

# PLAN OF ADEQUACY IMPROVEMENT OF FACILITIES FOR THE FUEL SUPPLY TO THE BRAZILIAN MULTIPROPOSE RESEARCH REACTOR - RMB



## RMB25 Project



- 1 Portaria do Núcleo de Produção e Pesquisa
- 2 Prédio dos Pesquisadores
- 3 Oficina
- 4 Unidade de Produção de Radiosótopos
- 5 Laboratório de Materiais Irradiados
- 6 Prédio do Combustível
- 7 Laboratório de Radioquímica
- 8 Prédio do Reator
- 9 Laboratório de Física Nuclear
- 10 Laboratório de Engenharia de Materiais

Elita F.Urano de Carvalho  
IPEN/CNEN-SP



**Cost**

**R\$ 24.460.000,00**

**Proponent**

**Fundação Pátria**

**Executor**

**Comissão Nacional de Energia Nuclear**

**Participants**

<b>Coordinator</b>	Jose Augusto Perrotta
<b>CTMSP-SP</b>	Ana Maria Vaz de Araujo
<b>IPEN/CNEN-SP</b>	Antônio Teixeira, Elita F. Urano de Carvalho

# OBJECTIVS

**CTM**

To develop and fit the 20% uranium enrichment to meet the reactor operating requirements of the RMB enterprise.

**CCN**

To develop and adapt the manufacturing infrastructure of fuel elements and uranium targets for both the continuous supply to the operation of the reactor of the RMB Enterprise and production of  $^{99}\text{Mo}$ , respectively.

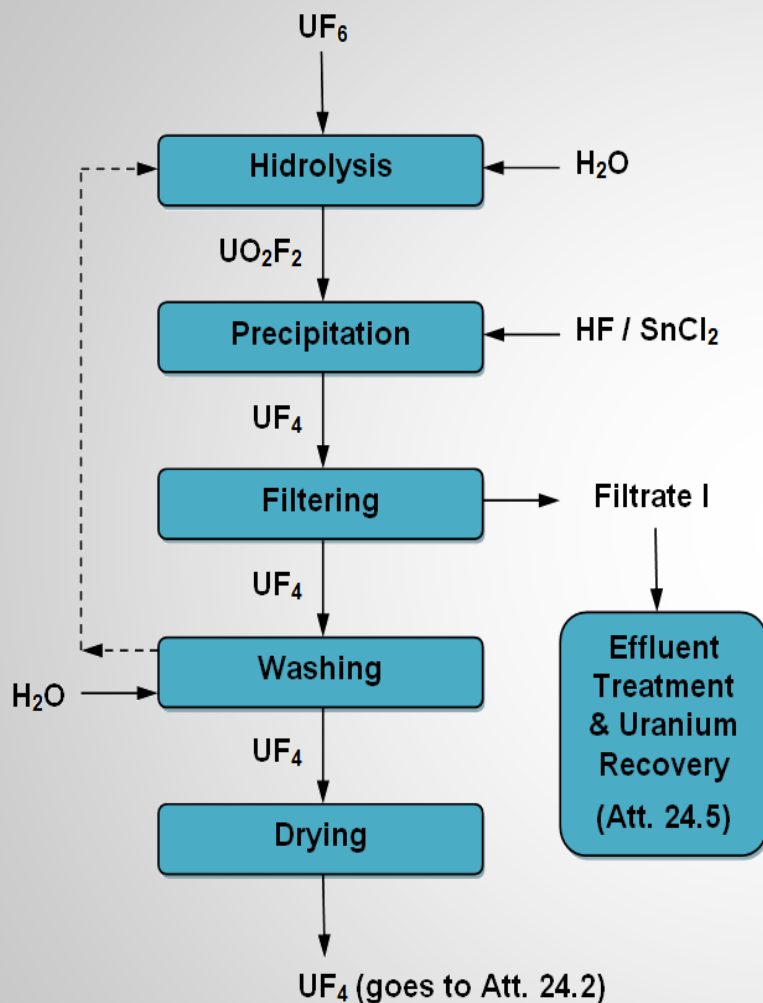
**IPEN/  
CNEN**

To fabricate a set of fuel elements to operate the IPEN MB01 core reactor aiming at testing the reactor physics for the Enterprise RMB

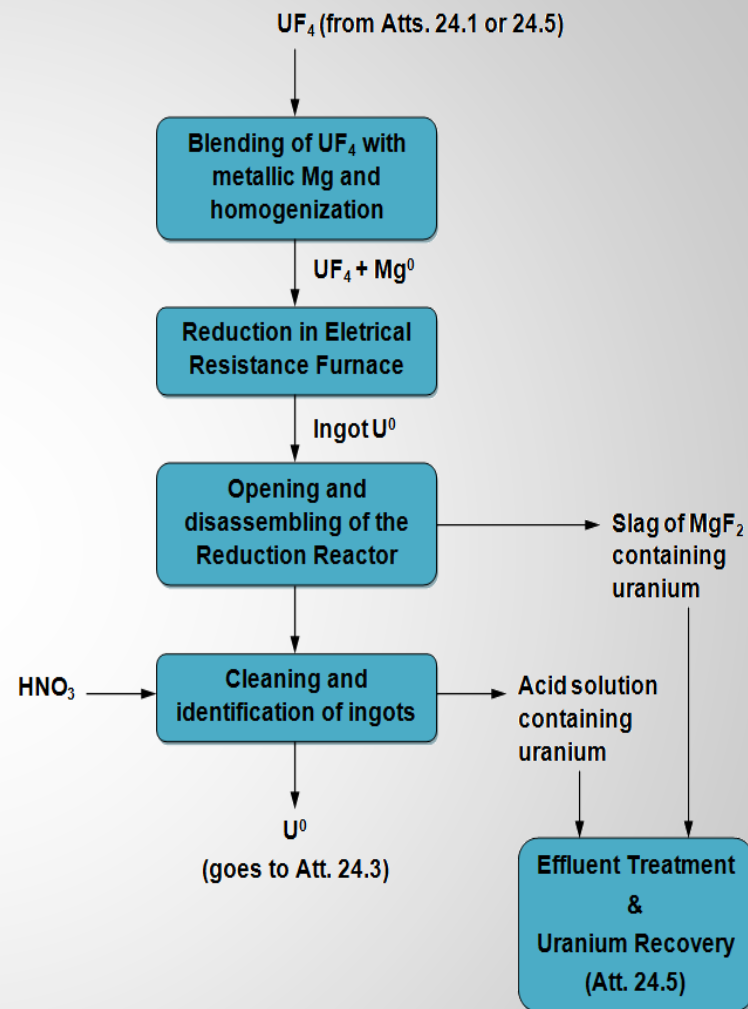
**CEN**

To carry out the IPEN MB01 reactor core adequacy project (manufacturing and assembly project) and nuclear licensing for RMB reactor physics tests;

## UF<sub>4</sub> production from UF<sub>6</sub>

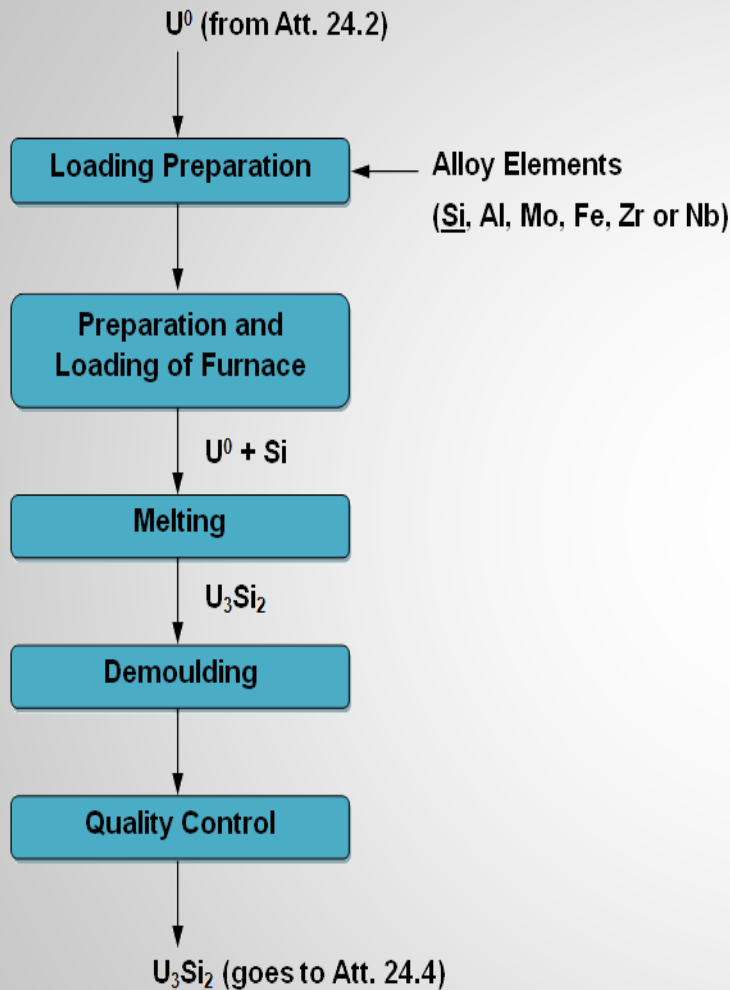


## Reduction process from UF<sub>4</sub> to metallic uranium

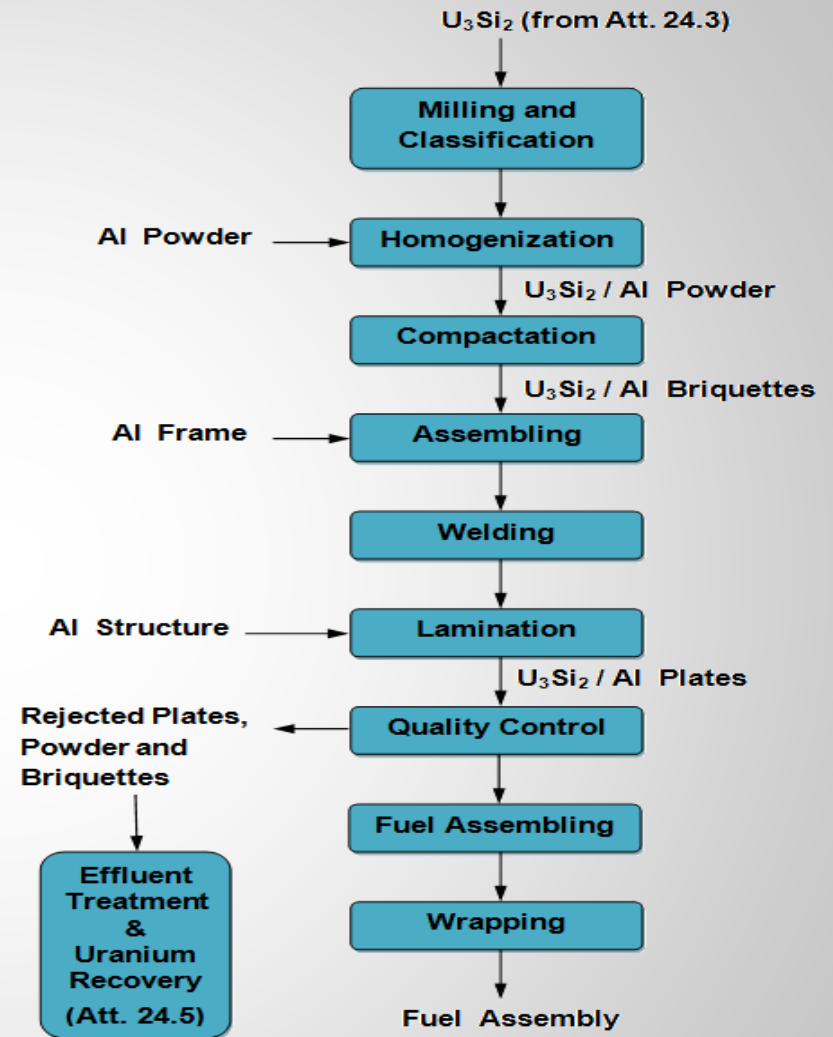


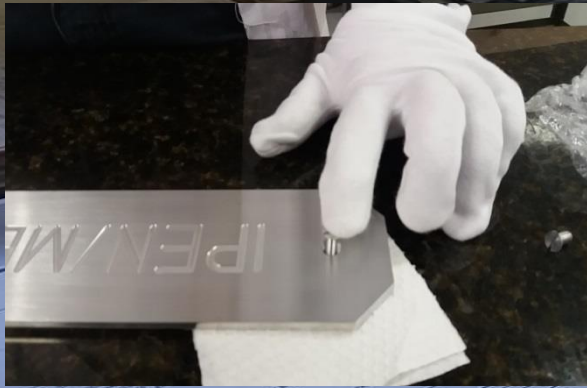


## Obtention of $U_3Si_2$ from metallic uranium

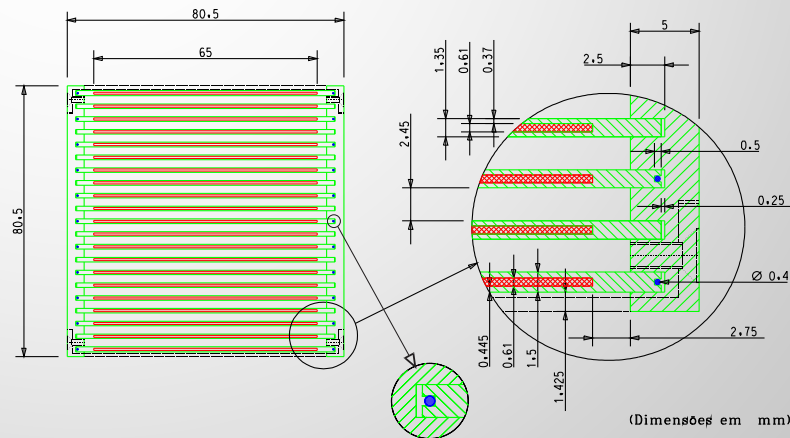
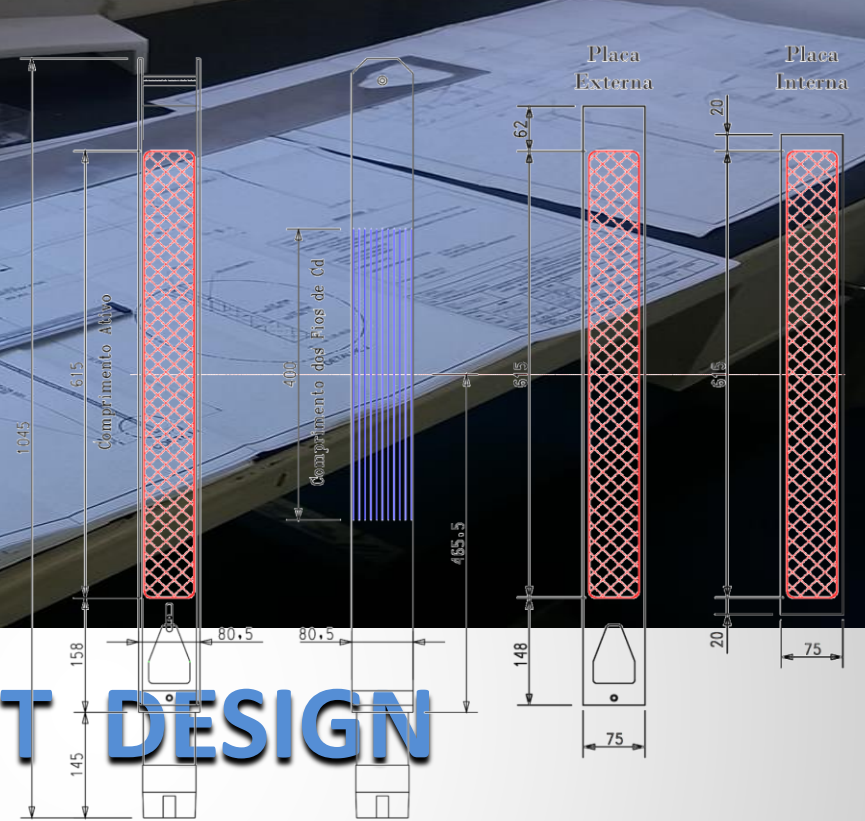


## Assembly line for fuel Elements





# FUEL ELEMENT DESIGN



Fuel Element – set of 21 fuel plates, 02 external and 19 internal maintained in suitable geometry by means of lateral supports which are fixed to a cozzle.

# CHARACTERISTICS

IPEN MB 01  
Reactor

STANDARD FUEL ELEMENT  
(21)  $U_3Si_2$  - Al FUEL PLATES

IPEN MB 01  
Reactor

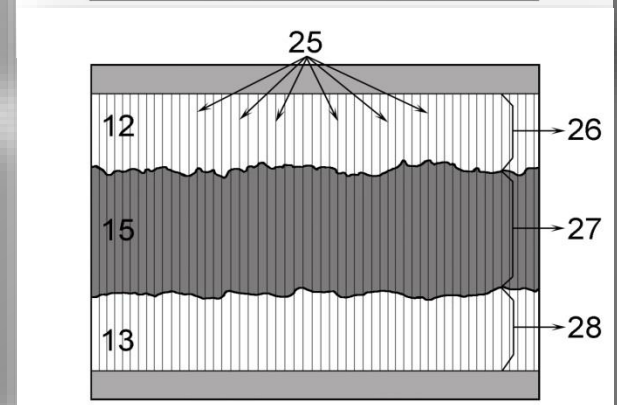
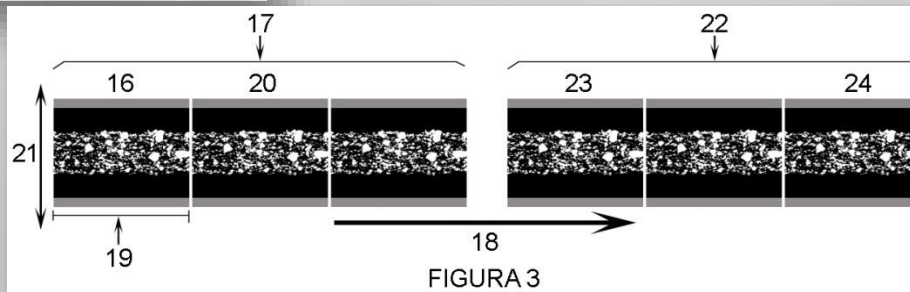
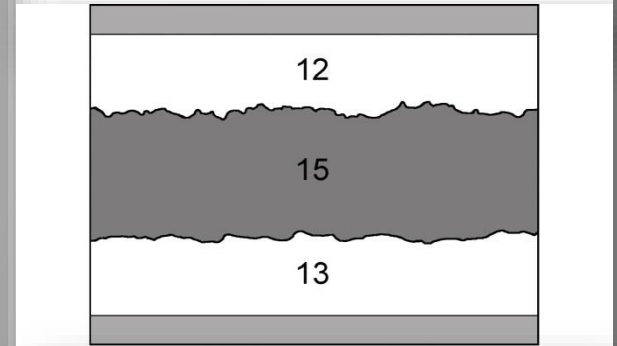
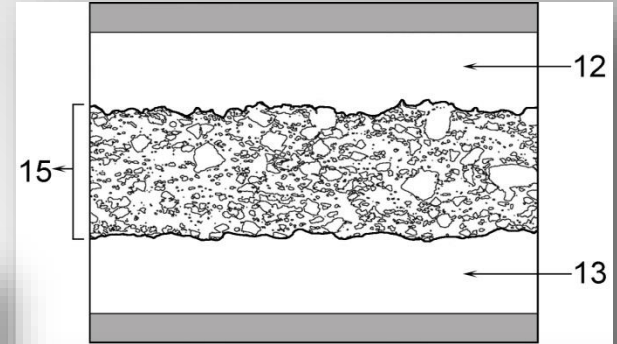
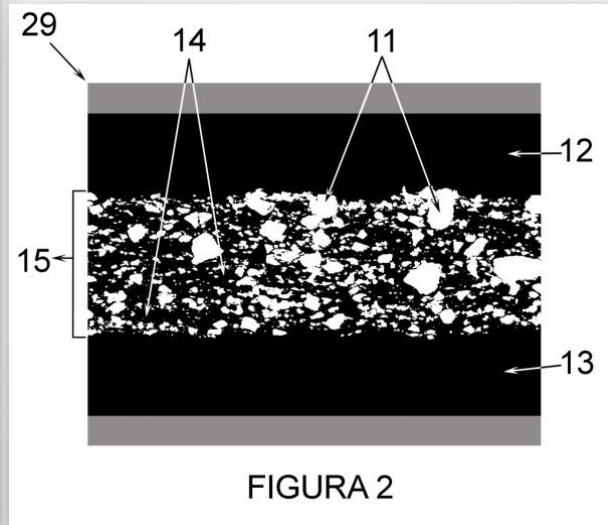
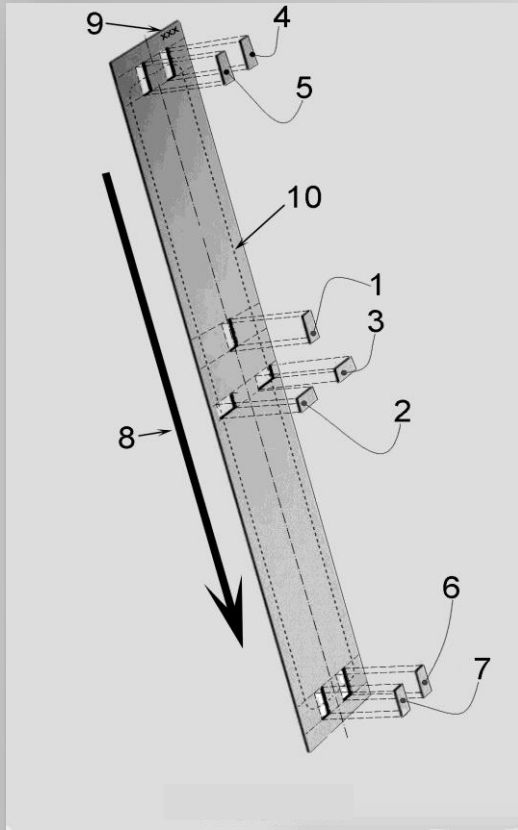
DEMOUNTABLE FUEL ELEMENT  
(21)  $U_3Si_2$  - Al FUEL PLATES

Material	Density	Number of plates	Mass of uranium/plate (g)	$U^{235}$ massa/plate (g)	Total mass of uranium /fuel element (g)
$U_3Si_2$	2,8gU/cm <sup>3</sup>	21	68,28 ± 0,1	13,48 ± 0,02	1.433,88 ± 2,1

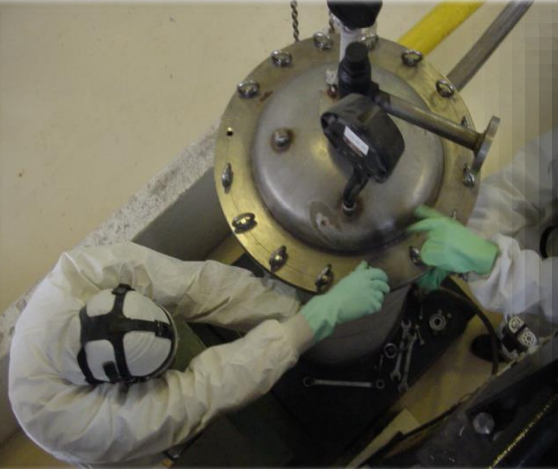
Enrichment: 19, 75 ± 0,20 wt %<sup>235</sup>U

Burnable Poison : Cadmium wire

# MEASUREMENT OF THE THICKNESS AND CORE OF THE FUEL PLATE COATING







**DEVELOPMENT AND  
MANUFACTURE OF THE FUEL  
ELEMENT  
FOR THE IPEN MB01 REACTOR**



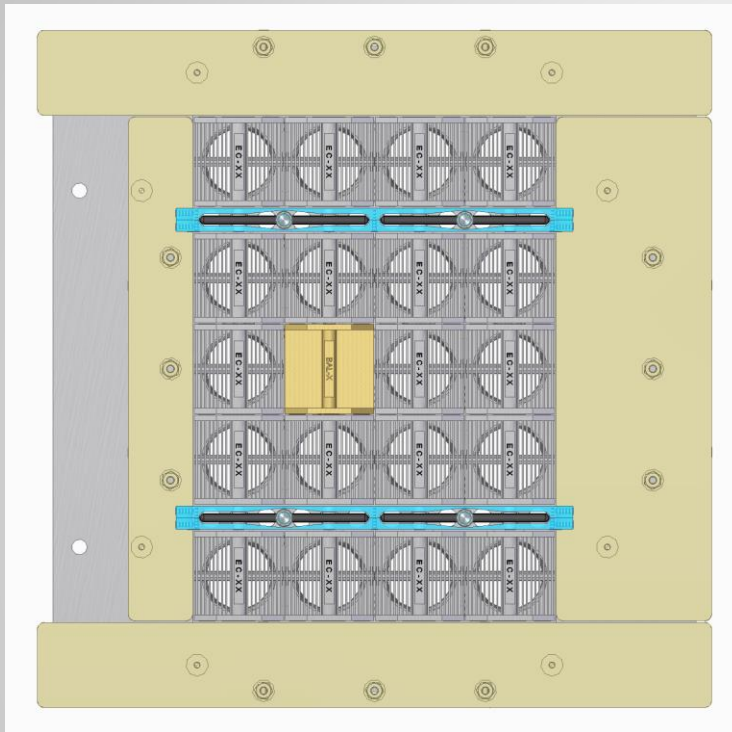
# FUEL ELEMENT

This is the first nuclear plate-type fuel for the IPEN/MB-01 Nuclear Research Reactor fabricated at CCN. The first of a set of 19 fuel elements that will compile the core of this reactor and which will simulate the Multipurpose Reactor - RMB



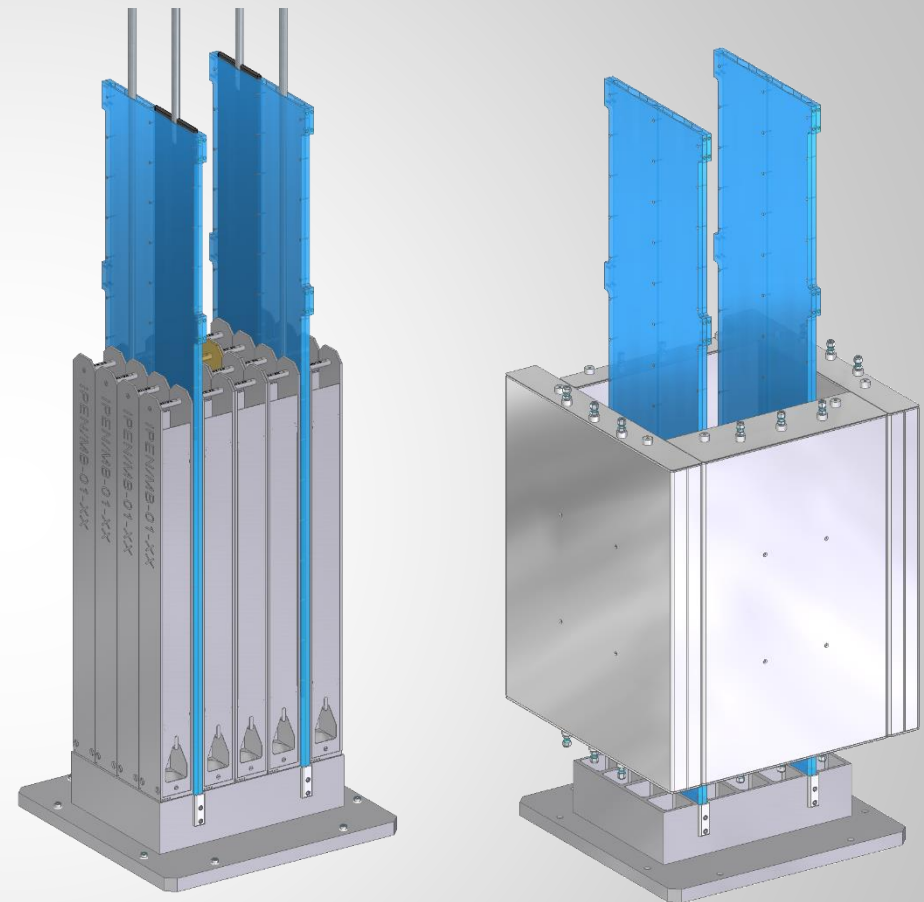


# SUITABILITY OF THE IPEN MB 01 REACTOR CORE



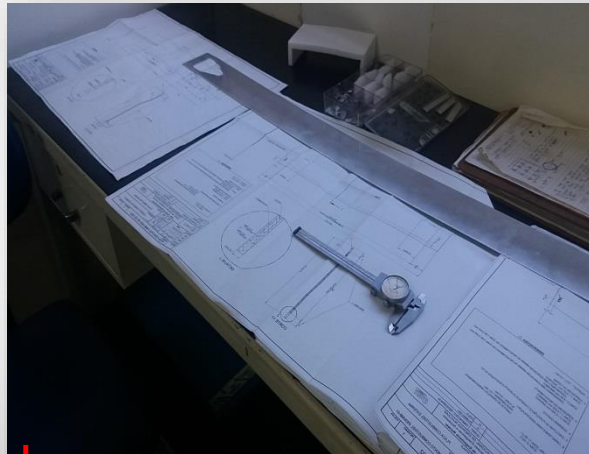
**Core Arrangement**

- 19 Fuel Elements ( gray)
- 01 Aluminum Block ( yellow)
- 02 Control Bar Guide Structure ( blue)
- 04 Control Bars (black)
- 04 D<sub>2</sub>O tanks (Reflector) around fuel elements (yellow)



**3D View of Core Components**

# RMB25 Projects Milestones



**December 08, 2016**

Inauguration of the enrichment cascade: CTMSP – Aramar

\* Commissioning to CNEN

**Junho 2017**

Project validation and successful final development of the Fuel Element

**August 31, 2017**

The first nuclear plate - type fuel for the Nuclear Research Reactor IPEN / MB-01

\* Commissioning to CNEN



# Future Milestones - Project RMB25

**September 2018**

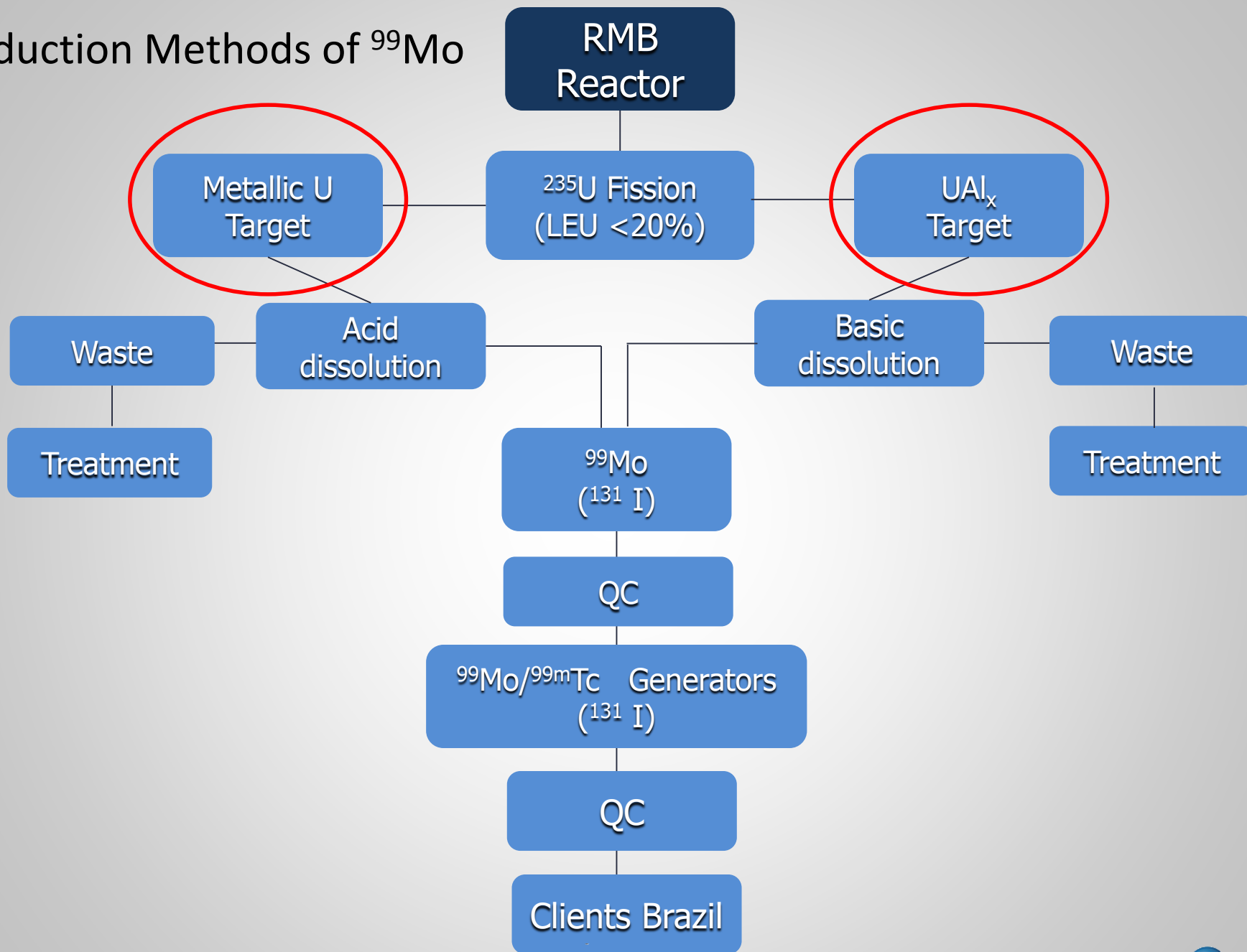
Delivery of 19 Fuel Elements to the IPEN MB-01 Nuclear Reactor

**November 2018**

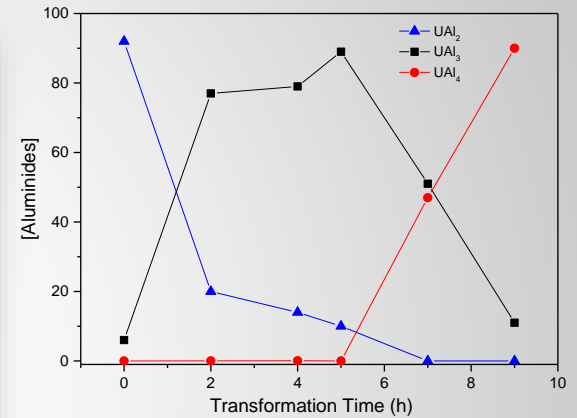
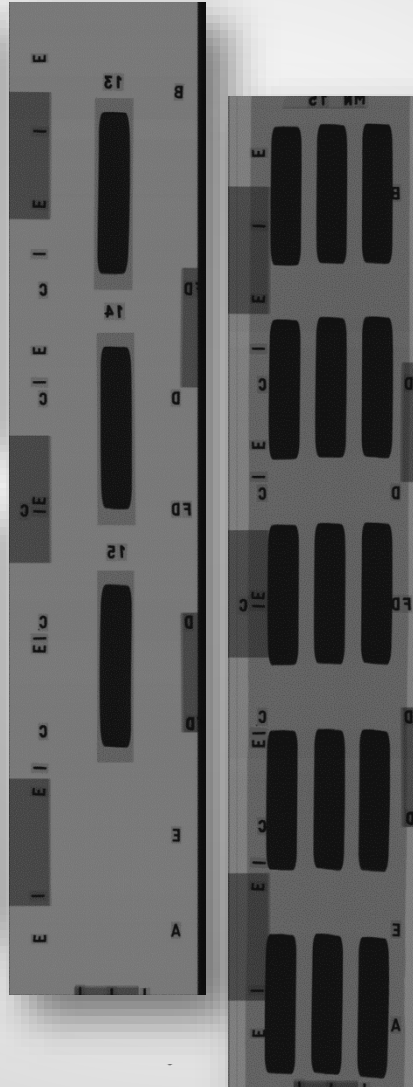
First Criticality of IPEN MB-01 Nuclear Research Reactor



# Production Methods of $^{99}\text{Mo}$

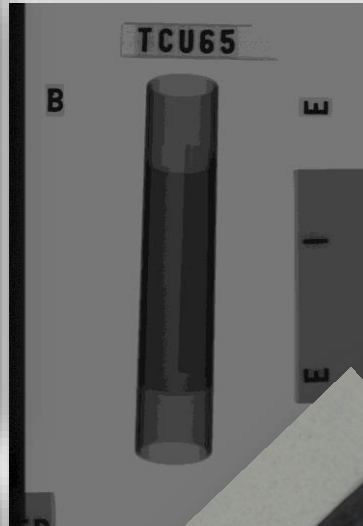


# Uranium targets (UAlx-Al) at $19.75 \pm 0.20$ wt% of $U^{235}$



To increase the productivity of the traditional manufacturing process of this type of target, by means of the implantation of an innovative methodology based on the modification of the frame plate of the assemblies to be laminated, allowing the joint lamination of multiple nuclei and thus, obtaining multiple targets.

# Uranium foil plate target at $19.75\% \pm 0.20$ wt. of $U^{235}$



The uranium foil plate targets consist of a thin sheet of uranium metal, 125 to 150  $\mu\text{m}$  thick, wrapped in sheets of nickel and encapsulated in an aluminum tube. The cylindrical design is used to ensure the structural integrity of the target, increase heat transfer and facilitate its disassembly after irradiation.



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## RMB

Reator  
Multipropósito  
Brasileiro

### RMB 25 Project

## Thank you!



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- 8 Prédio do Reator
- 9 Prédio dos Serviços de Apoio
- 10 Prédio dos Serviços de Apoio