Status of Medical RI Production and Plan of Ac-225 Development in Indonesia

National Research and Innovation Agency
Nuclear Energy Research Organisation

INTRODUCTION

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Research Center for Radioisotope Radiopharmaceuticals and Biodosimetry Technology

- √ National Nuclear Energy Agency of Indonesia (BATAN) from 2011
- √ National Research and Innovation Agency (BRIN)

LIPI (Sciences Institute)

batan (Nuclear Agency)

BPPT (Assessment Tech)

LAPAN (Aeronautics & Space)

1st September 2021

Other Research Institutes

BRIN
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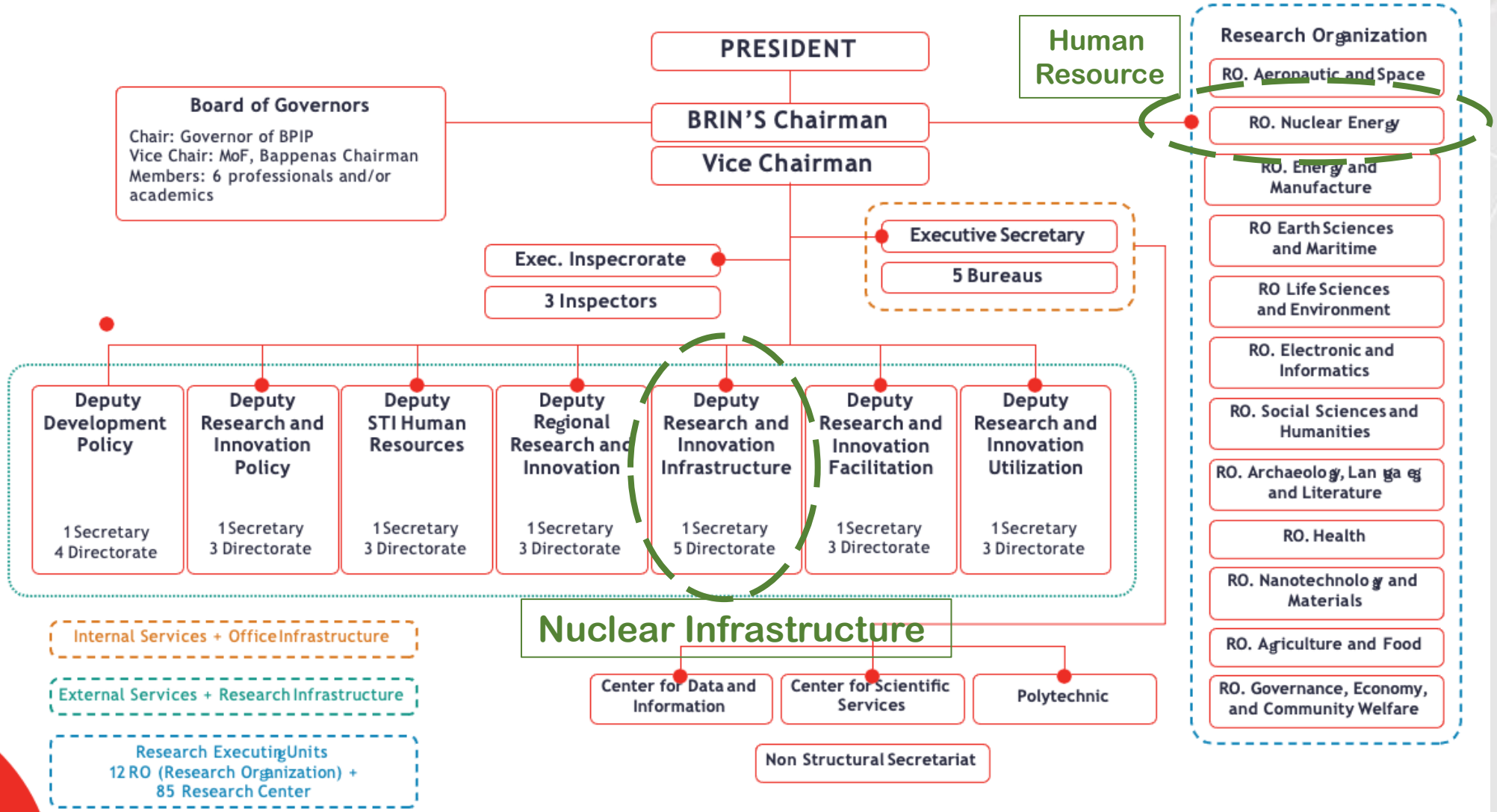
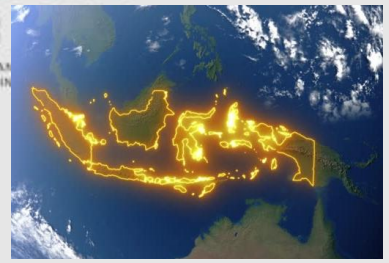
BRIN's Organization

Source: Presidential Decree 78/2021 about BRIN, Peraturan BRIN 1/2021 about BRIN's Organization



INDONESIA

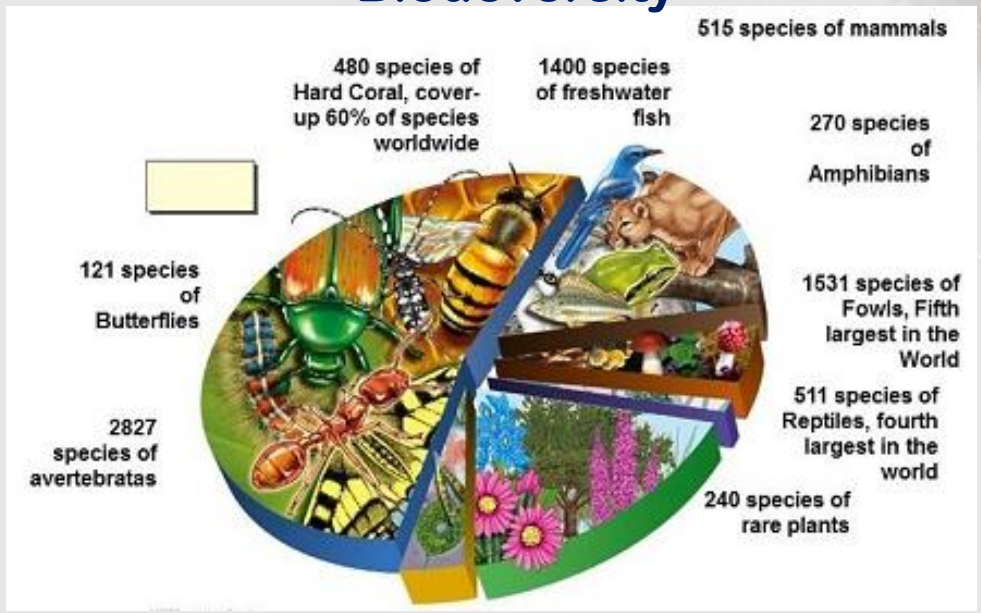


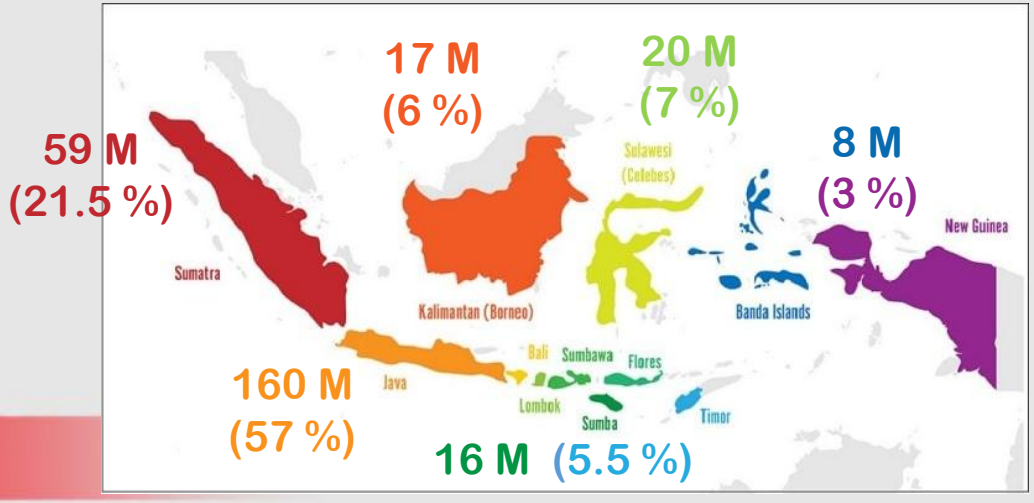
Tropical-Archipelago
~ 17,500 islands
(with 5 big islands)

- 81,000 km of coastline

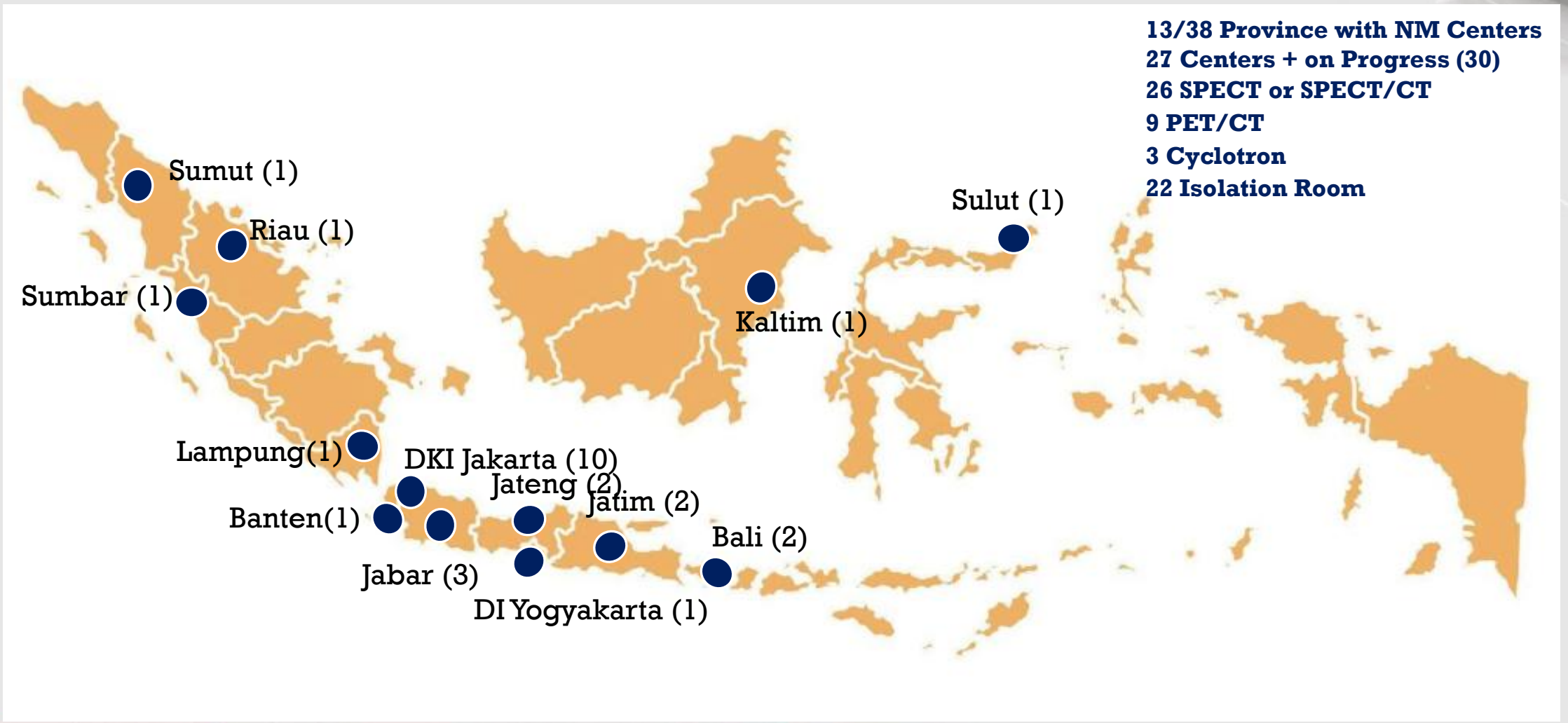
- 285 Million of the population (4th)

Biodeversity





Current Status of Nuclear Medicine Centers in Indonesia



NUCLEAR ERA IN INDONESIA

1958 : National Nuclear Energy Agency (BATAN)
1965 : First research reactor in Indonesia (Triga Mark) start-up in Bandung Nuclear Center (upgaraded to 2 MW)
1967 : First Nuclear Medicine Service located in Bandung
1979 : "Kartini" Reactor in Yogyakarta Nuclear Center (300 KW)
1987 : Multipurpose Reactor "Siwabessy" in Puspiptek Research Park (Max ~30 MW) in Tangerang Selatan
1989 : Operation of Radioisotope and Radiopharmaceuticals Production facilities (BATAN)
1996 : Radoisotop-Radiopharmaceuricals Company (PT Batan Teknologi) (transfer RIPR and Fuel Facility from BATAN)
1997 : Establishment of a Nuclear Regulatory Agency (BAPETEN)
2013 : BATAN Build new facilities for RIRP Research (small scale Production
2014 : Batan Teknologi Company → PT Inuki (Industri Nuklir Indonesia)
2022 : BATAN join became part of BRIN
2023 : Inuki did not meet operational safety requirements (STOP)

Indonesia Research Reactor Status

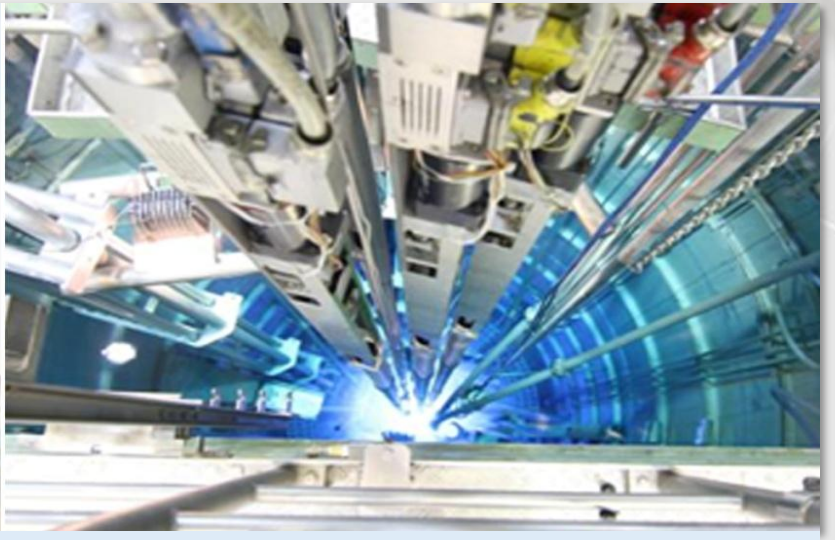
TRIGA MARK II REACTOR

- Location: Bandung
- Operated in 1964, 250 kW
- Upgraded to 2000 kW in 2000
- Main Function: Isotope production and research

(Propose for decommissioning → update: reactivation)

KARTINI REACTOR (TRIGA MARK II)

- Location : Yogyakarta
- Operated in 1979, 100 kW
- Main Function : Research and Human Resource Training Facilities



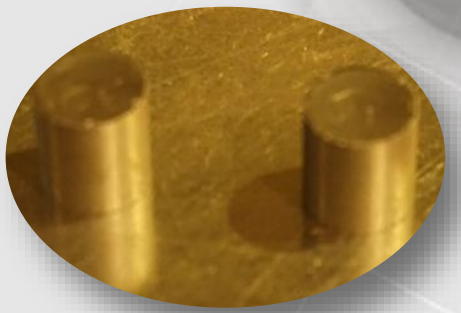
G.A. SIWABESSY (GAS) MULTI-PURPOSE REACTOR

- Location : Serpong, Tangerang
- Operated in 1987, 30 → 15 → 5 MW
- Main Function : Isotope production and neutron research
- Revitalization Plan for Radioisotope Production Reactor

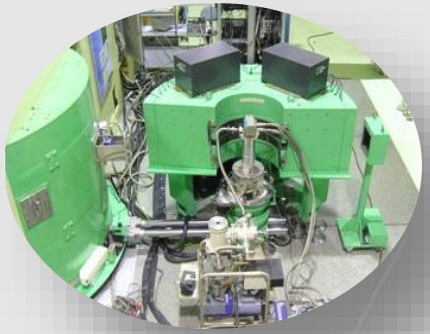
Utilizations of GAS-MPR Reactor

$^{99}Mo/^{99m}Tc$ (fission)
Generator
I-131
Ir-192

RI Production



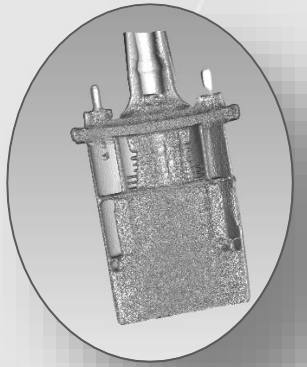
Power Ramp Test



Neutron Beam Research

Gemstones (topaz) Coloring

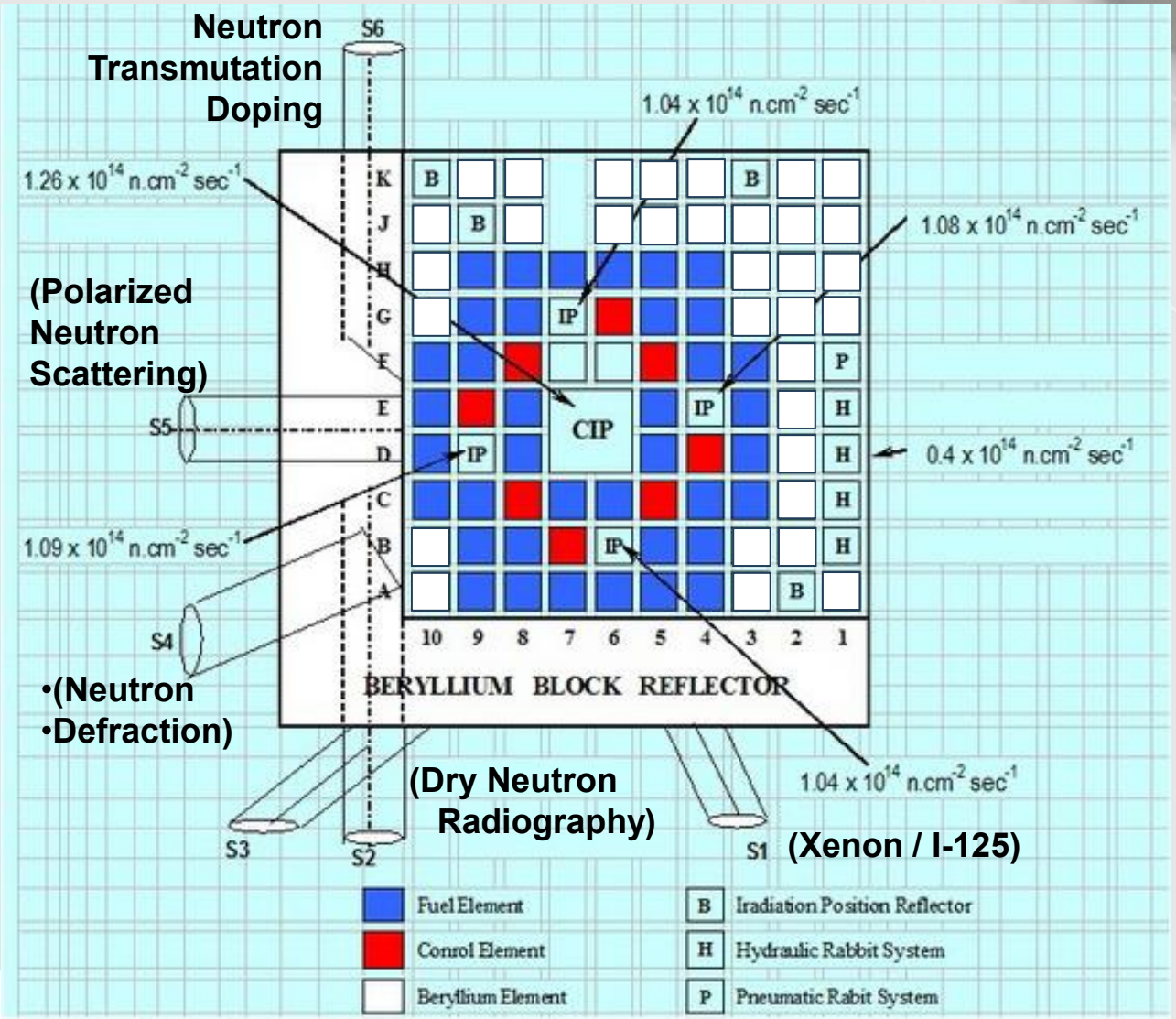
Neutron Activation Analysis



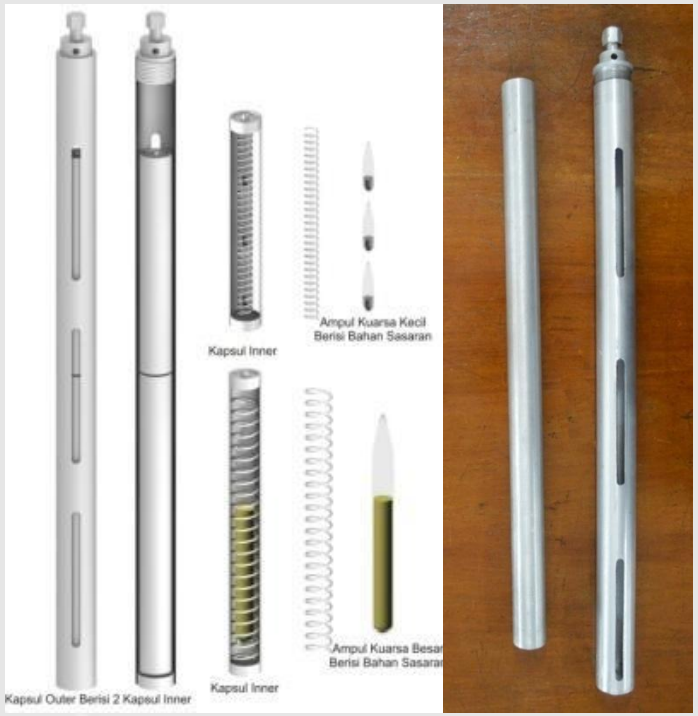
Neutron Radiography

The configuration of Siwabessy Reactor core

Power	30 MW (Routine Op : 15 MW) → 5MW
Neutron Flux	1.2-1.5 x 10^{14} n/cm^2.s 0.5-0.6 x10^{14} n/cm^2.s
Cooling Material	Light Water
Fuel Type	MTR
Fuel Material	U_3Si_2Al
^{235}U Enrichment	19.75 %
^{235}U Density	2.96 gr/cm^3
Absorber	Ag-In-Cd
Number of Control Rod	8
Reflector	Beryllium
Number of Neutron Beam	6
Radiation Protection Facility	Warm Water Layer



Radioisotope Production (for Research)



CIP capsule

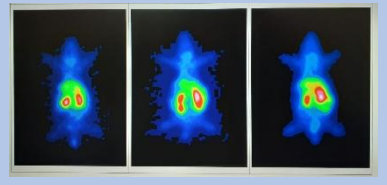
Xenon loop for I-125 Production

Rabbit capsule

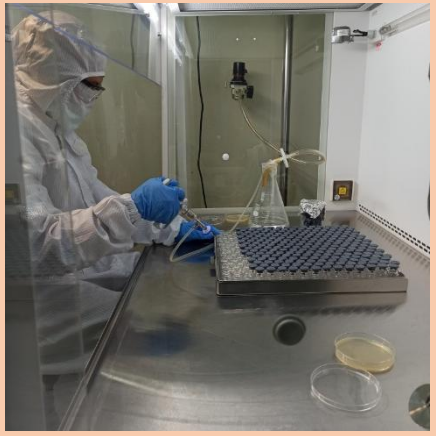
No	Radioisotope	Nuclear reaction	Target	Radiation
1	Sm-153	$^{152}Sm\ (n,\gamma)\ ^{153}Sm$	Sm_2O_3	β^- (694, 641 KeV) γ (103 KeV)
2	I-131	$^{130}Te\ (n,\gamma)\ ^{131}Te \rightarrow ^{131}I$	TeO_2	β^- (190 KeV) γ (606, 364, 248 KeV)
3	Mo-99	$^{98}Mo\ (n,\gamma)\ ^{99}Mo$	MoO_3	β^- (1215 KeV) γ (739 KeV)
4	Tc-99m	$^{98}Mo\ (n,\gamma)\ ^{99}Mo \rightarrow ^{99m}Tc$		γ (140 KeV)
5	P-32	$^{32}S\ (n,p)\ ^{32}P$	Sulfur	β^- (1710 KeV)
6	Ir-192	$^{191}Ir\ (n,\gamma)\ ^{192}Ir$	Ir wire	β^- (208, 160 KeV) γ (316, 468, 308.. KeV)
7	Au-198	$^{197}Au\ (n,\gamma)\ ^{198}Au$	Au foil	β^- (961, 285 KeV) γ (411 KeV)
8	Lu-177	$^{176}Lu\ (n,\gamma)\ ^{177}Lu$ $^{176}Yb\ (n,\gamma)\ ^{177}Yb \rightarrow ^{177}Lu$	Lu_2O_3 / Yb_2O_3	β^- (496, 175 KeV) γ (208, 112, KeV)
9	Ho-166	$^{165}Ho\ (n,\gamma)\ ^{166}Ho$	Ho_2O_3/ Dy_2O_3	β^- (1773, 1854 KeV) γ (80 KeV)
10	Gd-153	$^{152}Gd\ (n,\gamma)\ ^{153}Gd$	Gd_2O_3	γ (76 KeV)
11	Sc-45	$^{45}Sc\ (n,\gamma)\ ^{46}Sc$	Sc_2O_3/ Sc foil	β^- (111 KeV) γ (889, 1120 KeV)
12	I-125	$124Xe\ (n,\gamma)\ ^{125}Xe \rightarrow ^{125}I$	Xe gas	γ (35 KeV)

RESEARCH CENTER FOR RADIOISOTOPE AND RADIOPHARMACEUTICALS TECHNOLOGY (BATAN)

Build in 2013-2017



Research facilities for Radioisotope and Radiopharmaceuticals Development



GMP facilities for Radiopharmaceutical Cold-kit Production

Hot-lab for Radionuclide and Labelled Compound Production

BRIN
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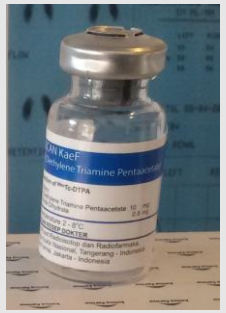
Collaborate since 2011

batan

kimia farma

2013



Renalscan KaeF
(DTPA)

Bonescan KaeF
(MDP)

Cardioscan Kaef
(MIBI)

2016

TB-scan
(Ethambutol Kit)

2021

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STOP

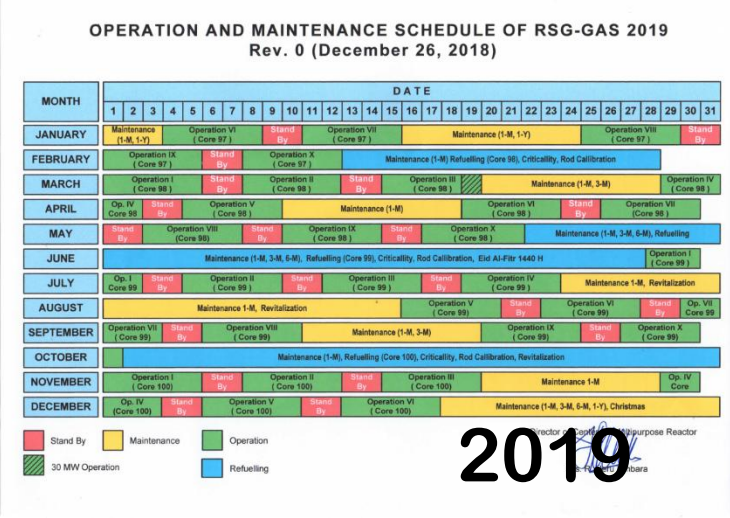
2022

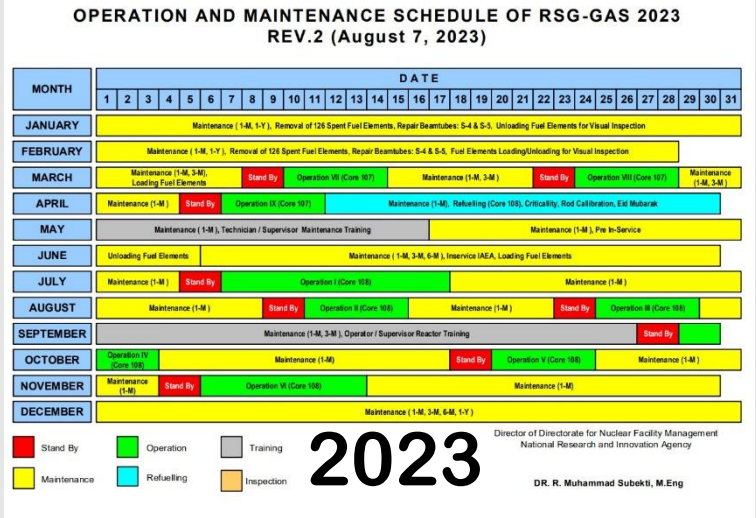
2019

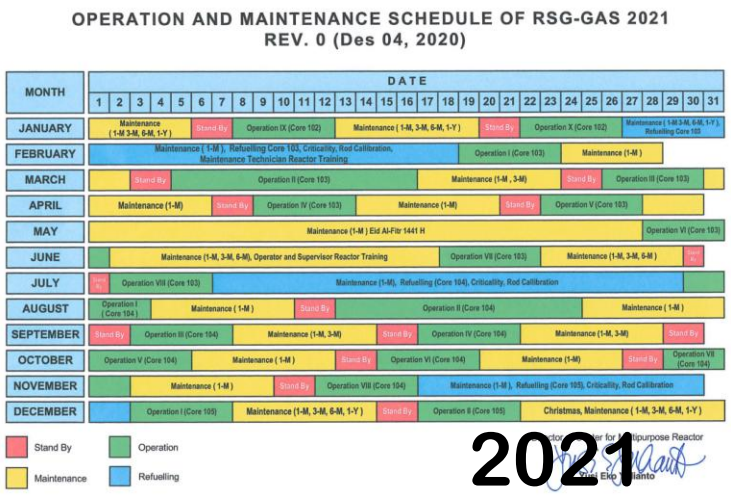
T-Bone KaeF
(^{153}Sm-EDTMP)

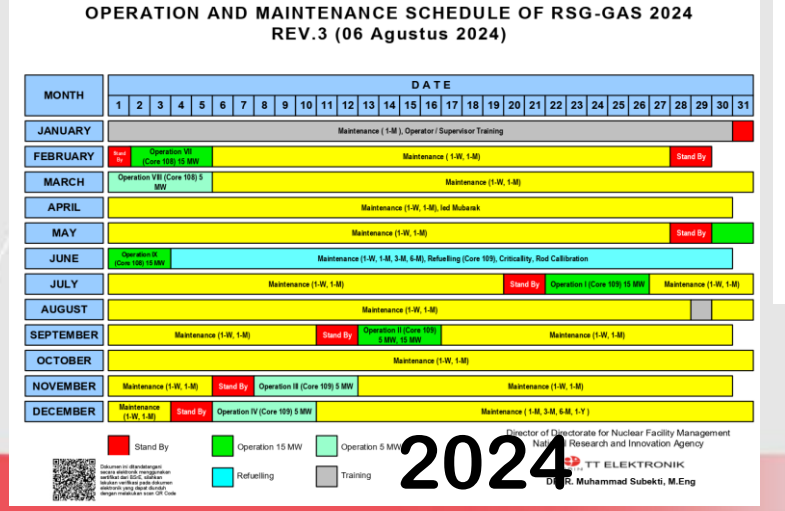
Endoneuroscan KaeF
(^{131}I-MIBG)

Reactor Operation Schedule

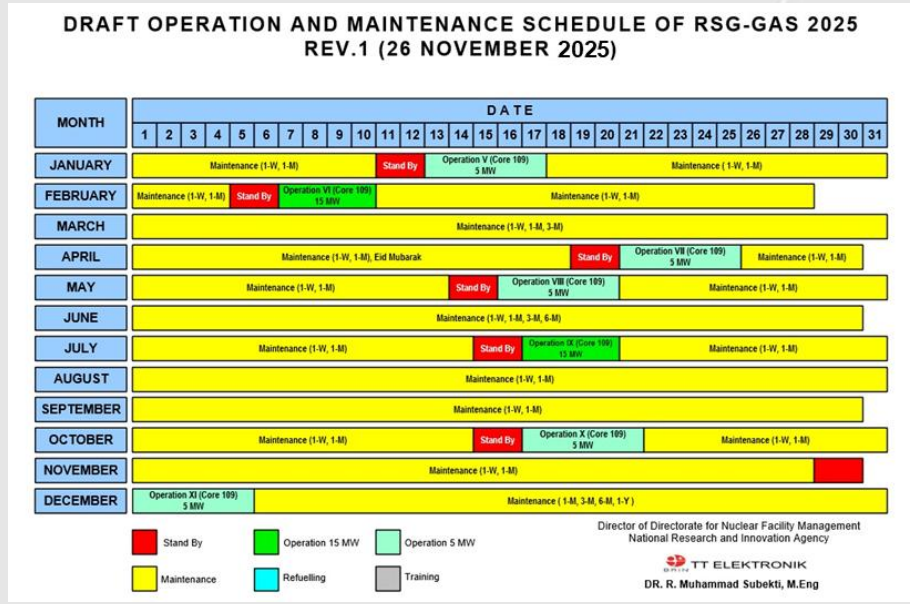








2025



Decontamination and Revitalisation Program for Nuclear Facilities Program

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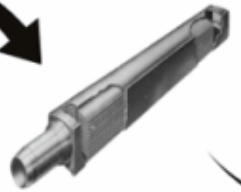
02 Revitalization and Improvement of RSG-GAS Utilization

Decontamination and Radioactive Waste Management 04

Radiation Safety System
Radiation Protection System

Fabrication of nuclear fuel for research reactors

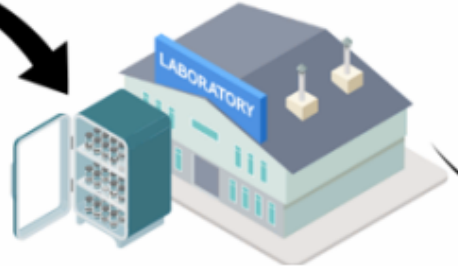
to produce



Research reactor fuel

used

Research Reactor in Operation



RIRP's facilities

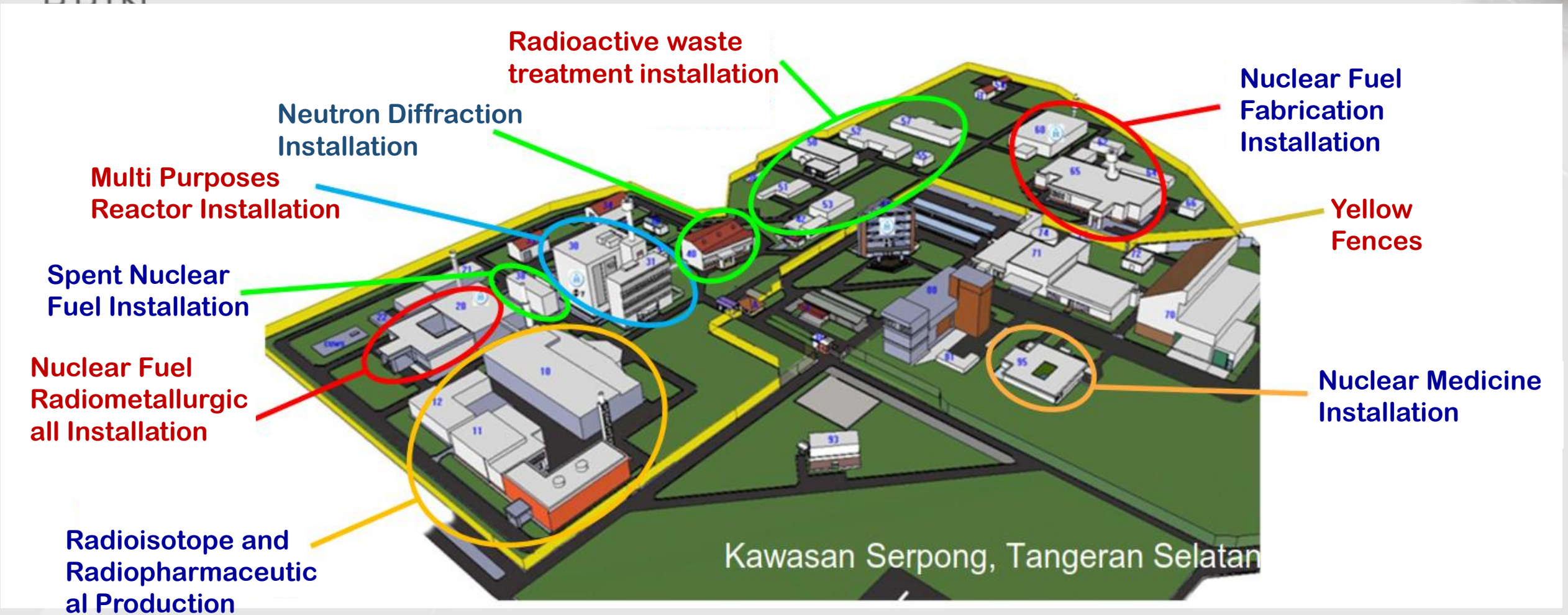
RIRP's Product

03 Radioisotope and Radiopharmaceuticals production technology

01 Revitalization and Development of Nuclear Fuel Fabrication Facilities

Research and Innovation PeLUIt Reactor Technology 05

Directorate of Nuclear Energy Facilities Management
Location : KST BJ Habibie, Tangerang Selatan



Ac-225 Radiopharmaceuticals: Emerging Potentials and Challenges in Indonesia”

- CRP F22075 : Production and Quality Control of Ac-225 radiopharmaceuticals
- RC26334 : Production and Quality Control of (Ac-225) Ac-PSMA-I&T for Treatment of Prostate Cancer in Indonesia

Emerging Potentials In Indonesia

Indonesia’s/ **BRIN** infrastructure (reactors, radiopharmacy labs) provides a foundation.

- Opportunities:
  - **Local production** of Ac-225 from Th-229 decay or Ra-226 targets.
  - **Research collaboration** with hospitals and universities for clinical trials.
  - **Development of indigenous ligands** suited to local cancer prevalence.
  - Could position Indonesia as a **regional hub for alpha therapy radiopharmaceuticals.**

Ac-225 Radiopharmaceuticals: "Emerging Potentials and Challenges in Indonesia"

Challenges :

Aspect	Challenges
Production	• Limited access to parent isotopes (Th-229, Ra-226); lack of high-energy accelerators. • Based on BRIN Waste management : 4.7 Ci (Ra-226 seal in SS capsule) 4.0 Ci (Ra-226 not yet conditioned)
Radiochemistry	• Complex handling of alpha emitters; need for shielded hot cells and advanced chelation chemistry.
Regulation & Safety	• High radiotoxicity requires strict handling, waste management, and dosimetry protocols.
Clinical Translation	• Need for trained personnel, GMP facilities, and ethical approval pathways.
Economic Feasibility	• High initial investment; uncertain reimbursement and market size.

Facilities prepared for the synthesis of radiopharmaceutical Ac-225

CONCLUSION

- Currently, all radioisotopes and radiopharmaceuticals in Indonesia are imported.
- Revitalization of existing nuclear facilities is very important for reactor operations, especially for the production of radioisotopes and radiopharmaceuticals in Indonesia.
- Strategic investment, capacity building, and international cooperation are key to success.
- Ac-225 radiopharmaceuticals represent a transformative leap in nuclear medicine.
- With proper planning, Indonesia could become a leader in alpha-based targeted therapy in Southeast Asia.

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Terima Kasih

Thank You ありがとう
감사합니다 Рақмет сізге

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