The Impact of Uncertainty in Thermal Scattering on Nuclear Reactor Parameters

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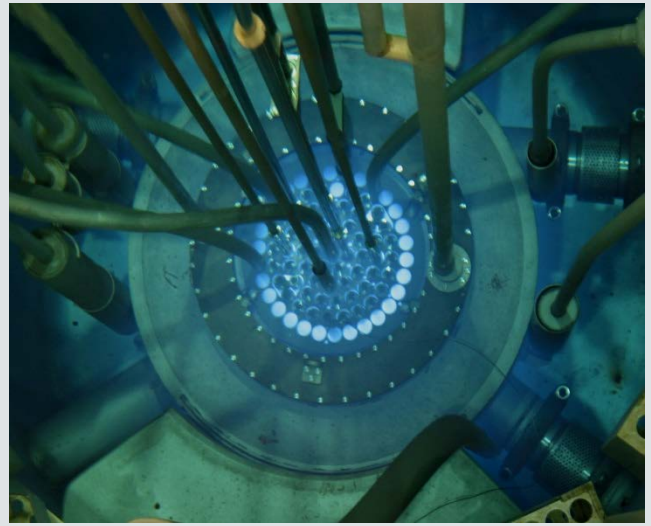
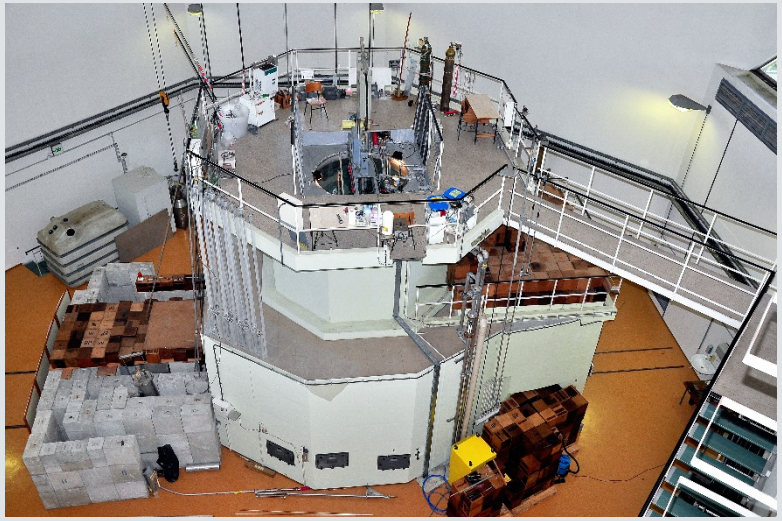
Outline

- TRIGA JSI research reactor description
- Experimental data
- Motivation
- Objectives
- Implementation
- Summary

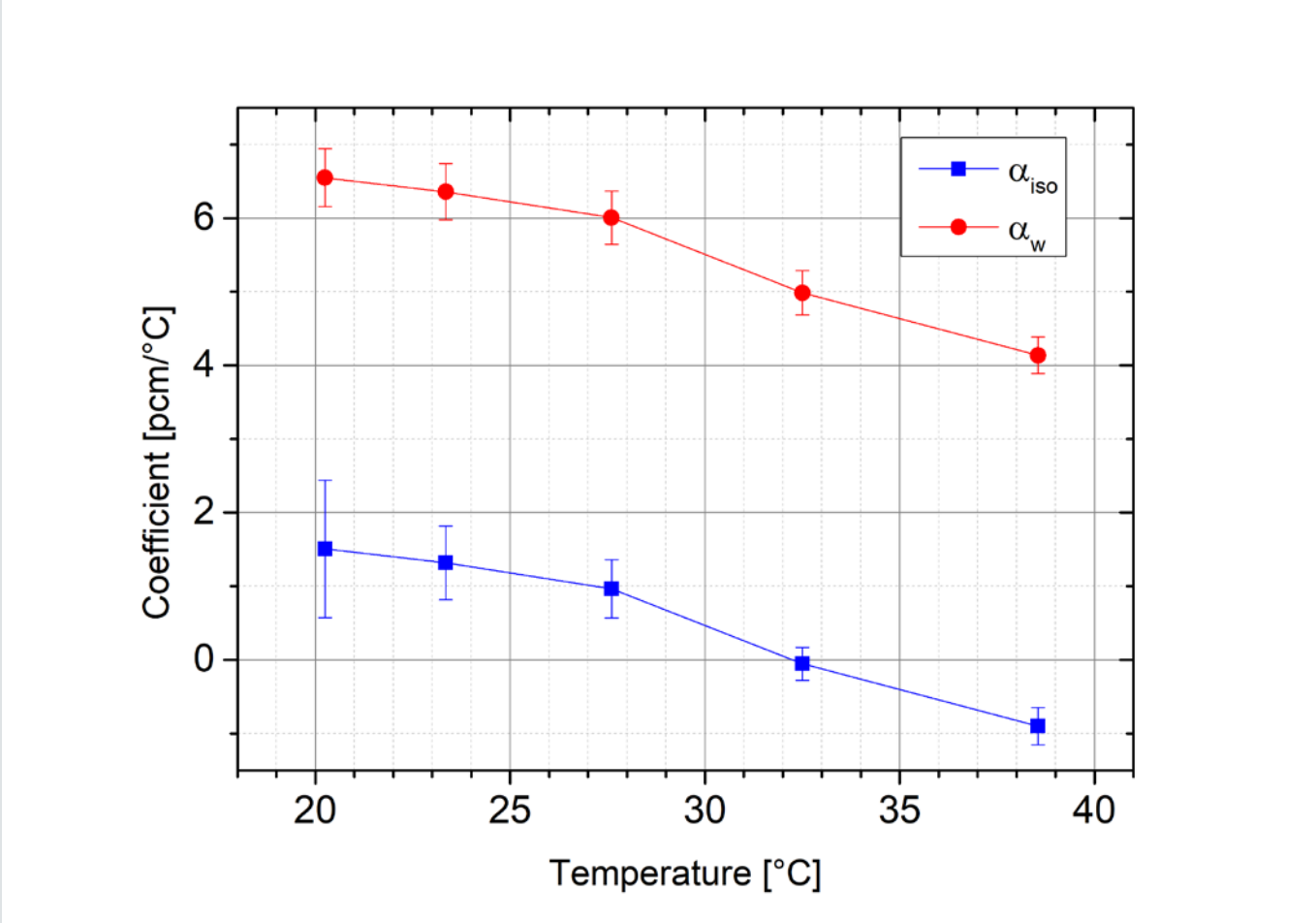
TRIGA Mark II Reactor Ljubljana



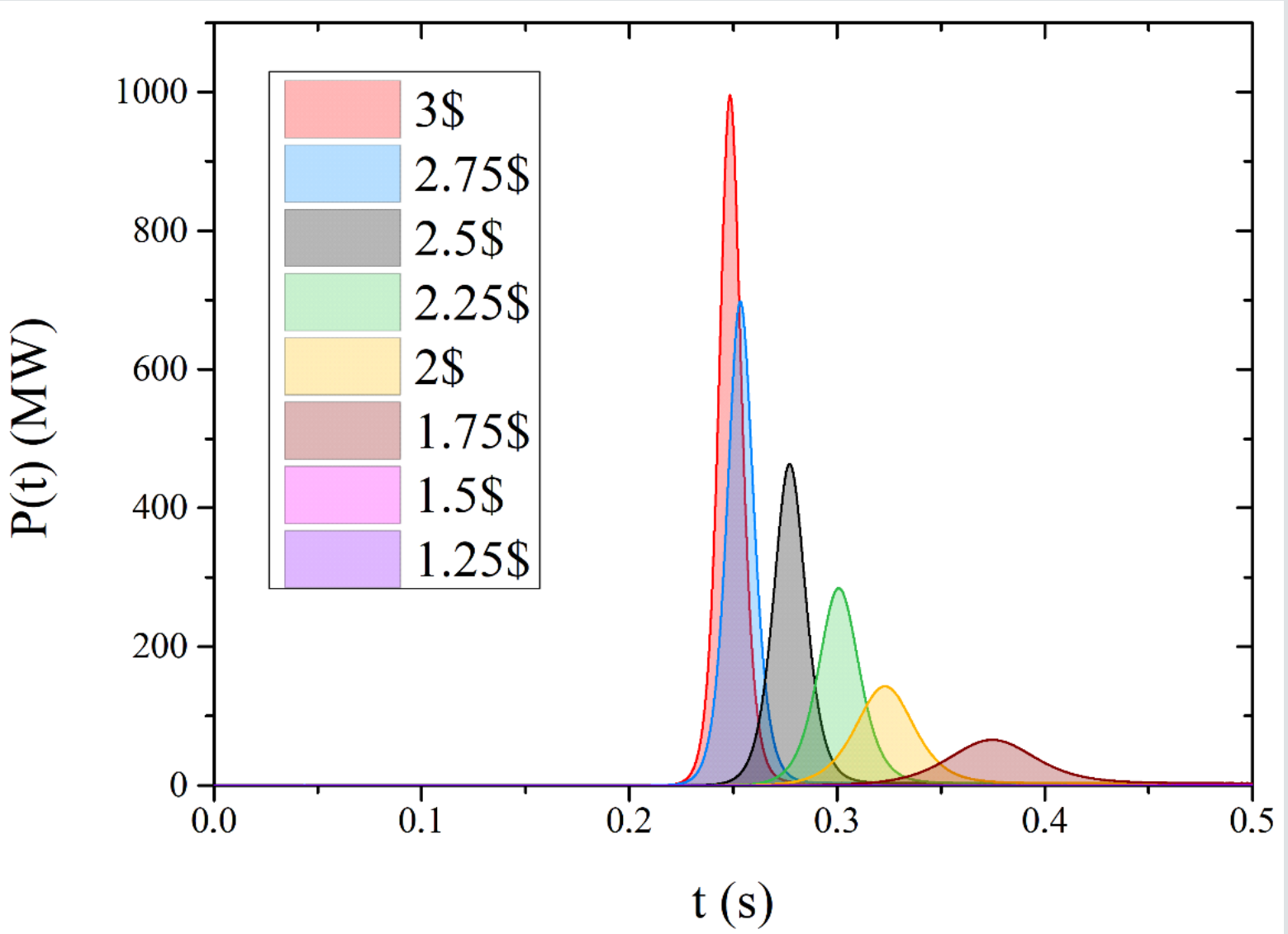
- 1st criticality: 31st May, 1966
- P_{max}
  - *250 kW (steady state)*
  - *1 GW (pulse)*
- Fuel
  - *UZrH (12 wt. % U)*
  - *E= 20 %*



Isothermal and water temperature reactivity coefficient



Pulse experiments



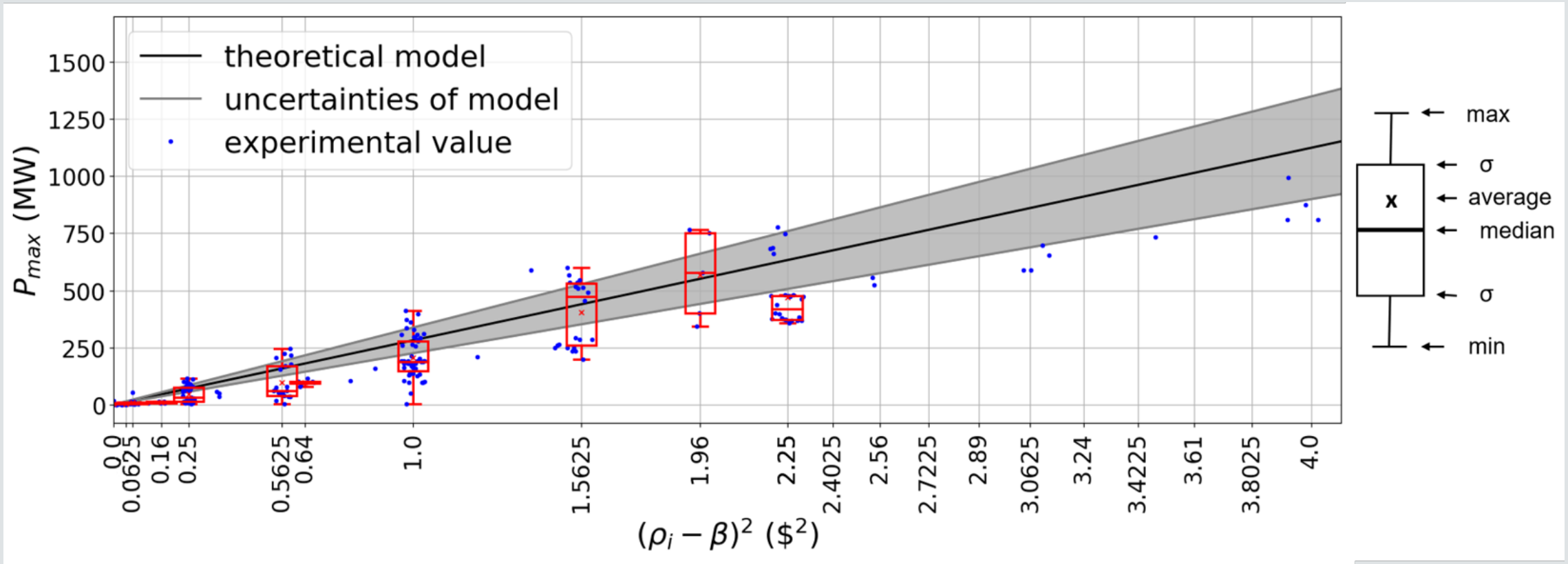
Reproducibility of the pulse

- Fuchs-Hansen model

$$P_{max} = \frac{\rho_p^2}{2\gamma\Lambda} \qquad E_{tot} = \frac{2\rho_p}{\gamma} \qquad FWHM = \frac{3.525\Lambda}{\rho_p}$$

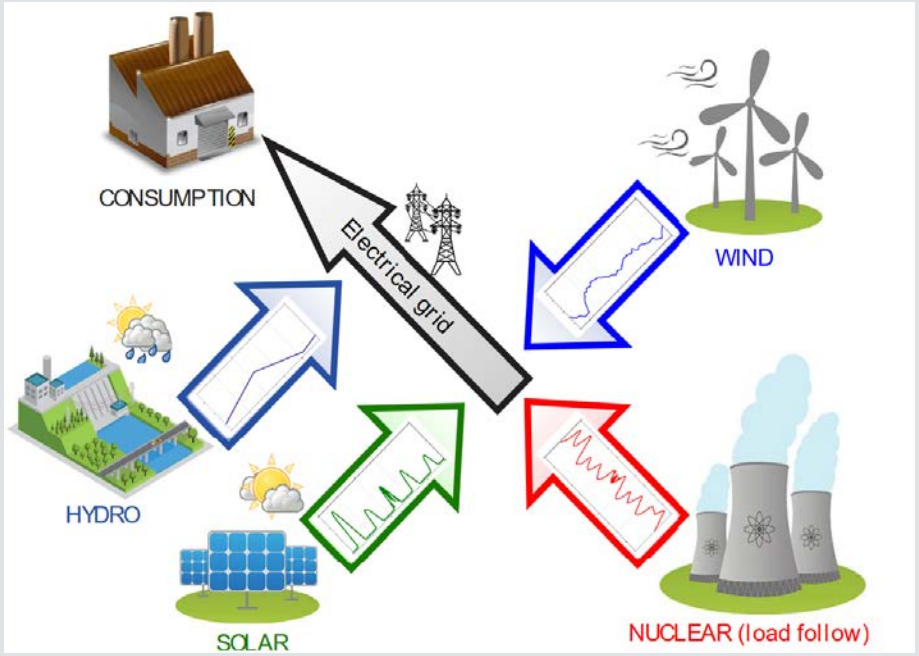
γ … Fuel temperature reactivity coefficient

$\Lambda = l/k$ … Average neutron generation time



Motivation

- Difficulties in calculational reproduction of experiments
- High importance of TSL in UZrHx
- Study criticality of ultracold systems
- Fuel for small modular reactors suitable for load follow (prompt negative temperature reactivity coefficient)



Objectives

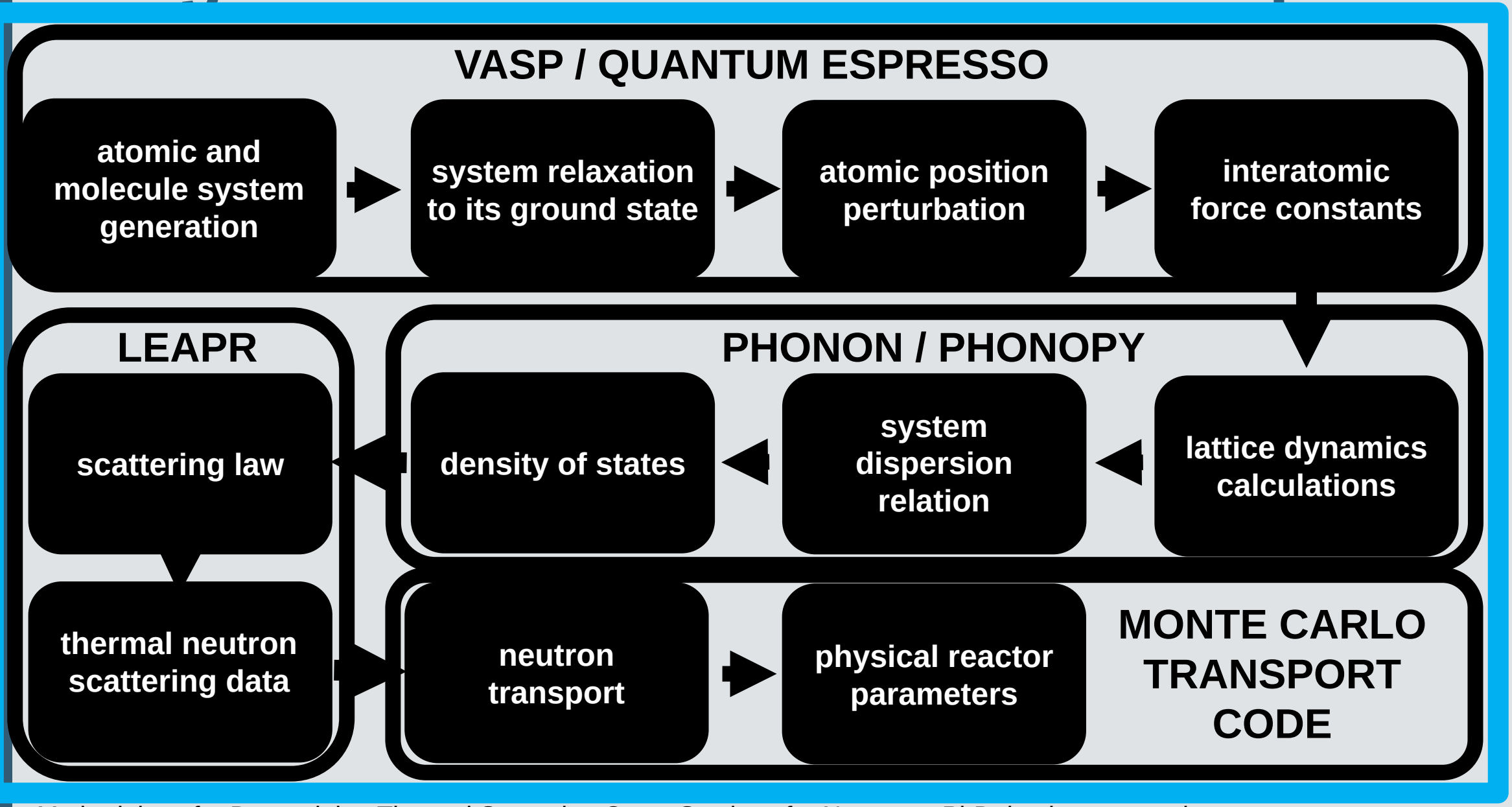
- Generate thermal neutron scattering cross sections and corresponding covariance data in a rigorous manner, i.e. from first principles
- Material of interest: $UZrH_x$ (nuclear fuel in TRIGA research reactors).
- The thermal neutron scattering data validation on experiments
- Evaluation of uncertainties in physical parameters of TRIGA reactor due to uncertainties in thermal neutron scattering law
- Contribute to thermal neutron scattering cross section covariances, format and data
- Publicly share all experimental data and knowledge gained within the project

Implementation

- We just started ➔ posses little knowledge on the TSL topic ➔ looking for assistance and collaboration
- CEA –JSI project on „Advances in Thermal Scattering Law Analysis“ (L. Snoj & G. Noguère)
- Ingrid Vavtar, PhD student, advisors: Andrej Trkov, Giles Noguère
- Collaboration with Ayman Hawari (NCSU), scientific visit of Ingrid Vavtar to NCSU planned for summer 2020 but postponed due to COVID-19
- Collaboration with WPEC SG 48

Additional slides

Ingrid Vavtar‘s PhD thesis work plan



Electricity production in future

- Electricity needs will greatly increase
- Generation of carbon-free electricity:
  - Fluctuations in electricity generation from solar and wind sources
  - Small modular reactors can provide reliable, load-following electricity