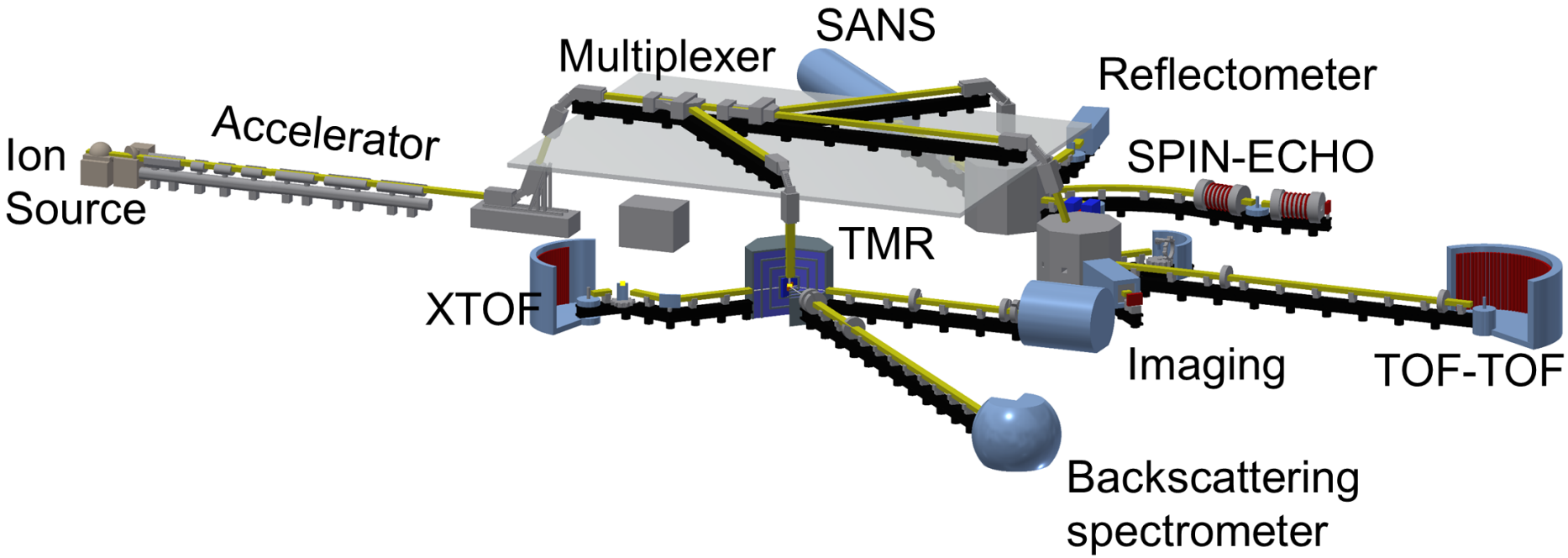


Instrumentation at a compact accelerator-based neutron source

Paul Zakalek, JCNS

High Brilliance Neutron Source

Target Moderator Reflector

3 Stations with each:

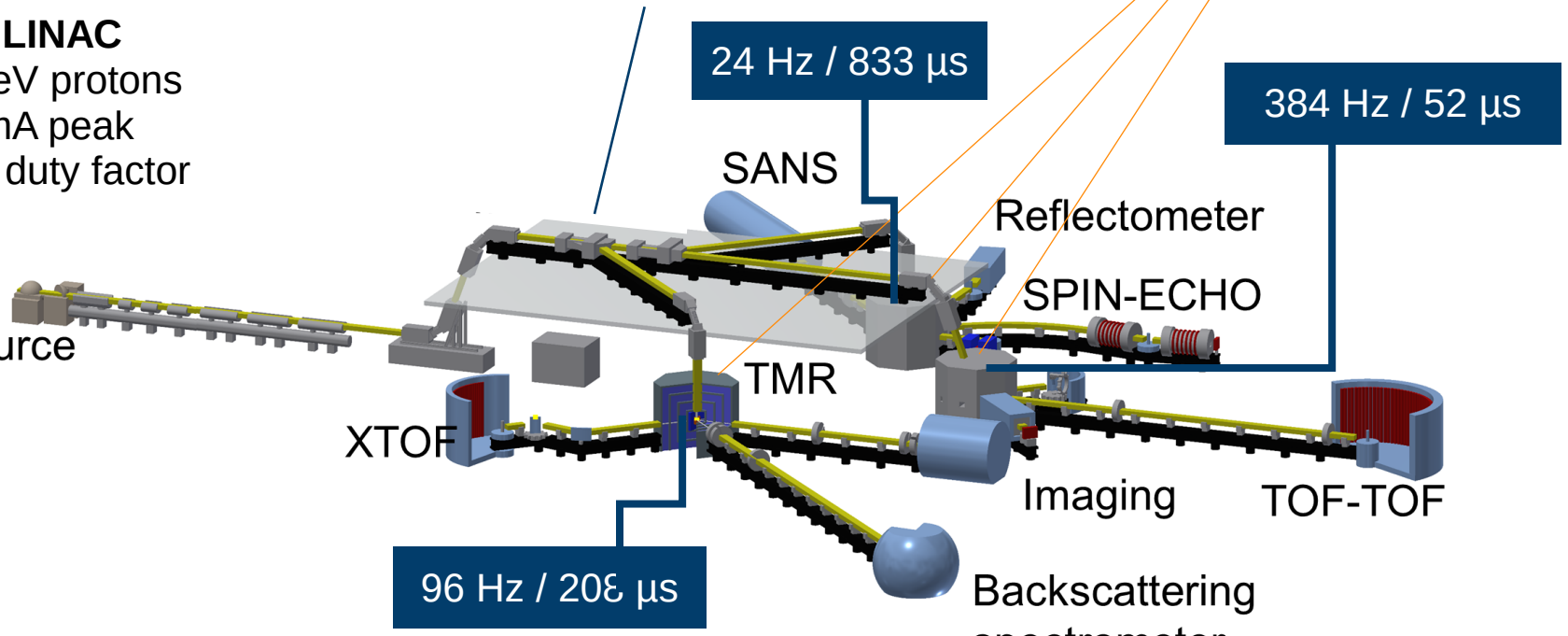
- 100 kW average
- 100 mA peak
- < 2% duty factor

Beam Multiplexer (2nd floor)

- Pulse Distribution to TMRs
- 24 Hz, 96 Hz, 384 Hz
- 833 µs, 208 µs, 52 µs

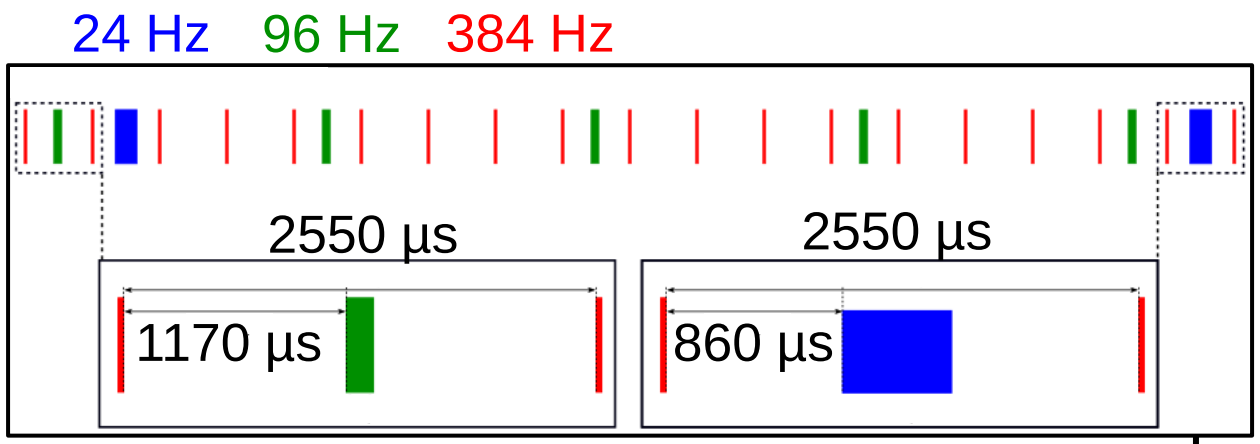
LINAC

- 70 MeV protons
- 100 mA peak
- < 6% duty factor



Distributing the protons

Multiplexer



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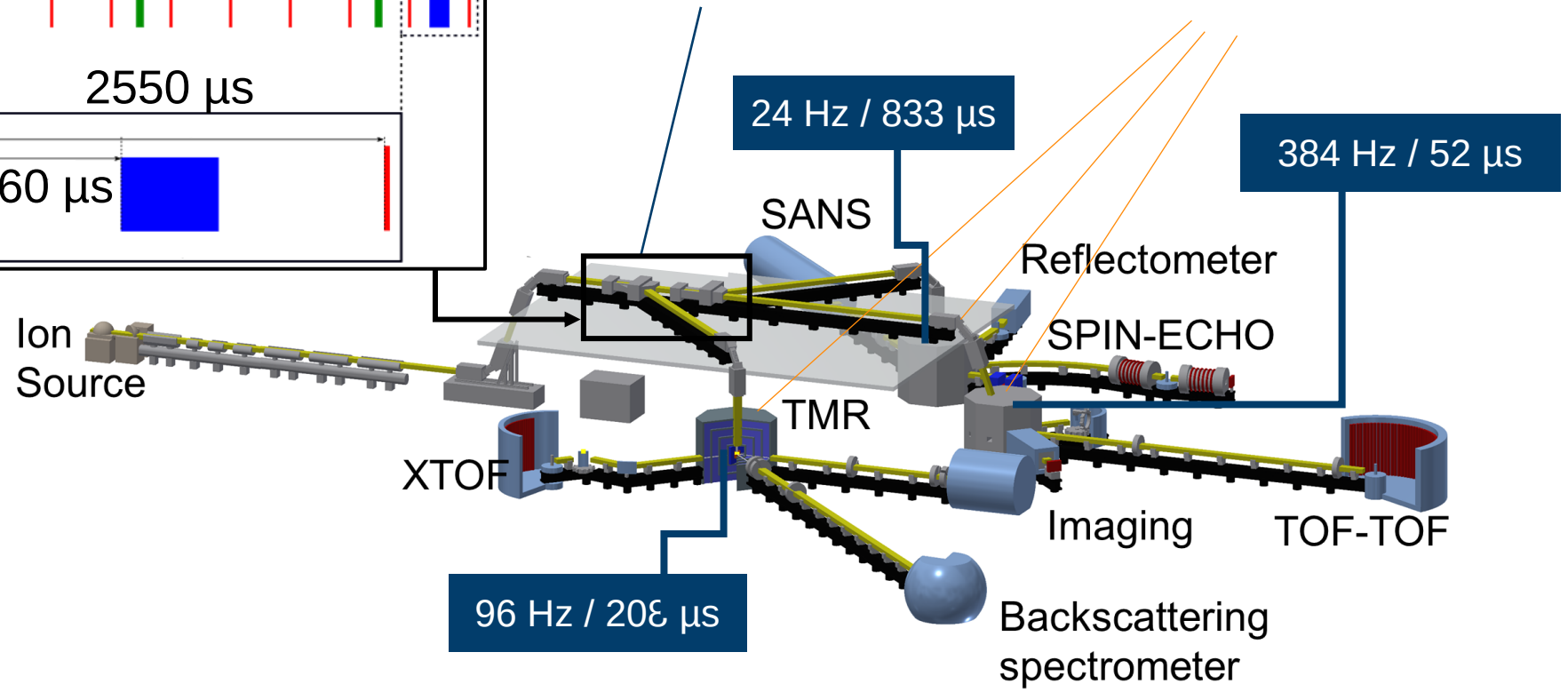
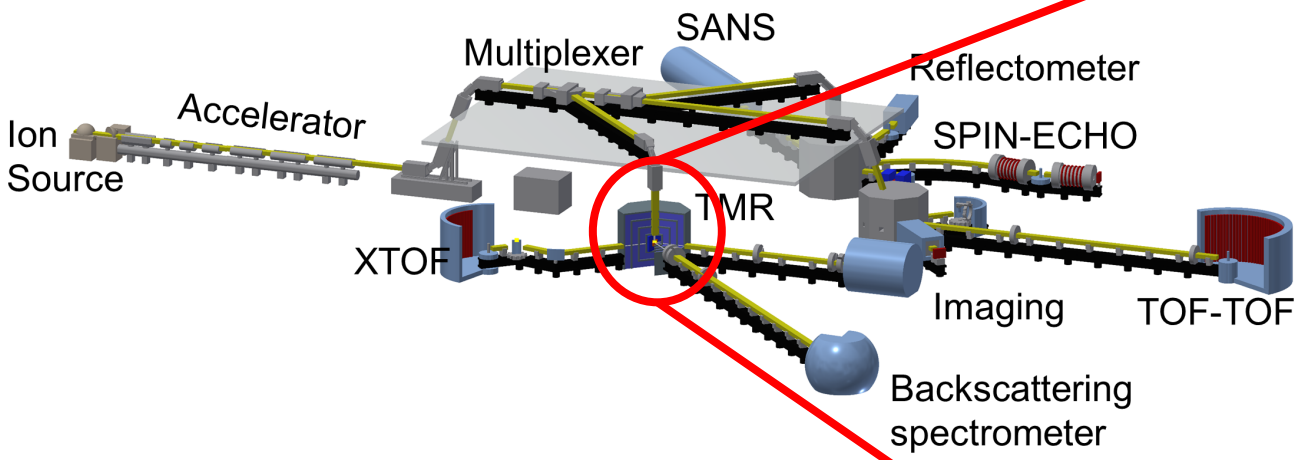
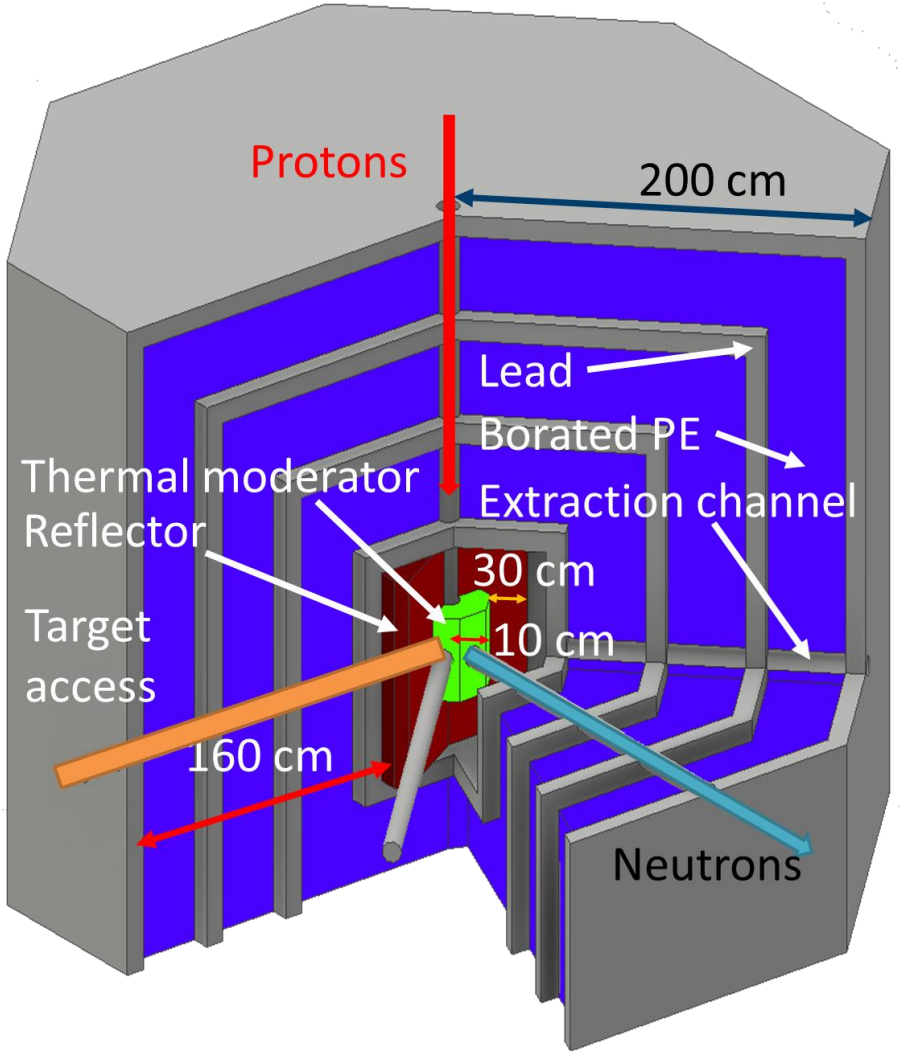


Target / Moderator / Reflector



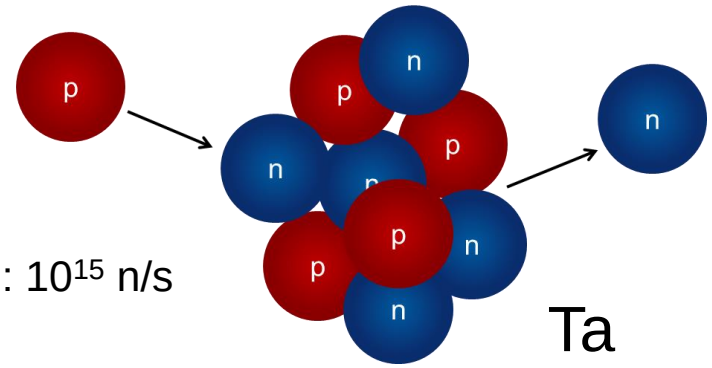


- Each TMR station optimized for selected frequency and pulse length
- Compact design due to low proton energy
- Neutron guide can start 40 cm away from moderator surface

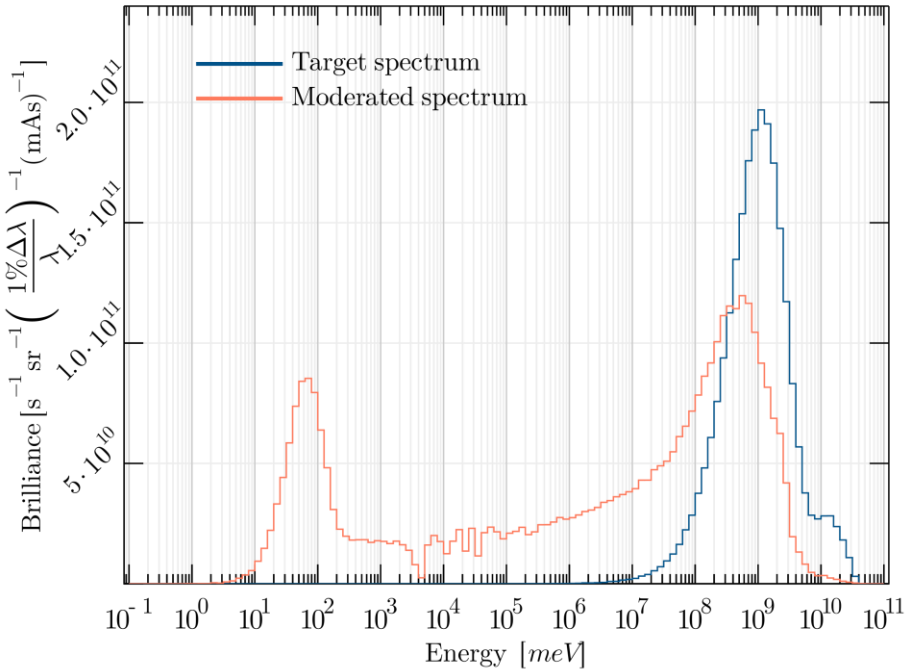
Neutrons production for neutron scattering experiments

Primary neutrons: MeV energy range
Moderator: Energy reduction to meV range

Nuclear processes



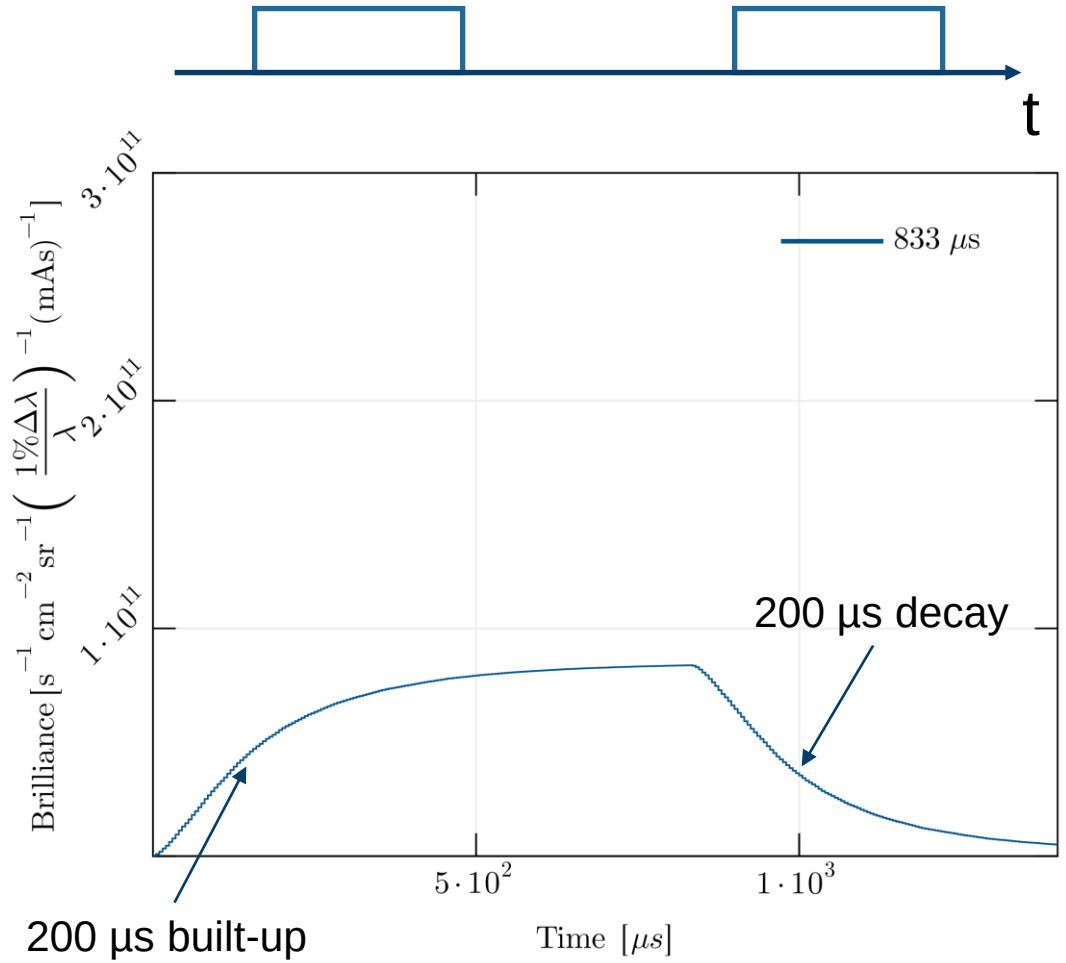
Neutron yield: 10^{15} n/s



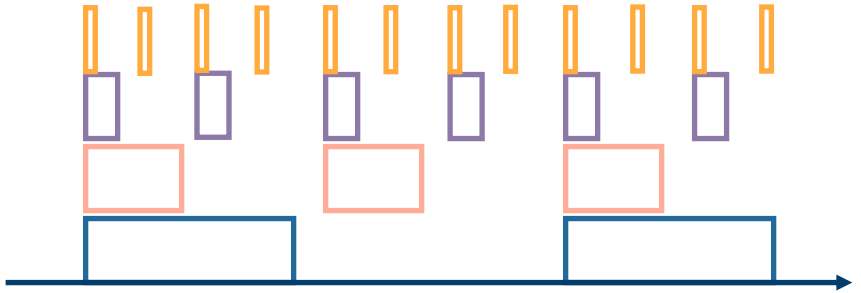
Neutrons production for neutron scattering experiments

Primary neutrons: MeV energy range
Moderator: Energy reduction to meV range

Moderation process needs time
→ convolution of proton pulse and moderation time
→ neutron pulse shape is modified



Neutrons production for neutron scattering experiments



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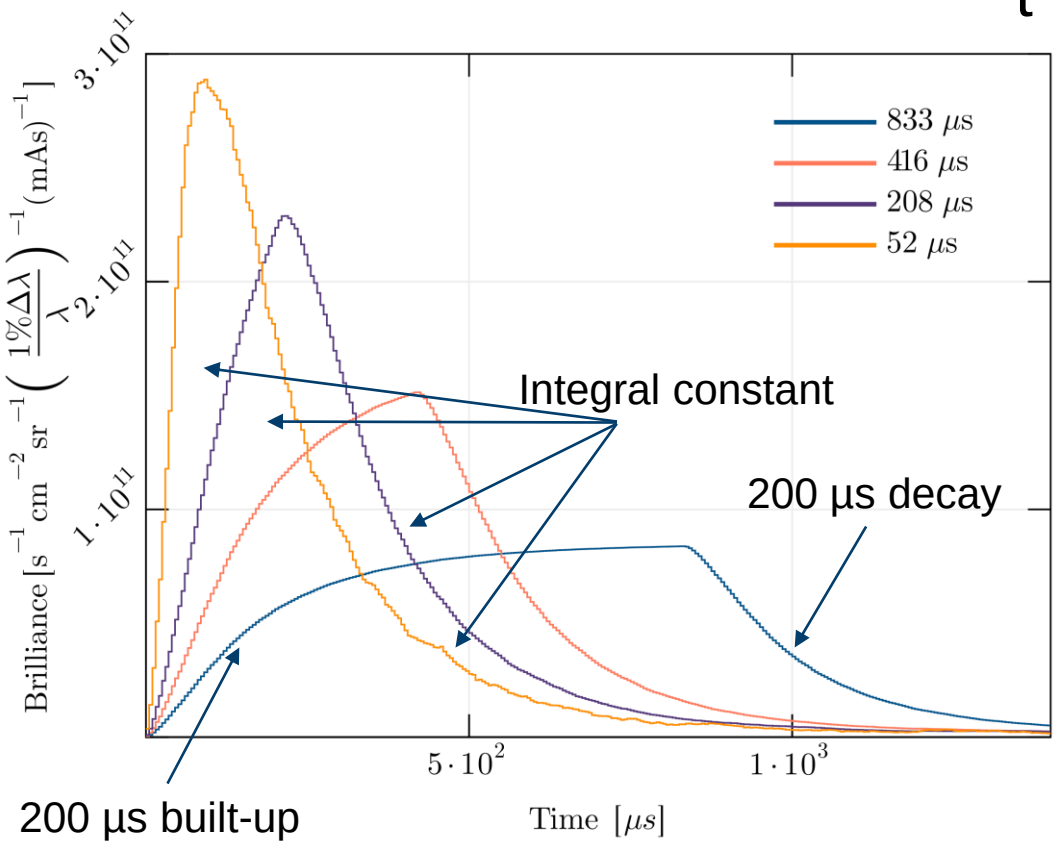
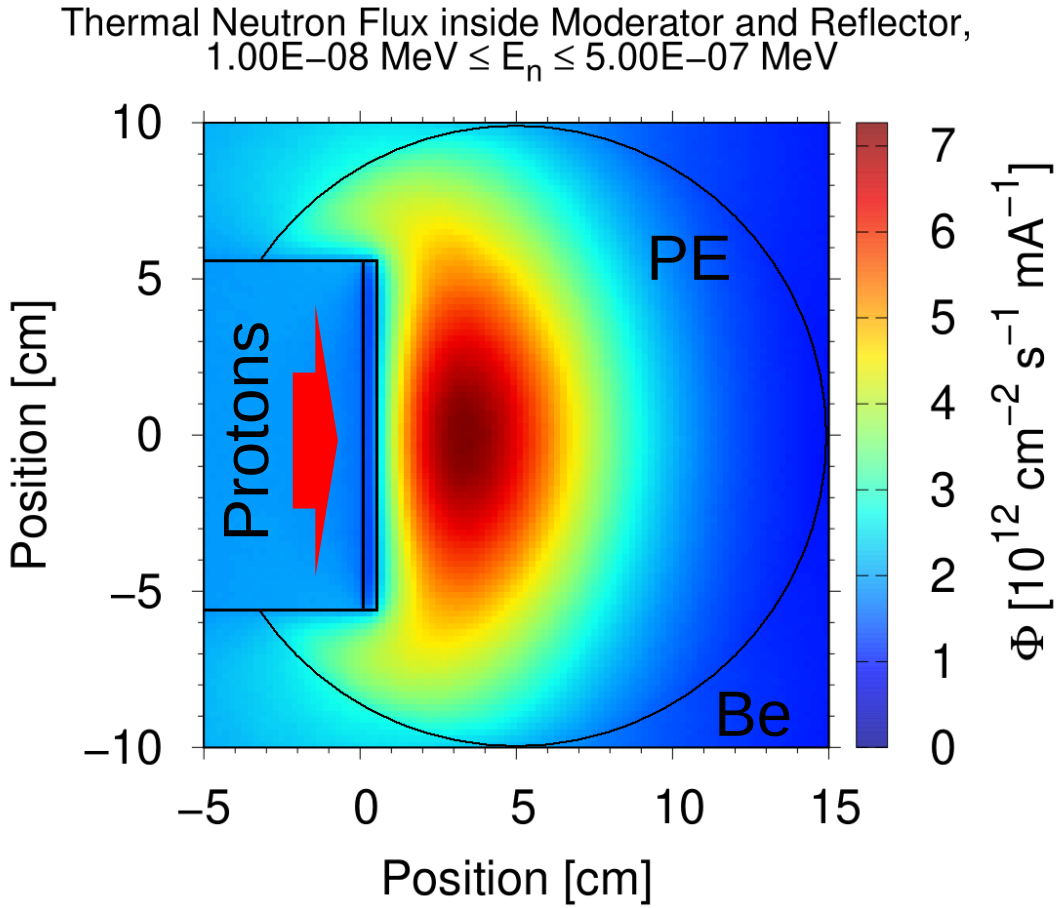


Neutrons production for neutron scattering experiments

Primary neutrons: MeV energy range
Moderator: Energy reduction to meV range

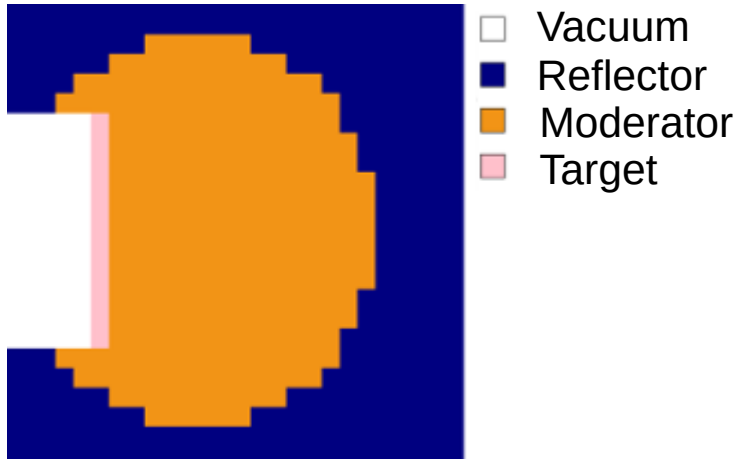
Moderation process needs time
→ convolution of proton pulse and moderation time
→ neutron pulse shape is modified

Main Parameters:
- Diffusion (dilutes the neutron cloud)
- Scattering (moderation)
- Absorption (reduces intensity)

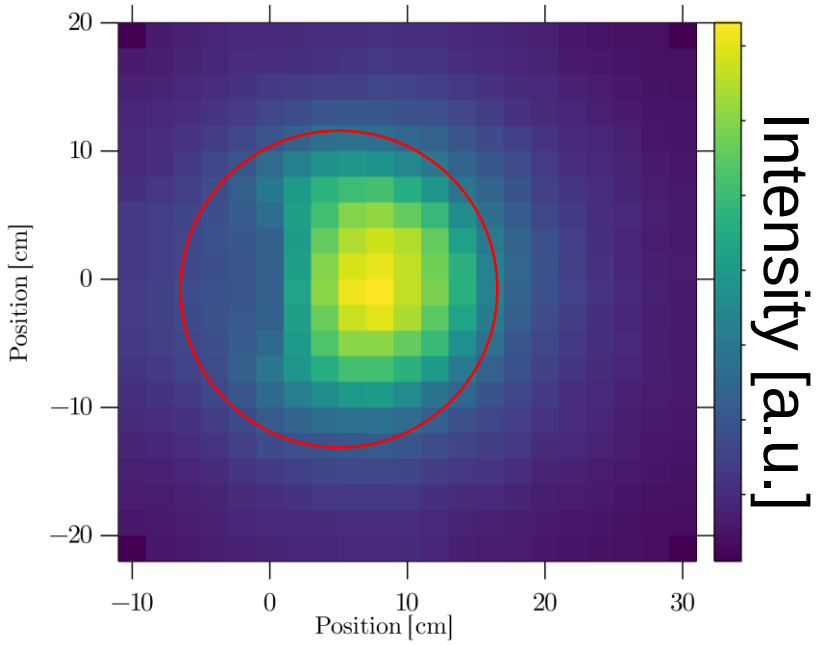


Neutrons production for neutron scattering experiments

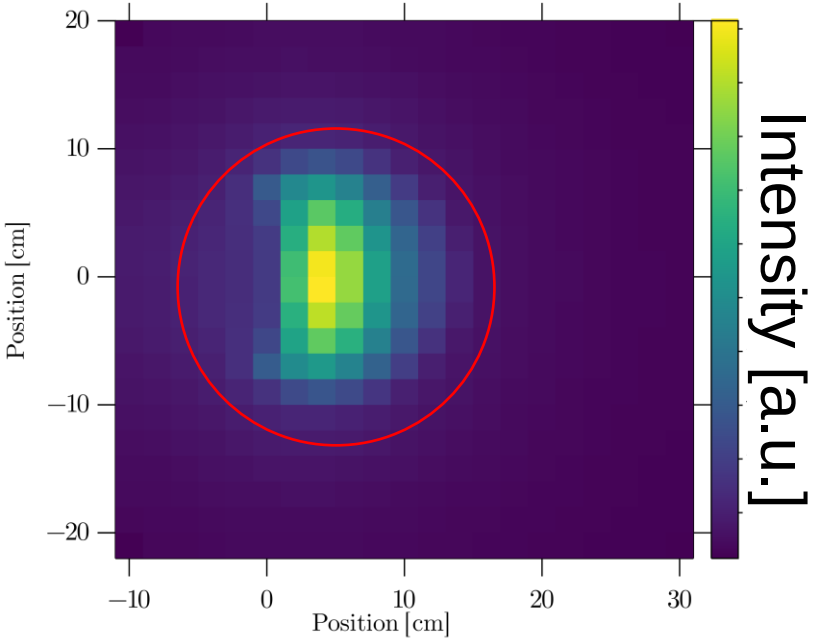
Moderator dependency



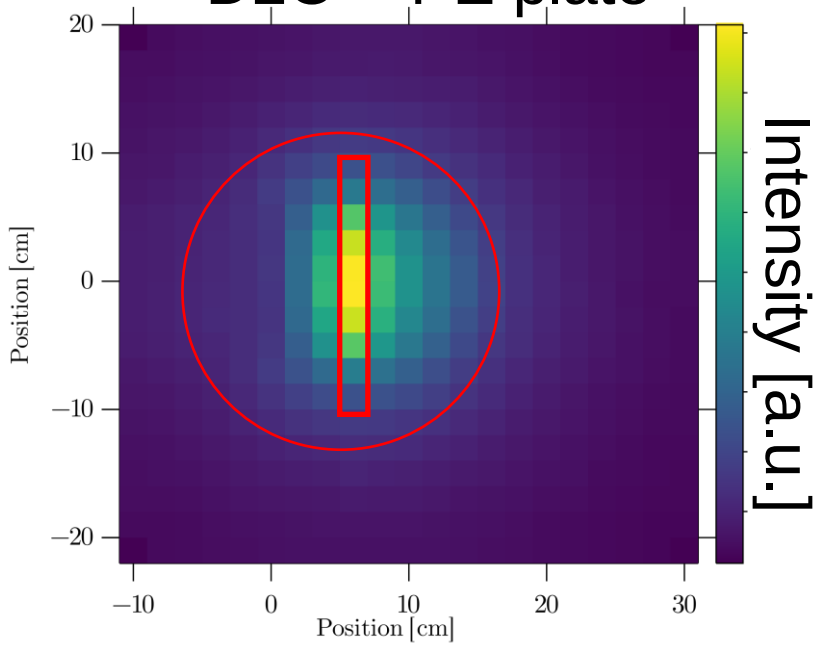
D2O



PE



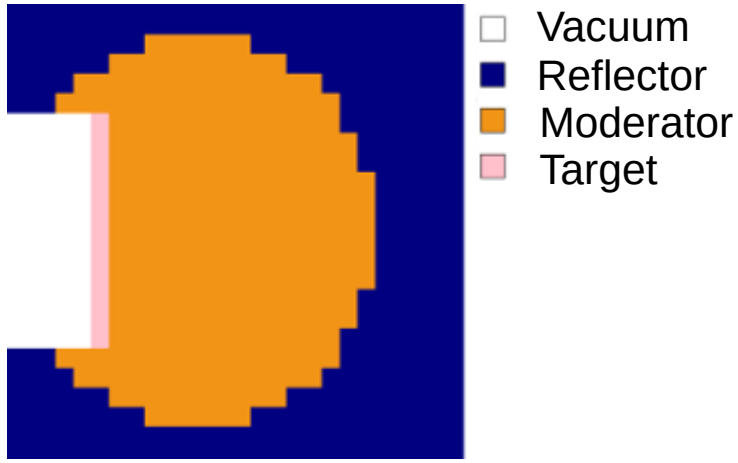
D2O + PE plate

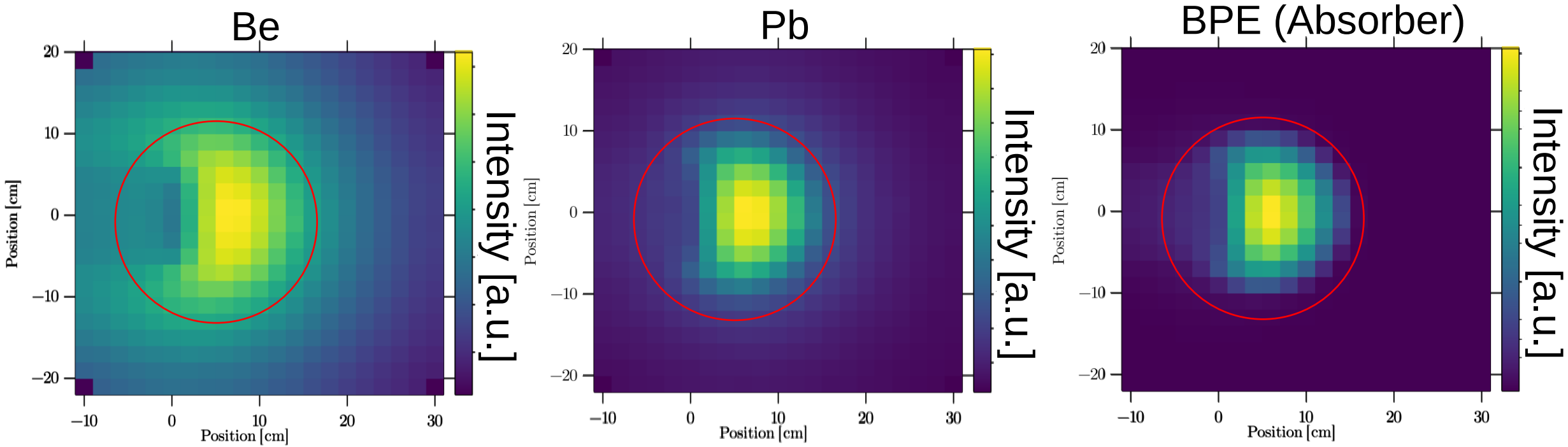


1 meV – 120 meV

Neutrons production for neutron scattering experiments

Reflector dependency



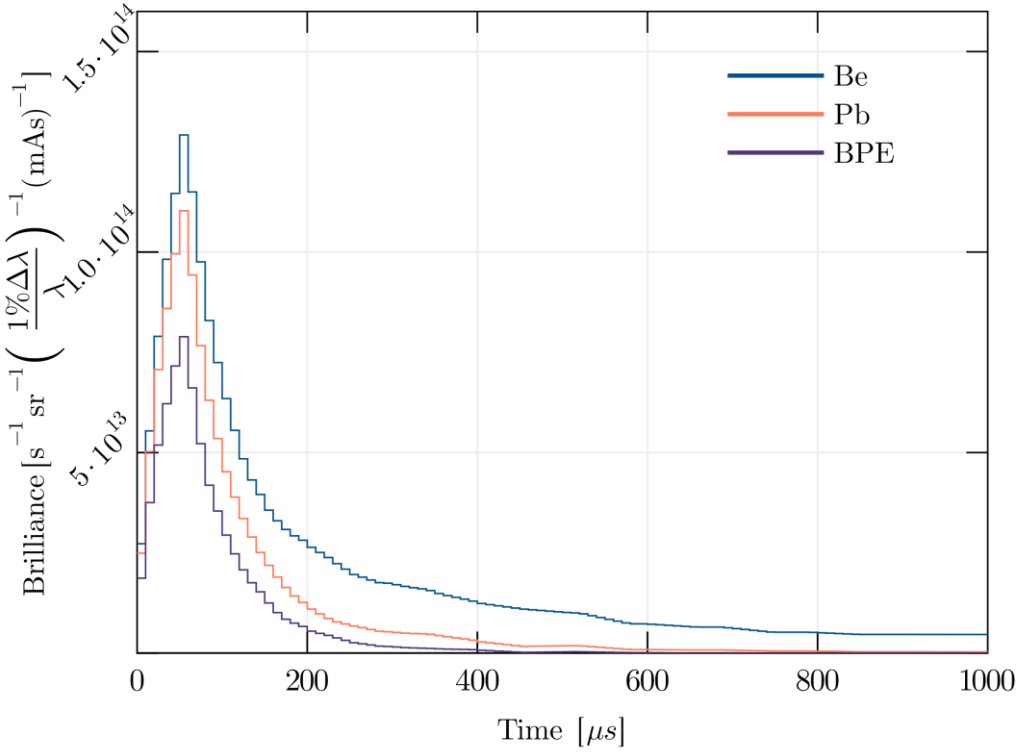


1 meV – 120 meV

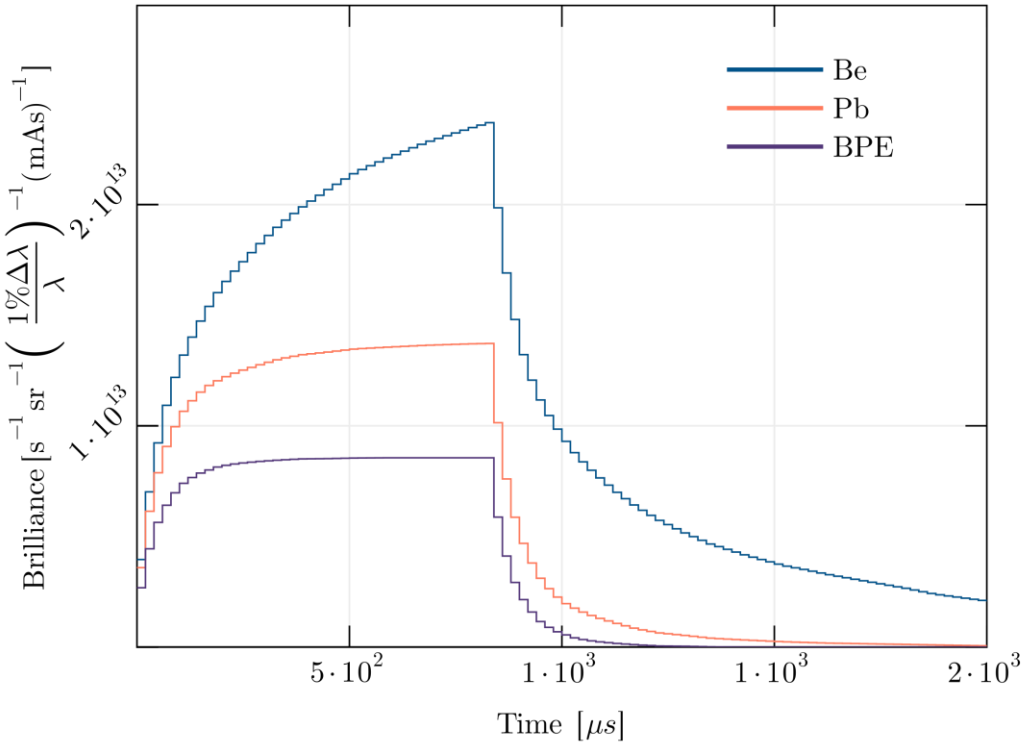
Neutrons production for neutron scattering experiments

Reflector dependency

52 µs Proton pulse



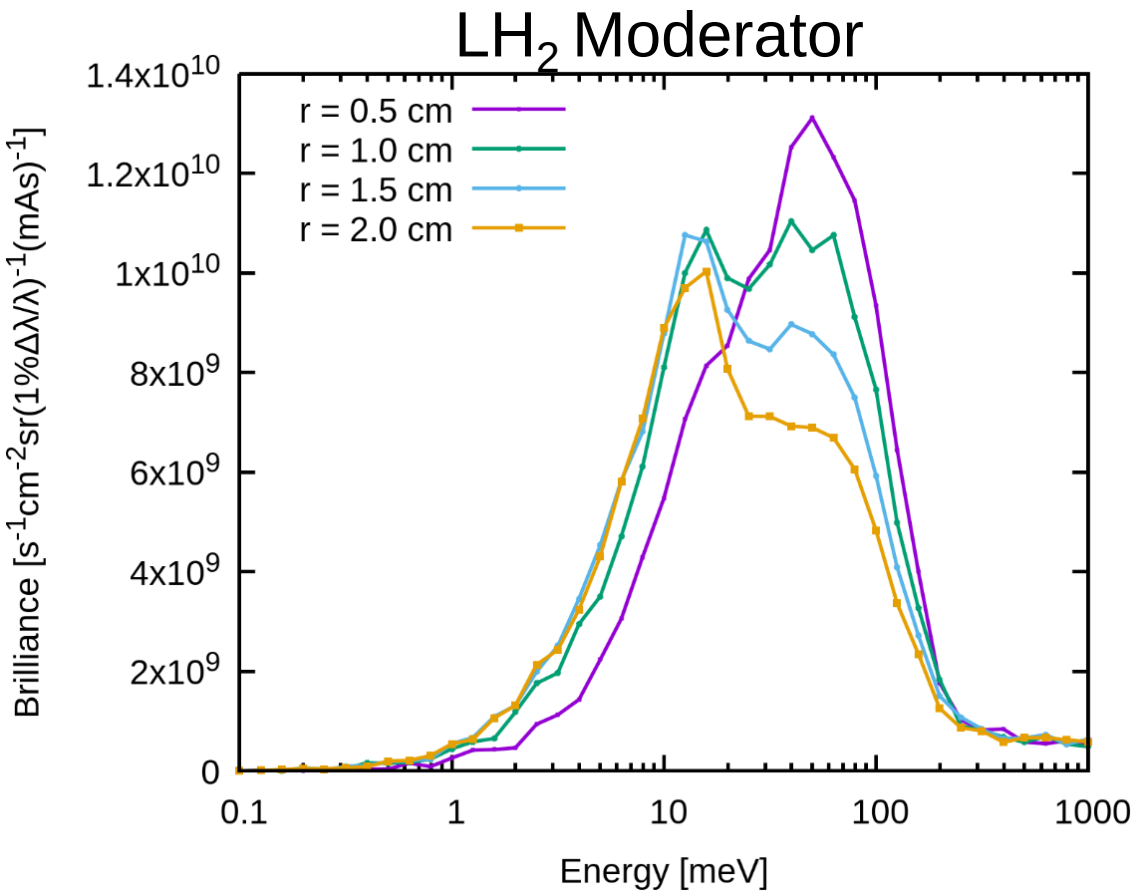
833 µs Proton pulse

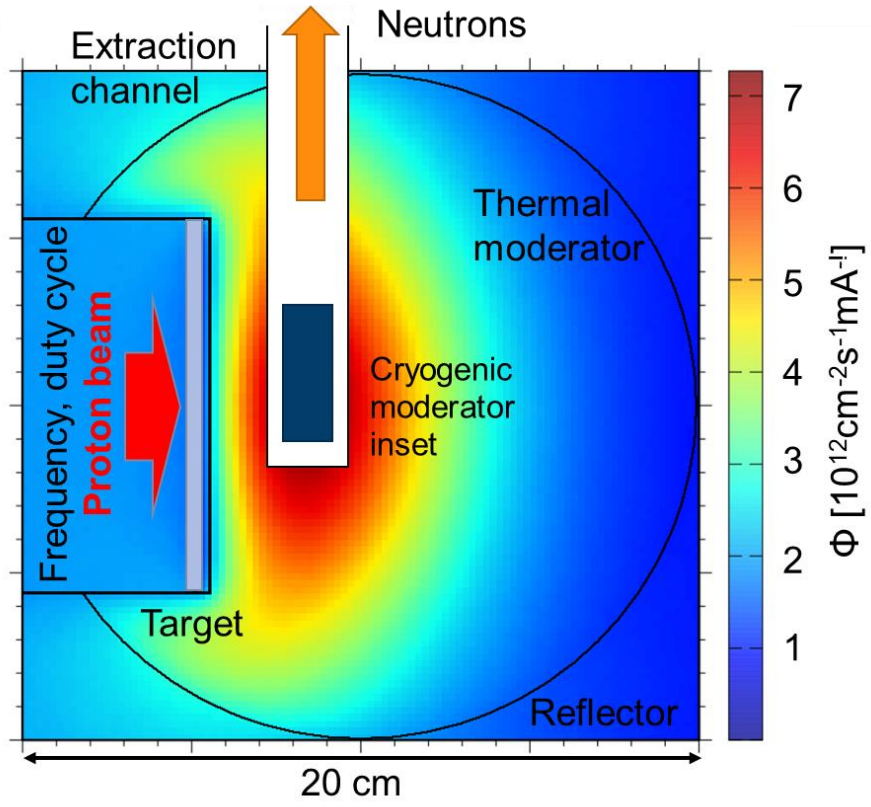


1 meV – 120 meV

Neutrons production for neutron scattering experiments

Cryogenic moderator optimization





High Brilliance Neutron Source

Possible Target / Moderator / Reflector Layout

24 Hz / 833 µs TMR:
- Optimized for high intensity and broad wavelength band
  → PE moderator and Be reflector

96 Hz / 208 µs TMR:
- Optimized for high brilliance and symmetric neutron pulse with fast decay
  → PE moderator and Pb reflector

384 Hz / 52 µs TMR:
- Optimized for short neutron pulse with no long tail
  → PE plate moderator and BPE reflector

LINAC
- 70 MeV protons
- 100 mA peak
- < 6% duty factor

Beam Multiplexer (2nd floor)
- Pulse Distribution to TMRs
- 24 Hz, 96 Hz, 384 Hz
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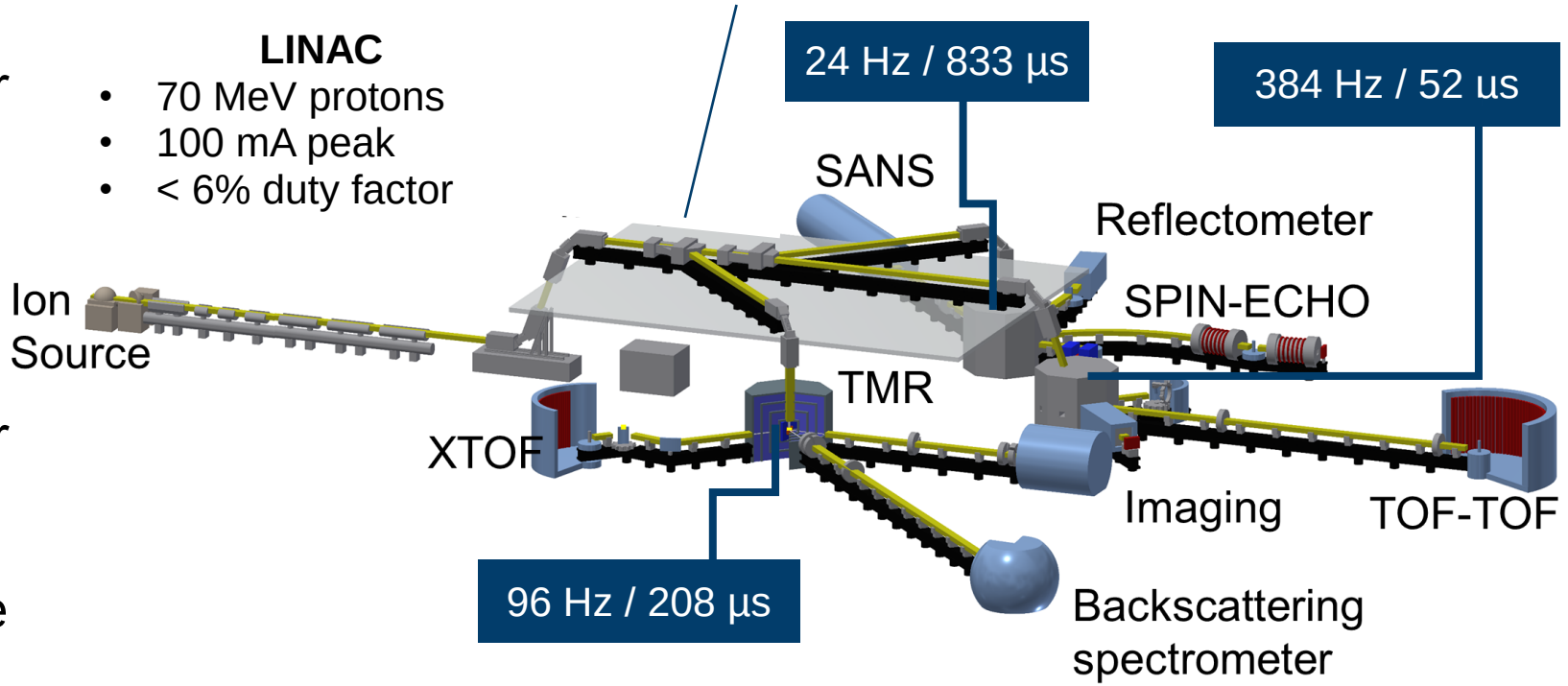
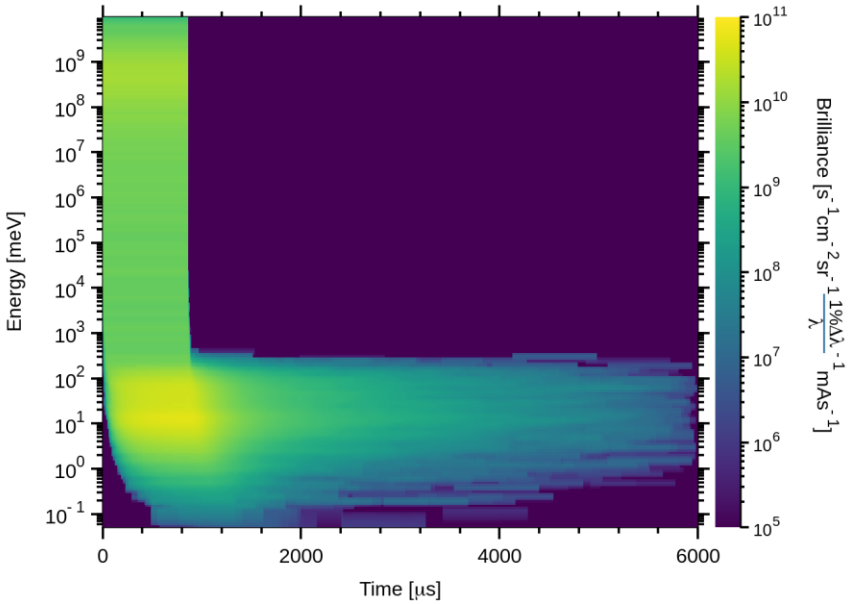


High Brilliance Neutron Source

Reflectometer

- Broad bandwidth target station
  → 24 Hz, 833 µs proton beam
- Intensity maximization
  → PE moderator + Be reflector
- Cold energy spectrum
  → LH_2 moderator with 1cm radius



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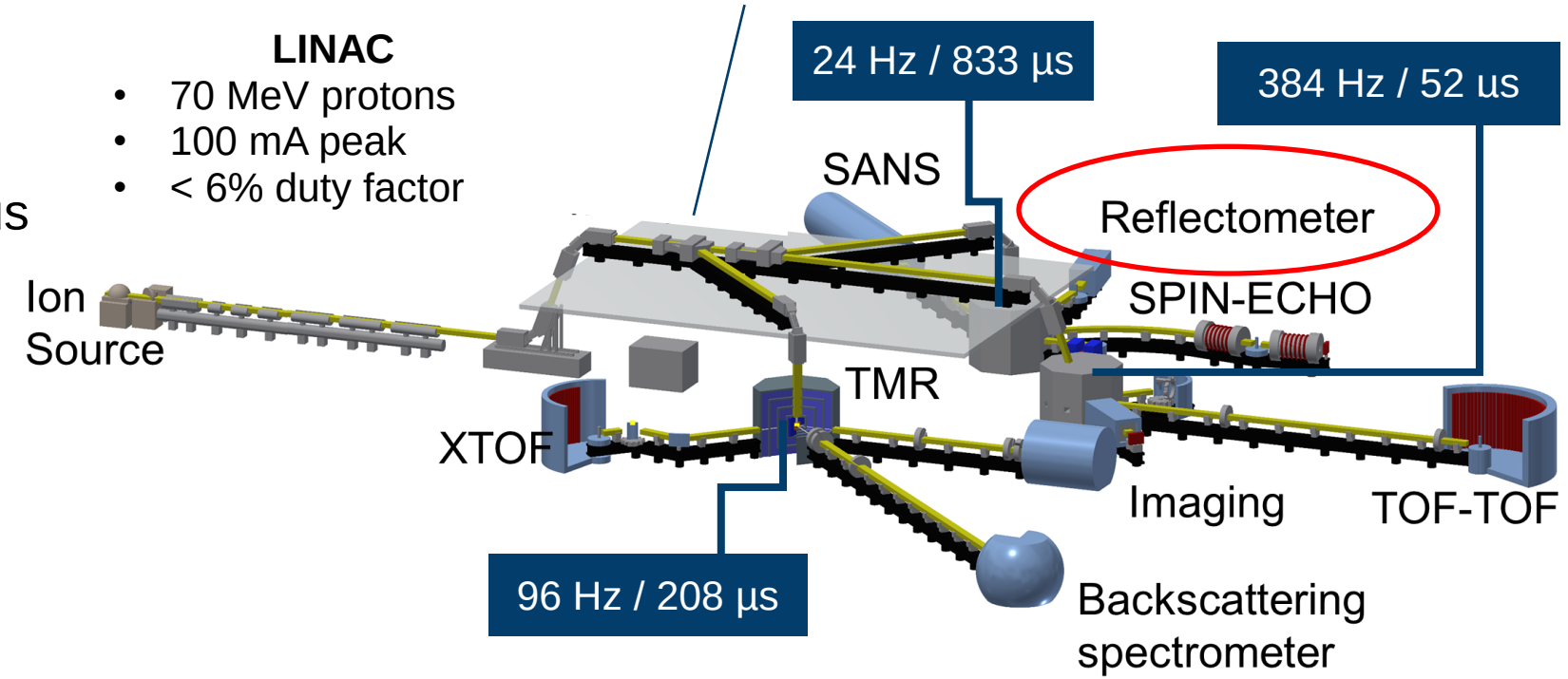
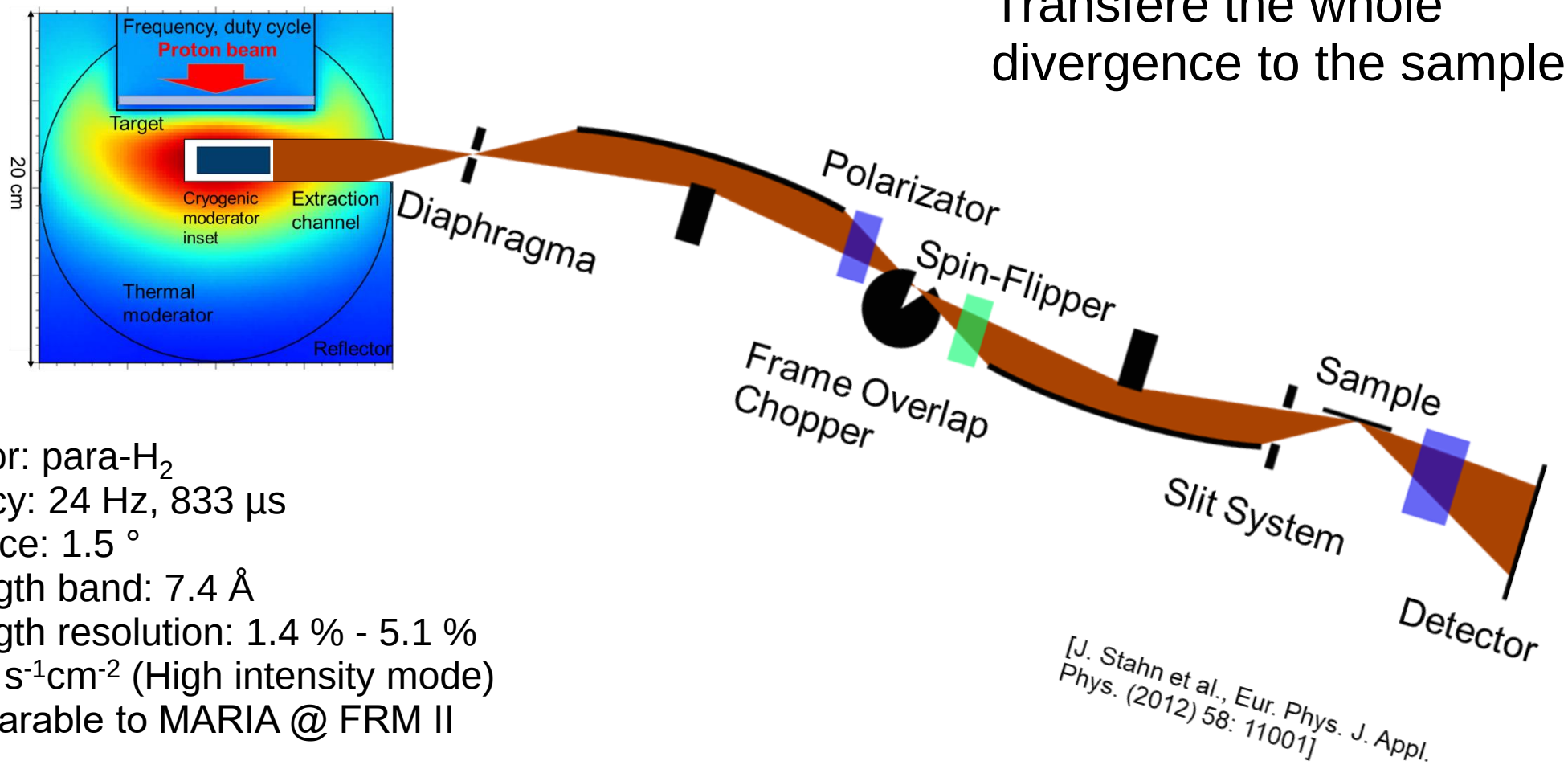


Reflectometer

Selene concept



Transfere the whole divergence to the sample

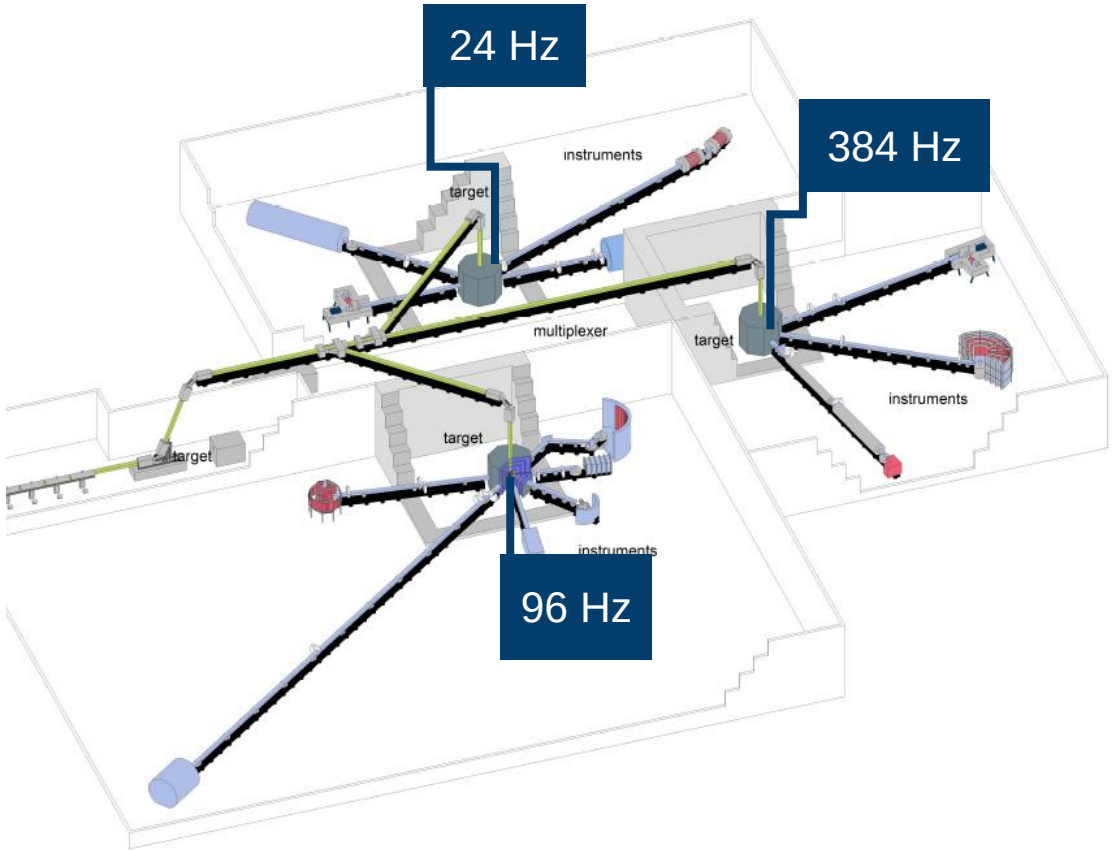
- Moderator: para-H_2
- Frequency: 24 Hz, 833 µs
- Divergence: 1.5 °
- Wavelength band: 7.4 Å
- Wavelength resolution: 1.4 % - 5.1 %
- Flux: 10^7 $s^{-1}cm^{-2}$ (High intensity mode)
  → Comparable to MARIA @ FRM II

[J. Stahn et al., Eur. Phys. J. Appl. Phys. (2012) 58: 11001]

Instrumentation

Calculated instrument neutron flux

	Length [m]	Resolution	Bandwidth	Flux [cm^{-2} s^{-1}]	Frequency [Hz]
SANS	20.0	5% $\Delta\lambda/\lambda$	2.0-9.0 Å	9.4×10^7	24
Reflectometer	22.0	4% $\Delta\lambda/\lambda$	1.3-8.0 Å	1.7×10^7	24
SELENE reflectometer	22.3	1.5-5.1%	3.0-10.4 Å	4.0×10^7	24
Thermal powder diffr.	100.8	0.0061-0.014 $\Delta\ d/d$	0.75-2.4 Å	1.5×10^8	24
Cold neutron imaging I	6.0	2.0-10.0%	1.0-15.0 Å	3.0×10^8	96
Disordered material diffr.	61.0	0.016-0.028 $\Delta\ d/d$	0.5-1.2 Å	1.9×10^7	96
Macromolecular diffr.	12.5		2.0-4.0 Å	4.0×10^7	96
Cold chopper spectr.	18.5		1.6-10.0 Å	3.4×10^5	96
Backscattering spectr.	102.5	3.0-20.0 μeV	6.05-6.0 Å	7.0×10^6	96
Epithermal neutron imaging	37.0		25-80 meV	5.0×10^9	384
High energy chopper spectr.	28.5	4% ΔE/E	0.5-2.5 Å	9.0×10^4	384
PDGNAA-2	21.0	50%	0.6 eV - 10 MeV	2.7×10^7	384



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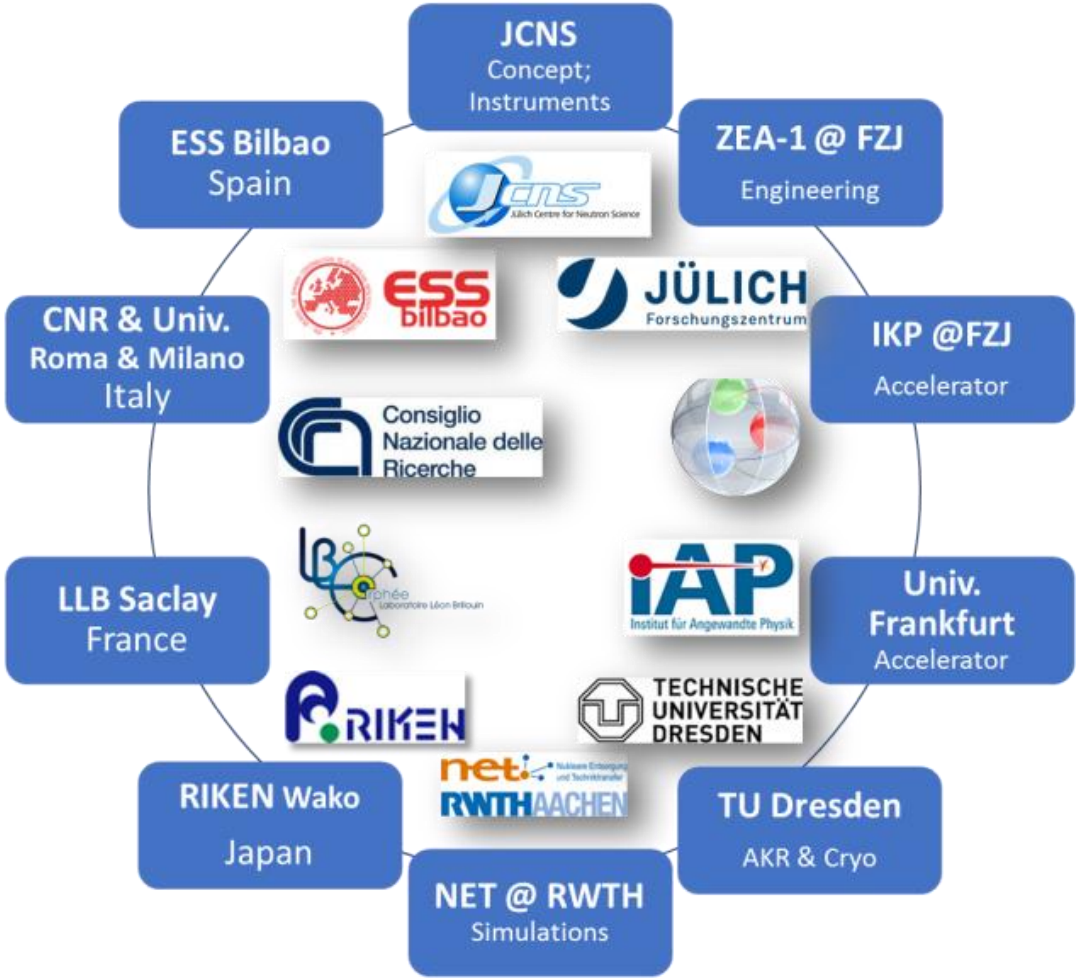

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Thank you for your attention.