SIEMENS

IGORR6
6th Meeting of the International Group on Research Reactors
April 29 - May 1, 1998
Taejon, The Republic of Korea

Do existing Research Reactors teach us all about Beam Tube Optimisation?

Hans-Joachim Roegler, Wolfgang Feltes,
Siemens AG, Power Generation (KWU), D-91058 Erlangen

The contribution makes the attempt to analyse the data base available in the literature and in Siemens' own projects and to find out potential systematics from the existing research reactors with beam tubes, separated into reactors with different reflectors and distinguished for tangential and radial tubes and cold neutron sources, resp. some generic calculations serve as gauging data.

The contribution is not meant as critics on any design. The results might serve supporting designers and operators when evaluating the pros and cons of existing or planned design in terms of the optimum beam tubes. Existing lacks of systematics are evaluated in view of suitable explanations and constraints, which do not allow optimisation. Examples of such constraints are the different material layers between fuel zone and reflector zone which have various reasons.

The limited data in the literature plus the numerous lacks of precision of the representation of those data should be an incentive to improve the performed analysis by collecting more exact data and re-doing the evaluation before answering the title-question really.

Do existing Research Reactors teach us all about Beam Tube Optimisation ?

Reasons for looking into the issue

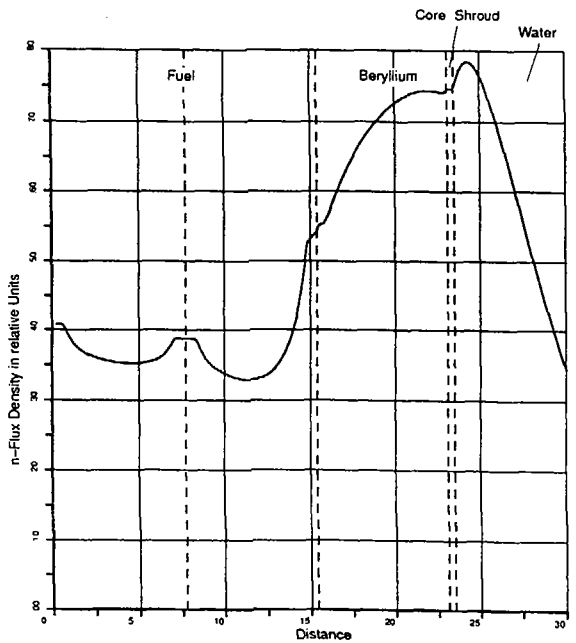
- Actual work for GKSS' FRG-1
- Attempts to use experience from older projects for FRG-1

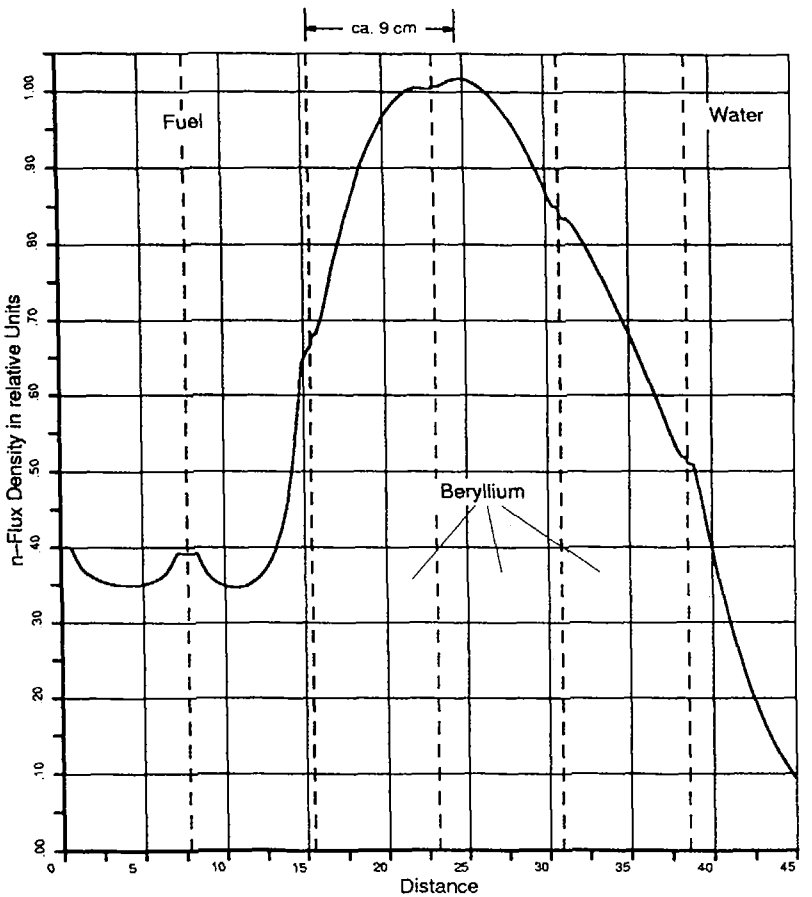
More general: Is it possible to

- avoid complex calculations by using simple rules ?
- get a feeling for potential improvements of existing plants ?
- have better answers to customers ?

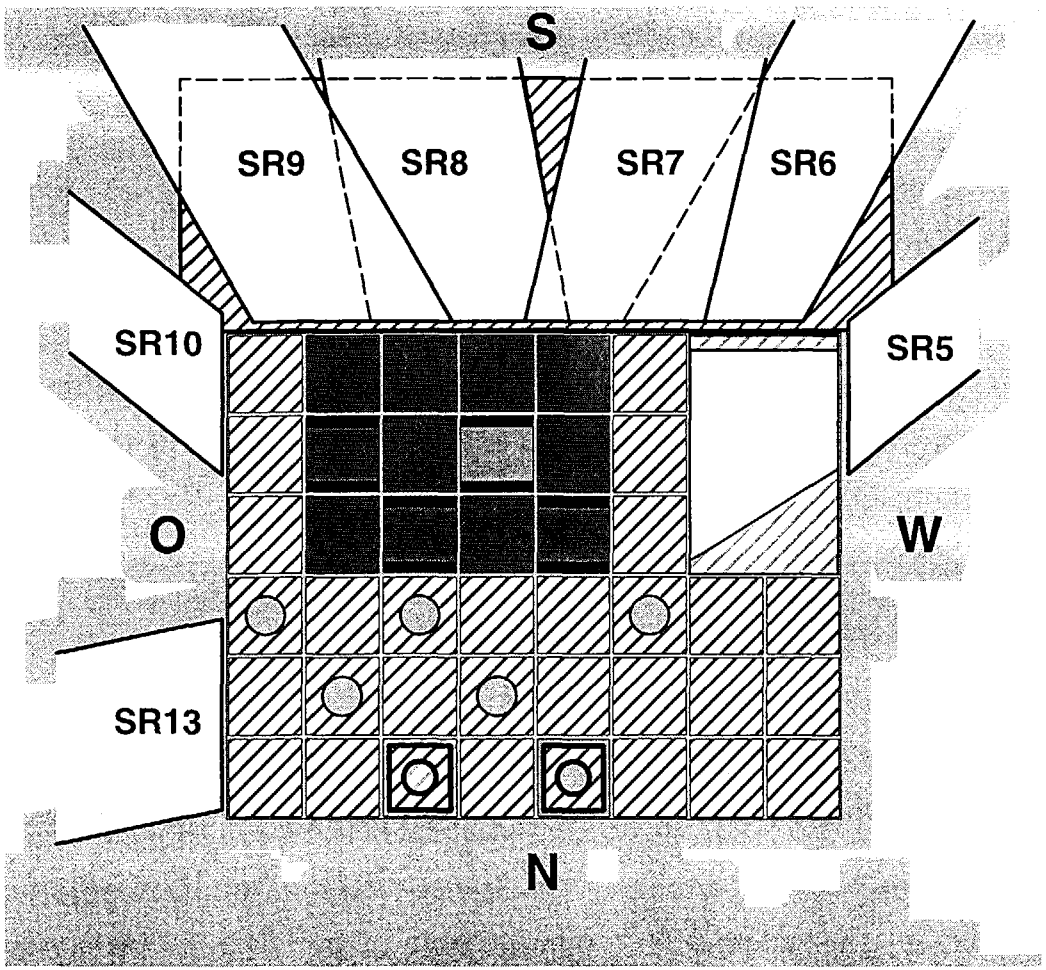
And an overall curiosity on physics phenomenon

5 MW MTR-type Research Reactor with Be-Reflector of different thicknesses
Thermal Flux Peak Position and Height





FRG–1
1998 – Study for GKSS



Fuel Element

Control Element

Beryllium Reflector Element

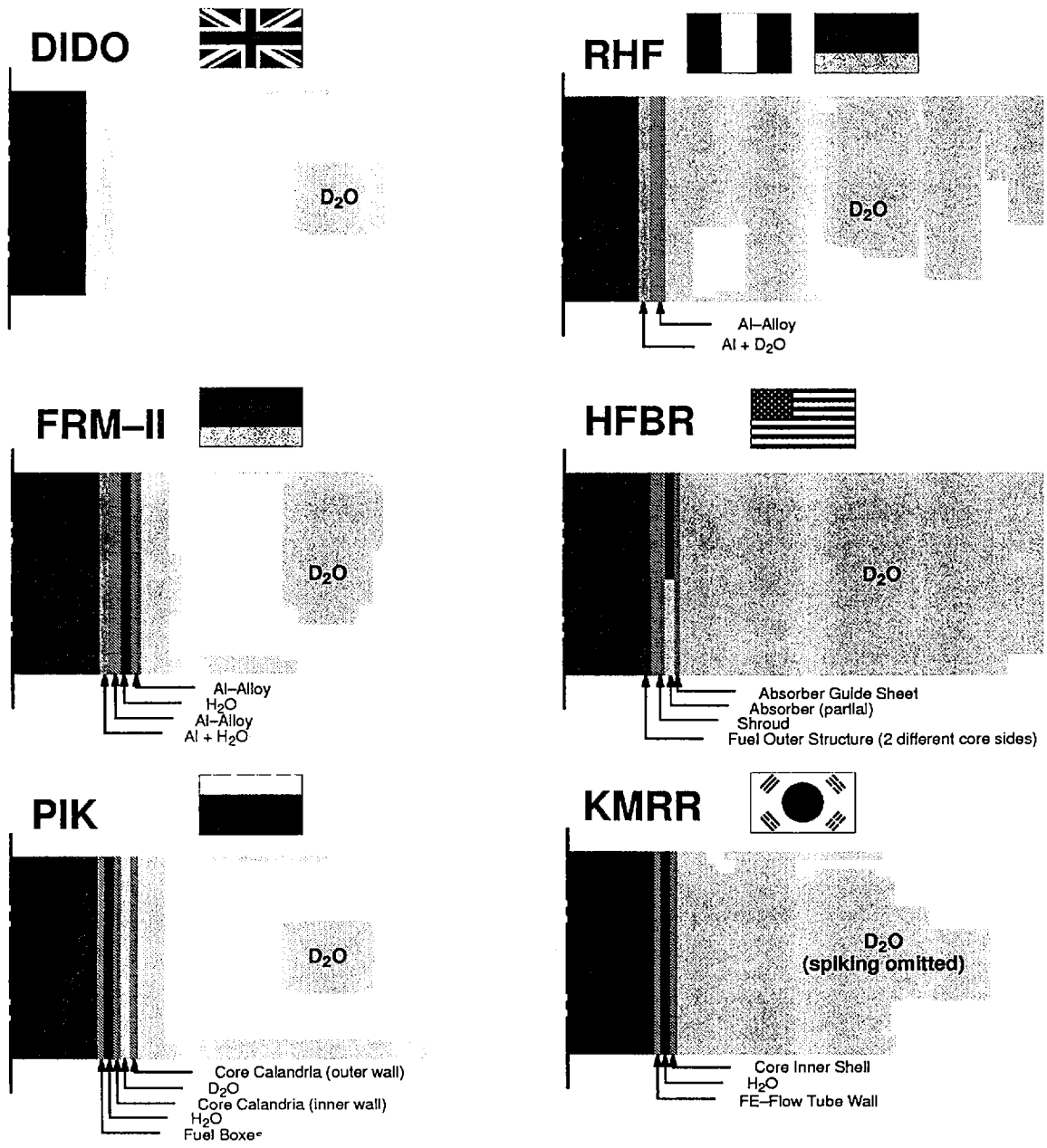
Beryllium Reflector Element with Incore Irradiation Postion Type I

Beryllium Reflector Element with Incore Irradiation Postion Type II

Beam Tube Optimisation

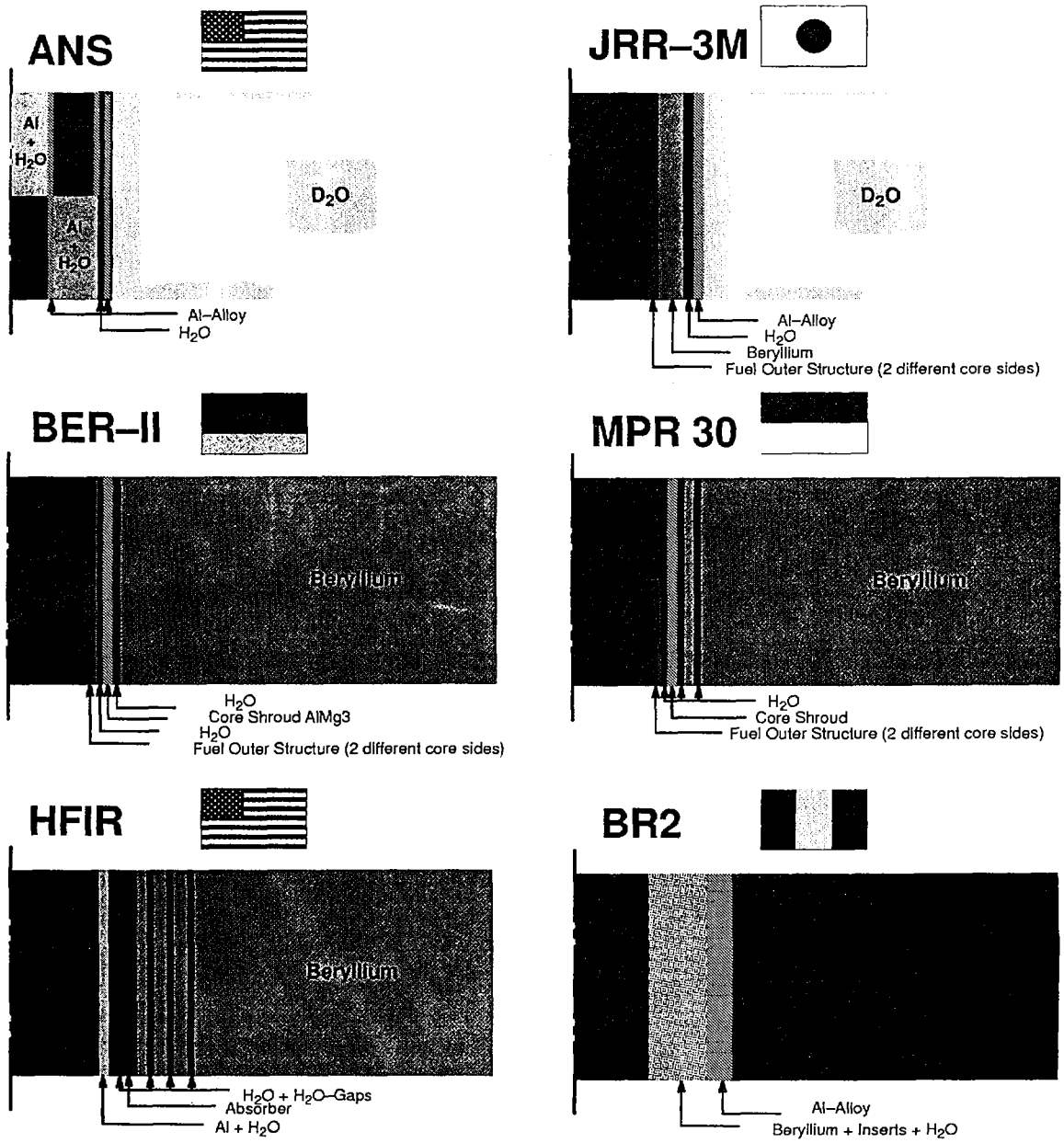
Obstacles Against Simple Answers

- Complexity of Research Reactor Designs
  - very different cores
  - different reflector materials
  - very different boundaries between core and reflector
- Lack of clarification in terms of physics dependencies
- Lack of exact data from the research reactor in terms of
  - distances / geometries
  - core-reflector border structures
  - power densities
  - moderation ratios
  - spectrum's hardness



Core – Border – Reflector
Different Material Layers at the Border
Part 1

KWU/NBTS/NL–S
04/98
IGORR6



Core – Border – Reflector
Different Material Layers at the Border
Part 2

KWU/NBTS/NL–S
04/98
IGORR6

How do the Obstacles influence the Findings

and

what are the Findings ?

Attempt to Compare Design Features of Different Plants

by

- comparing positions of radial tubes
- comparing positions of tangential tubes
- comparing positions of CNS

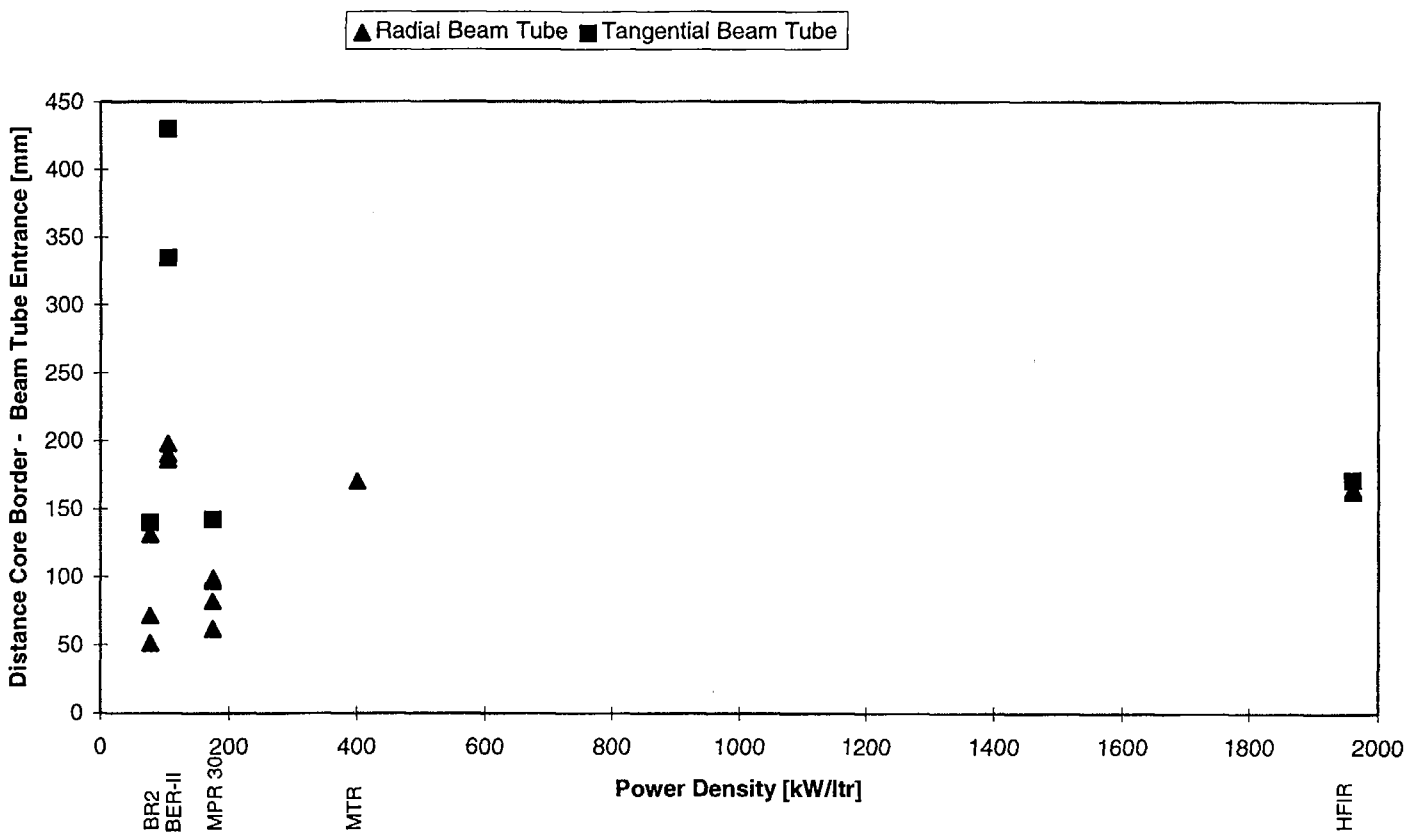
for

- Be-reflector
- D_2O-reflector

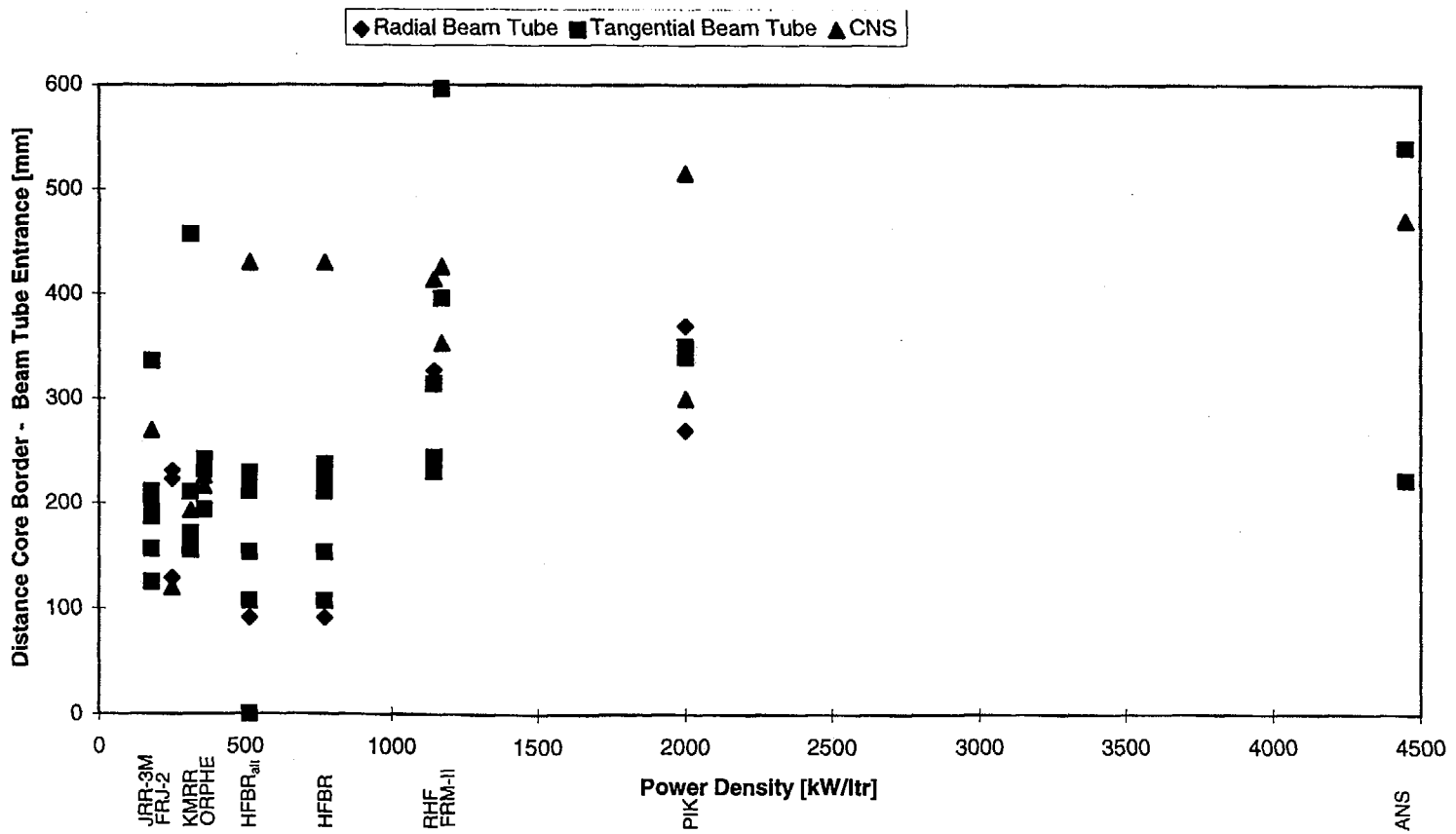
using a potential dependency from

- power density

Beam Tube Positions at Research Reactors with Beryllium Reflectors



Beam Tube Positions at Research Reactors with Heavy Water Reflectors



IGORR6

KWU/NBTS/NL-S
04/98

Overall Problems and Restriction in Placement of Tubes

- Change of Core Parameter during Life Time
  - Power Enhancement(s) } Power Density Change
  - Core Size
  - Uranium Loading → Moderation Ratio
  - Burn-up Enhancement
  - HEU/LEU-Conversions → Moderation Ratio
- Lack of Precision of the Codes during Decades Gone
- Optimum Thickness of Reflector Material
- Removable Be-Layers in front of Radial Tubes
- Diameter of Tangential Tubes in Be
- Heat Generation in CNS (Structure + LH_2/LD_2)
- Influence of Neighbouring Beam Tubes / Facilities in Reflector
- Others ?

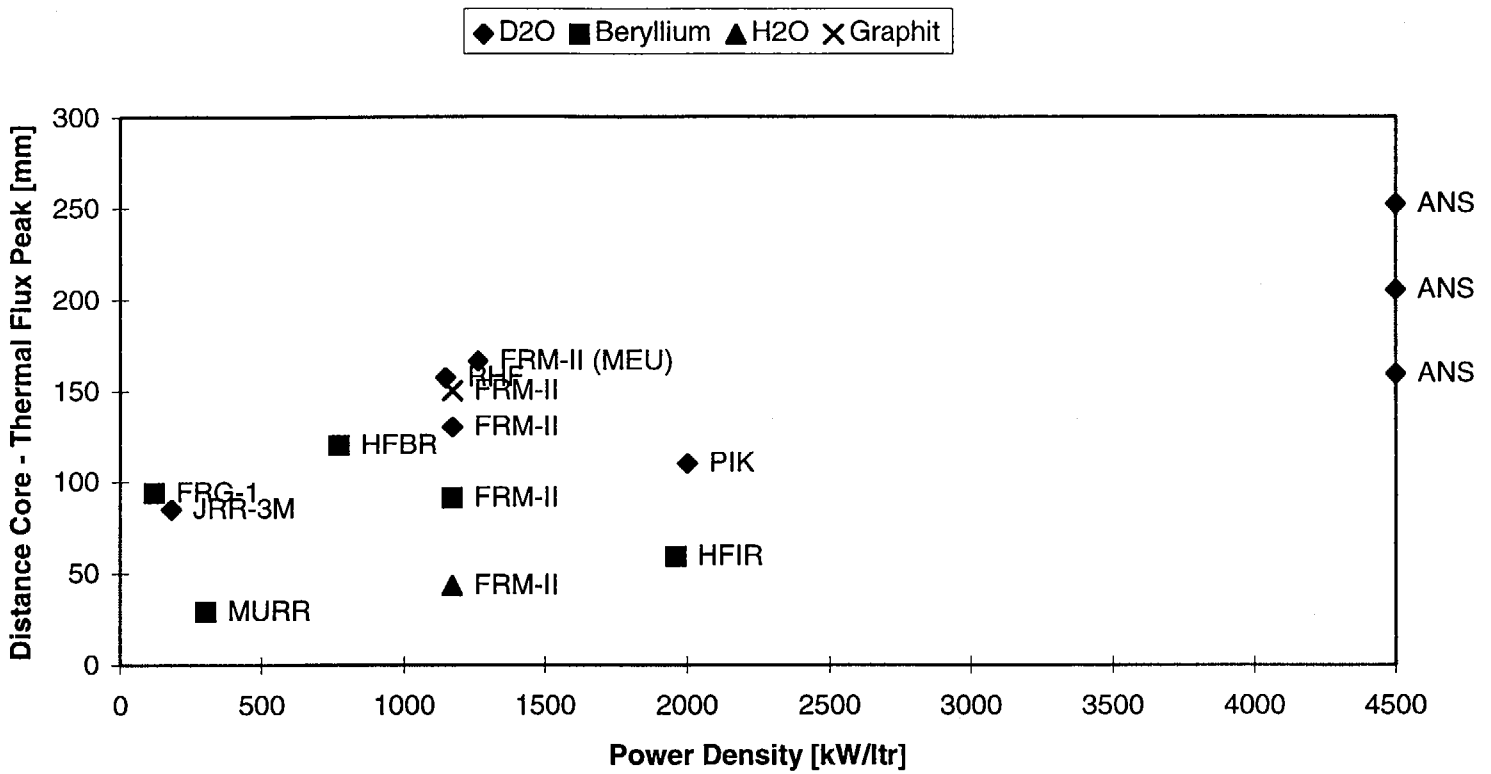
To get away from the uncertainties and the lacks of data of real reactors some generic calculations were performed:

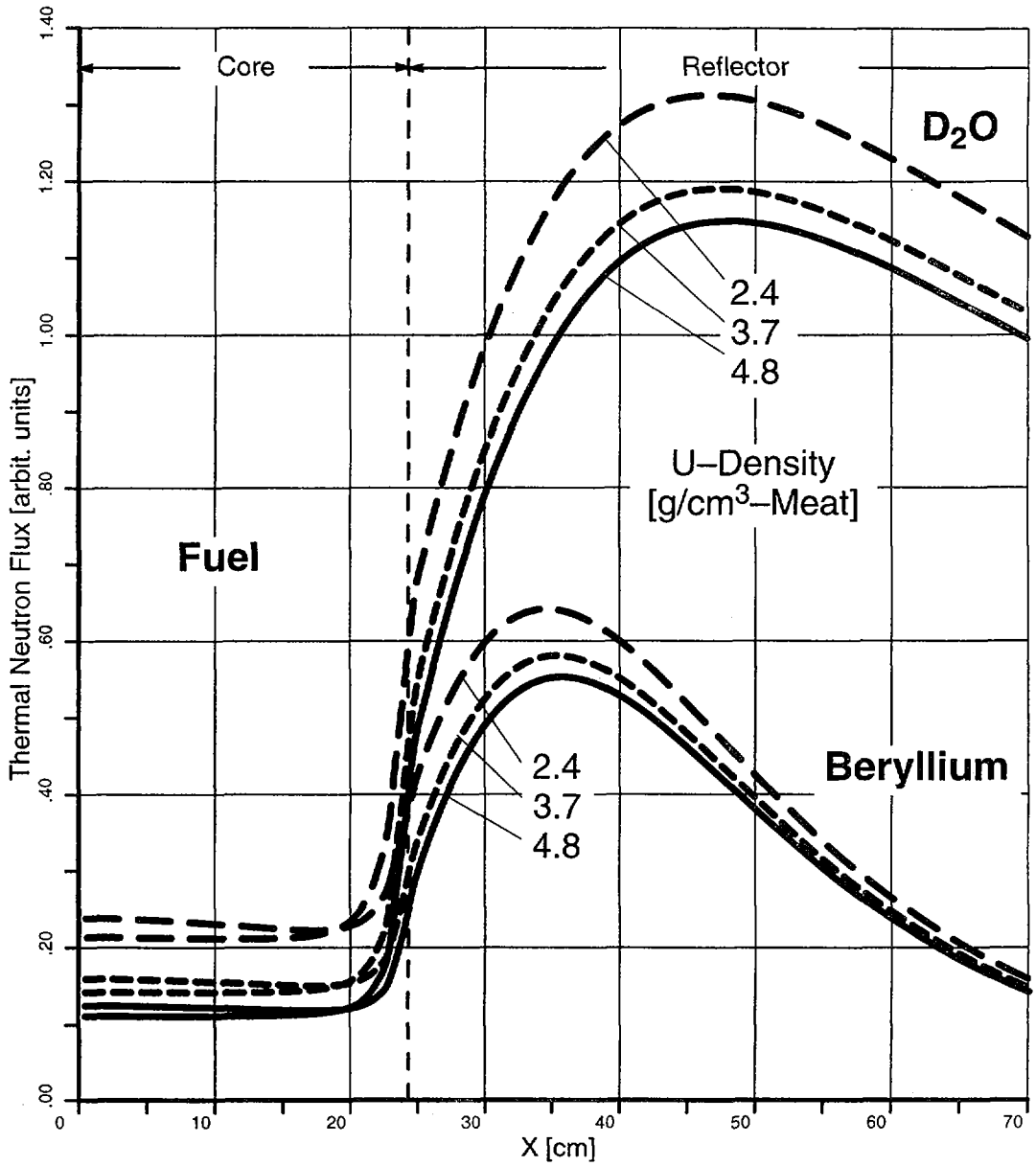
- for 2 reflectors
- for 3 U-loadings per MTR fuel element
- for 3 moderation ratios

- for 1 clear border between core and reflector

in order to get the thermal flux peak in height and position

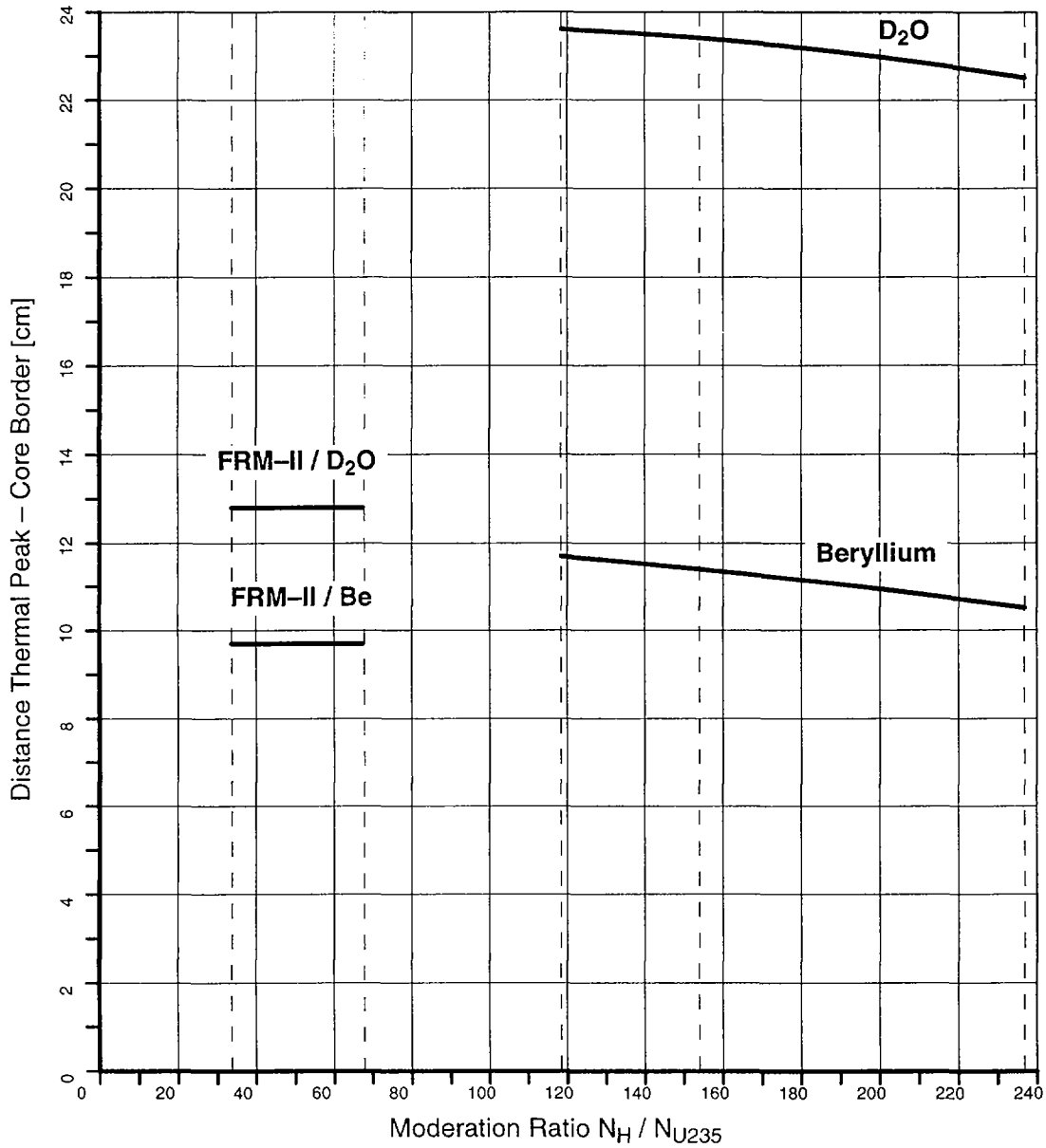
Thermal Flux Peak Positions at Research Reactors with Different Reflectors





Thermal Neutron Flux Peak with U–Density and Moderation Ratio as Parameter

KWU/NBTS/NL–S
04/98
IGORR6



Distance Thermal Flux Peak to Core Border vs. Moderation Ratio

KWU/NBTS/NL–S
04/98
IGORR6