



Business from technology

TSO view on the safety of in long term operation

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Content

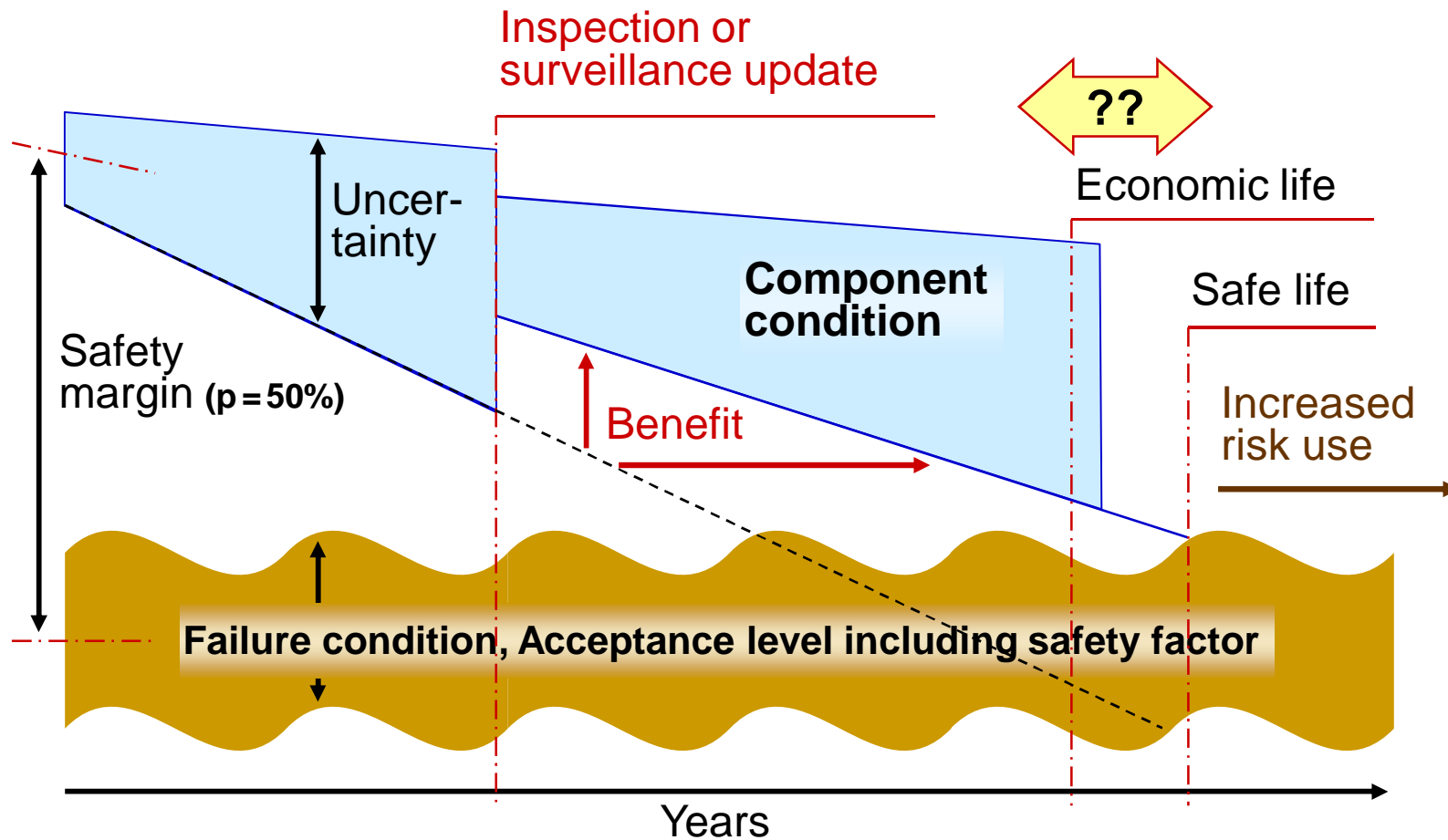
- Background/Introduction
 - Safety research – importance and impact to LTO
- Technical Safety Research and Technical Safety Support
 - Finnish operating model
 - National safety research forum – SAFIR2014
- Some case studies
- Summary

The image features a central glowing globe held by four blue robotic arms. The background is a light blue surface with interlocking puzzle pieces. A dark blue horizontal band across the middle contains the text "Background and introduction" in white. The overall aesthetic is clean, futuristic, and monochromatic.

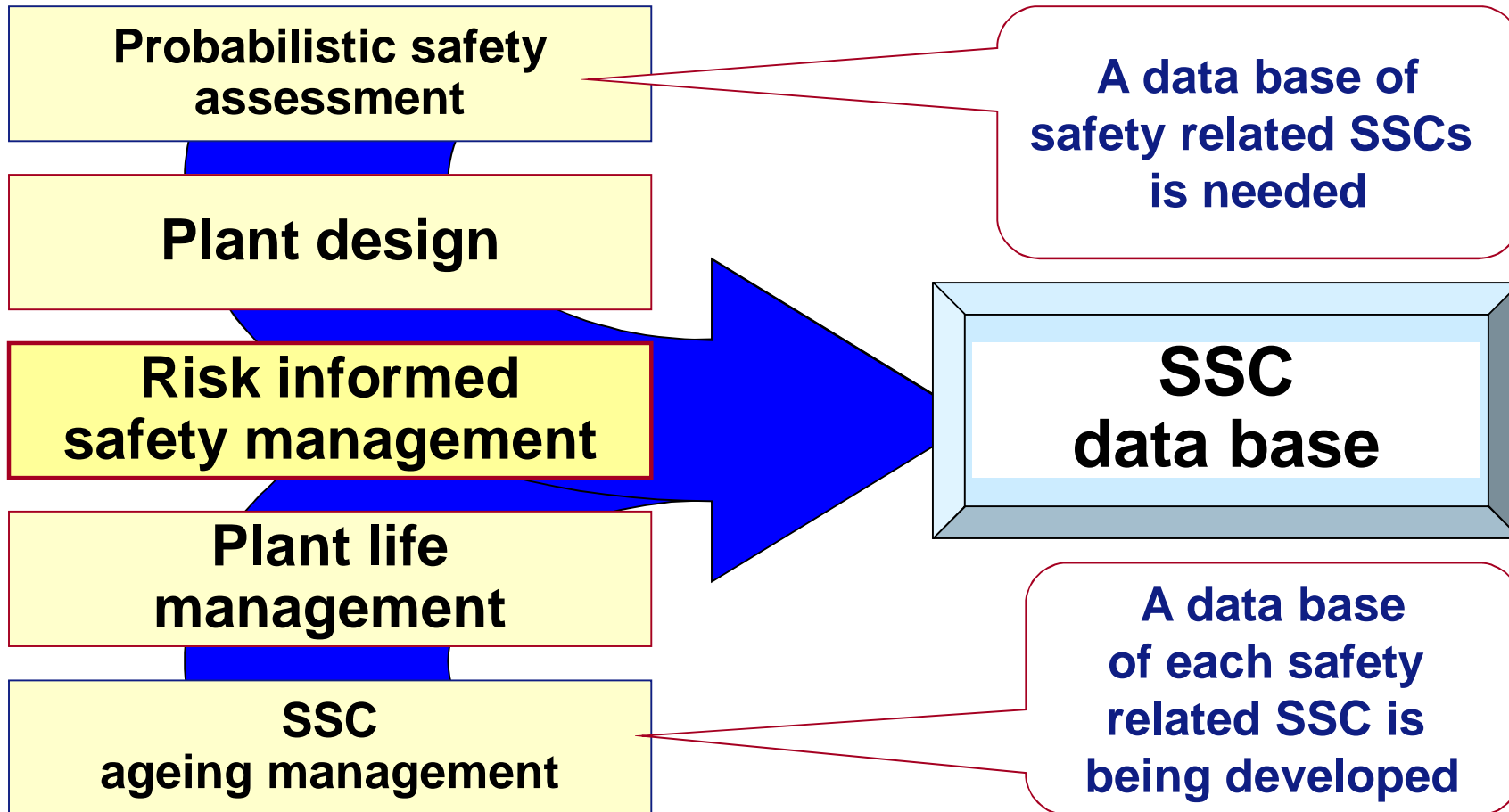
Background and introduction

R&D investments and long term operation

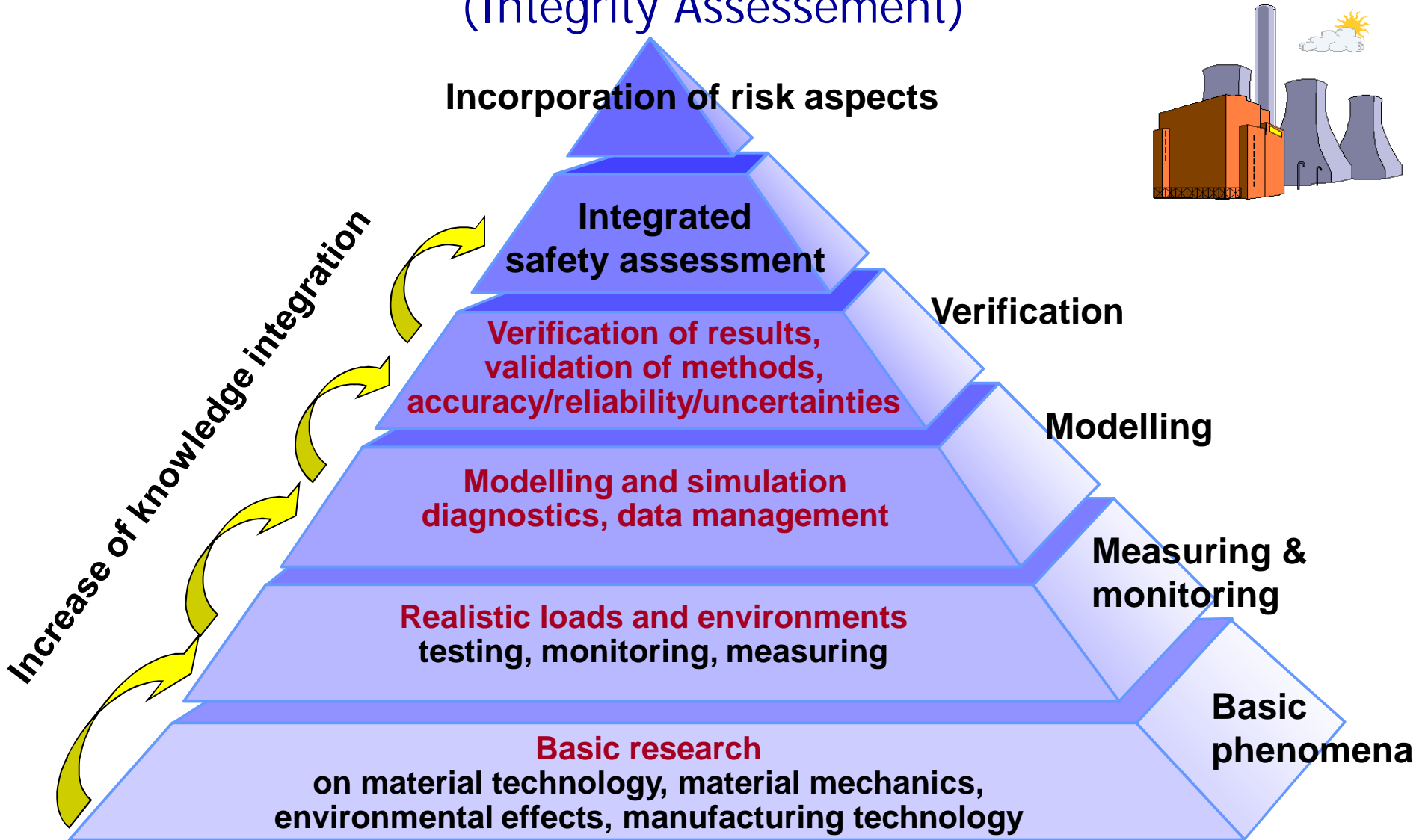
Challenge: Assure safety of any System, Structure and Component (SSC)



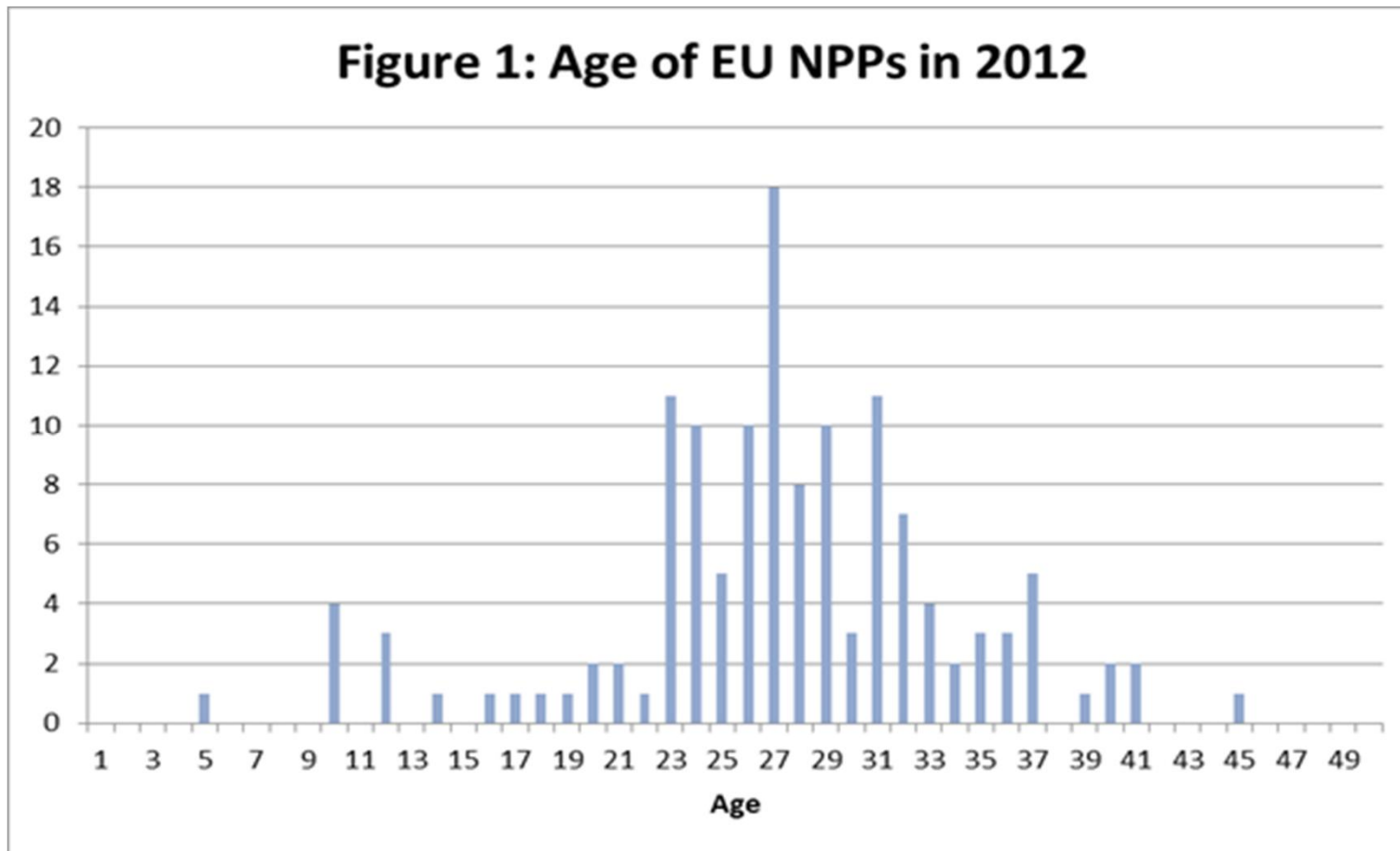
R&D for Plan Life Management and reactor safety



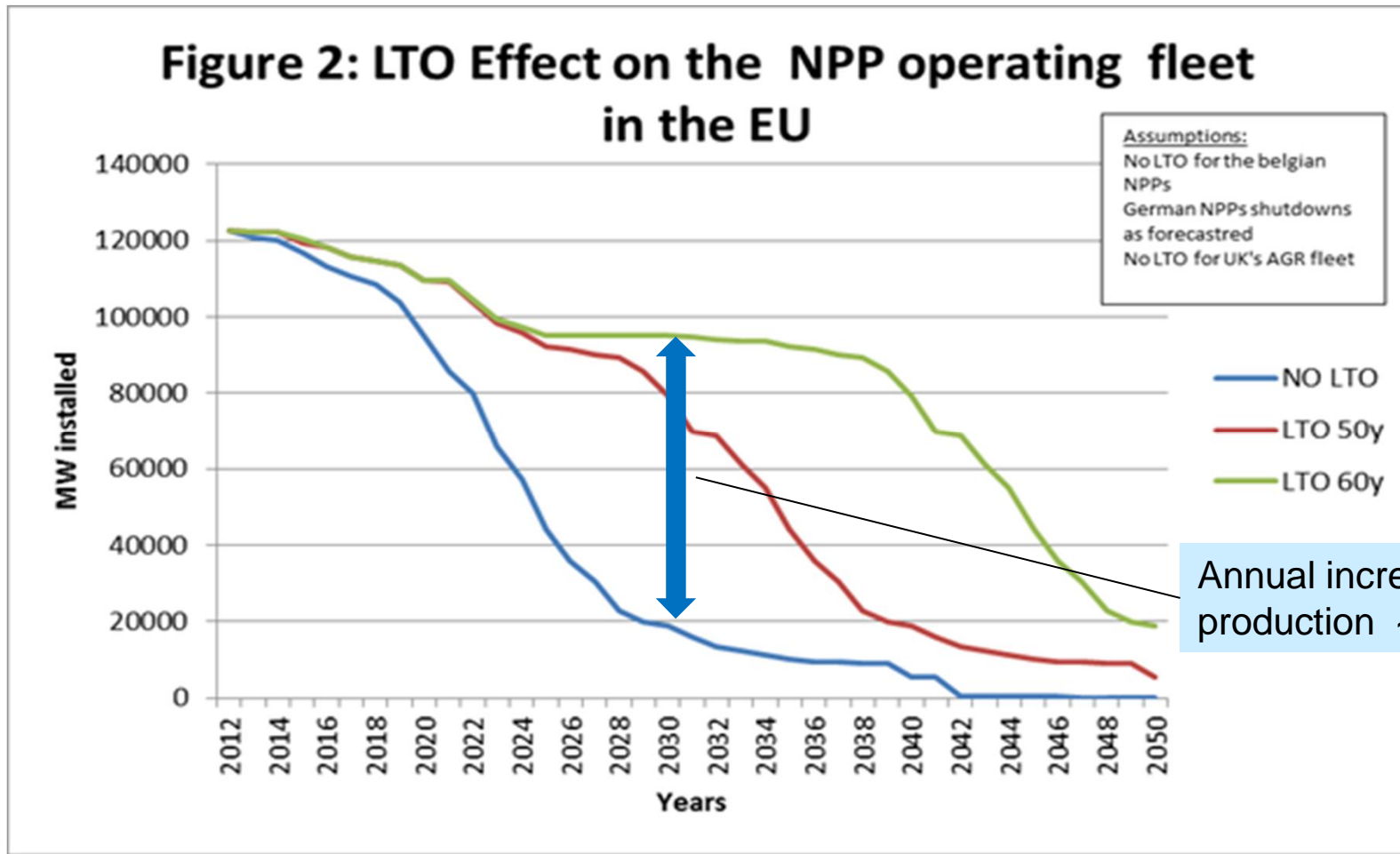
Challenge for knowledge integration (Integrity Assessment)



Age of nuclear plants in Europe



Potential of LTO in Lifetime operation



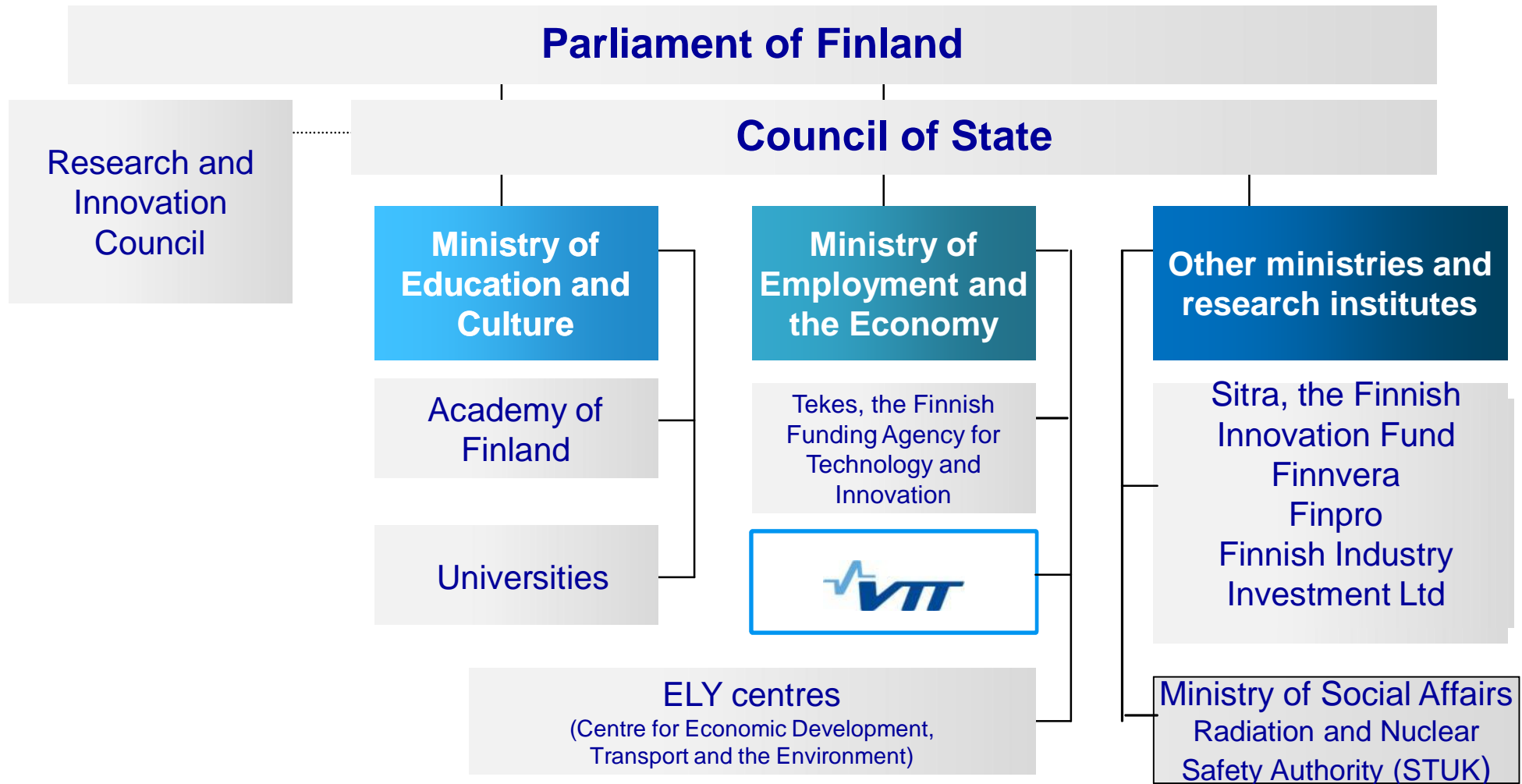
A photograph of a brown branch with several small green leaves, extending from the left side of the frame towards the right. A single, clear water droplet is suspended just below the branch, appearing to be about to fall. The background is a solid, light blue color.

Technical Safety Research and Technical Safety Support

- Finnish operating model
 - National safety research forum – SAFIR2014
- 
- A white, wavy line that starts from the left edge and moves towards the right, creating a series of rounded peaks and valleys. The background is a light blue color with a subtle gradient.

Public decision makers, financiers and R&D performers in Finland

(Nuclear licencing and safety authority bodies)



Nuclear energy R&D competencies and resources

- VTT has 200 experts and scientists in nuclear energy backed up with competent staff in other departments
- VTT research competencies cover
 - Reactor safety
 - Future reactors (Gen-IV)
 - Waste management and disposal of spent fuel
 - Fusion
- VTT performs contracted research on challenging topics related to nuclear safety, plant life management and nuclear waste management
- **VTT has policy and implementing measures to maintain effective separation between R&D activities and technical support activities for authorities**



Who needs independent safety assessment ?

- In **new plants**
 - The **regulatory/safety authority** during the plant licensing process
 - The **plant owner** and **vendor** may also use independent safety assessment to make sure that the plant will meet its design/performance criteria
- In **old plants**
 - The **regulatory/safety authority** in license renewal and/or in design changes
 - The **plant owner** to perform the required analysis for the license application or to verify that the plant changes / new components will meet their design/performance criteria

Independent Safety Assessment methods

- **Review of existing documentation**
 - Design documents, safety analysis results
 - Comparison with previous experience
 - With experienced experts and proven concepts good results
 - More on 'thin ice' with new concepts
- **Performing independent safety analysis**
 - Using tools that are different from those used by the vendor
 - Using same tools but independent experts
 - Creating independent plant models
 - Performing independent safety analysis
 - Full set of analysis
 - Conformity assessments (selected cases)

VTT – role in R&D and technical support

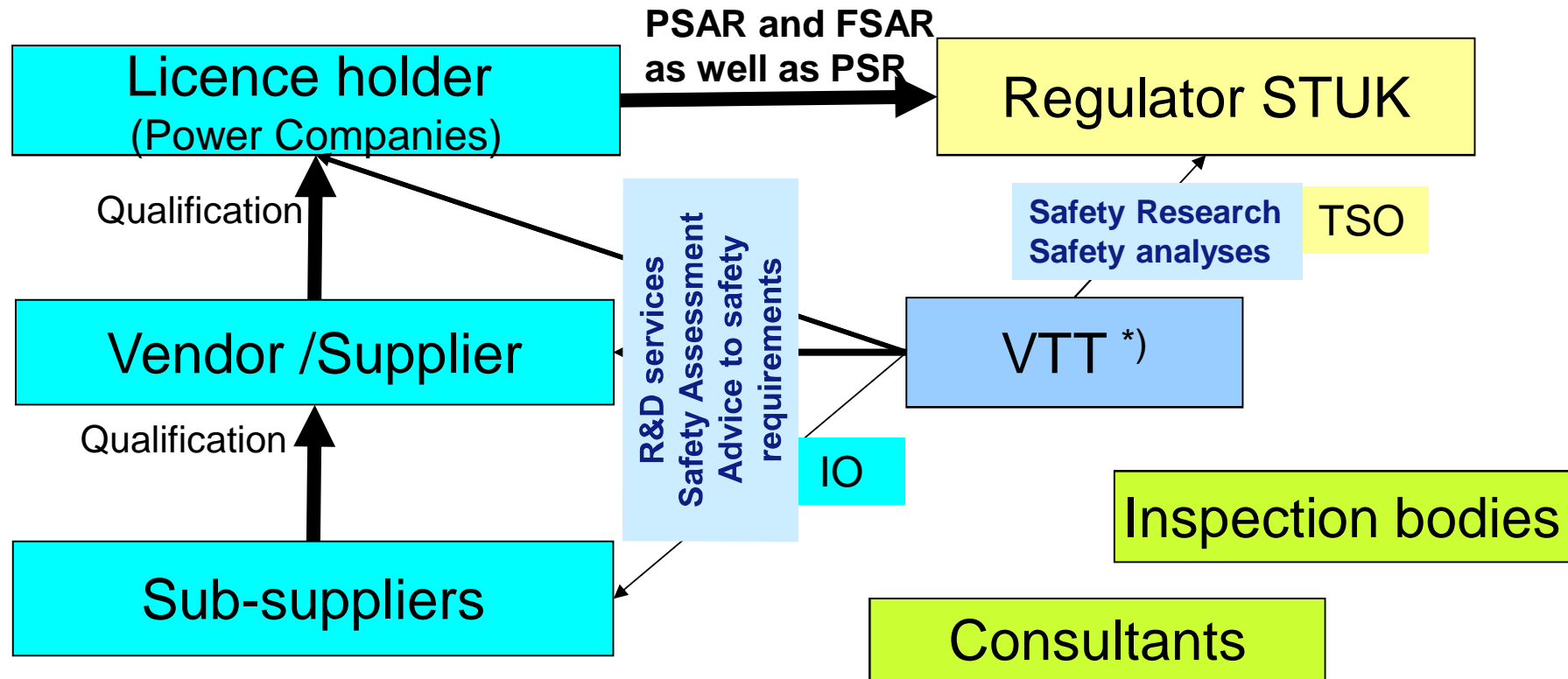
☞ VTT serves both STUK and industry

- Not the same analyses
- Not the same people
- Not the same equipment
- Not the same software
- In case of same application & same software:

Input data & assumptions are selected/given by STUK and sensitivity analyses are performed by VTT – preferably by a different person



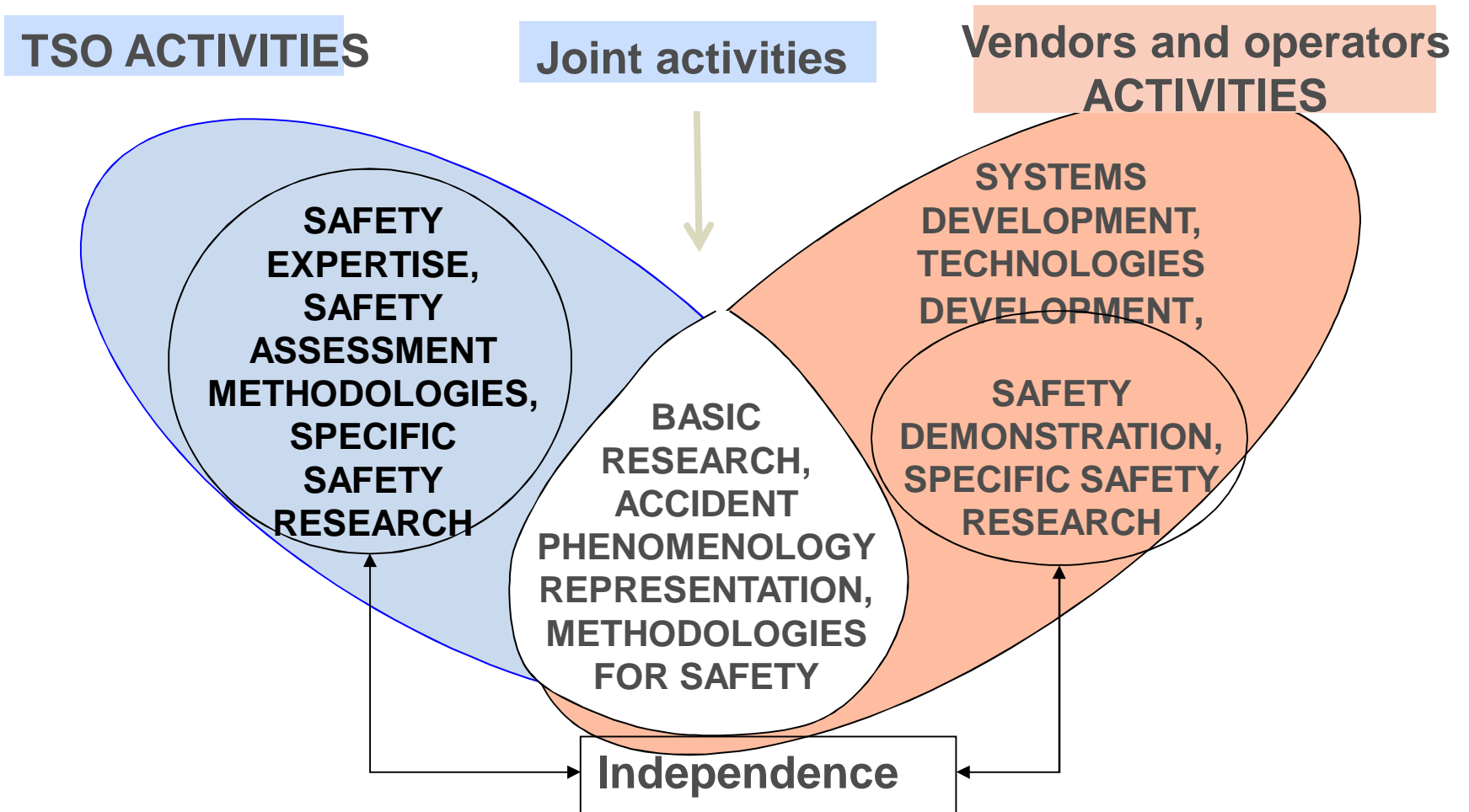
Position of VTT in old plants and new builds



- IO** Independent Organization
- TSO** Technical Support/Safety Organization

*)The independence and confidentiality aspects are respected and considered separately for each case

Joint R&D of TSO and Industry



SAFIR2014 programme 2011-2014

- Continuation to a series of national NPP safety research programmes
- Mission of the new research programme is derived from the stipulations of the Finnish Nuclear Energy Act:
 - *The objective of the SAFIR2014 research programme is to develop and maintain experimental research capability, as well as the safety assessment methods and nuclear safety expertise of Finnish nuclear power plants, in order that, should new matters related to nuclear safety arise, their significance can be assessed without delay.*

SAFIR2014 programme 2011-2014

■ National Nuclear Power Plant Safety Research Programme

- All Finnish nuclear stakeholders involved
- Chaired by the Finnish Nuclear Regulator STUK
- VTT as a Coordinator

■ Research areas in 2012

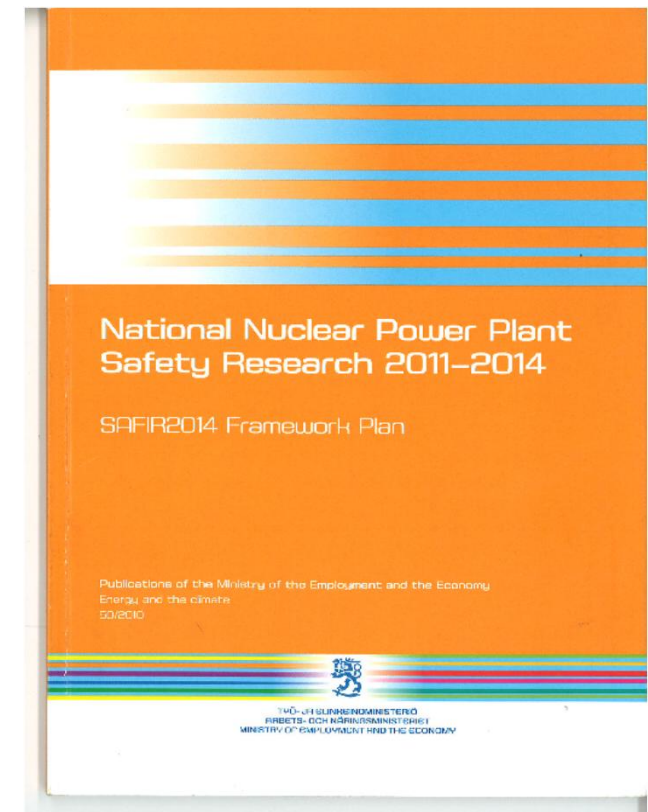
1. Man, organisation and society →LTO
2. Automation and control room →LTO
3. Fuel research and reactor analysis
4. Thermal hydraulics
5. Severe accidents
6. Structural safety of reactor circuits →LTO
7. Construction safety →LTO
8. Probabilistic risk analysis →LTO



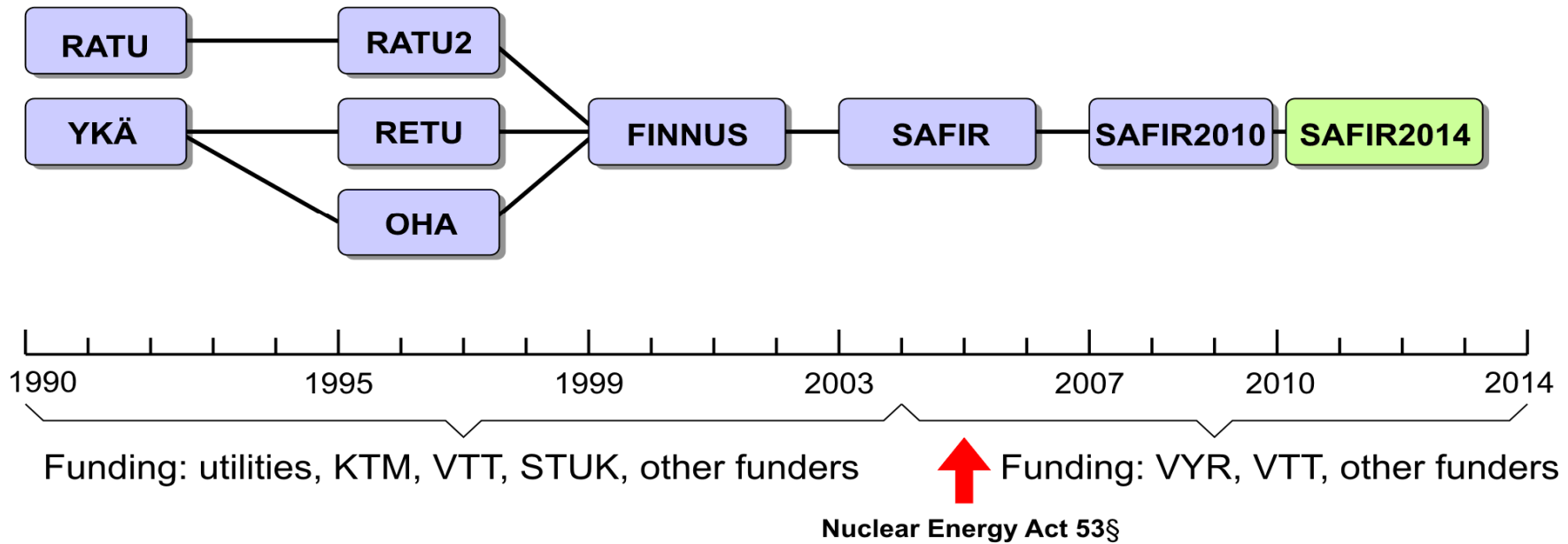
<http://safir2014.vtt.fi>

SAFIR2014 programme 2011-2014

- **Framework for the programme**
- SAFIR2014 **Framework Plan** published together with the **call for proposals** at the beginning of September 2010
- Supplements to the Framework Plan for the call for 2012
 - Fukushima-related issues
 - Topics for social research

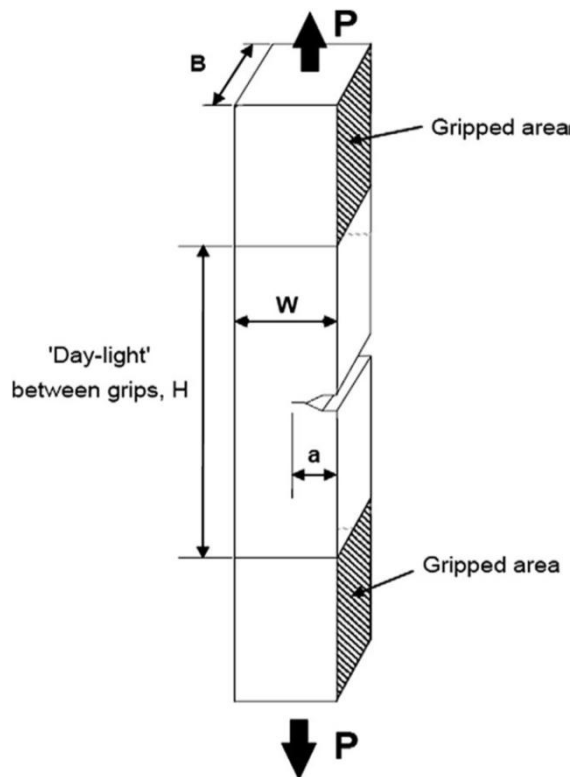


Publicly funded NPP safety research programmes 1990 - 2014



Research topics in 2012 as an example

Structural safety of reactor circuits

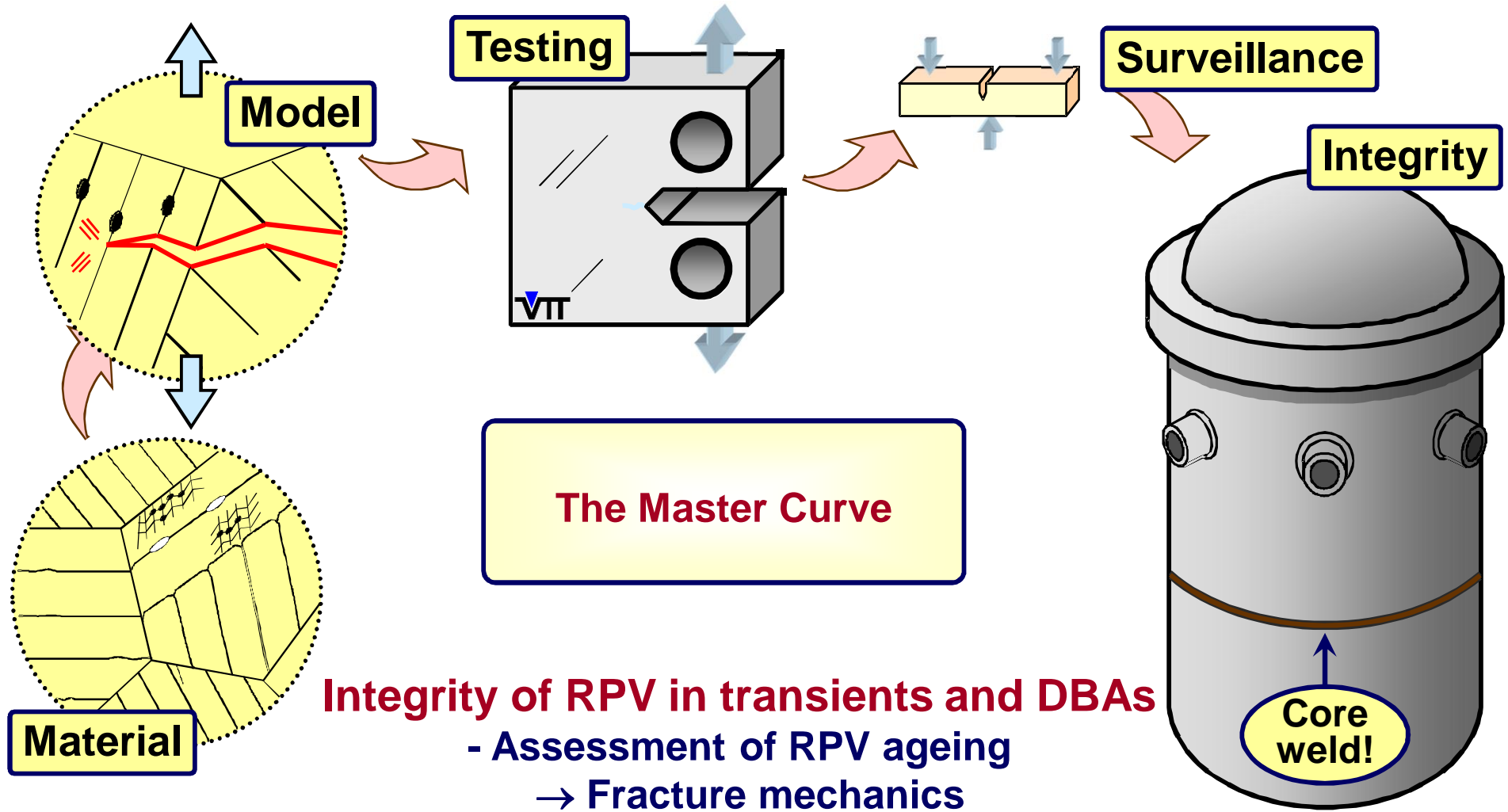


- Environmental influence on cracking susceptibility and ageing of nuclear materials (ENVIS)
- Fracture assessment of reactor circuit (FAR)
- Monitoring of the structural integrity of materials and components in reactor circuit (MAKOMON)
- RI-ISI analyses and inspection reliability of piping systems (RAIPSYS)
- Advanced surveillance technique and embrittlement modelling (SURVIVE)
- Water chemistry and plant operating reliability (WAPA)
- Fatigue affected by residual stresses, environment and thermal fluctuations (FRESH)



Some case studies

The Loviisa challenge behind the Master Curve approach



Key steps of life management in Loviisa RPV

Year	Operation/ data available	Means/technique
1977	Start of operation, surveillance programme, lifetime estimation	CVN, CVN precracked
1979	Irradiation response, revision of lifetime estimation	CVN (T), K_{Jc} (T) embrittlement
1980	Reduction of reactor core	higher than expected
1988-1995	Annealing response, reirradiation response	Dummy elements, backfitting
1996	Vessel annealing, revision of lifetime estimation	Specimen reconstitution, surveillance material
1996	Surveillance programme for annealing	Dry annealing
1999	Reirradiation response, revision of lifetime estimation	CVN, CVN precracked, tailored material
2004	Relicensing of RPV Periodic safety review (2010)	CVN, subsize, surveillance tests
2012	Relicensing of RPV, extension of life time up to 50 years	

Aircraft crash experimental simulation and numerical modeling

Motivation: Large passenger aircraft crash is one design criterion for modern NPPs

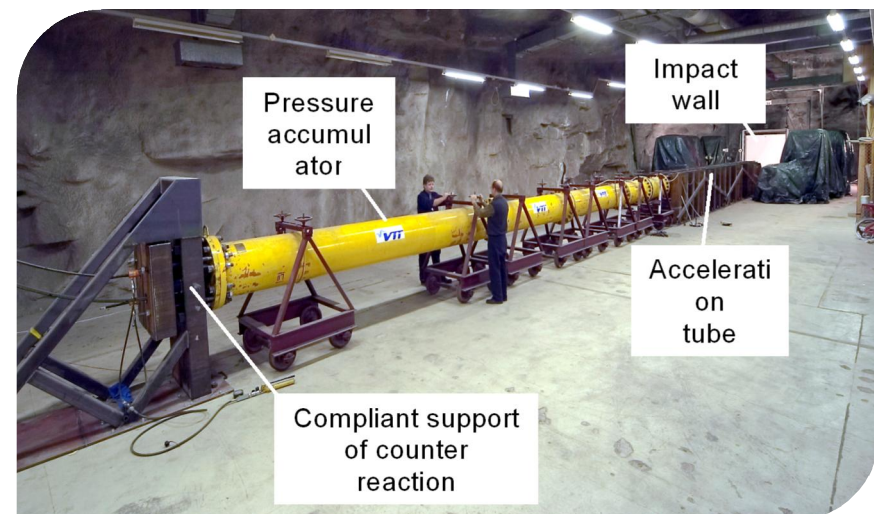
The main concerns:

- Structural integrity of the impact loaded reinforced concrete wall
 - Local perforation by hard particles (motors...)
 - Excessive global displacements
- Loading function due to an aircraft crash
- Penetration of fuel tanks inside the building
- Fuel release and spreading from disintegrating tanks

Experimental results are needed for verification and development of numerical methods and calculation models.

VTT special expertise:

- Flexible experimental platform
- Numerical tools verified against experimental data



Medium scale impact test facility capacity:

- missile 100 kg
- velocity 200 m/s (with light <40 kg missiles)

STUK: A review of Olkiluoto 3 Construction Licence Application

VTT provided advice and conducted independent analyses on several topics to support STUK's review:



- Deterministic safety analyses for postulated accidents
- Severe accidents
- Probabilistic safety analyses (PSA)
- Water chemistry
- Instrumentation and control system (I&C) validation
- Tests including simulation of aircraft crashes and of cable fires
- Civil engineering and concrete structures



Summary

Summary

- Safety research on any System, Structure and Component relevant to safety enables safe and economic operation during the design life and in particular beyond the design life
- Research and development of phenomenologies and methodologies relevant to safety should be performed through interactive dialogue between all nuclear stakeholders

SAFETY IS A JOINT CONCERN

- Implementing R&D work to applications can be adopted using separate pathways to nuclear regulators and industry
- In future NUGENIA Association together with ETSON are key instruments to coordinate and execute the Research, Development and Innovation work in European level



**VTT - 70 years of
technology for business and
society**

More info. www.vtt.fi