EuDuc =N

Pressurized Thermal Shock at NRG

Project development, progresses and future

L. Stefanini, 4-3-2021

NRG

Nuclear. For life.

Generality of PTS

PTS at NRG progress by year

PTS future

Nuclear. For life.

Presentator introduction

Lorenzo Stefanini

Born in Livorno, Italië, 5-Juli-1990 (30)

MSc. Universitá di Pisa in Nuclear Engineering

Previous experiences: SCK-CEN and JRC material scientist

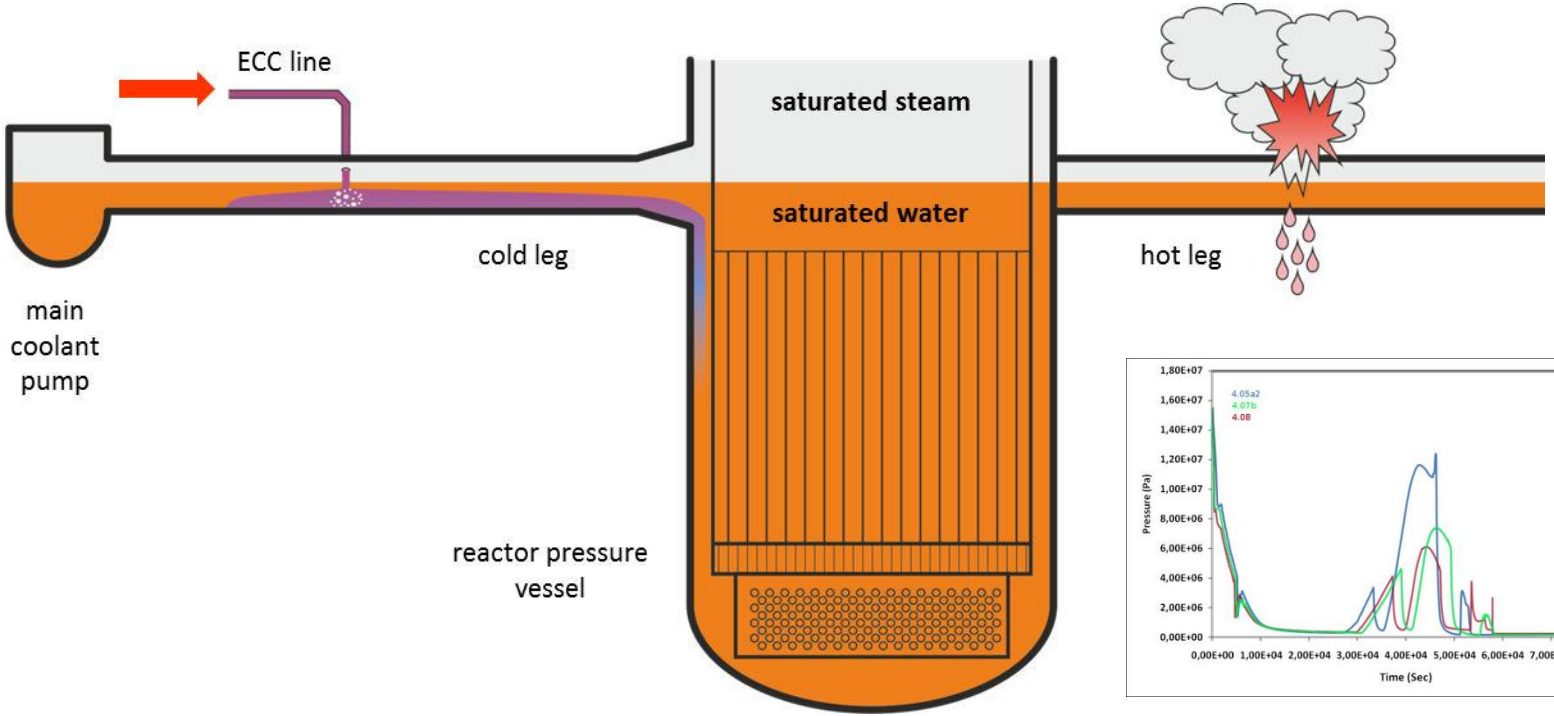
Since 2016 at NRG.

Current position: project manager, Ageing Management Coordinator HFR

Fields of specialization: nuclear industry, ageing, (probabilistic) fracture mechanics

Pressurized Thermal Shock

EuDuc =N



Pressurized Thermal Shock Analysis

EuDuc =N

LOCA (L,*M*,S)

↓

ECCS (cold water)

↓

Hot, high P RPV

↓

Subclad Crack/Defect

↓

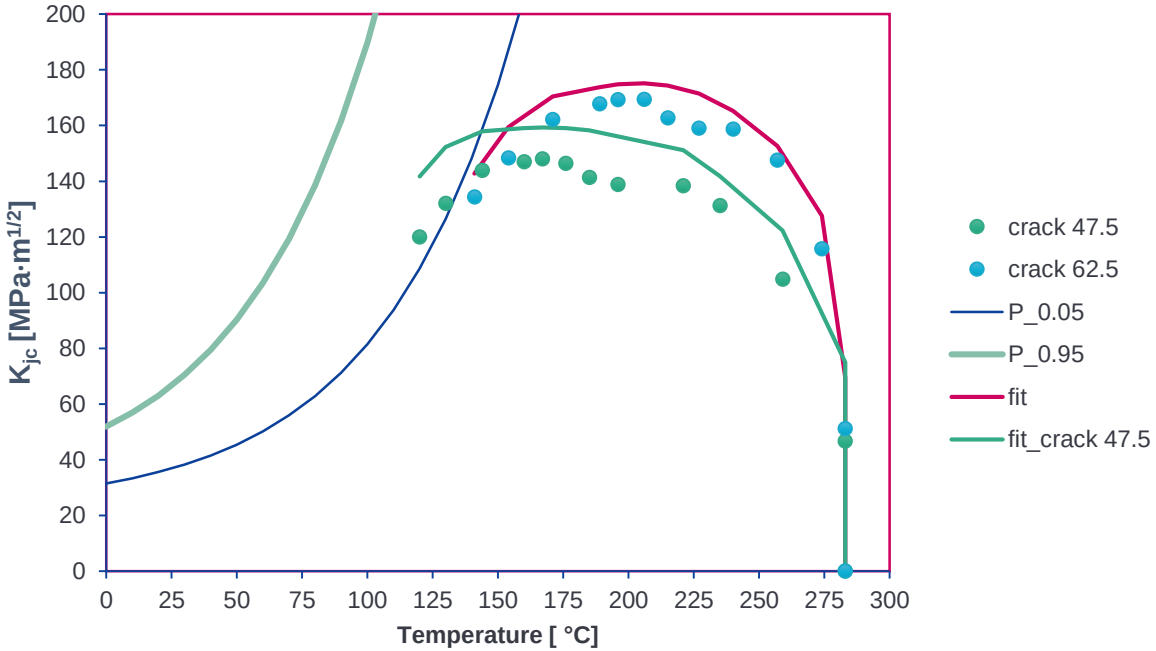
Descending cold plum

↓

High Thermal Stresses

+

High Mech. Stresses



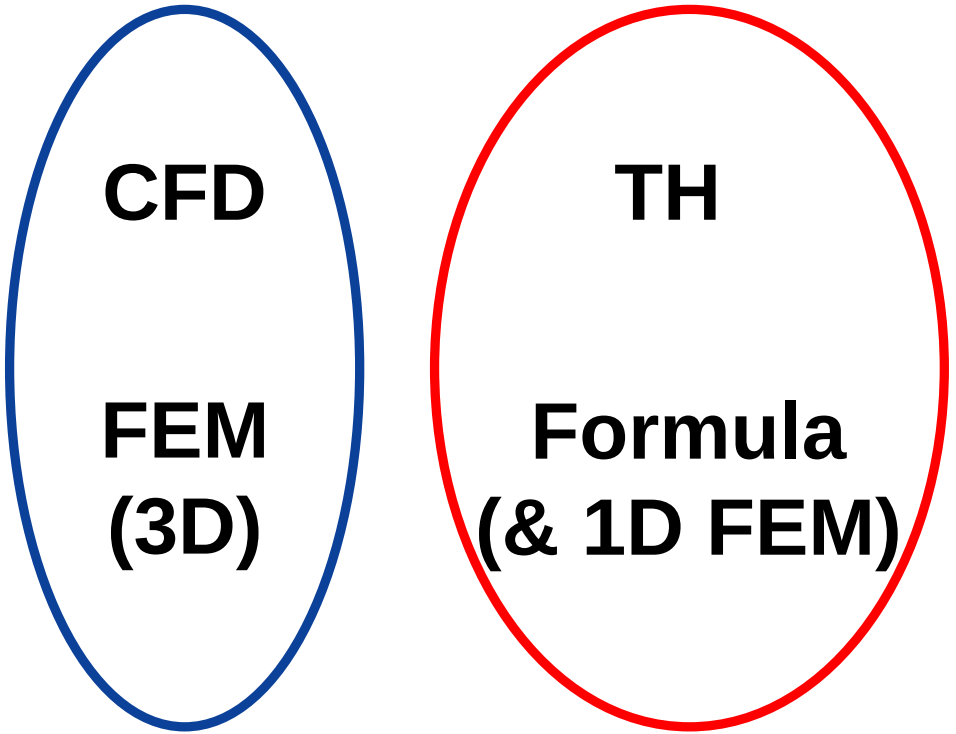
→ SIF → Fracture toughness

PTS Analysis Option

EuDuc =N

Thermal and Pressure transient

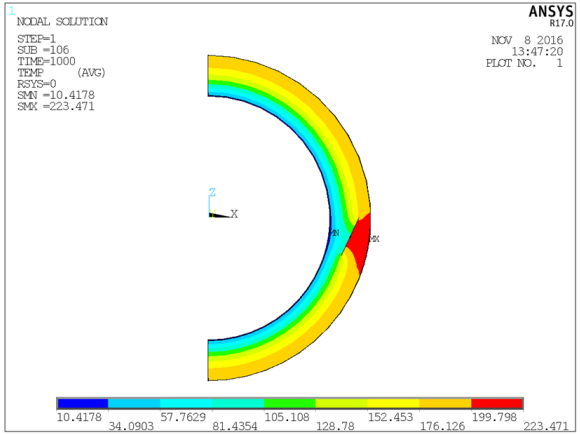
Crack analysis



PTS at NRG - 2017 – Analysis of embedded skewed cracks

No ‘thermal transient’ analysis

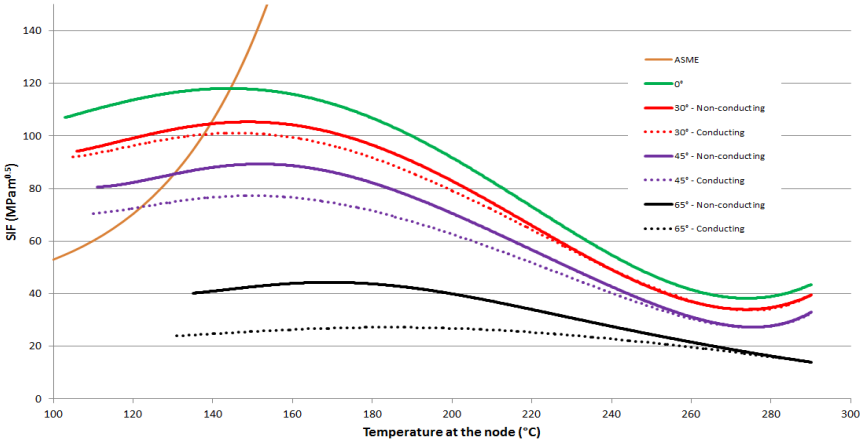
Crack as thermal obstacle



Conservatism ASME projection rules for PTS

↓

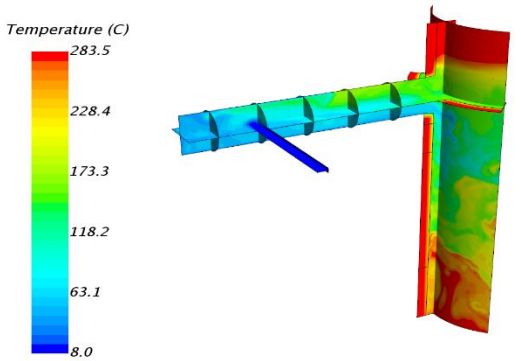
All cracks considered projectable in axial



EuDuc =N

PTS at NRG - 2018 – Use of master curve and CFD coupling

CFD thermal transient (HPCIS)
Constant pressure
Quarte downcomer geometry

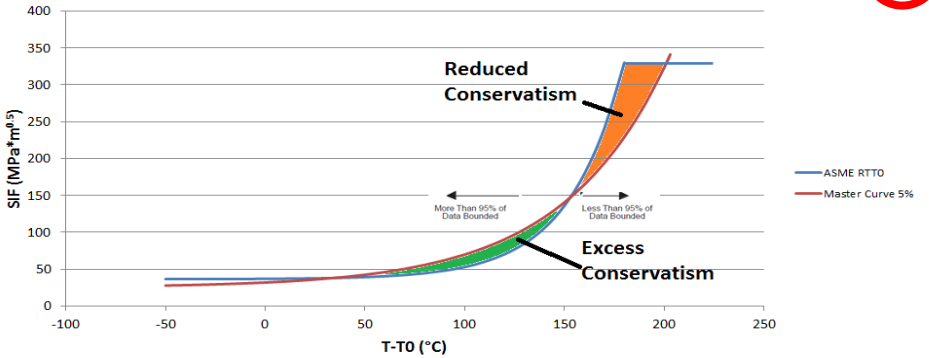


EuDuc =N

3D FEM
Multiple crack analysis
Sensitivity to shape ratio, orientation and position

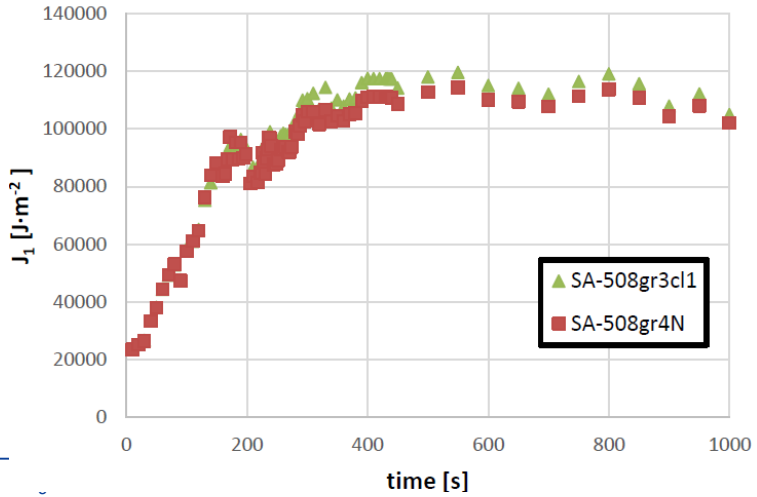
$$K_{Jc} = 20 + \left[11 + 77 \cdot \exp\left(0.019(T - T_0)\right) \cdot \left(\frac{25.4}{B}\right)^{\frac{1}{4}} \cdot \left(\ln\left(\frac{1}{1 - P_f}\right)\right)^{\frac{1}{4}} \right]$$

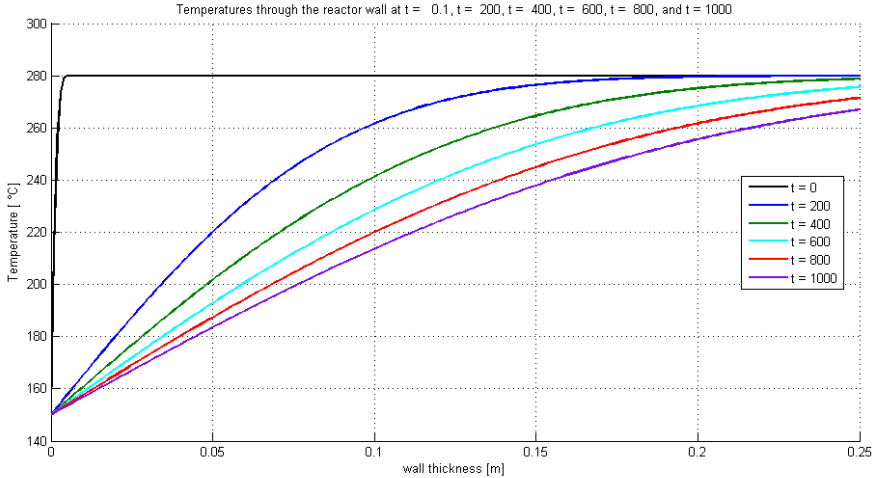
Probabilistic meaning via Master Curve – K_{IC} stochastic



PTS at NRG - 2019 – Transient extension and new materials

CFD thermal transient (HPCIS
Constant pressure
1000sec



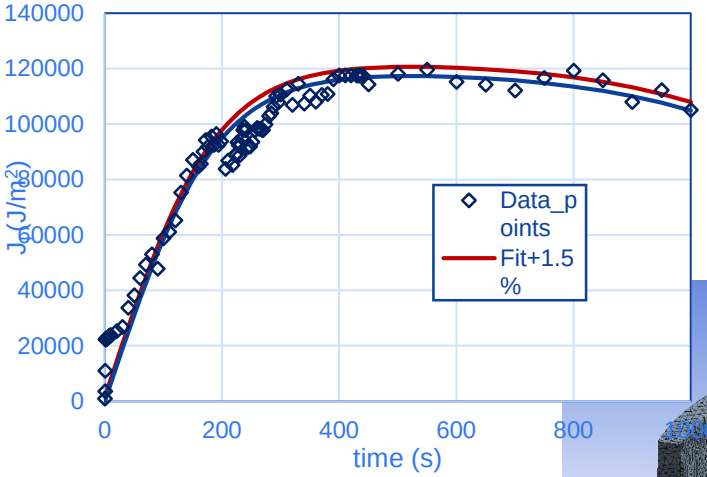


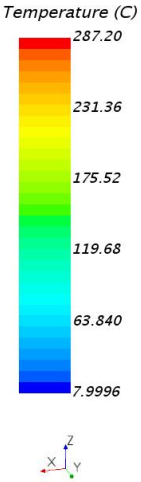
Irradiation embrittlement
Crack interaction

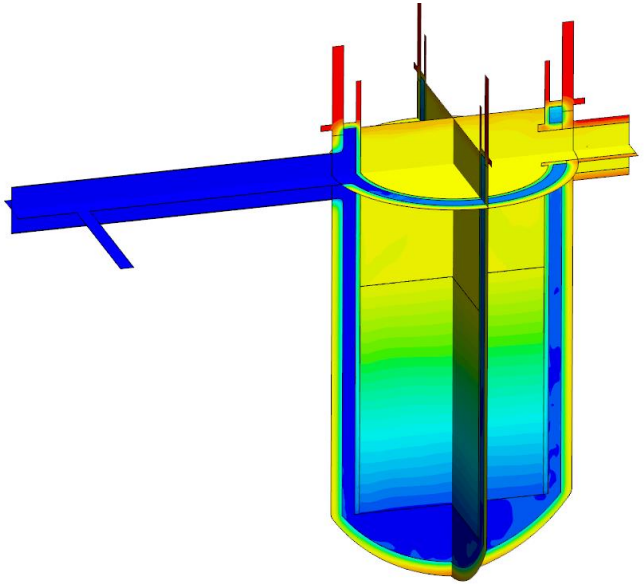
EuDuc =N

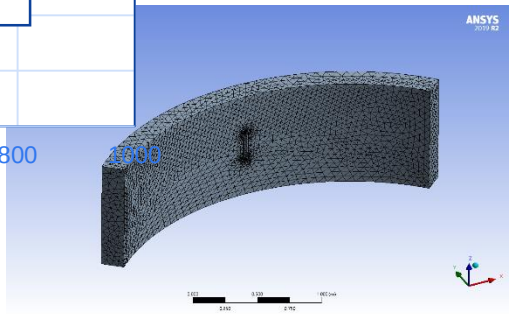
PTS at NRG - 2020 – Complete RPV and submodeling

CFD thermal transient (HPCIS/accumulator)
Constant pressure
1000sec
Core as porous medium







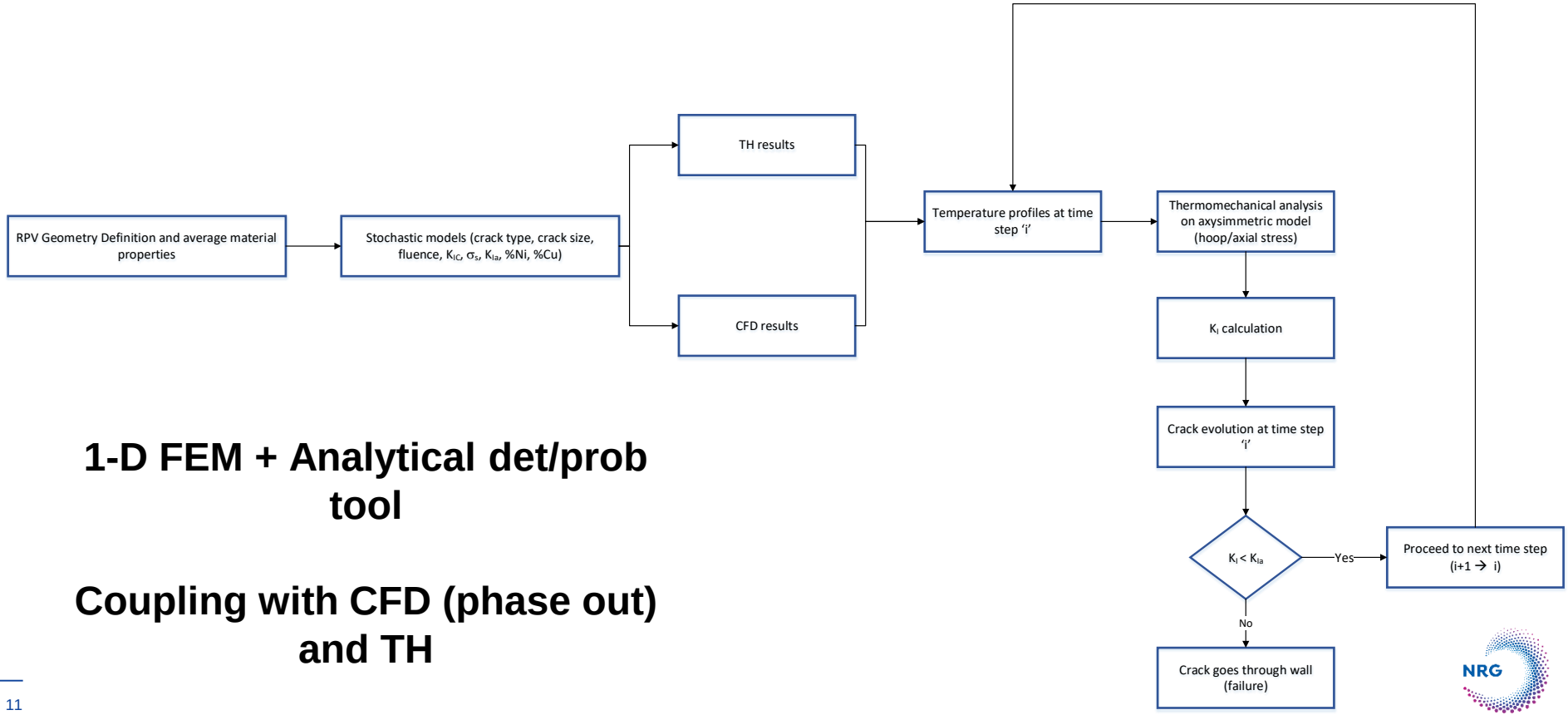


Sub-modeling
Fluctuation harmonisation
(phase out CFD)

EuDuc =N

PTS at NRG – 2021-2024 the (fully probabilistic) future

EuDuc =N



1-D FEM + Analytical det/prob tool

Coupling with CFD (phase out) and TH

Bedankt voor uw aandacht!

EuDuc =N NRG