III SENCIR

SEMANA DE ENGENHARIA NUCLEAR E CIÊNCIAS DAS RADIAÇÕES

BELO HORIZONTE
4, 5 e 6 de outubro de 2016
Escola de Engenharia
UFMG

Universidade Federal de Minas Gerais
Escola de Engenharia
Departamento de Engenharia Nuclear
Programa de Pós-graduação em Ciências e Técnicas Nucleares

Proposed model for PGAA at TRIGA IPR-R1 reactor of CDTN

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TRIGA MARK I IPR-R1 Research Reactor

CNEN

CDTN
CENTRO DE DESENVOLVIMENTO DA TECNOLOGIA NUCLEAR

TRIGA MARK I IPR-R1 Research Reactor

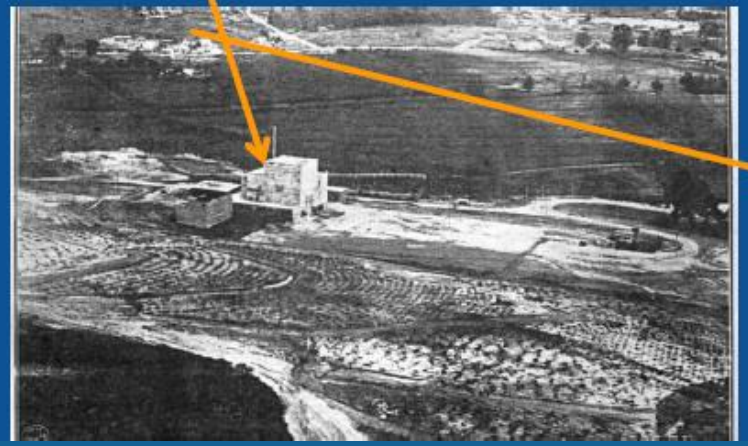
- ✓ CNEN Institutes
- ✓ Research Reactors
- ✓ TRIGA IPR-R1 (CDTN Belo Horizonte)

RESEARCH REACTORS IN BRAZIL

Ministério da Ciência, Tecnologia e Inovação

Name	Utilization	Power	Site	Startup	Type
IPEN/MB-01	Critical facility – PWR Core analysis	100 W	IPEN/CNEN-SP São Paulo	1988	Open Core - Pin Type
ARGONAUTA	Research -Education	500 W	IEN/CNEN-RJ Rio de Janeiro	1965	Argonaut
IPR-R1	Research -Education	100 kW	CDTN/CNEN-MG Belo Horizonte	1960	TRIGA MARK-I
IEA-R1	Research Radioisotope Production	5 MW (2MW)	IPEN/CNEN-SP São Paulo	1957	Reator MTR Piscina Aberta

1957 : IEA → 2014: IPEN/CNENSP



J. A. Perrota 2014

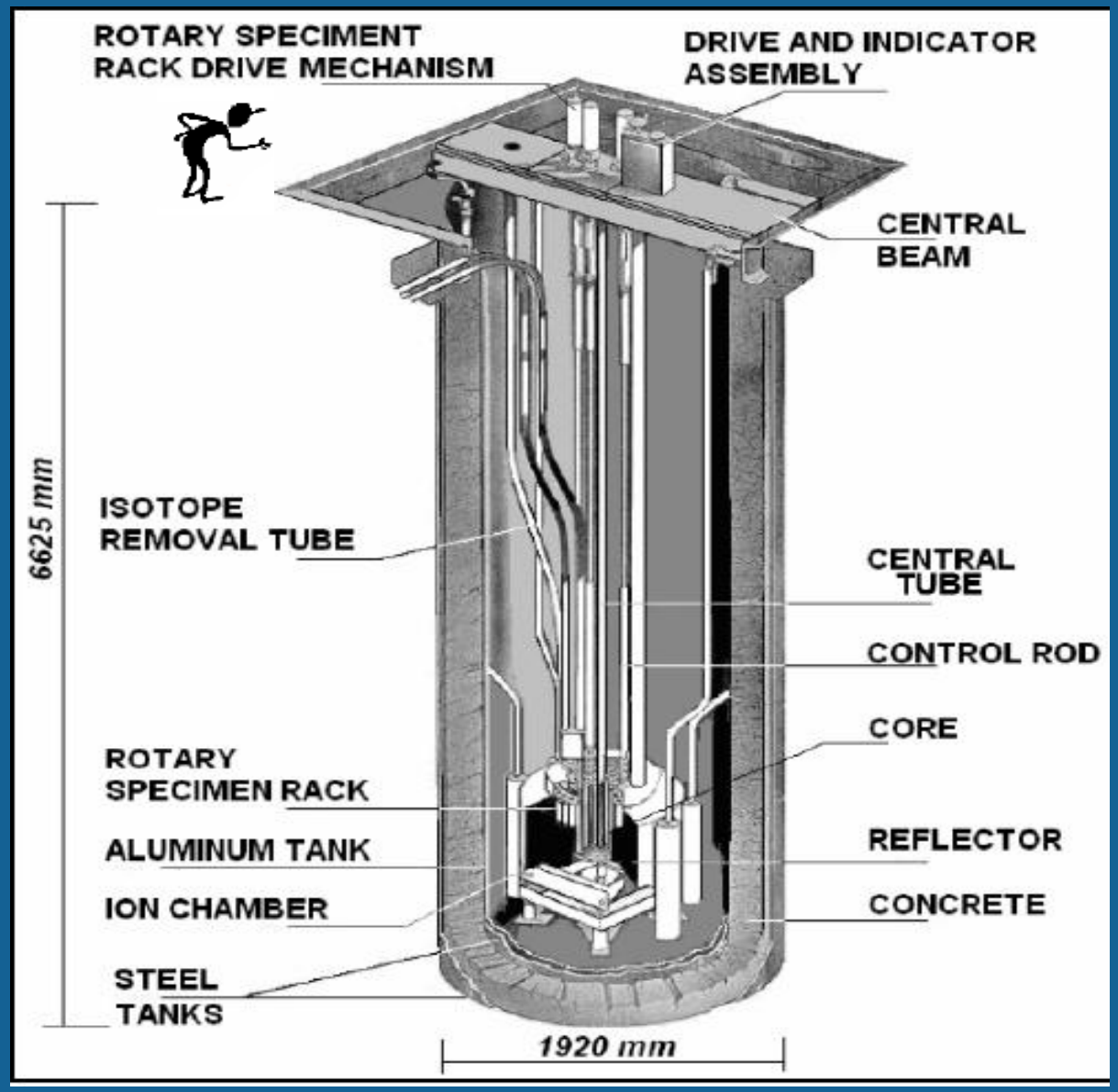
THE TRIGA MARK I IPR-R1 GA Research Reactor

- ✓ Installed in 1960
- ✓ Operating at 100kW. Ready (but no licensed !) to operate at 250kW
- ✓ Used mainly for training of NPP operators
- ✓ NAA applications
- ✓ Production of some radioisotopes

MOTIVATION

- ✓ 2005: “ Enhancement of TRIGA IPR-R1 Utilization “
- ✓ Upgrade of the NAA Laboratory
- ✓ Production of new radioisotopes: ^{195m}Pt, ^{64}Cu, ^{159}Gd, ^{125}Xe, …
- ✓ Study of materials
- ✓ Neutron Beam: A Challenging Goal !

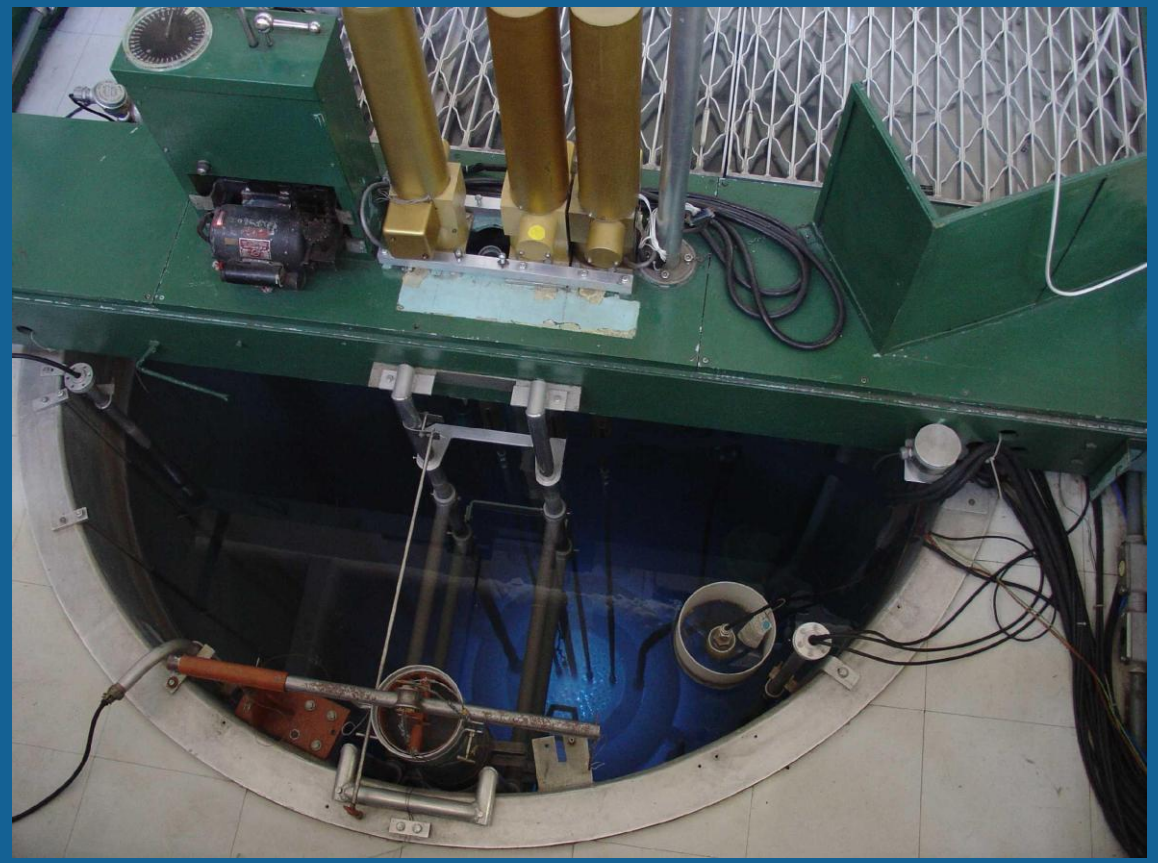
TRIGA MARK 1 IPR-R1

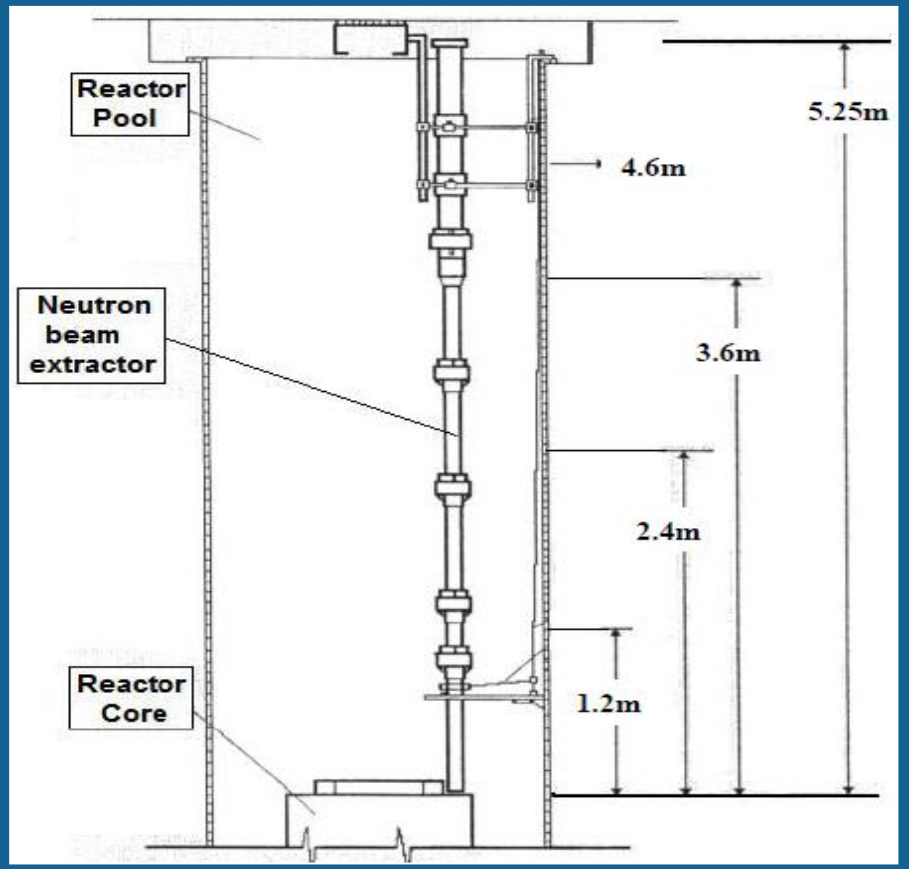


- ✓ Enhancement of the reactor utilization
- ✓ Upgrade of the NAA laboratory TRIGA IPR-R1 reactor
- ✓ Possibility of using the neutron beam for new applications

THE TRIGA MARK I IPR-R1 GA Research Reactor

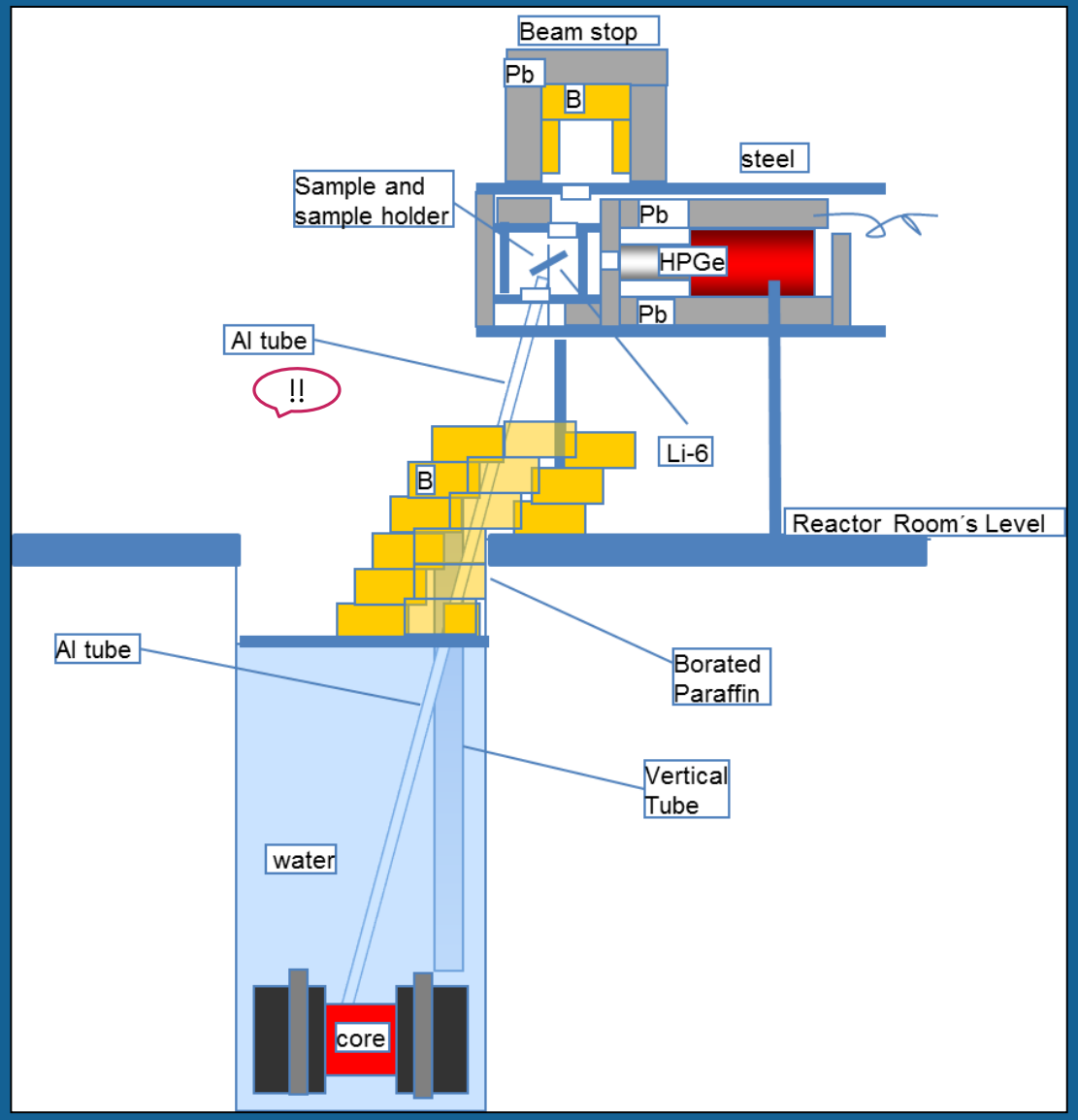
✓ 1980's: Vertical Neutron Beam



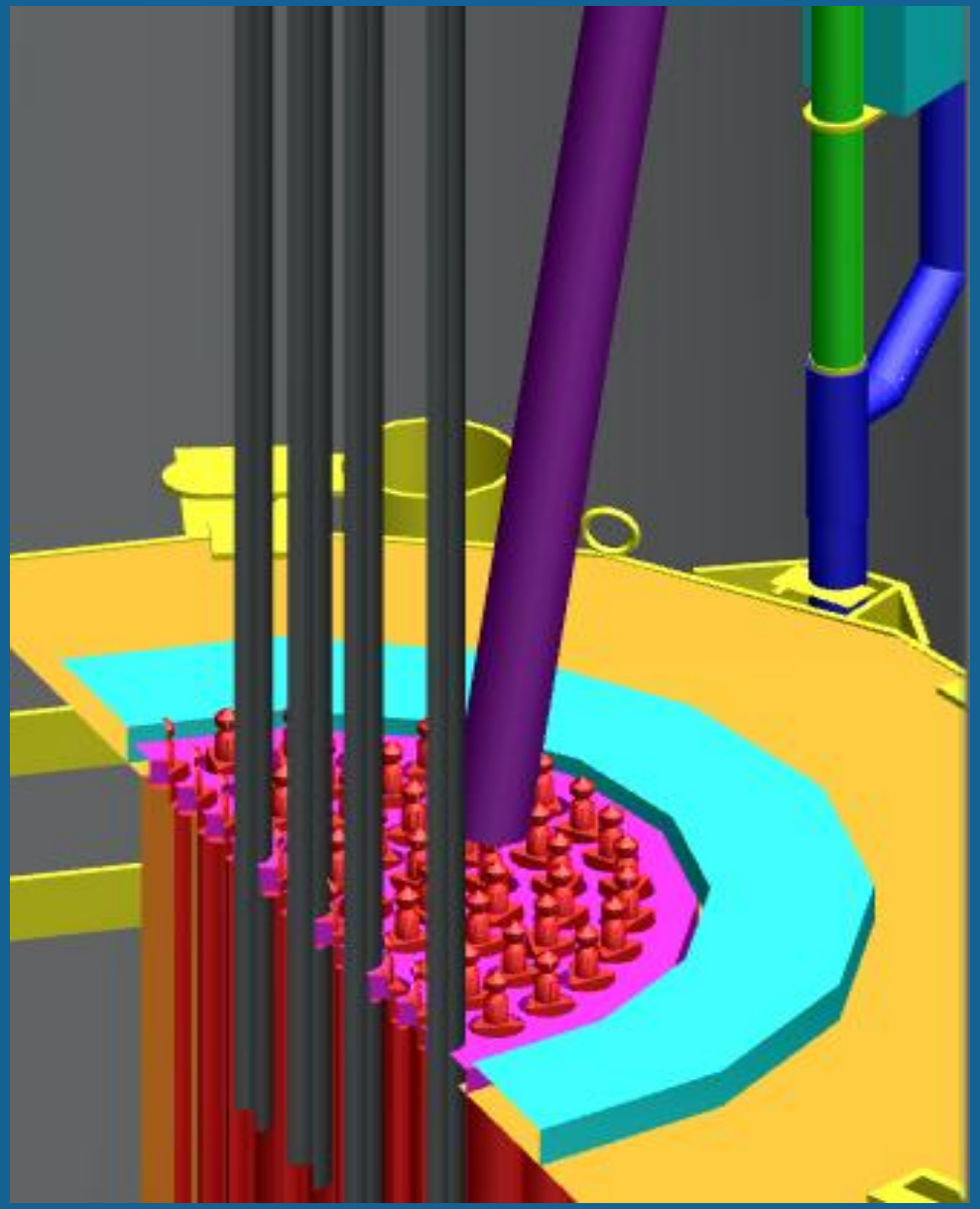


THE TRIGA MARK I IPR-R1 GA Research Reactor

- ✓ 2008: “Proposed Design for a PGAA “
- ✓ enhancement of the reactor utilization
- ✓ upgrade of the NAA Lab
- ✓ possibility of using the neutron beam for new applications

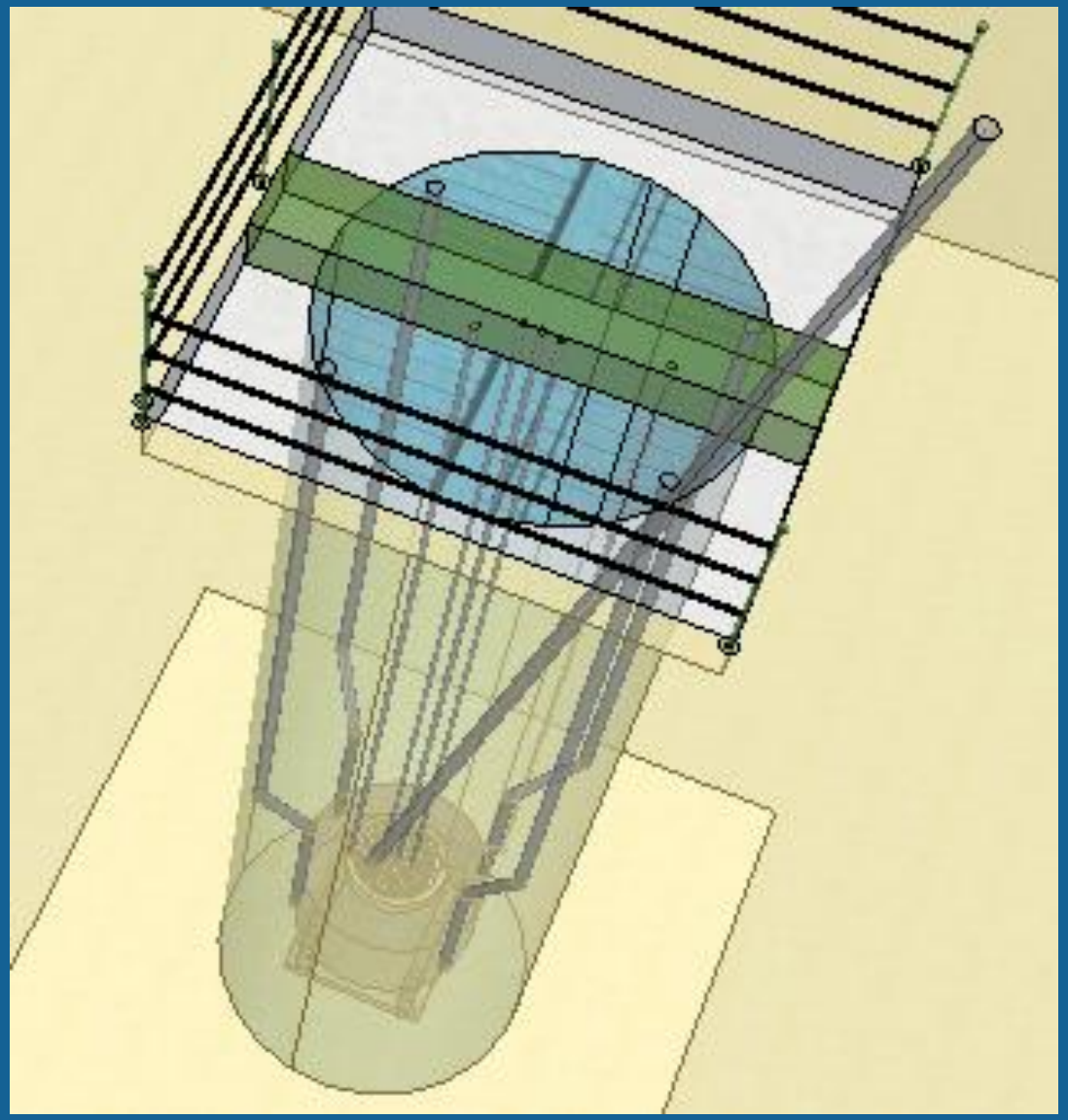


THE TRIGA MARK I IPR-R1 GA Research Reactor



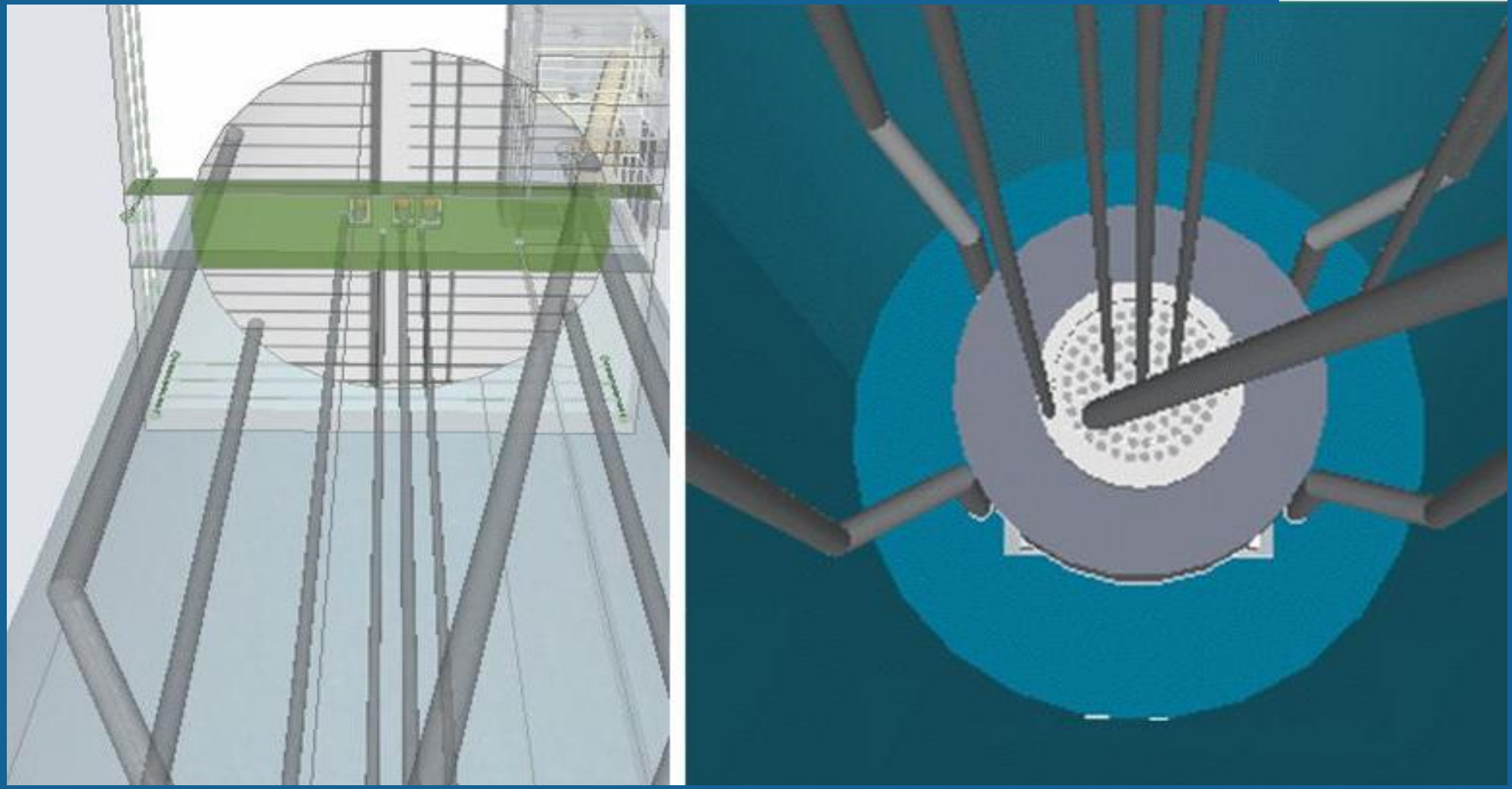
- ✓ Proposed inclined tube
- ✓ Control bars and central thimble
- ✓ Core and fuel elements

THE TRIGA MARK I IPR-R1 GA Research Reactor



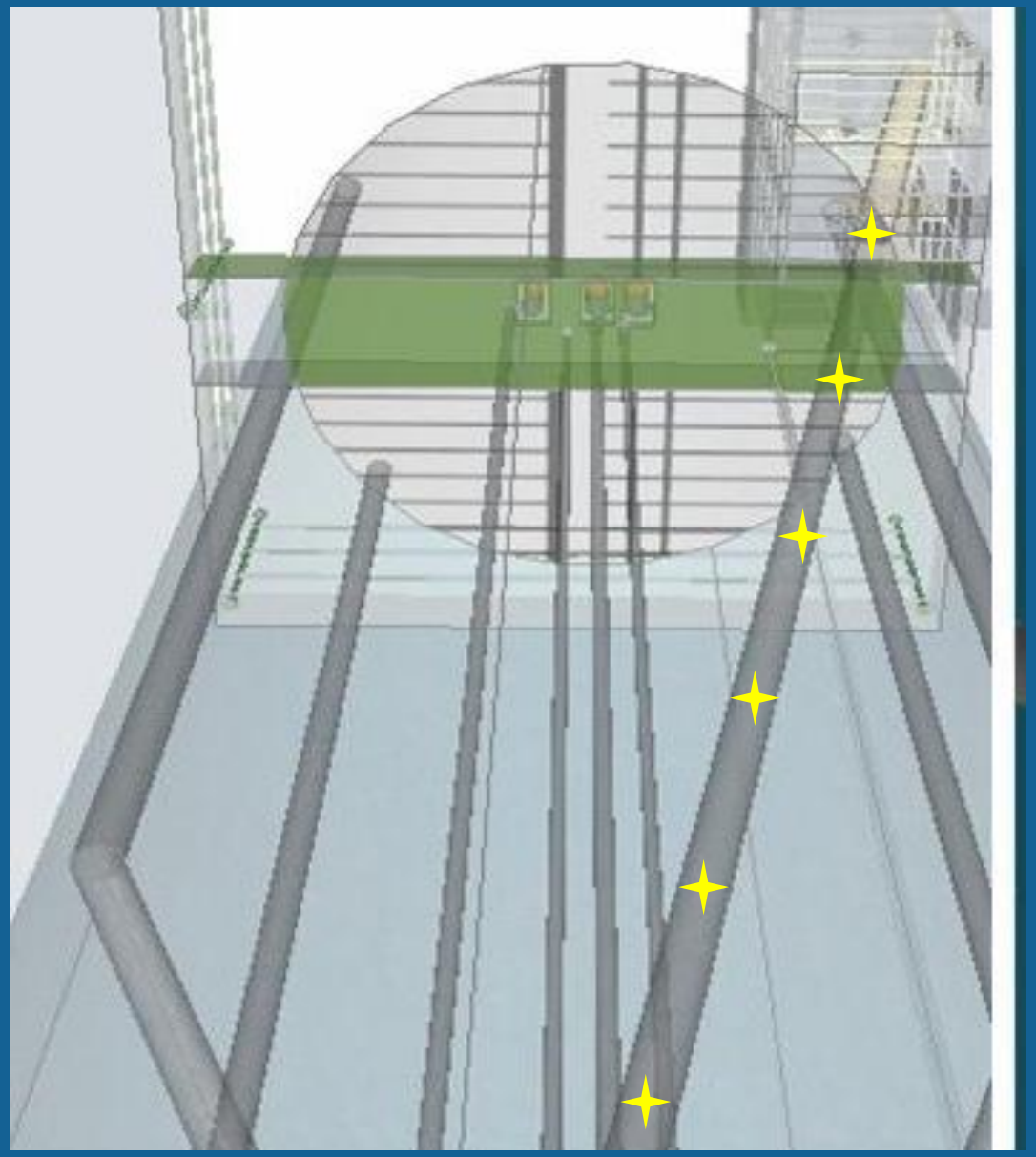
- ✓ **Inclined tube: view from the top of the pool and the reactor's room level**

THE TRIGA MARK I IPR-R1 GA Research Reactor



- ✓ views of the inclined tube: bottom (left), top (right)

EXPERIMENTAL - Determination of the neutron flux



- ✓ Preparation of the tube and the gold monitors (^{198}Au) 100%
- ✓ The monitors were positioned equally spaced along the tube

EXPERIMENTAL - Determination of the neutron flux

- ✓ The monitors were positioned in the equally spaced positioned using a nylon guide line and polyethylene vials

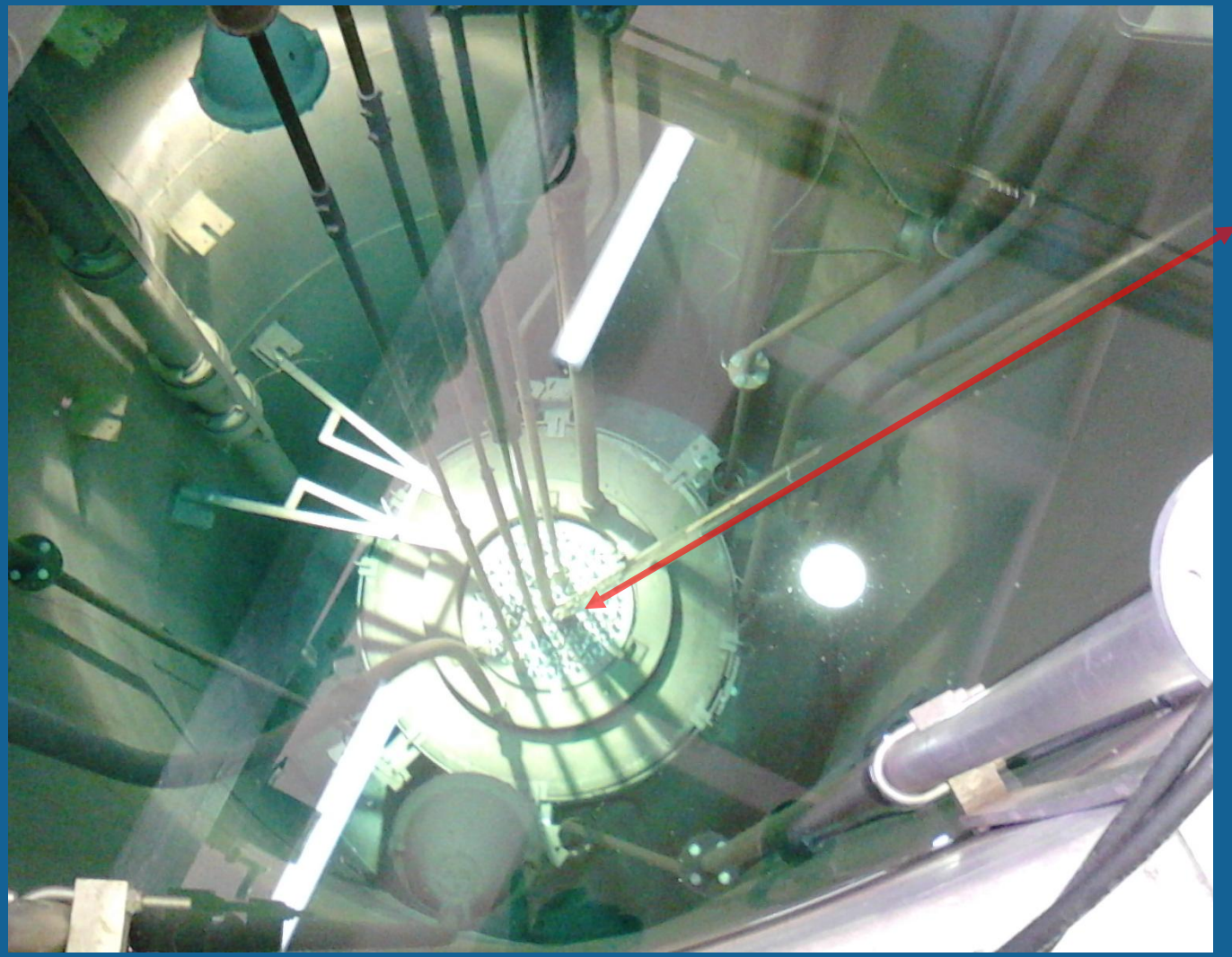
EXPERIMENTAL - Determination of the neutron flux

- ✓ Insertion of the gamma shielding: cylindrical tube of polyethylene (1,0 m) in to of the tube

EXPERIMENTAL - Determination of the neutron flux

- ✓ The insertion of the aluminum tube in the pool

5m length
5cm internal diameter
3mm thickness



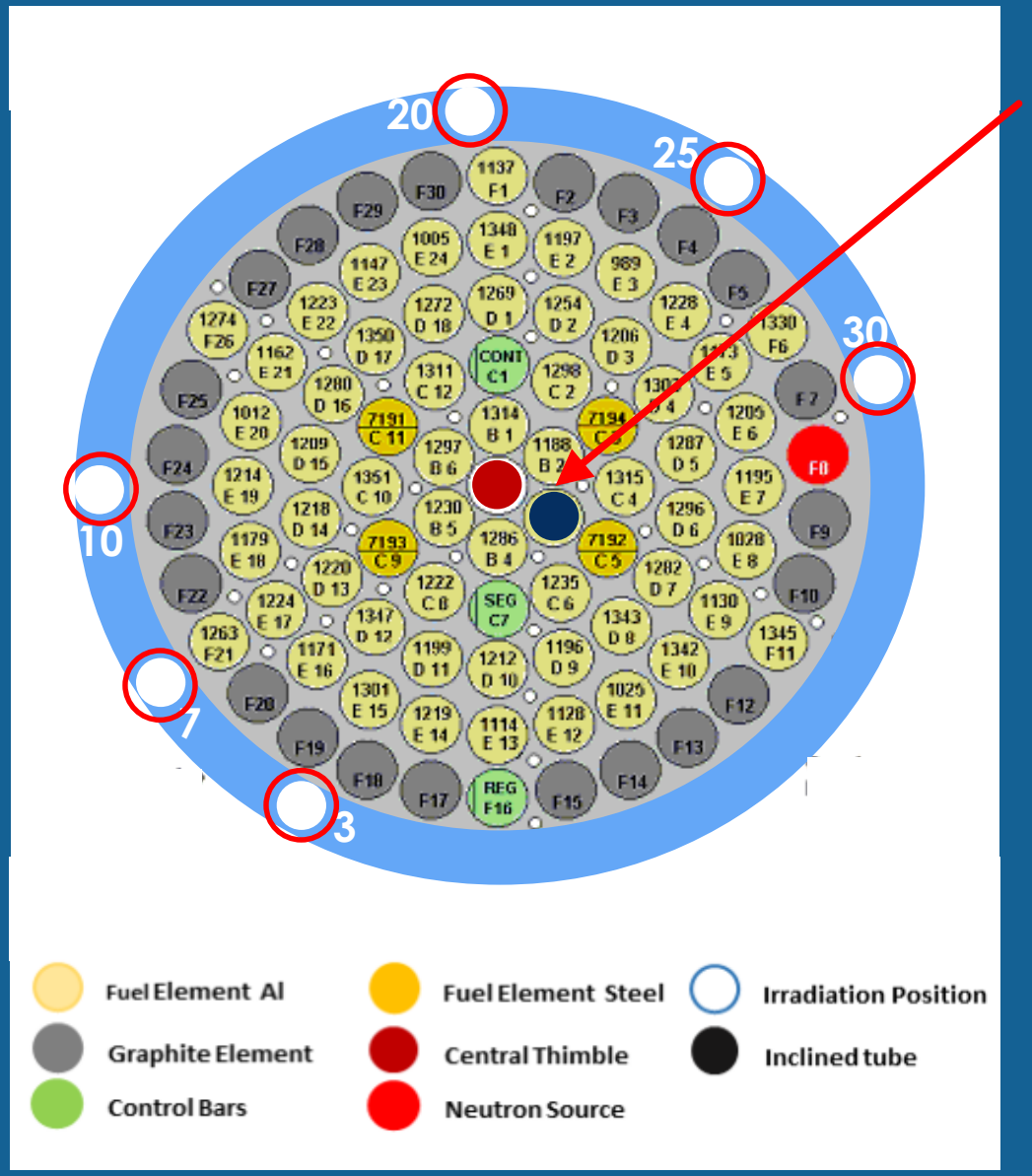
EXPERIMENTAL - Determination of the neutron flux

- ✓ The insertion of the tube in the pool
- ✓ Right material
- ✓ No pressure of the fuel elements

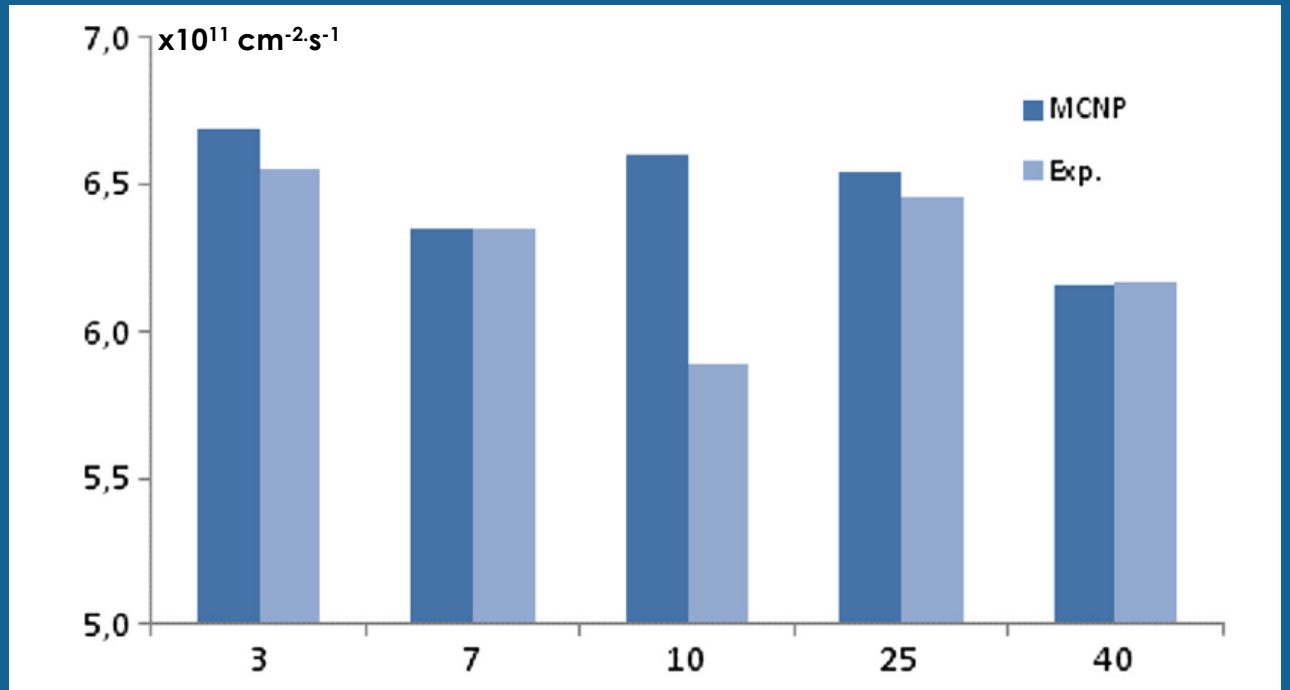
EXPERIMENTAL - Determination of the neutron flux

- ✓ The insertion of the tube in the pool
- ✓ Right material

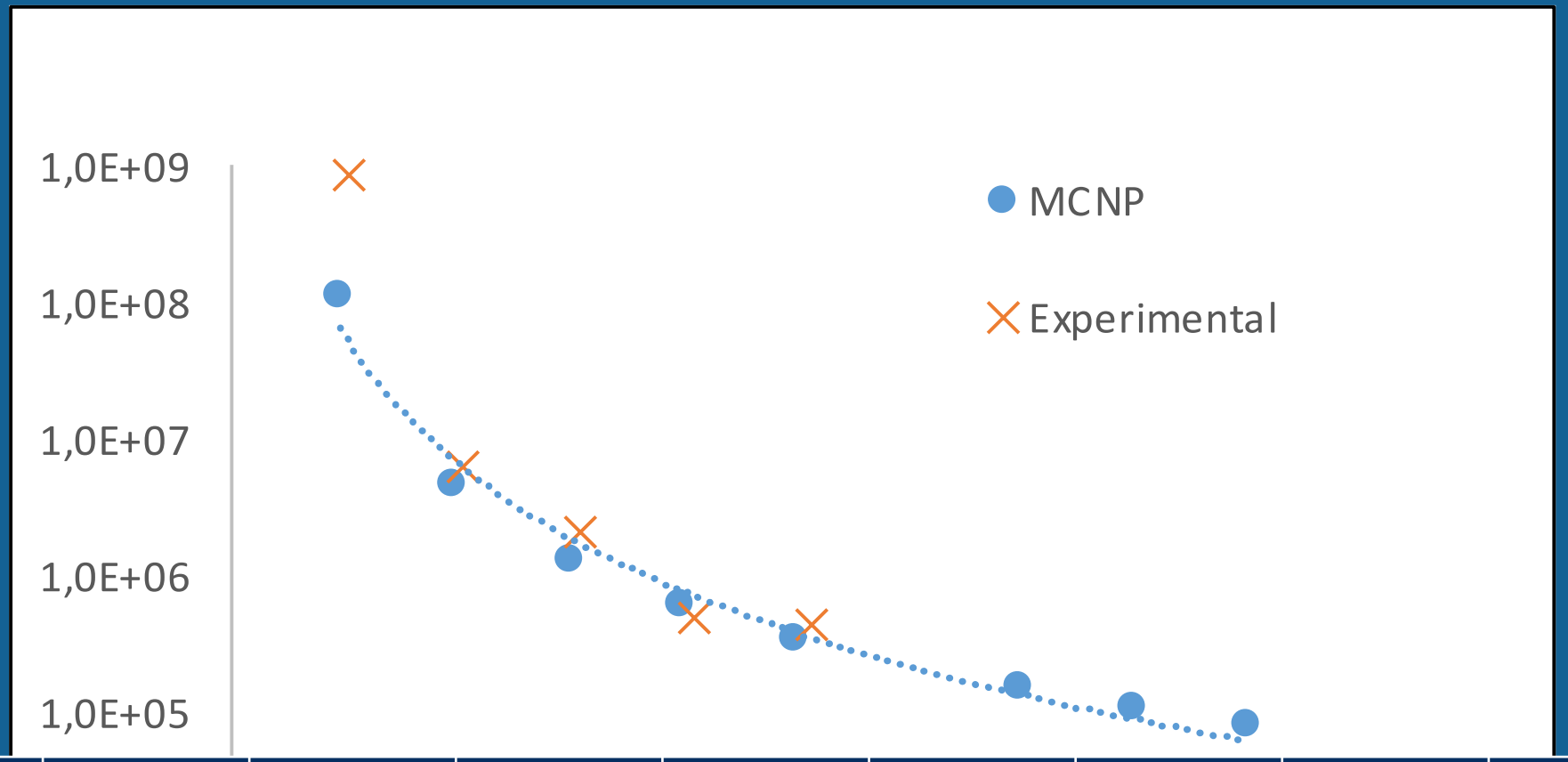
THE TRIGA MARK I IPR-R1 GA Research Reactor



- ✓ position of the inclined tube in the core
- ✓ positions used for NAA irradiations (3, 7, 10, 20, 25, 30) – validation of the MCNP Model

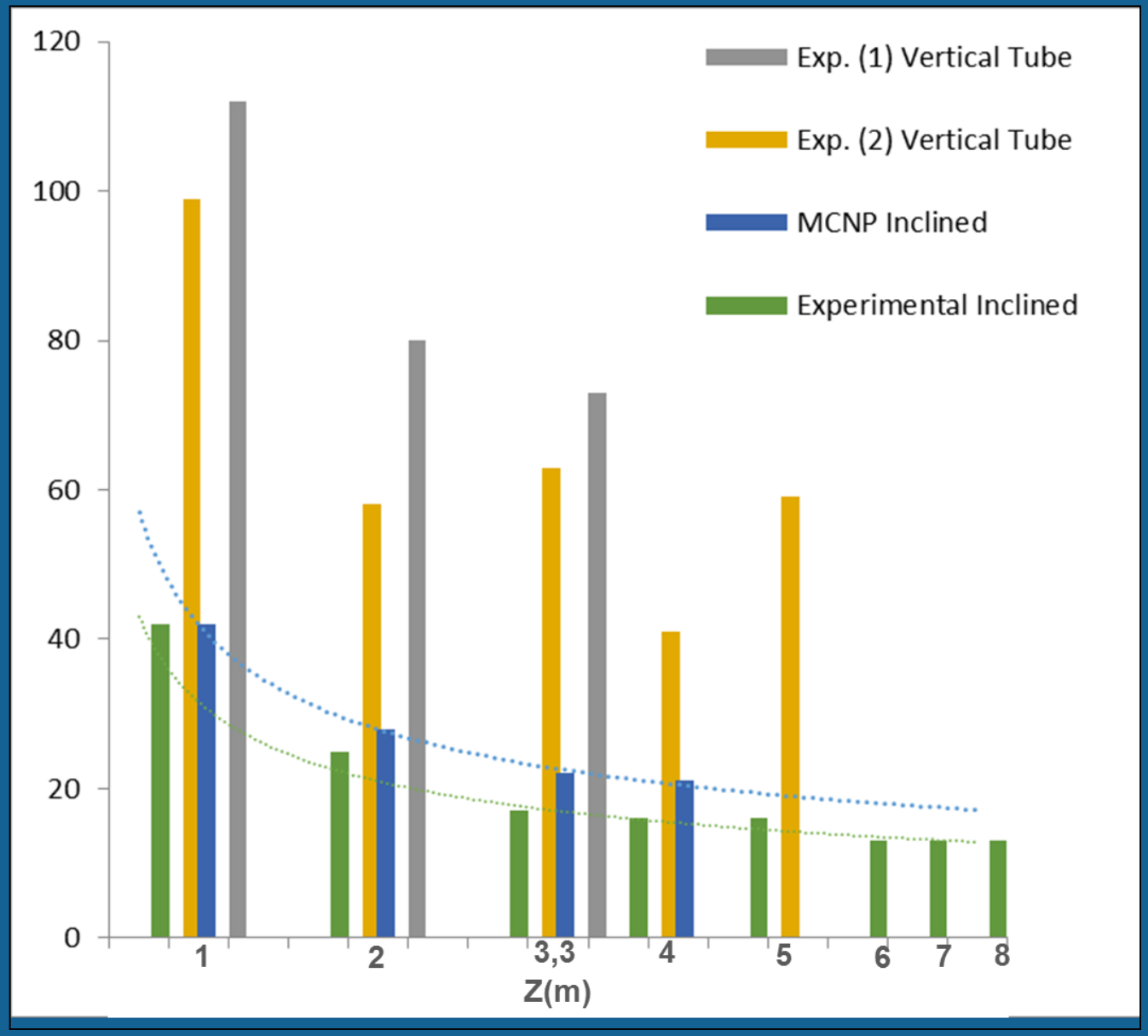


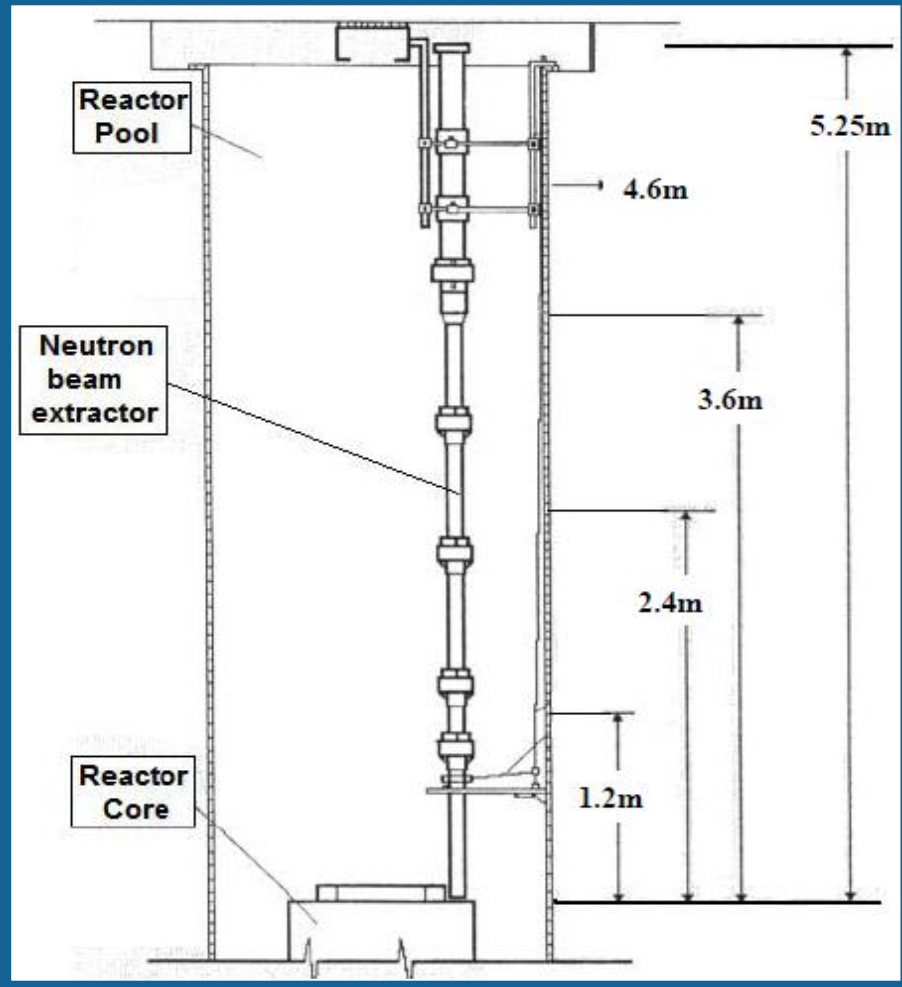
RESULTS - Thermal neutron flux



Z(cm)	86	178	270	360	450	630	720	810
$\Phi_{th\ (MCNP)}$	1.1×10^{8}	4.6×10^{6}	1.2×10^{6}	5.9×10^{5}	3.3×10^{6}	1.5×10^{5}	1.5×10^{5}	7.6×10^{4}
$\Phi_{th\ (exp)}$	1.7×10^{8}	6.0×10^{6}	2.0×10^{6}	4.6×10^{5}	4.2×10^{5}	--------	---------	--------
$\Delta_{exp(\%)}$	54	30	40	22	26	--------	---------	--------
$\Delta_{MCNP(\%)}$	9	10	2	3	3	2	2	2

RESULTS - (Thermal /Epithermal) neutron flux - *f*





RESULTS - (Thermal /Epithermal) neutron flux - *f*

Guerra *et al. SpringerPlus* 2013, **2**:597
http://www.springerplus.com/content/2/1/597

SpringerPlus
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TECHNICAL NOTE Open Access

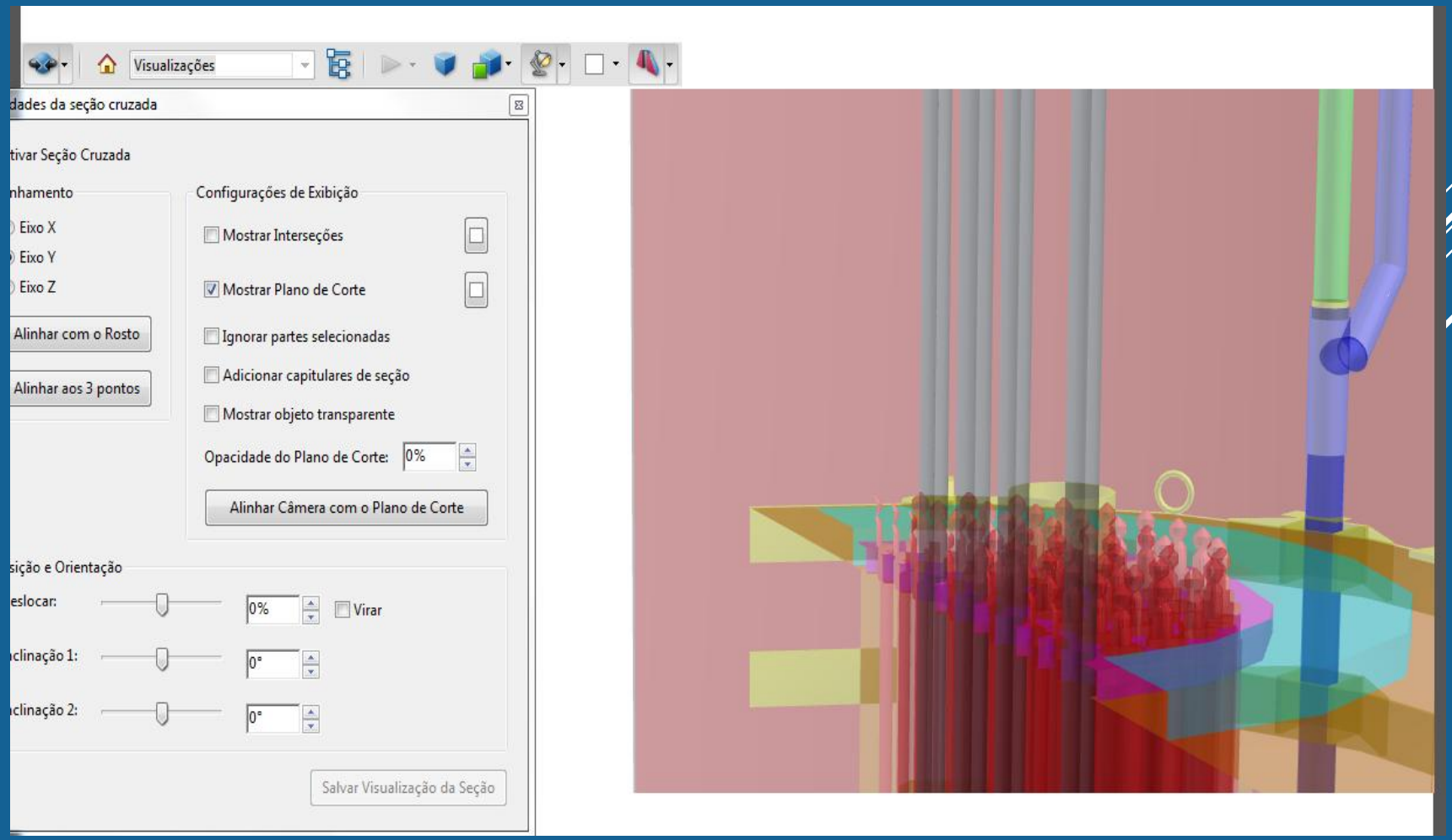
Proposed design for the PGAA facility at the TRIGA IPR-R1 research reactor

Bruno T Guerra[1,3], Radojko Jacimovic[2], Maria Angela BC Menezes[1,3] and Alexandre S Leal[1*]

✦ Utilization and Modification of the TRIGA Reactor

Inclined Neutron Beam

Proposed Design for a PGAA

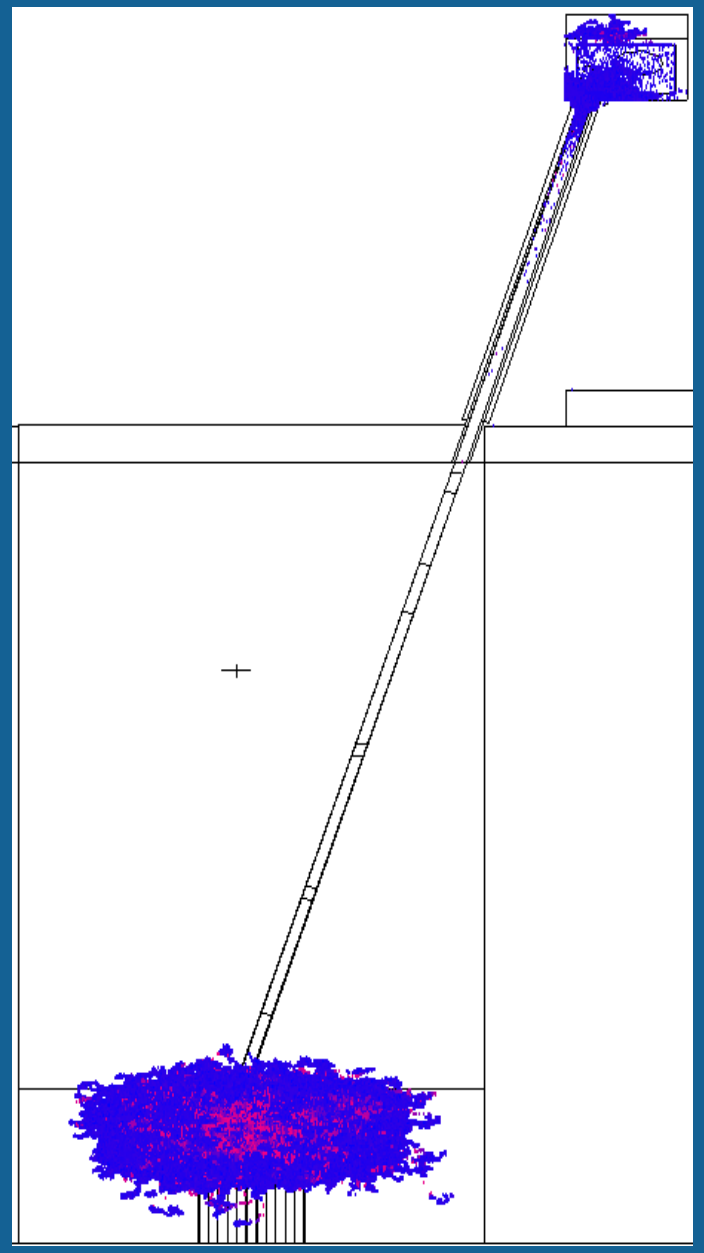


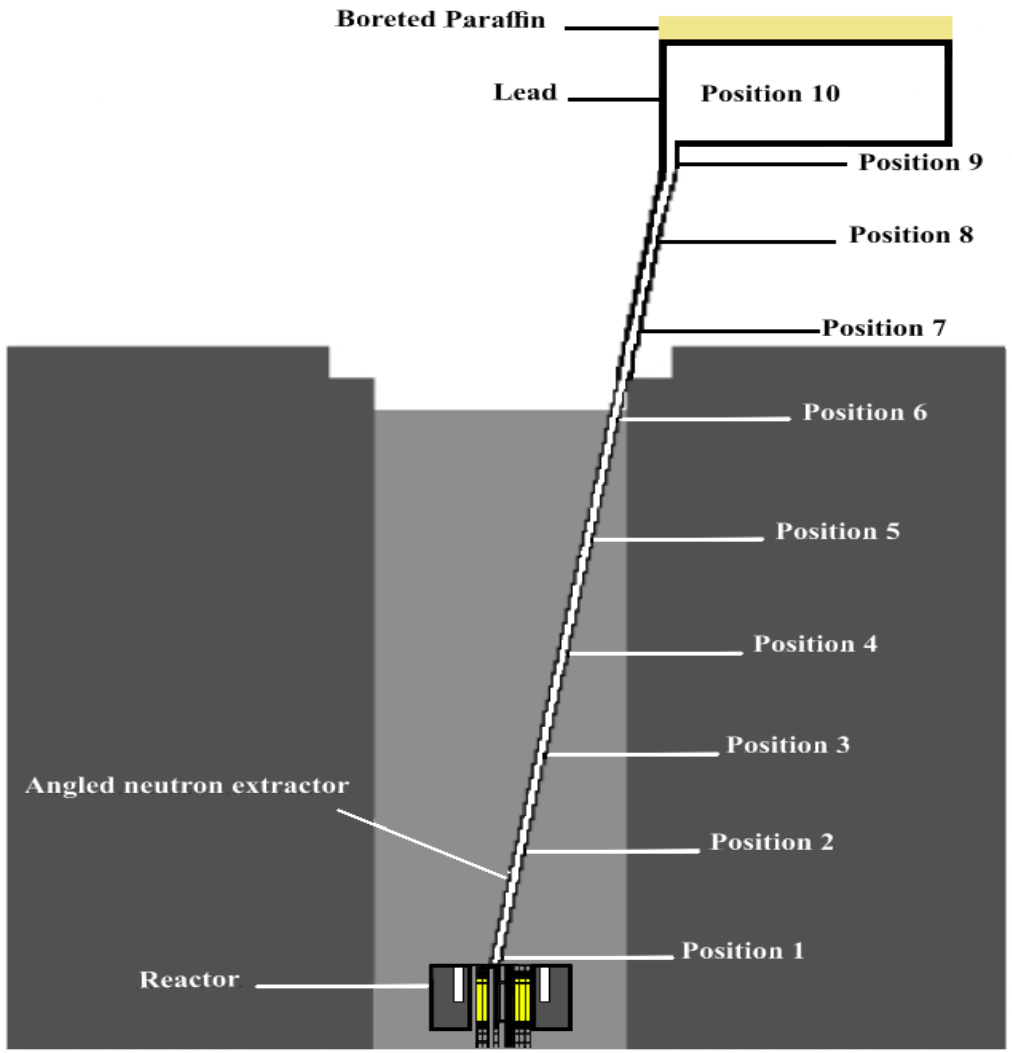
RESULTS - VISED (Version X 24-E1) *Particle Track Function*

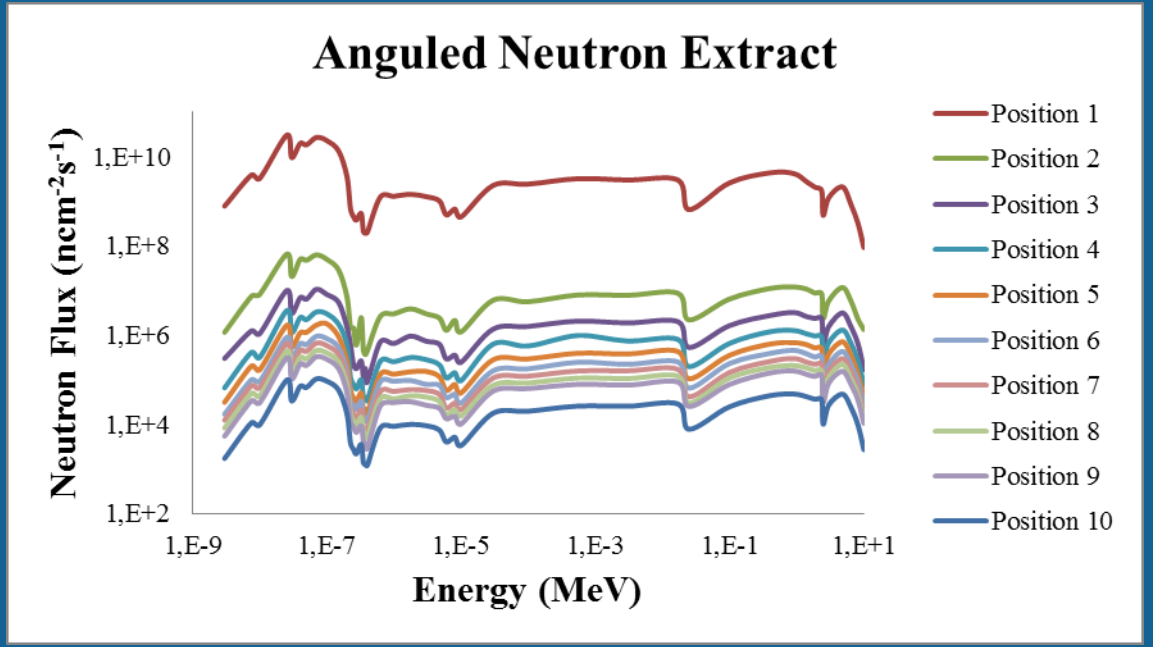
✓ Population of the neutrons in the core of the reactor and along across the inclined tube.

✓ The box in the top of the tube is a simplified model of the set sample-detector-shielding.

✓ The function *particle track* of the VISED platform was used to illustrate the geometry of the system and to facilitate the identification of possible problems, such as the neutrons or photons escaping from the tube

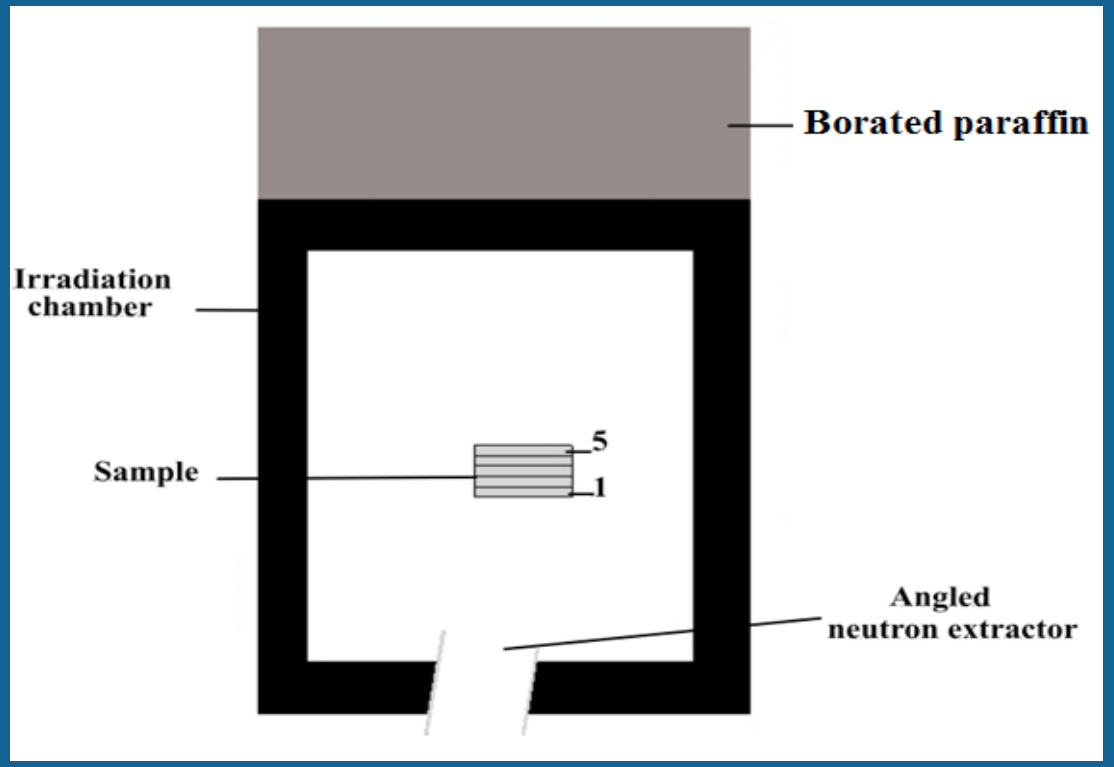


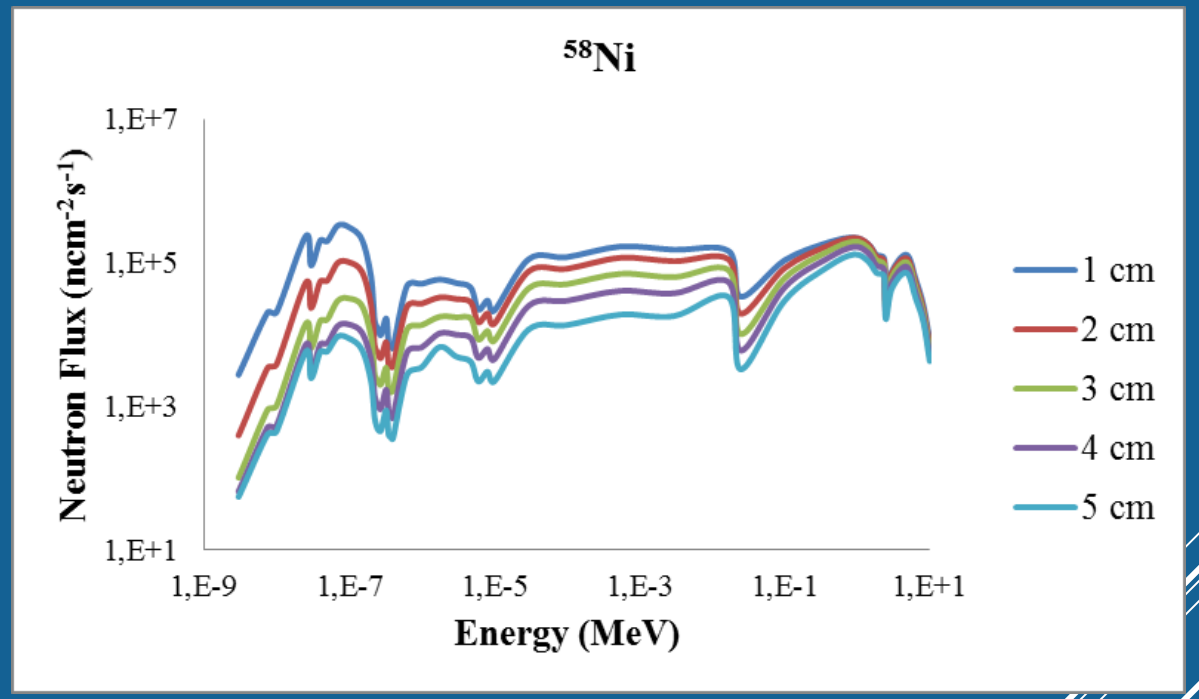




Monte Carlo Simulations for a Preliminary Design of TRIGA IPR-R1 PGNAA Facility

B. T. Guerra[1, 2], A. S. Leal[2], C. Pereira[1], M. A. B. C. Menezes[1, 2]





Monte Carlo Simulations for a Preliminary Design of TRIGA IPR-R1 PGNAA Facility

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C0NCLUSION

- ✓ In principle, obtained *suggests* that the inclined tube could be used as a neutron guide for the PGAA facility
- ✓ Better characterization of both: thermal and epithermal neutron flux is necessary: improvement of the MCNP model and additional experimental data !
- ✓ Feasibility of a PGAA facility : Lot of things to do !!!
- ✓ Definition of the power of the TRIGA IPR-R1 operation, 100-250kW !!??

obrigado !

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