Current developments on new production

The PALLAS-reactor

RPC Schram
NRG | PALLAS
The Netherlands

International Workshop on Medical Radioisotopes Supply October 30-31, 2023 Paris, France

What is NRG | PALLAS?

A personal union, 1 board of directors, 1 governing board, of two entities:

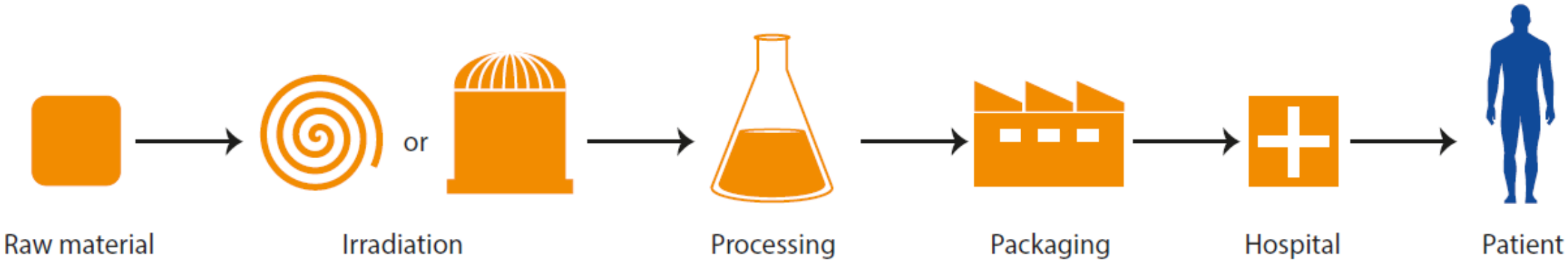
Nuclear Research and consultancy Group

- Founded 1998
- 700 FTE
- Locations: Arnhem, Petten (50 km north of Amsterdam)
- Crucial position in supply chain for medical isotopes through reactor + labs

PALLAS

- Founded 2013
- 100 FTE, >400 FTE on contract basis
- Location Alkmaar
- Design & licensing & building of PALLAS-reactor

The supply chain of nuclear medicine



Source | Medical Isotopes, Global Importance and opportunities for the Netherlands, in a EU context

All boxes must be checked

All boxes must be checked for Security of Supply

One box not checked => Backup Supply

No Backup Supply available? => **Shortage**

Sufficient raw Materials

Available irradiation capacity

Available processing capacity

Available packaging & logistics

Available treatment rooms

Source | Medical Isotopes, Global Importance and opportunities for the Netherlands, in a EU context

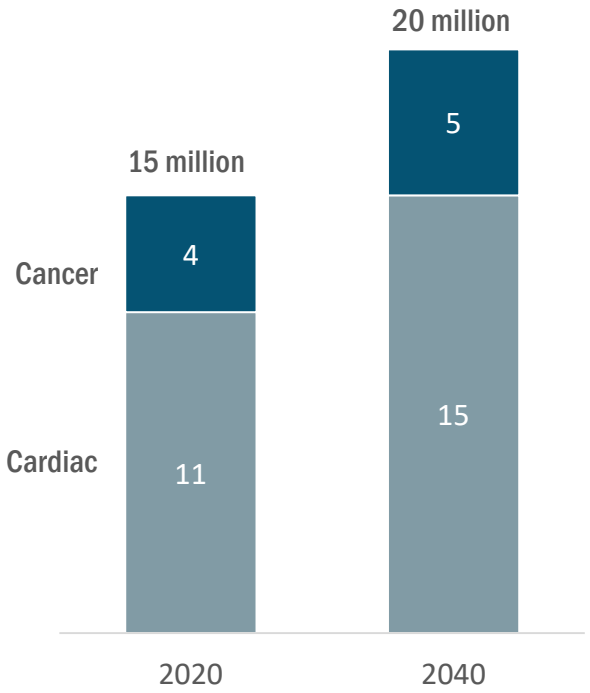
Supply & Shortages

The supply of nuclear medicine requires

- having the appropriate capacity ➔ Sufficient amount of reactors for normal demand
  Backup supply (outage reserve capacity) in case of outage
- available at the right time ➔ Well-planned reactor schedule
- through interconnected supply chain ➔ All boxes must be checked

Demand EU

new patients per year in Europe



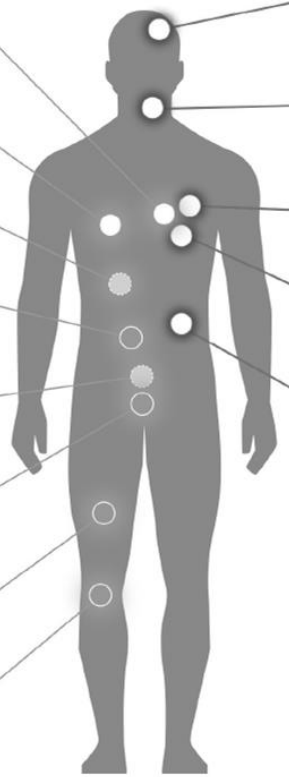
treatments with medical isotopes per year in Europe

Reactor-isotopes

10 million SPECT-scans

Therapy 0,2 million doses

- molybdeen-99 — diagnosis of diseases - e.g. heart failure, cancer - using Technetium-99m
- xenon-133 — lung ventilation studies
- holmium-166 — therapy of e.g. liver tumours
- lutetium-177 — therapy of e.g. neuroendocrine tumours
- iodine-125 and iodine-131 — therapy of prostate cancer and thyroid conditions
- iridium-192 — therapy of cervical, prostate, lung, breast and skin cancer
- strontium-89 — pain management in bone cancer
- yttrium-90 — therapy of liver cancer and rheumatic conditions



Cyclotron-isotopes

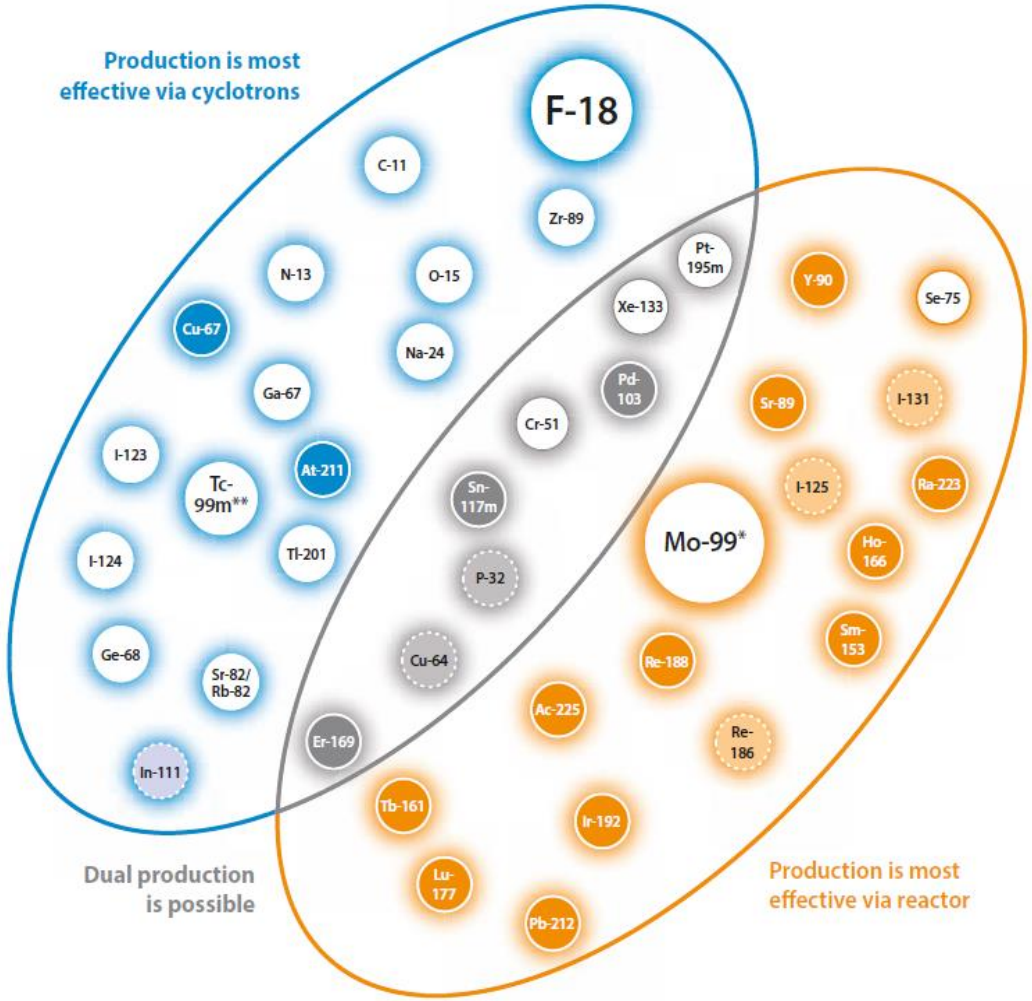
1,8 million PET-scans

- indium-111 — diagnoses, investigations of the brain and colon
- iodine-123 — diagnosis of thyroid function
- thallium-201 — detecting cardiac conditions
- rubidium-82 — detecting cardiac conditions
- gallium-67 — diagnosis of infections and inflammation

MEDRaysintell:
48 million procedures
globally per year

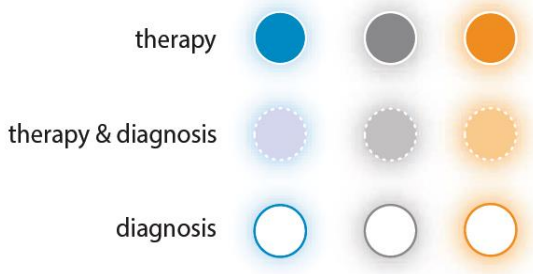
Source | **Globocan, Nucleair Nederland, MEDRaysintell, IKNL, RIVM**

Therapeutic isotope production requires reactors



Reactor (neutron-based) production options:

- Research Reactors
- Other reactortechnologies, such as SHINE
- Power Reactors



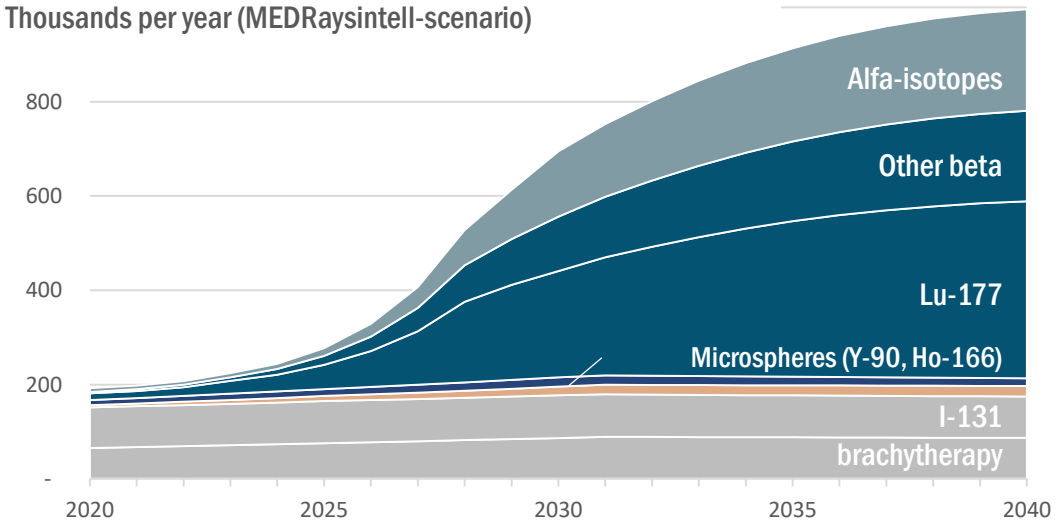
Source | Medical Isotopes, Global Importance and opportunities for the Netherlands, in a EU context

Therapeutic isotopes demand is growing

Therapeutic isotopes

 # treatments in Europe

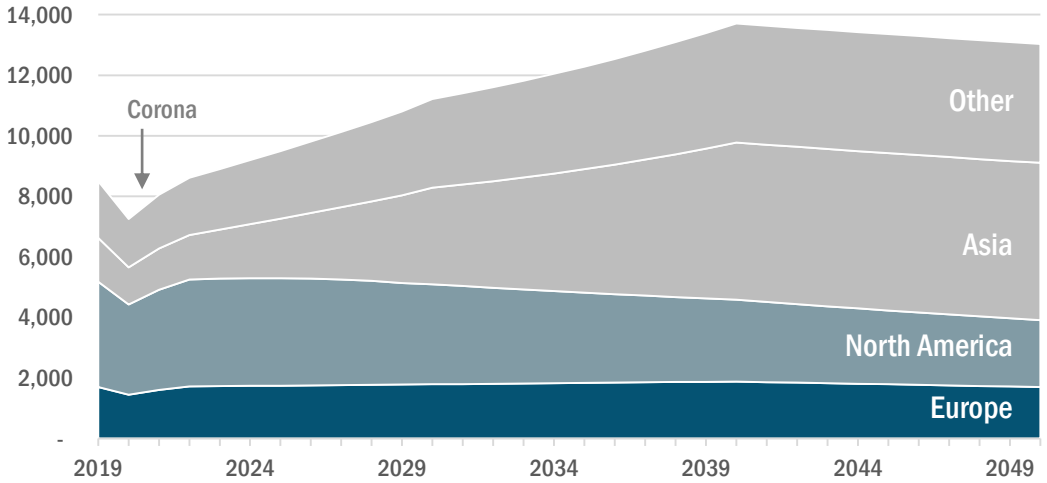
Thousands per year (MEDRaysintell-scenario)



Diagnostic isotopes (Mo-99)

Global volume Mo-99

6D Ci-EOP per week (base scenario)



Source | **MEDRaysintell 2021, investor document BC 1.2 (15-dec 2022)**

Supply chain dependent on handful of reactors

Many current reactors may stop in 2030-2040

Europe

- HFR
- BR2
- LVR-15
- Maria

- Safari

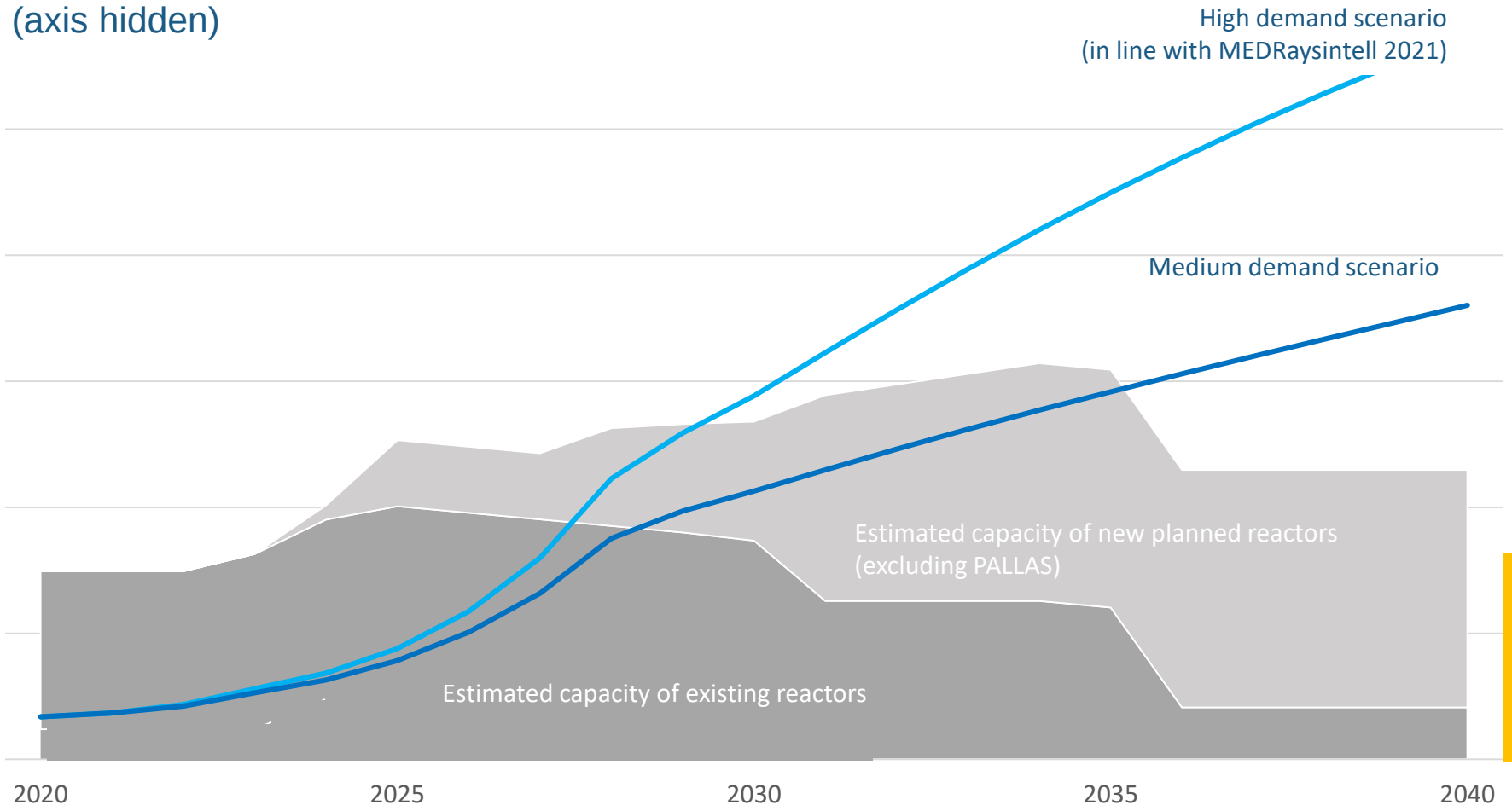
But there are new initiatives

- PALLAS – Will take over from HFR
- FRM-II – New Mo-99 facility
- JHR – Start after 2030
- ARTHUR – Feasibility stage
- MYRRHA – beyond 2027, accelerator produced radionucludes

- NorthStar, SHINE, Niowave, newbuilt MURR ..
- BWXT / OPG

Risk of shortage, new initiatives are needed

Very indicative supply and demand scenario for Lu-177 nca (based on scarce data) (axis hidden)



Conclusions

- Shortages will emerge if no reactor capacity is added
- The gap needs to be filled by new initiatives

Disclaimer:
Capacities of other reactors are not published and depend on many factors

Likewise, demand cannot accurately be predicted for the coming 20 years. It could be double or half or what is shown.

Source: Lu-177 nca capacity model (2021)

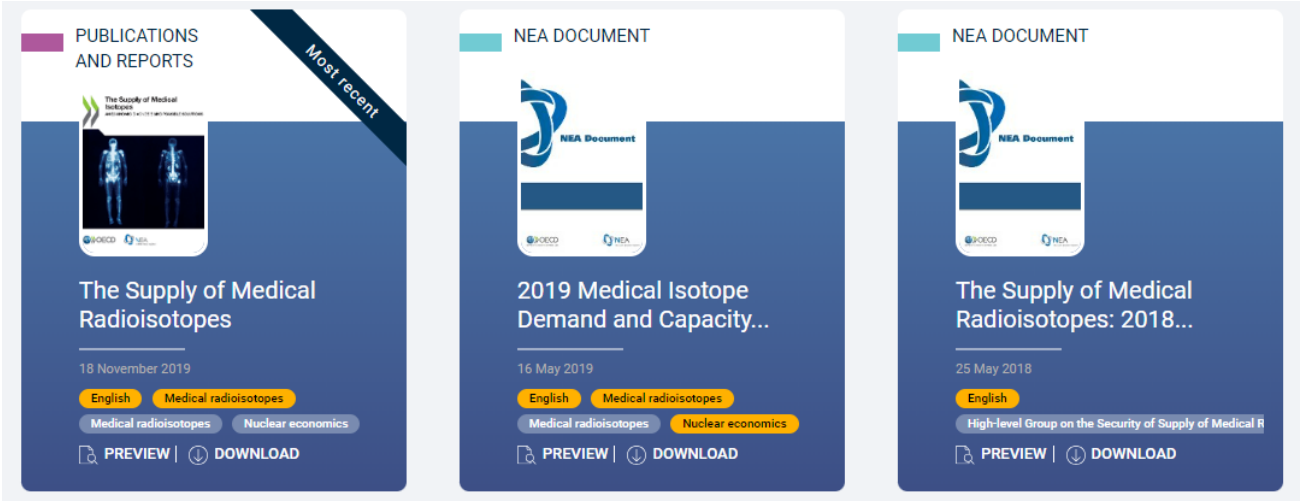
What was the problem again?

- From 2008-2010, global isotope blackout:
  - Vulnerable supply chain for diagnostics, Mo-99, simultaneous outage of 2 large isotope reactors (HFR, NRU)
  - ageing reactors, discussion on full cost recovery

- Now:
  - **better organized** global supply chain, especially for diagnostics, Mo-99
  - **volumes have gone up**, a more **diverse therapeutic isotope portfolio**
  - **consider the whole supply chain:** not only reactors, also raw materials,processing capacity, and clinical capacity
  - **supply chain remains fragile**

NEA High-level Group (HLG-MR)

- During its four mandates (2009 – 2017) the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) has delivered insight in supply & demand situation, economic analyses, mitigation measure (six principles), etc.
- And most of all: **created awareness in the medical community and governments**



PALLAS-reactor

PALLAS-reactor

Goverment decisions

- Full financing of the investment of the project available
- Completion of legal procedure for starting a state-owned entity
- A detailed plan for governance of the building project

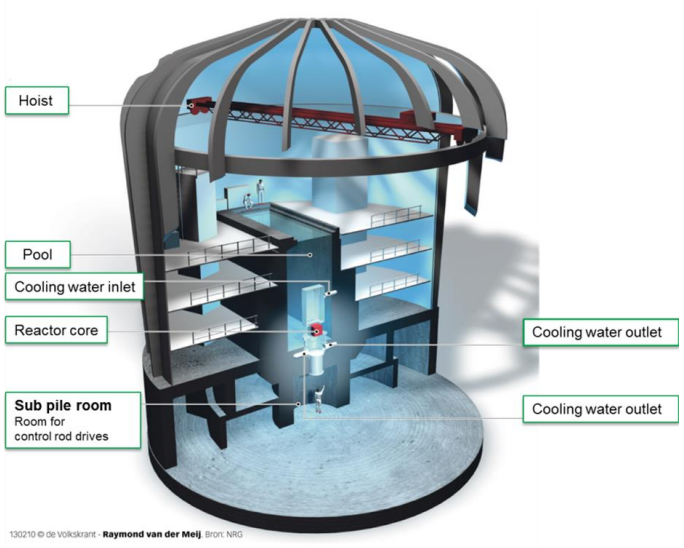
- Completion of the state-aid procedure with the EC — Pending, in progress

Planning

- Pit & Foundation, preparatory works — 2022
- Pit and Foundation works started — Q1 2023
- Reactor Construction – General contractor planned start — Q4 2024
- Operation - planned — around 2030

High Flux Reactor & PALLAS-reactor

High Flux Reactor

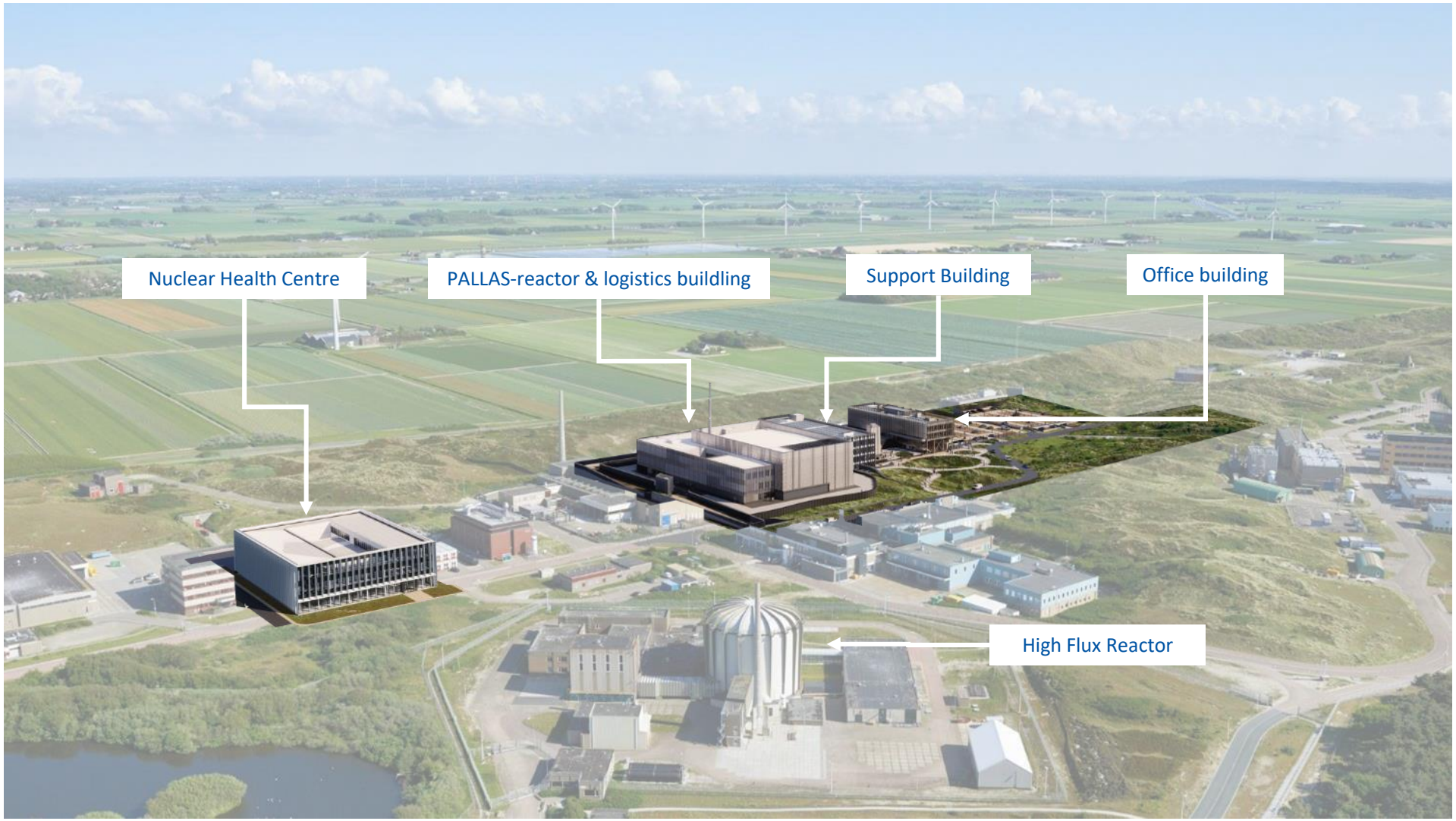


- Designed for research
- Construction 1957-1960
- Operational since 1961
- 45 MW thermal power
- 260-265 full power days per year

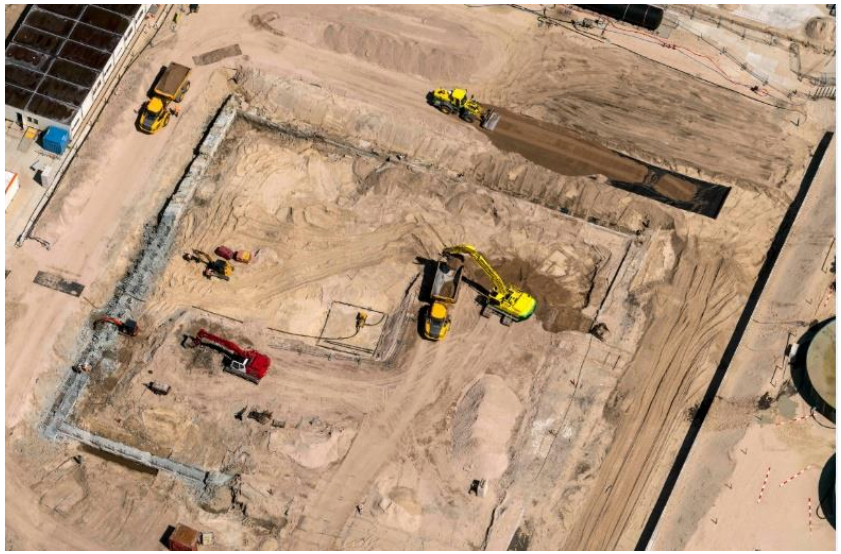
PALLAS reactor

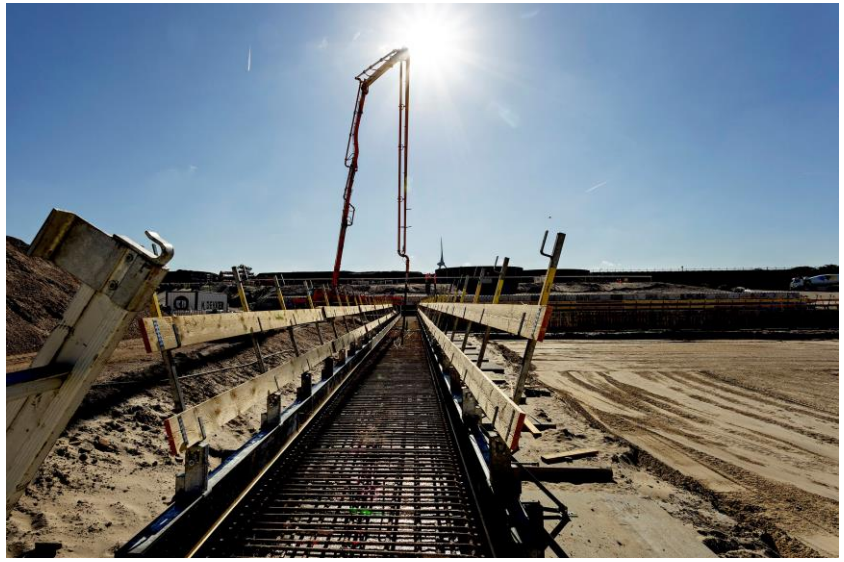
- Designed for medical isotopes and research
- Project started in 2013
- Start operation target 2030 — PALLAS will take over HFR role
- 25 MW thermal power
- 300 full power days per year

Overview

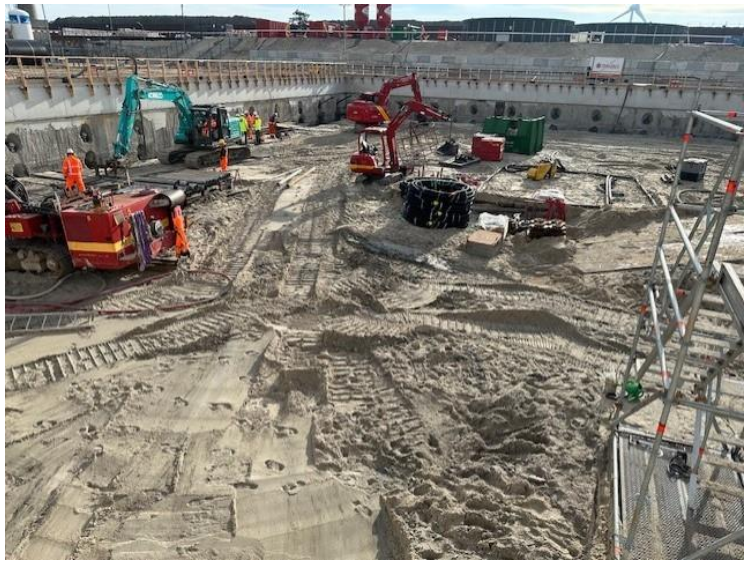

Nuclear Health Centre
PALLAS-reactor & logistics buildling
Support Building
Office building
High Flux Reactor

PALLAS-REACTOR: construction of Pit & Foundation



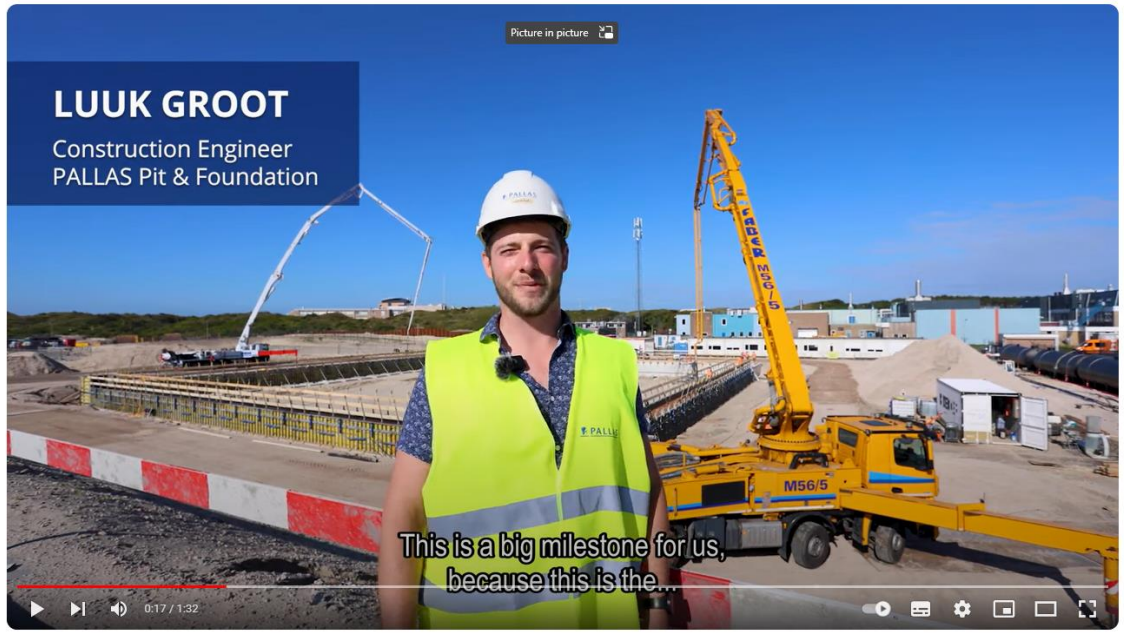


PALLAS-REACTOR: construction of Pit & Foundation



PALLAS-REACTOR on Youtube

Luuk Groot, Construction Engineer, explains works done on the ring beam, https://www.youtube.com/watch?v=H9eE6l810cc



Onsite Video Update PALLAS Programme September 2023 (1)

PALLAS- reactor
119 abonnees
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13
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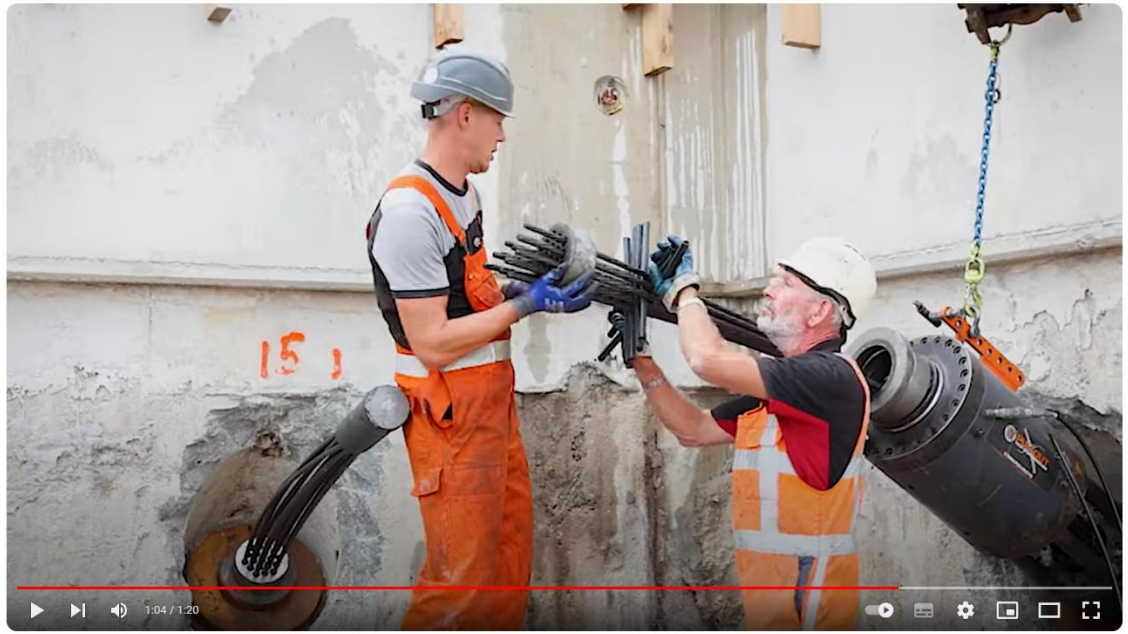
Opslaan

The overview of the recent works including anchoring, https://www.youtube.com/watch?v=HwbpQhtXiw



Onsite Video Update PALLAS Programme September 2023 (2)

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Thank you

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