

Prediction of Low-Pressure Onset of Nucleate Boiling using SPACE-RR Code

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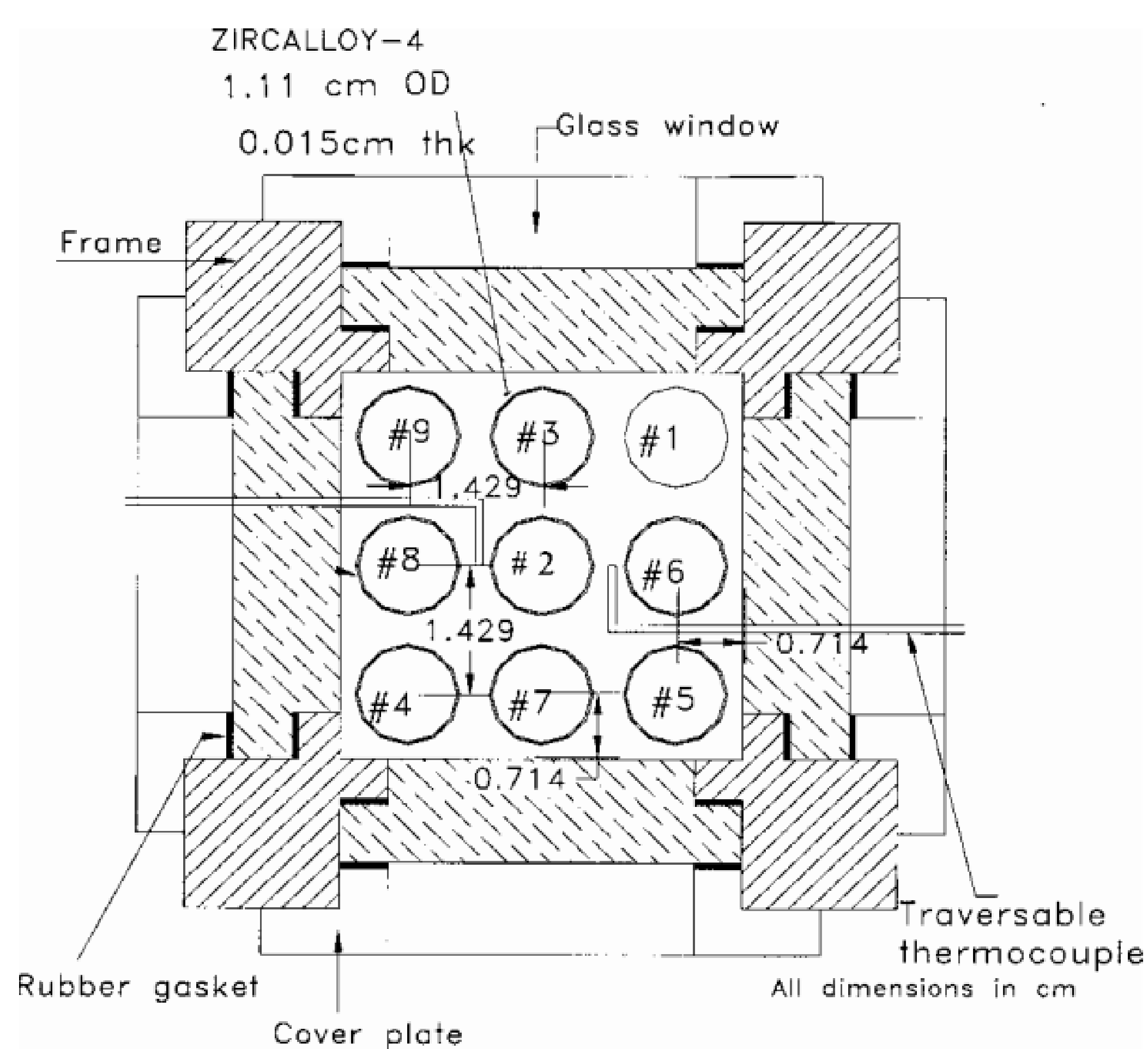
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Introduction

- SPACE-RR code is being developed based on SPACE for research reactor safety analysis application
- ONB models have been implemented which are used for determining steady-state operational limits
- Low-pressure experiment results are predicted using embedded Bergles-Rohsenow (1964) correlation

ONB Experiment by Basu et al. (2002)

Test section cross-section



Test section specification

Item	Value
Geometry	
Heater configuration	Square, 3x3
Heater pitch [m]	1.429e-2
Heater diameter [m]	1.11e-2
Heated length [m]	0.91
Material	
Cladding	Zr-4
Test condition (40 cases)	
Pressure [bar]	1.03
Mass flux [kg/m ² -s]	186~631
Inlet subcooling [°C]	1.7~38.6
Heat flux (uniform) [W/cm ²]	1.6~14.3

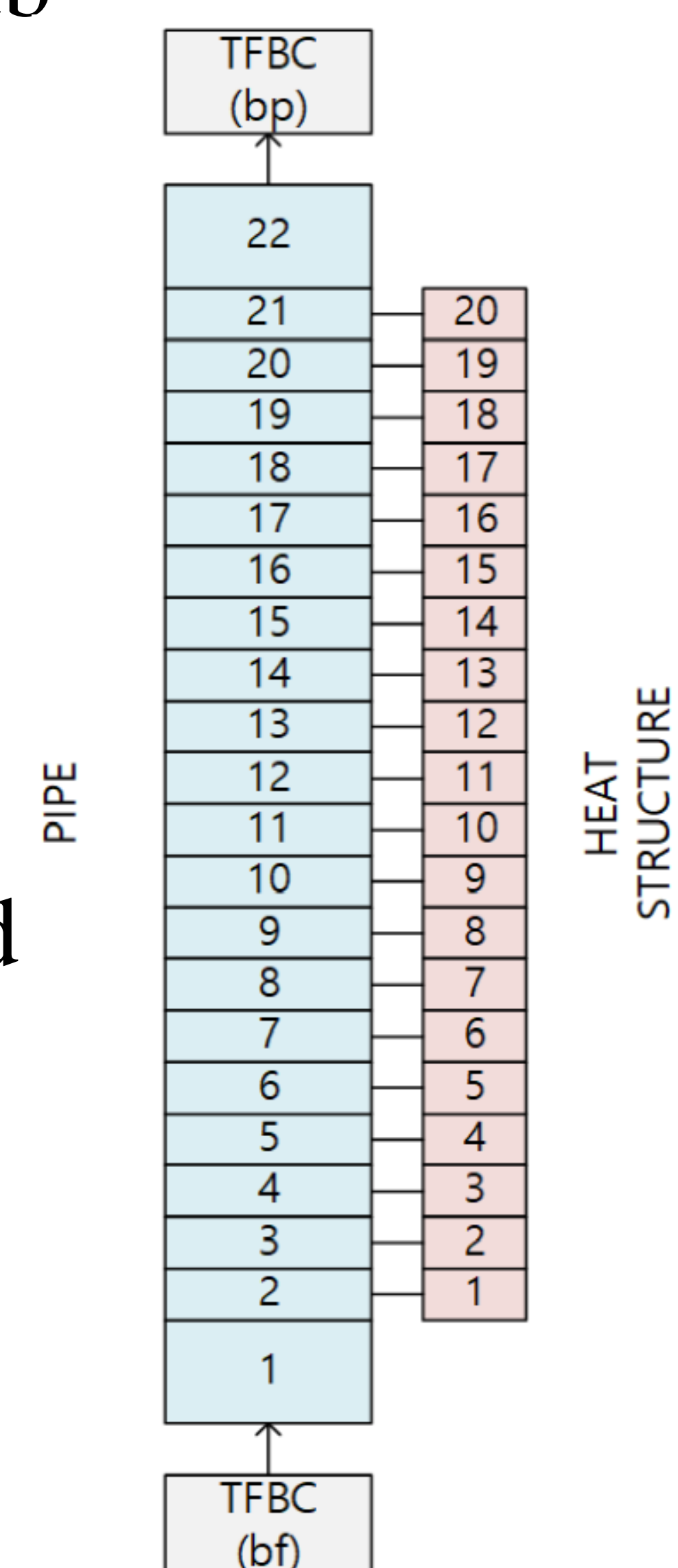
Bergles-Rohsenow (1964) ONB Correlation

- Developed from equilibrium condition of bubble pressure/Clapeyron equation/heat transfer, fitted using saturated/subcooled pool boiling data

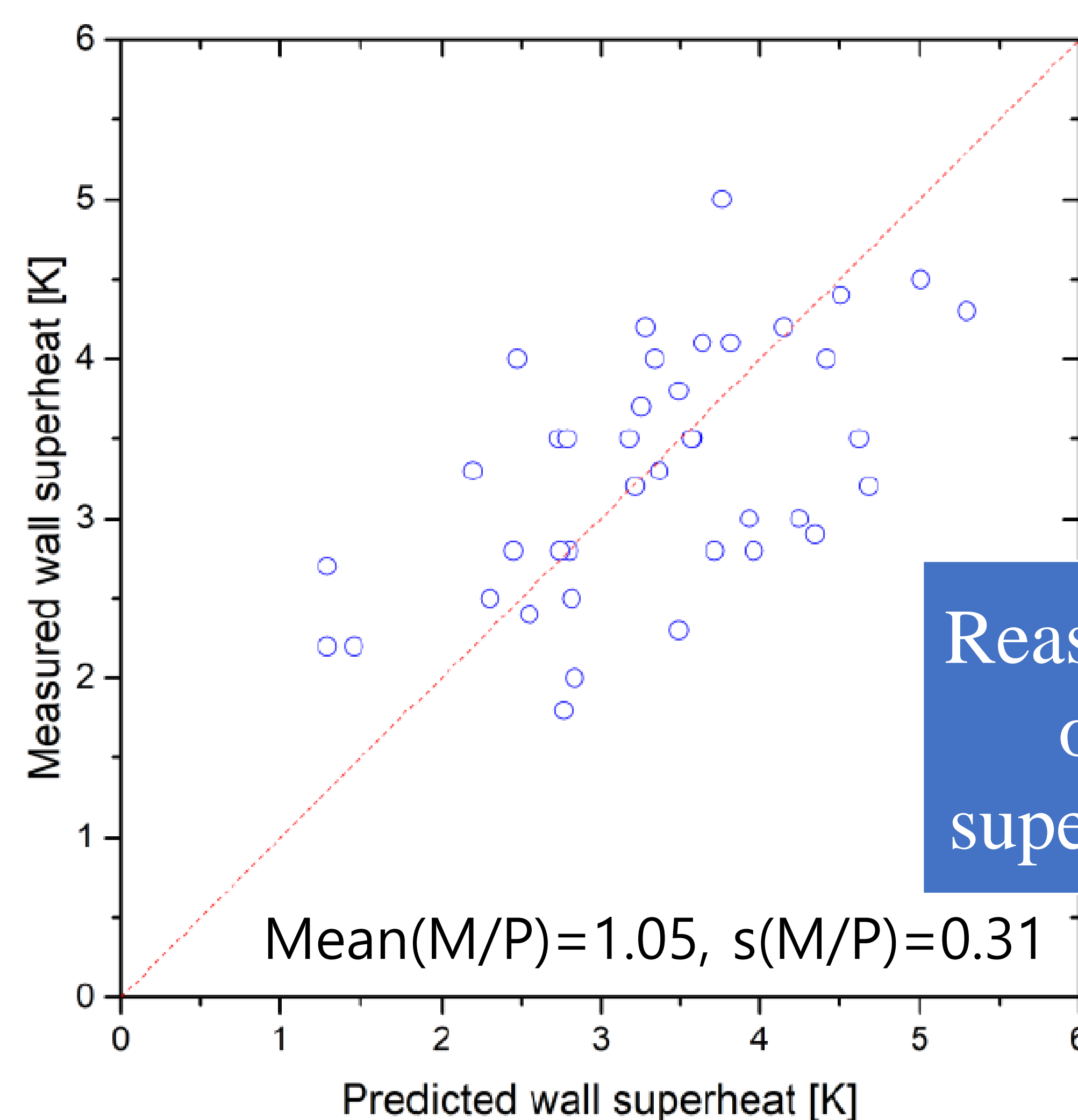
$$T_w = T_{sat} + \frac{5}{9} \left(9.23 \frac{q}{p^{1.156}} \right)^{\left(\frac{1}{2.16} p^{0.0234} \right)}$$

SPACE-RR Code Simulation

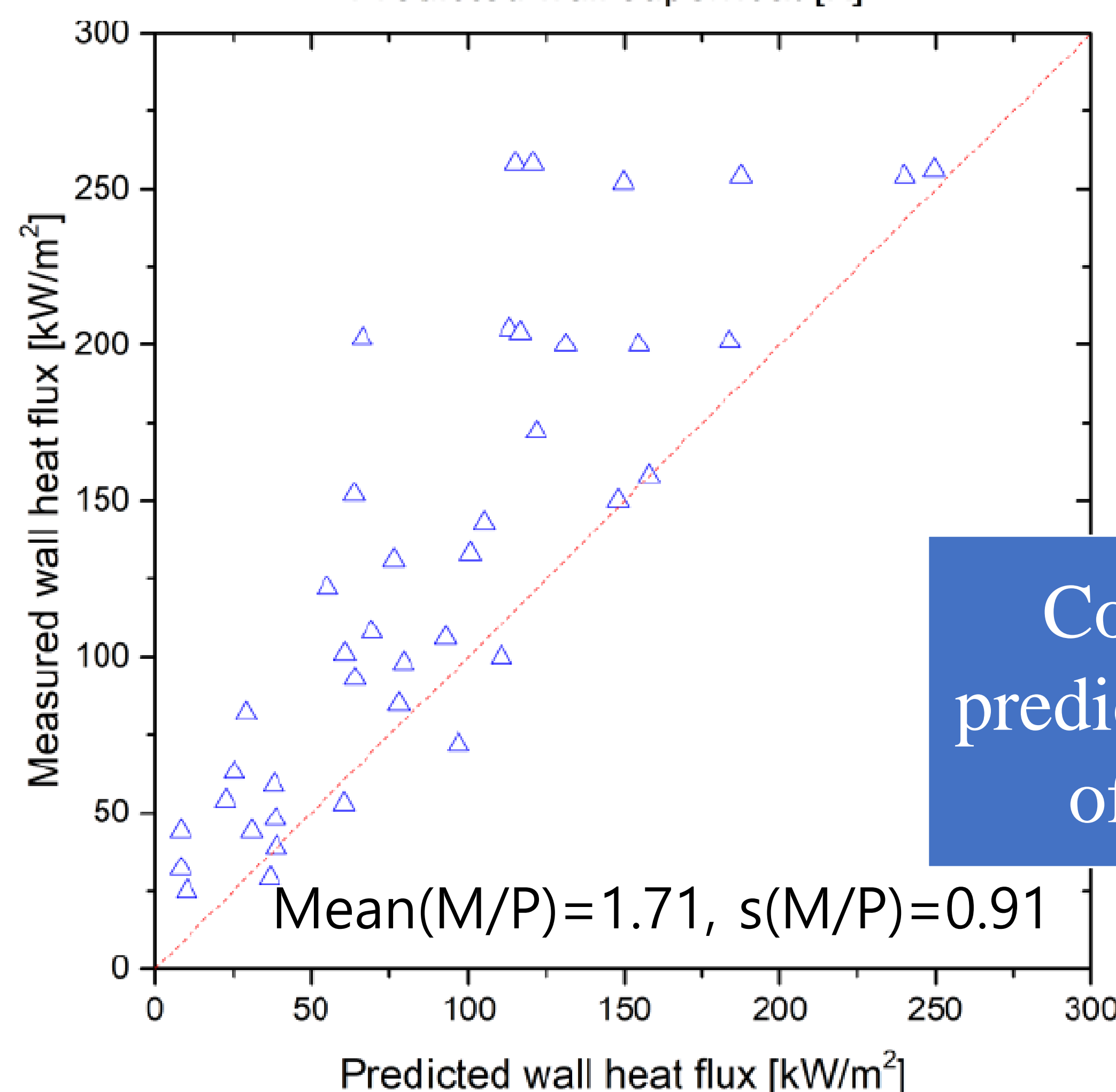
- Modeled only single interior sub-channel
- Pipe component with 22 sub-volumes used
- Temporal face boundary conditions are used at in/outlet
- Heat structure is attached to simulate heater
- Power input is slowly increased until wall temperature reaches ONB temperature prediction
- EXCEL/DOS based batch method is utilized to automate input generation/batch run/output processing



Experiment-Code Comparison Results



Reasonably predict overall wall superheat behavior



Conservative prediction in terms of heat flux