DE LA RECHERCHE À L'INDUSTRIE

MEGAPIE SPALLATION TARGET: A KEY DEMONSTRATION FOR FUTURE ADS

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MEGAPIE-TEST

MEGAPIE 11thTechnical Review Meeting Bregenz (Austria)

2014 October 23rd-24th

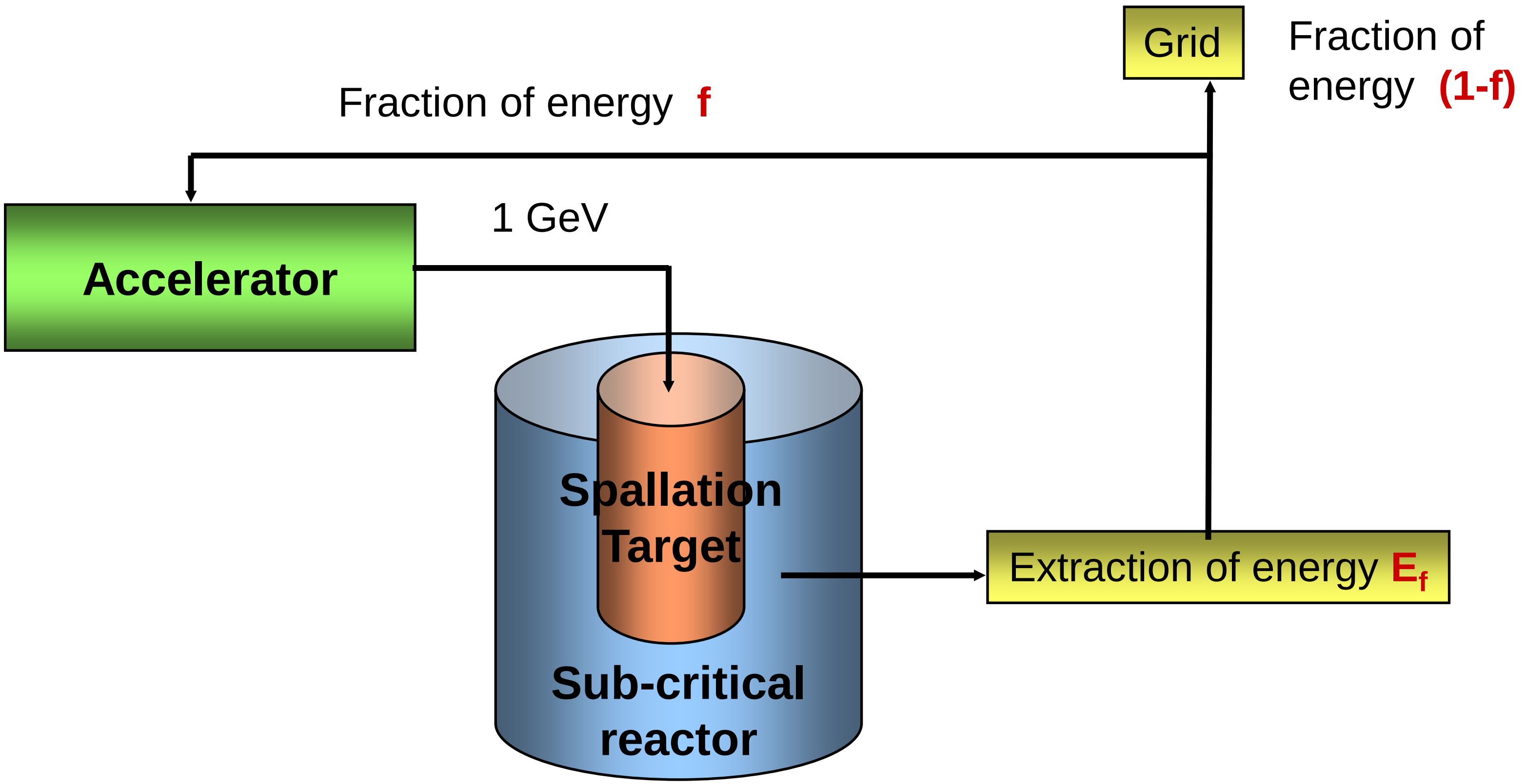
www.cea.fr

A key component for ADS: the target

General consensus :

- up to 1MW of beam power solid targets are feasible from a heat removal point of view.

- for higher power levels, liquid metal targets are the option of choice because of their higher heat removal capability, higher spallation material density in the volume, lower specific radioactivity,…



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한국원자력연구소
Korea Atomic Energy Research Institute

Forschungszentrum Karlsruhe
Technik und Umwelt

MEGAPIE-TEST

MEGAPIE EXPERIMENT

A key experiment in the ADS roadmap:

MEGAwatt PIlot Experiment (MEGAPIE) (1 MW) initiated in 1999 in order to design and build a liquid lead-bismuth spallation target, then to operate it into the Swiss spallation neutron facility SINQ at PSI .

It was to be equipped to provide the largest possible amount of

scientific & technical information without jeopardizing its safe operation.

Several main challenges for the MEGAPIE project:

- to design a completely different concept of target in the same geometry of the current spallation targets used at PSI.

- to develop and integrate two main prototypical systems : a specific heat removal system and an electro magnetic pump system for the hot heavy liquid metal in a very limited volume.

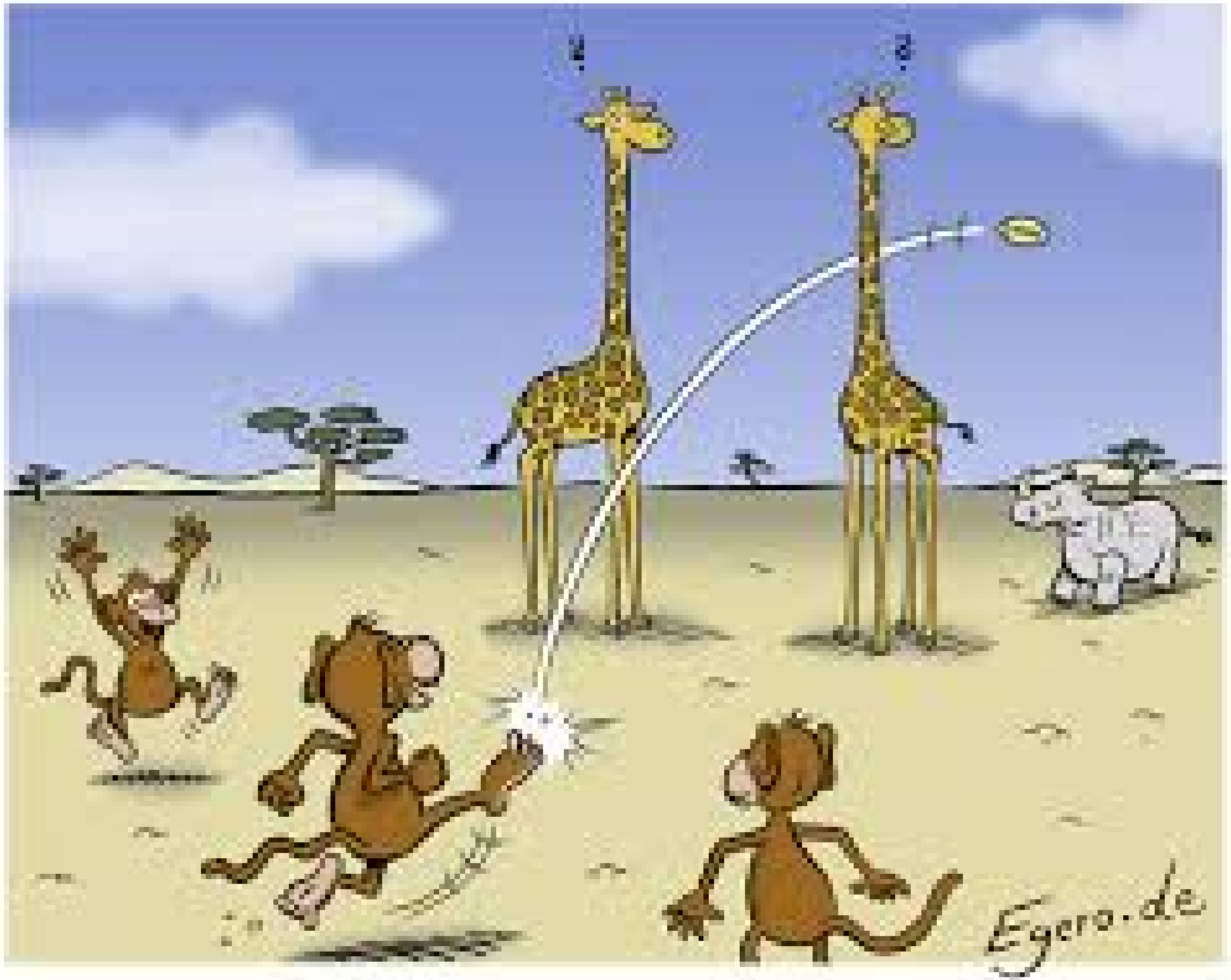
- to design a 9Cr martensitic steel (T91) beam window able to reach the assigned life duration.

- to license a LBE target in relevant conditions

- to operate a LBE target

- to develop the decommissioning strategy and waste management

Necessity to innovate when no previous design & operational feedback is available!



MEGAPIE TARGET

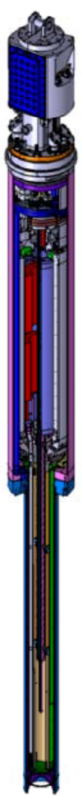
Heat Exchanger (Oil)
10 l/s, 5.5 m/s
140-175°C inside

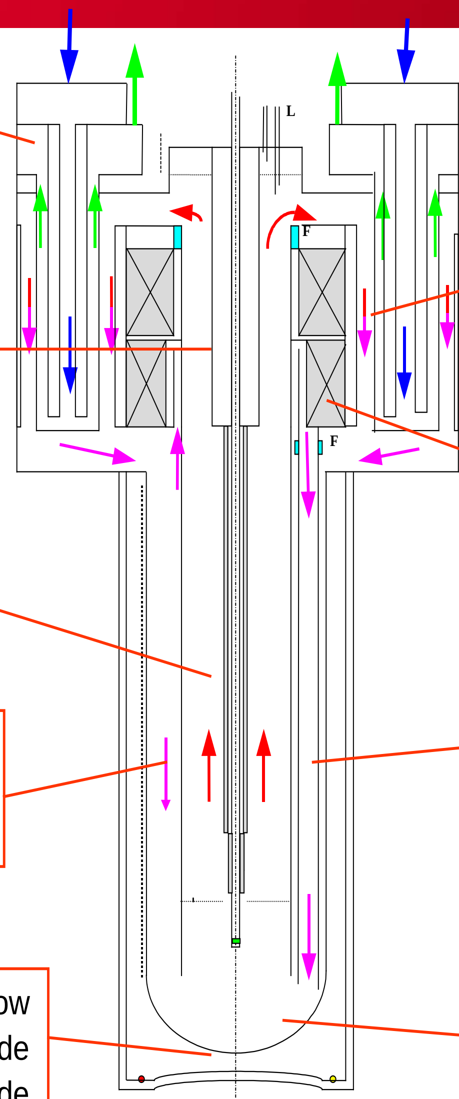
Main Pump
4 l/s, 1.2 m/s
380°C

Guide Tube
4 l/s, 0.33 m/s
380°C

Downcomer
3.75 l/s, 0.33 m/s
230-240°C

Beam Window
380°C outside
330°C inside





Heat Exchanger
4 l/s, 0.33 l/s/pin
0.46 m/s
380-230°C inside

Bypass Pump
0.25 l/s, 0.2 m/s
230°C

Bypass Tube
0.25 l/s, 1m/s
230-240°C

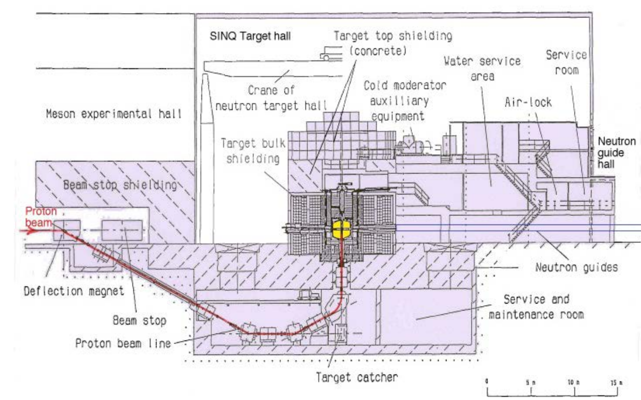
Nozzle 1.2 m/s
Beam Window 1 m/s

Design parameters:

p-beam energy: 575 MeV
p-current: 1.74 mA
Heat removal: 650 kW
Design pressure: 16/10 bar
Design temp.: 400°C
Cover gas press: 3.2 bar
Operation: 1 year
with max 6000 mAh
Radiation damage: 20-25 dpa

Dimensions

Length: 5.35 m
Weight: 1.5 t
LBE-Volume: 89 l



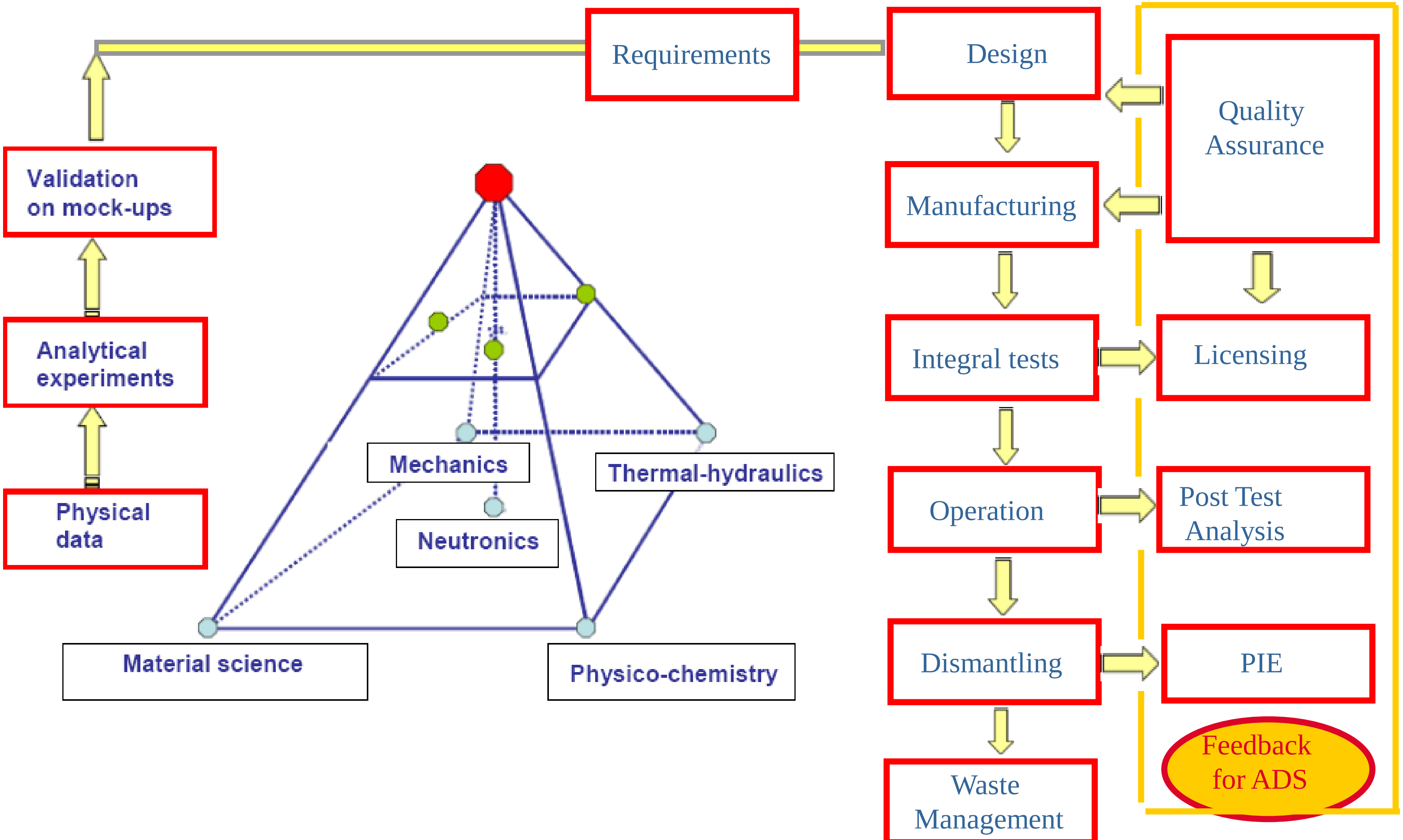
MEGAPIE Project: Development Strategy

➔ Numerical simulation + experiments : from basic science to engineering tools for design & operation

➔ Progressive validation of concept by basic studies, design calculations, integral tests

➔ Operation with Post Test analysis and Post Irradiation Examination

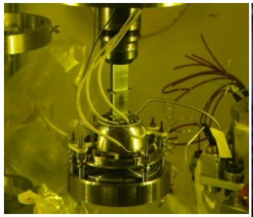
➔ Decommissioning and Waste management



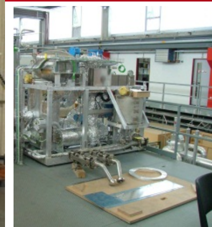
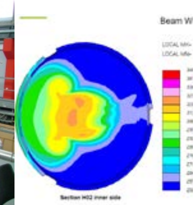
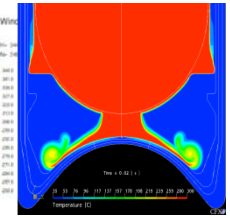
MEGAPIE PROJECT: MAIN STEPS

Requirements definition, organization:	**1999-2000**
Feasibility studies :	**2000**
Design studies:	**2001-2004**
Design support:	**2001-2005**
Manufacturing target & ancillary systems:	**2004-2005**
Integral Test:	**Sept. to Dec. 2005**
Transfer to SINQ:	**Jan. to Mai 2006**
Irradiation :	**Aug. 2006 to Dec. 2006**
Post Test Analysis:	**2007-2009,**
Decommissioning	**2009-2012**
Sampling for PIE:	**2011-2012**
PIE:	**2013 & 2014**
Waste management	**2011-2013**

A research project from « A » to « Z »

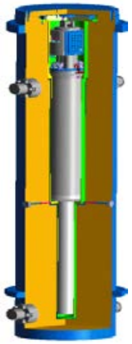
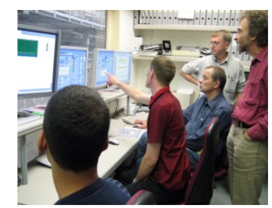


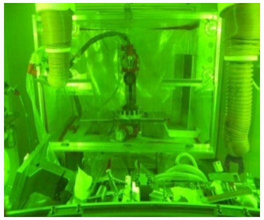


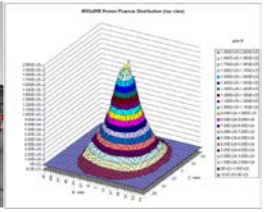
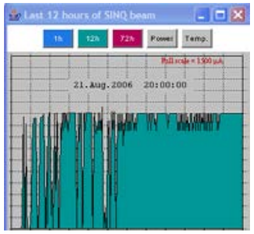




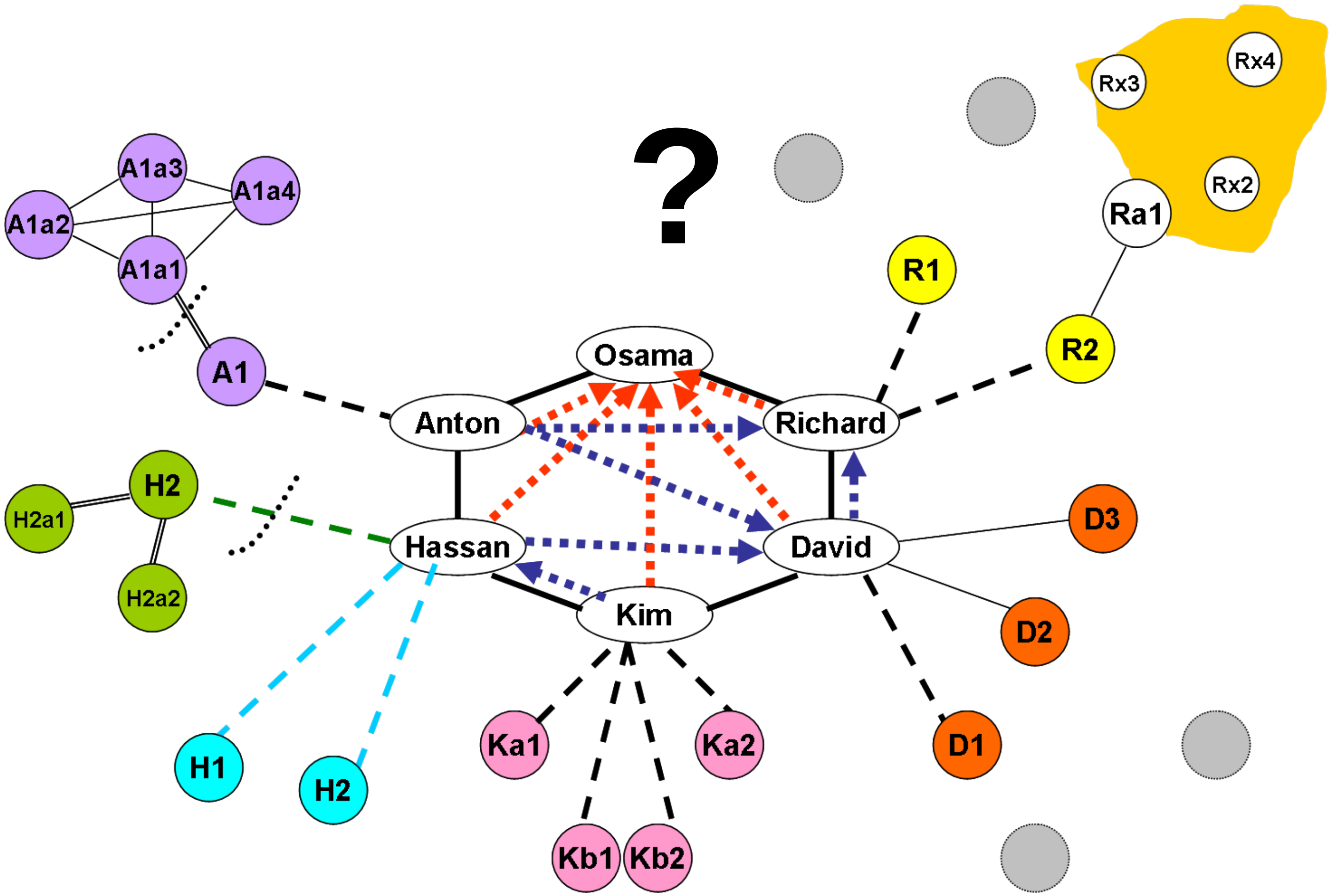






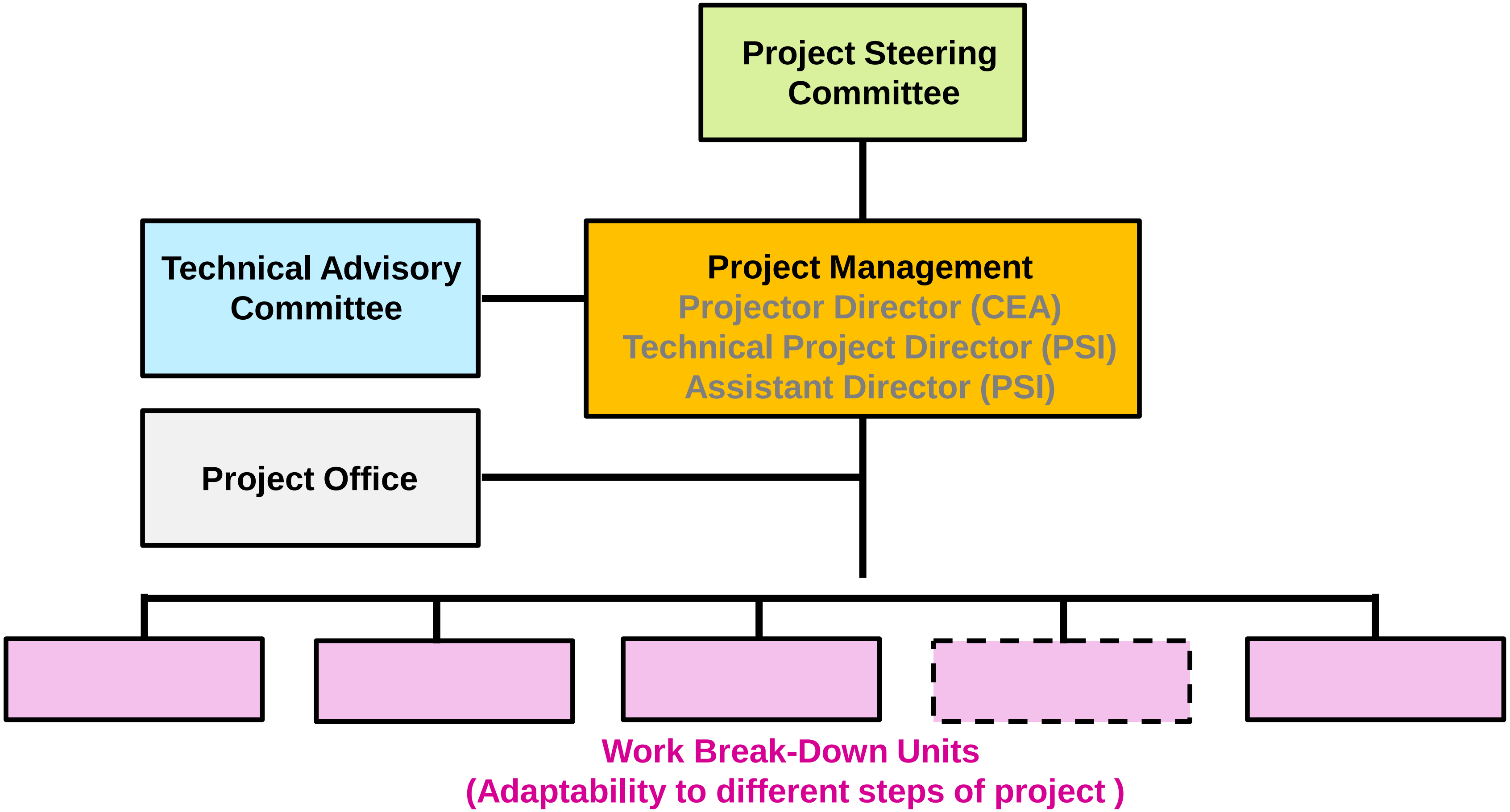


WHICH ORGANIZATION?

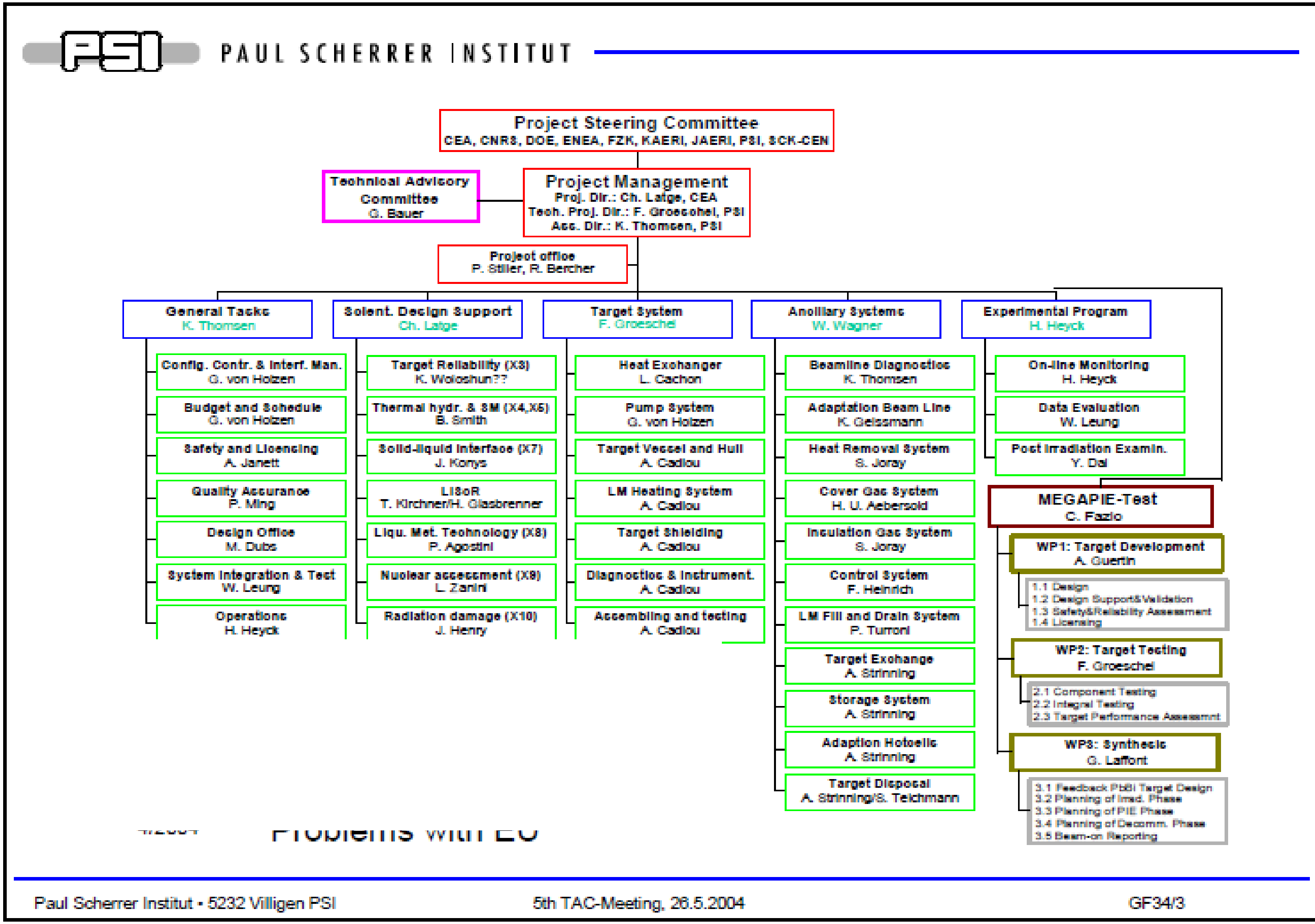


PROJECT ORGANIZATION



Technical Advisory Committee Chair: G. Bauer
Steering Committee Chair: R. Eichler, J. Knebel
Projector Director (CEA): M. Salvatores, M. Delpech, C. Latge
Technical Project Director (PSI): G. Bauer, F. Groeschel, M. Wohlmuther
Assistant Director (PSI): K. Thomsen & W. Wagner
Project Office: Renate Bercher, Peter Stiller,

AN EVOLUTIVE ORGANIZATION



TECHNICAL ADVISORY COMMITTEE

G.S. Bauer, FZJ (chair),

T.A. Broome, RAL

Y. Ikeda, JAERI

M. Salvatores, CEA

H. Ravn, CERN

J.M. Carpenter, ANL, then J. Haines, ORNL

Initial phases:

Attachment

Phase 1	Baselining	Specify goals of the project List boundary conditions Define technical options Identify R&D-needs Outline operational procedures and monitoring Define post irradiation examinations Identify requirements for final disposal
Phase 2	Feasibility study	Refine technical options Establish design data base Analyse anticipated load levels Identify problem areas Perform scoping calculations Verify cost and schedule plans Identify requirements to ancillary systems
Phase 3	Conceptual design	Select reference technical design Select reference materials Define instrumentation and controls for operation Size individual components Verify compatibility of components' specifications Identify possible sources of failure Analyse consequences of individual components failure Outline design for ancillary systems
Phase 4	Engineering design	Carry out detailed calculations to optimise system Verify designs of all individual components Analyse life expectancy and possible failure modes of components and system Carry out overall safety and life time analysis Design ancillary systems Establish QA plan for manufacturing and testing Produce final design report
Phase 5	Detailed design and manufacturing	Produce drawings of individual parts for manufacturing Procure and quality control individual parts of subsystems Assemble and factory test subsystems Provide test rigs and equipment
Phase 6	System Integration and Testing	Assemble complete system from components Carry out functional tests without beam Demonstrate concepts for remote operations on irradiated target, in particular draining of PbBi
Phase 7	Operation	Insert target in SINQ Run target with beam Continuously record relevant operation parameters Make periodic checks according to monitoring plan Remove target at end of irradiation period

MEETINGS

Technical Advisory Committee Meeting (TAC): 7

Project Steering Committees Meeting (PSC): 18

Project Co-ordination Group Meeting (PCG): 25 (since 2004 and more since 2000)

Technical Review Meetings (TRM): 11

Many Xxx Meetings (Technical meetings in a given field ie physics)

Meetings with suppliers (ATEA, IPUL, CRYOTEC,…..)

Meetings with Safety authorities

Internal meetings in each organizations

TECHNICAL REVIEW METEINGS

- ➔ Information exchange among project team
- ➔ Review of technical status
- ➔ Discussion of open issues

Cadarache, June 2000
➔ Feasibility of Concept

Karlsruhe, February 2001
➔ Design on good way, Licensibility not yet achieved

Bologna, March 2002
➔ Design completed and okay, PSAR approach clear

Paris, March 2003
➔ Detailed Design completed, Manufacturing & Licensing process started

Nantes, May 2004
➔Detailed Design optimisation, Manufacturing & Licensing process

Mol, June 2005
➔ Readiness for testing, Summary of Design Support Basics

Villigen, May 2006
➔Readiness for irradiation, Licensing process

Karlsruhe April 2007
➔PTA :Preliminary evaluation of irradiation, decommissioning strategy

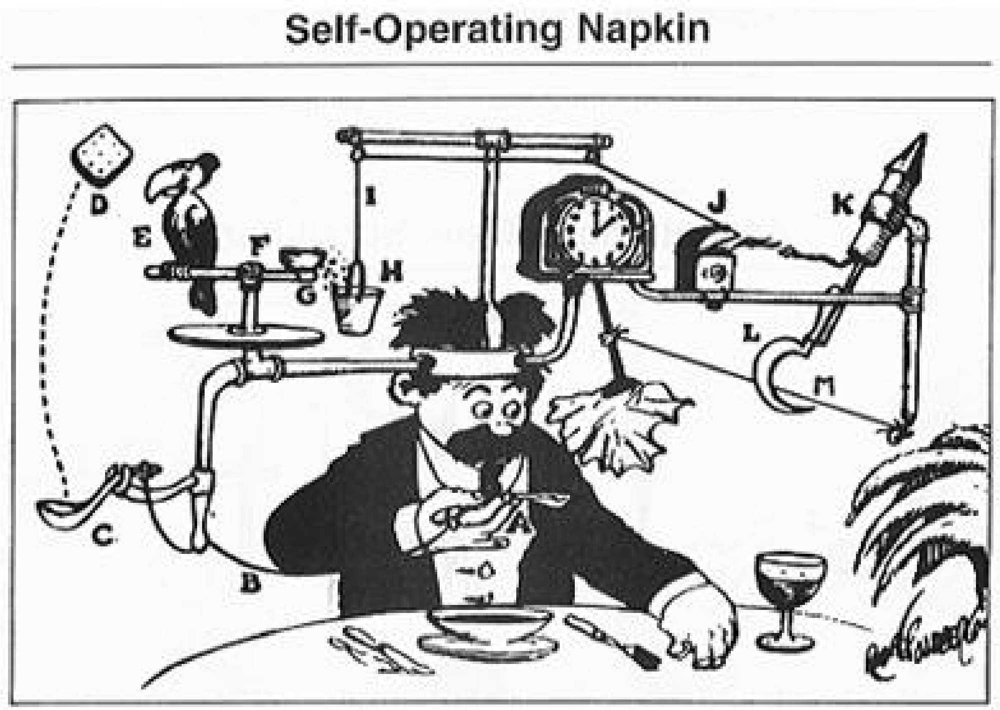
Cadarache September 2008
➔PTA :Final evaluation of irradiation, PIE consolidation

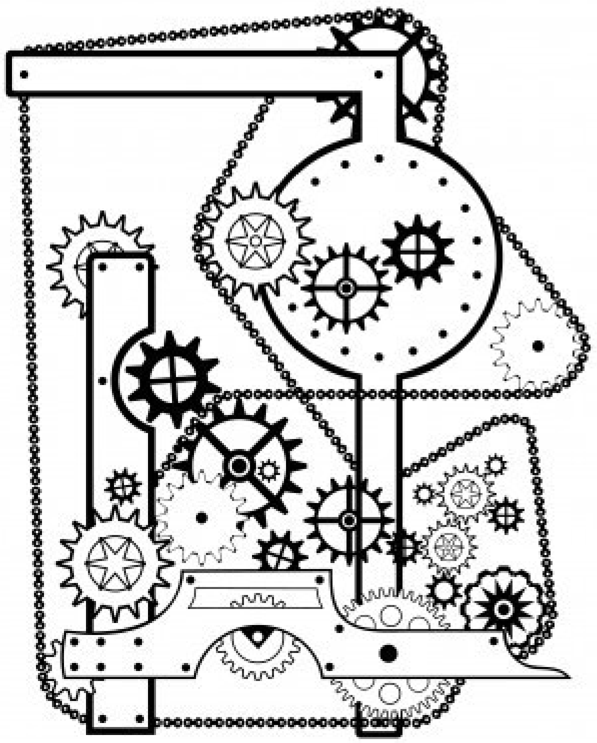
Luzern October 2010
➔ Decomissioning, confirmation of PIE

Bregenz October 2014
➔ PIE, Project synthesis

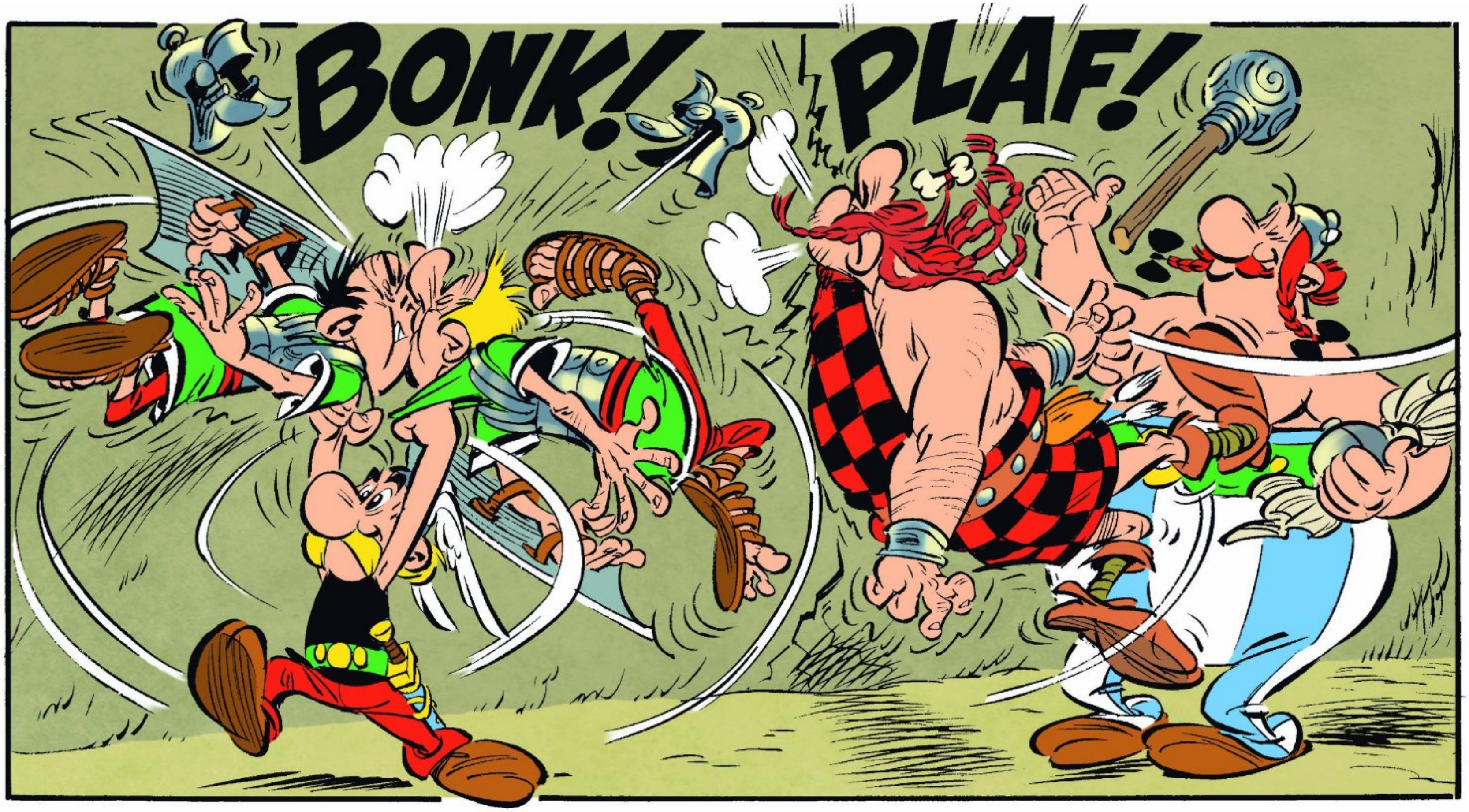
Four main challenges in such a project:

NECESSITY TO MANAGE THE COMPLEXITY





NECESSITY TO MANAGE THE INTERFACES



NECESSITY TO FACE THE DIFFICULTIES

NECESSITY TO BE ON TIME

Thank you for your kind attention !

Commissariat à l'énergie atomique et aux énergies alternatives
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