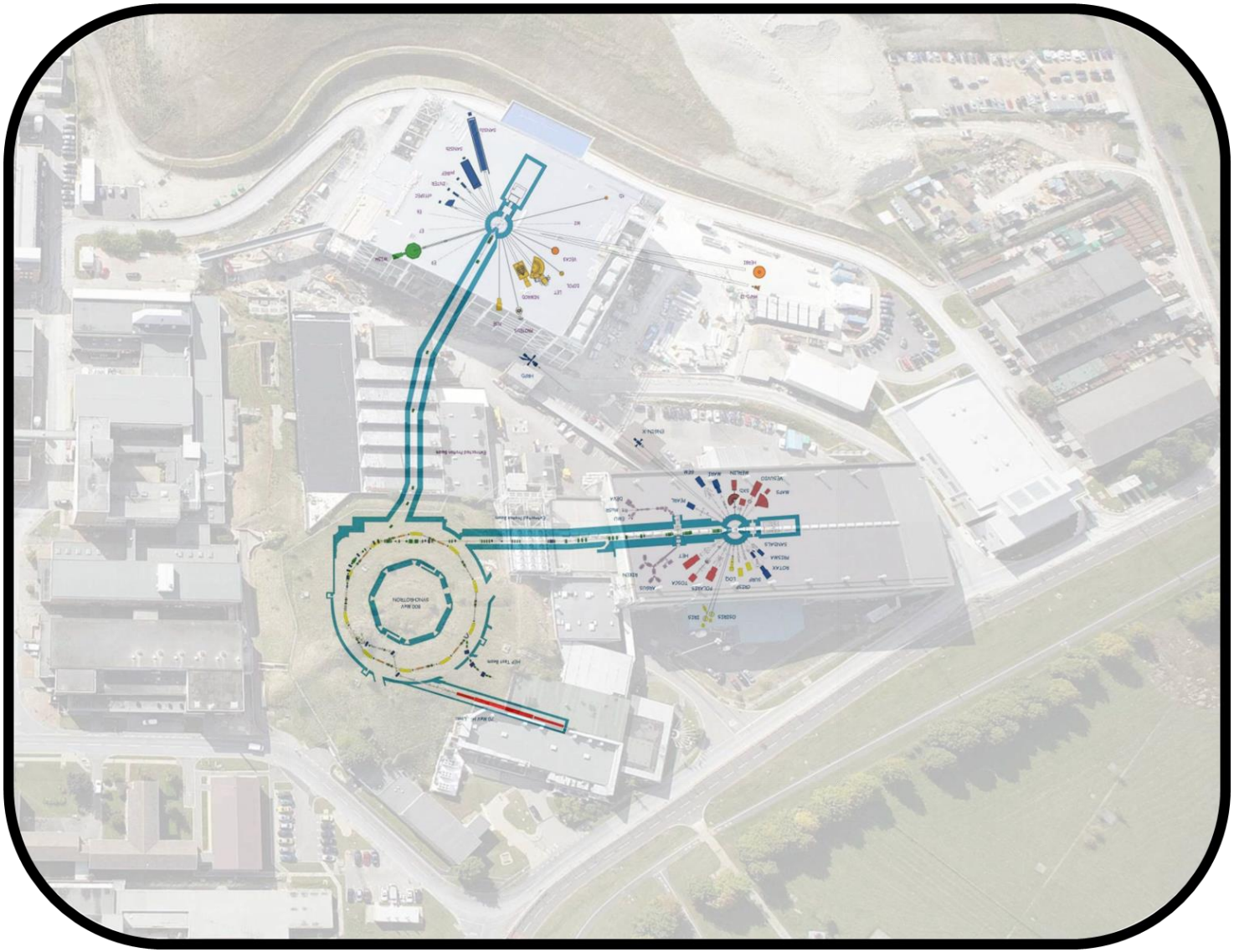
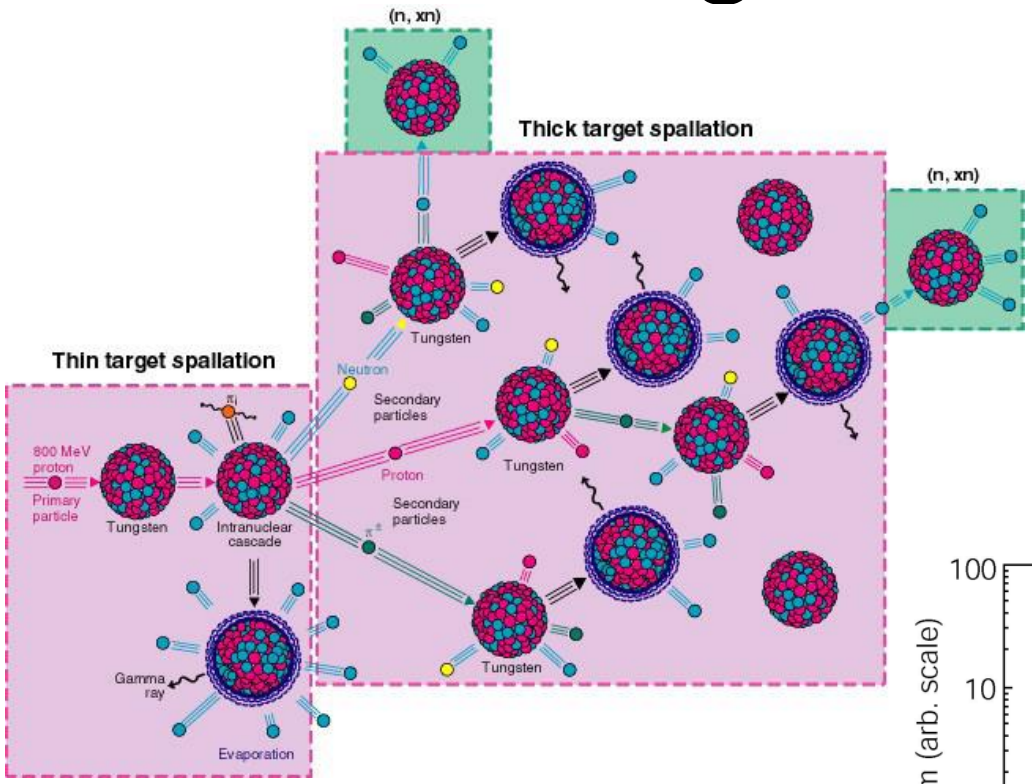
TS1 upgrade

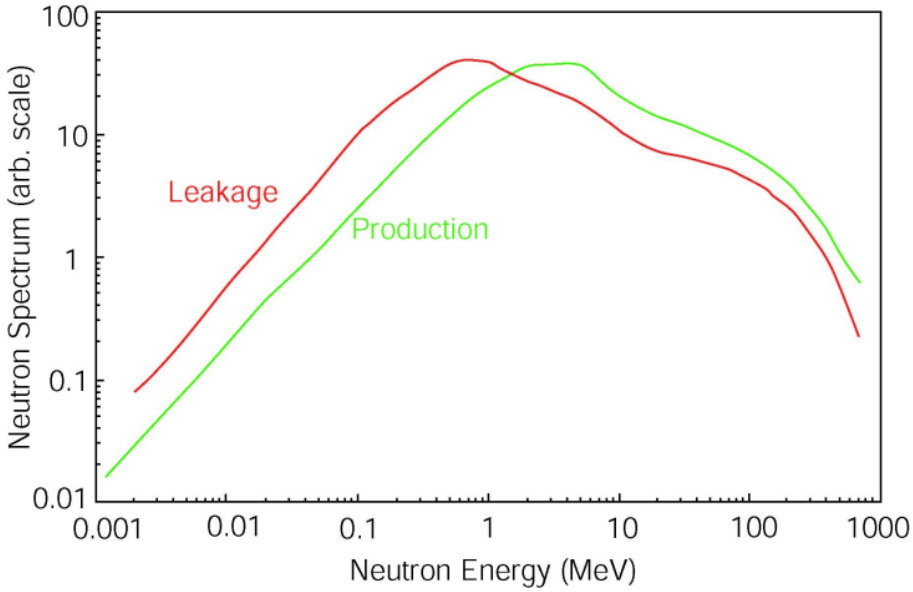


- Brief function of targets / moderators
  - Reminder why…..
- Brief description of TS1
- Challenges
- Importance of QA

Target function

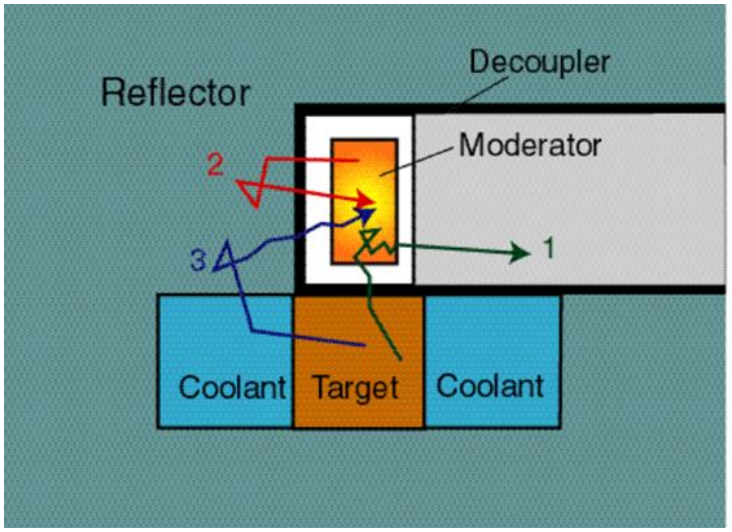


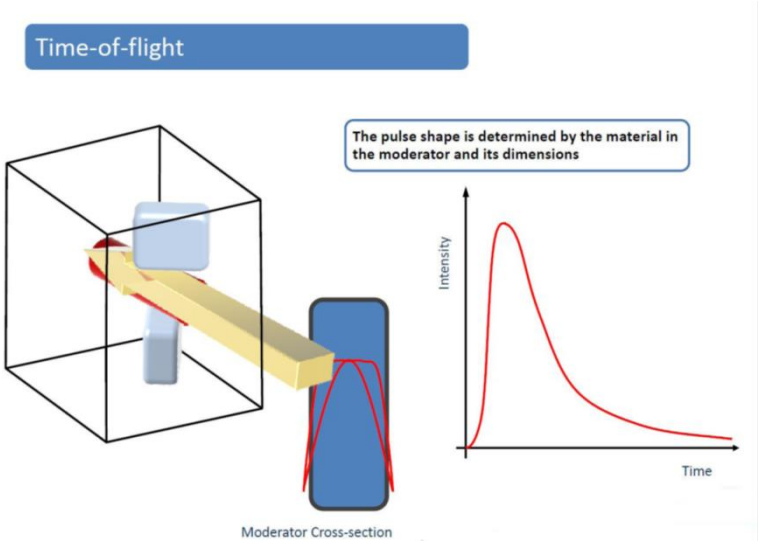
High energy protons (800MeV) create neutrons in all directions with varying energies below incoming energy



Neutrons

- Instruments want particular speed neutrons at the right time
- Moderators slow down the incoming neutrons
- Reflectors change the direction (also slow them down)



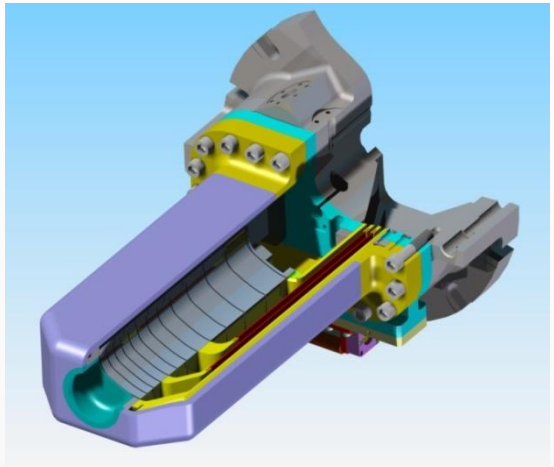


Useful Neutrons and Background

- A useful neutron is one where the wavelength is consistent with the arrival time at the detector.
- A background neutron is one where the wavelength is not consistent with the arrival time at the detector.
- (Gamma rays can also present background problems)
- Sources of Background:
  - Fast neutrons scattering in shielding and moderating near the instrument (Poor shield design)
  - Moderated neutrons drifting to the instrument (Collimator design)
  - Leakage from the TRAM down the beam channel
  - Delayed neutron production in the target

TS1

Ambient water moderators



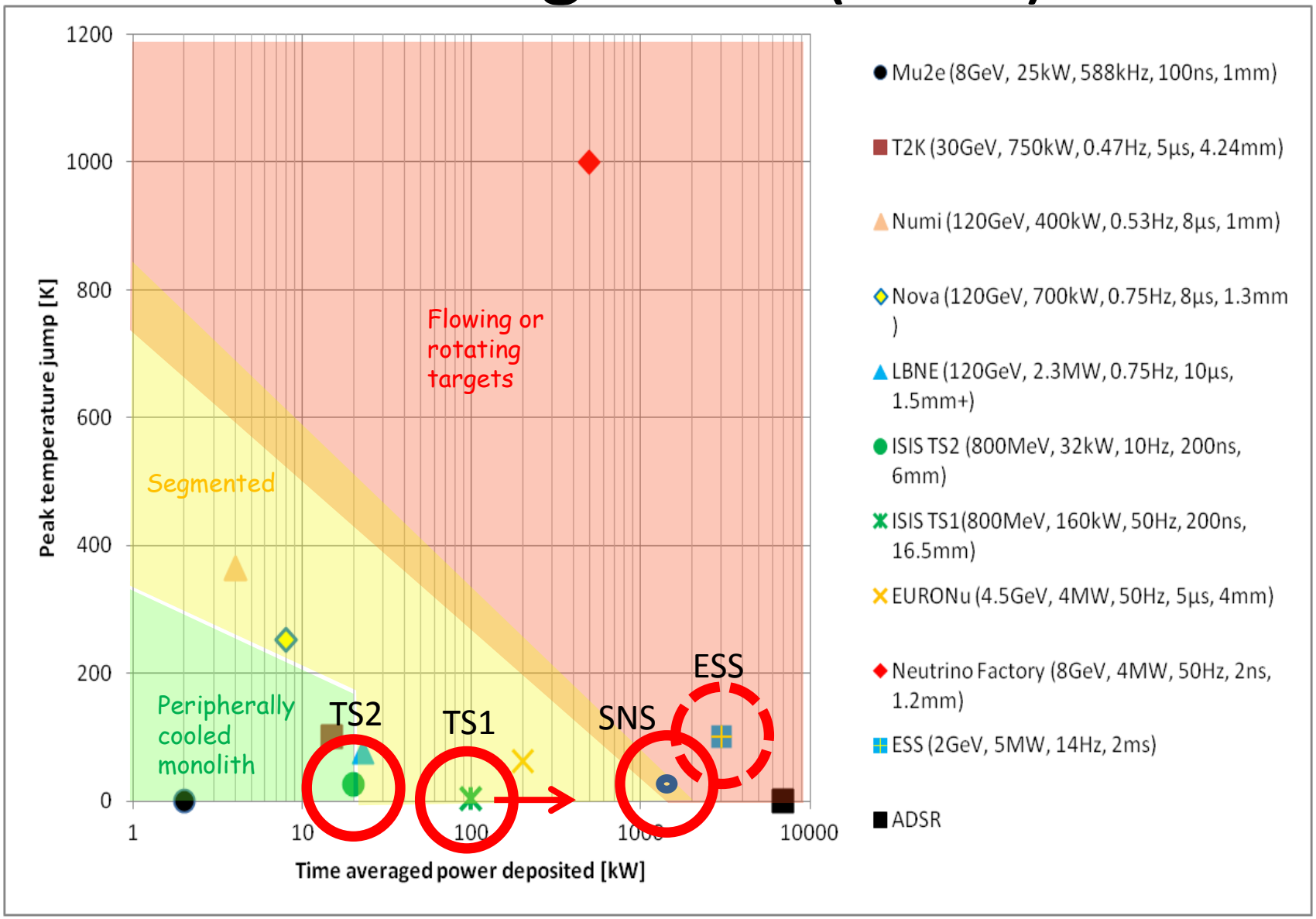
Liquid methane moderator

Liquid hydrogen moderator

Challenges

- Optimising performance
  - Engineering / neutronic / operation balance
- Developing on an operational machine

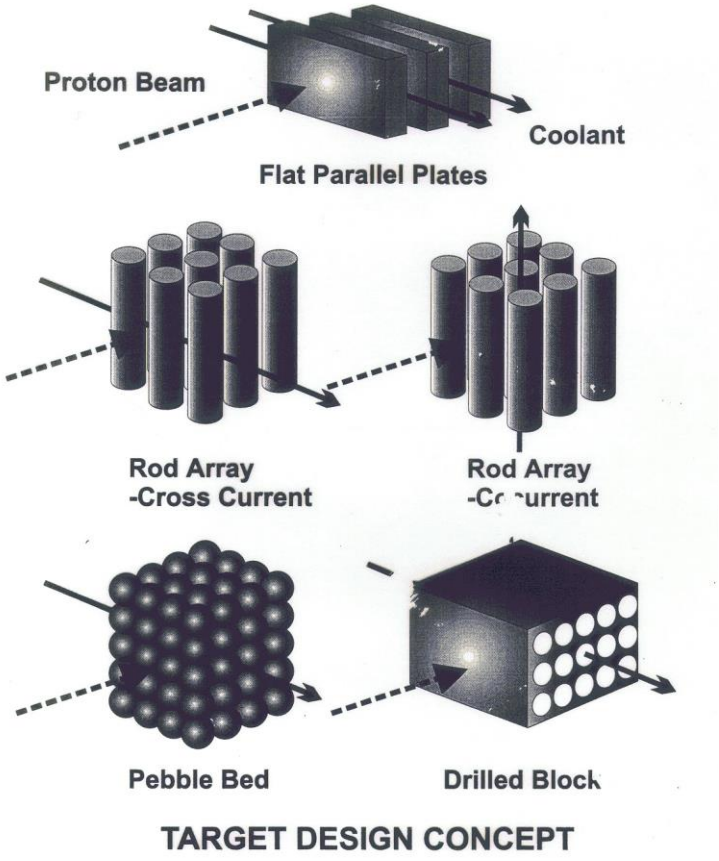
Challenges ctd (Heat)



Target Choice (Solid)

- **High atomic weight for neutron yield**
- **High density for brightness**
- **High melting point**
- **High thermal conductivity**
- **Chemically inert**
- **Resistance to radiation damage**
- **Low resonance integral (absorption of keV neutrons)**
- **(Low absorption cross section for thermal neutrons)**
- **High scattering cross section (reflector)**

Candidates: Lead, Tantalum, Tungsten

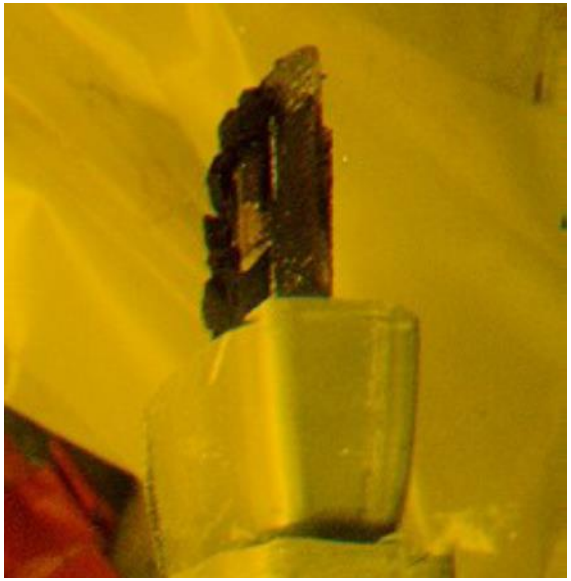


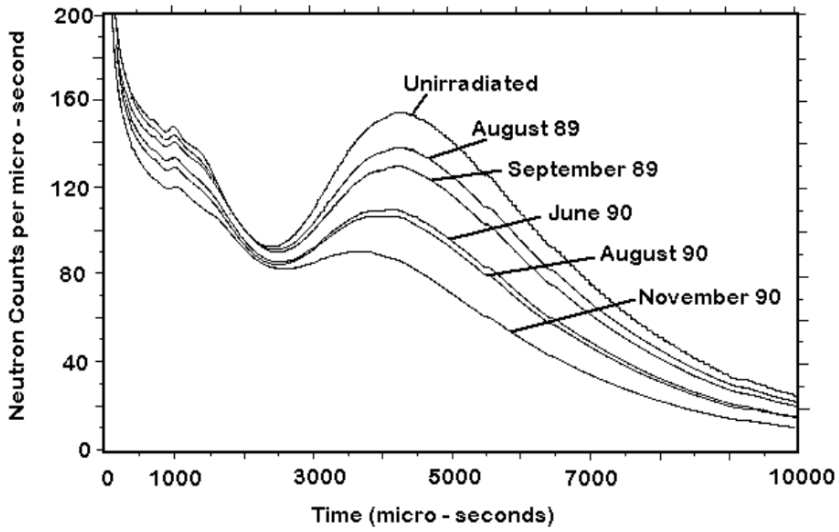
Challenges ctd

- Material integrity in multiple dpa condition
  - Limited data – engage with other facilities
- Instrumentation – ‘ready to accept beam’
- Fixed (or at least very inflexible) infrastructure
- Remote handling
- Robustness
- Operability
  - Monitoring / maintenance etc

Challenges ctd

- Lifetime (component change)
- Cost – E.g. targets circa £100k each to manufacture – Disposal £000's each
- Knowledge / experience of staff
- Investigation compromise to operations
- QA (manufacture)

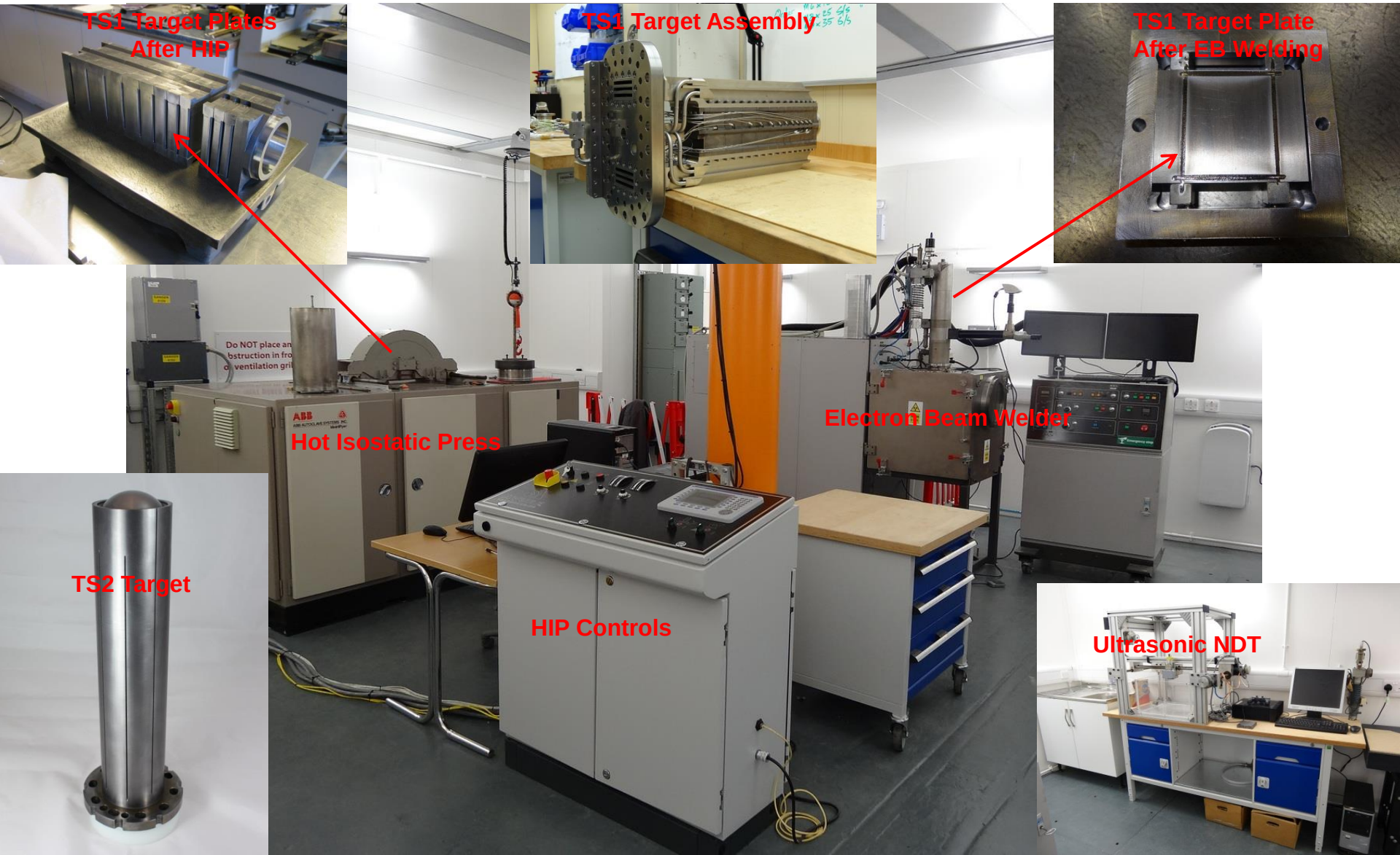




Quality Assurance

- Demanding requirements on the target in operation (likely to be at the edge)
- Costly
- Difficult to investigate after first operation
- Manufacture is complex
- When you do have a concern – one of the first questions is about the manufacture and first test results

Target Manufacturing



Target Testing

- Offline pressure tests
- Offline heat transfer tests
- Offline water flow tests

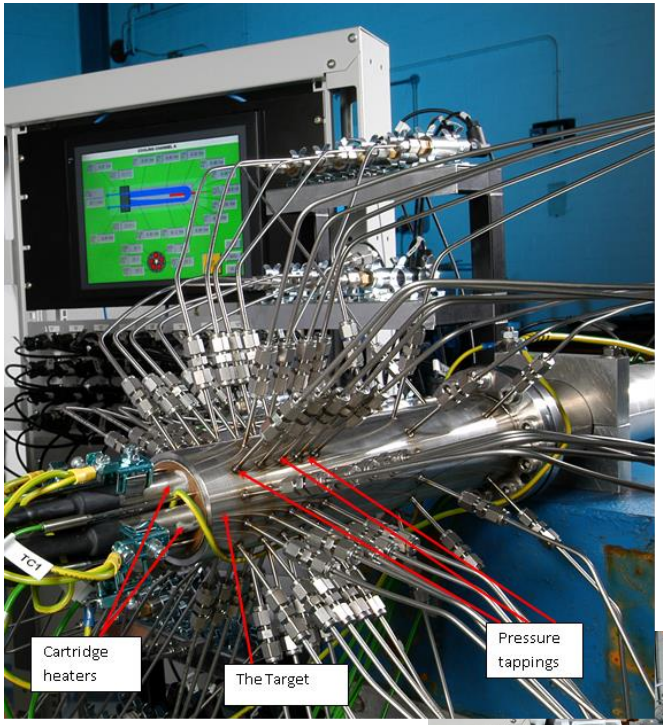


Figure 1: The test target setup.

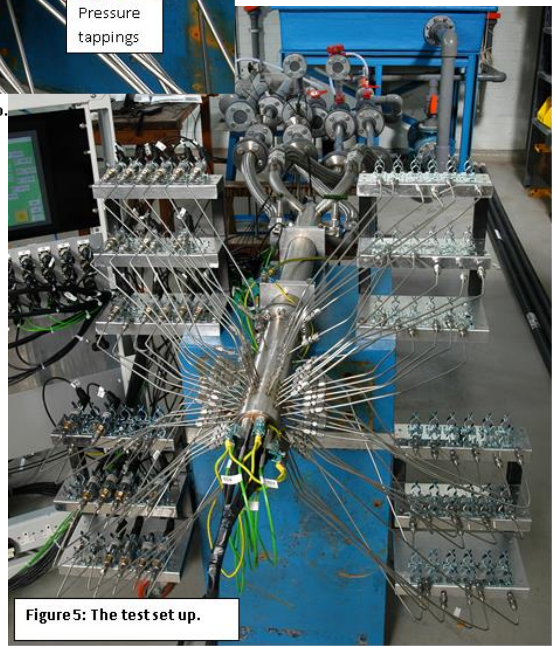
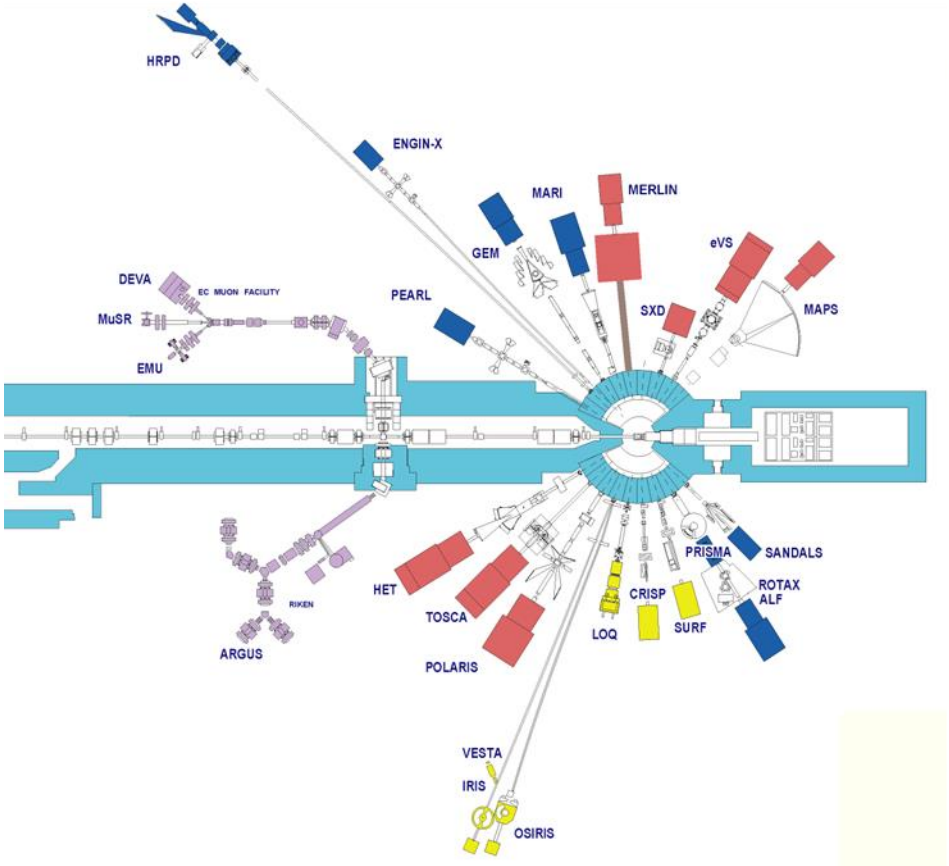


Figure 5: The test set up.

Moderator testing

- Offline instrumentation tests (strain gauges)
- Offline heat transfer tests
- Offline cryogenic flow tests

TS1 Upgrade

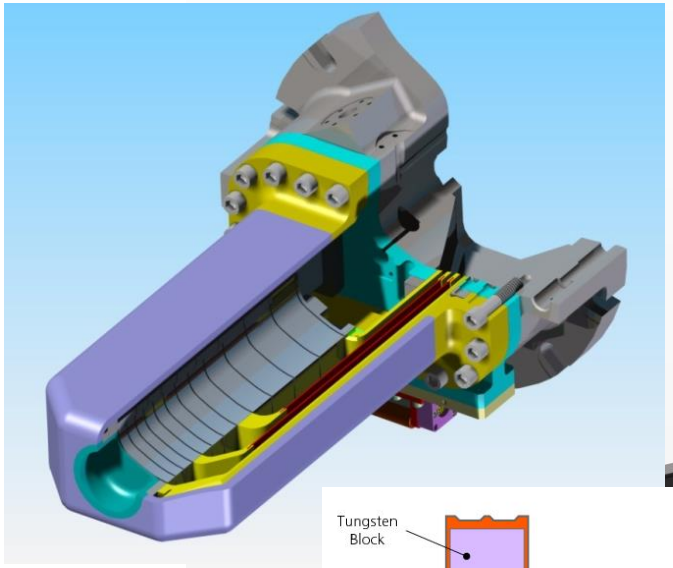

HRPD
ENGIN-X
MARI
MERLIN
GEM
eVS
DEVA
EC MUON FACILITY
PEARL
SXD
MAPS
MuSR
EMU
PRISMA
SANDALS
HET
ROTAX
ALF
TOSCA
CRISP
RIKEN
LOQ
SURF
ARGUS
POLARIS
VESTA
IRIS
OSIRIS

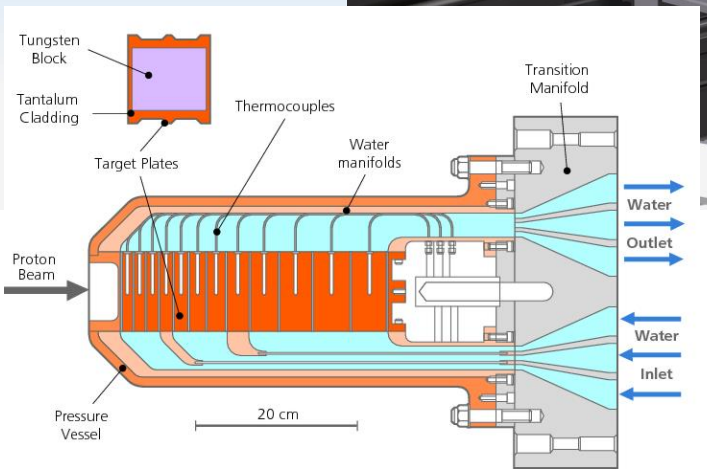

Pelloby

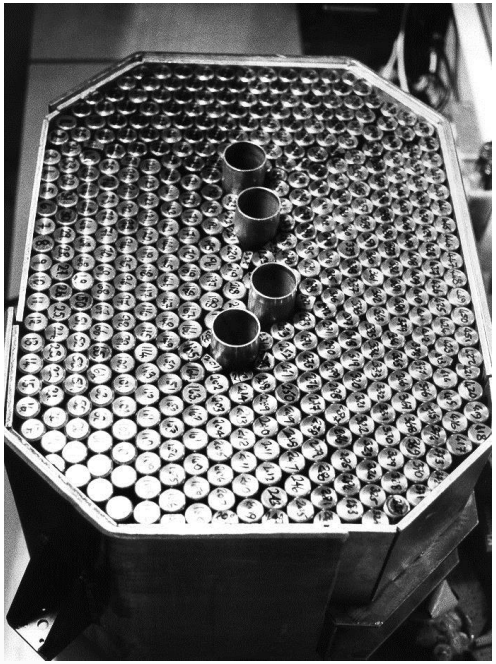
Hydrogen

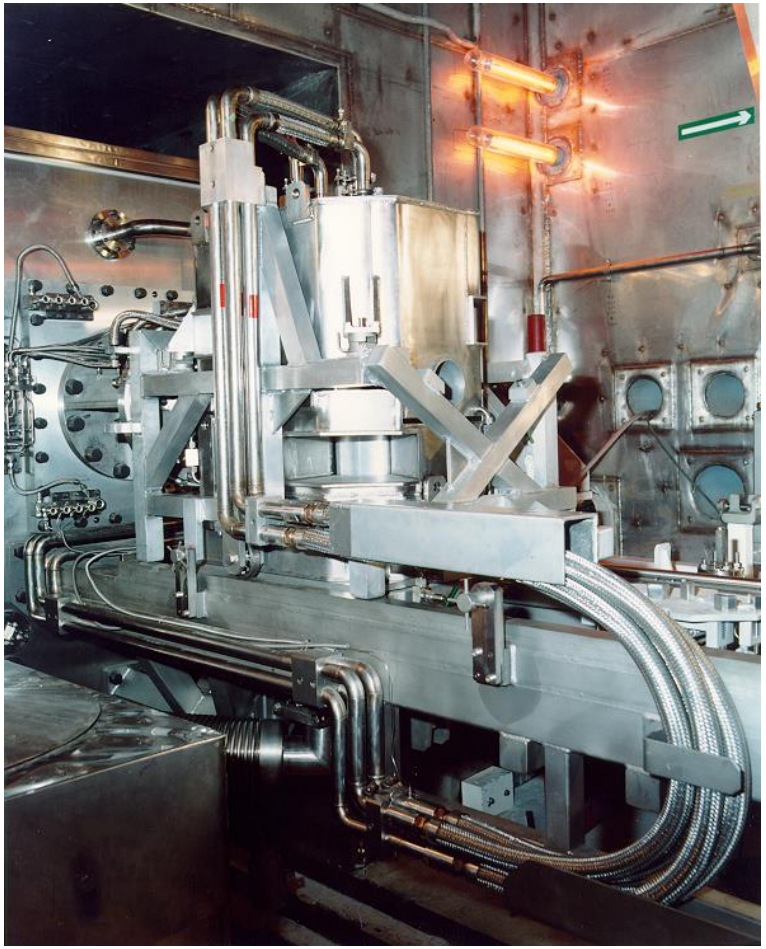
Ambient Water

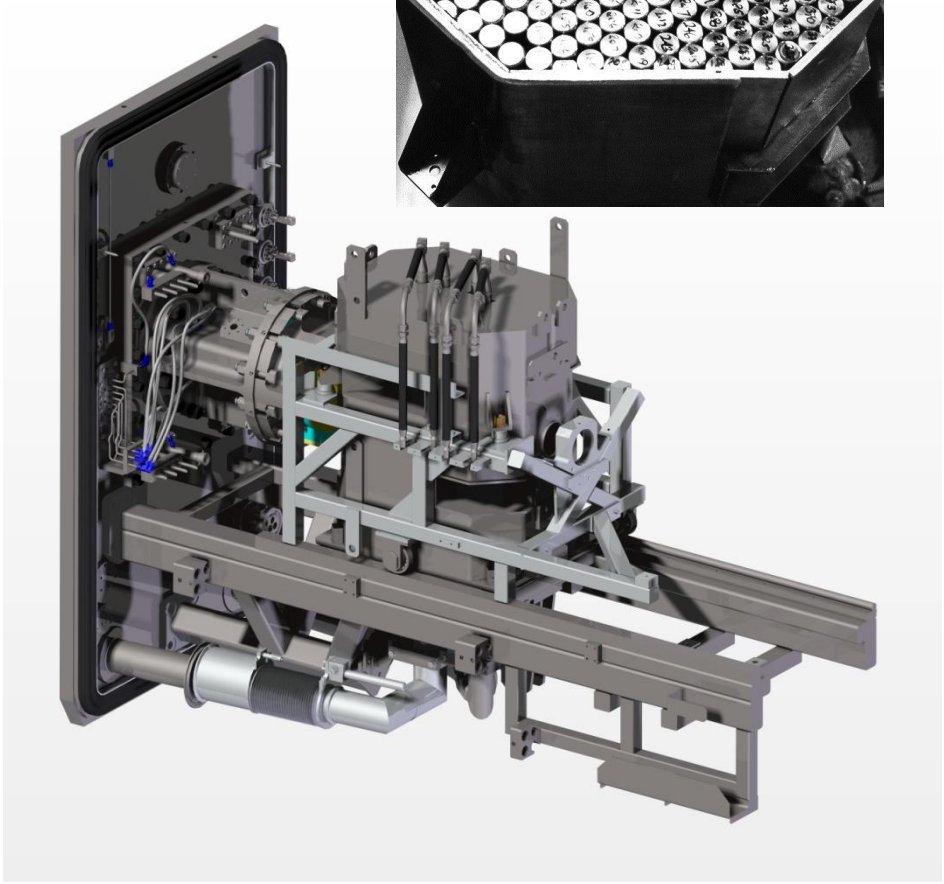
Methane

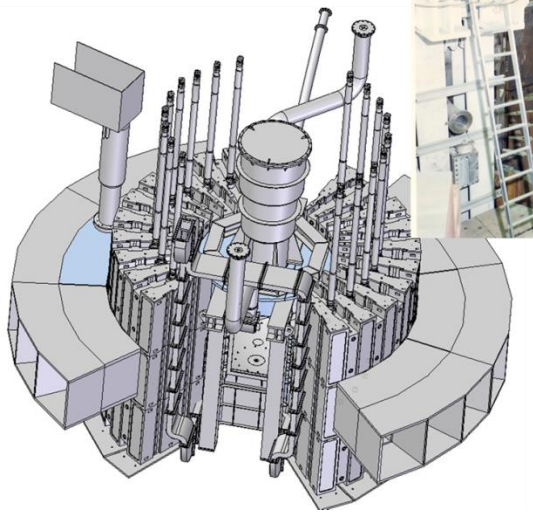


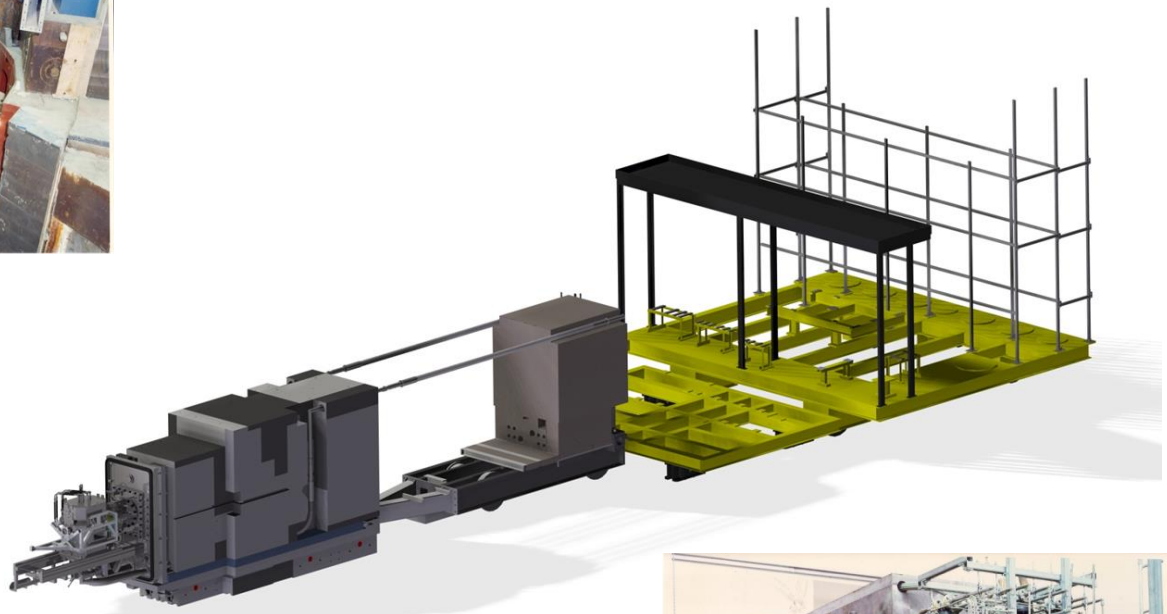


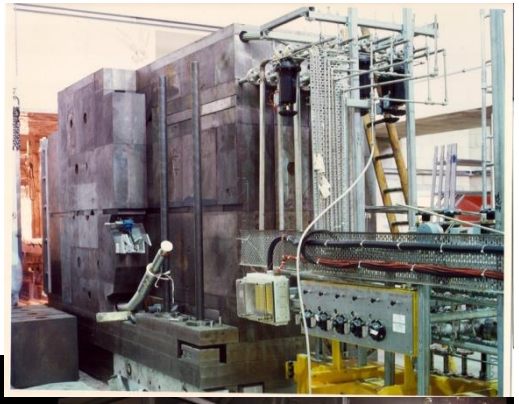


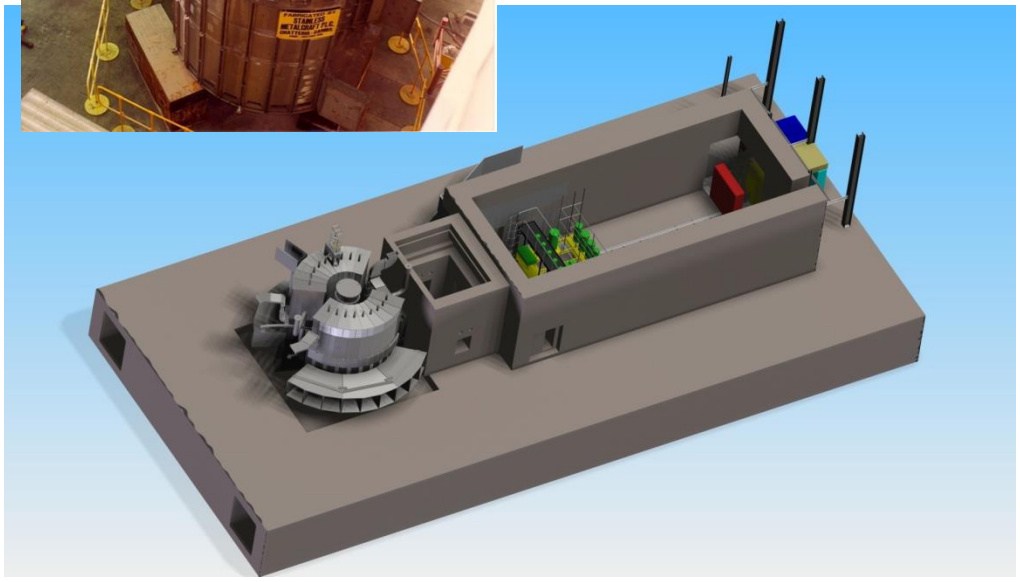


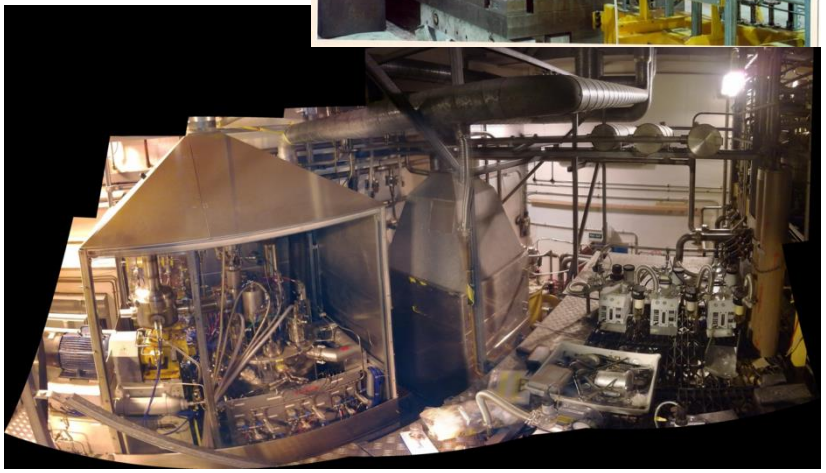










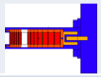


Performance (same protons)

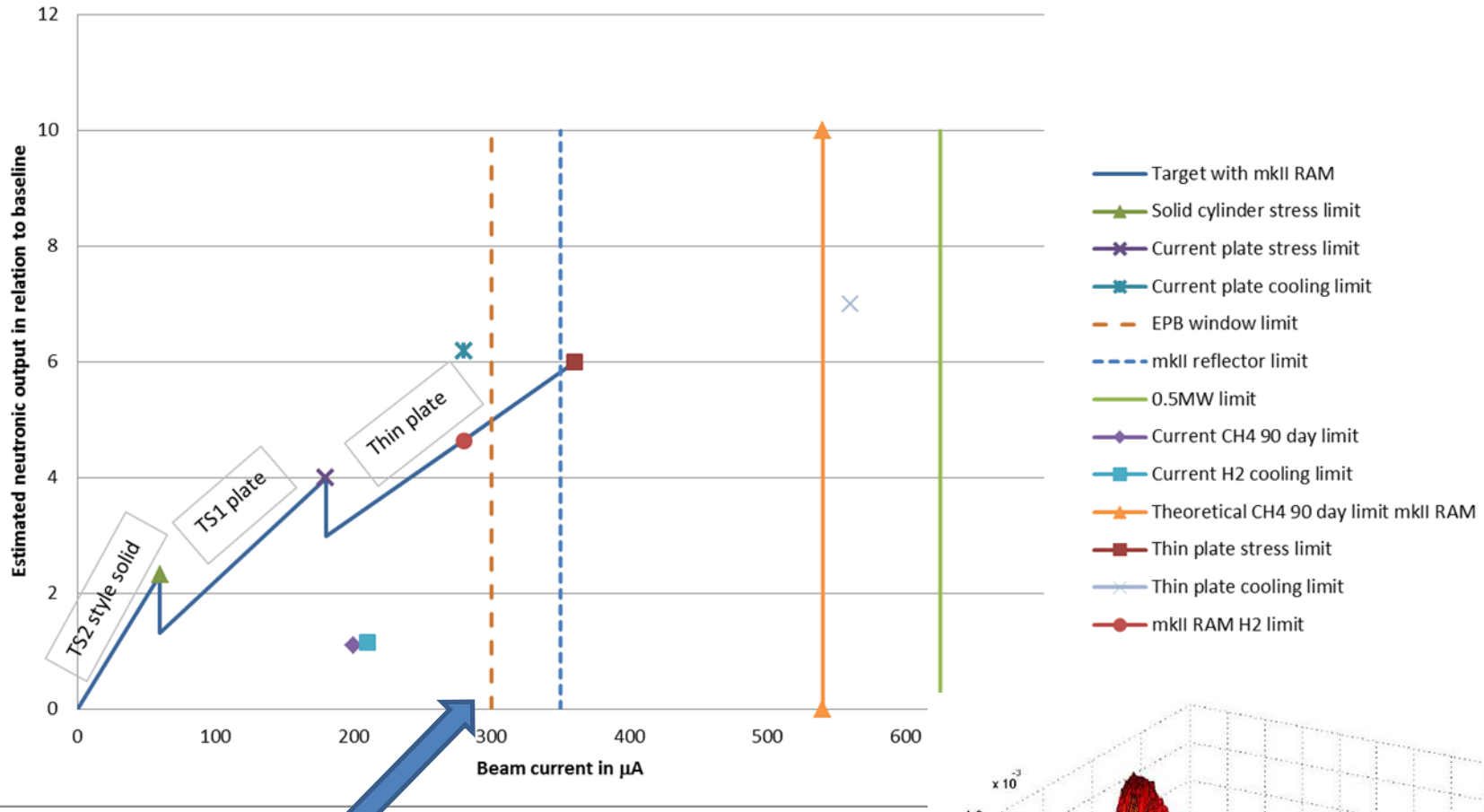
Current says circa 5 times more flux

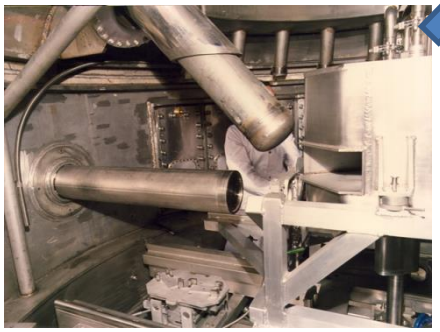
- Goal – at least twice
- Suspect that with engineering reality this will drop to circa 3 increase

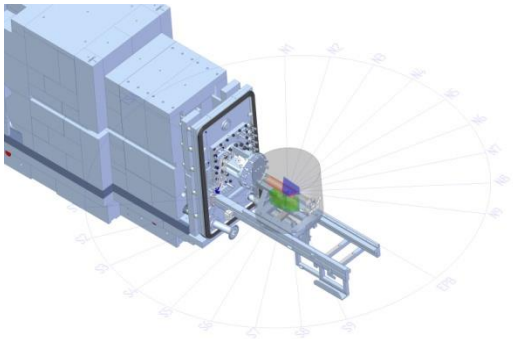
Moderator upgrades

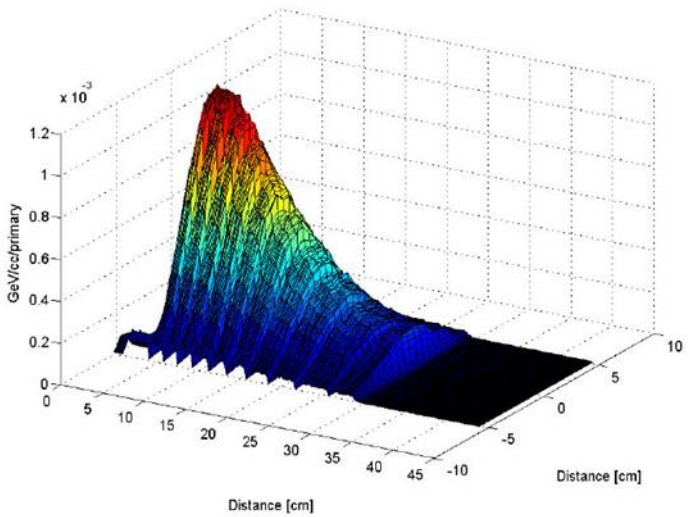
Target	Baseline model	Mark II model
Plates (current)	1	4
Cylindrical	1.10	7
Cylindrical with inner core	0.98-1.02	5
Thick plates	1.05	
Thin plates	0.95	
Split target**	 1	 7
Cannelloni	Model ready. Optimisation just started. Many parameters to vary…	

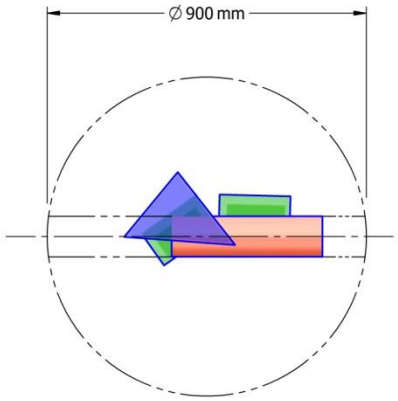
TS1 Upgrade Feasibility Review of Performance Limitations



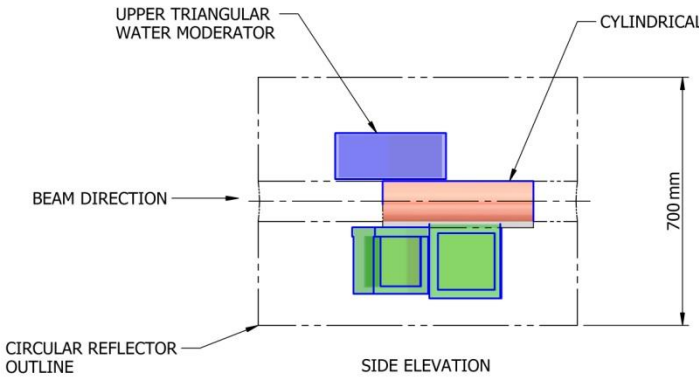




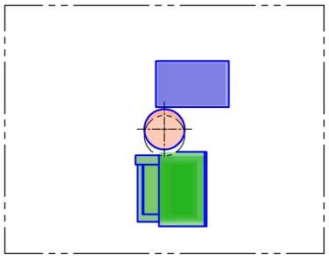




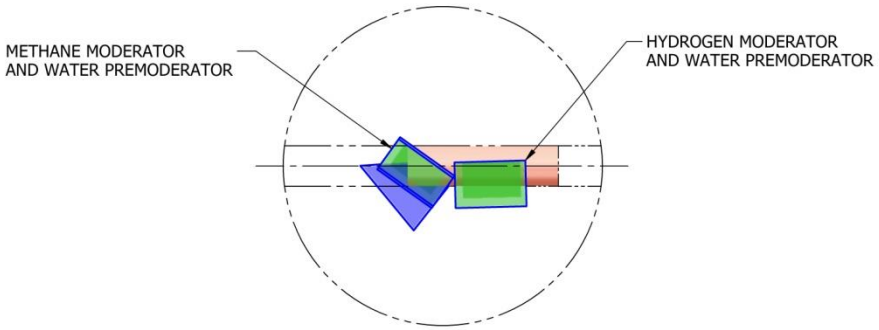
TOP ELEVATION



SIDE ELEVATION

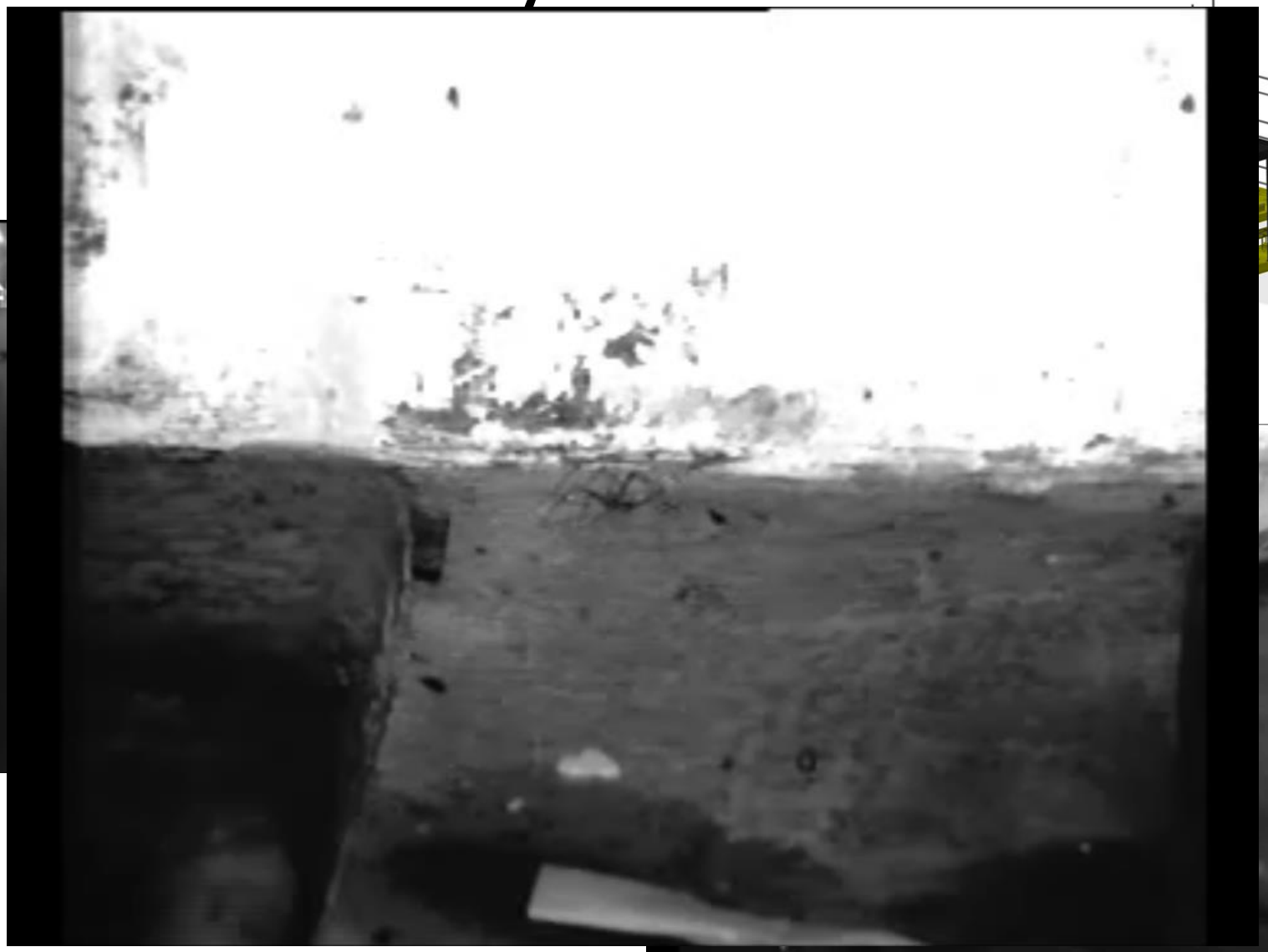


FRONT ELEVATION
DOWNSTREAM
TOWARDS TARGET

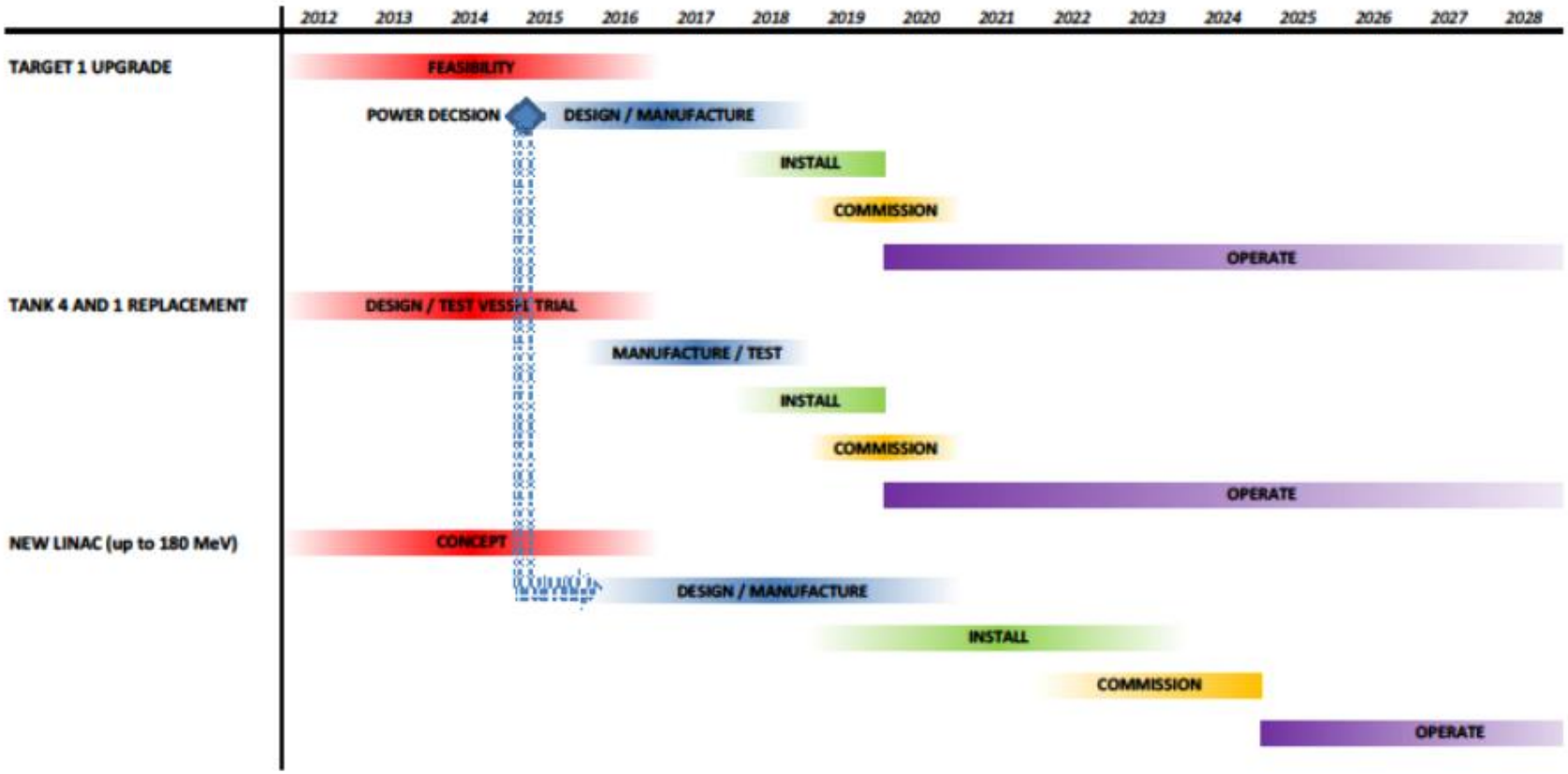


BOTTOM ELEVATION

Trolley movement



Timeline


2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
TARGET 1 UPGRADE
FEASIBILITY
POWER DECISION
DESIGN / MANUFACTURE
INSTALL
COMMISSION
OPERATE
TANK 4 AND 1 REPLACEMENT
DESIGN / TEST VESSEL TRIAL
MANUFACTURE / TEST
INSTALL
COMMISSION
OPERATE
NEW LINAC (up to 180 MeV)
CONCEPT
DESIGN / MANUFACTURE
INSTALL
COMMISSION
OPERATE

Current project challenges

- Creating a decent baseline
  - Neutronics of targets and instruments
  - Engineering analysis
  - Exact understanding of existing equipment
- Iterating through proposed concepts
- Communication and understanding
  - Helped by co-location
  - Momentum building

Key points for TS1 Upgrade

- Operationally robust
- Low risk
- QA of design / manufacture
- Limited data for materials
  - Engagement with other facilities for data share
- Moderator upgrades in future possible
- Existing infrastructure constraints
  - Ensure don’t build in any more than necessary

Importance of the input

- Proton beam critical
- Not just the theoretical – but the expected variation also

- Over to Bryan Jones…..