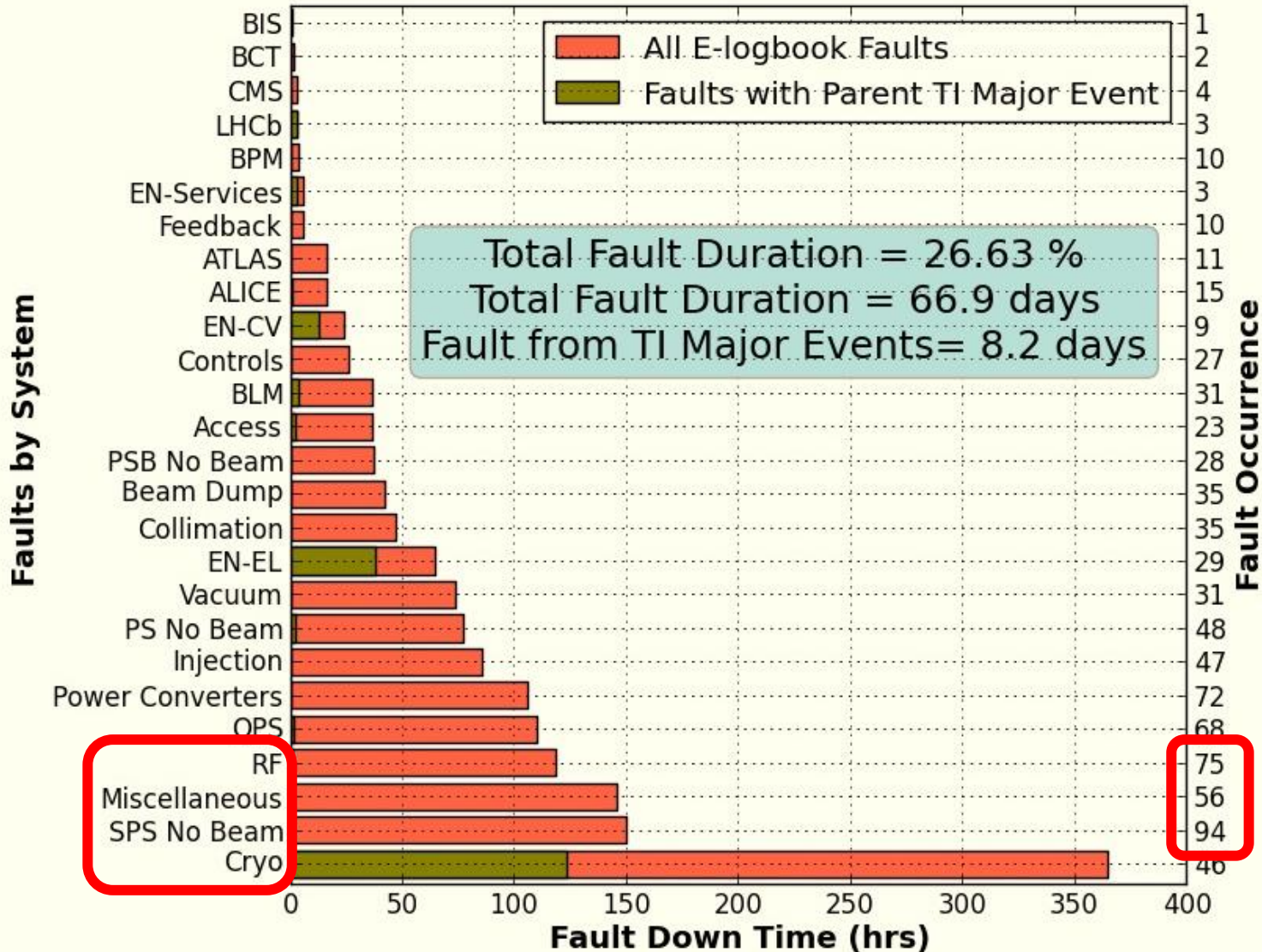


Observed

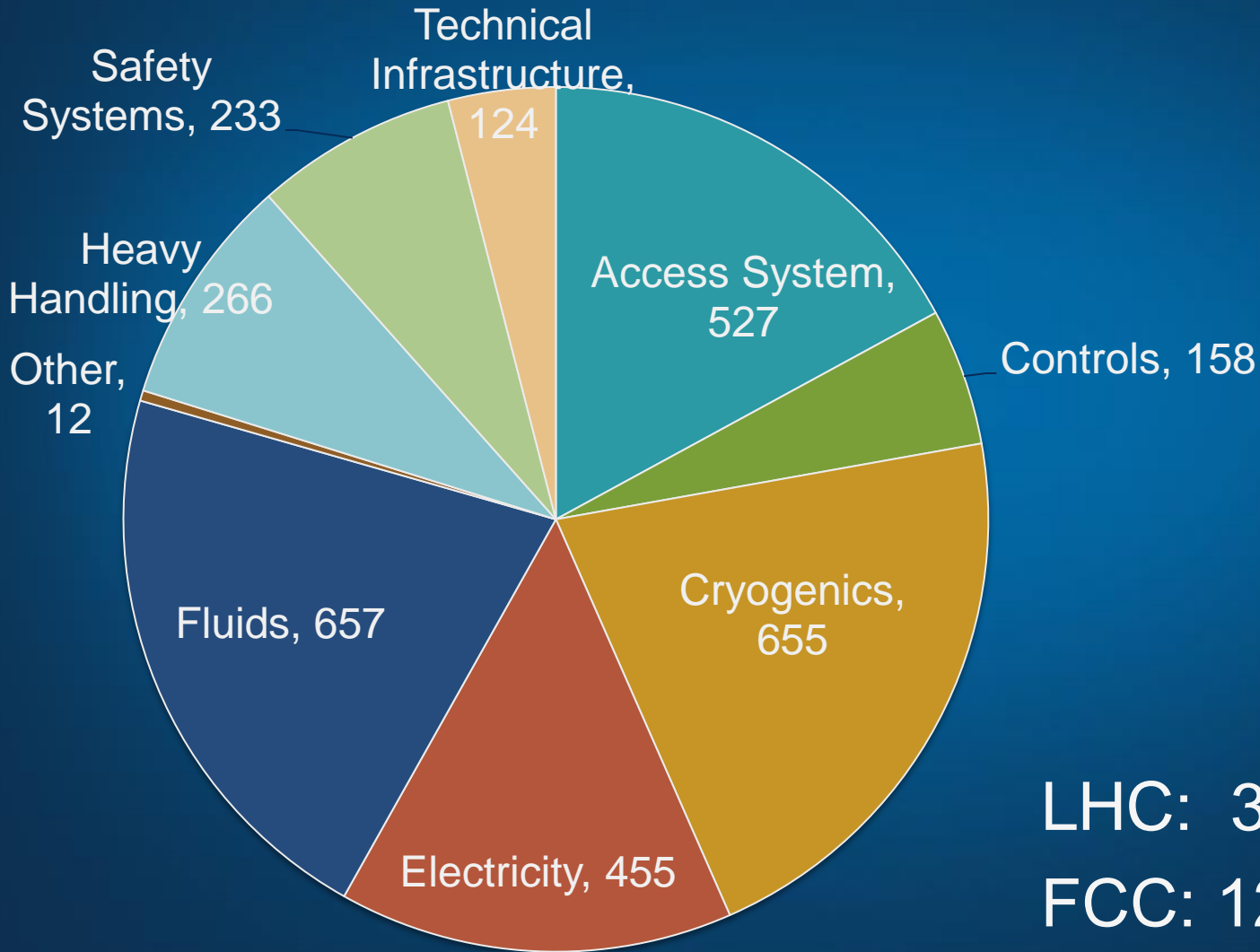
- 6 hour physics coasts
- Faults and down time mainly in no beam, setup & injection phases



Fault Drivers



Corrective Interventions



LHC: 3087 / yr

FCC: 12'500 / yr ?

Approach

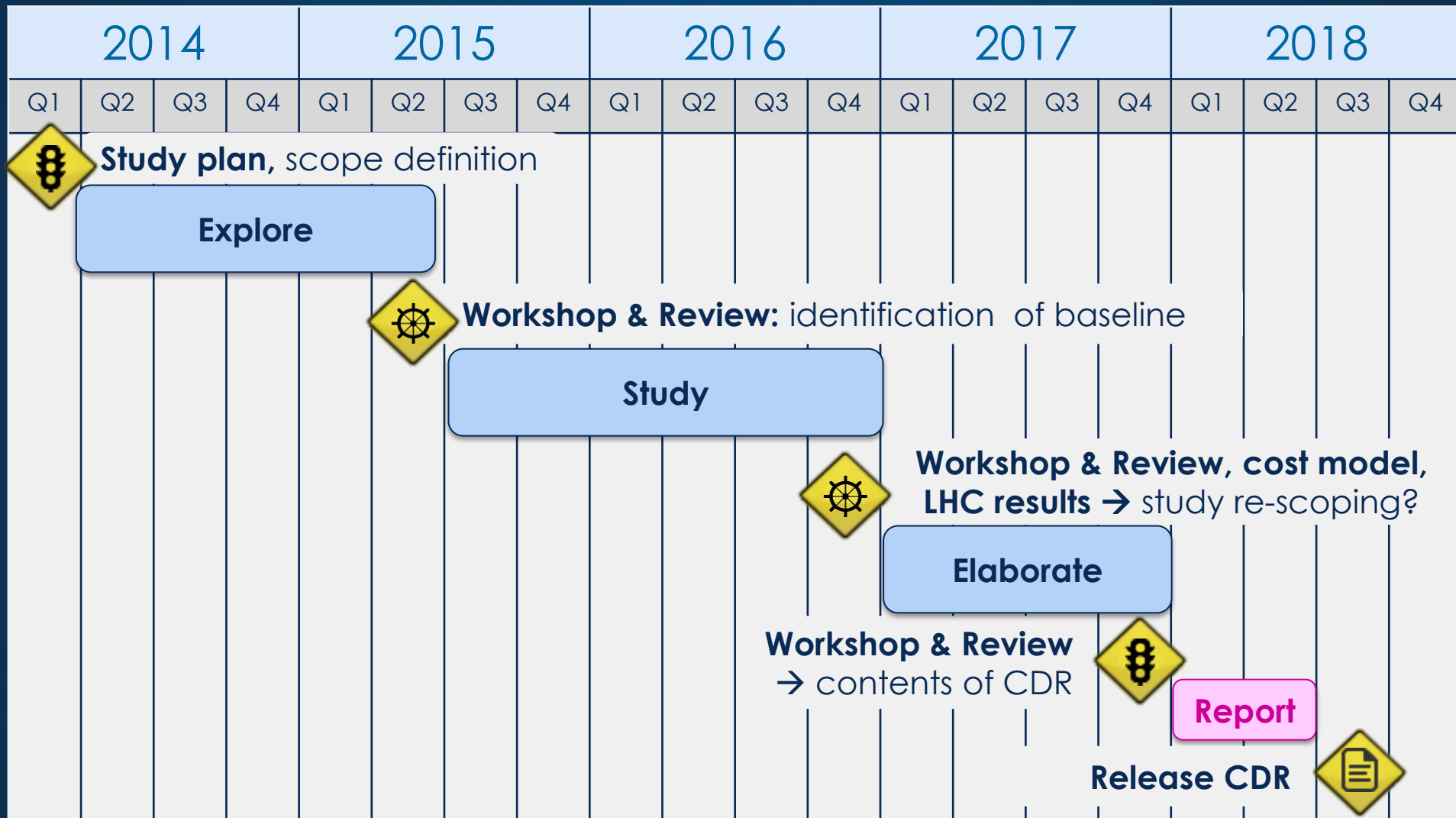
- Analyze large quantities of historic monitoring data
- Confirm suspected correlations
- Derive prediction laws
- Detect yet-unknown patterns

...followed by
in Time Analytics

Study iTA

- Scale free streaming analytics
- Raw, transformed, secondary and derived data as input
- Multi data source “data lake”
- Timely processing and partial processing to achieve deterministic response

Study Timeline



Contributions to the Study

- The study is, what people contribute to it
- Scope can be adjusted on the way
- Resources need to be estimated together with the study planning team
- Together, means will be worked out to complete resources according to agreed scope

Phase 1 (2014)

- **Establish international collaborations**
 - involve operation experts from external institutes
 - Involve IT experts from external organizations (academia and industry)
- Establish comprehensive catalogue of data analytics **use cases for accelerator complex**
 - **To be done by operation experts**
- Learn how to do data analytics
 - **Involvement from external academia and industry needed**
- Derive **functional and performance requirements catalogue for a data analytics ecosystem** that fits accelerator complex and experiment operation
 - **To be done by computing experts**

Phase 2 (2015-16)

- **Understand** today's and emerging data analytics technologies in terms of functions and performance
- **Quantify** the functional and performance limitations of today's and emerging data analytics technologies
- **Formulate scaling laws** and identify potential limitations in terms of usability, functions and performances

Phase 3 (2017)

- **Extrapolate** from existing functions and performances and their evolution over the next four years to the time frame of an FCC realization phase
- **Derive recommendations** for a data analytics ecosystem for future accelerator and collider projects

Triple-Win Situation



1. Validation of models in **future LHC** runs

Better understanding of machine

2. Provide opportunities for **HL-LHC**

Improvement of availability

3. R & D for **FCC** based on current data

Suitable technologies for future machines