

# The PALLAS Reactor

**KIVI-NNS, 14 April 2023**

Jan van der Marel, Technical Director PALLAS Reactor



# Who am I?



- 30 years of experience in engineering, consultancy and project management, of which 10 years in the nuclear industry
- PALLAS Reactor Project: Technical Project Director responsible for
  - Engineering and Commissioning
  - Safety Demonstration, Quality and Information Management
- Nuon / Vattenfall
  - Director Engineering new build projects
  - Project Manager life time extension Velsen 24, Velsen 25 and IJmond power plants.
  - Technical Project manager new build Hemweg 9 and Diemen 33 gas power plants
- Education: Master of Business in Energy Systems. TU Delft
- Jacobs:
  - Project Manager / Consultant energy and utilities projects
- Comrimo / Nucon
  - Nuclear I&C and process engineer
- Education: Applied Physics, TU Delft

# INTRODUCTION

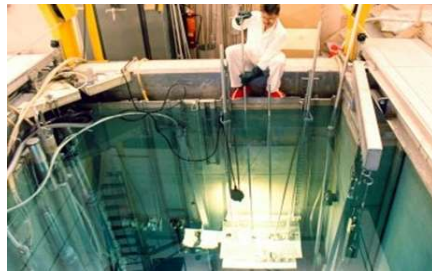
Supported by the Dutch Government



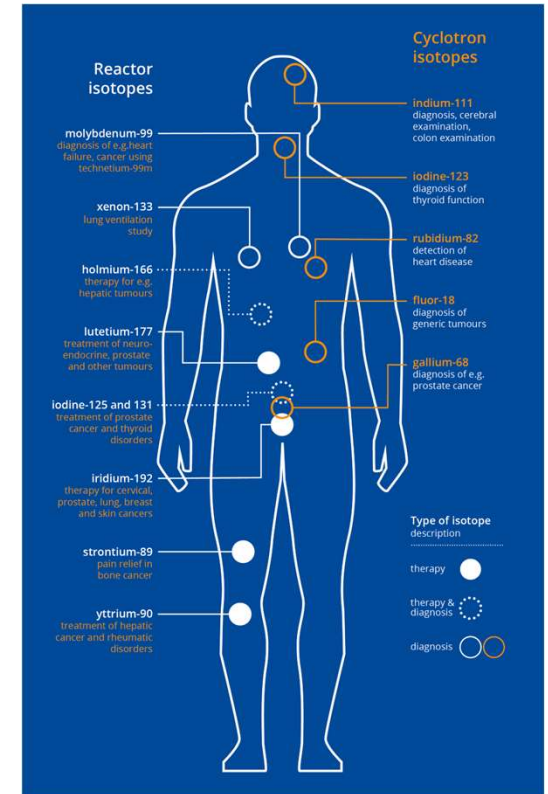
Secure supply of medical isotopes



Key nuclear infrastructure



Driver of local economy



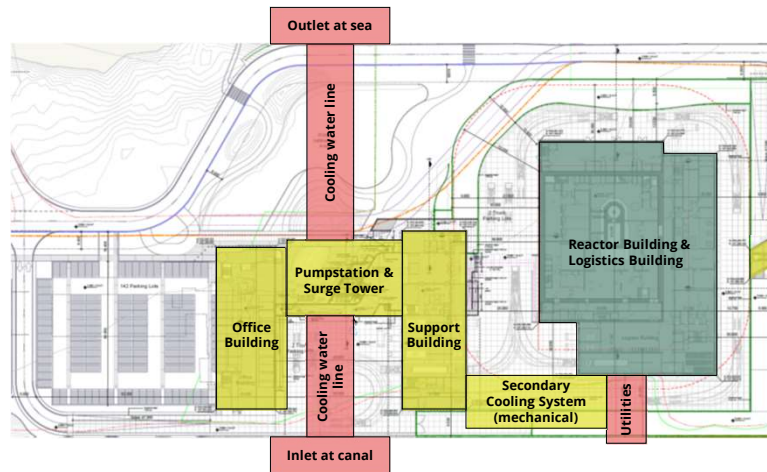


# PROJECT SCOPE



# PROJECT SCOPE

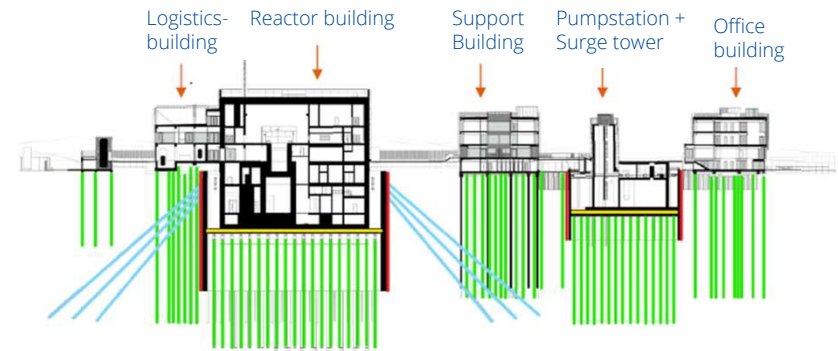
- Reactor building
- Auxiliary buildings and site
- Outside 'the fence'



PALLAS Reactor & Logistics building

Support building

Office building



# ARCHITECTURE VIDEO

PALLAS



# 9 YEARS OF PALLAS

- PALLAS was founded December 2013
- Funded by the Ministry of Economic Affairs and Province of North Holland with in total 80M Euro
- With the assignment to develop the PALLAS reactor replacing the HFR

## Objectives:

1. Develop the design
2. Obtain the licences
3. Develop the business case
4. Obtain financing

## Short Story

✓

✓

✓

✓

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Long Story  
Challenges  
Successes  
Set backs  
Reviews  
Changes of Strategy  
Milestones achieved  
Hard work and extra hours

PALLAS  
has many  
lessons  
learned



# DEVELOP PALLAS ORGANISATION



- Develop 'from scratch' an organisation that:
- Is a **Nuclear Licensee** having a NEA for Construction
- Can demonstrate **Compliance** to the legal framework
- Has **Contracts** in place to design and execute the PALLAS reactor
- Is capable to manage the contracts and the work: "**Intelligent Customer**"
- 'Owns' the "**Safety Case**"
- Can fulfil the role of "**Design Authority**"
- Is capable to apply a "**Graded Approach**"
- Has all the attributes and "**Safety Culture**" of a capable nuclear organisation
- Has the support "**draagvlak**" from local, regional and national stakeholders

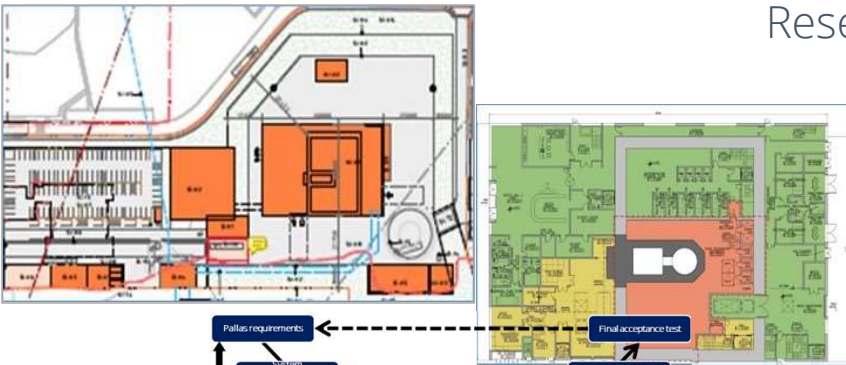
=> Will realize the first new nuclear reactor in NL since NPP Borssele mid 70's

That is quite a Journey!!

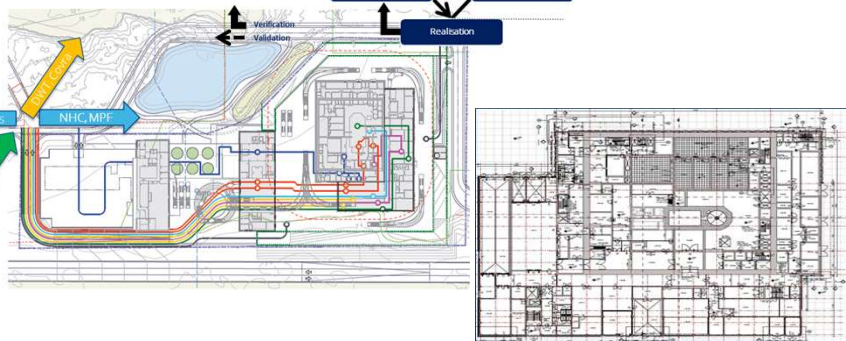
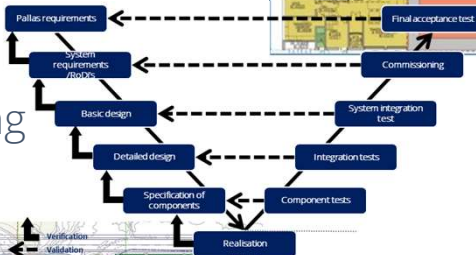
# DEVELOP PALLAS ORGANISATION - DESIGN PERSPECTIVE



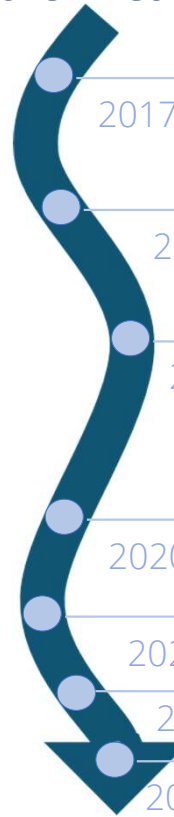
Research Reactor



Systems Engineering



Medical Isotope Production Facility



2017 User requirements defined

2018 Conceptual Design; Value Engineering

2019 Design Integration Site Layout

2019 Design Integration Building Layout

2020 Basic Design ready

2021 Integrated Design for Production, Waste and Radiation Protection

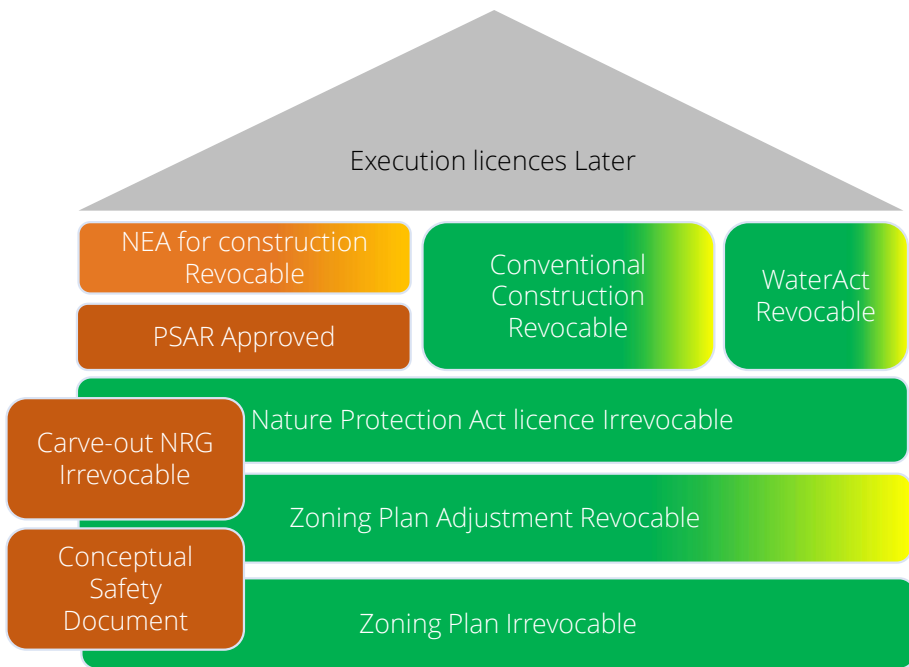
2022 PALLAS becomes Design Authority

2022 Detailed Design Started

# DEVELOP PALLAS ORGANISATION – SAFETY & LICENSING



## Research Reactor



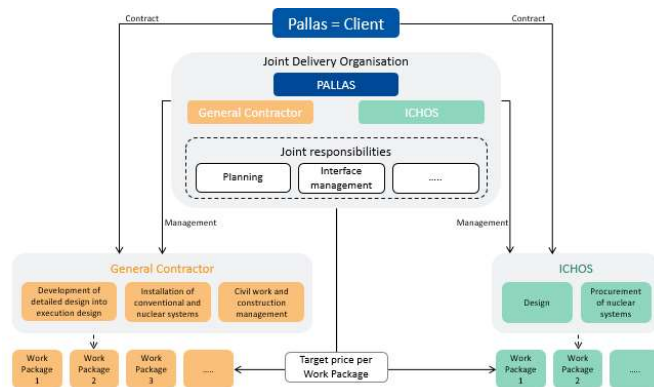
2017	DSR	EIA Zoning plan
2018	CSD	
2019		Zoning plan Adjustment
2020	PSAR	Nature Protection act (Nitrogen!)
2021	NRG carve-out	EIA
2022	PSAR approved	WaterAct licence
2022	NEA submitted	Conventional Construction Licence

## Medical Isotope Production Facility

# DEVELOP PALLAS ORGANISATION - CONTRACTING



## Research Reactor

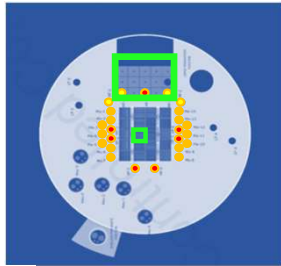


- 2017 User requirements defined
- 2018 EPCM/EPC Contract with ICHOS
- 2019 Conceptual Design under EPCM  
Basic Design under EPCM
- 2020 Construction Company left ICHOS
- 2021 Market Consultation  
Tender Strategy
- 2022 Definition of joint Delivery Model
- 2022 Tender for General Contractor  
Medical Isotope Production Facility

# DEVELOP PALLAS ORGANISATION BUSINESS CASE & FINANCING PERSPECTIVE



Irradiation positions and # hot cells.



Capability Reports

Document Number: PALS-0000-2009EN-001-A  
PALLAS Foundation  
PALLAS Project

Document Number: PALS-7620-2009EN-004-B  
PALLAS Foundation  
PALLAS Project

Document Number: PALS-0000-2009EN-001-C  
PALLAS Foundation  
PALLAS Project

RESTRICTED  
CAPSULE BASED EXPERIMENTAL IRRADIATION FACILITIES - DESCRIPTIVE REPORT  
Presented by ICHOS for PALLAS Foundation  
June 2020  
Page 1 of 10

RESTRICTED  
MOLYBDENUM-99 PRODUCTION CHAIN AVAILABILITY ASSESSMENT  
Presented by ICHOS for PALLAS Foundation  
June 2020  
Page 1 of 21

RESTRICTED  
RADIOISOTOPE PRODUCTION - IRRADIATION ASSESSMENT  
Presented by ICHOS for PALLAS Foundation  
April 2021  
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**PALLAS**  
Business Case 4.0  
"It is PALLAS' mission to provide unique solutions for nuclear medicine and research"  
Preliminary version - DRAFT - CONFIDENTIAL  
Business Case & Financing Team, 27 June 2019

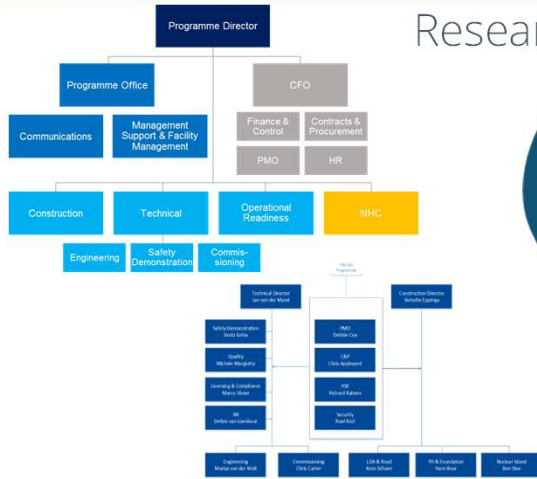
Research Reactor



- 2017 Assignment for private financing. BC v1.0
- 2018 Conceptual Design; Value Engineering  
Grow of therapeutic isotopes
- 2019 Letters of Intent from Investors  
Shifting towards Public Financing
- 2020 Ministry of Health investor
- 2021
- 2022 September 2022: Investment Decision!
- 2022 NewCo BC 4.0: PALLAS + NRG  
Medical Isotope Production Facility



# DEVELOP PALLAS ORGANISATION STAKEHOLDER AND PROJECT ORGANISATION PERSPECTIVE



## Research Reactor



2017  
Financed by Economic affairs & Province  
Set-up project organisation

2018

2019  
Shift towards ministry of Health

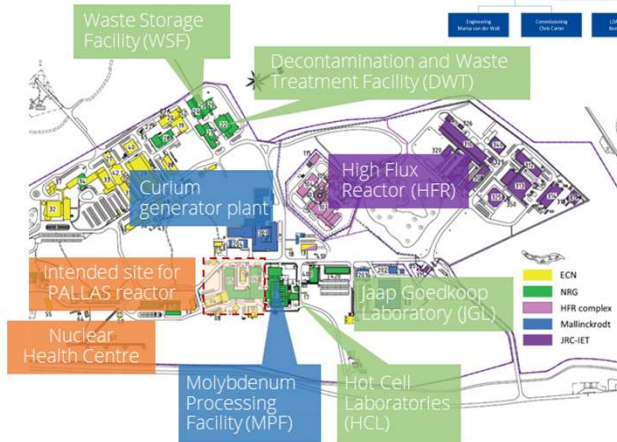
2020  
Integration with NRG started => NewCo

2021  
Restructure organisation from  
contract to project management

2022  
"Investment decision" to Ministry of health

2022  
Medical Isotope  
Production Facility

Positive investment decision on "NewCo"  
Lenders and Finance agreements





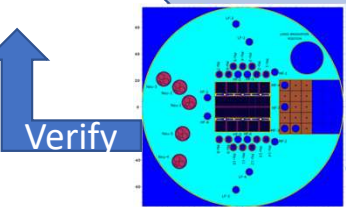
# REACTOR PROJECT



- Isotope Production Facility (no research reactor)
- Business Case (private as well as public)
- Safe / Licensable



- Safe Commercial Operation of the PALLAS reactor



- Guaranteed performance
- Number of irradiation positions
  - Neutron Flux
  - Cycle Length

Verify

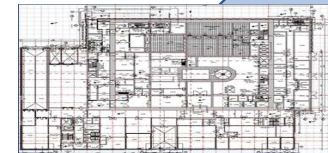
Validate

Validate

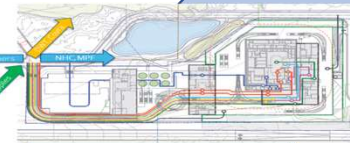
PSAR + Capability reports = Product Baseline



Verify



- Performance test



- Commissioning

Validate



Basic design / Technical Baseline

System integration test

Detailed design

Integration tests

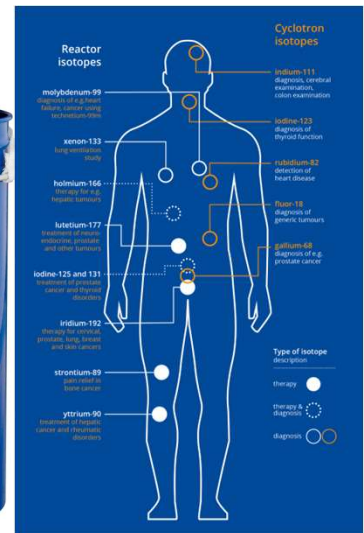
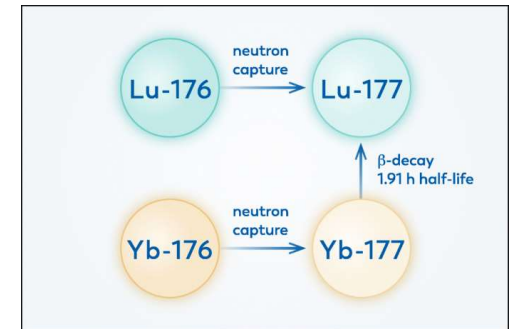
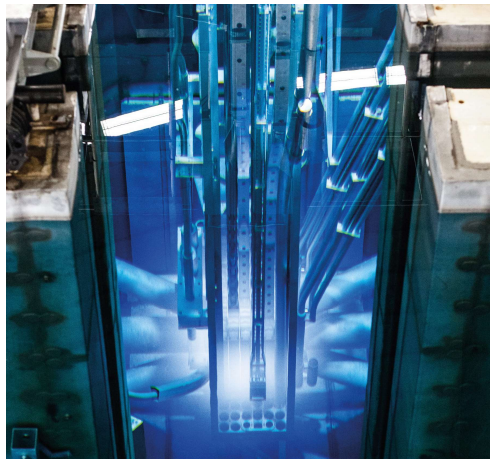
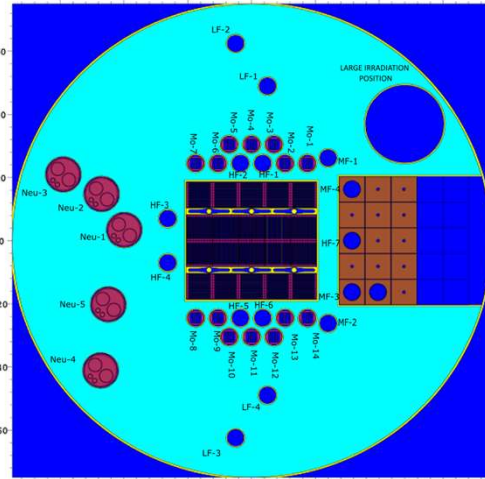
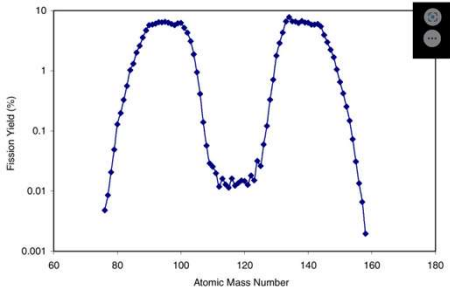
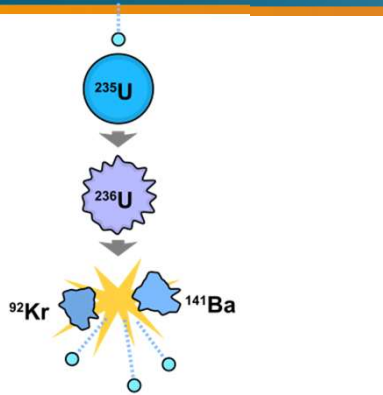
Specification of components

Component tests

Realisation



# ISOTOPE PRODUCTION



# SAFETY DEMONSTRATION TECHNOLOGY

“PALLAS shall ensure that protecting people and the environment from the harmful effects of ionising radiation, occupational or industrial hazards is always achieved”

## Fundamental safety functions

1. Reactivity Control
2. Cooling
3. Containment

## Defence in Depth levels

1. Level 1
2. Level 2
3. Level 3a 3b
4. Level 4

## Internal and external Hazards

- Flooding, storm
- Earthquake
- Fire

## PIE: Postulated Initiating Event

- Pipe Break
- Target melt

## Barriers and retention

- Cladding
- Water systems
- Containment

## Safety Classification

- Cladding
- Water systems
- Containment

## Safe Design Features

- Redundancy
- 2oo3
- Separation
- Diversity
- Passive systems
- Safety Margins

## DSA Deterministic Safety Assessment

- Neutronics
- Hydraulics

## PSA Probabilistic Safety Assessment

- Level 1: core damage
- Level 2: release
- Level 3: dose to public

# REACTOR PROJECT CAPABILITIES: SAFETY



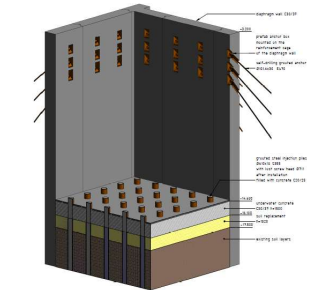
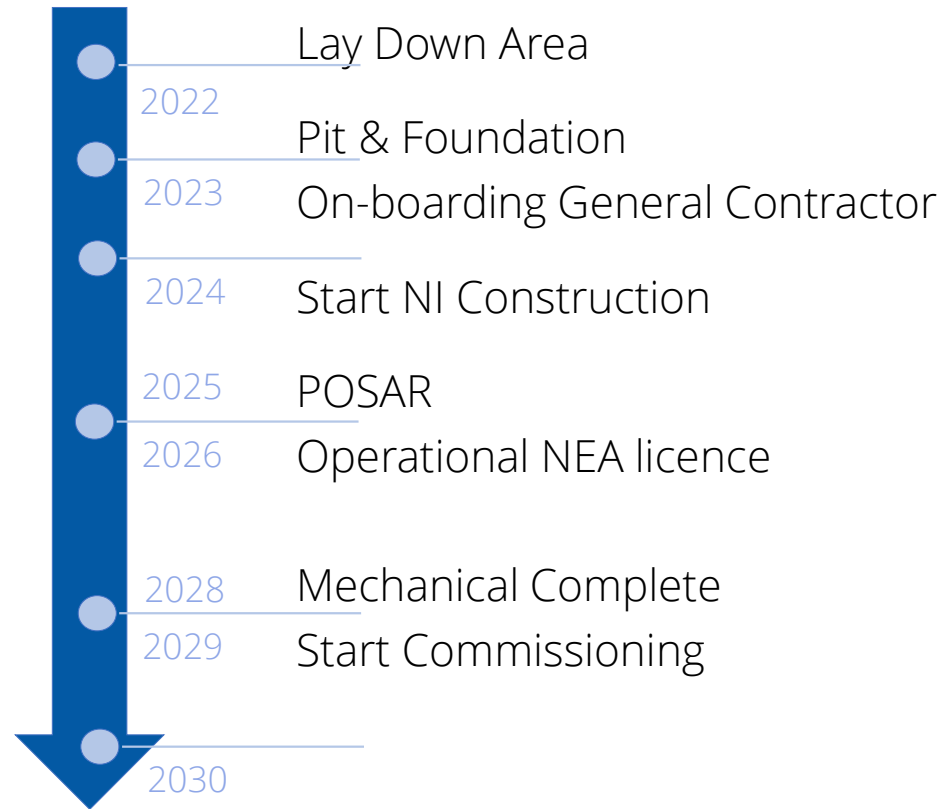
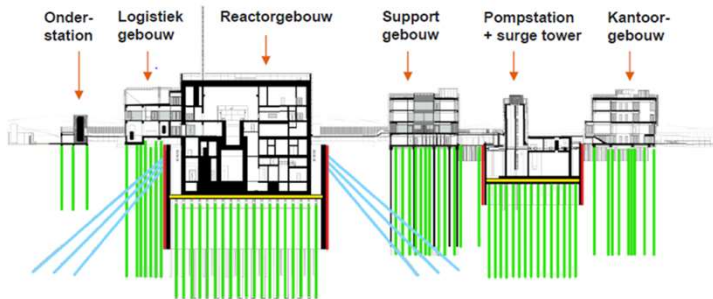
“PALLAS shall ensure that protecting people and the environment from the harmful effects of ionising radiation, occupational or industrial hazards is always achieved”

- Very strong Design Safety Characteristics
  - Reactivity Control
    - Negative feedback coefficients
    - Diverse and independent second shut down system
  - Cooling
    - Passive cooling with natural circulation after shut down
    - Sufficient water for 72 hours grace time with no intervention required
  - Confinement
    - Barriers and Retention functions
- Very low risk to workers and public
  - Core Damage Frequency is more than two orders of magnitude below legal limit
  - The maximum individual risk is more than three orders of magnitude below legal limit
  - Dose to workers and public are well within legal limits



# AND NOW: STRAIGHT LINE FROM CONSTRUCTION TO COMMERCIAL OPERATION

## Design + Licences + Funding



Commercial operation of PALLAS Isotope Production Facility



Thank you for your attention!

Any questions?

