

INTERACTIVE SESSION III : RPV EMBRITTLEMENT COMPUTING A DUCTILE-BRITTLE TRANSITION TEMPERATURE T_0 USING A LOCAL APPROACH TO FRACTURE

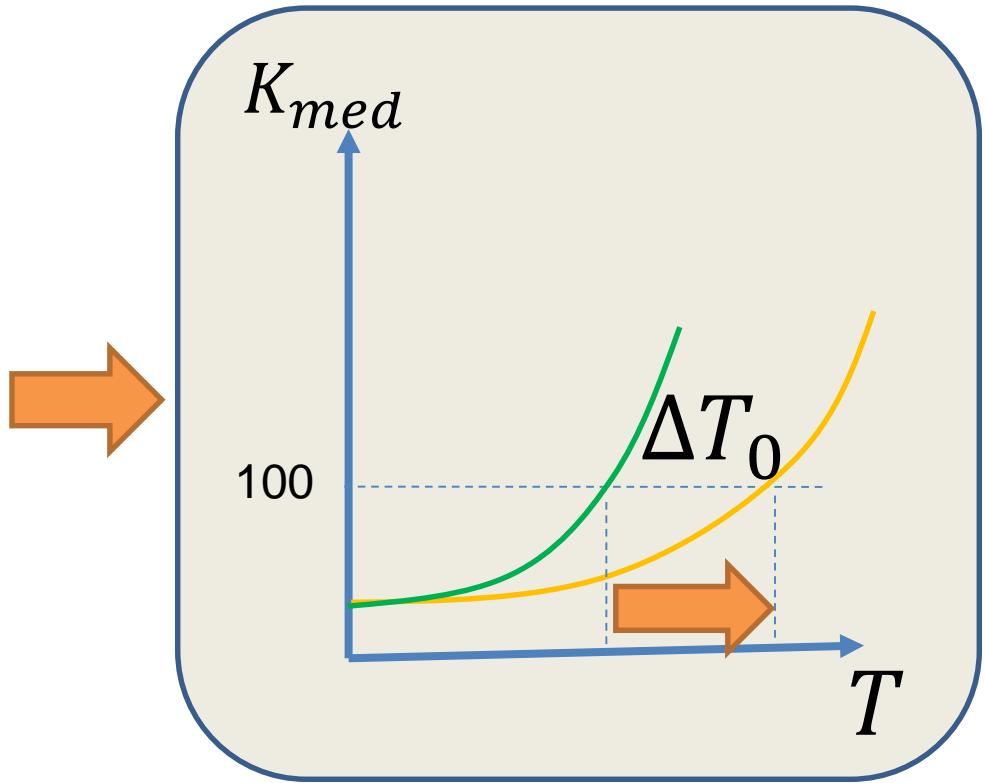
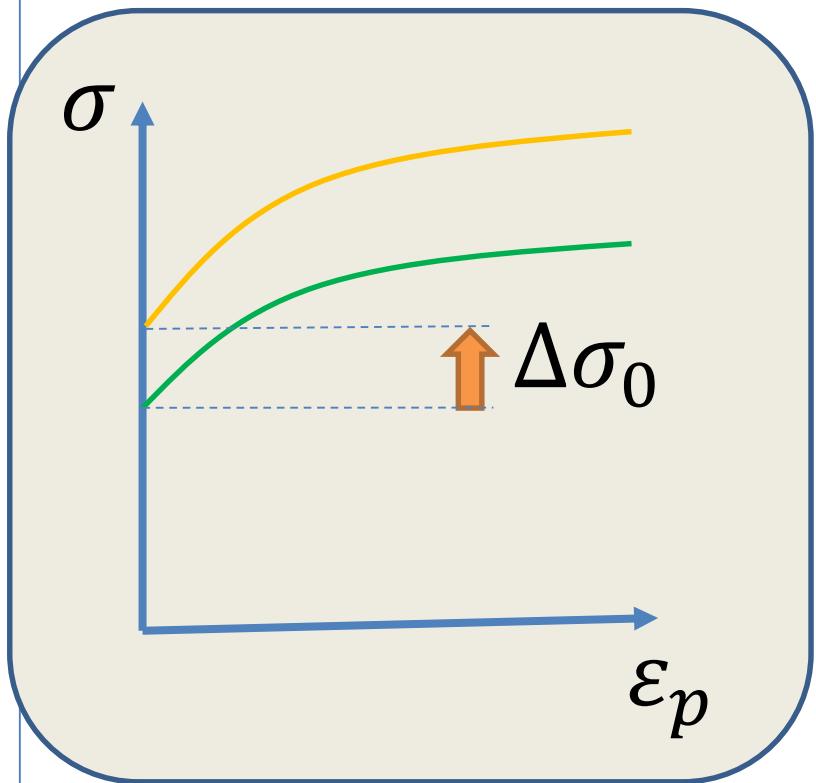
A. Marchenko

P. James

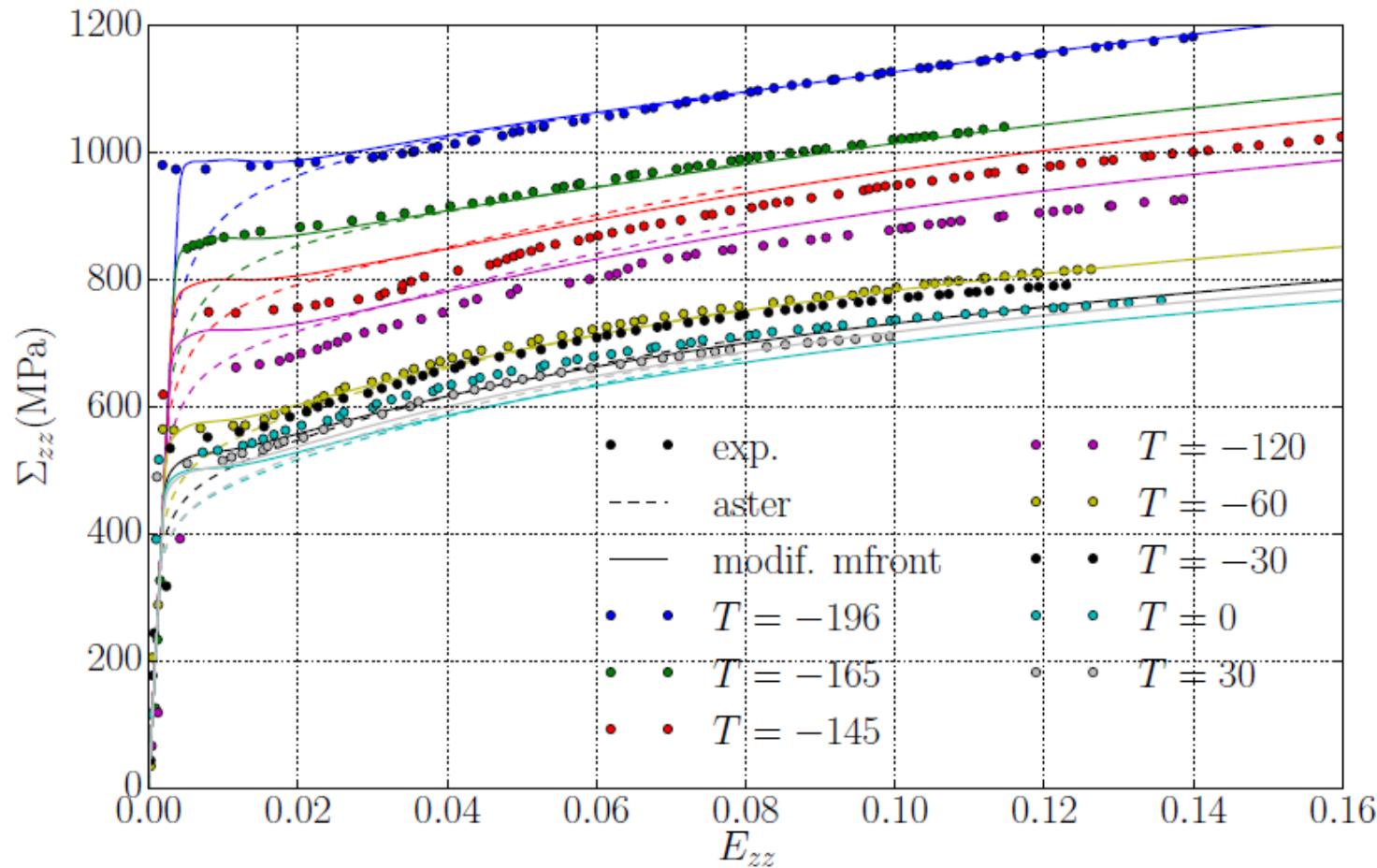


This project received funding under the Euratom research and training programme 2014-2018 under grant agreement N° 661913

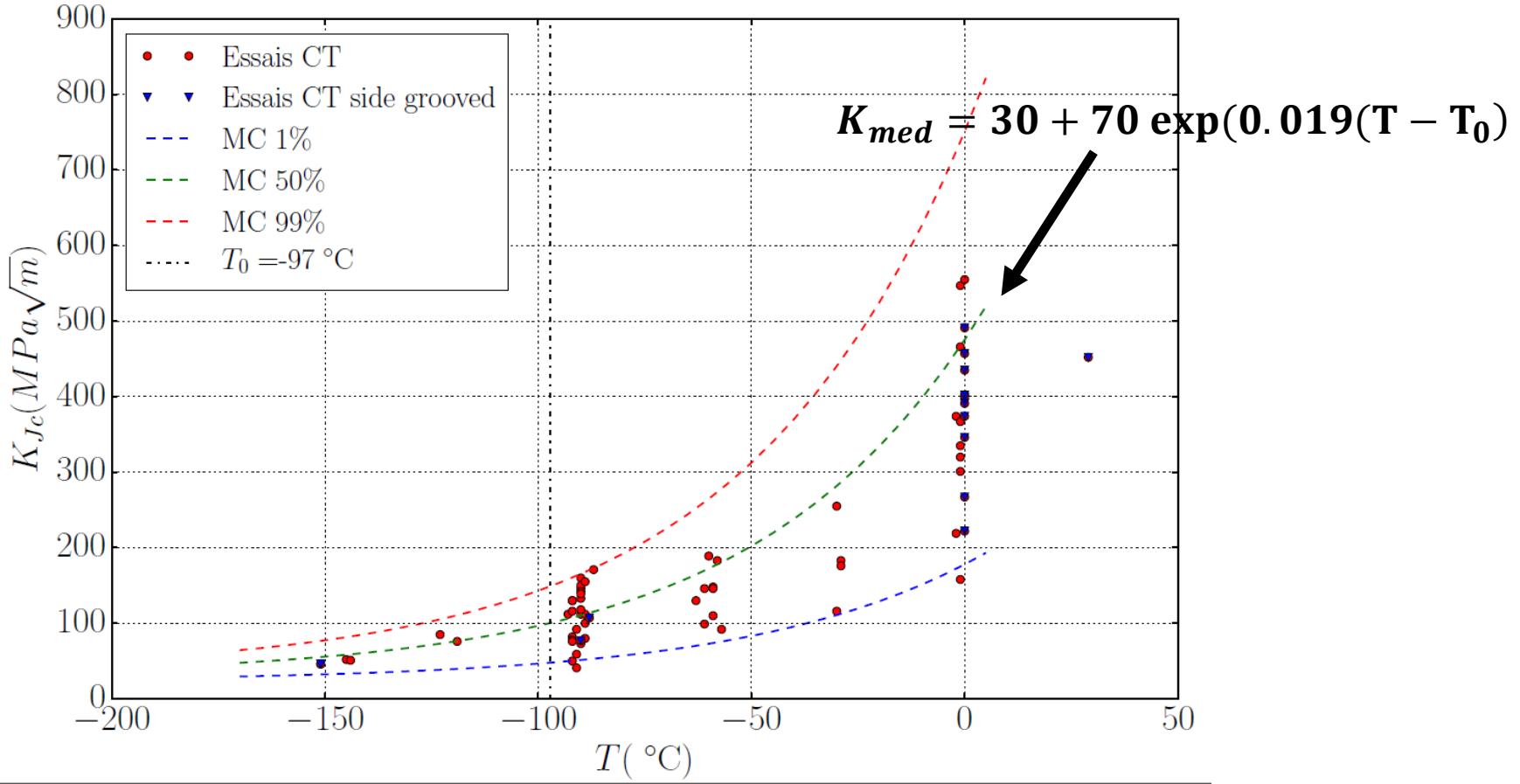
Exercise Objective



H1BQ12 Steel tensile properties



H1BQ12 Steel fracture properties



Master Curve

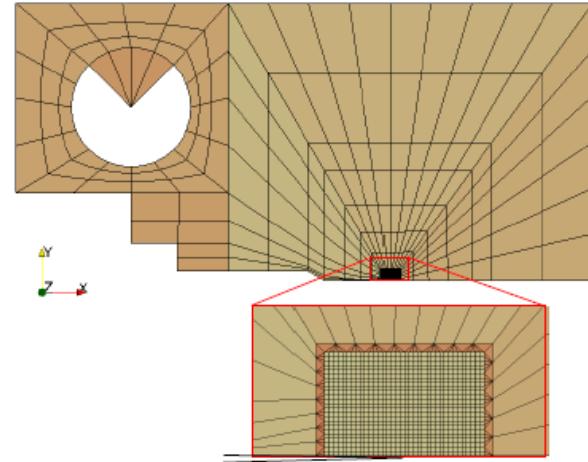
06/09/2018

$$P_f(K_{Jc} \leq K) = 1 - \exp \left[-\frac{B}{B_0} \left(\frac{K - K_{min}}{K_{med} - K_{min}} \right)^4 \right]$$

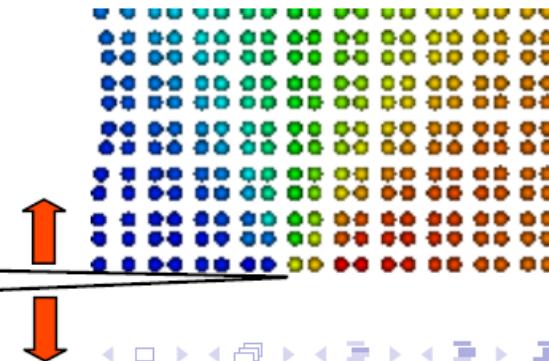
CT Calculation with the platform



- To circumvent the limitations of the Master Curve approach, the local approach to failure proposes a **chaining** of a **plastic** calculation and a **failure post-treatment**
- The plastic calculation proposed in the platform is available in the RPV Toughness Module as "CTCalculation"
- It is a 2D calculation using Code_Aster as solver
- possible chainings with homogenized **crystal plasticity law** to benefit from lower scale plastic models



$$\sigma_I(x) = f(K_J)$$

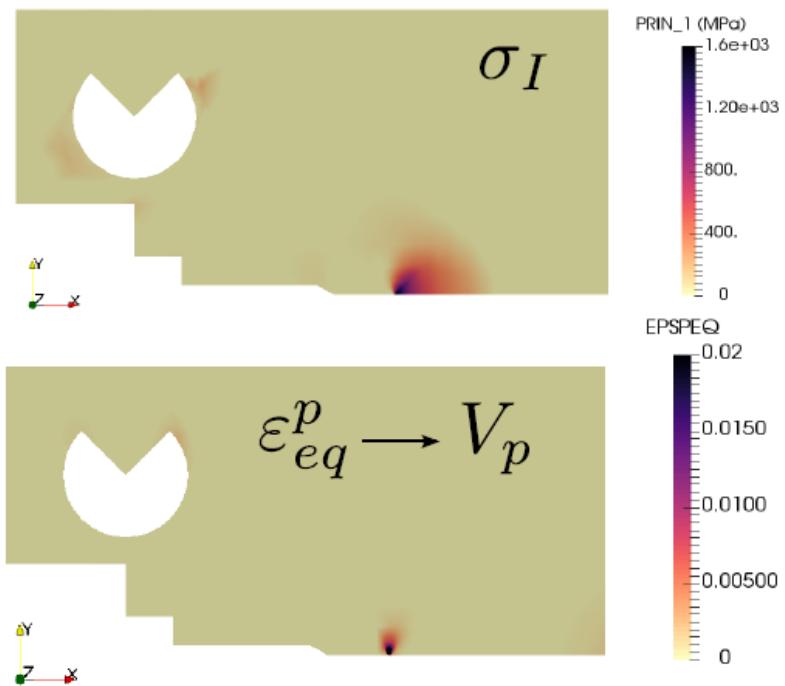
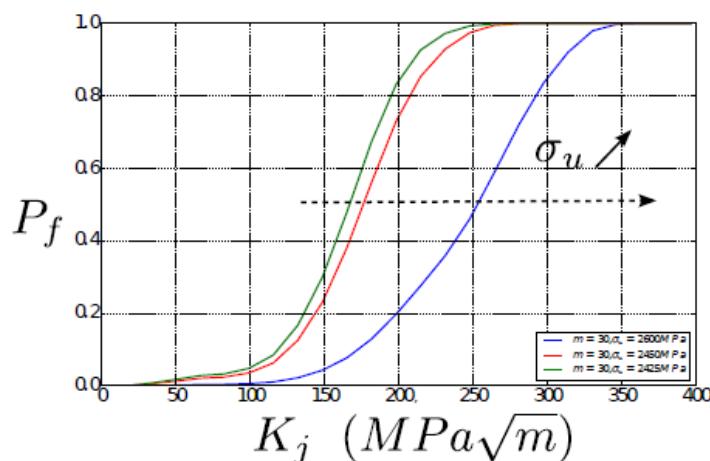


Beremin model

- $\forall K_j(t_i)$

- fitting a Weibull stress σ_W on the plastic Volume V_p using the σ_I field
- Compute the failure probability P_f

$$\begin{aligned}\sigma_W &= \left(\int_{V_p} \sigma_I^m \frac{dV}{V_0} \right)^{m^{-1}} \\ P_f &= 1 - \exp \left[- \left(\frac{\sigma_W}{\sigma_u} \right)^m \right]\end{aligned}$$

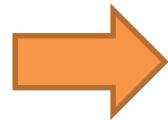
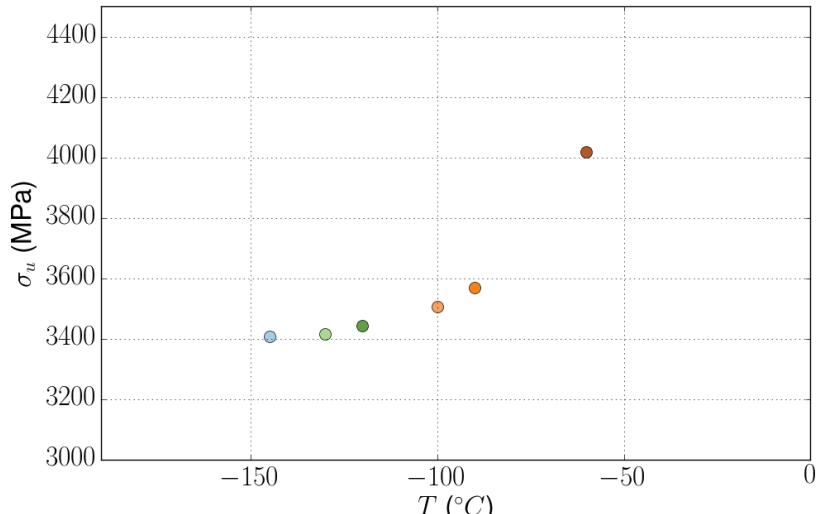
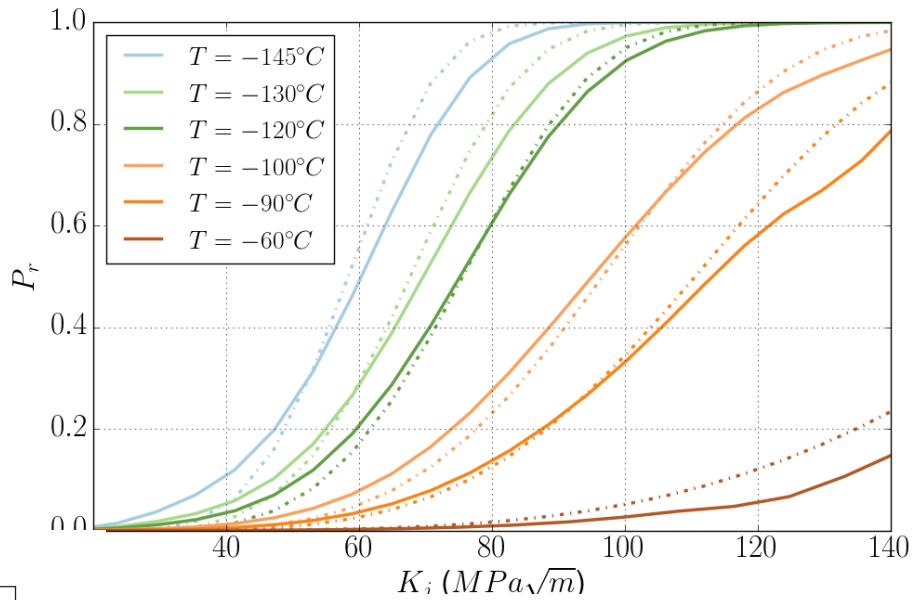


- Beremin parameters : m , σ_u , V_0

Correlation Beremin – Master Curve



Solid Line = Beremin
Dashed Line = Master Curve

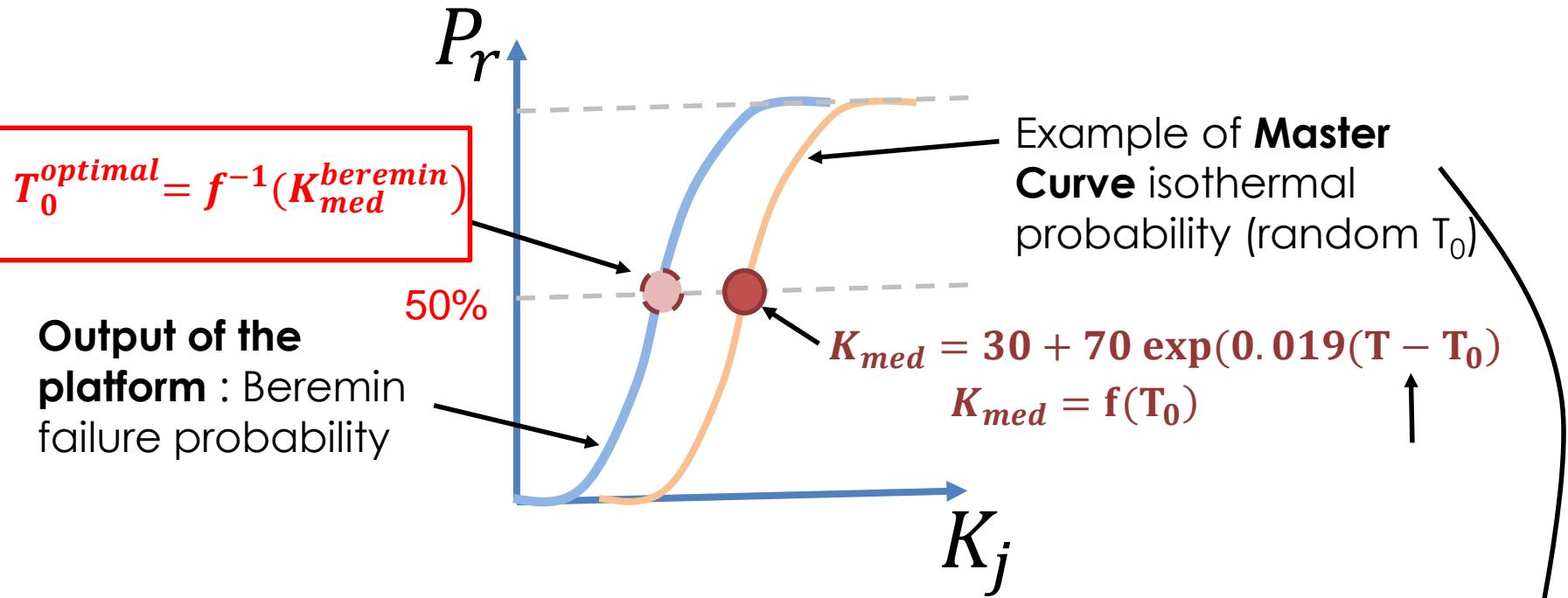


$$\sigma_u = A + B \exp(C T)$$

A (MPa)	B (MPa)	C
3267	961	0.025

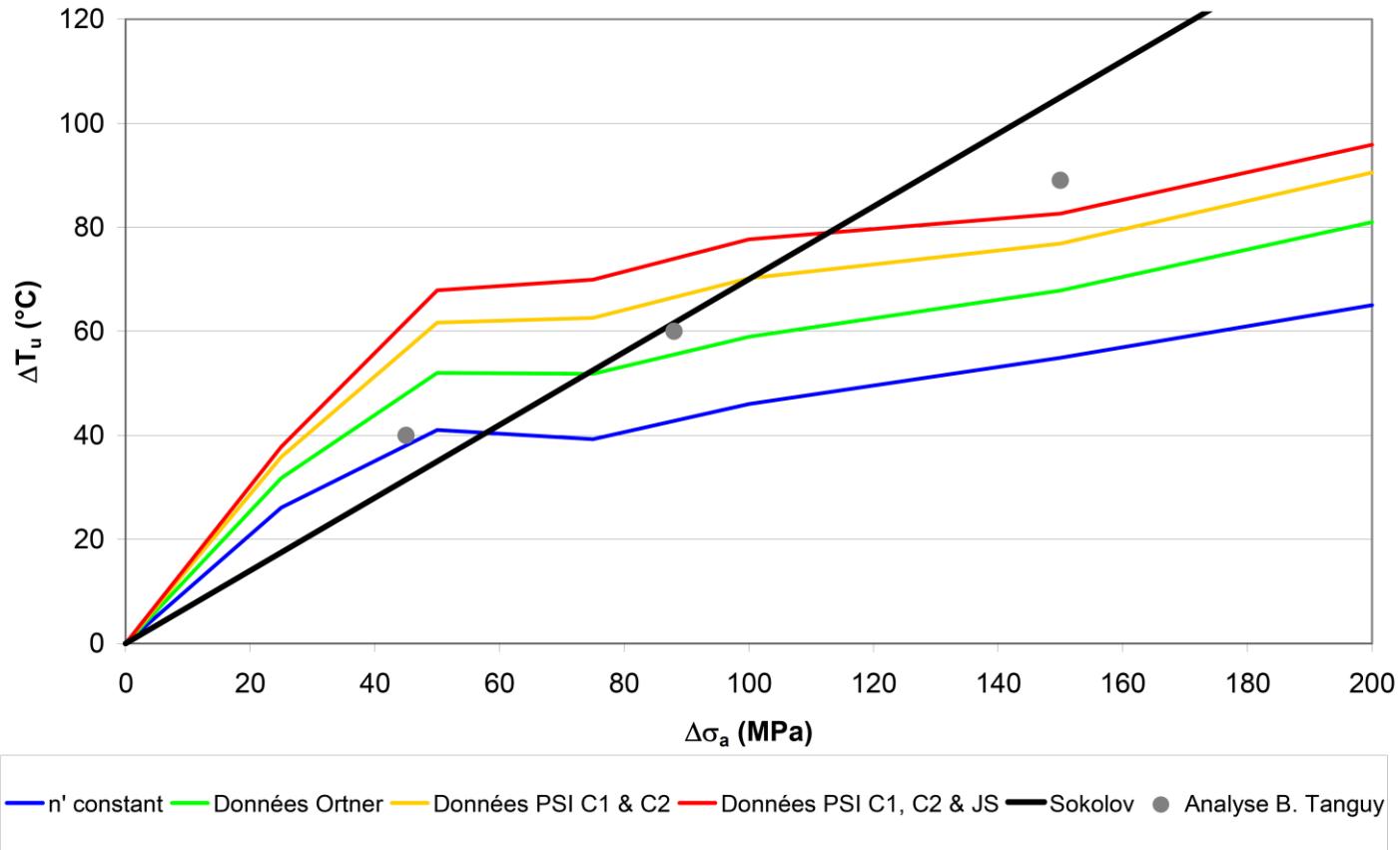


Fitting T_0 with MasterCurve



$$P_f(K_{Jc} \leq K) = 1 - \exp\left[-\frac{B}{B_0}\left(\frac{K - K_{min}}{K_{med} - K_{min}}\right)^4\right]$$

Irradiation effect on fracture



$$\sigma_u = A + B \exp(C (T - \Delta T_u)), \quad \Delta T_u = \Delta T_0,$$

$$\Delta T_0 = \alpha \Delta \sigma_0, \quad \text{with} \quad \alpha = 0.7$$

B.Tanguy, A. Parrot

Sokolov relation

Modules chaining



The screenshot shows the 'Beremin - Perspycace' application window. The interface includes a menu bar (Study, Run, Options, Help), a toolbar, and several tabs: Study, Chain (which is selected), Data, Run, and Graphics. A large bracket on the left side of the window is labeled 'list of available modules'. An arrow points from the 'Chain' tab to the 'Module Tree View' panel. This panel displays a hierarchical tree of available modules under the 'RPV' category. The 'Beremin' module is highlighted with a blue selection bar. A second bracket on the left side, below the first, is labeled 'chain'. The 'Selected Modules' panel at the bottom contains the text 'Chain' and a list of three selected modules: 'ToughnessModule.FlowBehaviour.Homogenisation.BZ_DD_CC', 'ToughnessModule.FractureBehaviour.LocalApproach.CTCalculation', and 'ToughnessModule.FractureBehaviour.LocalApproach.PostProcessor.Beremin'. The 'Module Help' panel on the right provides detailed information about the selected 'Beremin' module, including its module name, author (S. Bugat), version (01.01.00), end module status (True), and short documentation (Beremin post-processing). A 'Full Documentation' section is also present in the help panel.