

FROM RESEARCH TO INDUSTRY



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PIP-II RISK WORKSHOP: CEA VIEW

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on behalf of
CEA, DRF/Irfu

13 July 2018



- Specific plans to be developed, but general vision is:



Dressed/Qualified Cavities

- Lab-sourced prototypes
- Indian industry sourced production
- Lab Prep&Test



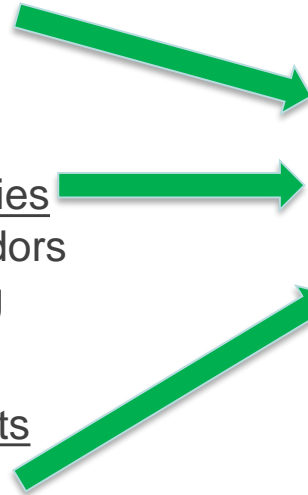
Dressed/Qualified Cavities

- Established EU Vendors
- Industrial Processing
- Lab qualification



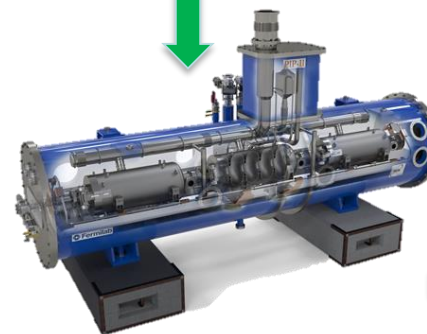
Cryomodule Components

- Established EU Vendors
- RF couplers
- Other opportunities

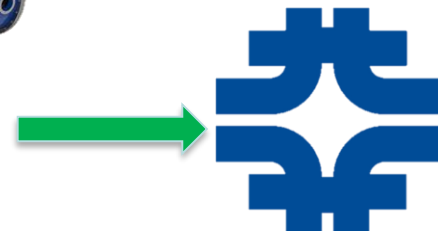


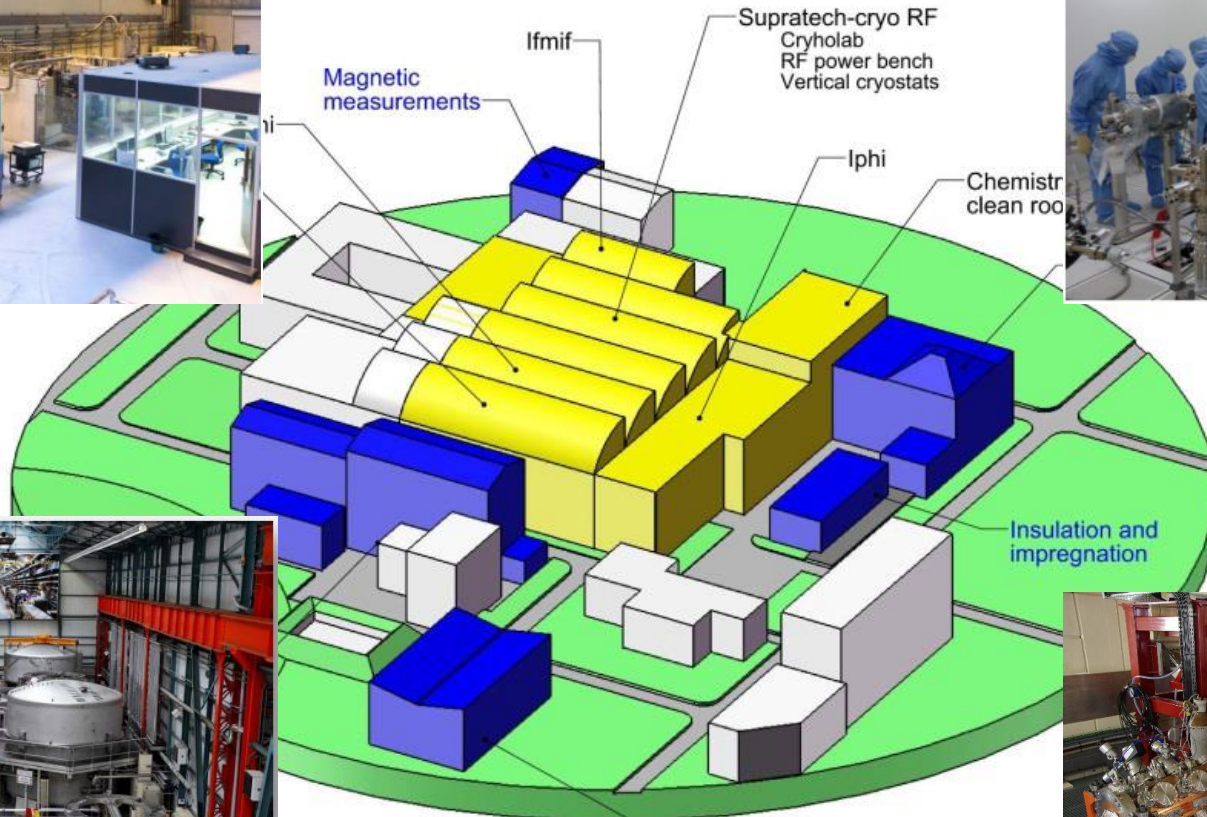
CM Integration

- Possible CM Qualification
- Overseas Shipment



CM Qualification



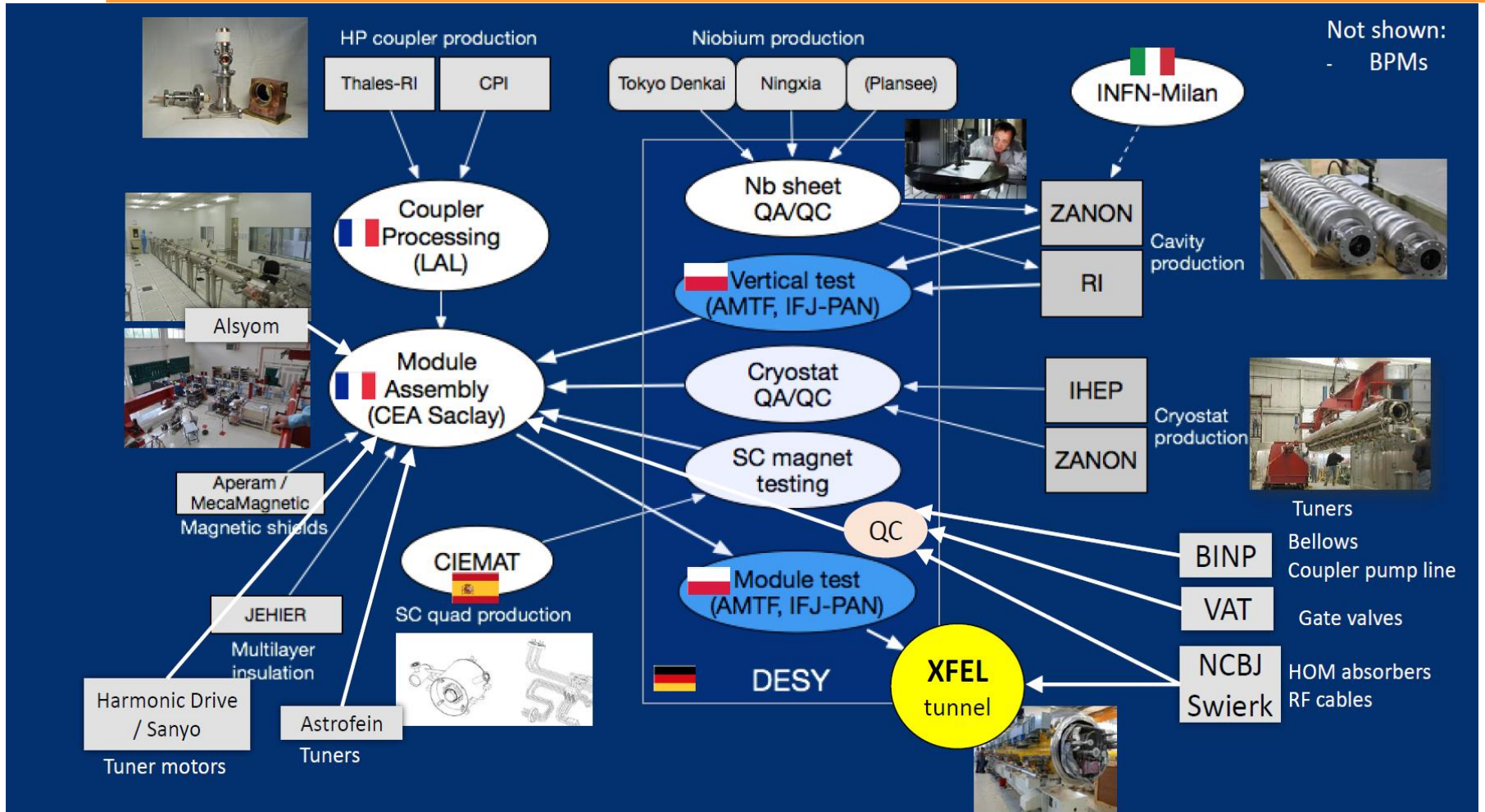


Superconducting magnet test facilities
 W7-X facilities
 Schema
 Vertical cryostat
 Seht

Characterization facilities
 Cetace
 Christiane
 Sejos
 Mecti
 Thermosiphon
 Mecanical tests

In-Kind Contributors to E-XFEL Cold Linac

In one shot !



The PM is like a symphony orchestra director trying to get all sections synchronized: an impossible task with a risk occurrence of 100% ⇒ **work impact on the critical path.**

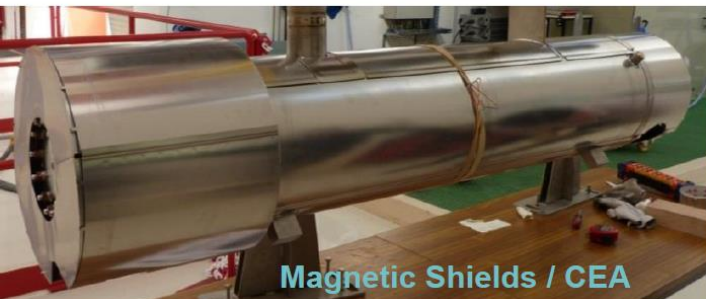
Cryo-systems



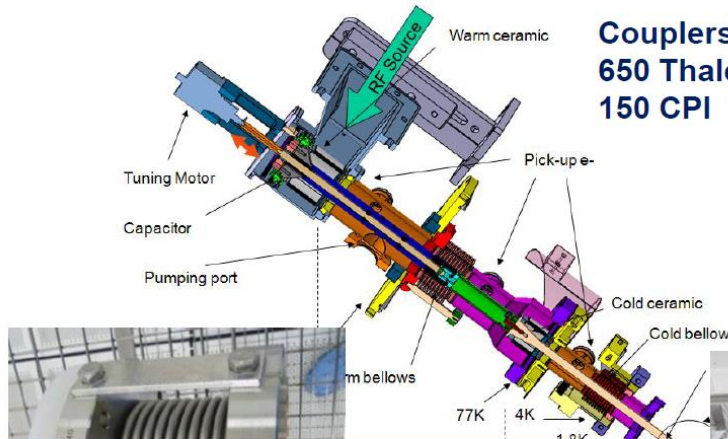
Vacuum vessels



45 from Zanon, 58 from IHEP/DESY



Magnetic Shields / CEA



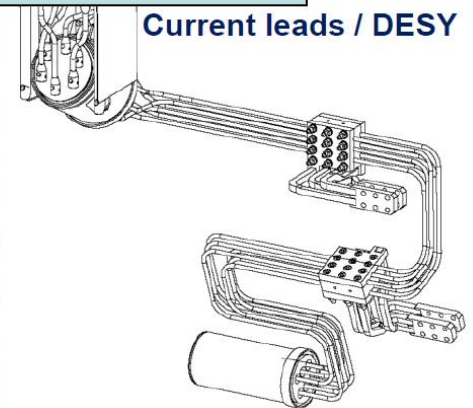
Couplers / IN2P3
650 Thales-RI
150 CPI

Quadrupole-BPM / DESY
103 Magnets / Cimat
BPM / 72 DESY – 31 CEA
206 Gate Valves / DESY

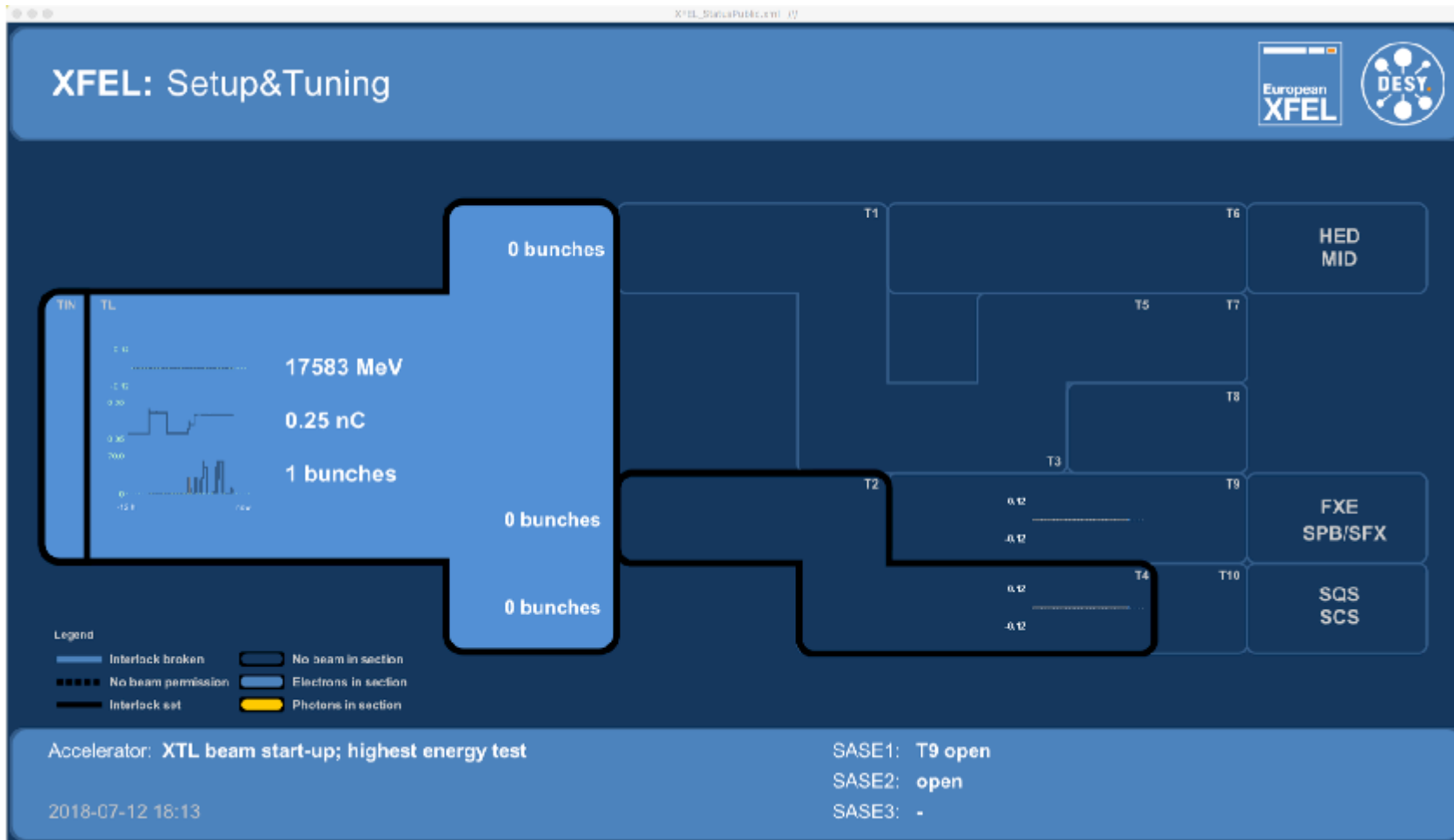
**There are 9 422 individual components integrated
and over 12 400 individual parts manipulated
per cryomodule**

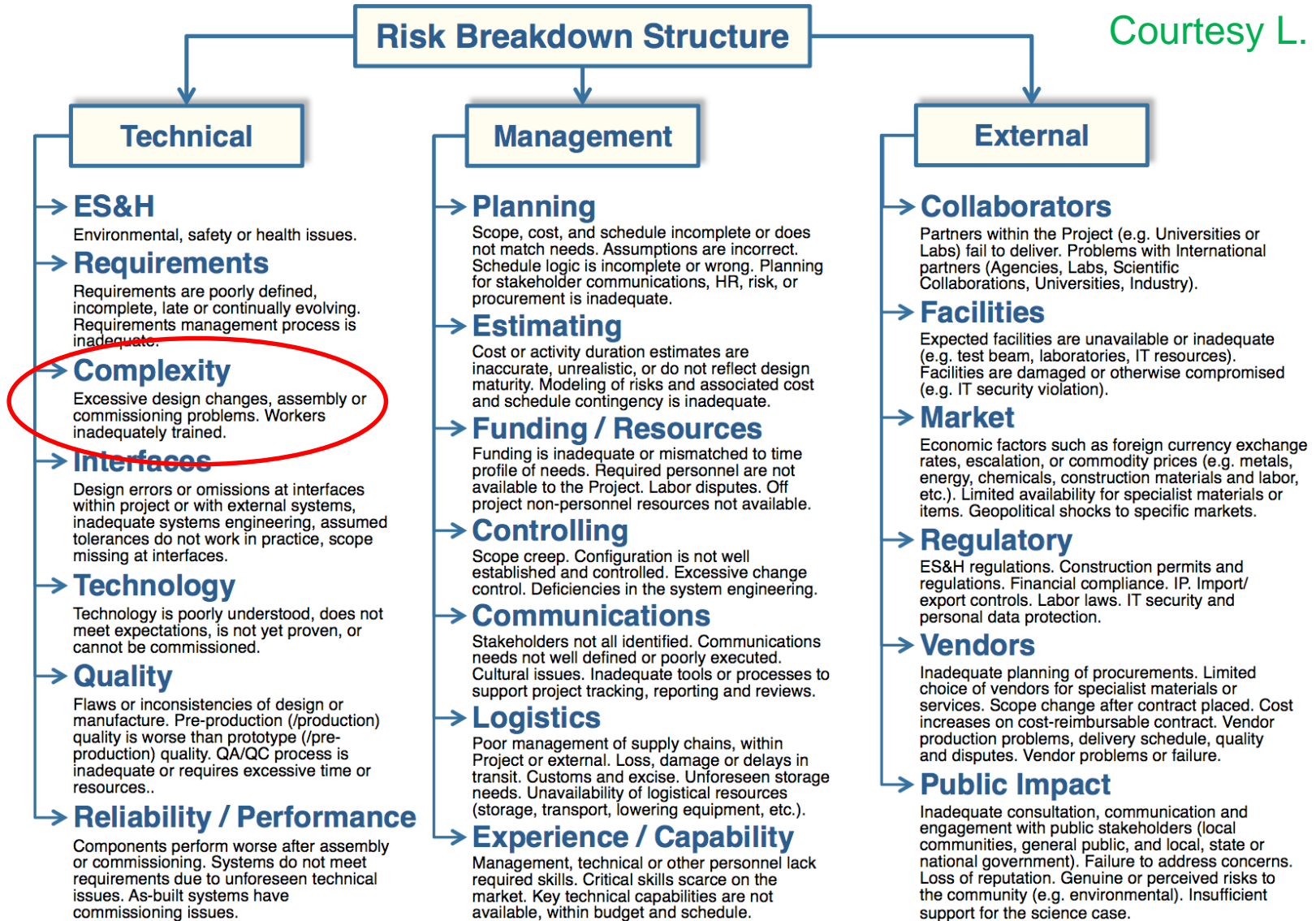
800 Cavities / DESY
400 Zanon / 400 RI

Current leads / DESY



« Yesterday, 12.07.2018 at 18:00, the superconducting accelerator of the European XFEL has for the first time accelerated electrons up to its design energy of 17.5 GeV »







Courtesy L. Taylor

Risk Breakdown Structure

Technical

- **ES&H**
Environmental, safety or health issues.
- **Requirements**
Requirements are poorly defined, incomplete, late or continually evolving. Requirements management process is inadequate.
- **Complexity**
Excessive design changes, assembly or commissioning problems. Workers inadequately trained.
- **Interfaces**
Design errors or omissions at interfaces within project or with external systems, inadequate systems engineering, assumed tolerances do not work in practice, scope missing at interfaces.
- **Technology**
Technology is poorly understood, does not meet expectations, is not yet proven, or cannot be commissioned.
- **Quality**
Flaws or inconsistencies of design or manufacture. Pre-production (/production) quality is worse than prototype (/pre-production) quality. QA/QC process is inadequate or requires excessive time or resources..
- **Reliability / Performance**
Components perform worse after assembly or commissioning. Systems do not meet requirements due to unforeseen technical issues. As-built systems have commissioning issues.

Management

- **Planning**
Scope, cost, and not match needs. Schedule logic is for stakeholder procurement is in
- **Estimation**
Cost or activity d inaccurate, unrealistic. Modeling and schedule co
- **Funding**
Funding is inadequate. Profile of needs. available to the F project non-person
- **Control**
Scope creep. Control established and control. Deficiencies
- **Communication**
Stakeholders not needs not well de Cultural issues. I support project tr
- **Logistics**
Poor management. Project or external transit. Customs needs. Unavailable (storage, transp
- **Experience**
Management, technical or other personnel lack required skills. Critical skills scarce on the market. Key technical capabilities are not available, within budget and schedule.

External

national government). Failure to address concerns. Loss of reputation. Genuine or perceived risks to the community (e.g. environmental). Insufficient support for the science case.

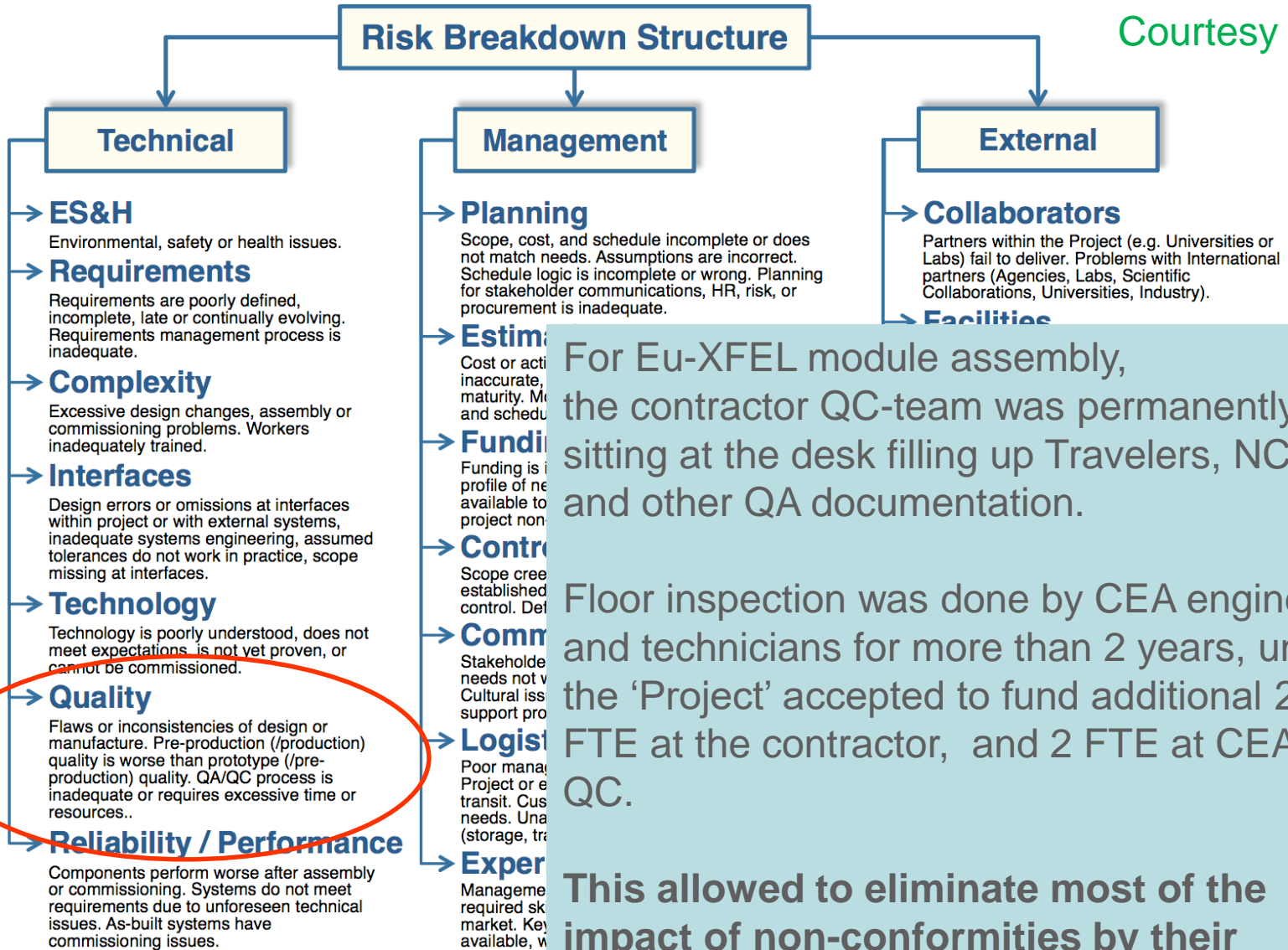
For Eu-XFEL module assembly, the quality of operators and technicians hired by the contractor was inadequate: management lack of skill ⇒ technical mistakes.

The event-uality of human induced technical mistakes is almost infinite: a reliable team of technicians/operators is worth any QA/QC Plan

The key factor is:

1. FLOOR inspection
2. FLOOR QA-QC
3. FLOOR coordination
4. FLOOR supervision

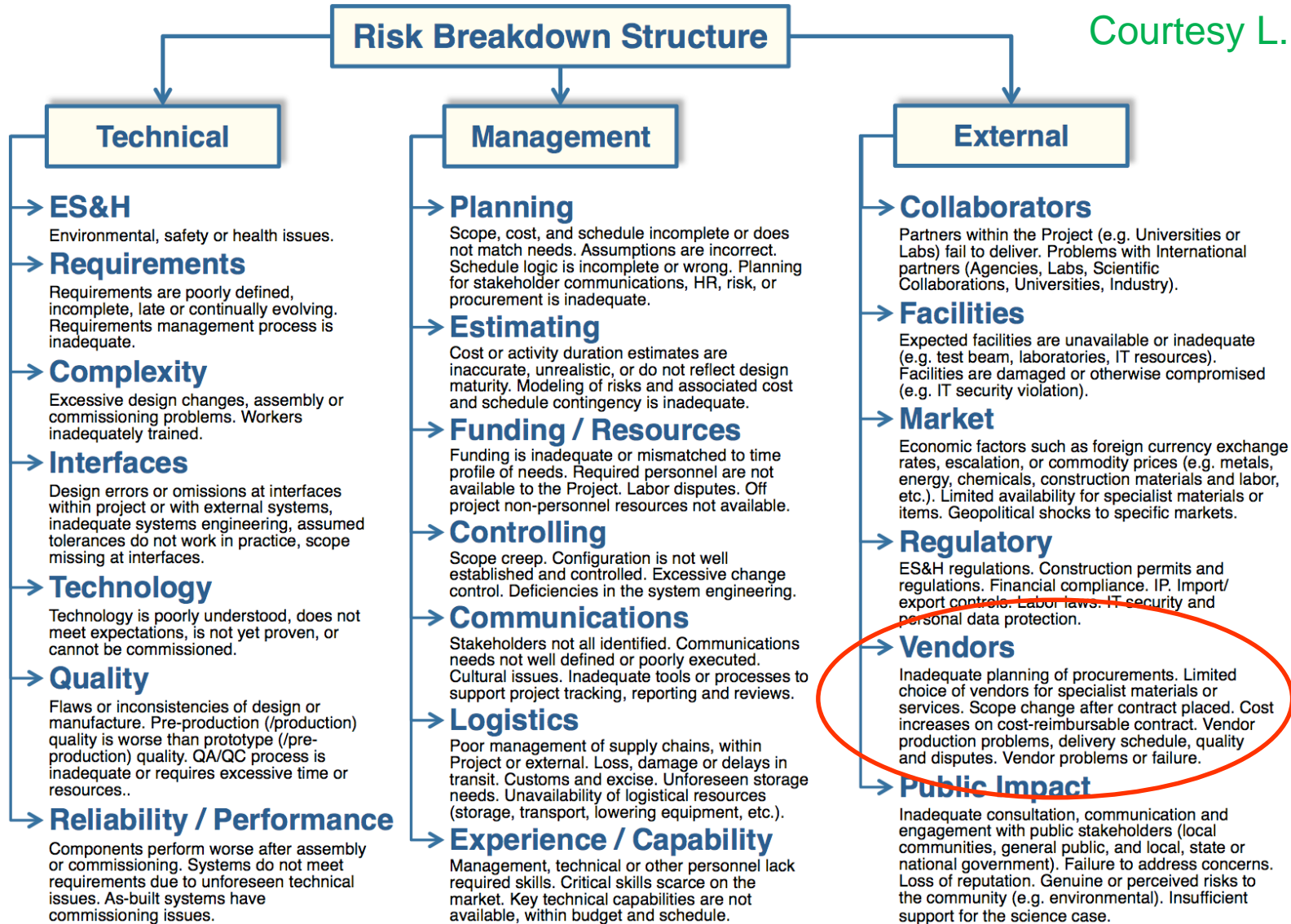
Courtesy L. Taylor

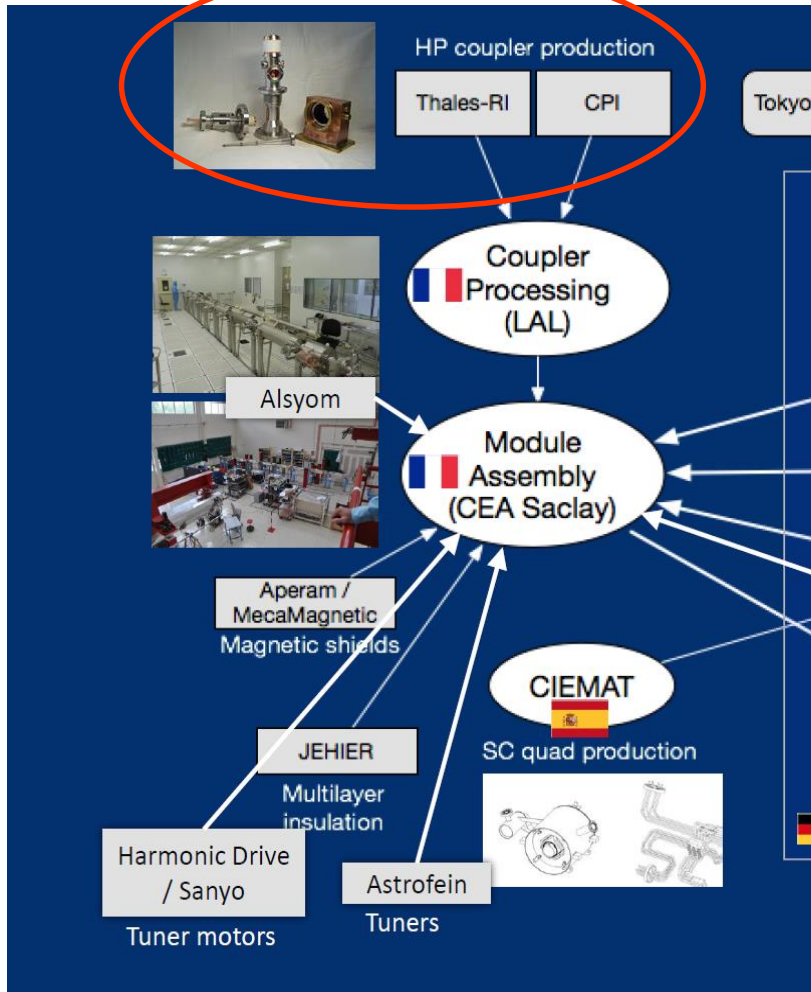


For Eu-XFEL module assembly, the contractor QC-team was permanently sitting at the desk filling up Travelers, NCRs, and other QA documentation.

Floor inspection was done by CEA engineers and technicians for more than 2 years, until the 'Project' accepted to fund additional 2 FTE at the contractor, and 2 FTE at CEA for QC.

This allowed to eliminate most of the impact of non-conformities by their 'timely' detection.





Key accelerator technology components are produced by a very small set (1,2,3...) of vendors.

For XFEL power couplers, the Cu-coating know-how was lost by **all** of them.

It resulted in 1-year delay, officially recognized by the Eu-XFEL Council, and ~100 M€ overcosts.

The good news is that Cu-coating capability has been recovered.

In Special Relativity, an **event** is a '*point in spacetime*'.

In Accelerator Construction, we may assume that space-time is not continuous by discrete, with grid sizes:

$$\Delta t \sim 5 \text{ minutes}$$

$$\Delta x \times \Delta y = 10 \text{ m}^2 \text{ (actually, we need a variable mesh size)}$$

$$\Delta z \sim 5 \text{ m}$$

Over ~ 10 years of design and construction, over $5 \times 10,000 \text{ m}^2$ of construction plants at **partners** labs + $n \times S \text{ m}^2$ of fabrication plants at industries + transportation routes:

\Rightarrow there is an infinite number of events *when* \times *where* non-conformities can occur.

- One Toshiba Klystron was on board of this vessel... and is finally lost; replacement by Toshiba within schedule is possible.

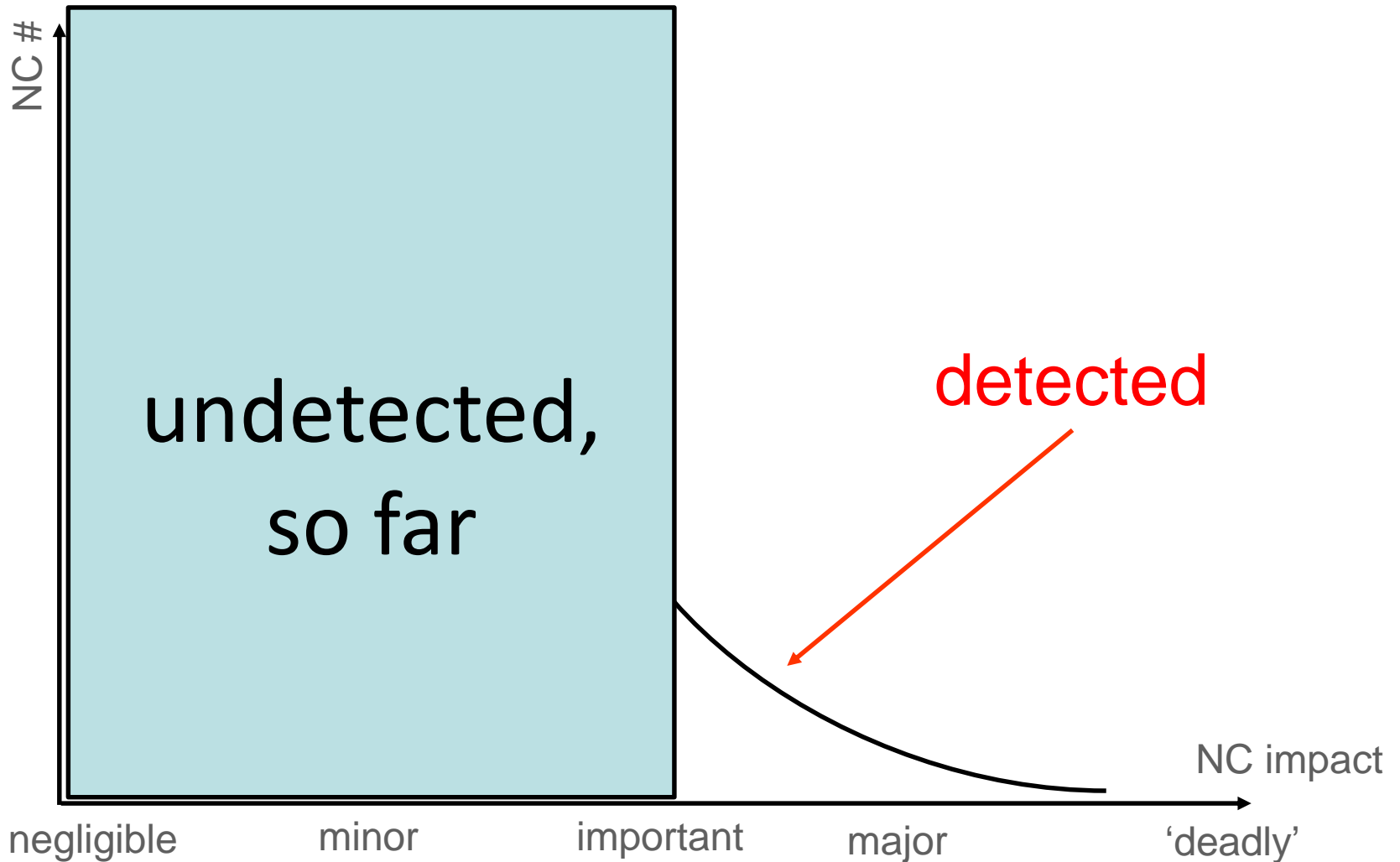


Joachim Mnich | DESY | Plenary ECFA 2013, CERN

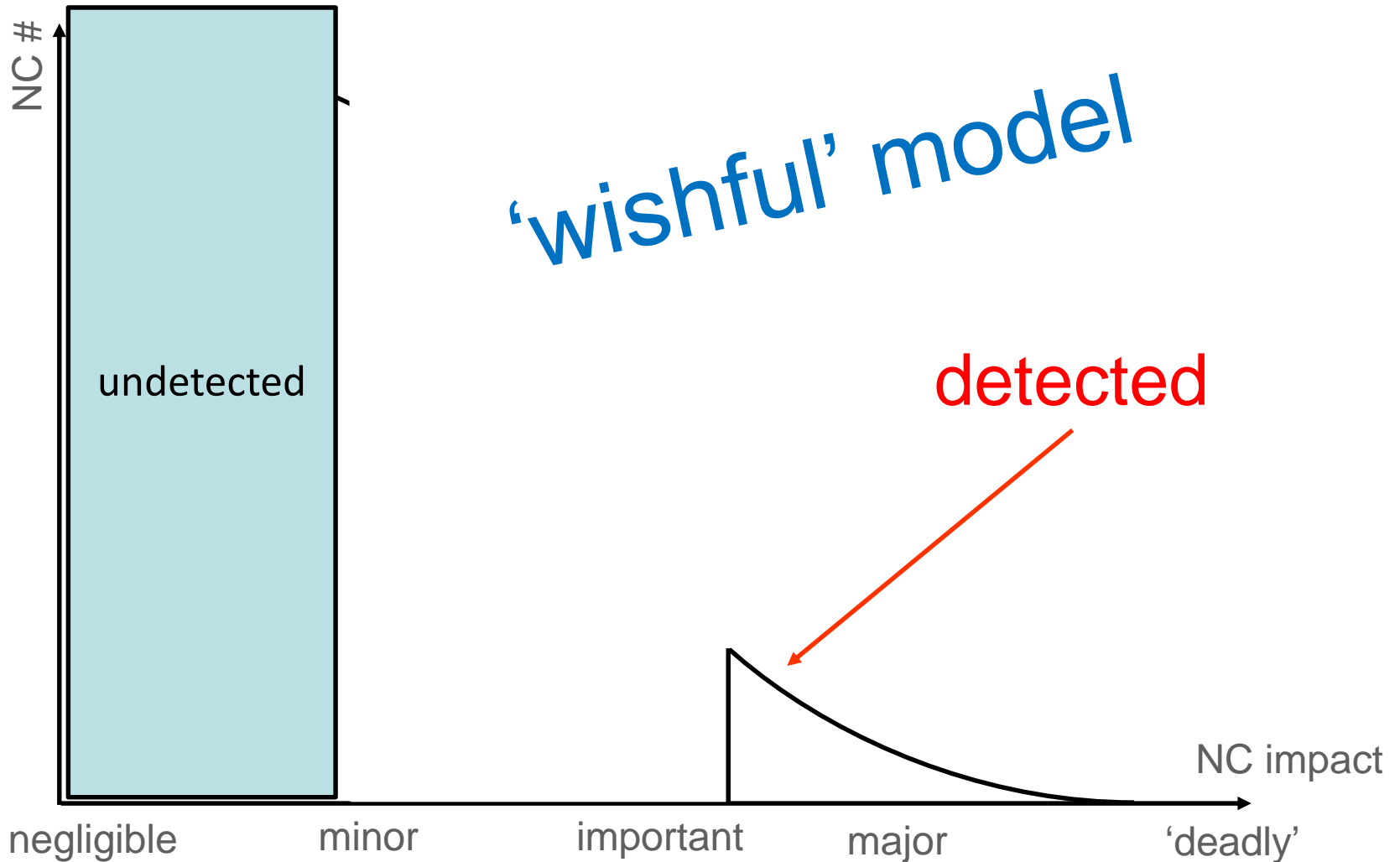
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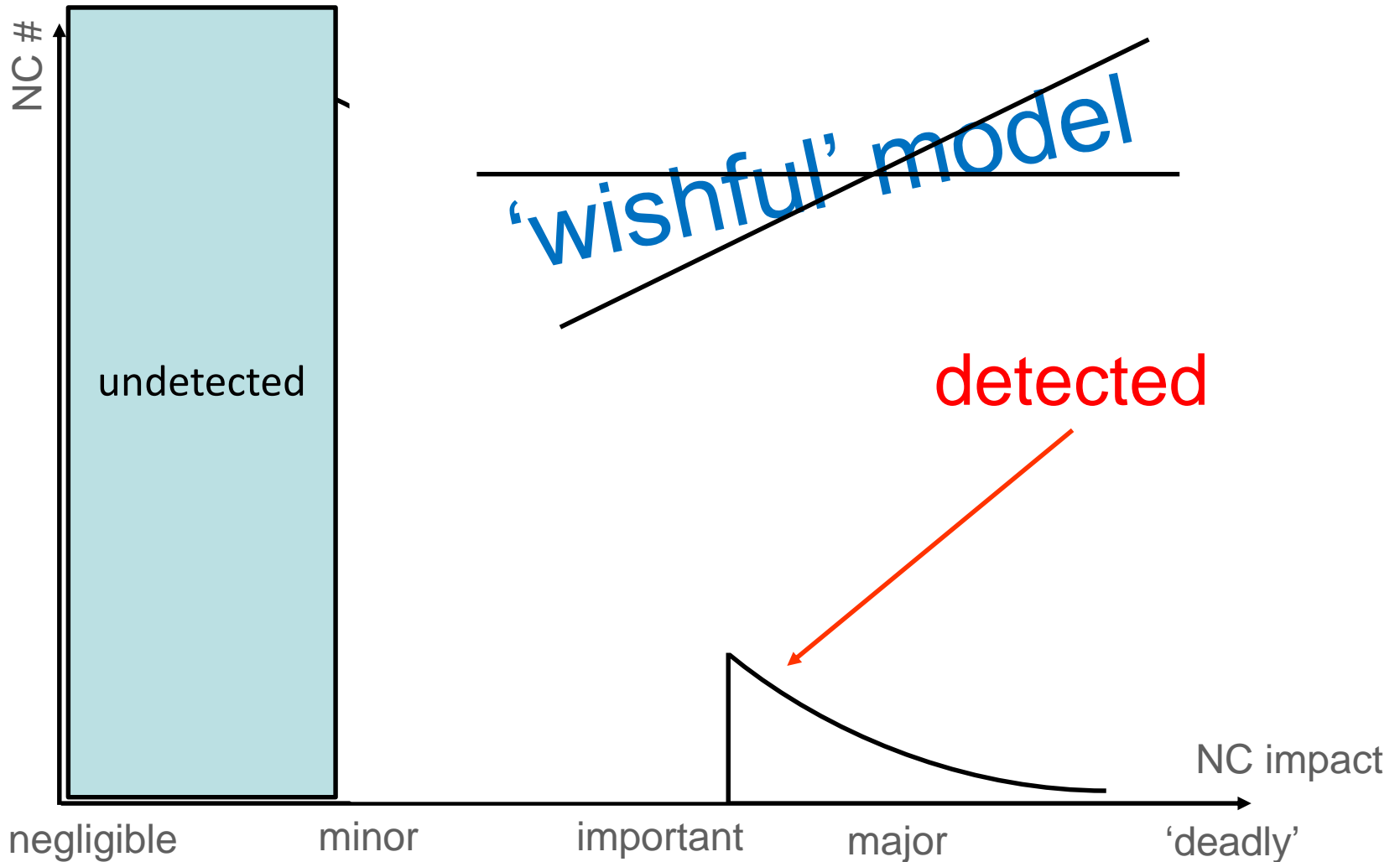
at time T_0



at time $T > T_0$



at time $T > T_0$



at time $T > T_0$

'Iceberg' model

True model as long as $d(\text{NC}\#)/dT$ is large

