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Assessment of model uncertainty for effective thermal conductivity model of the SPACE in crumbled fuel

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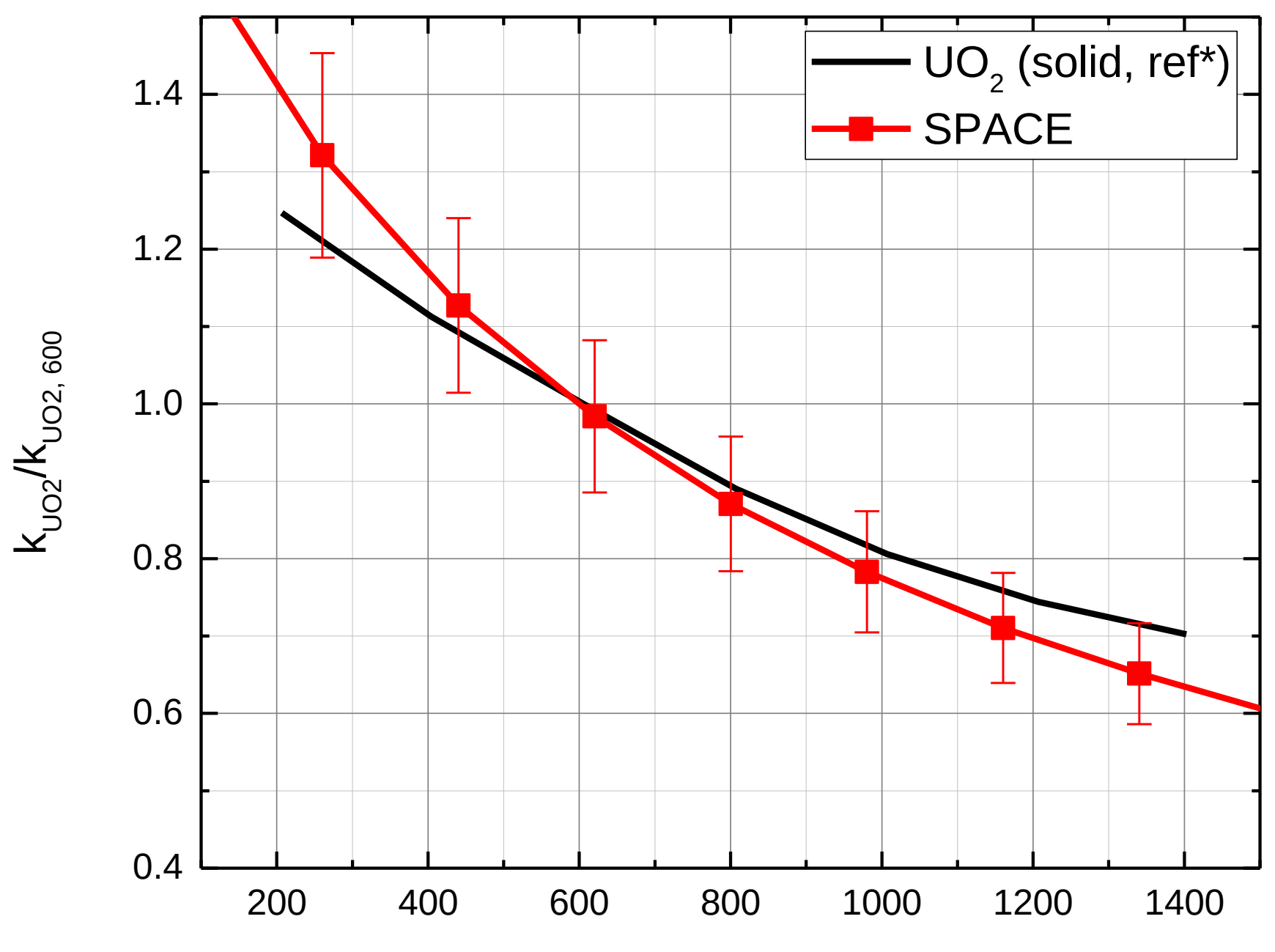
Background and Objective

- ❑ **Under LOCA conditions, clad ballooning can occur due to internal overpressure and fuel rods can be overheated and undergo a complex process known as fuel fragmentation, relocation, and dispersal (FFRD) dependent upon fuel burnup.**
- ❑ **The developed model for FFRD phenomena have been added to the SPACE to take into account the effect of mass relocation on heat generation and thermal conductivity degradation.**
- ❑ **Objectives of this paper**

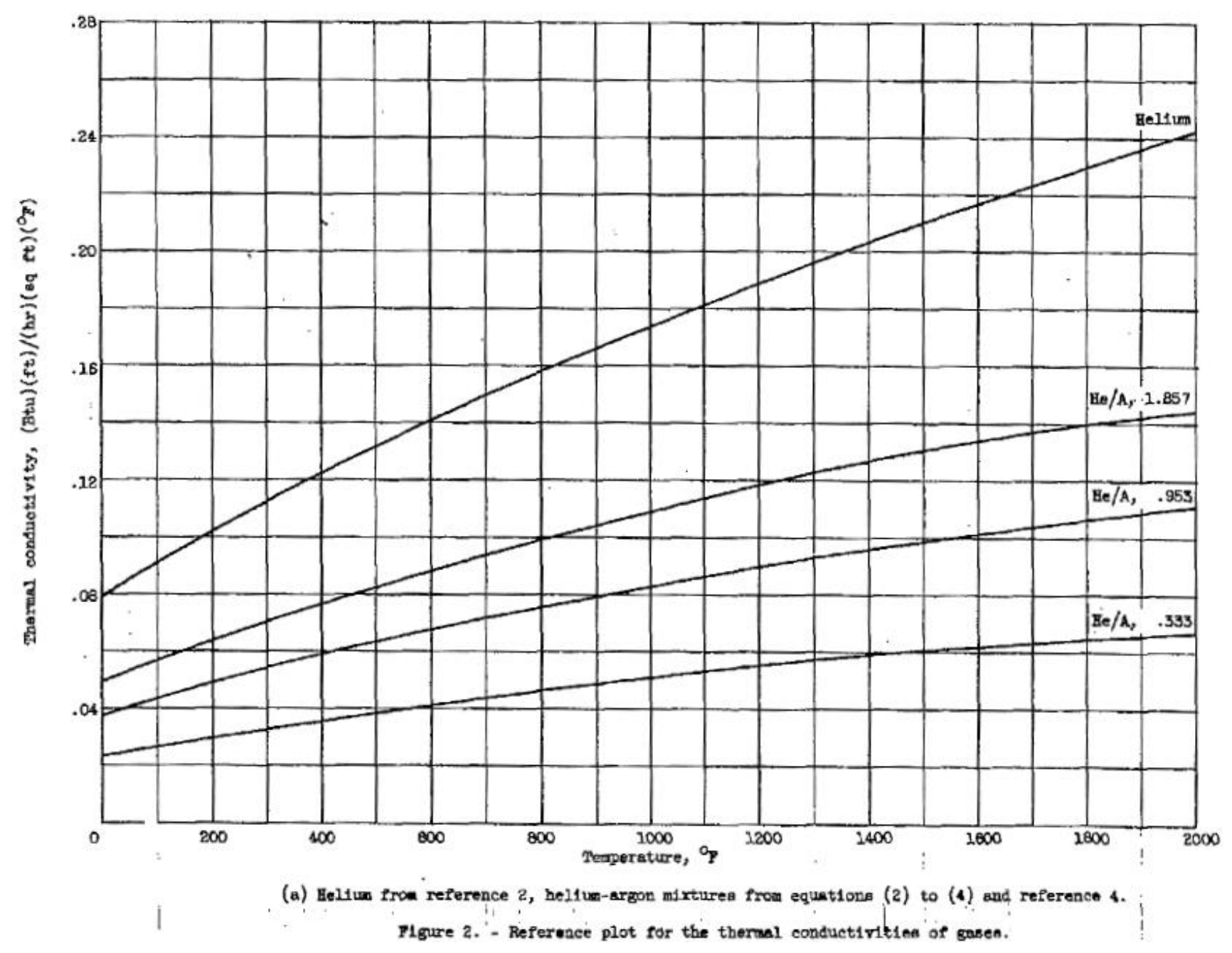
To assess the model uncertainty for effective thermal conductivity by comparing the experimental data for measured effective thermal conductivity of uranium oxide power in the gases.

Assessment

- ❑ **Boegli & Deissler's experimental study(1955) was introduced to compare the model accuracy for an effective thermal conductivity of crumble fuel.**
- ❑ **The experiments were conducted between 200 and 1500 °F in an atmosphere of various gases. The powder had a mean particle size of approximately 85um. The void fraction occupied by the gas was 0.405.**
- ❑ **In the assessment, the thermal conductivity of UO_2 was acquired from the internal thermal property function of the SPACE at each temperature. And thermal conductivity of gases (He, He/Ar) was taken from ref*. data**



< UO_2 thermal conductivity >



< He, He/Ar thermal conductivity >

Conclusions

- ❑ **Effective thermal conductivity model was implemented into the SPACE. The implemented model was assessed by comparing with experimental data for measured effective thermal conductivity of UO_2 powder in the various gases.**
- ❑ **It is clear that Chiew and Glandt correlation for effective thermal conductivity reproduces the experimental data quite well within 25% of uncertainty.**

Thermal conductivity Model

- ❑ **Effective thermal conductivity of crumbled fuel**
  - ● **Chiew and Glandt model (implemented in FRAPTRAN)**

$$\frac{\lambda_{eff}}{\lambda_f}=\frac{(1-\beta)}{(1+2\beta)(1-\beta\phi)}\left(1+2\beta\phi+\left(K_2-3\beta^2\right)\phi^2\right)$$

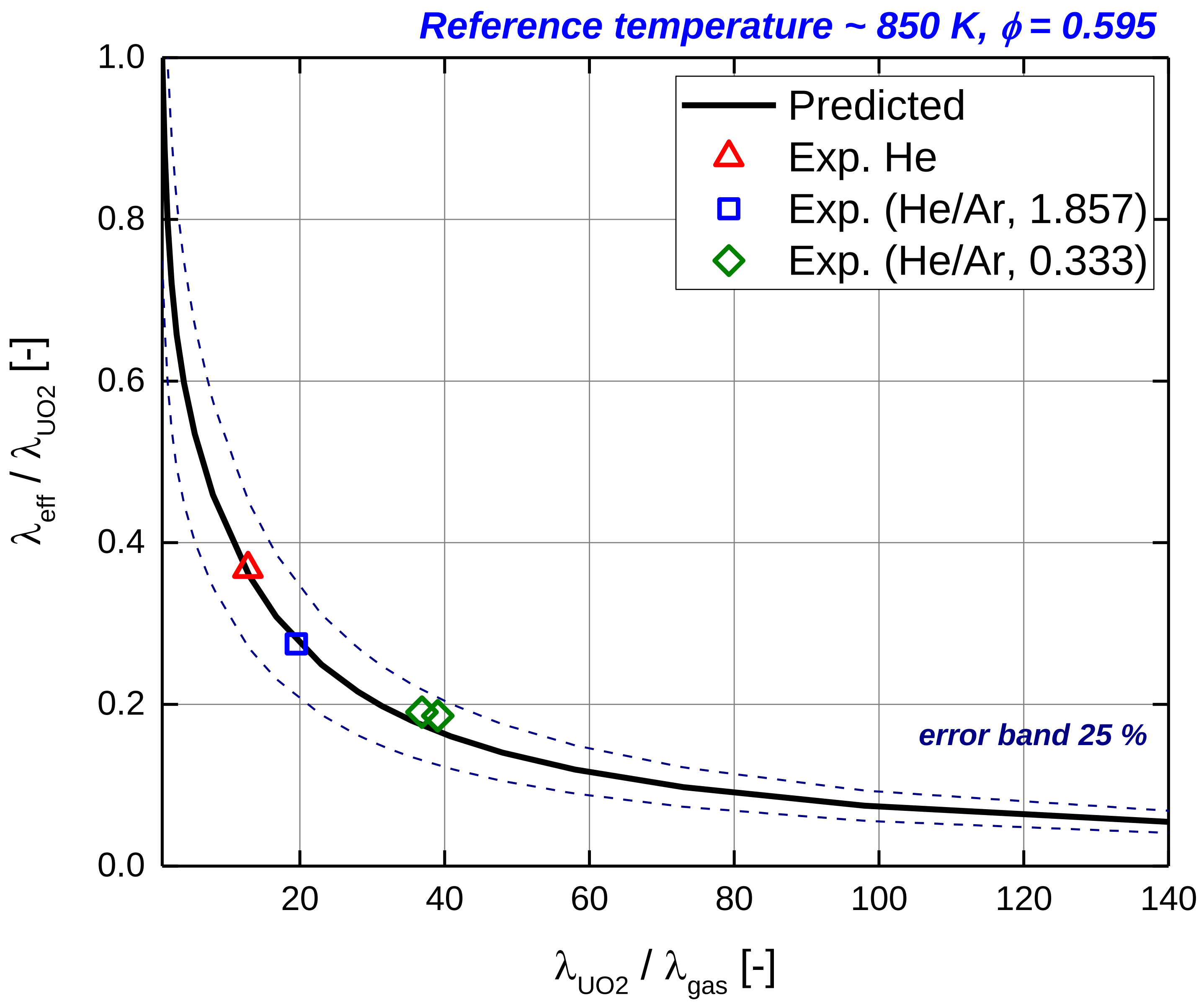
Where,
Thermal conductivity of fuel fragmentation (λ_f),
Thermal conductivity of gas (λ_g), and
Packing fraction (ϕ)

$$\beta=\frac{\lambda_f-\lambda_g}{\lambda_f+2\lambda_g}$$

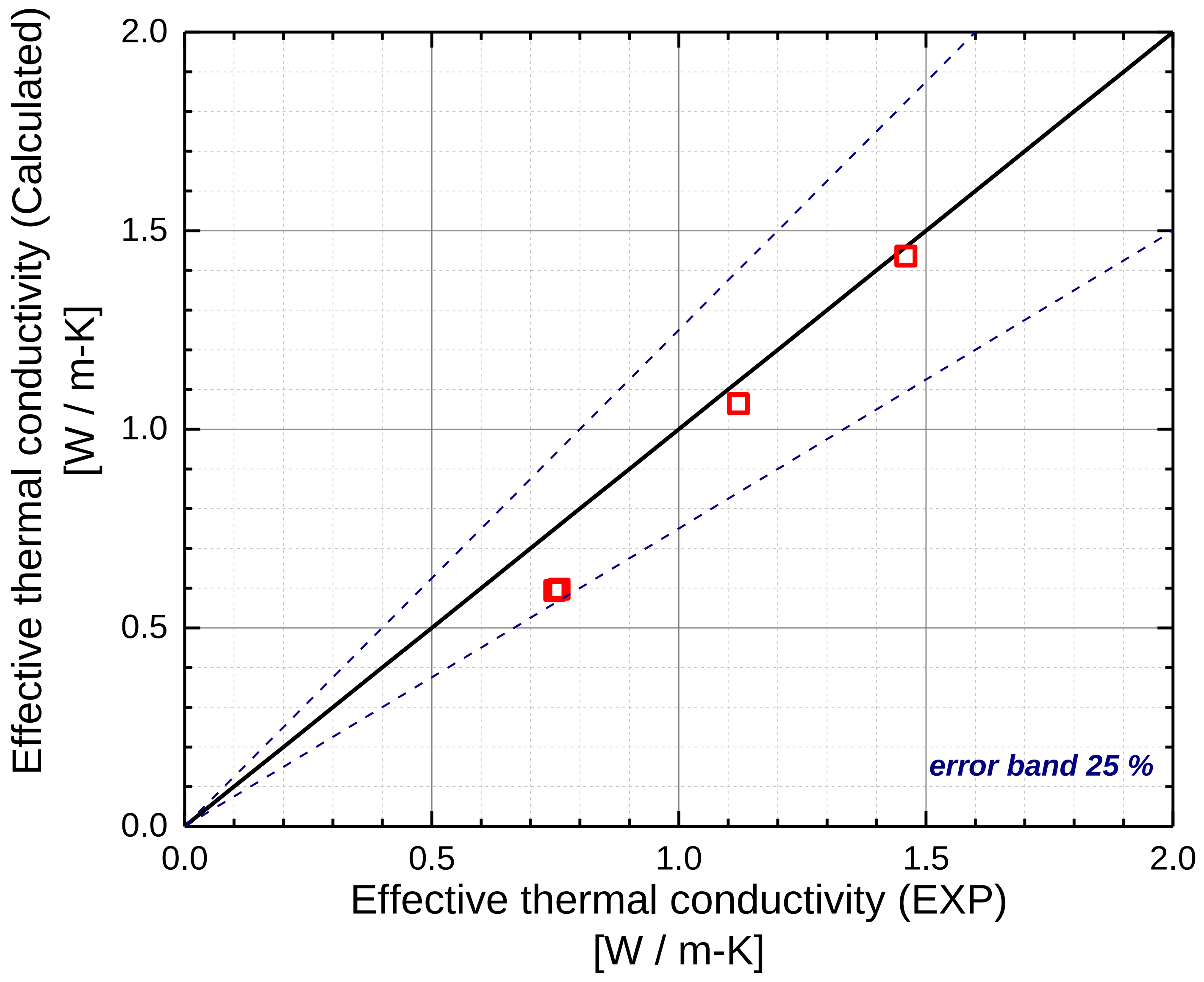
$$K_2(\beta,\phi)\approx K_2^{(0)}(\beta)+K_2^{(1)}\phi$$

$$K_2^{(0)}(\beta)=1.7383\beta^3+2.8796\beta^2-0.11604\beta$$

$$K_2^{(1)}(\beta)=2.8341\beta^3-0.13455\beta^2-0.27858\beta$$



Calculated effective thermal conductivity of UO2 powder in various gases, in comparison with experimental data



Comparison of effective thermal conductivity of UO_2 powder in various gases at a temperature of 850 K & packing fraction of 0.595.

Ref : J.S. Boegli & R.G. Deissler, NACA RM E54L10, 1955.*