

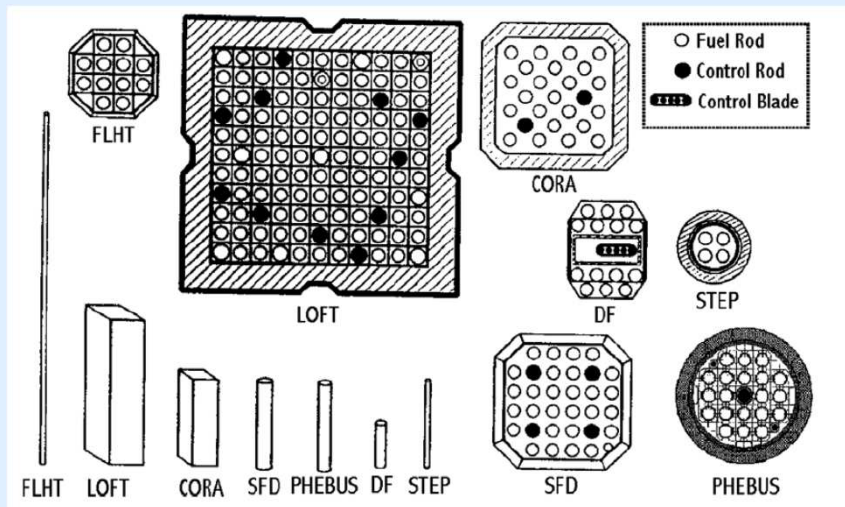
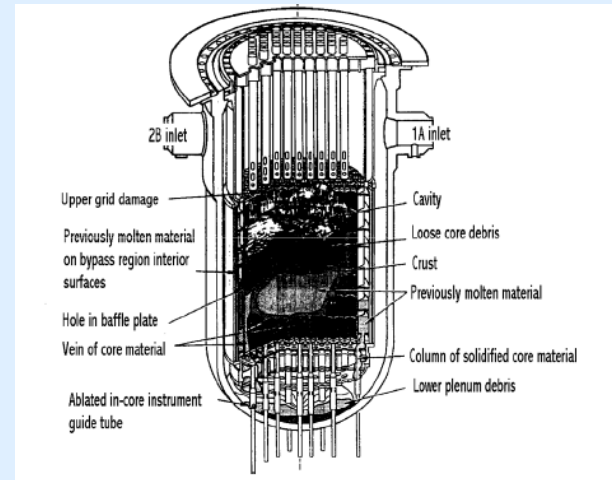
Preliminary Assessment of MELCOR1.8.6 using Integral Data

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PSI

INTRODUCTION

Outline

- Introduction
- Assessment studies
 - Phébus-FP
 - QUENCH
 - TMI-2
- Planned further assessments
 - LOFT
 - ACRR
- Conclusions and outlook

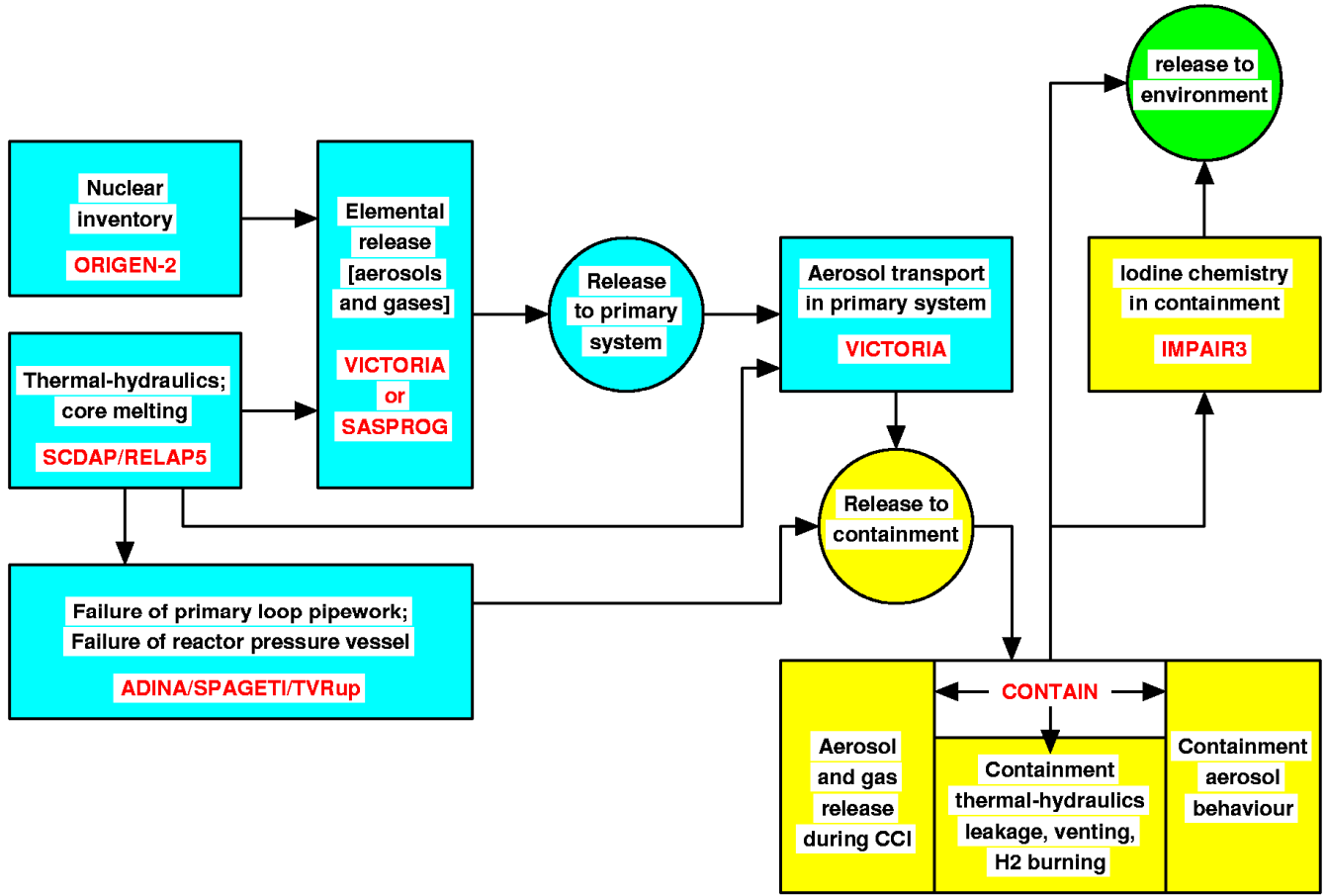


General Approach

- Plant analysis strategy for severe accidents based on a 2-tier approach
 - *system-level* (currently MELCOR) for overall plant response
 - MELCOR1.8.5 is the current production version
 - MELCOR1.8.6 is being assessed
 - improved models for late phase/in-vessel retention and SIC release
 - *component and sub-system level* (currently SCDAP-based) for specific features
 - more detailed, more accurate models
- Approach was adopted ca. 8 years ago and supersedes earlier strategy
- Activities have include plant application, support to experimental programmes, code assessment and model development
- Most work performed in the frame of international collaborations: SARNET, USNRC/CSARP, ISTC, ISTP, PHEBUS FP and QUENCH

INTRODUCTION

Strategy for plant analysis (tedious hand coupling method)



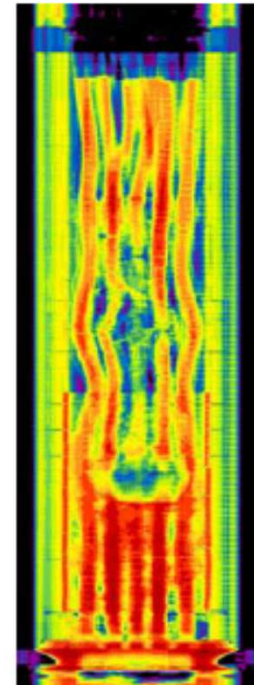
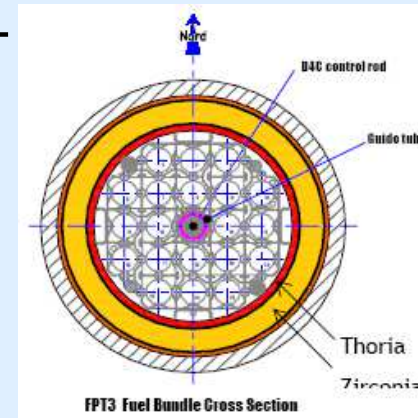
Strategy for plant analysis (preferred method)

Everything

MELCOR

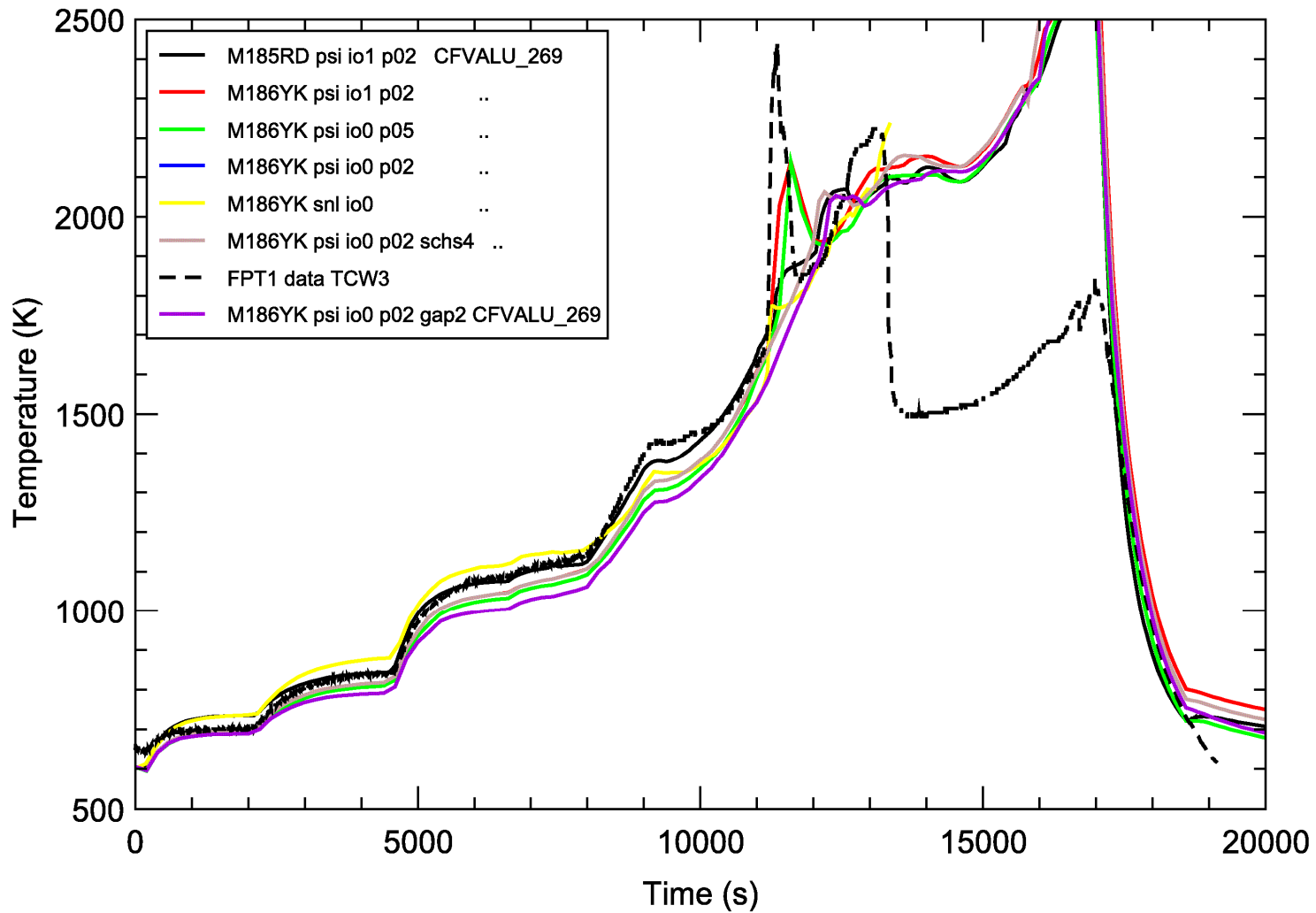
Phébus-FP simulations

- Numerous calculations performed using Melcor 1.8.5 and 1.8.6
 - FPT-1 in frame of ISP-46
 - FPT-2, -3 pre- and post-test
 - same basic input model used throughout
- Comparison calculations
 - Melcor 1.8.5 RD, 1.8.6 YK (2006) and YR (2007)
 - input deck converted to Melcor 1.8.6; same Phébus representation
 - comparison with detailed model used by SNL
- Selected results
 - bundle temperatures (FPT-1, -2)

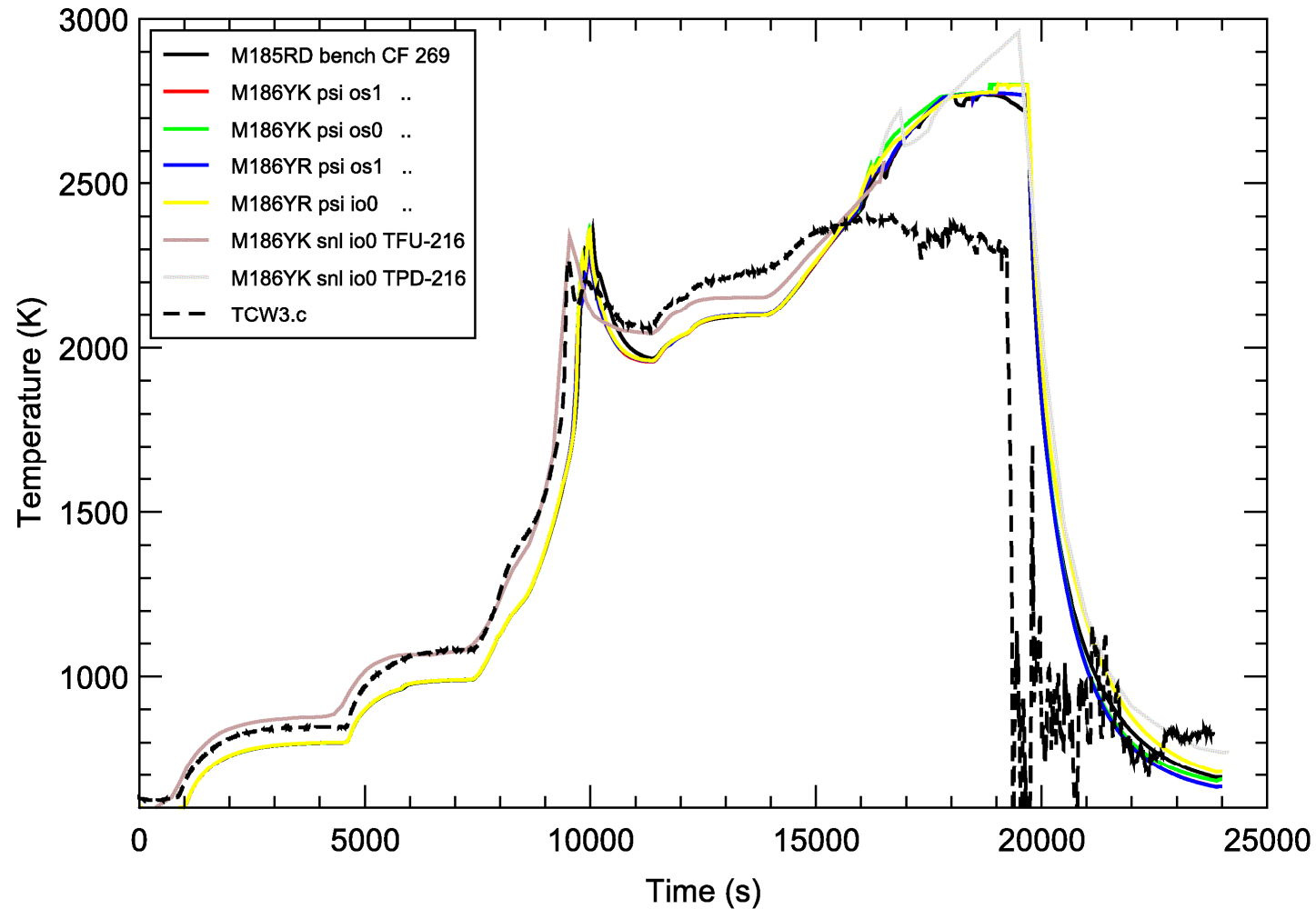


ASSESSMENT USING PHEBUS FP

Phebus FPT-1 : trial comparison with outer ring fuel rod temperature at 400 mm



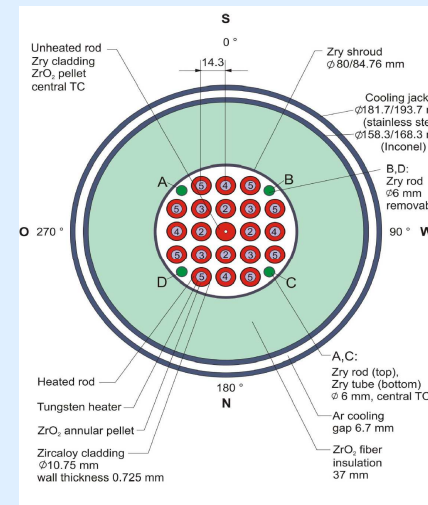
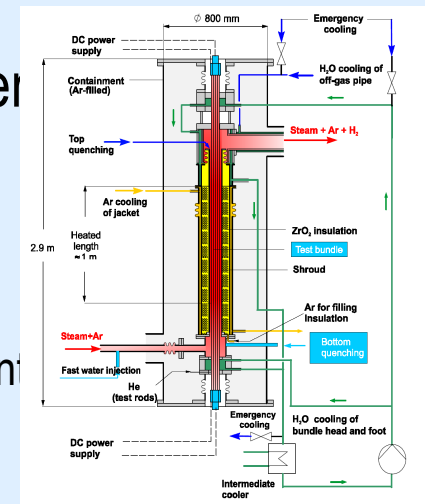
Phebus FPT-2 : trial comparison with outer ring fuel rod temperature at 400 mm



QUENCH simulations

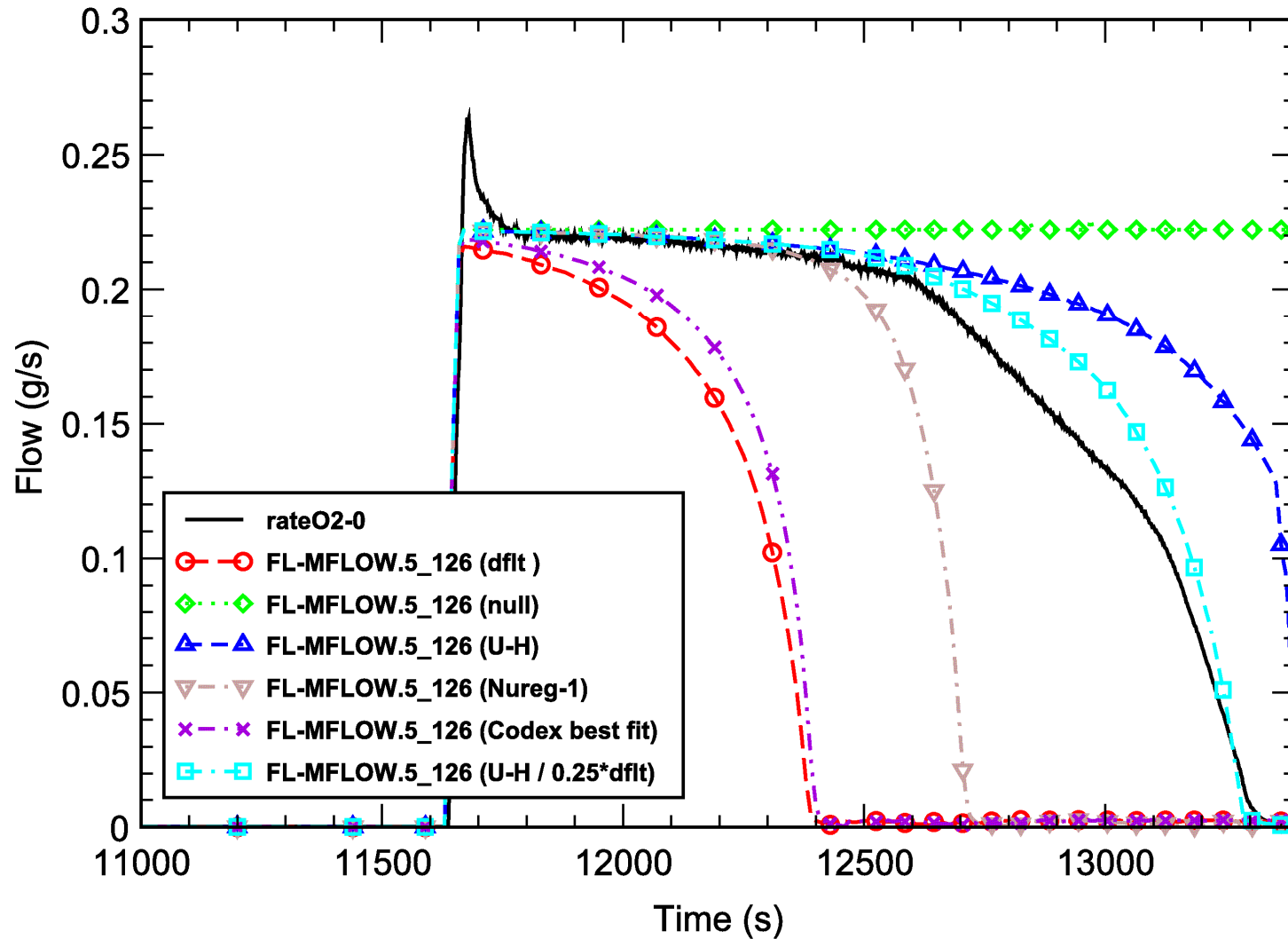
- Pre- and post-test analyses of all QUENCH experiments
 - SCDAP used as main support code
 - Melcor used to provide
 - confirmatory analyses
 - assessment of air oxidation, aerosol and gas release from container
 - all inputs based on MELCOR 1.8.5 model for QUENCH-06
 - conversion to 1.8.6
 - test specific modifications

- Selected results
 - air oxidation (QUENCH-10)
 - boildown and reflood (QUENCH-11)
 - bundle temperature (QUENCH-11, -14)
 - hydrogen generation (QUENCH-14)



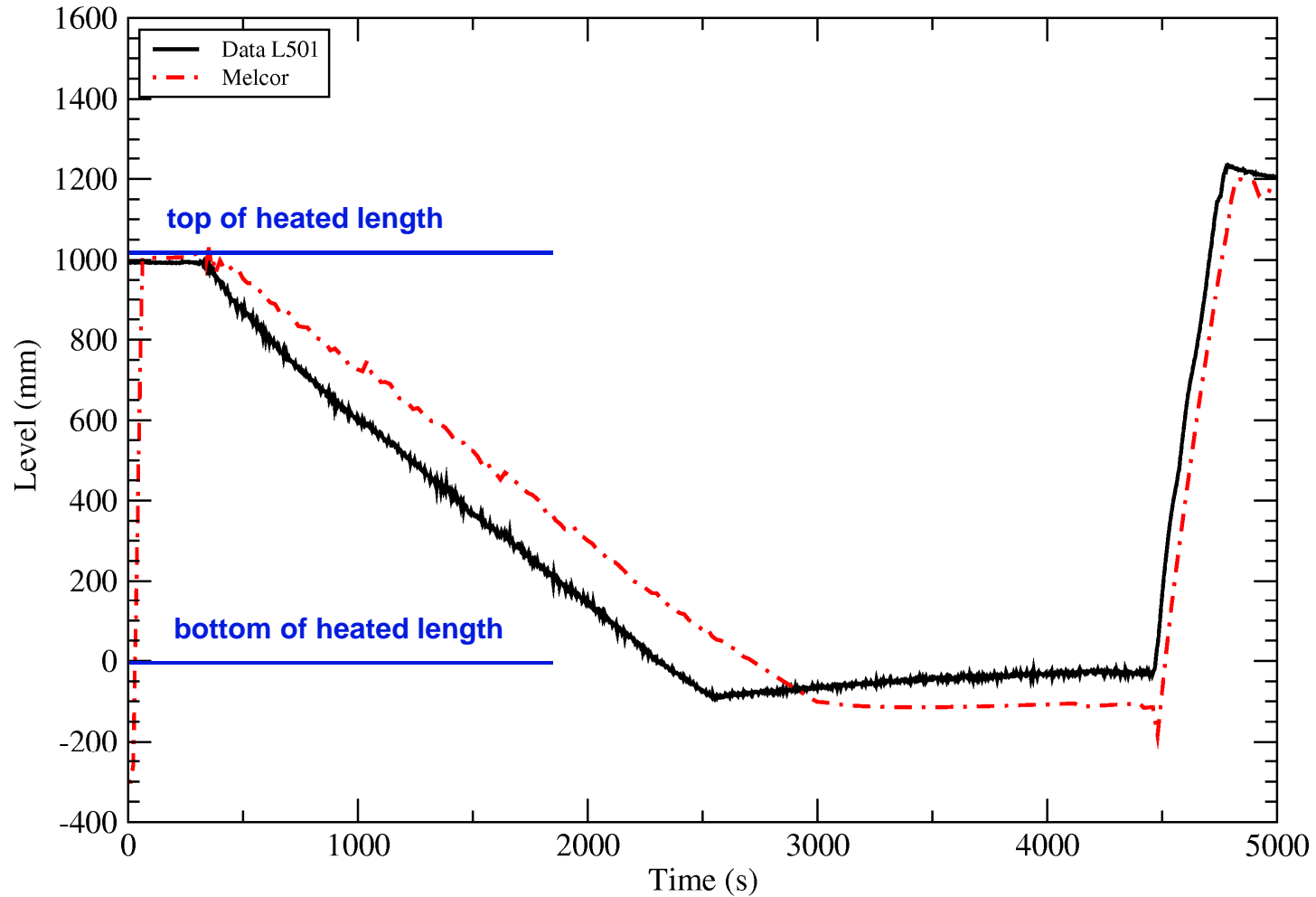
ASSESSMENT USING QUENCH

QUENCH-10 O₂ flow at bundle exit – comparison with MELCOR 1.8.5; effect of air ox model



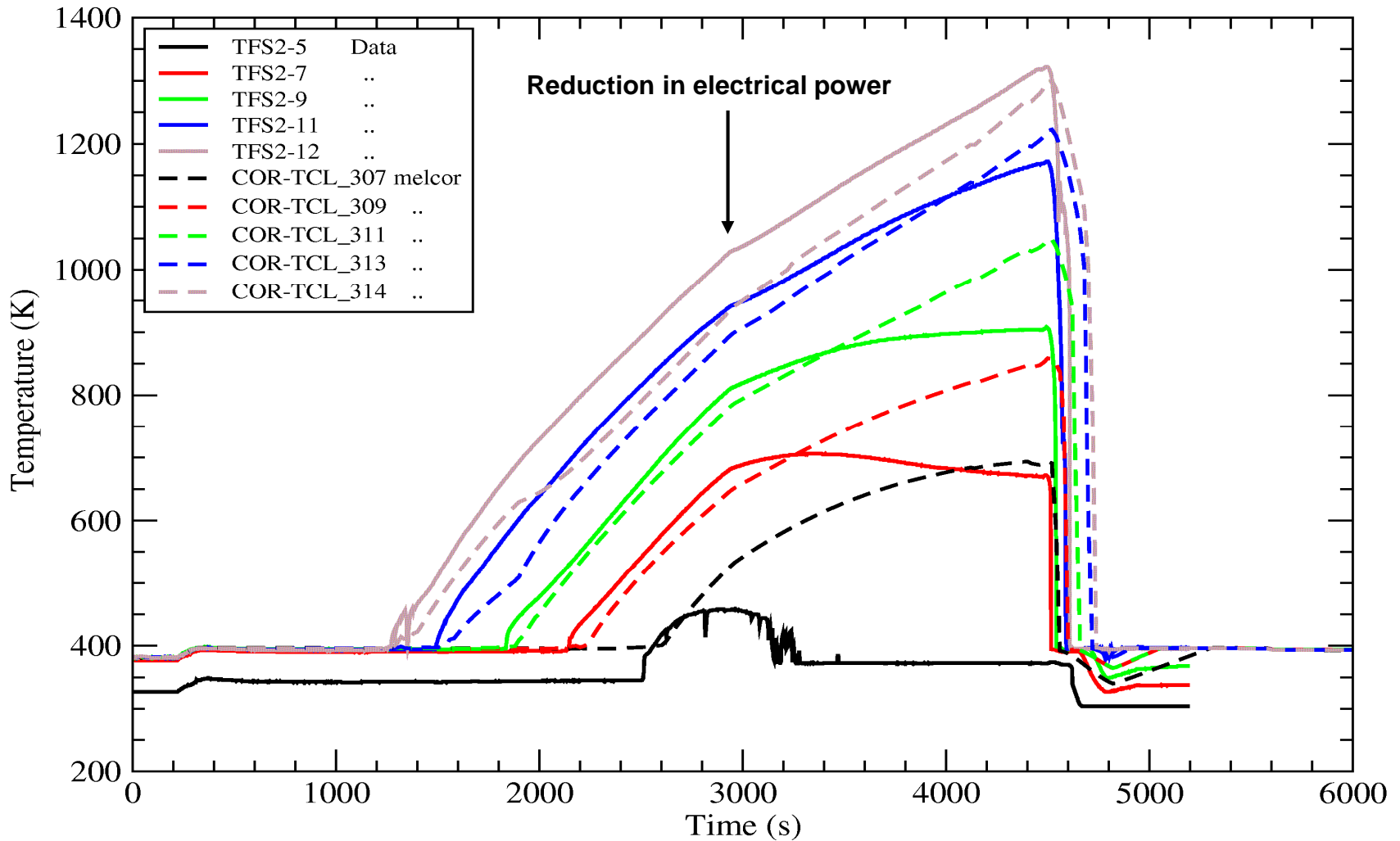
ASSESSMENT USING QUENCH

QUENCH-11 boildown test comparison with MELCOR 1.8.5 : liquid level



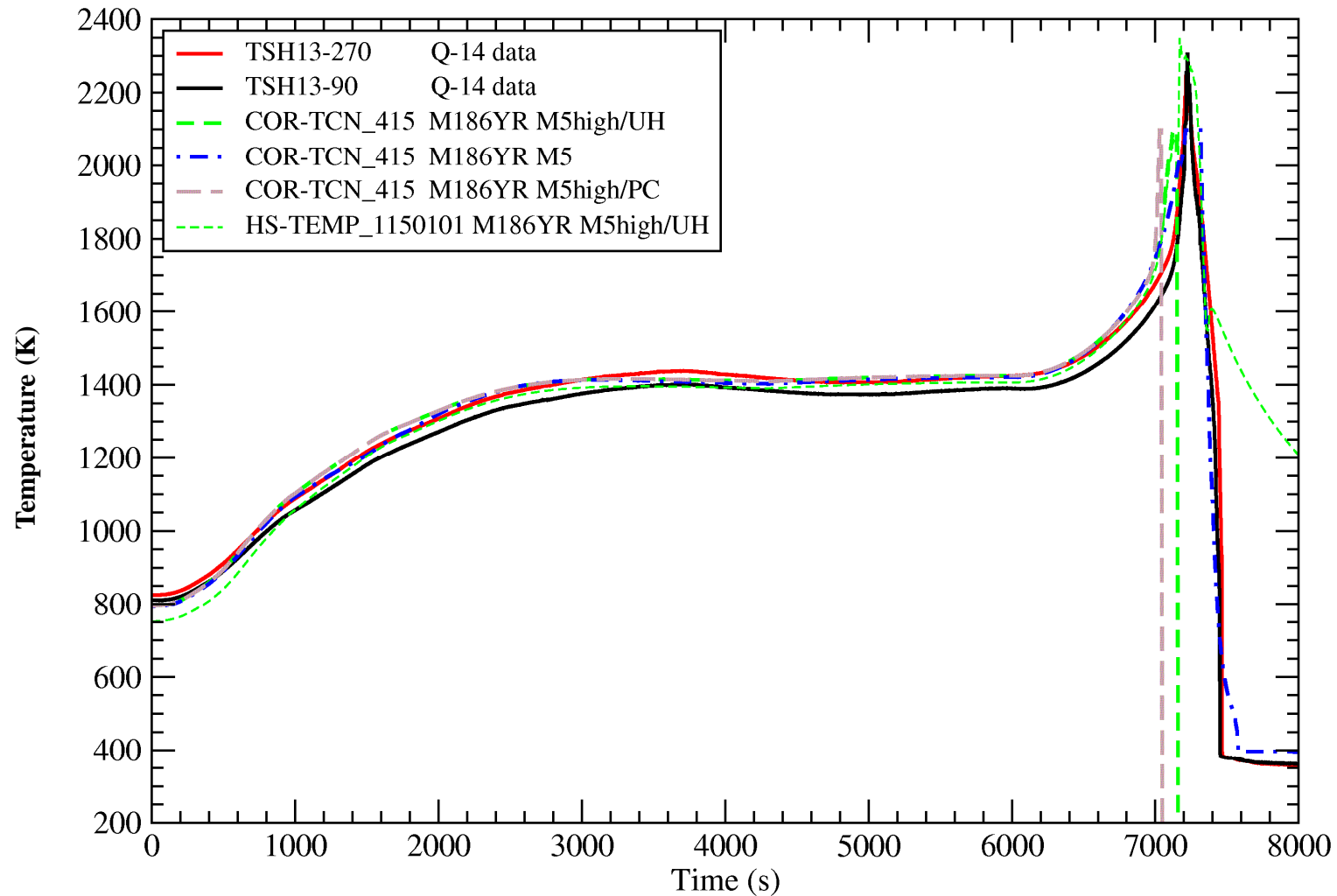
ASSESSMENT USING QUENCH

QUENCH-11 boildown test comparison with MELCOR 1.8.5: uncover and heat-up



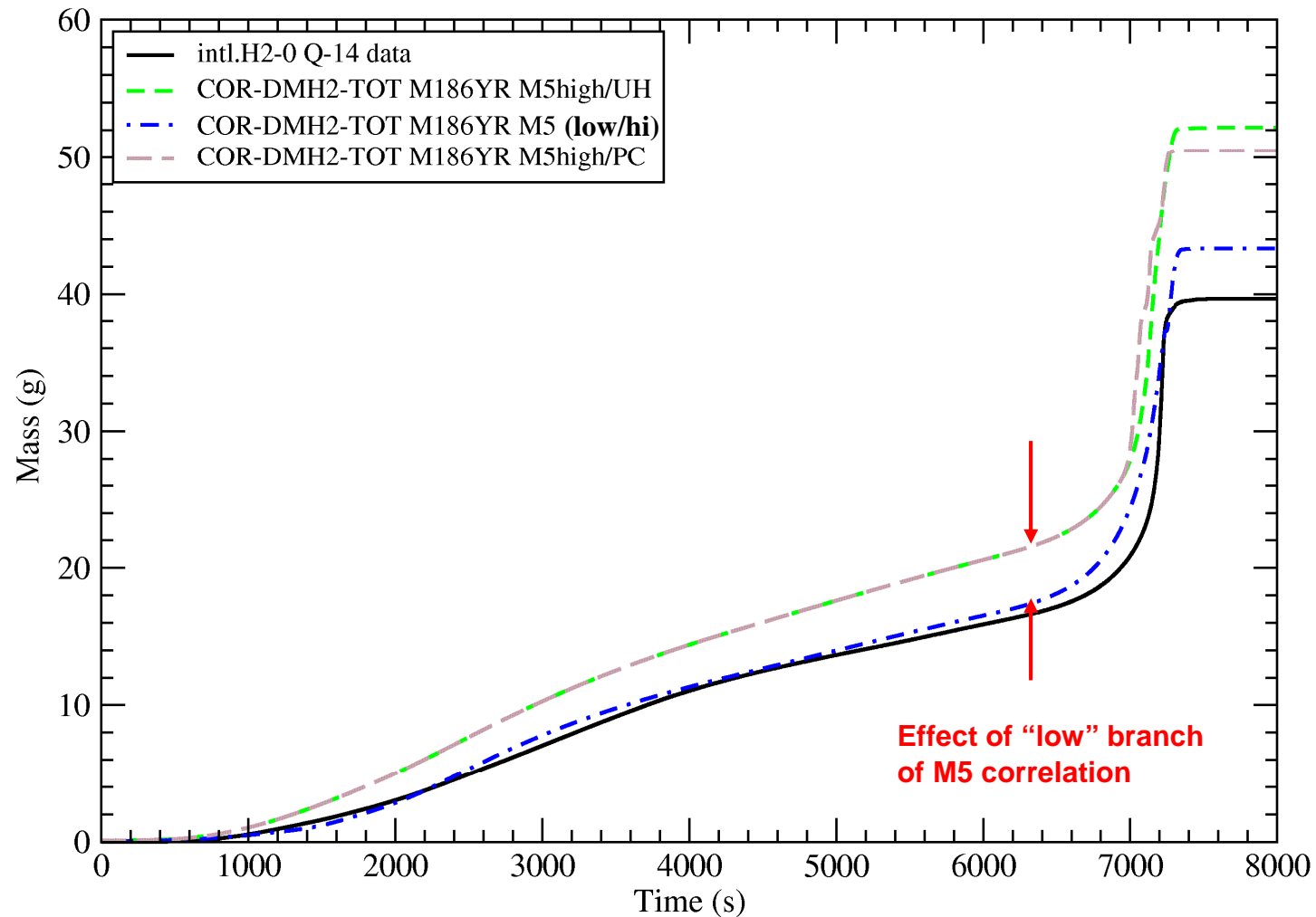
ASSESSMENT USING QUENCH

QUENCH-14 shroud temperature at 950 mm: comparison with MELCOR 1.8.6, ext res 3.6 mohm



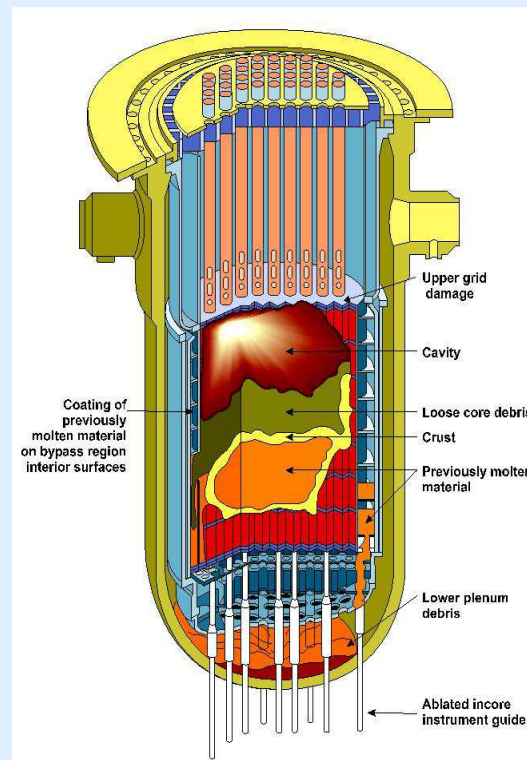
ASSESSMENT USING QUENCH

QUENCH-14 hydrogen generation: comparison with MELCOR 1.8.6, ext res 3.6 mohm



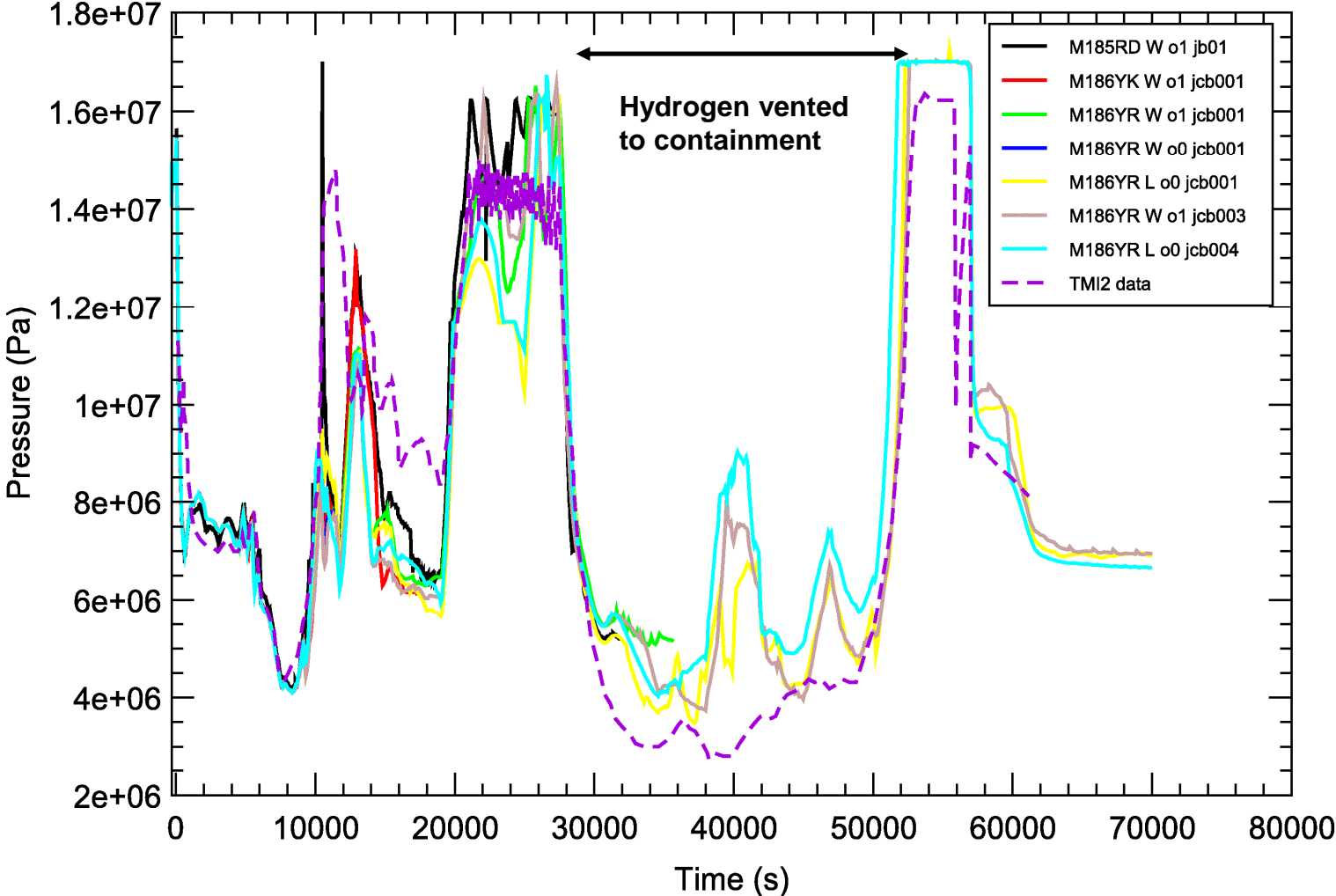
TMI-2 simulations

- Phases 1 to 5 (up to regaining of heat removal by forced circulation)
- Idealised boundary conditions forced by incomplete plant data
- Code comparison
 - Melcor 1.8.5 RD
 - Melcor 1.8.6 YK and YR
 - Windows and Linux
 - optimisation 0 and 1
- Comparison of selected results
 - primary system pressure
 - core liquid level
 - containment pressure
 - molten pool mass



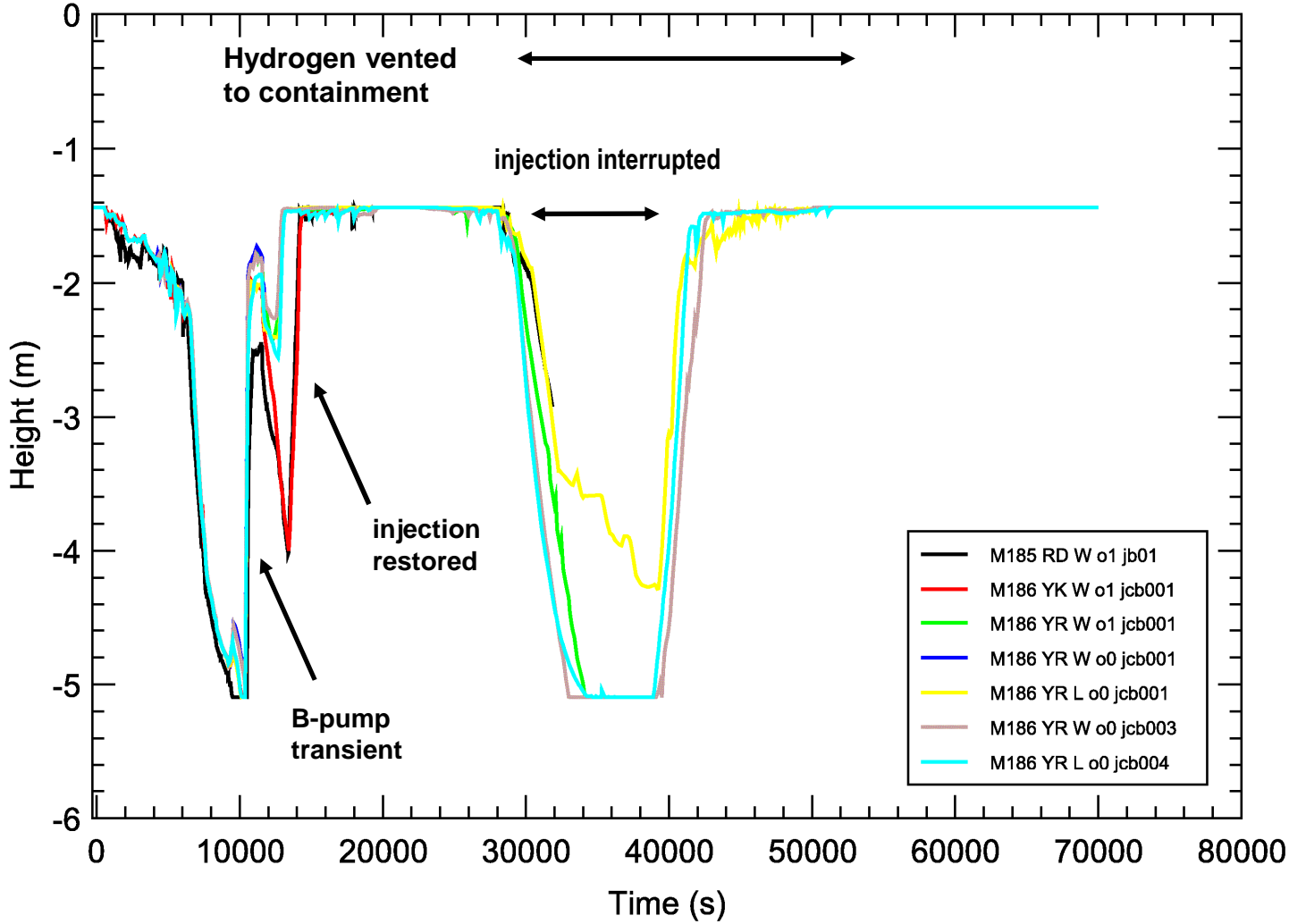
ASSESSMENT USING TMI-2

Pressure in reactor vessel



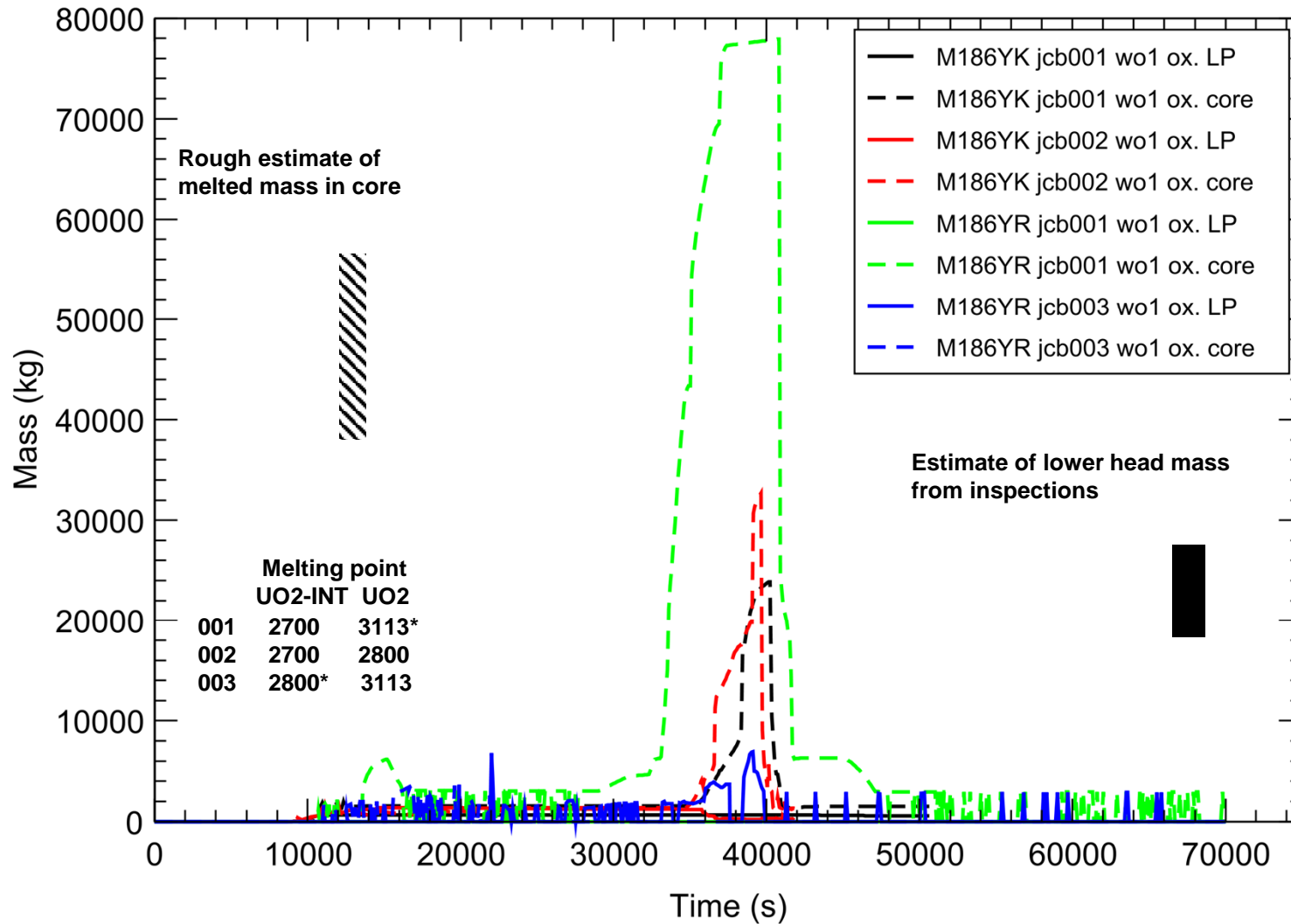
ASSESSMENT USING TMI-2

Liquid level in core

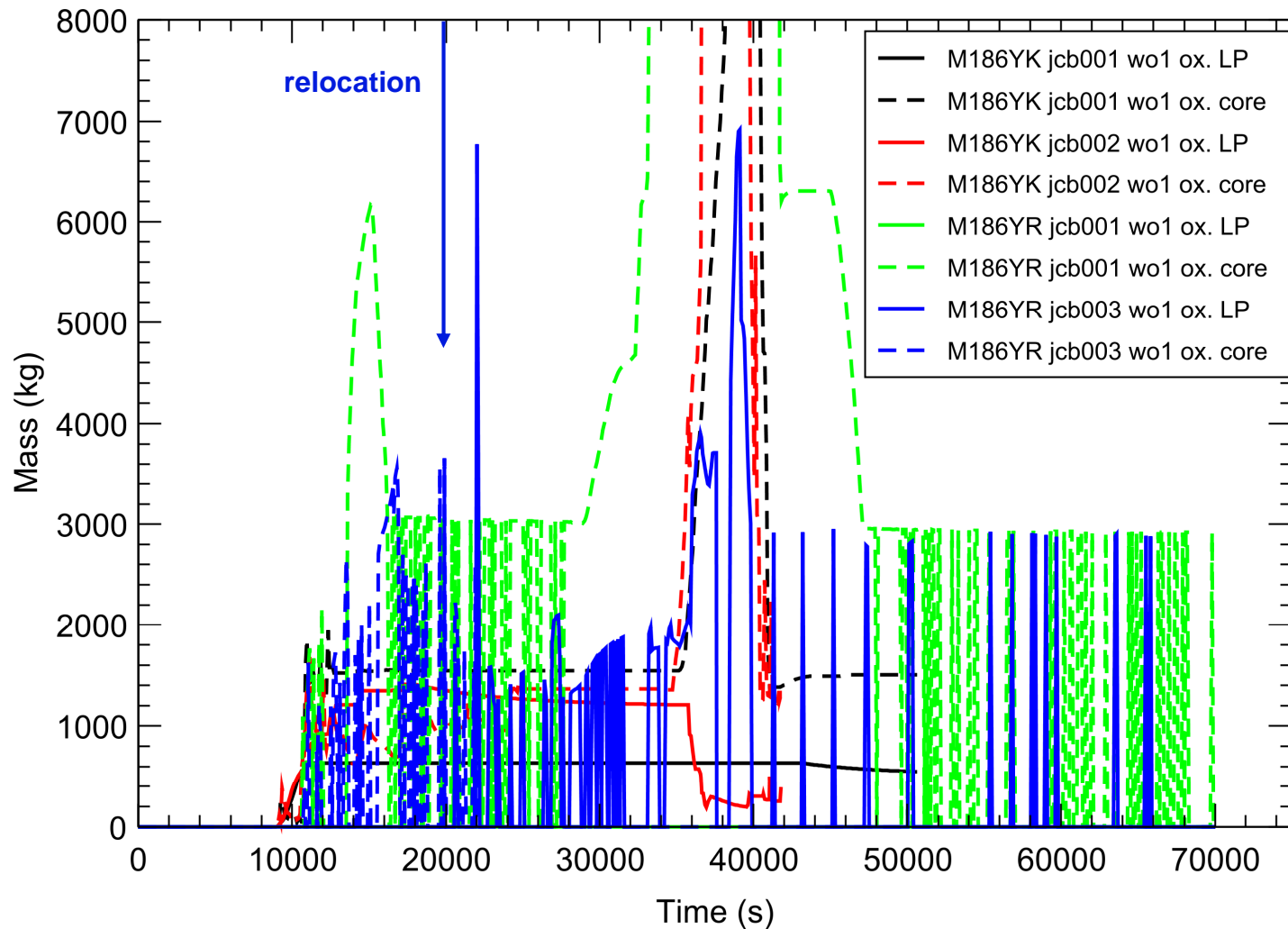


ASSESSMENT USING TMI-2

Molten pool mass in core

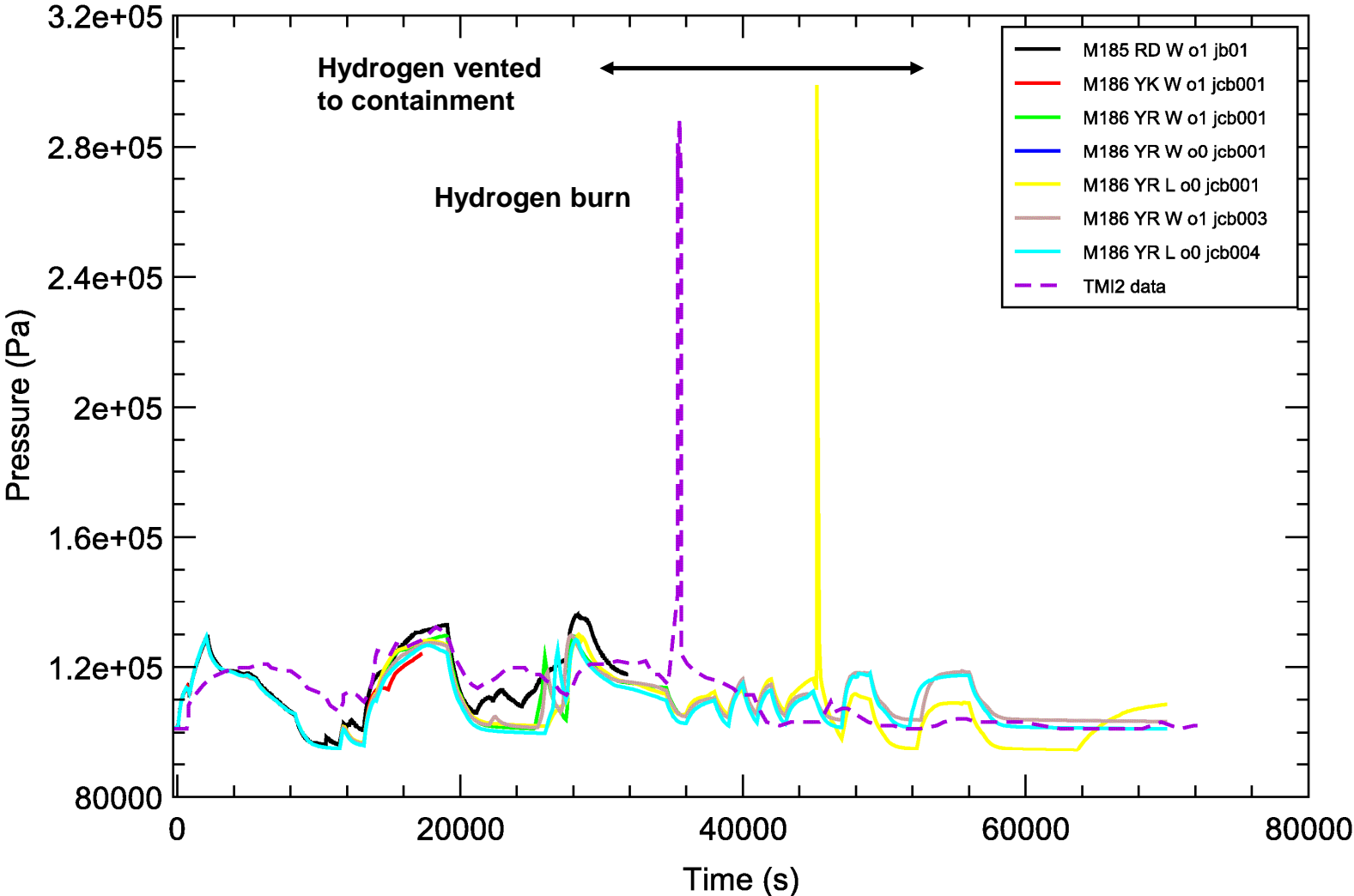


Molten pool mass in core (detail)



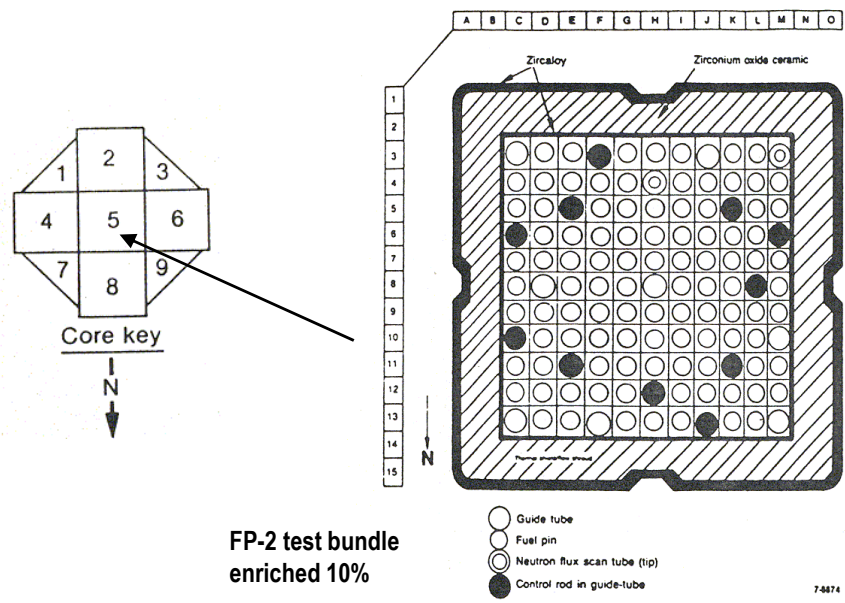
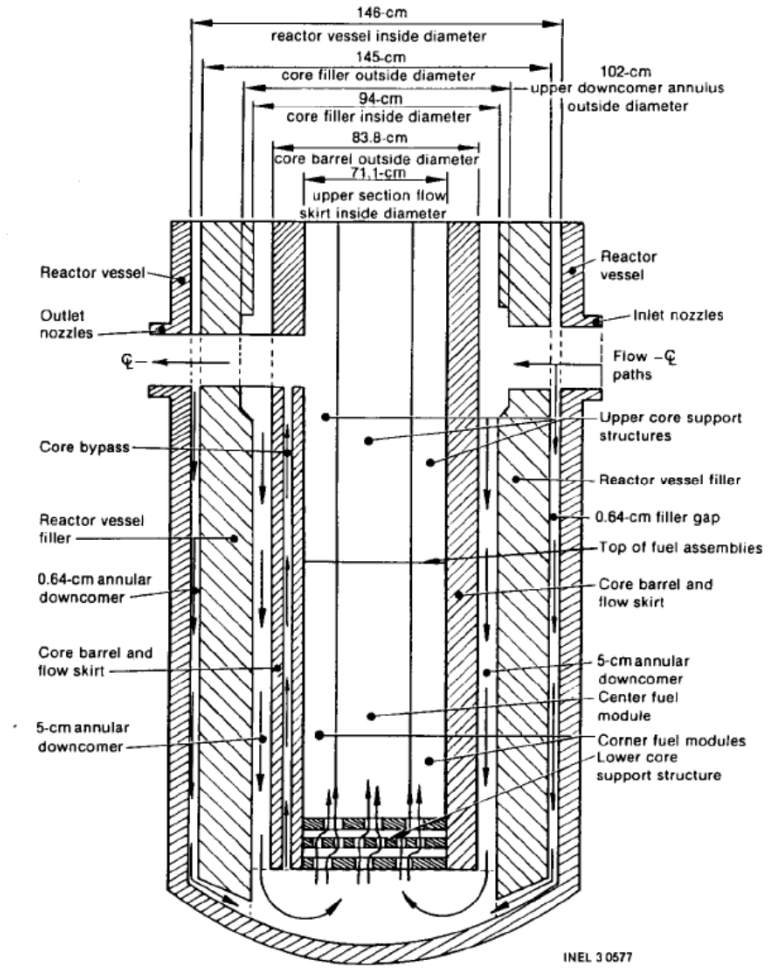
ASSESSMENT USING TMI-2

Pressure in containment



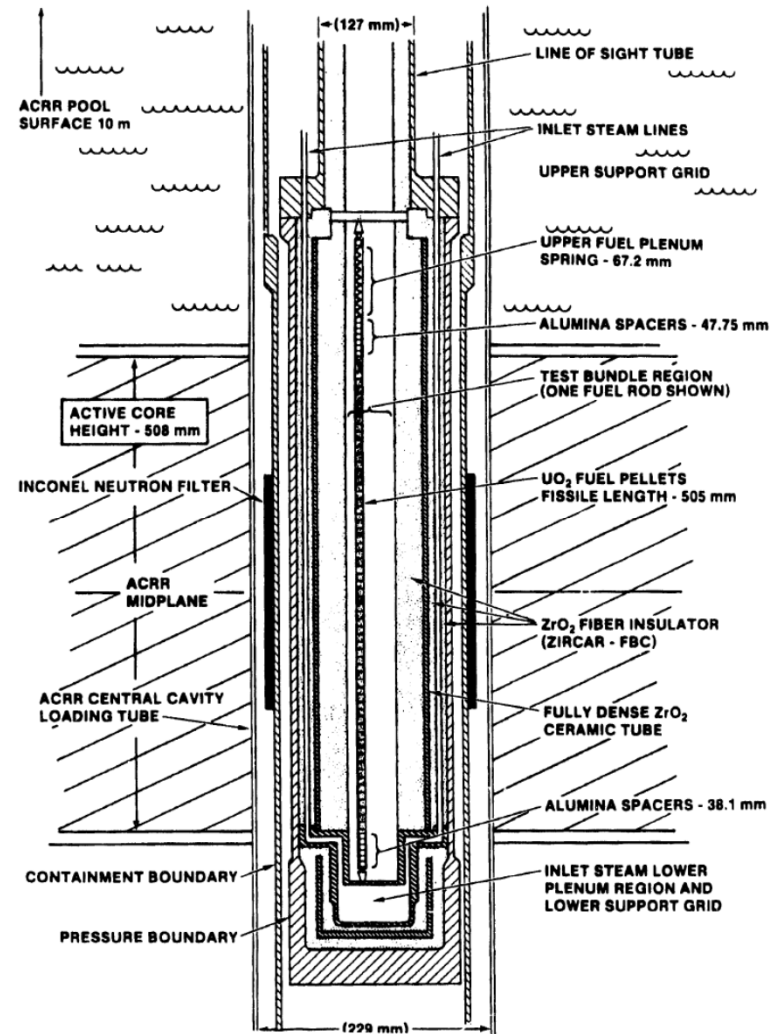
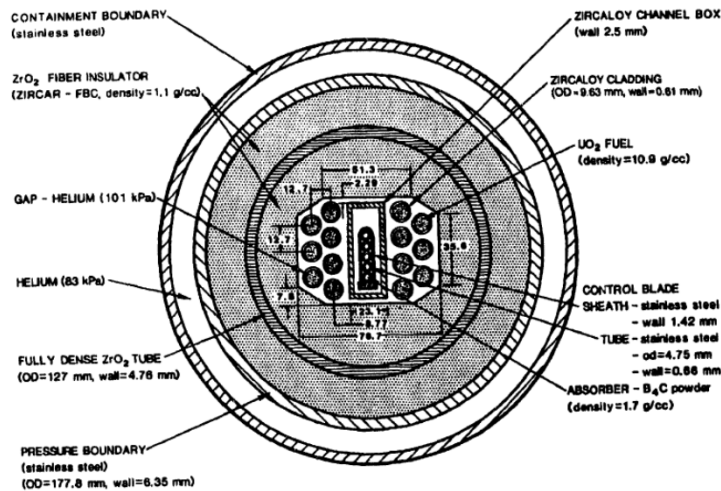
PLANNED FURTHER ASSESSMENTS - LOFT

- LOFT LP-FP-2 was a core melt and fission product experiment
 - previous MELCOR 1.8.5 simulation performed
 - conversion to 1.8.6 and calculations planned
 - comparison with test data and MELCOR 1.8.5
 - assessment of fission product and core melt models



FP-2 test bundle enriched 10%

- ACRR DF-4 was a BWR core melt experiment
 - test reports and input model to be sought from SNL
 - analysis with MELCOR 1.8.6 planned
 - focus on B_4C control blade degradation and interaction with fuel rods



Experience with MELCOR 1.8.5/1.8.6 - summary

- MELCOR V1.8.5 generally robust and flexible to use
 - simple hydraulic models generally adequate and practical for applications
 - Melcor used in tandem with detailed codes for more challenging cases
 - provides effective support for Phebus and QUENCH
- ... but gaps in modelling impact evaluation of some issues
 - SIC release (effect on FP chemistry)
 - B₄C rods (carbon gases, accelerated degradation)
 - dynamics of molten pool (focussing effect)
- V1.8.6 addresses 1.8.5 limitations but some deficiencies remain
 - oxidation sensitive to material interaction parameter values
 - erratic molten pool behaviour
 - limitations regarding models for Ag, In, Cd release and B₄C behaviour
 - don't miss companion presentation to be given by B. Jaeckel

Outlook

- MELCOR 1.8.6 has desirable features
 - can build on good experience with version 1.8.5
 - improved capability for molten core and SIC release
- Assessment of MELCOR 1.8.6 continues
 - LOFT LP-FP-2 and ACRR DF-4 planned
 - ongoing use in support of QUENCH; subordinate role to SCDAP-based codes
 - feedback being provided to USNRC and Sandia Labs
- **MELCOR likely to remain primary choice for plant analysis at PSI**

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Thank you for your attention

