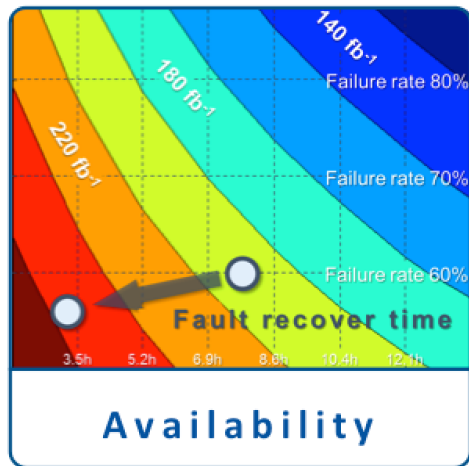


## A key quality attribute of a Future Circular Collider - Availability performance (RAMS)



P. Sollander,

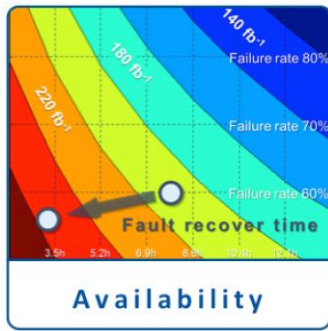
Thanks to A. Apollonio, J. Gutleber, M. Lamont,  
P. Collier, S. Virtanen,



# Outline



- Reminder of terms
- Motivation
- FCC work package
- Collaboration
- Plans



# DEFINITIONS

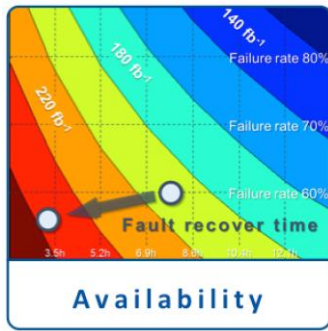


Availability is the proportion of time a system is in a functioning condition



**Availability**, a function of  
**Reliability** – Mean Time To Failure,  
**Maintainability** – Mean Time To Repair and  
**Supportability** – Mean Logistics Delay Time

$$Availability = \frac{MTTF}{MTTF + MTTR + MLDT}$$



# MOTIVATION



# RAMS requirements are being formulated here and now



- FCC-hh luminosity 250-1000 fb<sup>-1</sup> per year

*Michael Benedikt's talk*

- Turn-around time limits integrated luminosity

*Daniel Schultes' talk*

- Beam loss can destroy the machine !

*Bill Foster, Daniel Shulte, Miguel Jimenez, Freddy Bordry, ...*

- Breakthrough in availability needed

*Michael Benedikt*

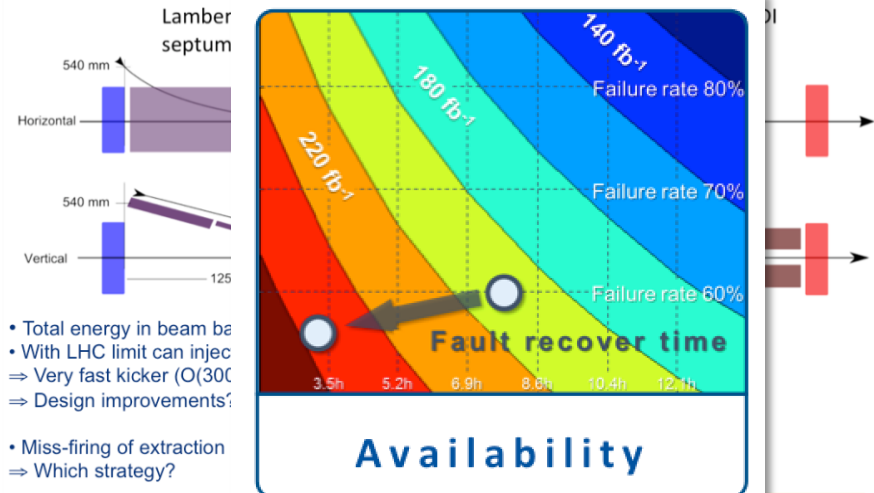
- ...

## FCC-hh Luminosity Goals

- Two parameter sets for two operation phases:



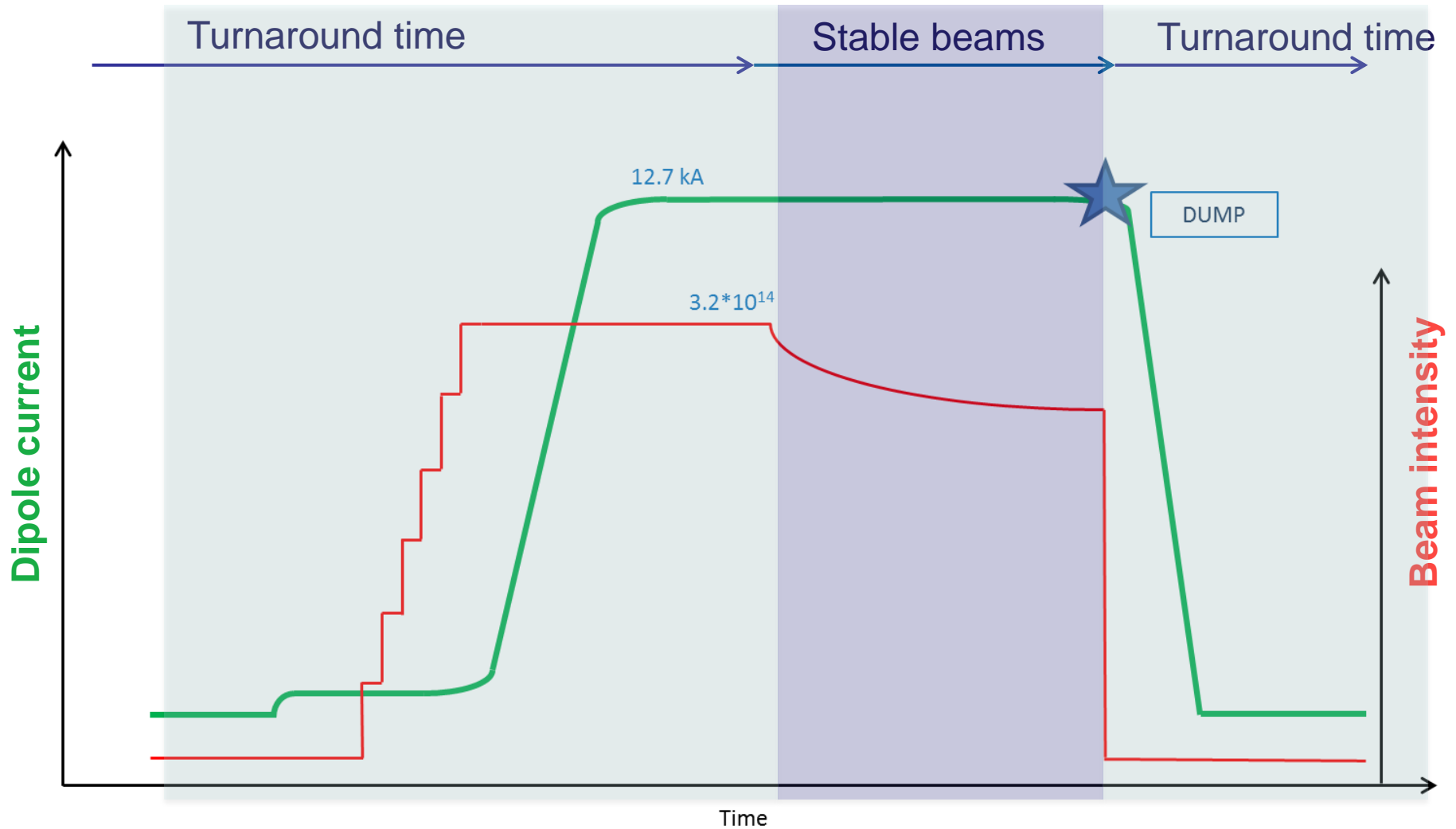
### Injection/Extraction Challenge



Number of subsystems requires breakthrough in reliability, availability



# Collider operation is *Stable beams + Turn-around time*





# Faults increase turn-around time



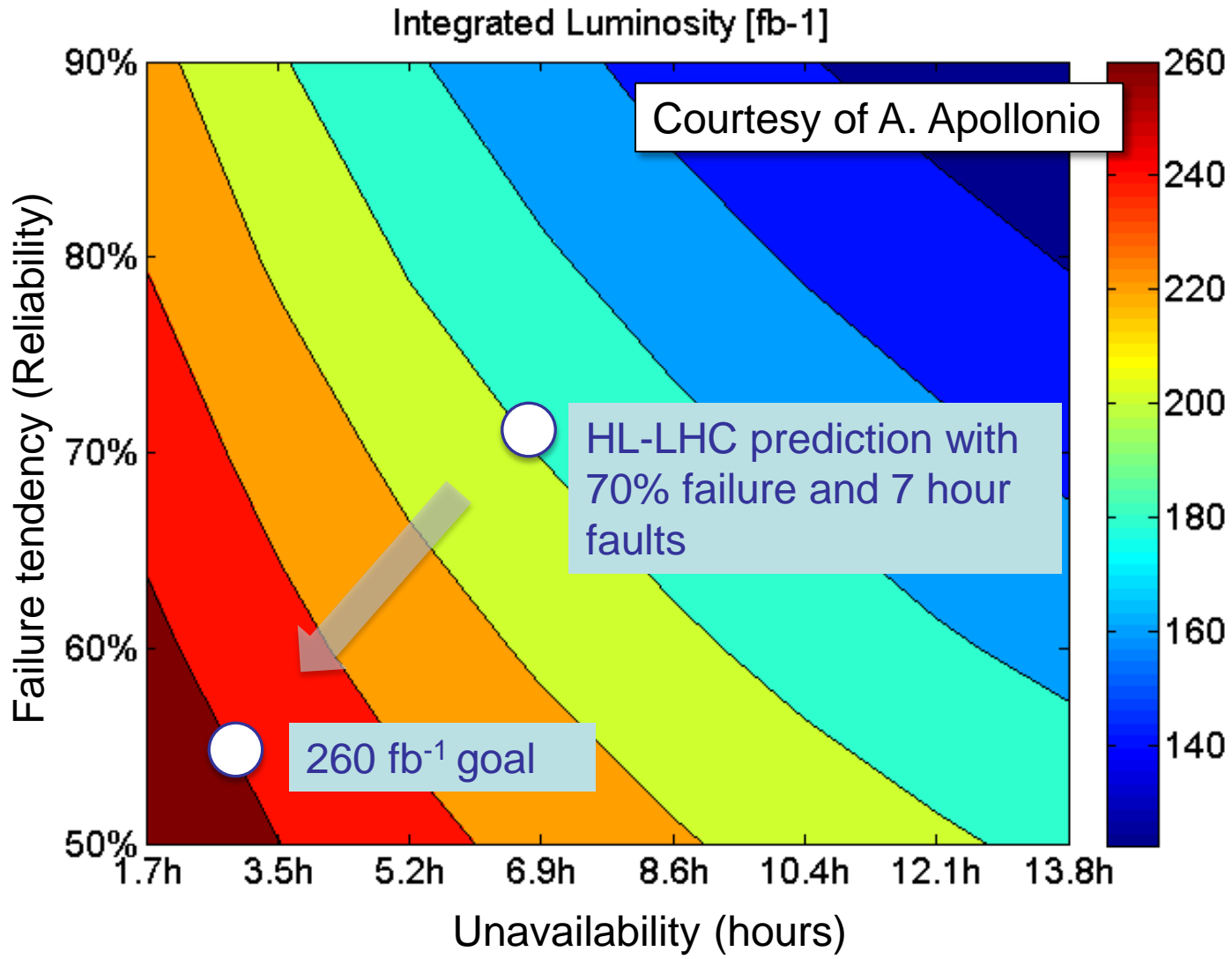
## ❑ LHC example

- ❑ **Failure tendency** – 70% of fills dumped prematurely
- ❑ **Average unavailability caused by fault** – 7 hours
  - ❑ Mean Time To Repair plus
  - ❑ Localization, Diagnostics, Logistics

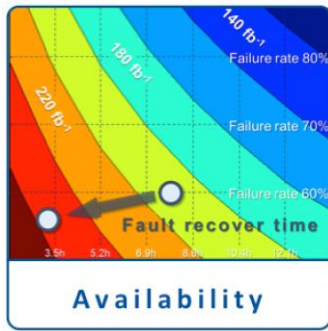




# Performance can be increased by reducing failure tendency and unavailability



*Localization + Diagnostics + Logistics + Repair*

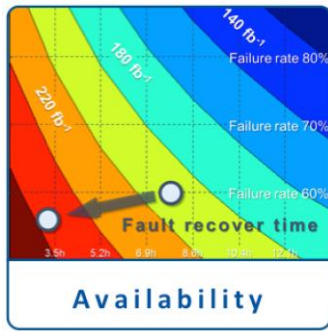


# FCC WORK UNIT

## 3.3.1.9



- **Evaluate** the **suitability** of industrially applied RAMS methods and tools for use in particle **accelerator projects**
- **Assess benefits** for the design of future accelerators
- Formulate high level recommendations
- Train system experts to use selected methods and tools



# COLLABORATION



# Tampere University of Technology concluded FCC MoU and Addendum



TAMPERE UNIVERSITY OF TECHNOLOGY +



Professor Seppo Virtanen

- One of the world's leading RAMS researchers
- Foundation fellow of the ISEAM
- RAMS studies since 1983

Prof. Virtanen's has successfully carried out many **RAMS-studies** within **feasibility and conceptual design phase** of large scale investment projects worldwide (e.g. Statoil, Procter & Gamble, Wartsila, Metso, Kone, Cargotec Corporations and Posiva (Nuclear Waste Management) ).

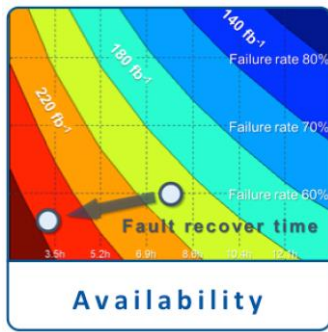
TUT-based spin-off [Ramentor Oy](#) was born out of research conducted by Virtanen's group. Ramentor has developed ELMAS (Event Logic Modeling and Analysis Software) for the RAMS engineering and management of systems and for probabilistic risk assessment throughout their lifecycle.



# TUT made RAMS design for Finnish nuclear waste encapsulation plant



- [Posiva nuclear waste management plant video: https://youtu.be/hZI3AYI85n8](https://youtu.be/hZI3AYI85n8)



# PLANS



# Tampere University of Technology will take part in the FCC study



- 3.5 person strong team from TUT involved for the duration of the study.
  - 2 TUT doctoral students
  - 1 CERN doctoral student
  - 50% of Professor Virtanen's time
- Collaboration with CERN team
  - 1 Research Fellow
  - 1 doctoral student
  - staff
- Work starts in May 2015 with the arrival of the CERN doctoral student



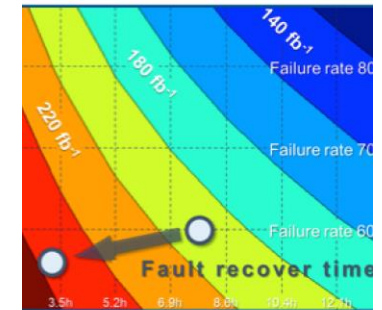


# Modeling an existing accelerator will tell if RAMS methods are applicable to accelerators



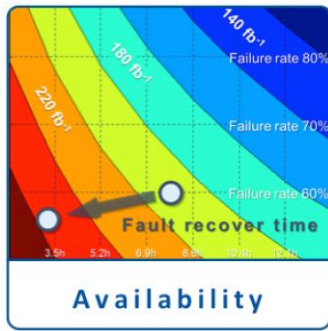
- Identify key contributors to downtime and areas for deeper studies and application of RAMS methods
- Example areas that may be interesting to study
  - Impact of injectors on availability
  - Optimizing turn-around time
  - Large scale technical systems
  - Machine protection
  - Maintainability (100km ring)
  - ...
- Collaboration with existing groups and initiatives treating availability and reliability for the current accelerators at CERN

- Availability is key to achieve requested performance ( $\text{fb}^{-1}/\text{year}$ )
- Tampere University of Technology has RAMS expertise and will work for the FCC study
- Work units are defined and about to start
- More collaborators are welcome



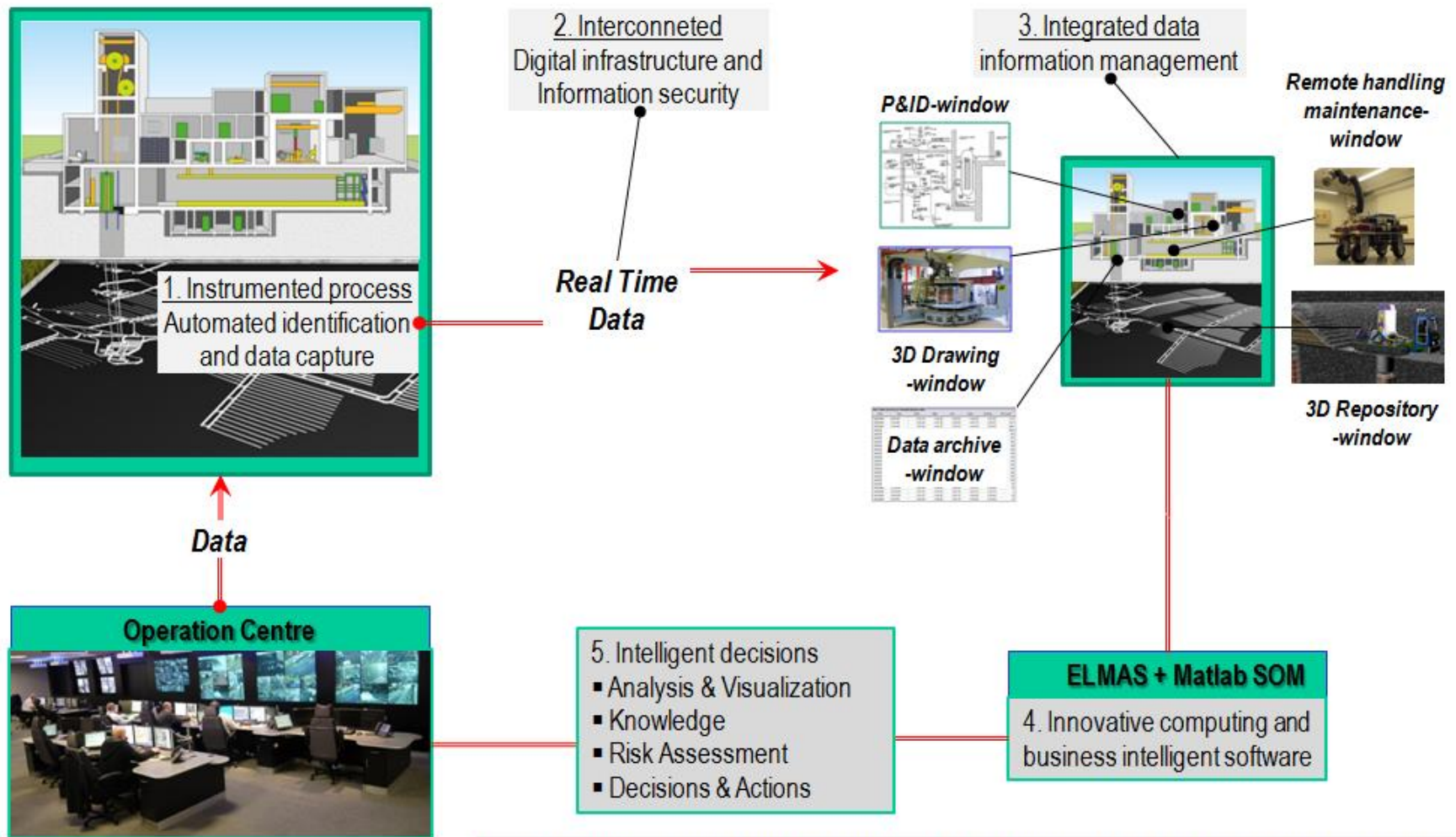
Availability





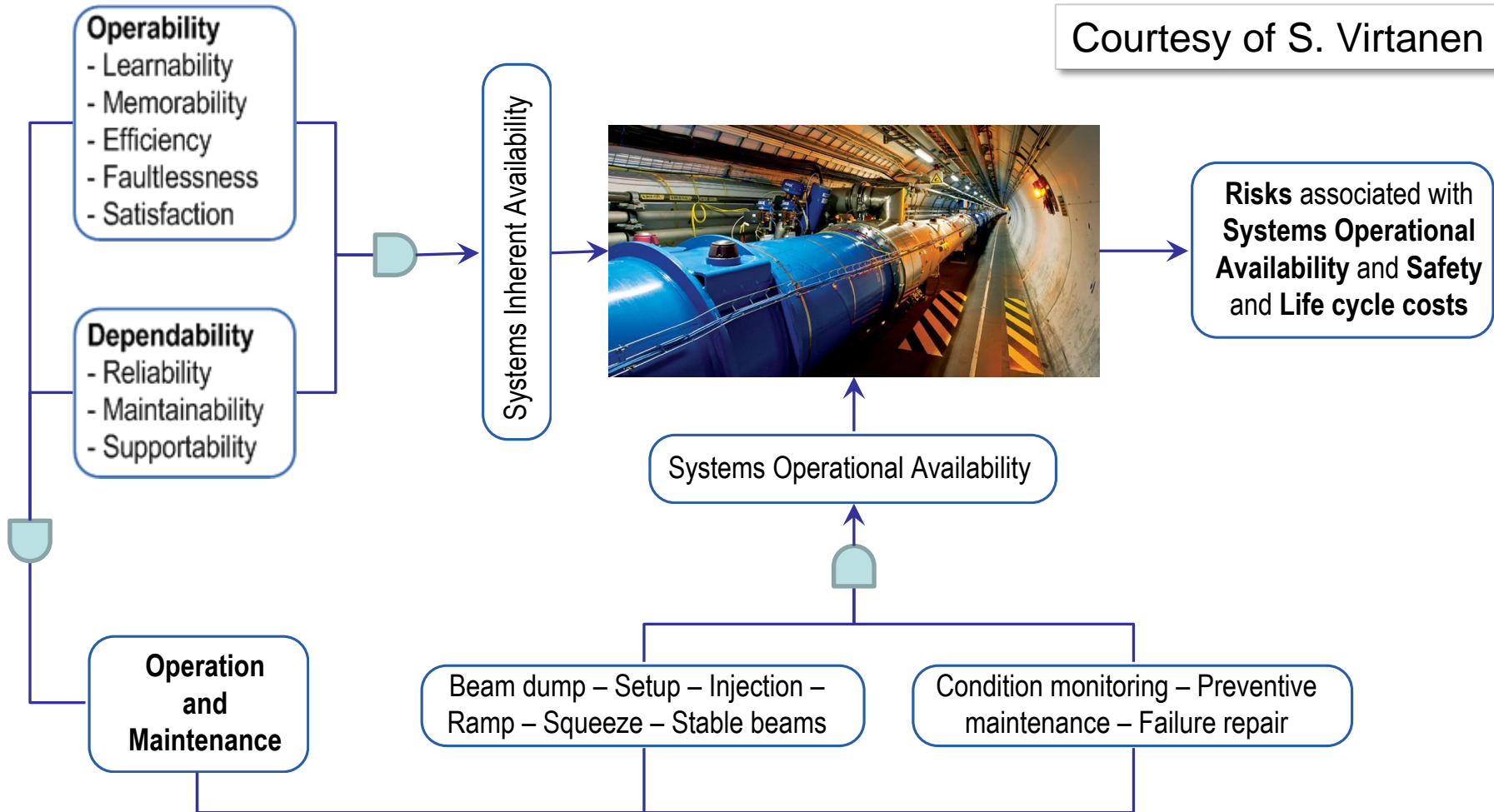
# THANKS FOR YOUR ATTENTION

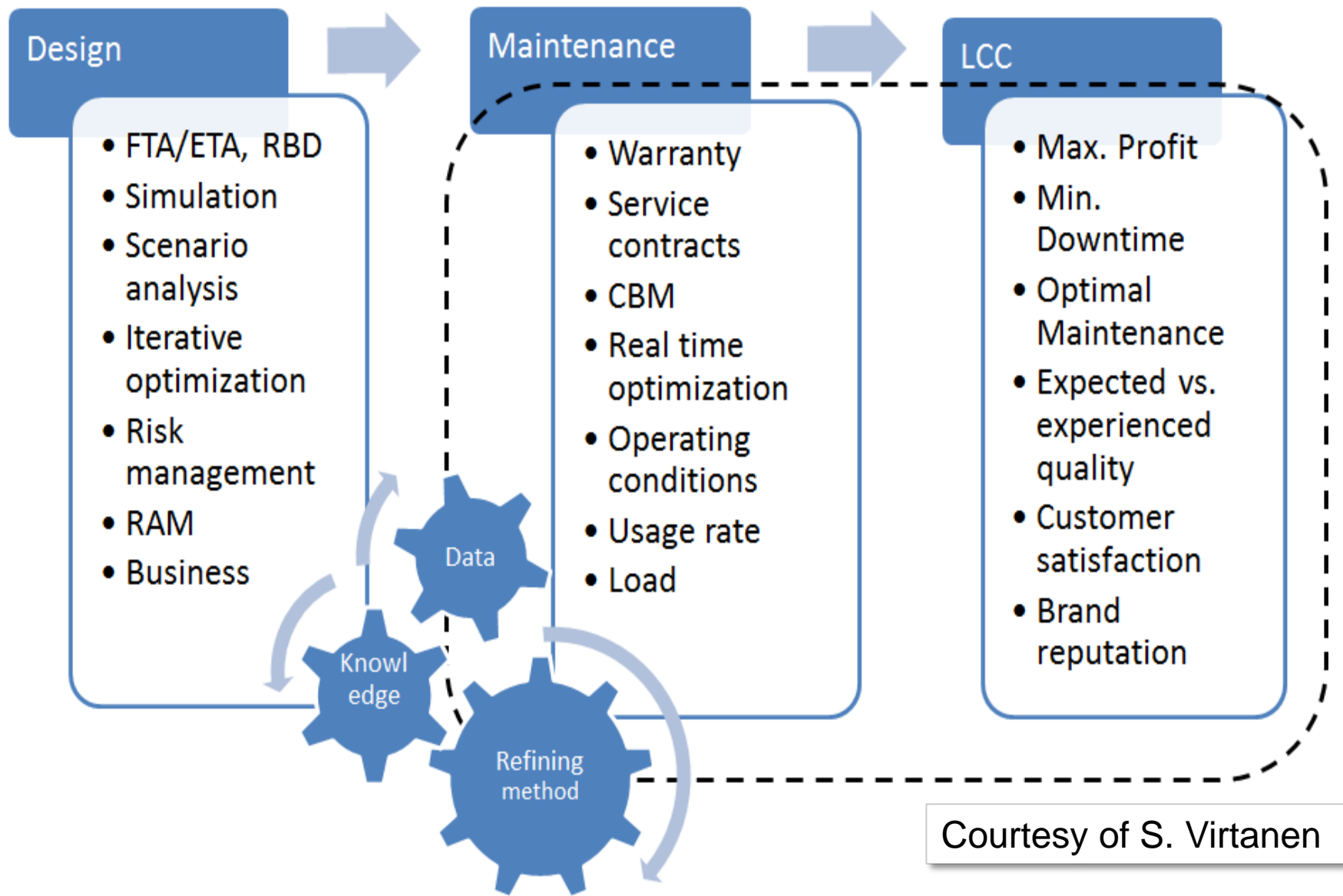
# Posiva: Encapsulation and Repository Integrated Operations – RAMS study



Integrated Operations = Real time data + covering data to information + technical & organizational consequences

Courtesy of S. Virtanen





Courtesy of S. Virtanen