MIRRO•TRON
THE WORLD OF NEUTRON

Progress report for the LvB HCANS project in Martonvásár

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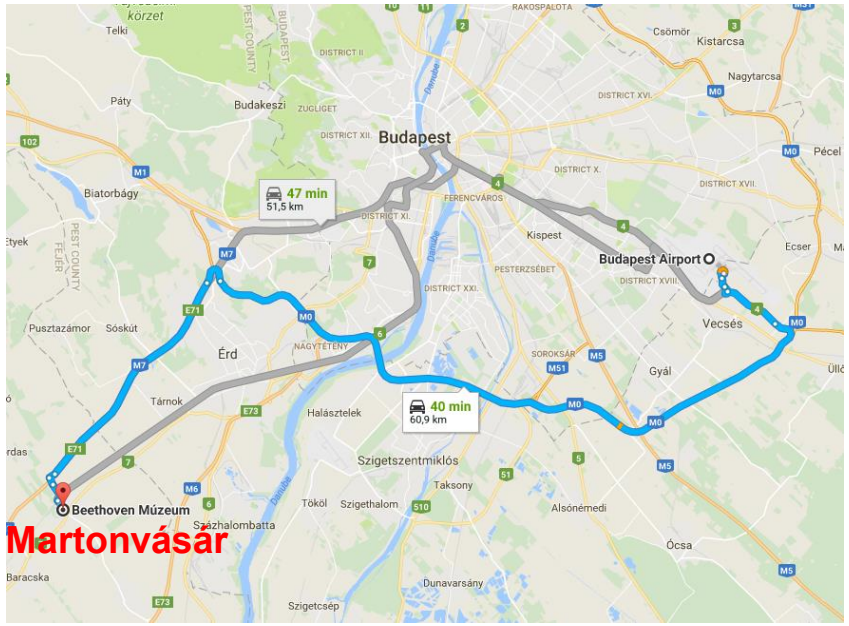
MIRROTRON
THE WORLD OF NEUTRON

Martonvásár

Criteria: regional development outside central Hungary
close to Budapest airport
cultural/research tradition
collaboration: Mirrotron Ltd. (est. 1991): private company
CER: government owned research center



Mirrotron Ltd: est. 1991

Business plan: (2017)

- **Neutron instrumentation tests for Mirrotron's own needs saves**
- **New products and services for neutron source developments**
- **Provide neutron beams for industrial applications (freely for partner CER)**
- **Beam for cancer therapy (BNCT investors?)**
- **Support for developments on larger neutron source for > 2024 in Hungary**
- **Neutron beams for investors of instruments → beam time to be provided at full costs**
- **Diversify Mirrotron's products spectrum to turn-key CANS sources (e.g. for hospital or industrial site use).**

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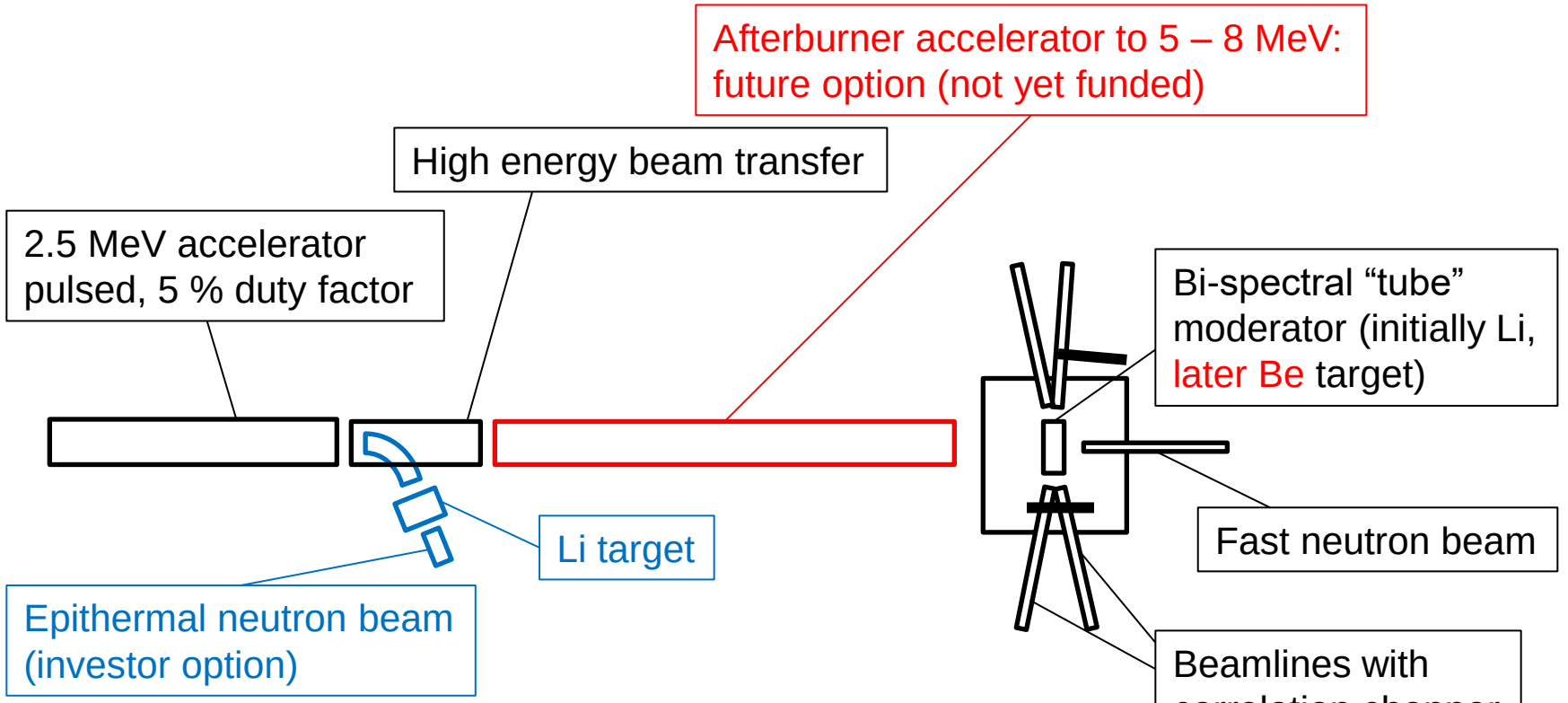
- Neutron beams for investors of instruments → beam time to be provided at full costs
- Diversify Mirrotron's products spectrum to turn-key CANS sources (e.g. for hospital or industrial site use).
- Enhance Mirrotron's visibility for its traditional business

Mirrotron LvB CANS project plan 2019



Public procurement tenders (from mid 2018):

- Ion source + Low energy beam transfer
- 2.5 MeV accelerator, 20 mA peak
- RF amplifier
- Integration and controls

Mirrotron’s own design and production:

- High energy beam transfer
- Target-moderator-reflector (TMR) system

Fast neutron production:

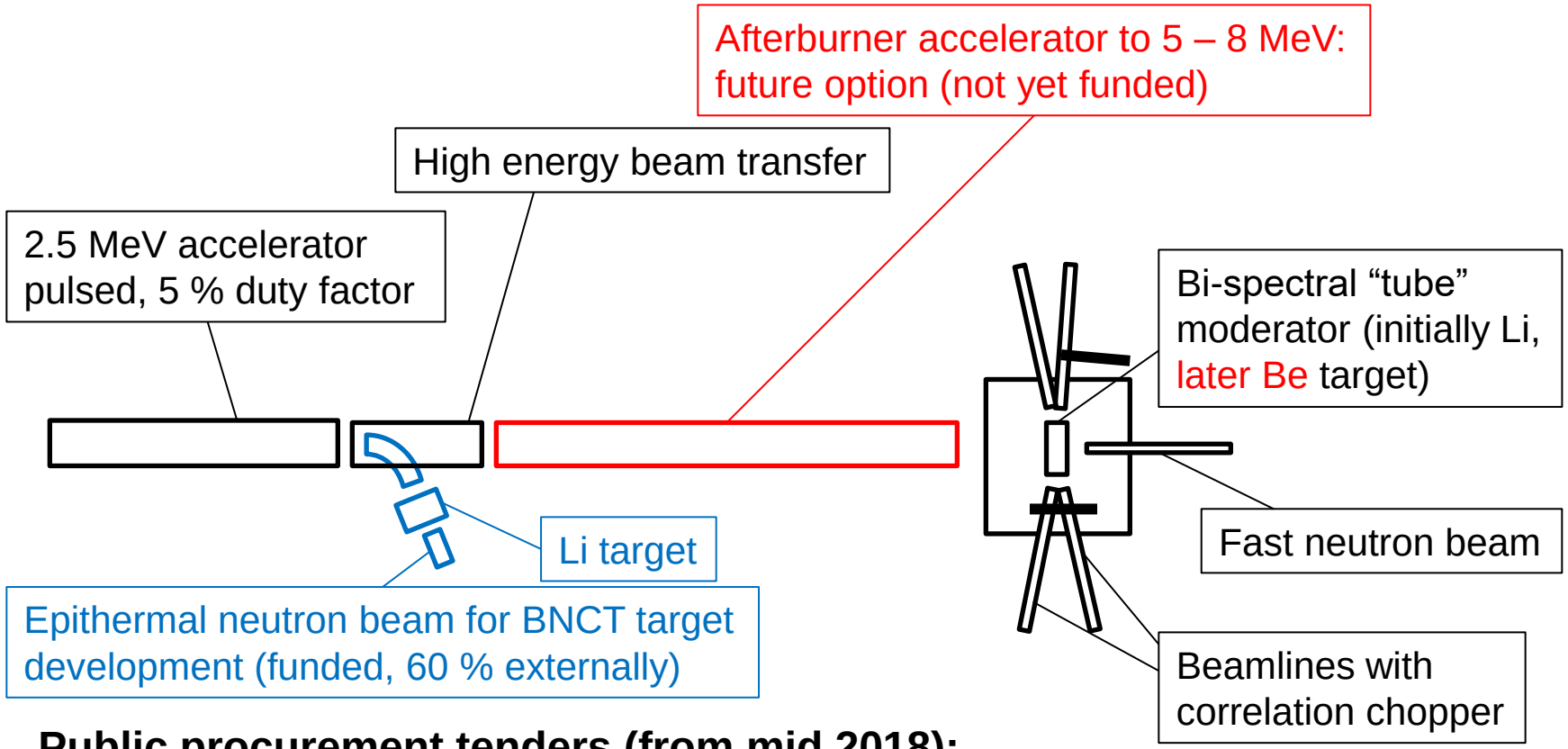
2.5 MeV 2.5 kW $3x10^{11}$ n/s

5.0 MeV 5.0 kW $3x10^{12}$ n/s

[L. Zanini et. al. 2020]

ESS @ 5 MW: $1x10^{18}$ n/s

Mirrotron LvB CANS project plan 2022



Public procurement tenders (from mid 2018):

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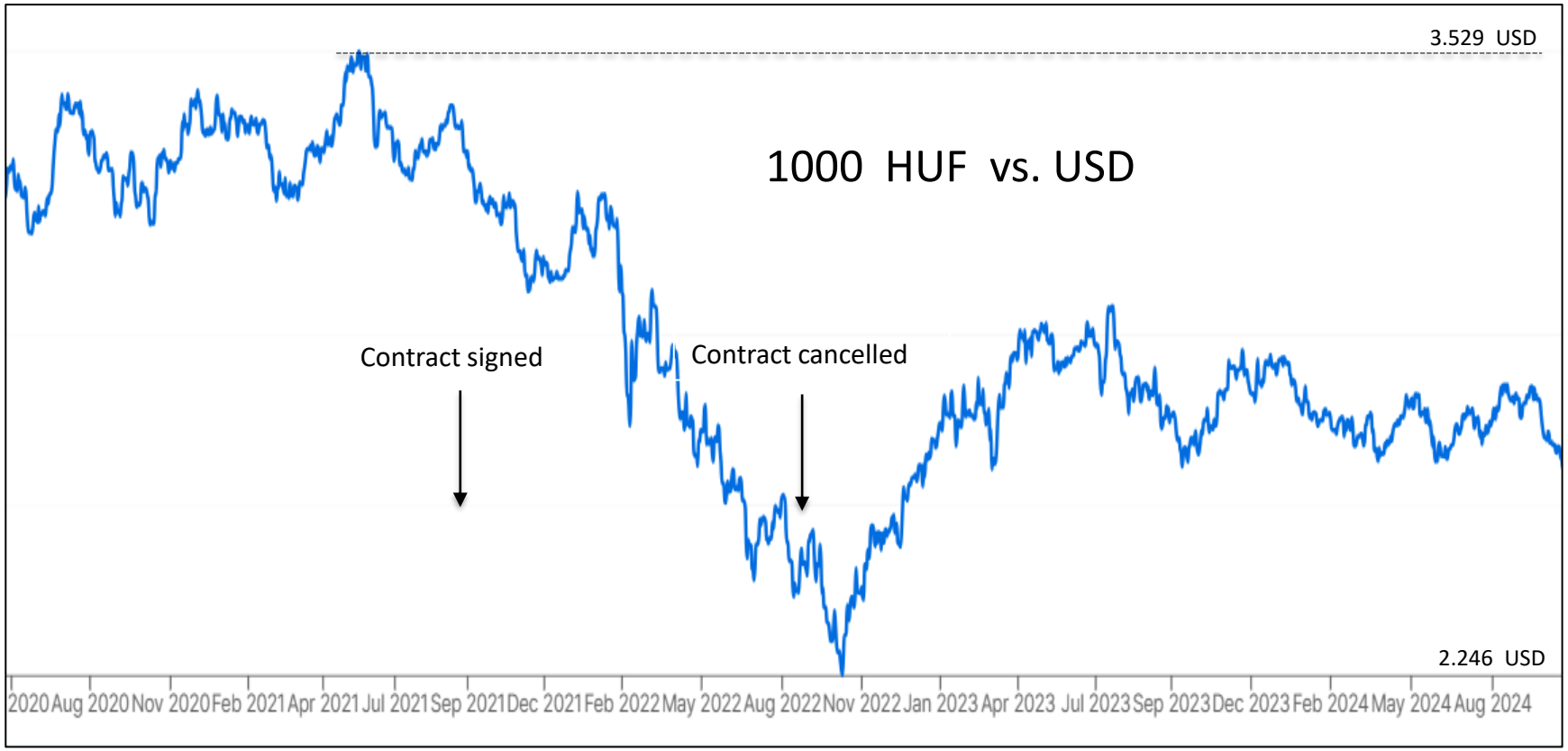
Ion source manufacturing contract:

public procurement:

high risk inevitable



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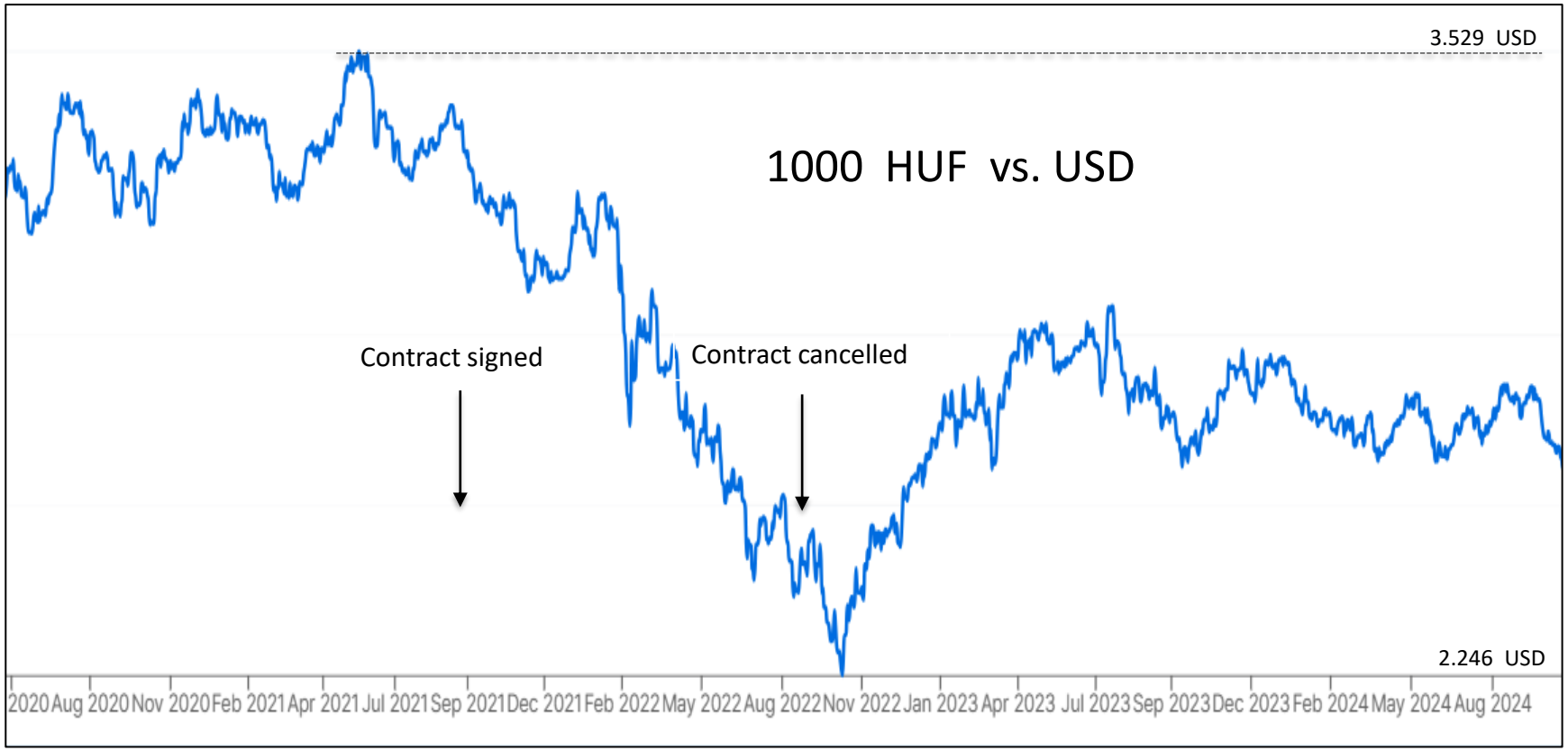
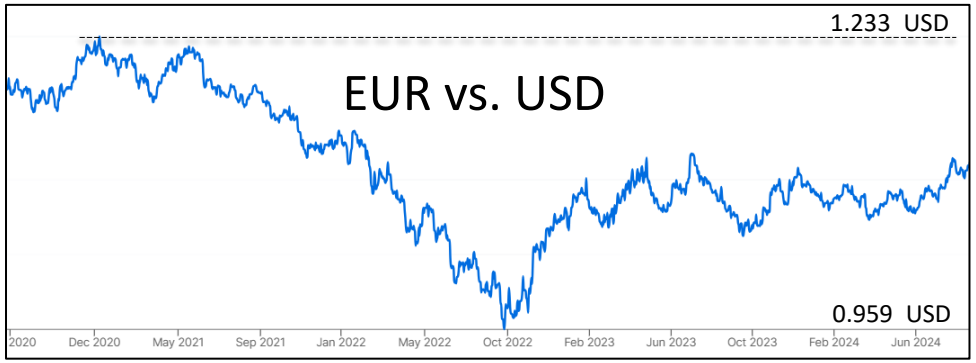


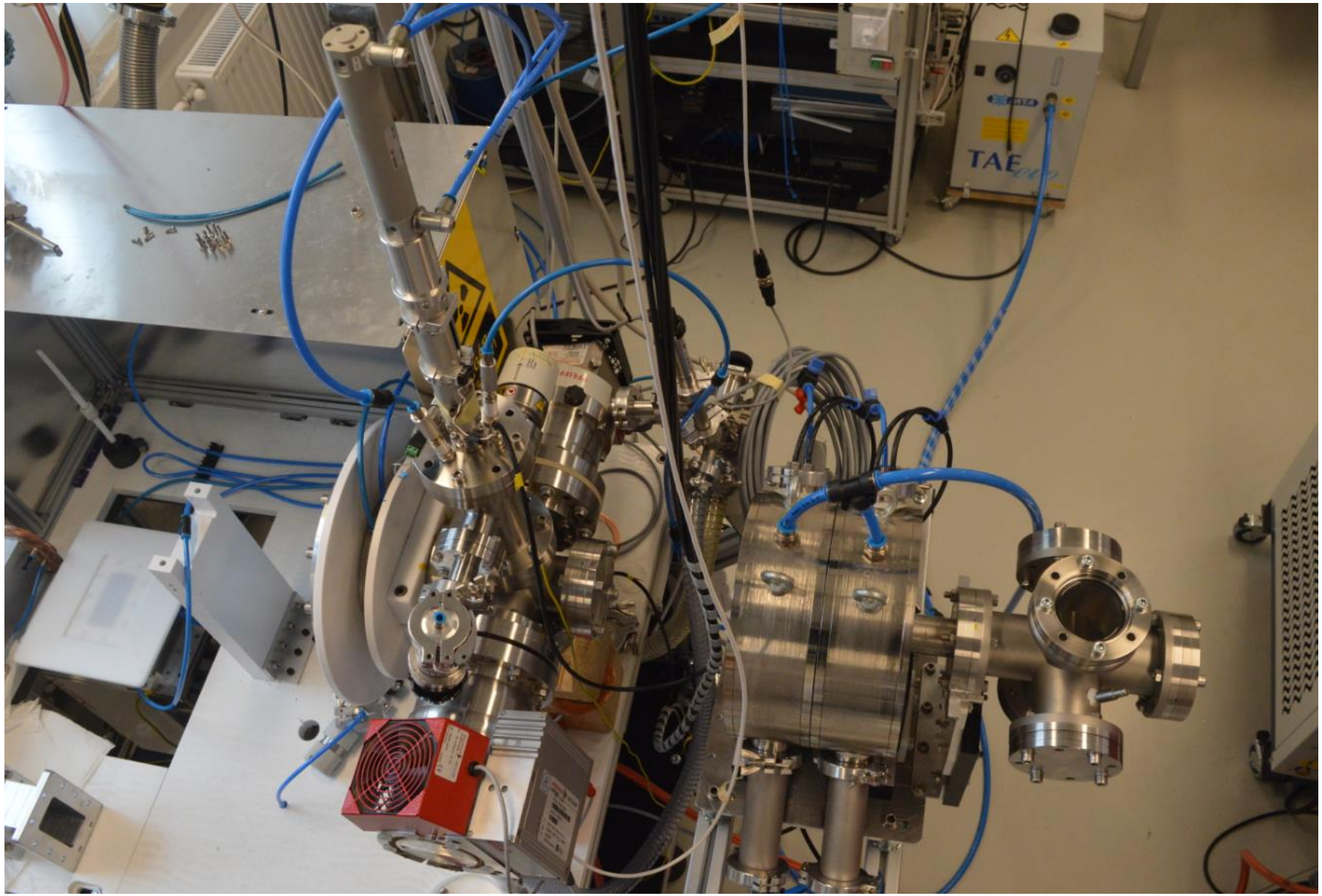
No negotiation allowed, just cancelling

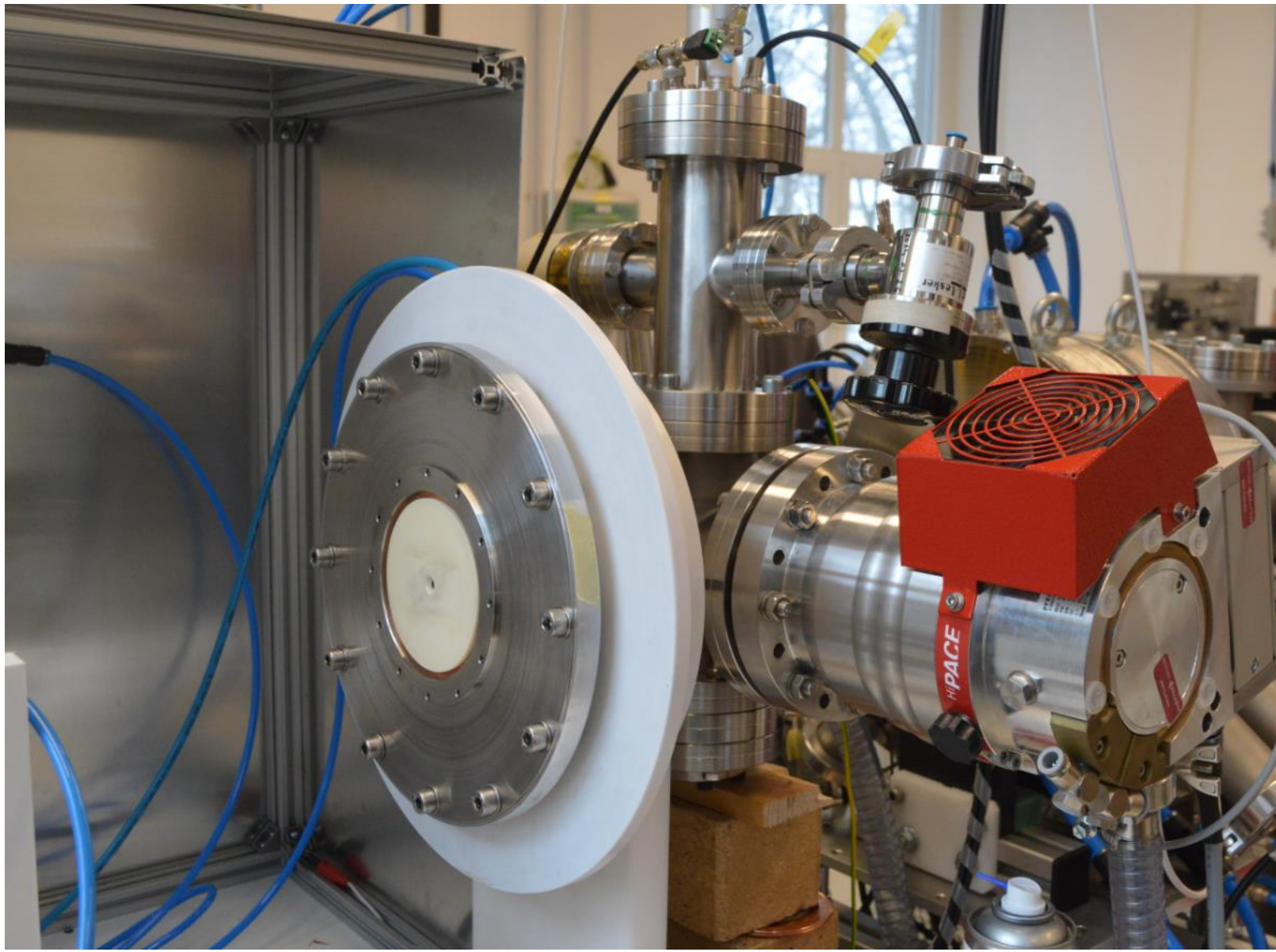


Not to lose the funding:

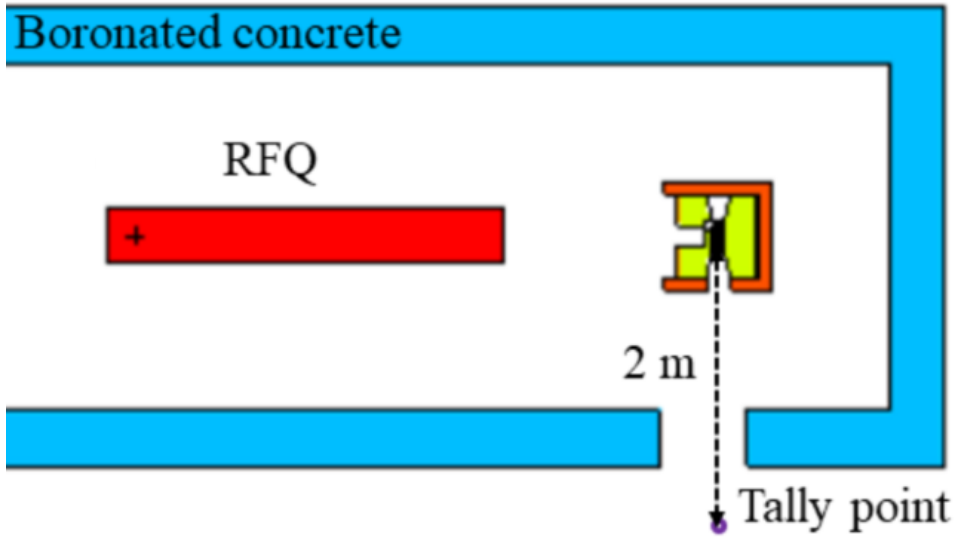
reduce performance,
make it yourself: CER

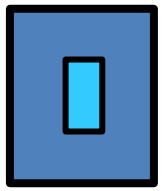
Status of Feb. 24, 2025
Planned current:
pulse peak: 1- 4 mA




HiPACE

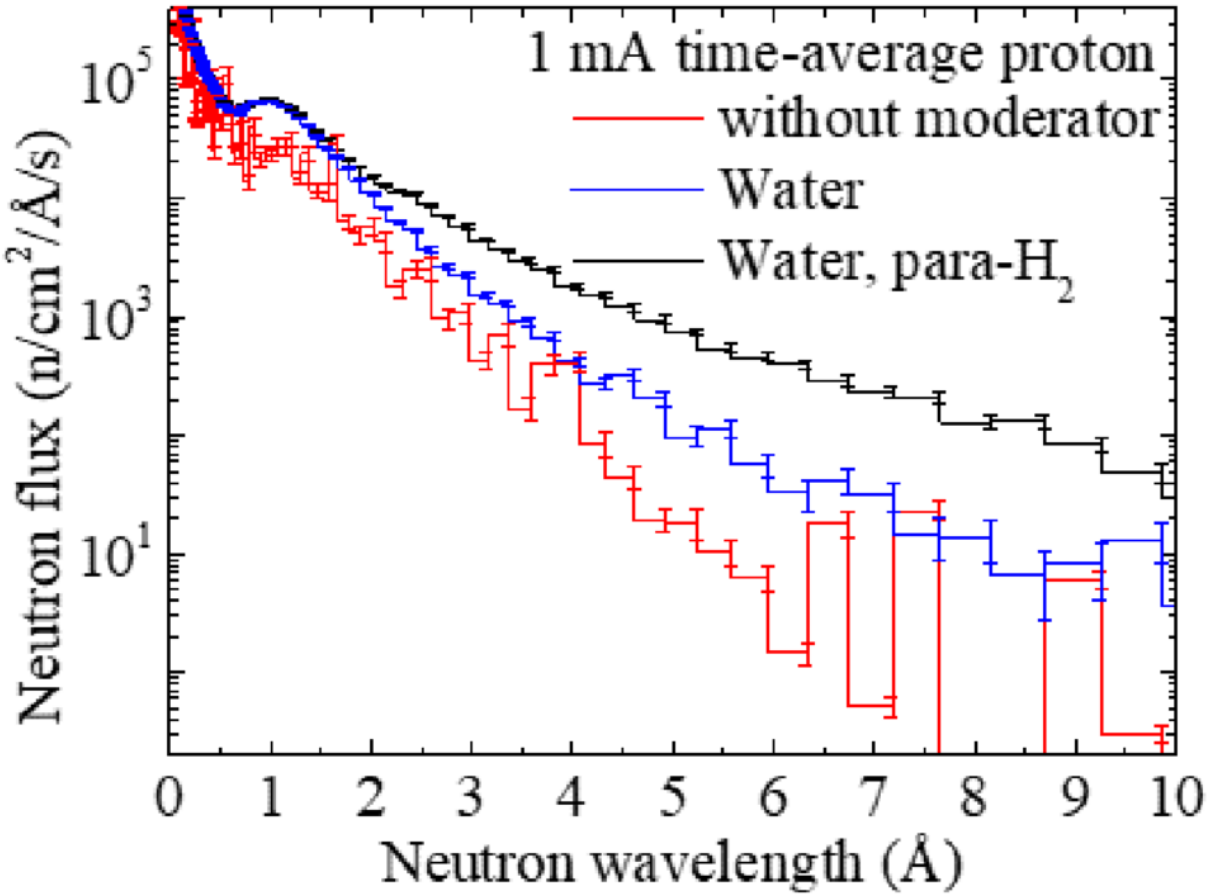
MCNP simulation results: moderated thermal neutron spectra and fluxes:





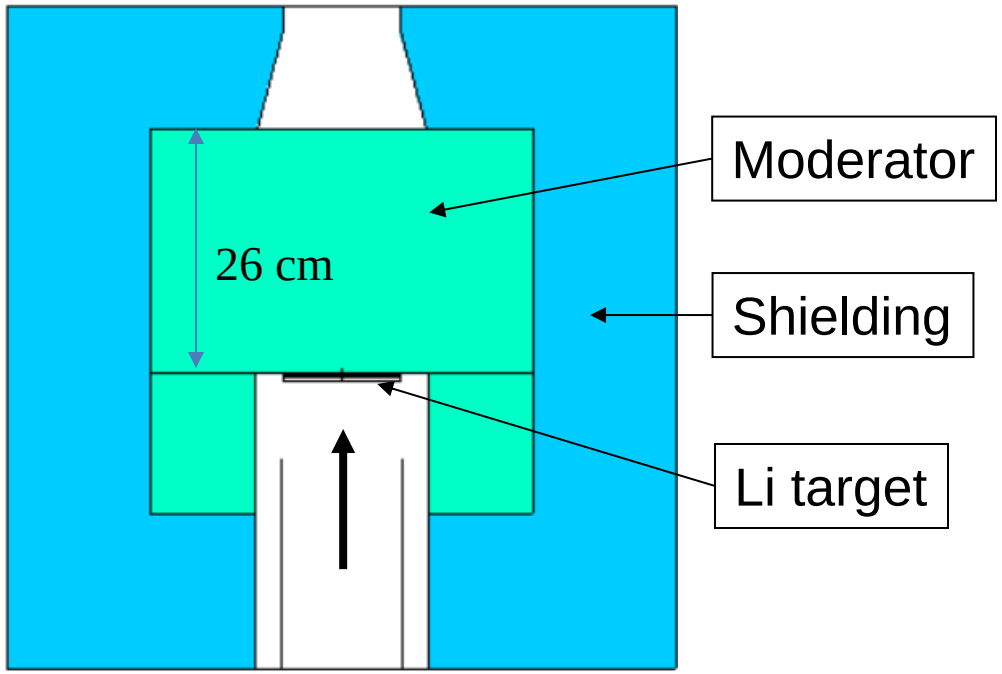
70 mm

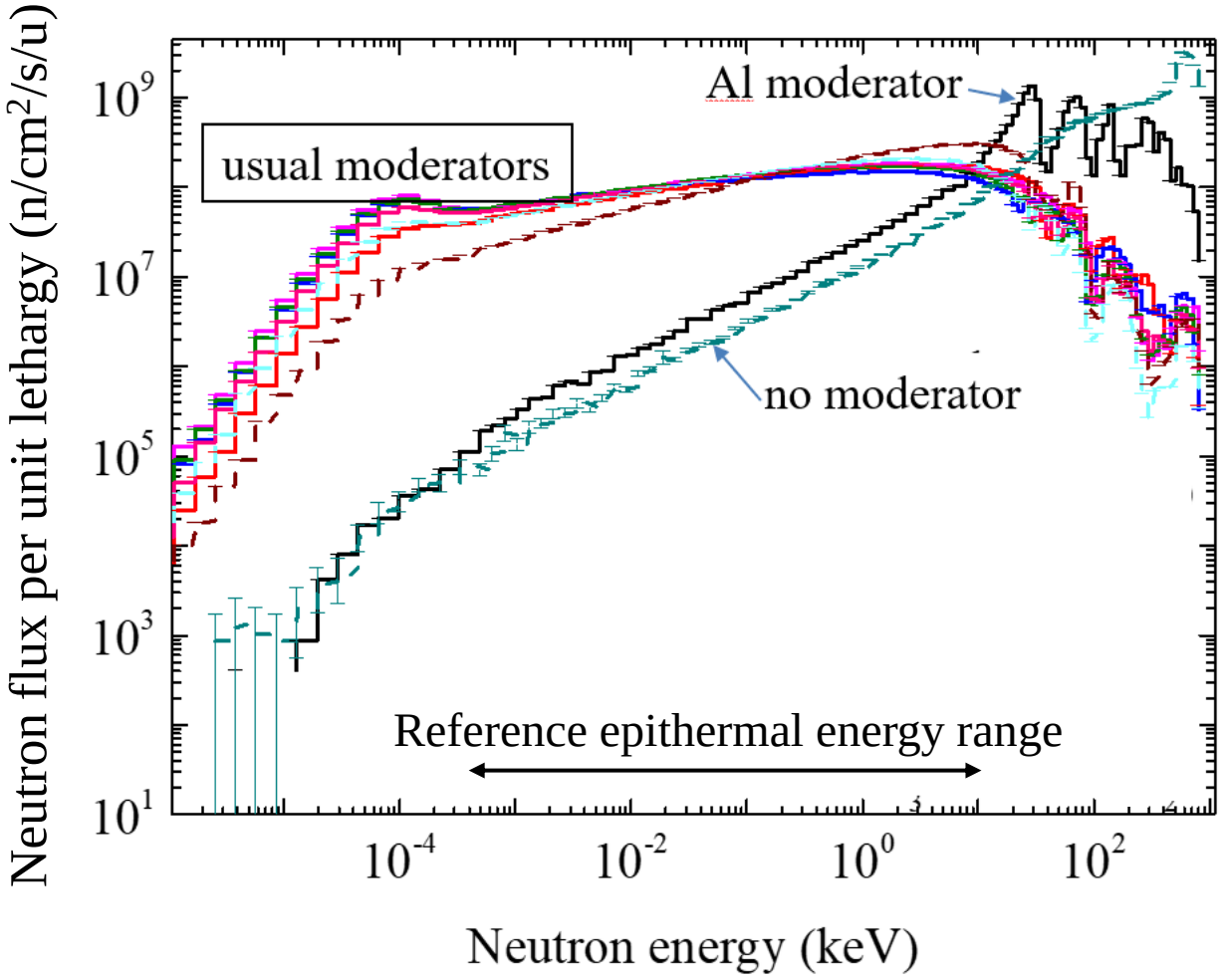
Viewed bi-spectral moderator face



Conclusion:
Testing for supermirror production: < 1 h/sample

Simulation results: BNCT target station

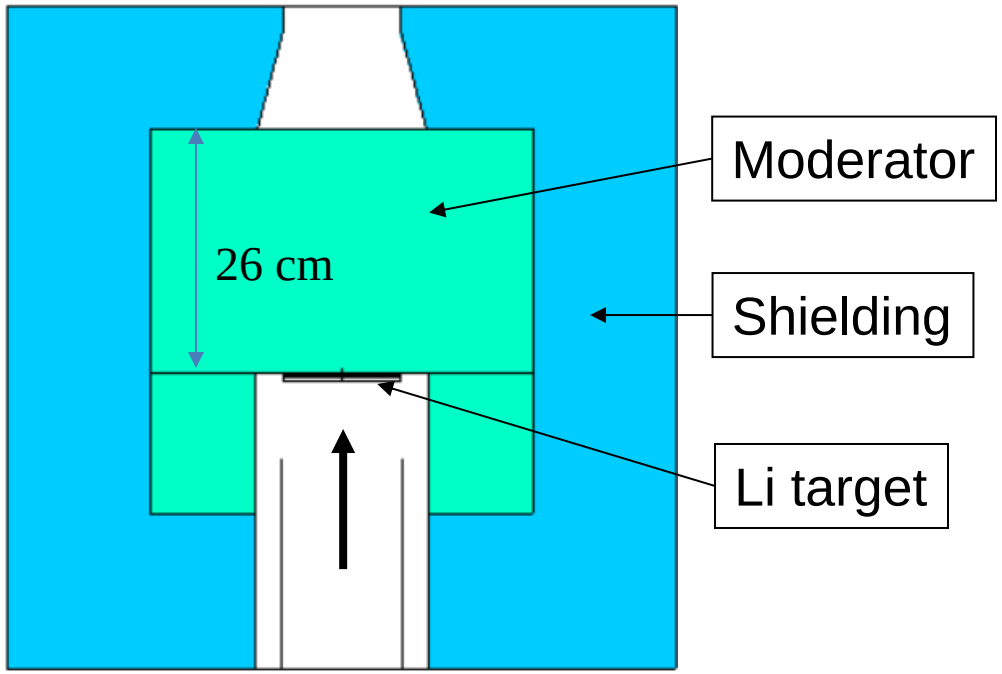


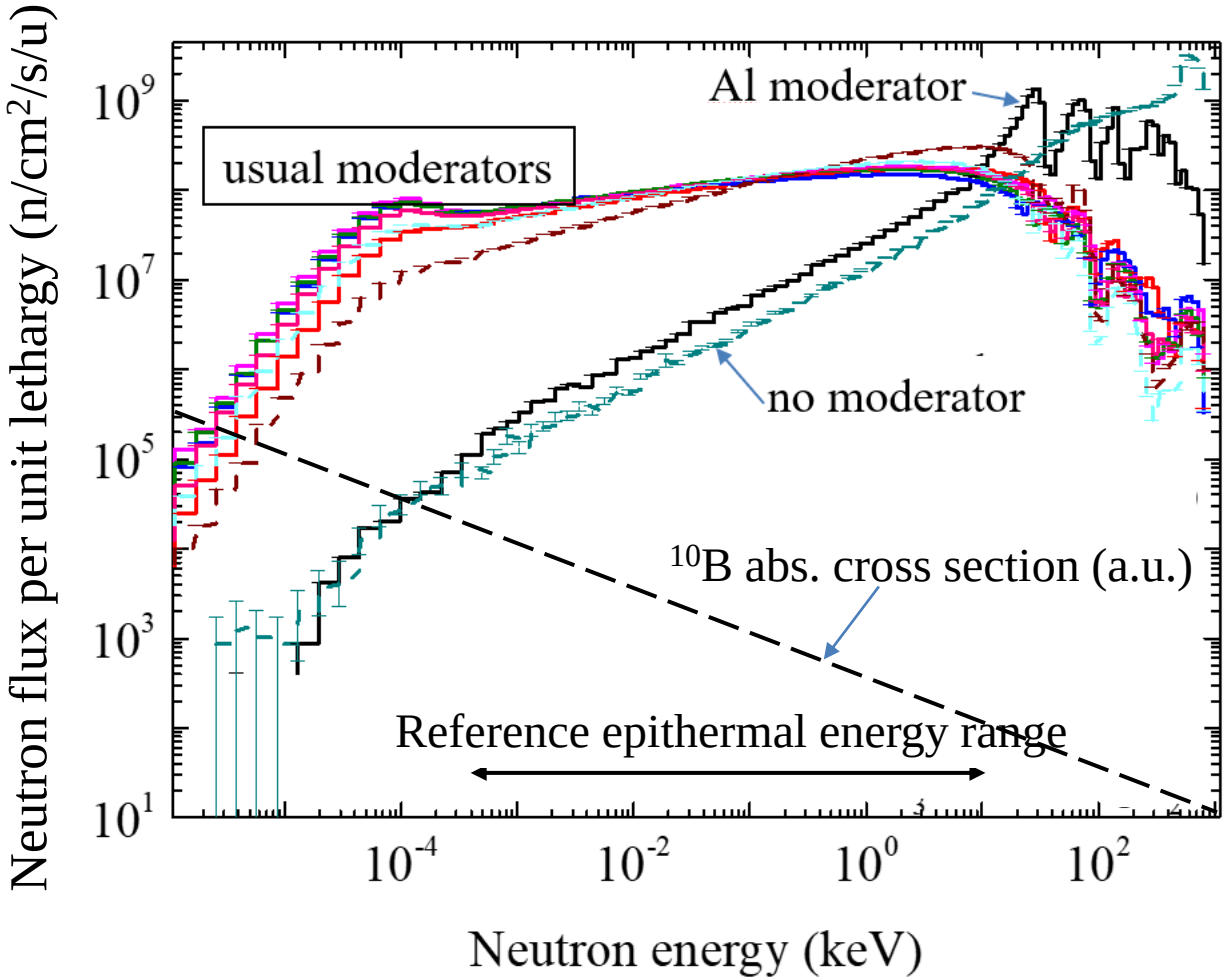


IAEA reference neutron beam intensities: achievable at 10 mA time average proton beam on target at 2.5 MeV proton energy

Ha Shuai et al., work in progress

Simulation results: BNCT target station





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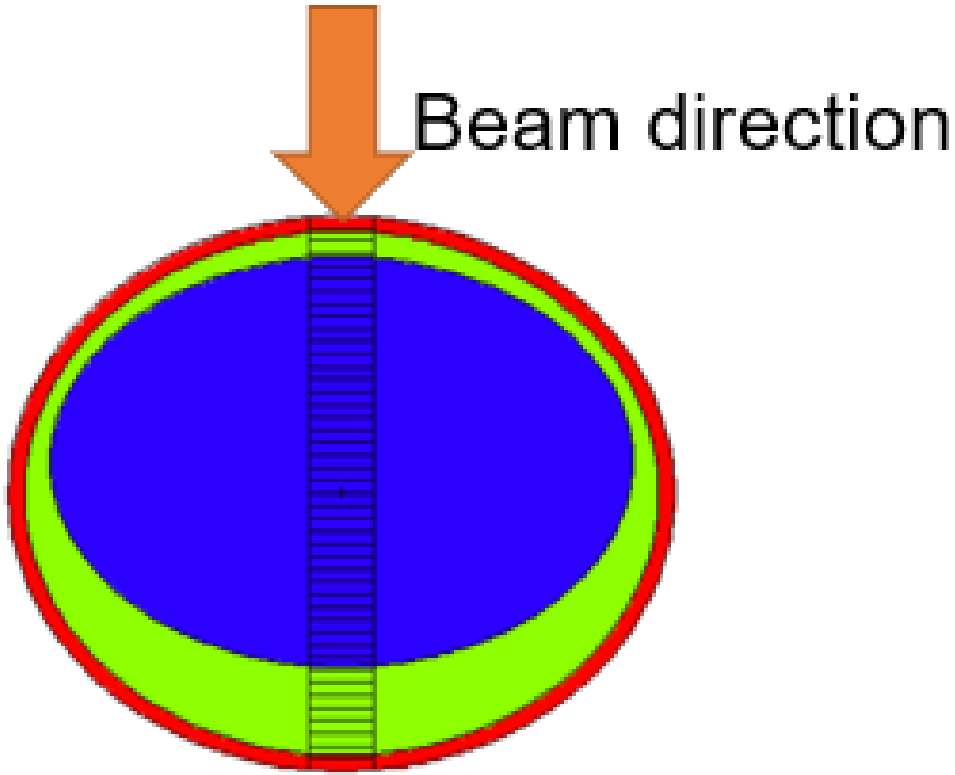
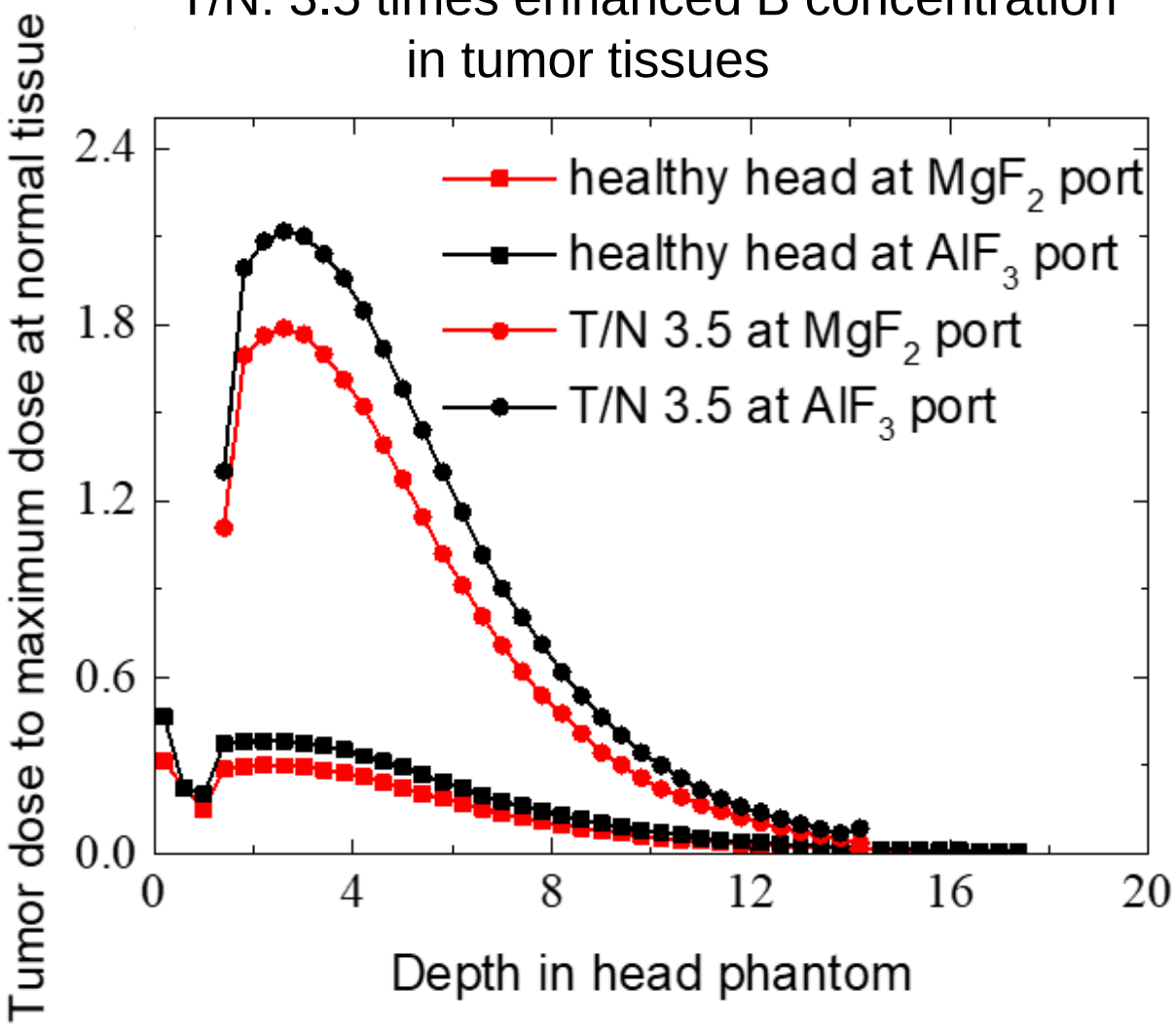
Simulation results: BNCT irradiation dose rates



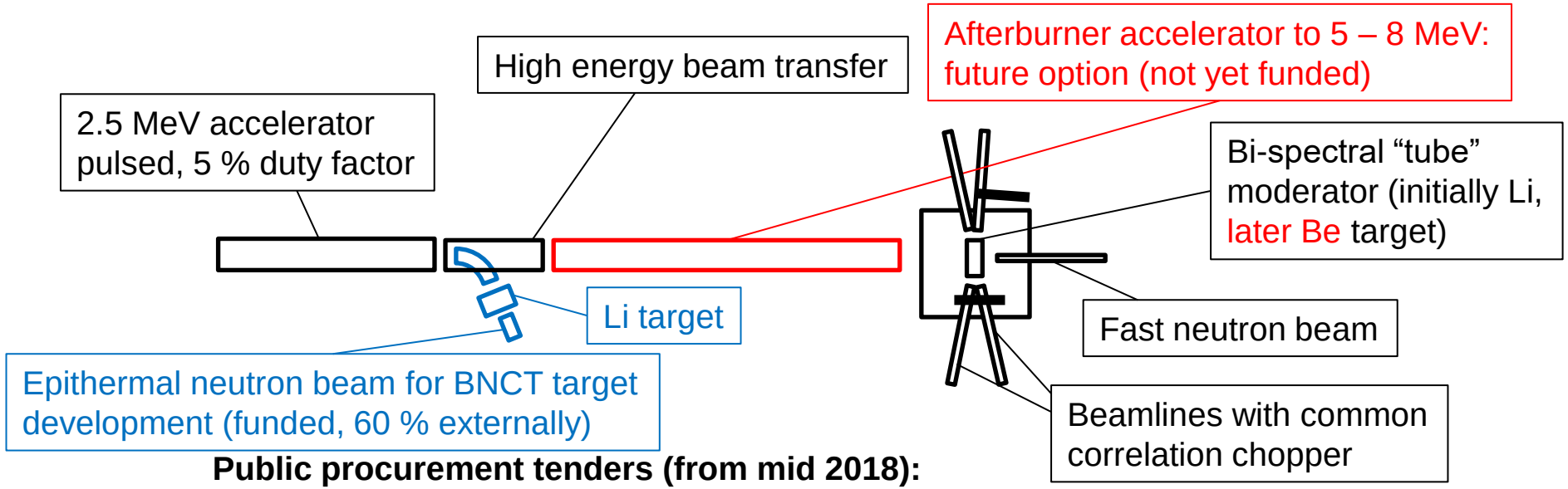
Snyder head phantom model

T/N: 3.5 times enhanced B concentration in tumor tissues



Mirrotron LvB CANS project in commissioning Martonvásár (patents pending)

Construction costs for 2.5 kW time average proton beam power: about 7 M€
Flexible, very cost-effective upgrade potential: just add DTL,.. afterburners up to even 200 MeV proton energy



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  Contractor failed, alternatives in sight.
- 2.5 MeV accelerator, 20 mA peak
- RF amplifier (private procurement)
- Integration and controls (private proc.)

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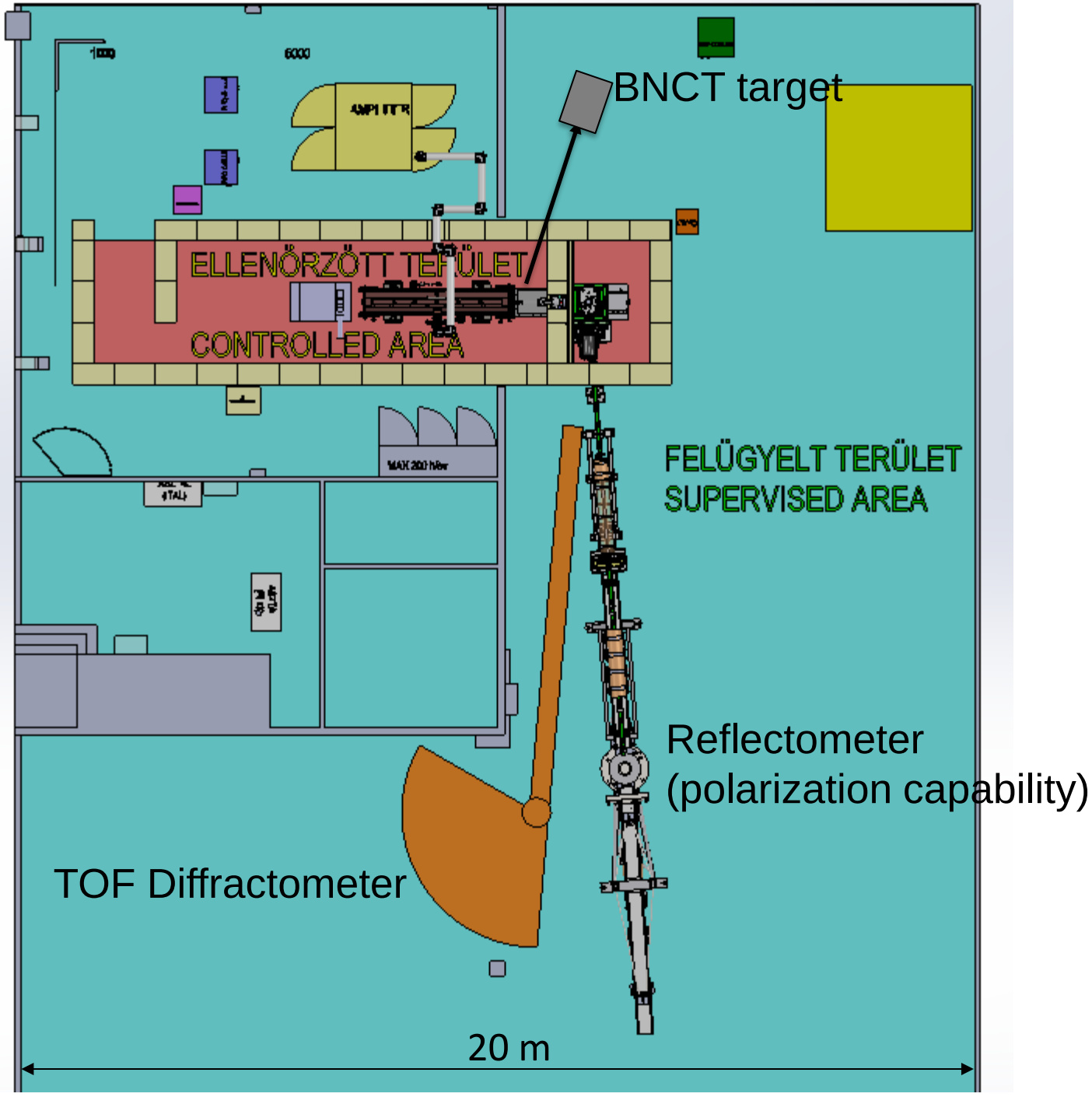
Added scope:

- Construction of a polarized neutron reflectometer and a TOF powder diffractometer (dismantled instruments from ILL: 580 k€ paid, 160 k€ debt)



Layout with first instruments

By using a solar panel park, the operational costs of LvB could be significantly lowered, not just the carbon emission!

- Solar energy use for electricity production is > 18 % in Hungary in 2024: highest in Europe, mostly private investments. Return on investment can be 5 years. By now solar energy can be cheaper than nuclear (0.03 €/kWh, industrial customers pay ~ 0.2 €/kWh).
- 2000 h/year LvB operation ~ 200 MWh/year electricity consumption
- Solar panels from eastern Asia cost much less than earlier expected in Europe.