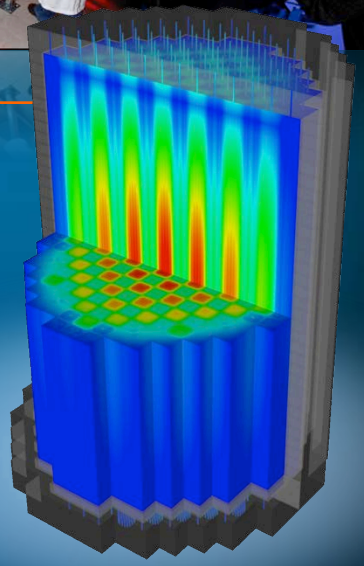
NE Knowledge and Validation Center

OECD Experts Group on Multi-Physics Experimental Data, Benchmarks and Validation



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Outline

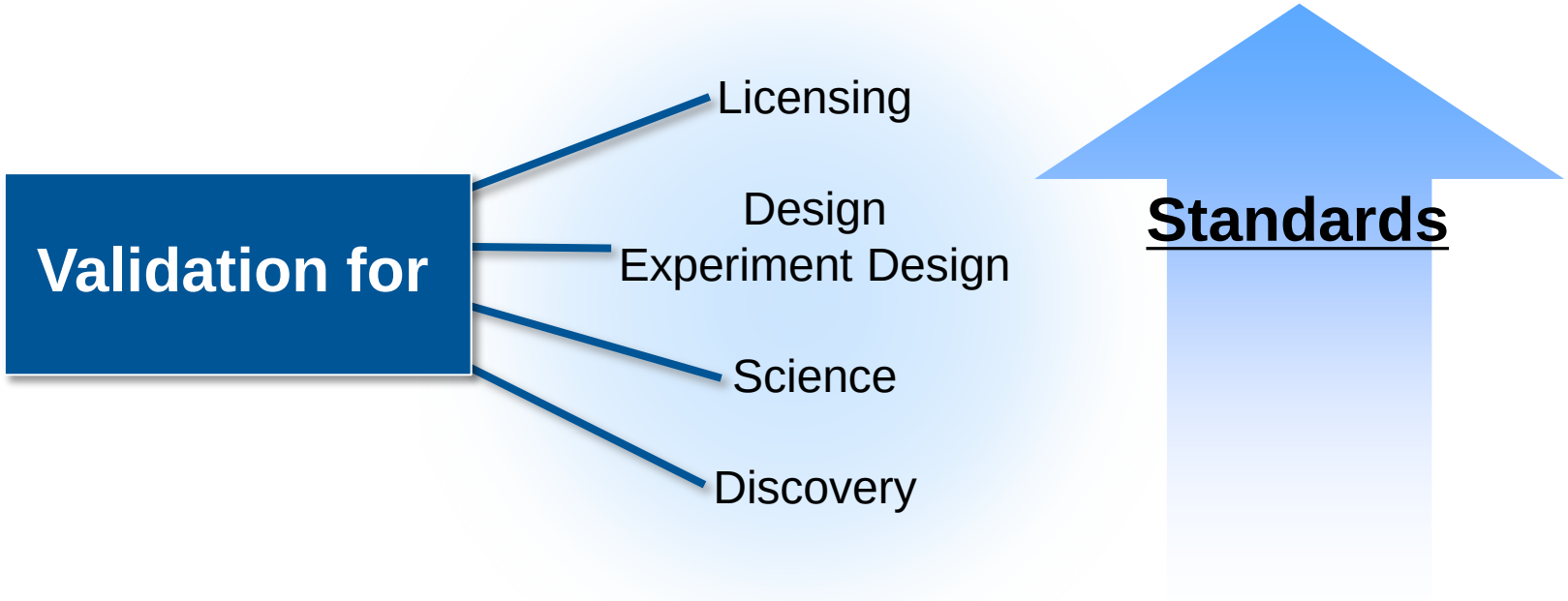
- **What is all this about?**
- **Rationale and opportunities**
- **Challenges (3 examples)**
- **Current and future activities**
- **Today's objectives**

Motivation

- **Over the past decade, NE has created a number of new "multiphysics" analysis tools that are the basis for:**
  - Reducing margins in systems analyses
  - Reducing the need for complex experiments
  - Accelerating the RD&D process
  - Promoting the understanding of basic phenomenology
  - Enabling discovery
- **In order to be fully operational, these tools require a validation effort commensurate with the intended applications <u>and</u> users**
- **In turn, that validation effort requires access to well constructed experimental databases**

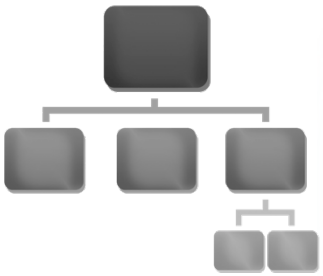
Validation Levels

- **Many definitions!** Validation consists of using experimental information to demonstrate the uncertainties associated with code predictions for a given set of parameters, in a given range of situations



Validation Process and Major Challenges

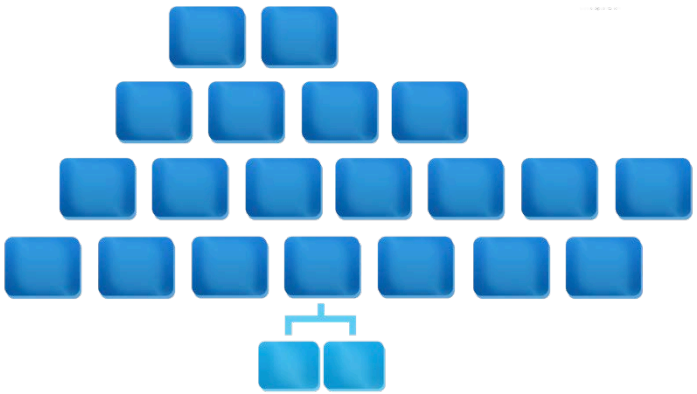
"OLD"



Existing Data

- **Standards?**
- **Broader utilization**
- **Knowledge management and preservation**

"NEW"



Old Process

Extensive reliance & Engineering judgment (experts) in uncertainty analysis

Technical challenges:
- "Prototypic" experiments
- Experimental uncertainties
- "Representativity"
- "Numerical validation"
- Experimental priorities

Data from Reactors and Scaled Integral Facilities

New Process

Expert judgment augmented with greater reliance on simulation and uncertainty quantification

Data from Separate & Mixed Effects (for correlations and subgrid models

Updated Methods & Standards

New Measurement & Data Reduction Techniques

A Very Simplified Description of Uncertainty Quantification

As applied to Fast Reactor Physics (almost linear equations; measured nuclear data [σ]) since the early 60's

Starting Point:

Measured quantities with covariance matrices: Pm
Calculated quantities for these experiments: Pc
Cross section files with covariance matrices: M_σ
Sensitivities $\frac{\delta Pm}{\delta \sigma}$

⇓

Bayesian Statistics

⇓

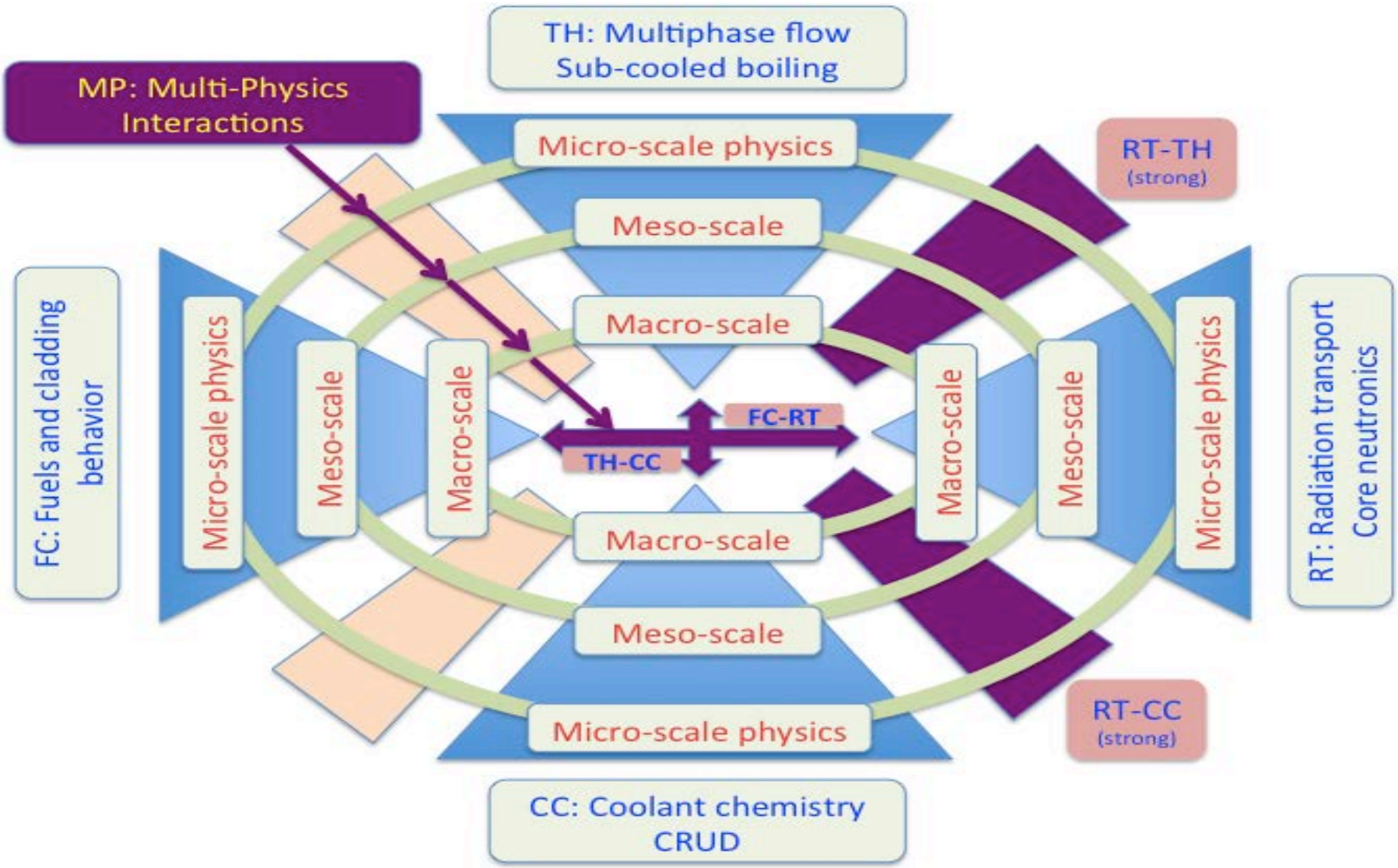
End Point: "Adjusted" cross sections files with "adjusted" covariance matrices $M_{\delta\sigma}$

Example: Superphenix reactivity (1986)
A priori (non adjusted) uncertainty: 1200pcm

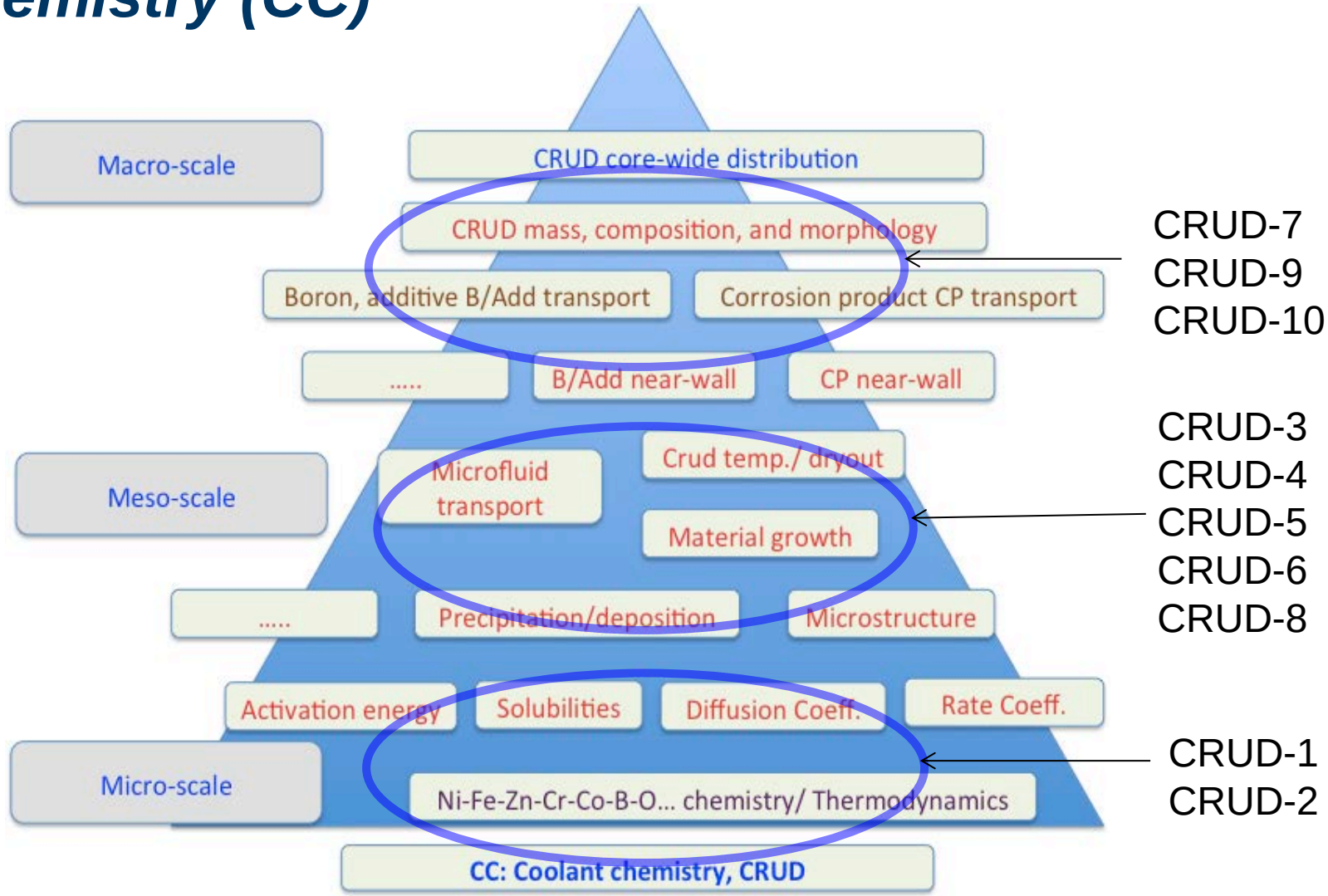
A posteriori (adjusted) uncertainty: 300pcm

$M_{\delta\sigma}$ ⟶ New "adjusted" calculated quantities Pc_a (direct calculations) with adjusted uncertainties (through propagation) for applied cases in a given representativity domain

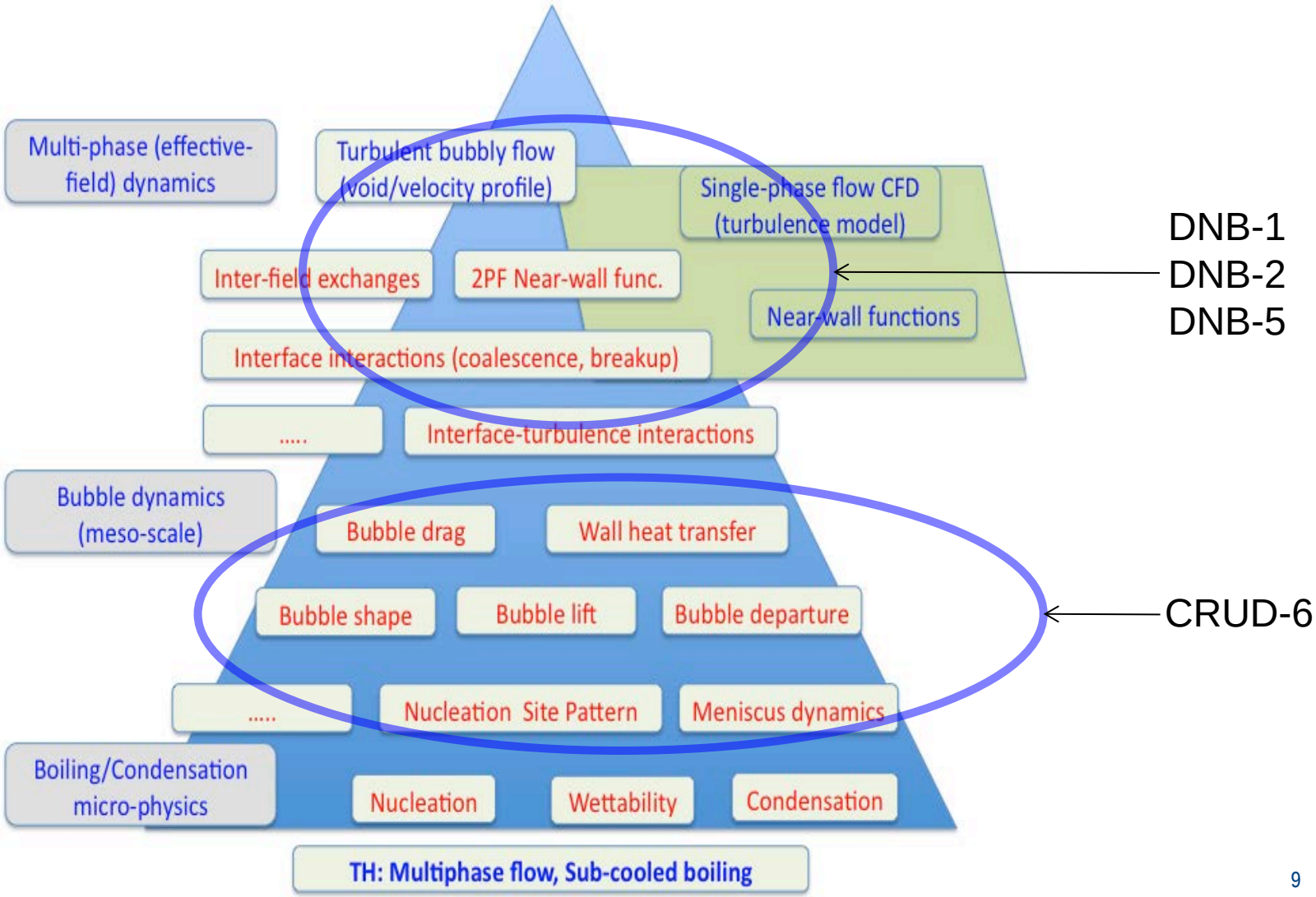
Example: CRUD Multi-Physics, Multi-Scale Pyramid



Validation Experiments Coverage – Coolant Chemistry (CC)



Validation Experiments Coverage – T-H



The role of NEKVAC and MPEBV Expert Group

- *Establish standards for experimental data*
- *Integrate data needs and priorities*
- *Coordinate access to International data*
- *Maintain knowledge of existing database*
- *Help create International experiment campaigns*
- *Help establish process for novel experiments and experimental techniques*
- *Create benchmarks*
- *Share validation best practices*

…but Not to Validate Codes

Roles and Responsibilities

NEKVAC	MPEBV
Director: Gougar **Co-Directors:** Valentine, Khalil	**Chair:** Finck **Task Forces:** Hudelot, Rohatgi
• Collect and maintain U.S. data • Resuscitate old data • Support definition and prioritization of experimental needs	• Collect and maintain data from international efforts • Define standards for experiments and benchmarks (and validation?) • Integration of international needs
• Evaluate legacy data for updating and creating benchmarks • Coordinate bilateral efforts	• Evaluate data for specifying international benchmarks • Organize and document benchmark evaluations • Collect best practices

The status of the NEKVAC

- *It has been created – 'charter' members representing programs and stakeholders have been recruited (industry, DOE program, Academia)*
- *Program Plan and Org Chart drafted*
  - *Initial technical tasks proposed*
  - *'Needs' workshop being planned*

and the MPEBV

- *It has been created – 'charter' members representing programs and stakeholders have been recruited (industry, DOE program, Academia)*
- *Detailed Program Plan slated for approval in December*
  - *Current focus on PWR analysis and transient fuel experiments*

Next Steps - NEKVAC

- *"Needs' Workshop – ANL, November 2014 – participants from Labs, DOE Programs, regulators, industry, academia*
- *Issue rev 0 of Program Plan*
- *Commence work on legacy experiment re-evaluation (LOFT, EBR-II, THORS)*
- *Initial planning of new experiments in HTTR/HTTF (US-Japan CNWG)*

- MPEBV

- *Finalize workplan – December 2014*
- *Choose an initial case*
  - "Experimental" Task Force (Hudelot) has started; focus: use of TREAT and CABRI for "novel" multiphysics applications; "traditional" applications are being continued towards higher accuracies and precision; US leadership provided by Valentine (ORNL) and Ivanov (Penn State)
  - "Standards" Task Force (Rohatgi) to be initiated in February; technical leadership provided by Rohatgi (BNL) and Bajorek (NRC)

This Week's Discussions

Define needs and priorities for NEKVAC

- *Who are the users? For what codes?*
- *What are their uses?*
  - *Applications?*
  - *What level of validation do they need?*
  - *What are the gaps?*

Needs

- *Priorities*
  - *Process*
  - *Who validates and who pays?*

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Translated: FESTINA LENTE

(Augustus)

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