Vanadium based beam monitor update

Vendula Maulerova, IKON18, 25th February 2020

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Paper submitted to PRAB, arXiv: 2002.10108

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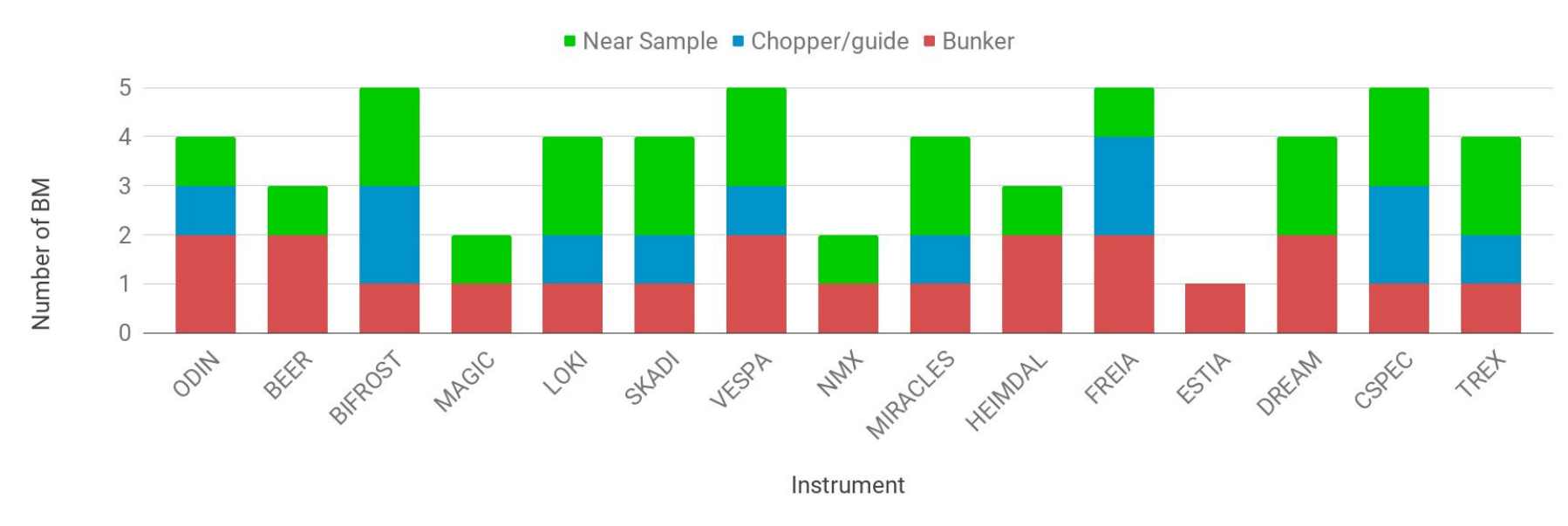
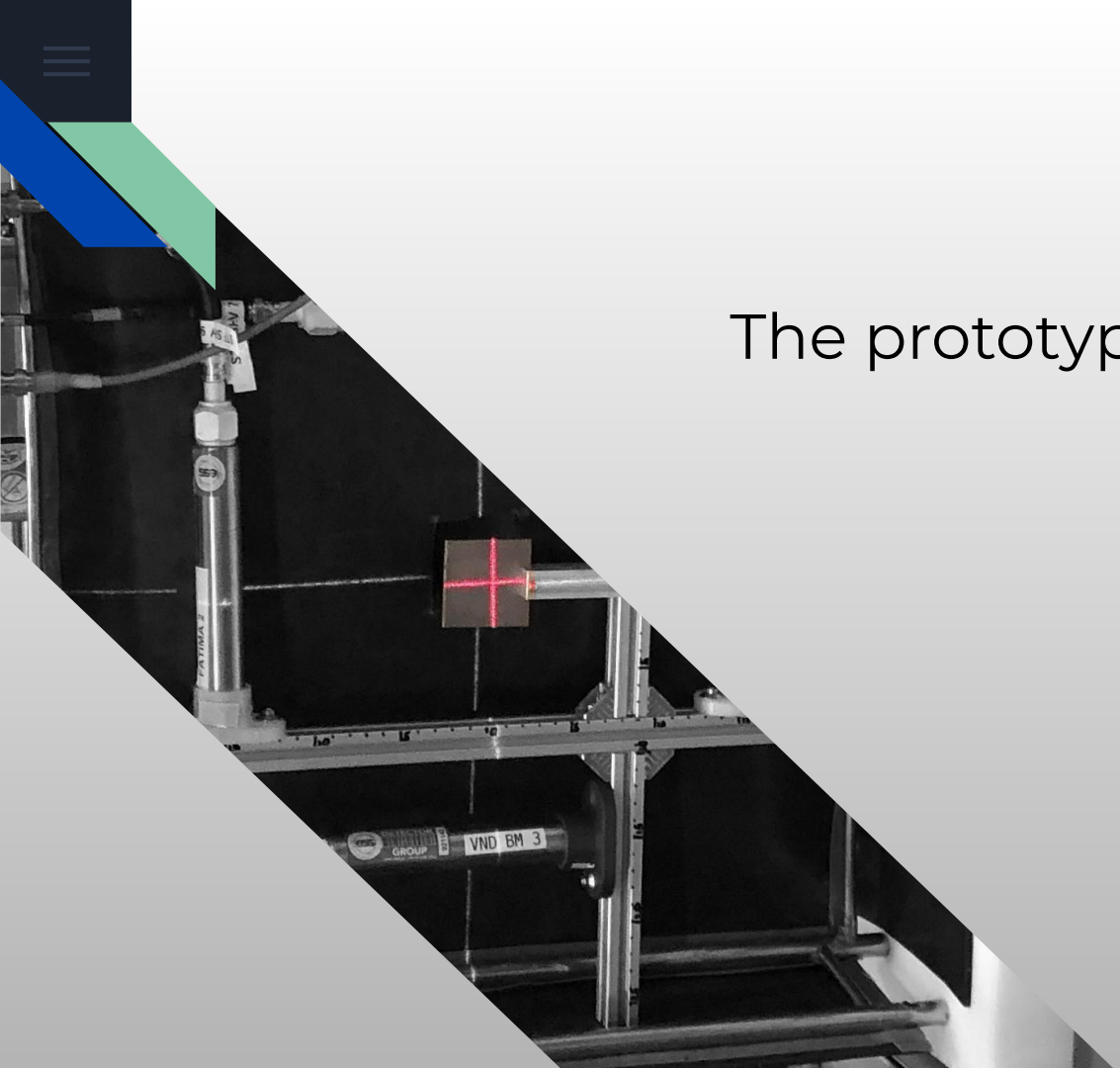
Beam Monitors anticipated to be required as ESS instruments

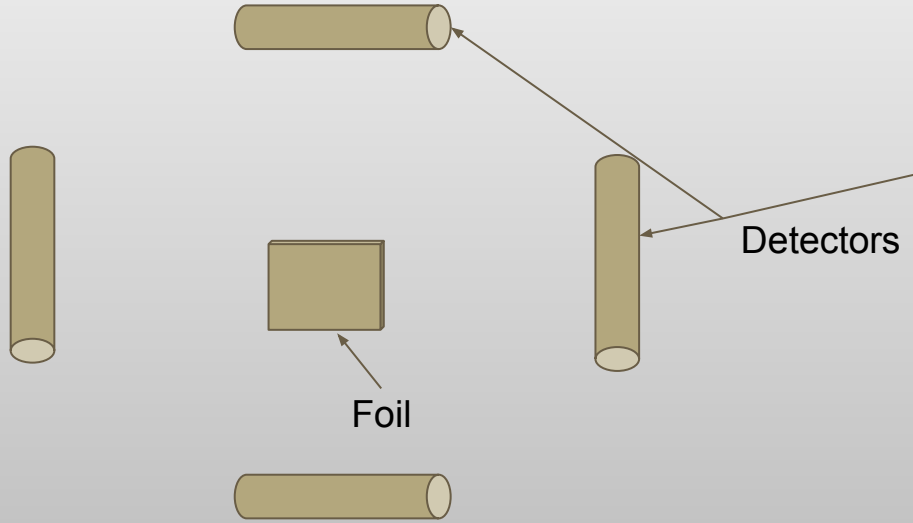


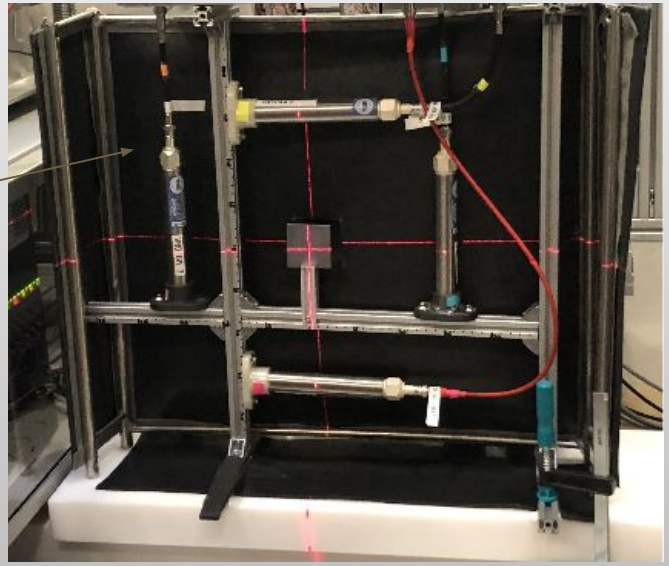
V-monitor as a candidate to be placed after **choppers** and between **guide sections**.

The prototype concept



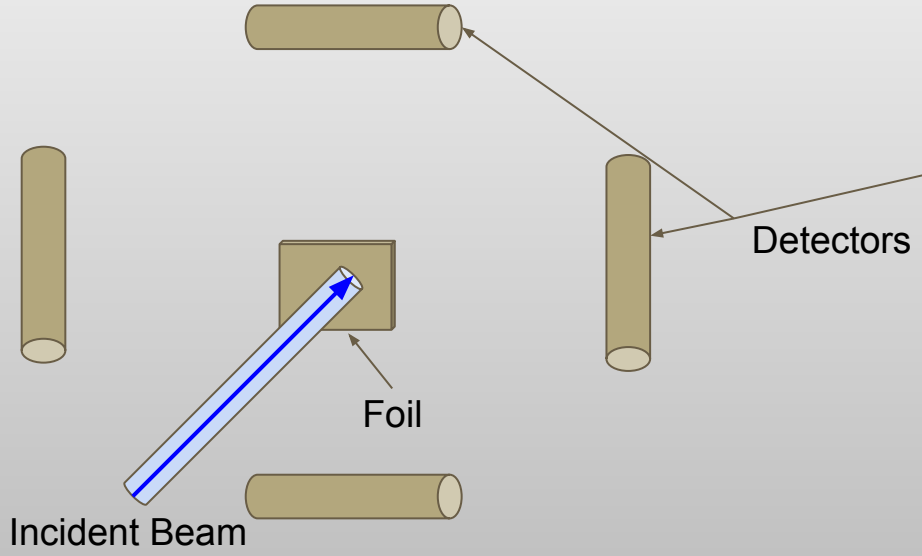
Thin foil-based neutron beam monitor concept

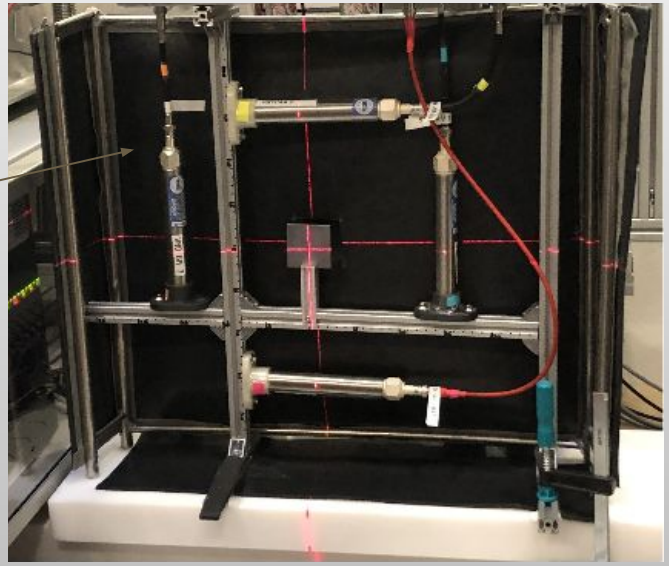




Concept Inspired by ISIS [1] [2]

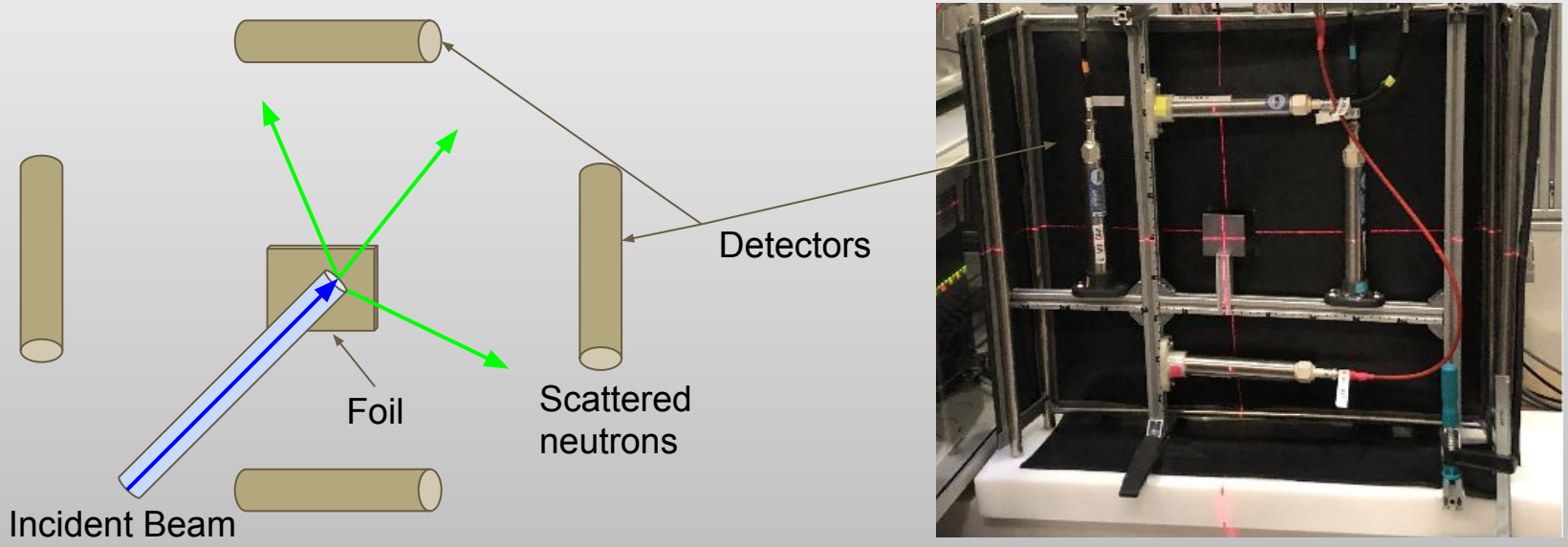
Thin foil-based neutron beam monitor concept





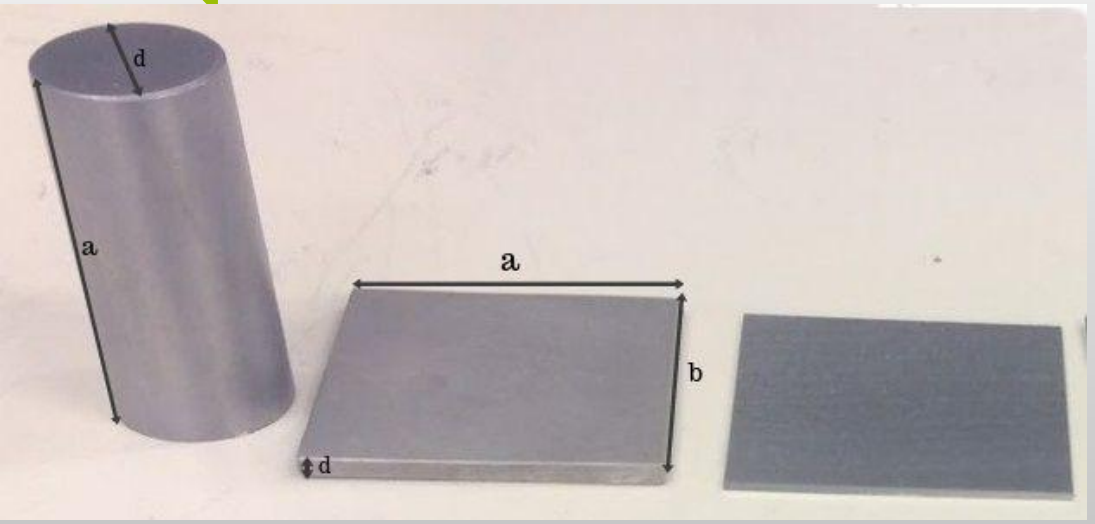
Concept Inspired by ISIS [1] [2]

Thin foil-based neutron beam monitor concept



Concept Inspired by ISIS [1] [2]

Why Vanadium?



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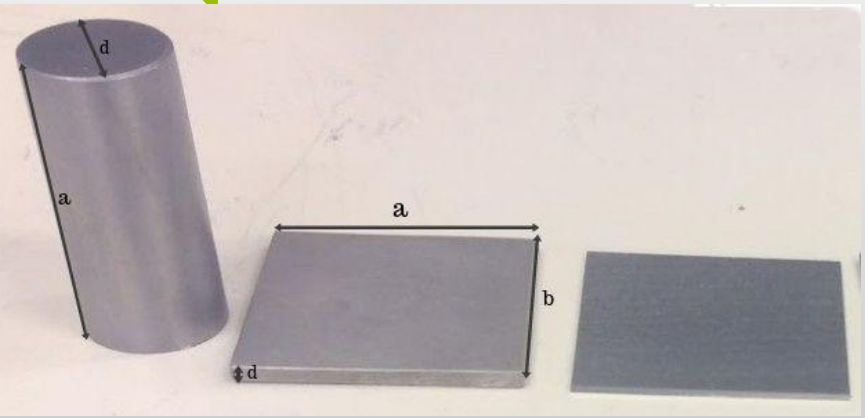

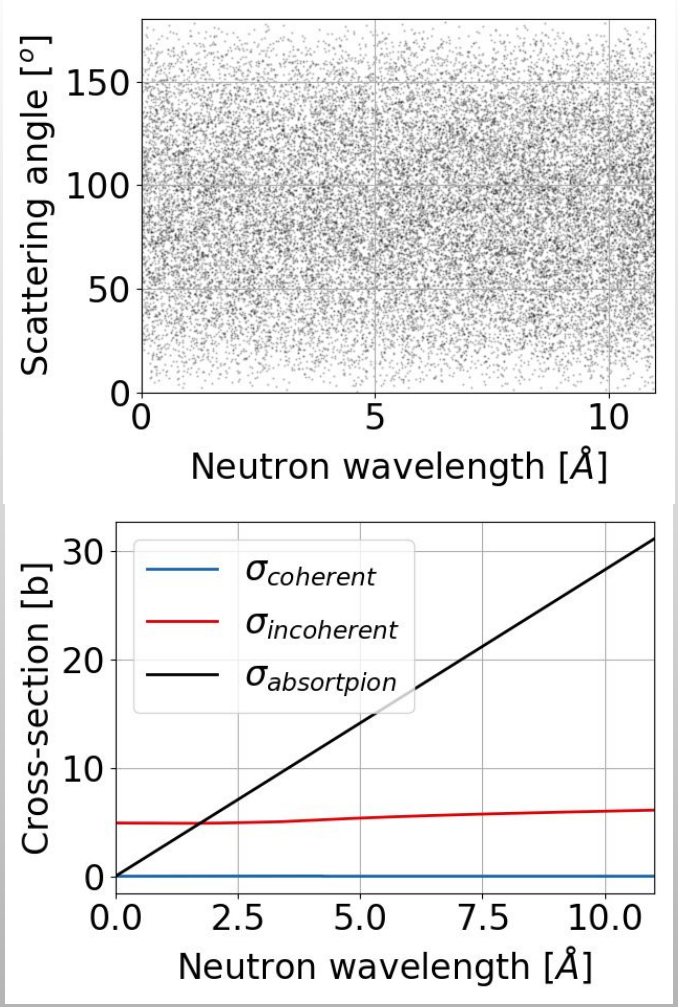

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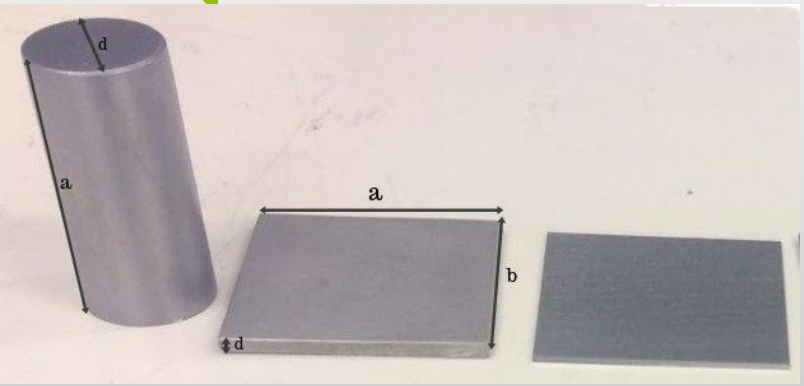
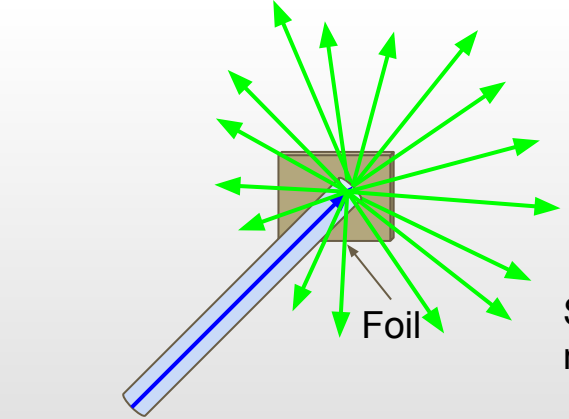
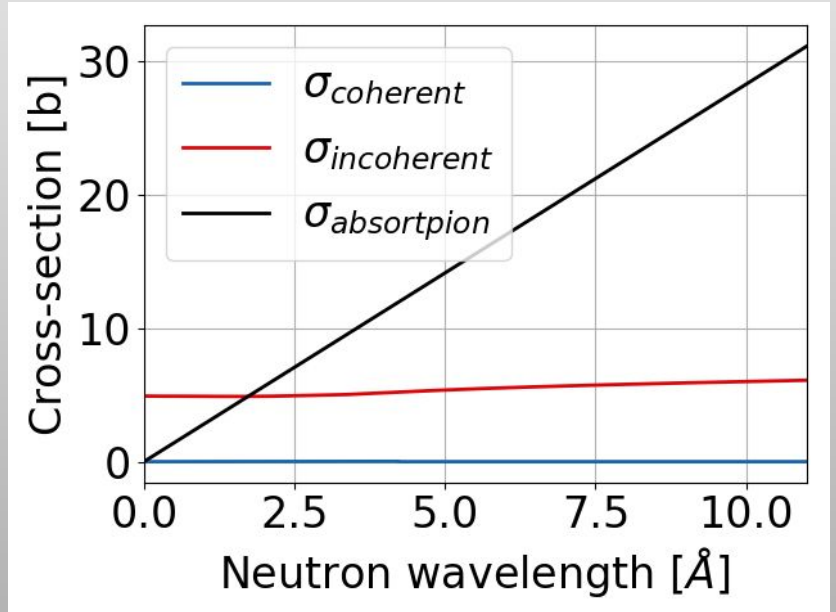


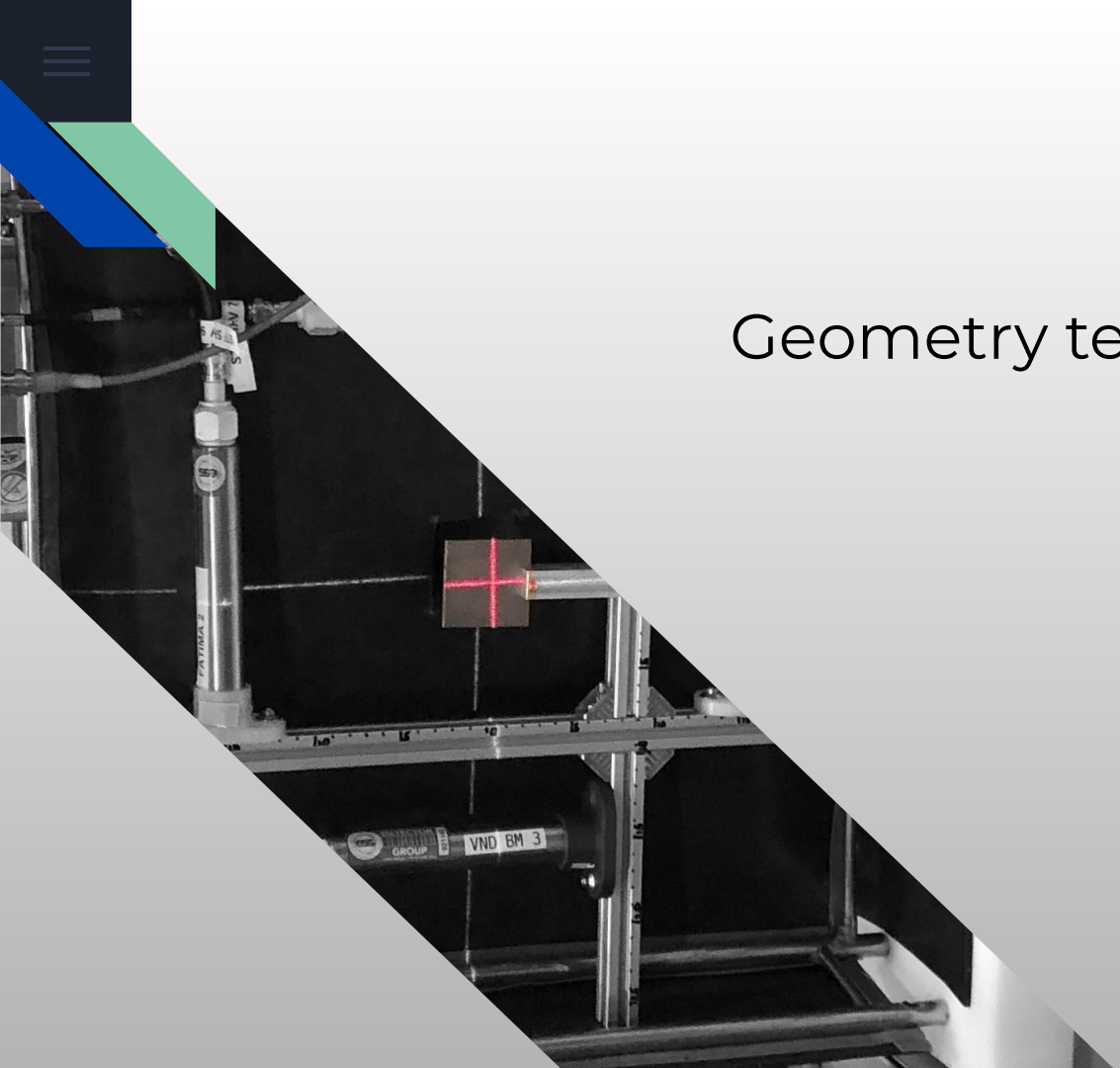


Cross section flat with wavelength

- Efficiency constant for 2-10 Å
- Below 2Å determined by the efficiency of the ^{3}He-counter



Geometry tested at V17

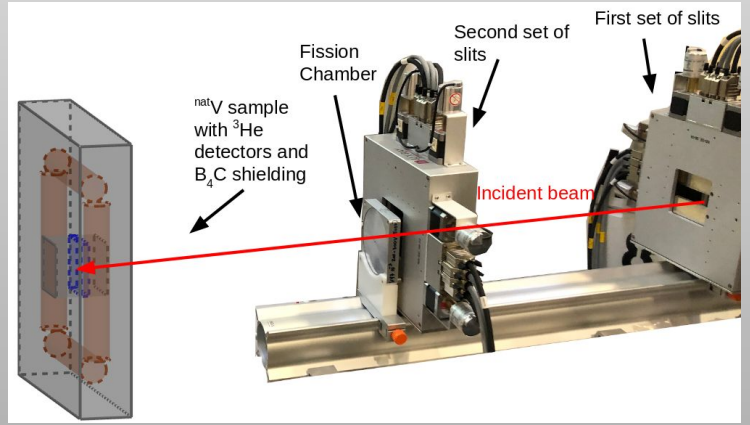


Geometry tested at V17

- 4 different ^{3}He counters at distances 4.9 cm, 5.1 cm, 11 cm, 13 cm from the center of the foil tested at V17 at 3.35Å

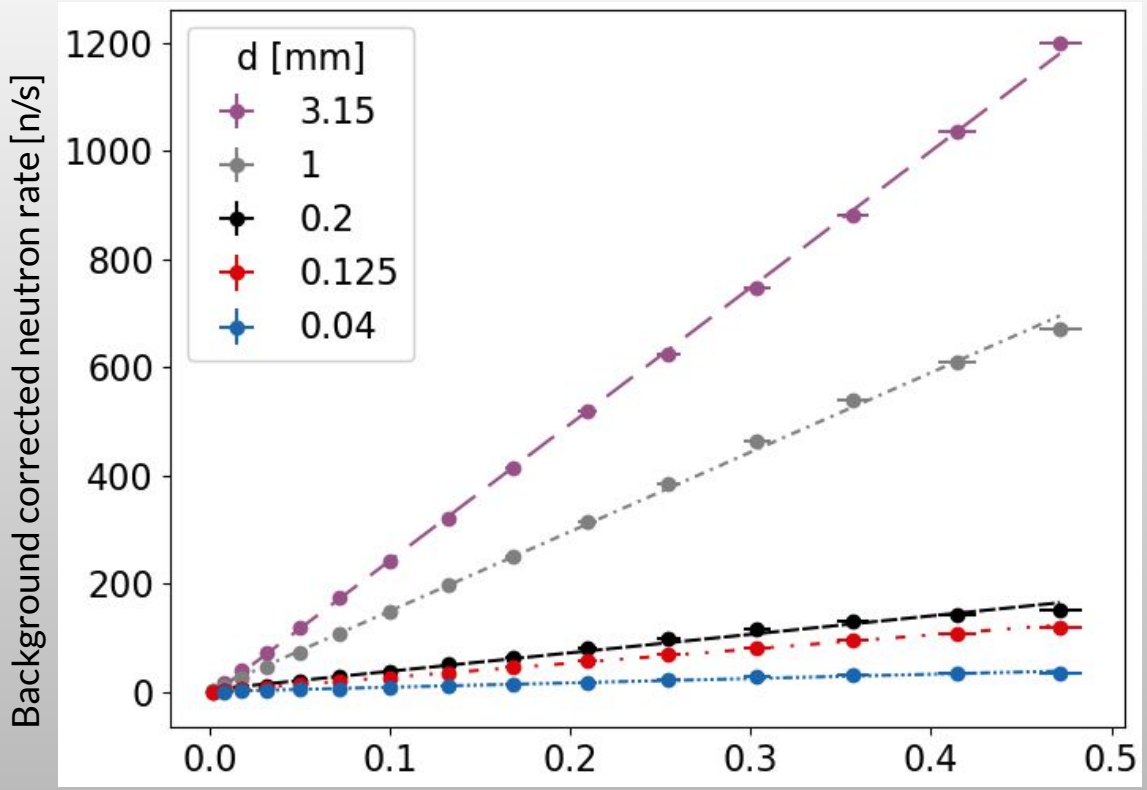
-geometry is the easiest way to adjust the flux range of the V-monitor prototype without changing the attenuation

-there is a limit of how far one can go with the ^{3}He counter

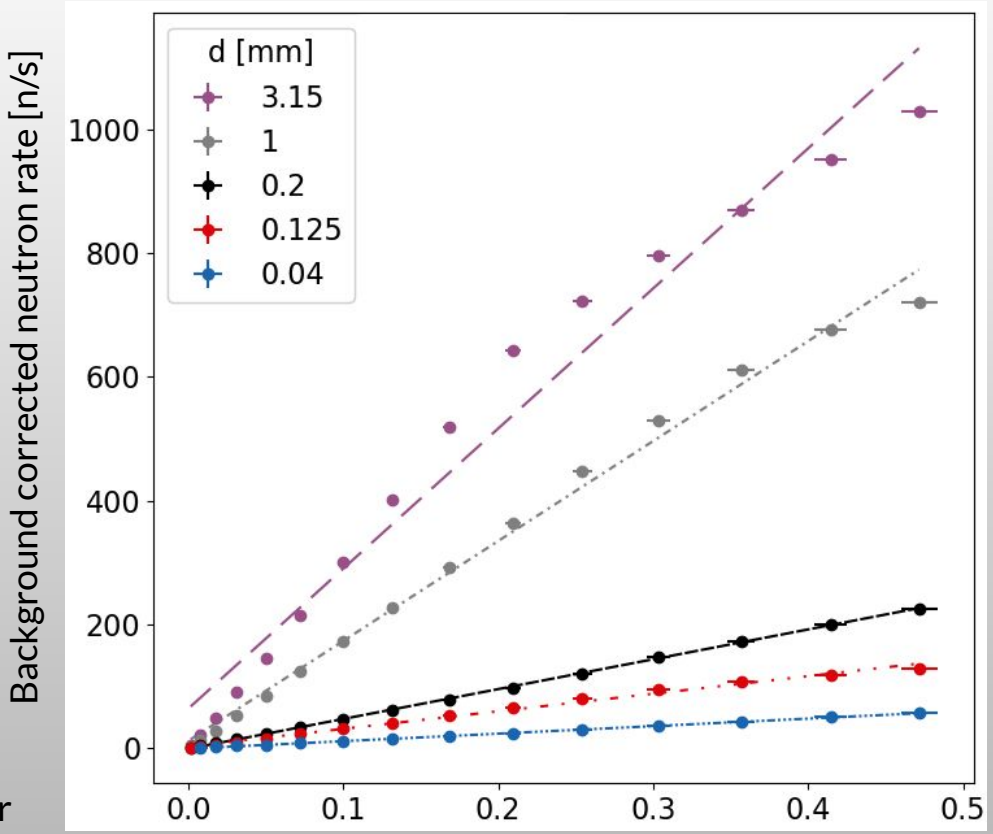


Geometry tested at V17

Response of 1 of the 3He counters for 5 different thicknesses of foils

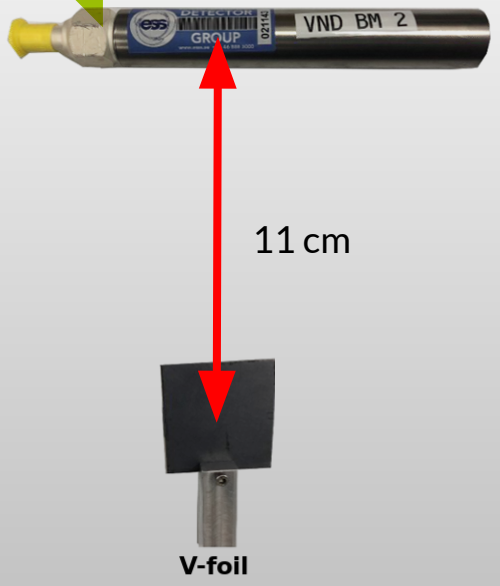


Geometry tested at V17



As the distance of the 3He counter increases, the detected neutron rate for all the thicknesses decreases.

Geometry tested at V17



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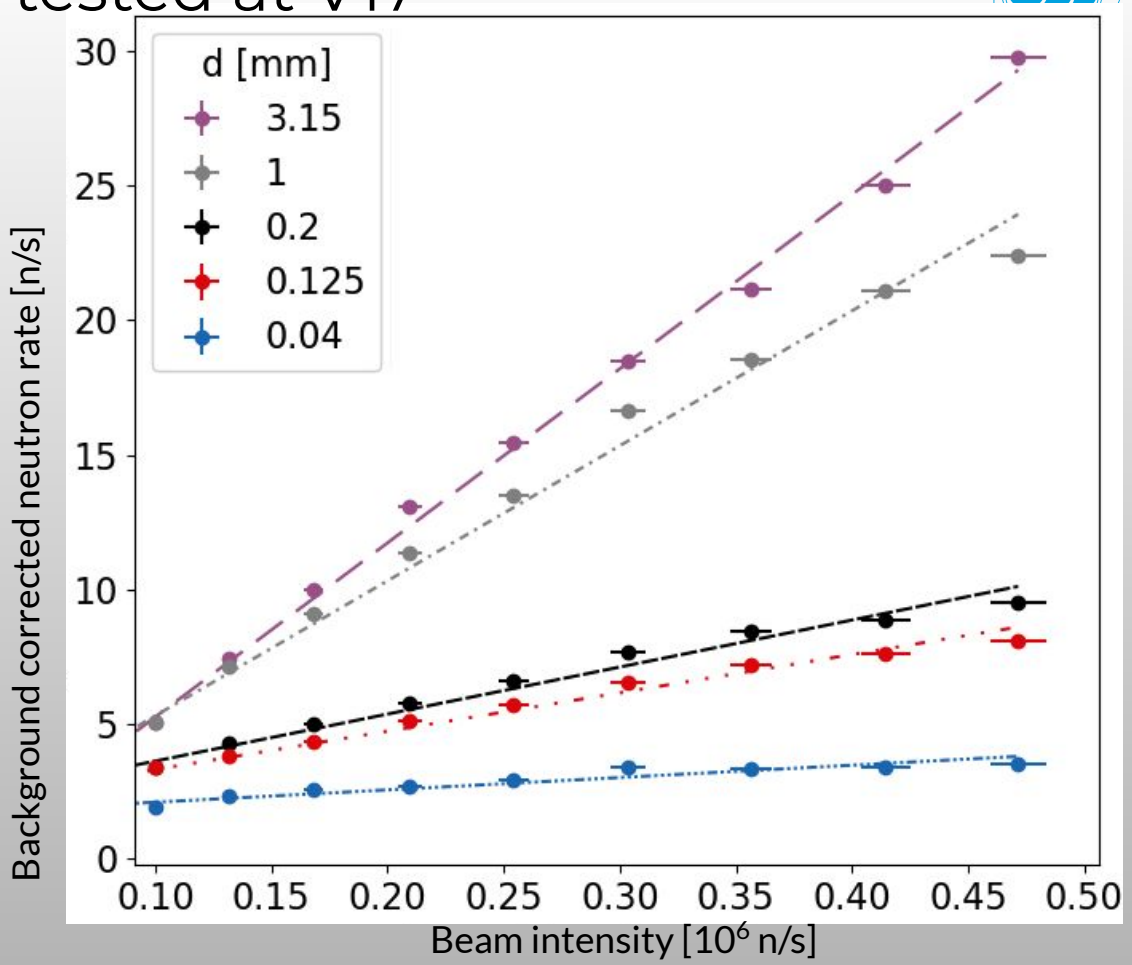
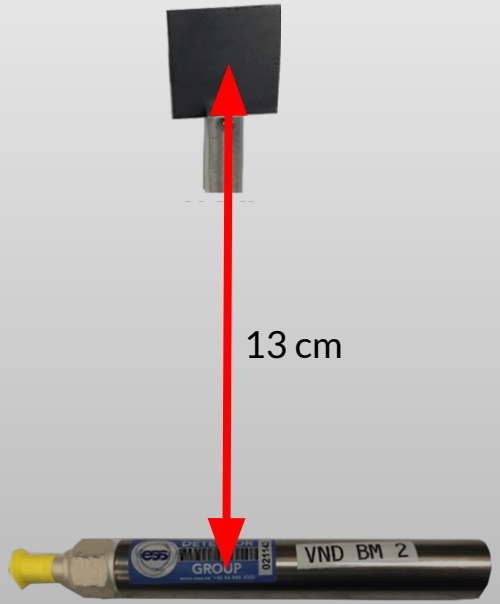
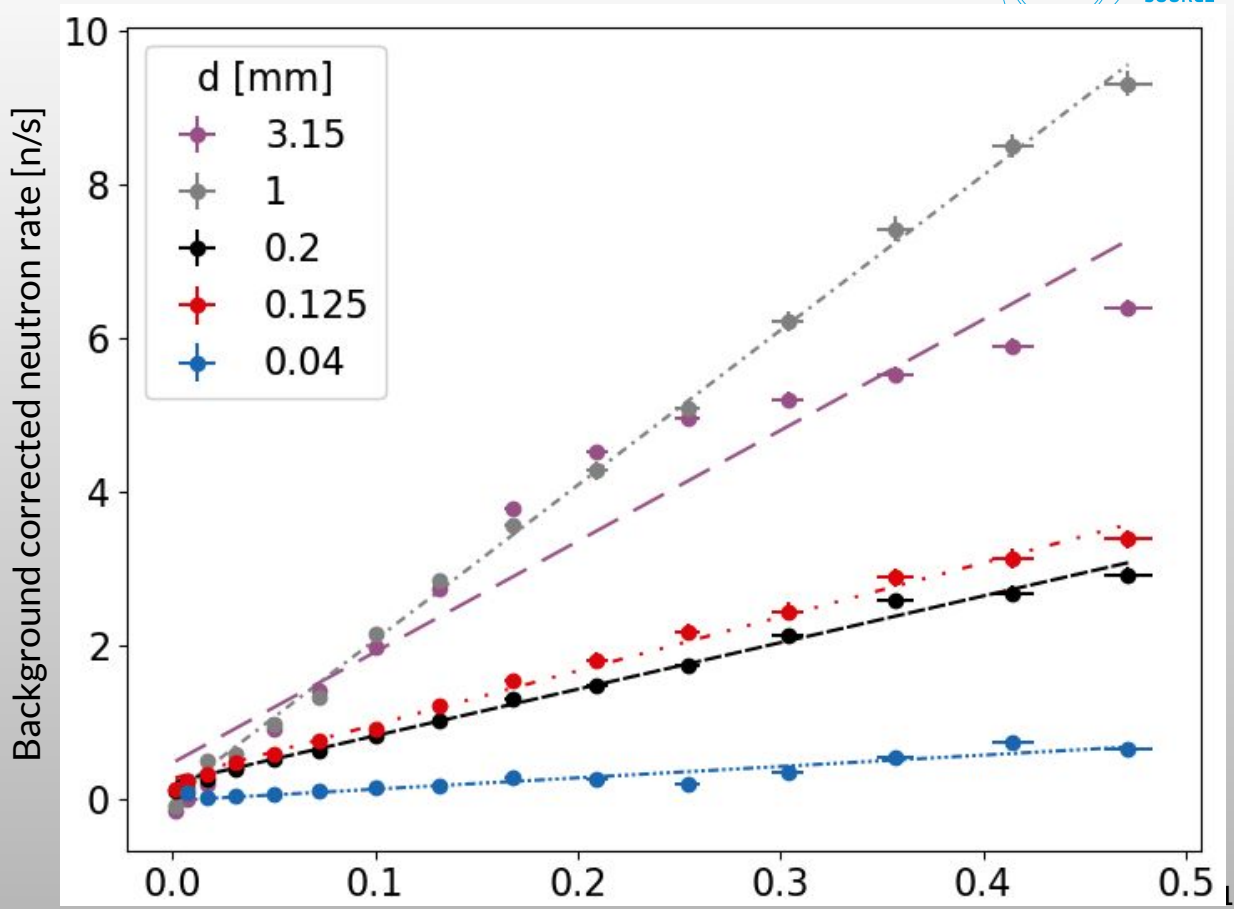
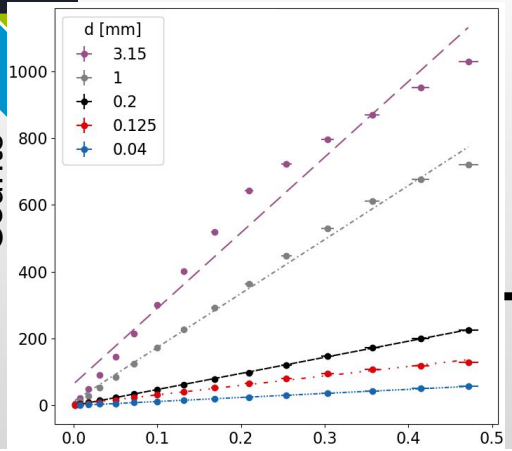


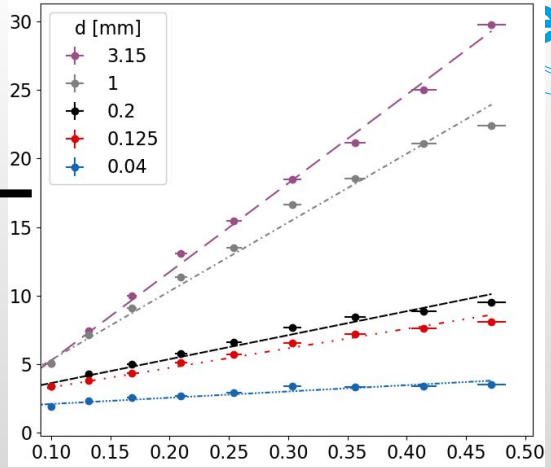
Geometry tested at V17

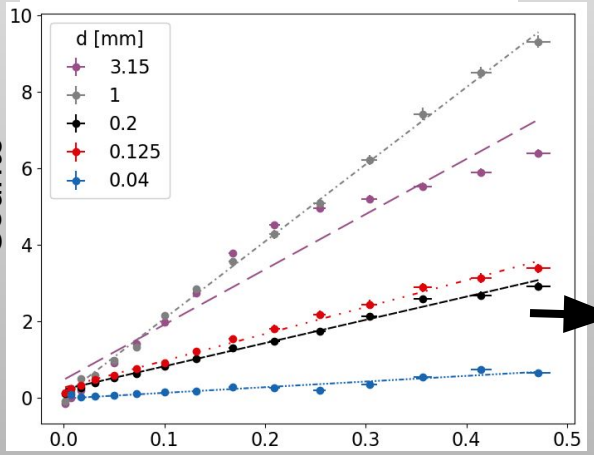


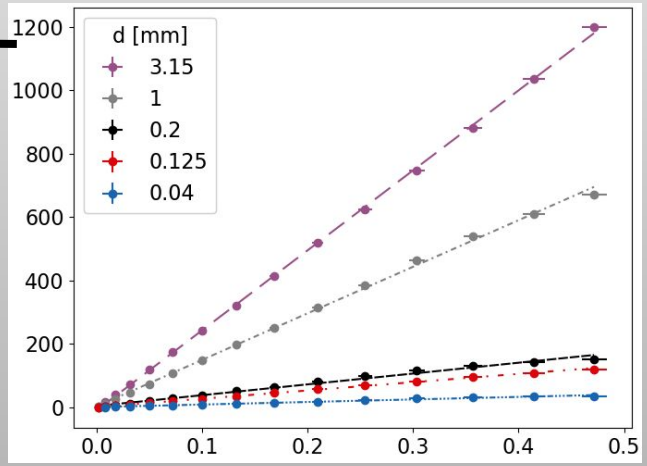


Geometry tested at V17









Linearity demonstrated

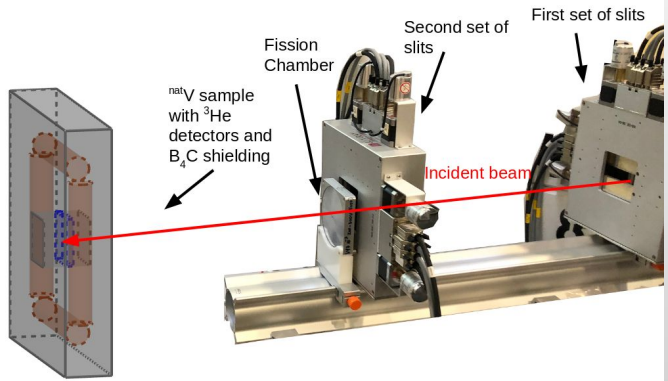
Adjustable range

Beam intensity [10^6 n/s]

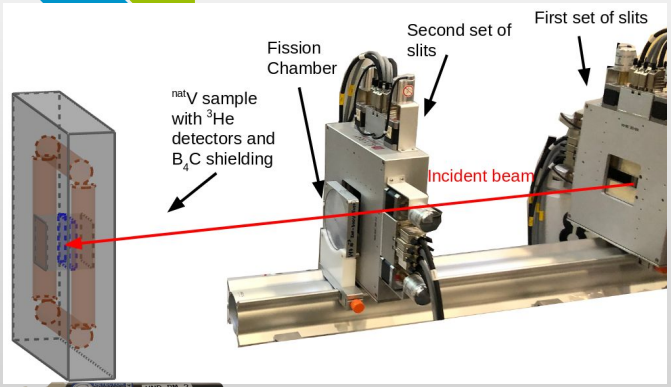
Beam intensity [10^6 n/s]

Absolute calibration at V17 and V20

V17: varying the intensity by varying the slit opening at constant flux

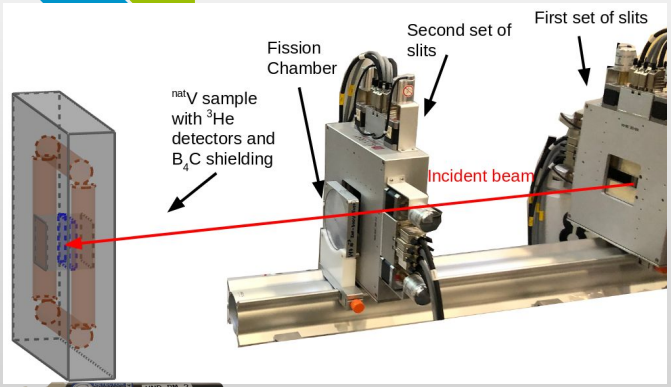


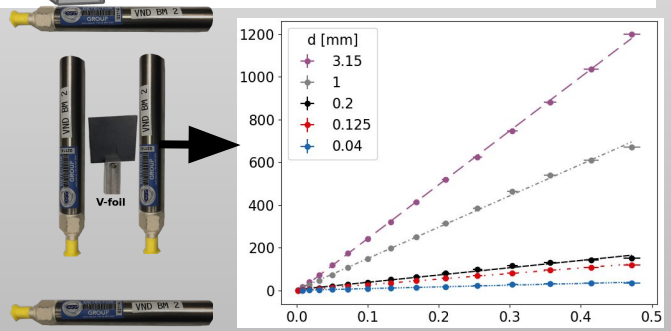
V17: varying the intensity by varying the slit opening at constant flux



Raw counts measured

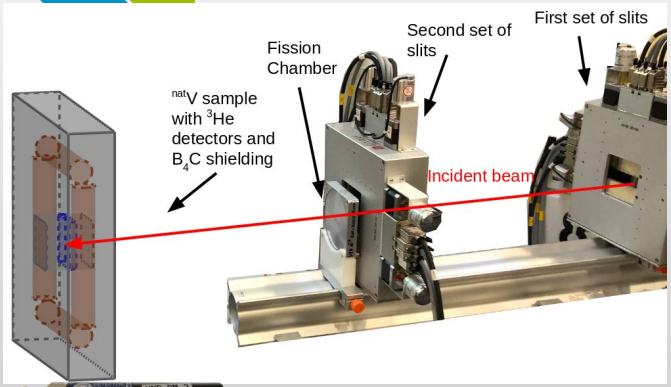
V17: varying the intensity by varying the slit opening at constant flux

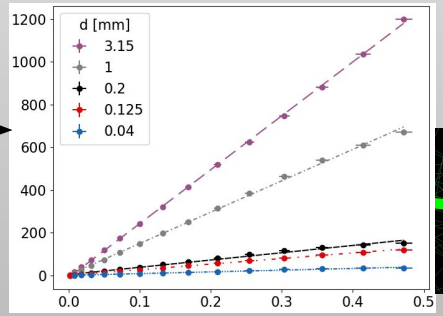


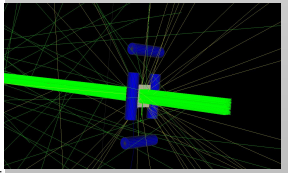


Raw counts measured → Background with Beam On subtracted

V17: varying the intensity by varying the slit opening at constant flux

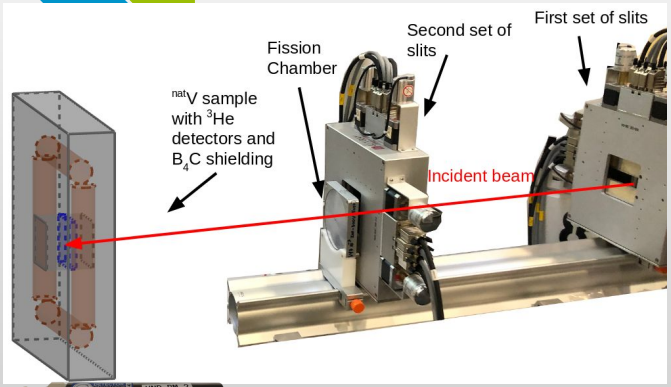


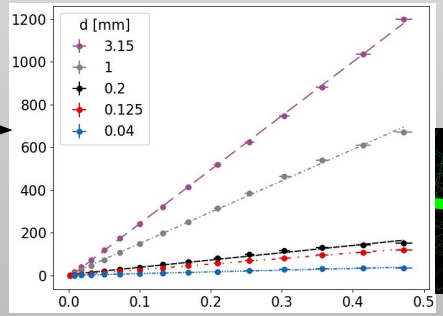


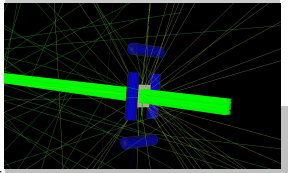


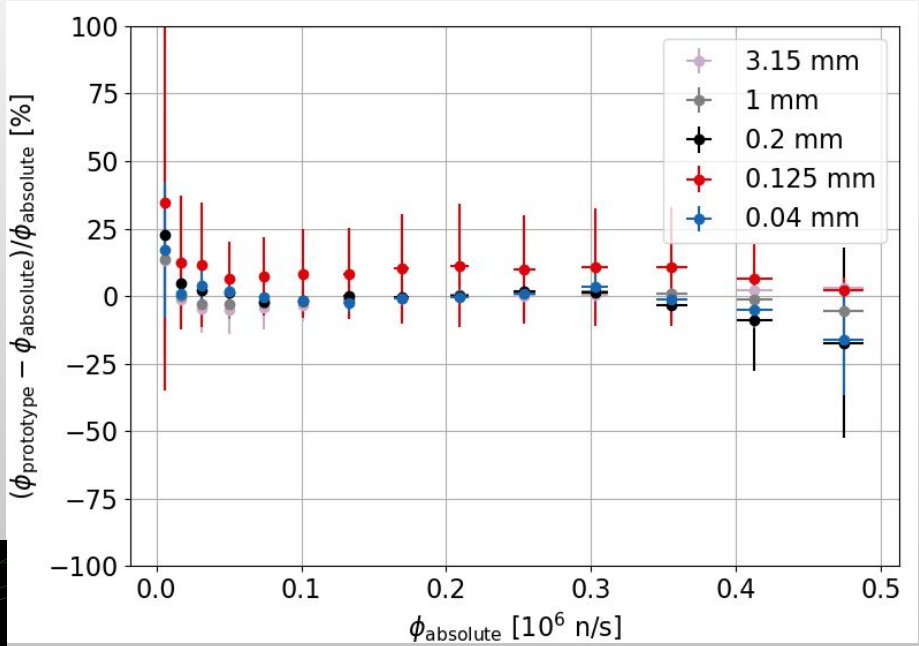
Raw counts measured → Background with Beam On subtracted → Setup Simulated

V17: varying the intensity by varying the slit opening at constant flux



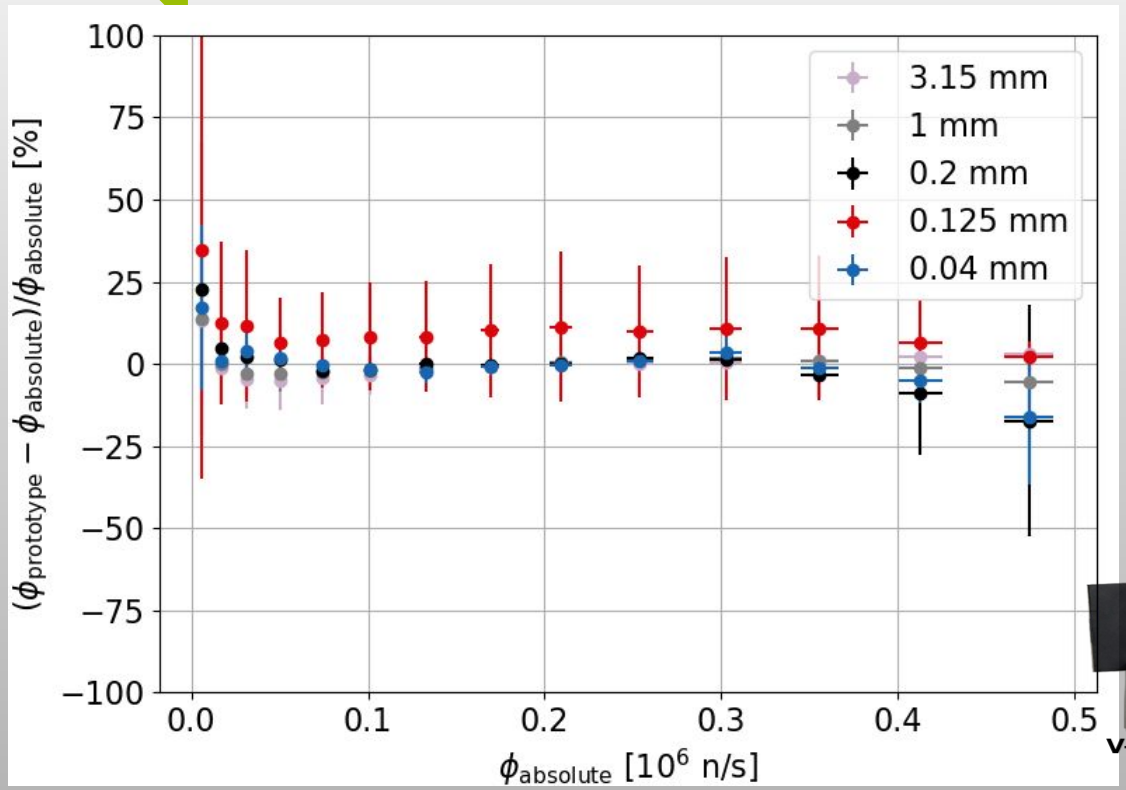






Raw counts measured → Background with Beam On subtracted → Setup Simulated → Absolute Intensity calculated → Compared to other Absolutely calibrated BM

V17: varying the intensity by varying the slit opening at constant flux

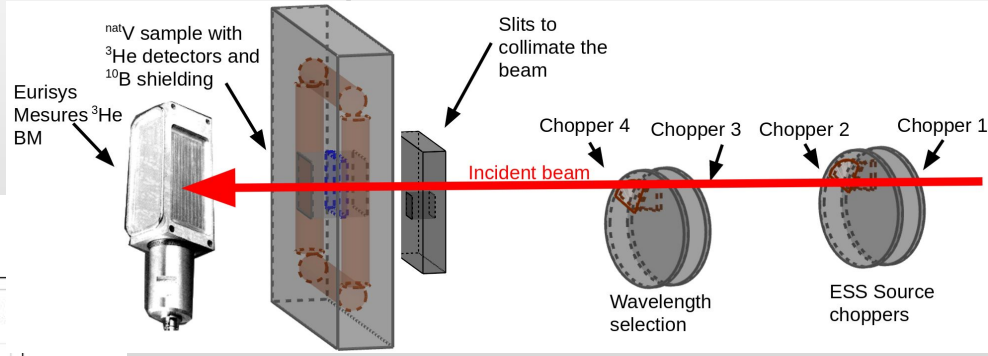


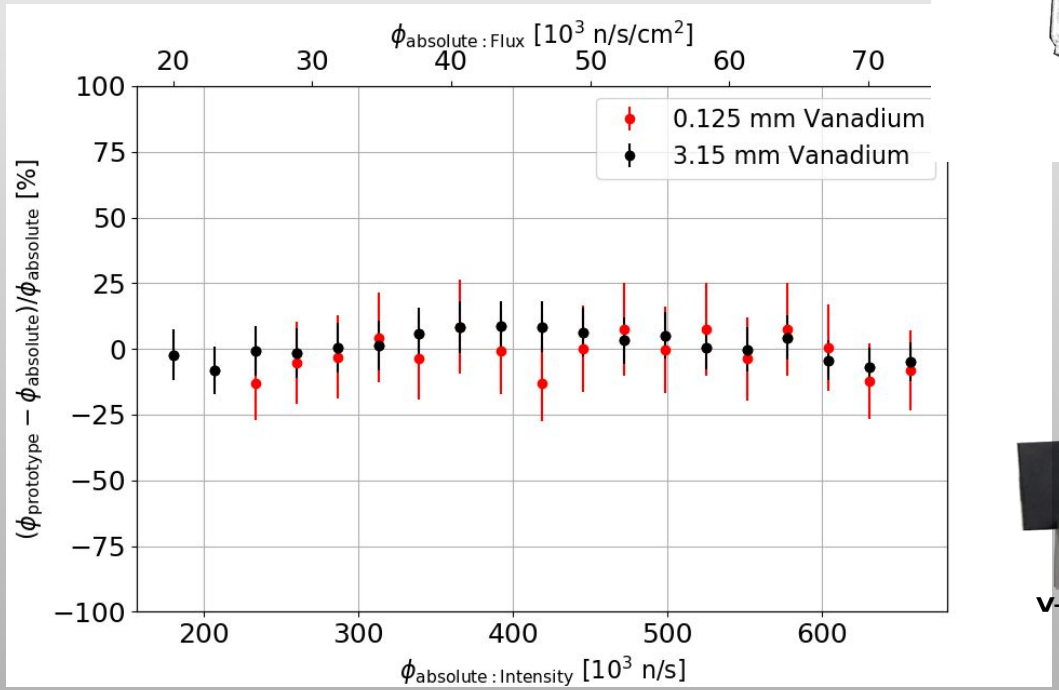
V17: 3.35 Å, monochromator

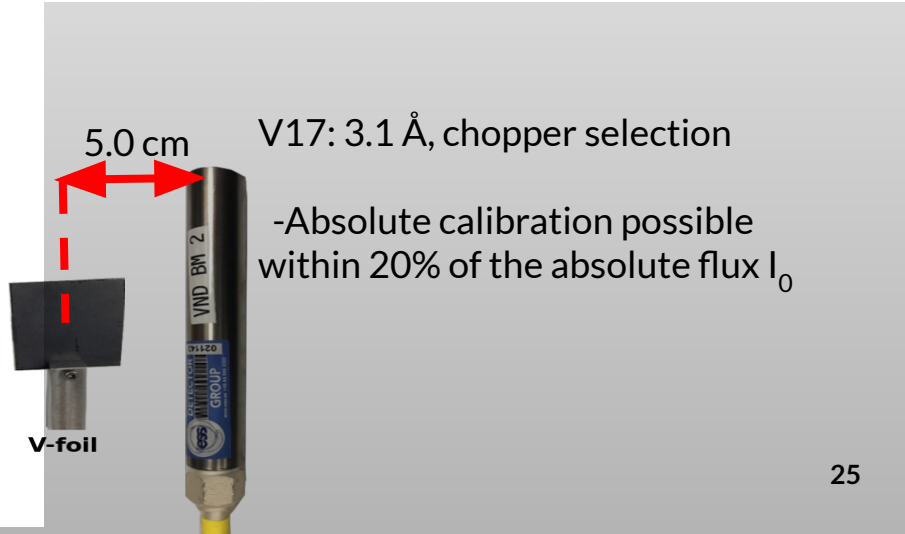
-Absolute calibration possible within 25% of the absolute intensity I_0

-The prototype detected decline in the flux of V17

V20: varying the intensity by changing the time structure of the pulse





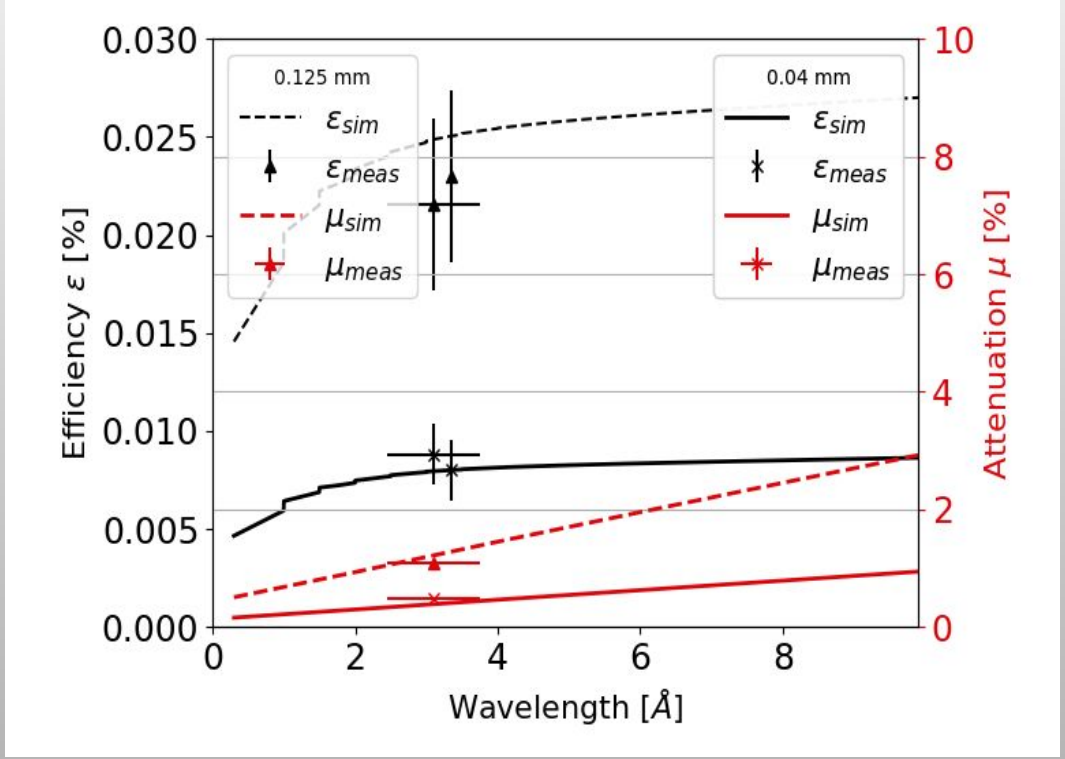


V17: 3.1 Å, chopper selection

-Absolute calibration possible within 20% of the absolute flux I_0

Efficiency, Attenuation of the V-monitor prototype

He-counters placed at 5 cm distance



V17: 3.35 Å, monochromator
V20: 3.1 Å, chopper selection

Attenuation:

-0.04 mm foil <1% for 0-10 Å
-0.125 mm foil <1% for 0-3 Å
<3% for 3-10 Å

Efficiency at 5 cm distance:

-0.04 mm foil ~ 10^{-4} for 0.5-10 Å
-0.125 mm foil ~ x 10^{-5} for 0.5-10 Å

Background limitations

Background beam off limitation

Conceptual figure

Suppose the maximum background intensity on the coutner is 1 n/s

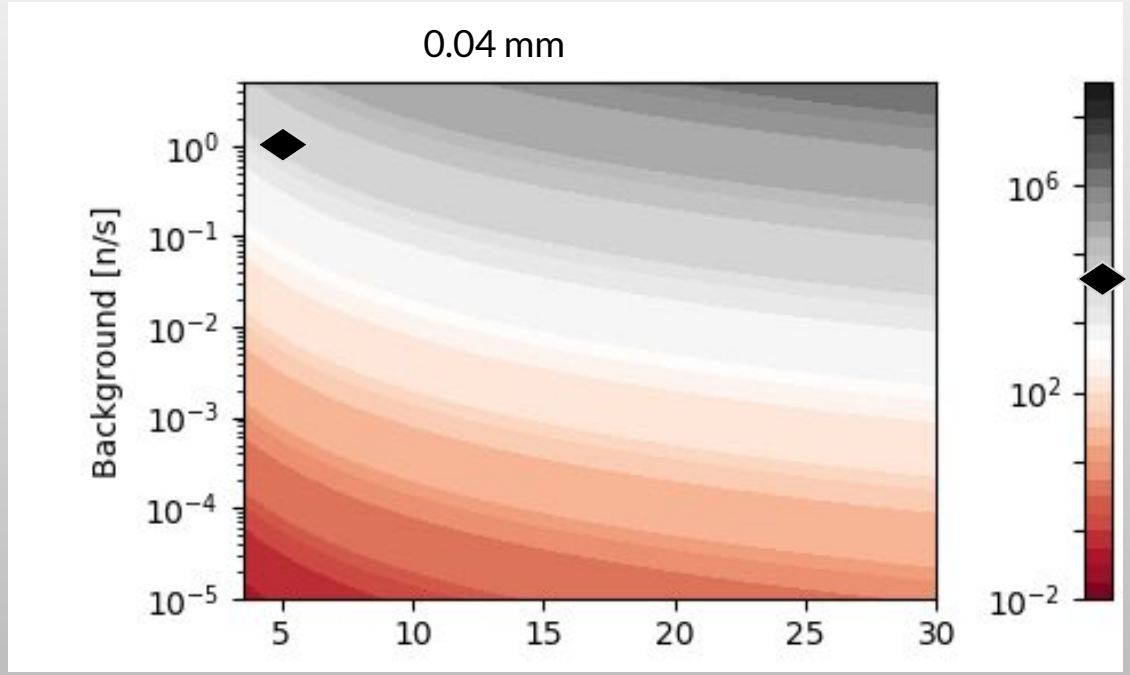
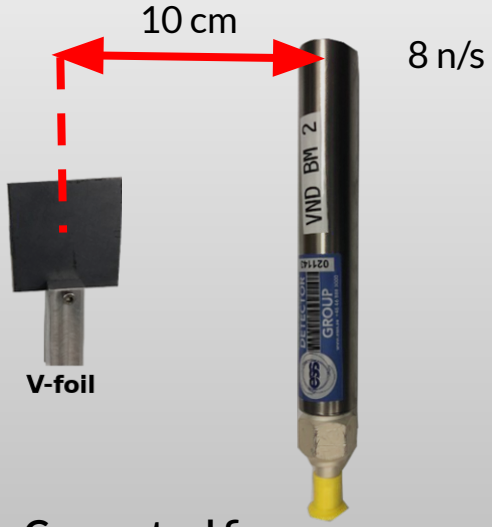


Figure for 0.04 mm foil

Background beam off limitation



Conceptual figure

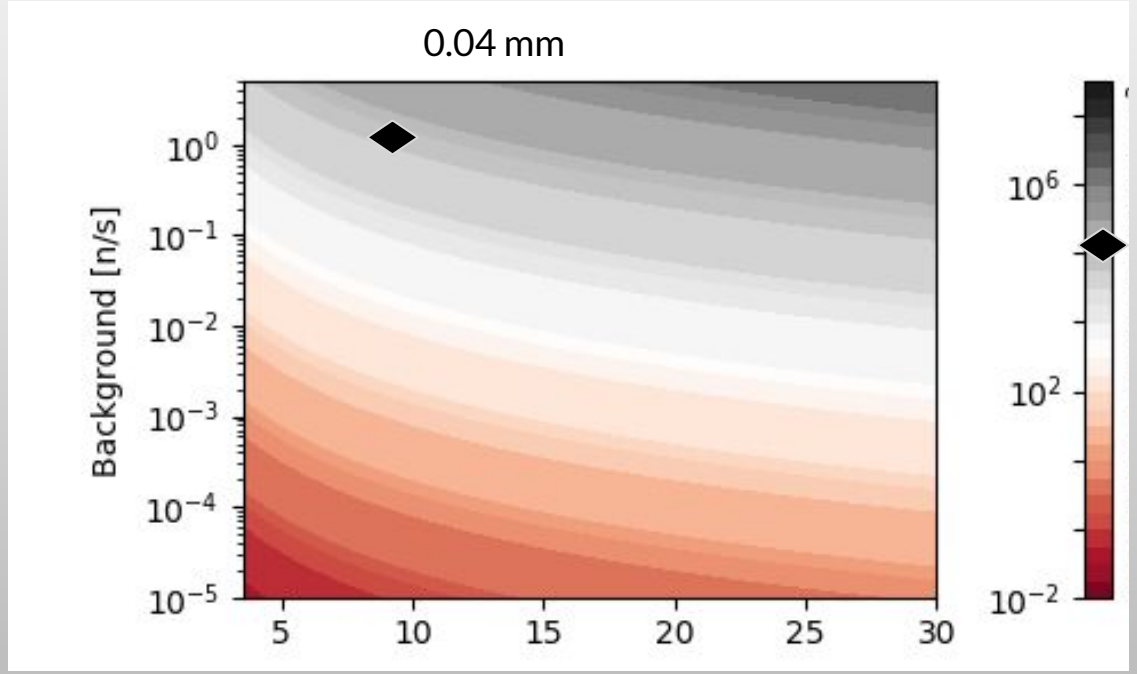
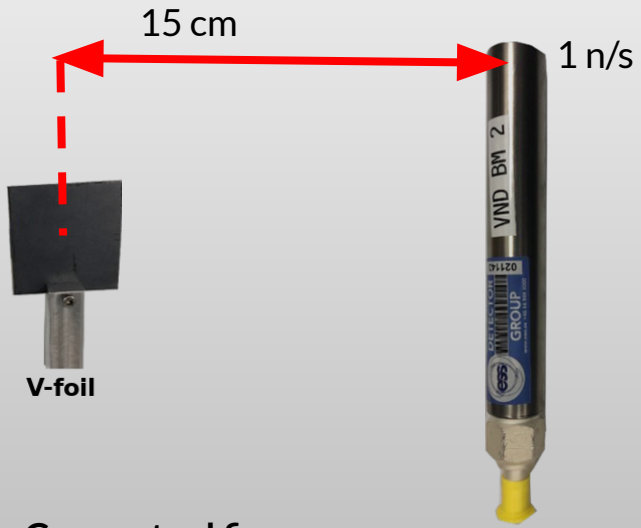


Figure for 0.04 mm foil

Suppose the maximum background intensity on the coutner is 1 n/s

Background beam off limitation



Conceptual figure

Suppose the maximum background intensity on the coutner is 1 n/s

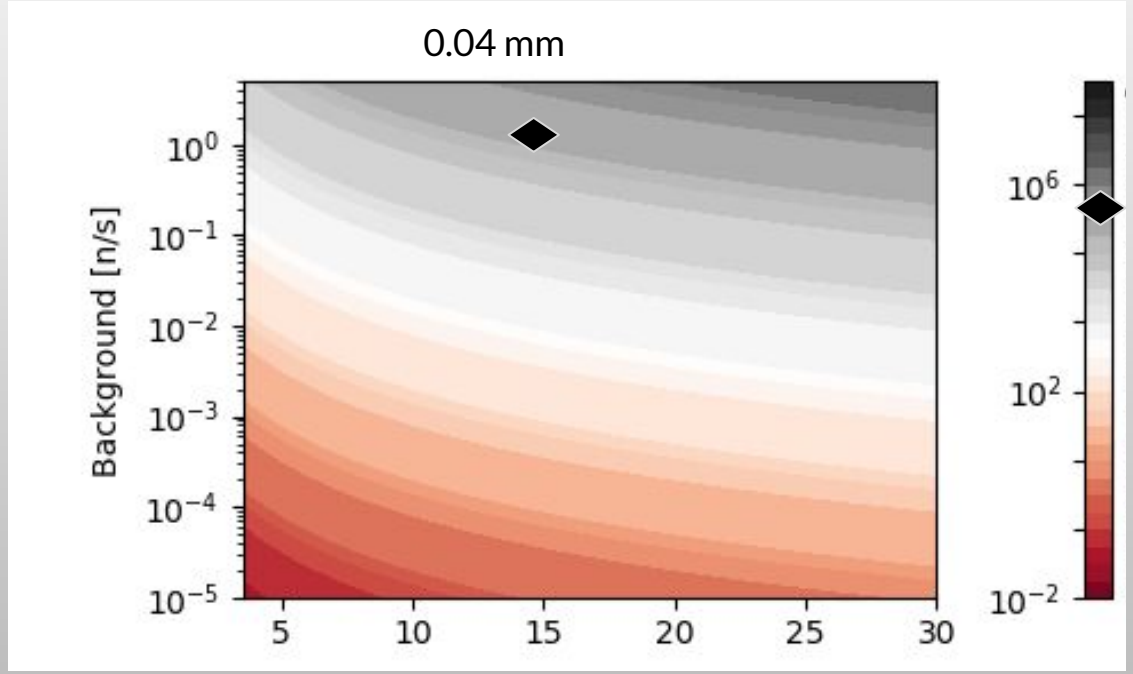
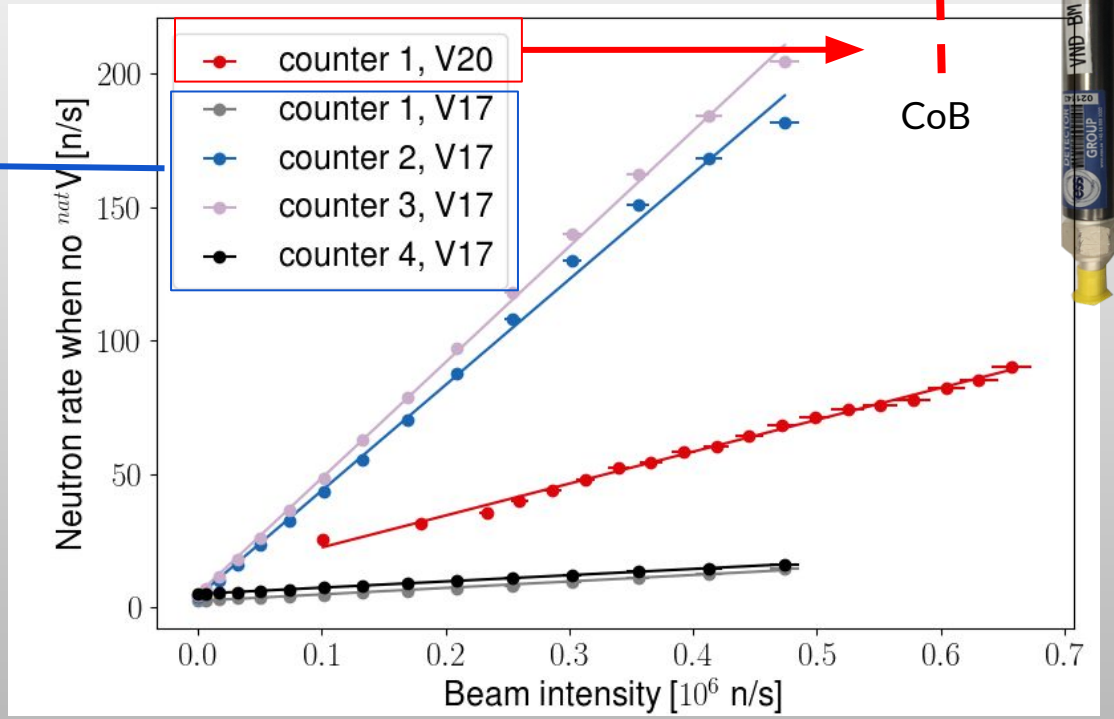


Figure for 0.04 mm foil

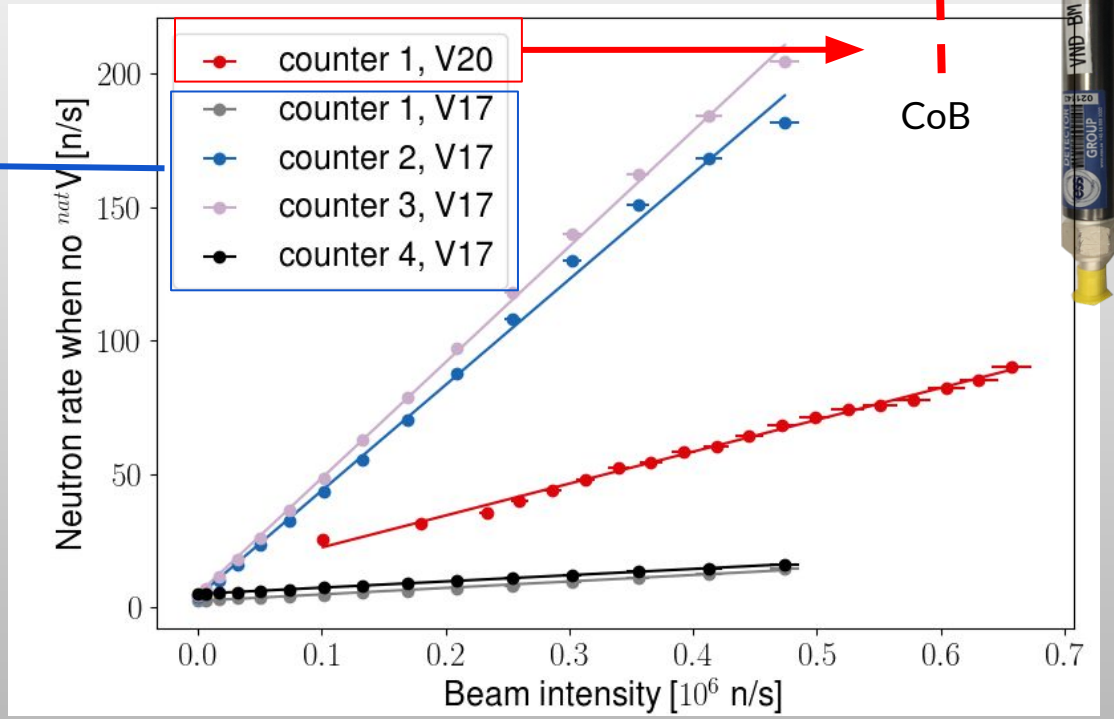
Background beam on limitation



Background limitation

-Beam off background limits the geometry or the lowest measurable flux

-Beam on background is specific to a beamline and care must be taken

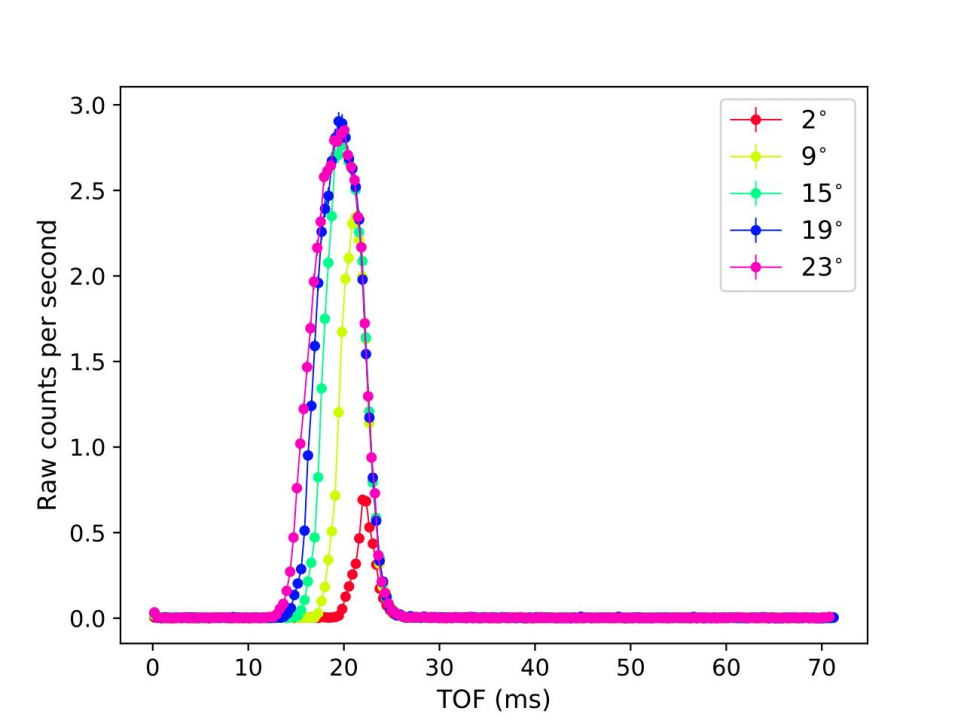


Submitted to PRAB :)
ArXiv: 2002.10108

V20: Timing

Timing adequate for most applications apart of spectroscopy

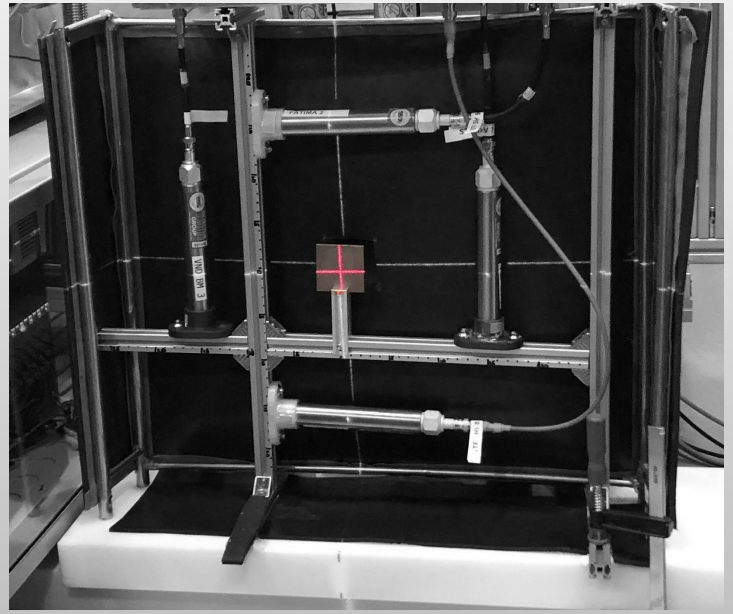
Current timing understanding limited by chopper setup on V20.



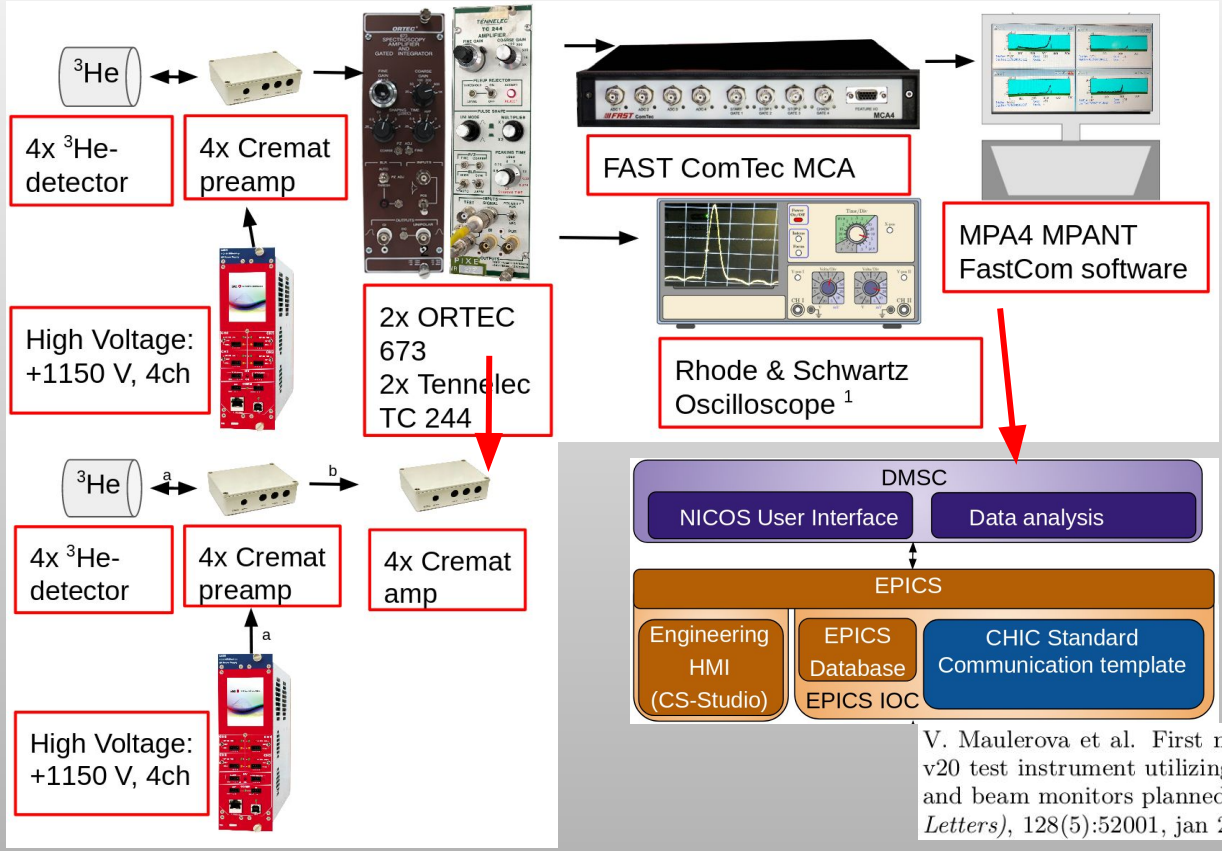
Next steps

Next steps

Testing with ESS vertical integration chain



Testing with subset of ESS vertical integration chain

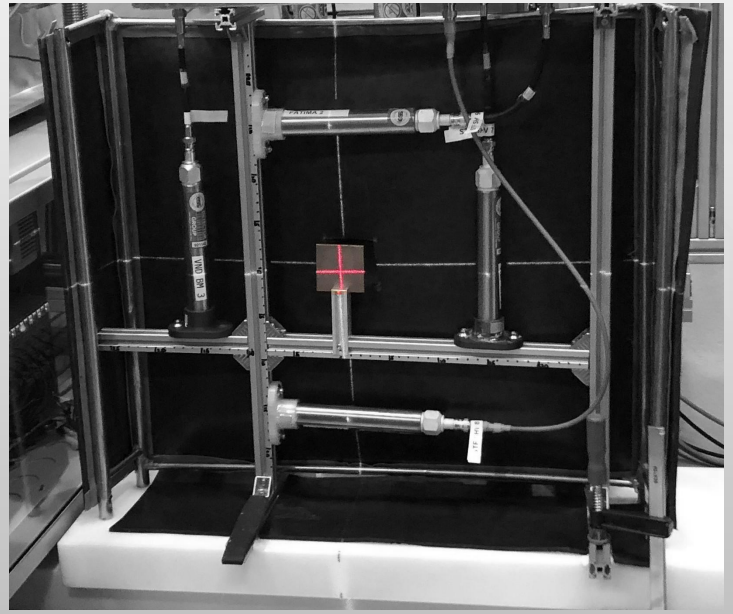


V. Maulerova et al. First neutron data recorded at the v20 test instrument utilizing prototype chopper systems and beam monitors planned for ESS. *EPL (Europhysics Letters)*, 128(5):52001, jan 2020.

Next steps

Testing with ESS vertical integration chain

Measuring at higher fluxes

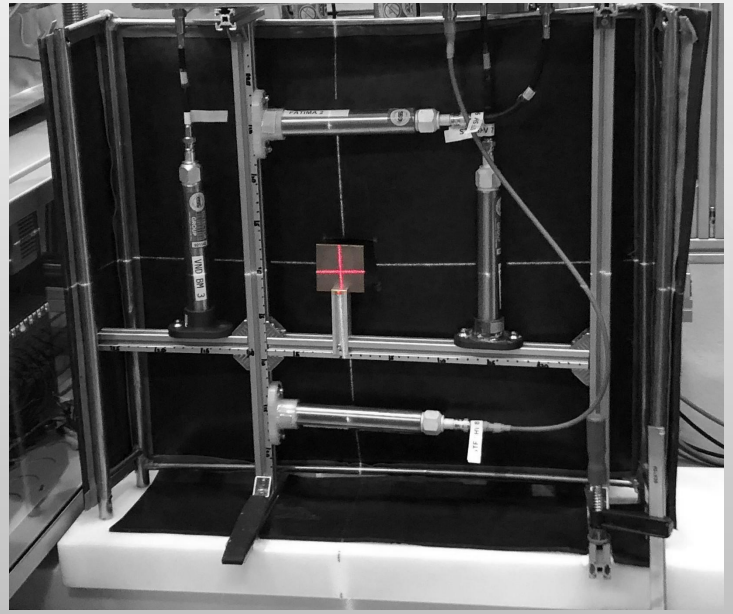


Next steps

Testing with ESS vertical integration chain

Measuring at higher fluxes

Stability measurements



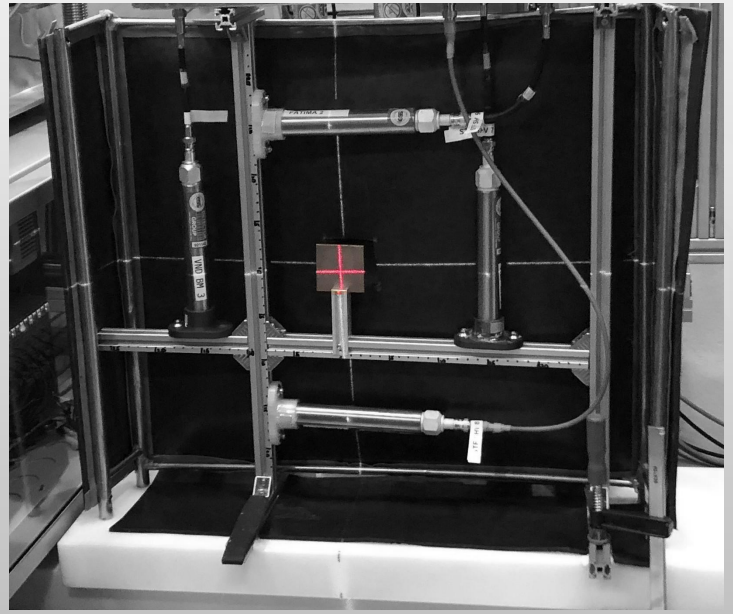
Next steps

Testing with ESS vertical integration chain

Measuring at higher fluxes

Stability measurements

TOF measurements



Next steps

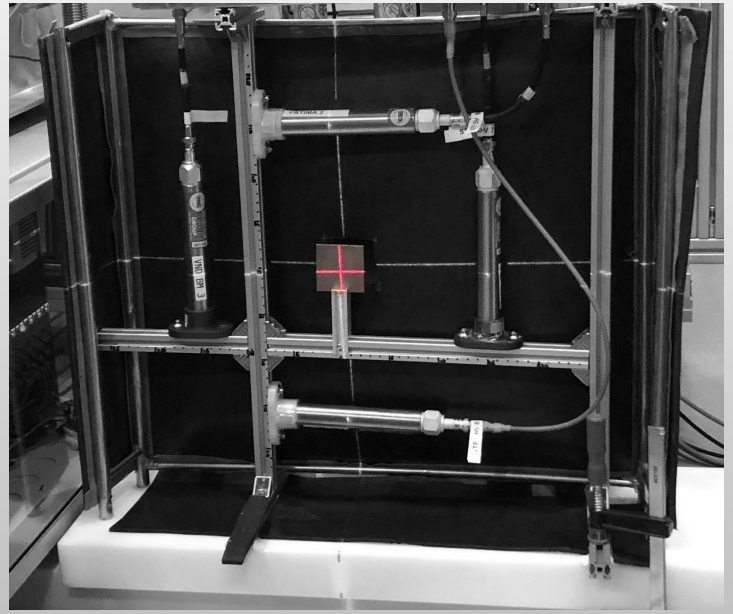
Testing with ESS vertical integration chain

Measuring at higher fluxes

Stability measurements

TOF measurements

Engineering implementation



Conclusions

Absolute calibration at V17 and V20

Efficiency, Attenuation

Background limitations

Paper submitted to PRAB, arXiv: 2002.10108

Present

High rates

Time of flight resolution

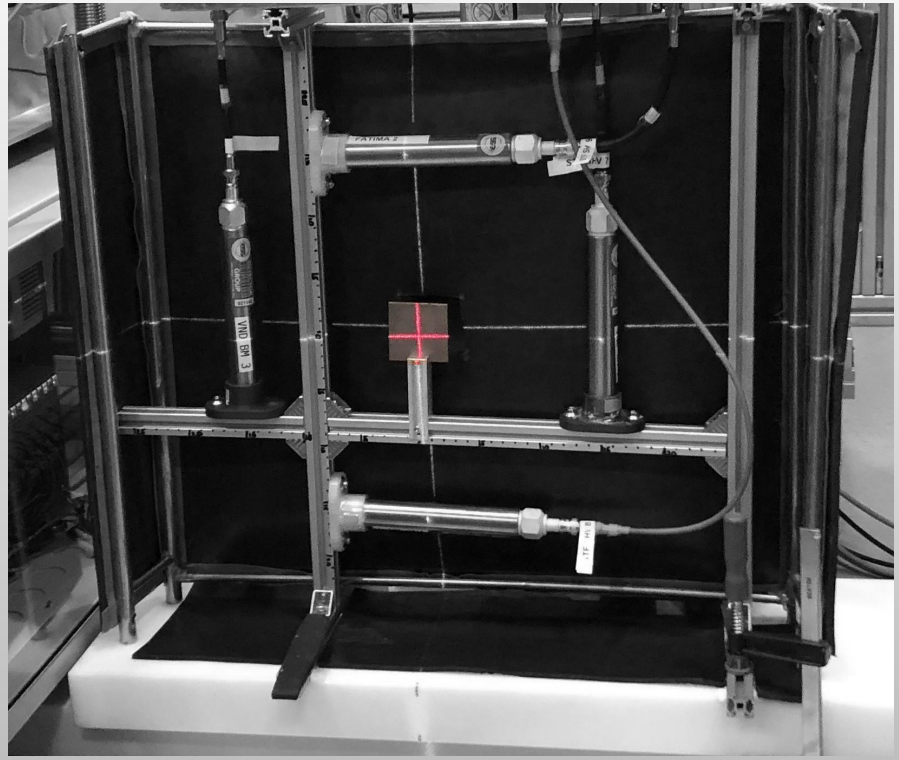
Stability

Engineering Implementation

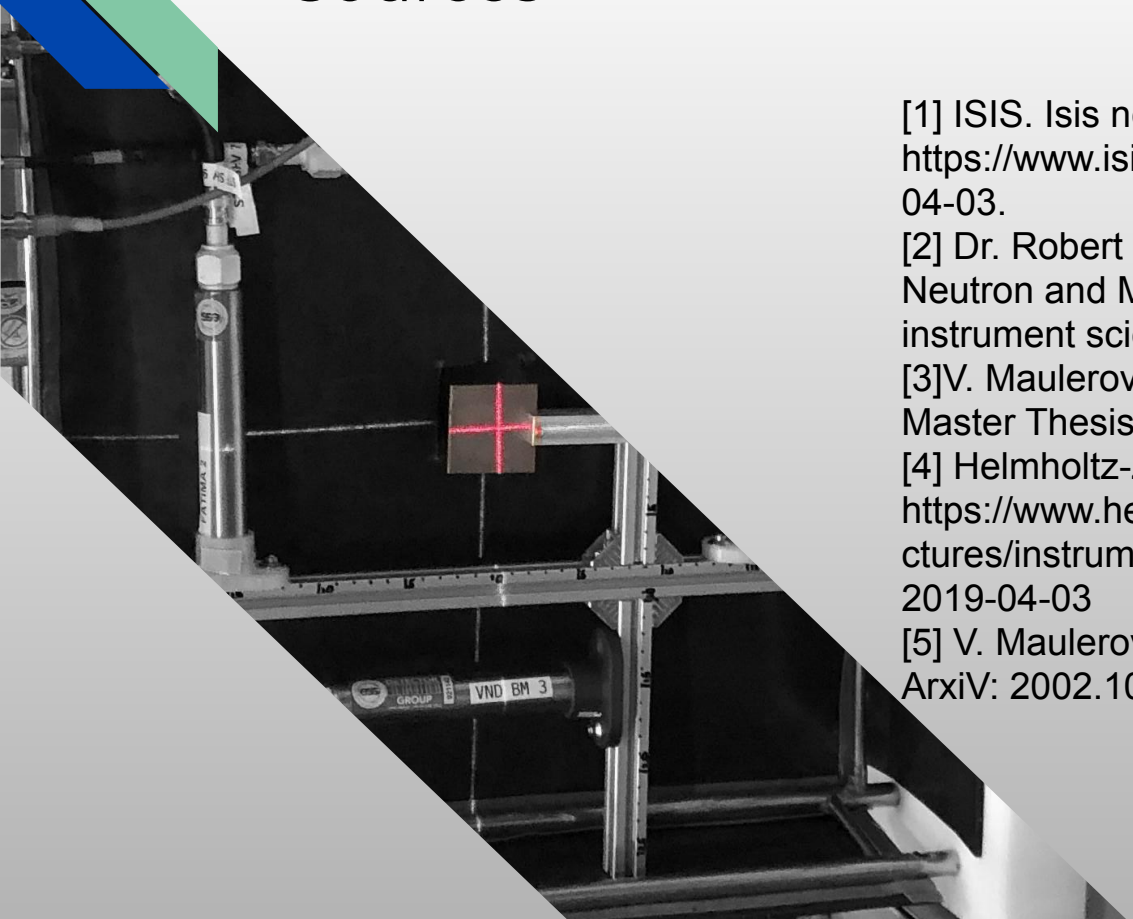
Future

EUROPEAN SPALLATION SOURCE

Thank you!



Sources



[1] ISIS. Isis neutron and muon source. https://www.isis.stfc.ac.uk, 2019. Accessed: 2019-04-03.
[2] Dr. Robert Bewley. Private commentation, 2018. ISIS Neutron and Muon Source, LET instrument scientist.
[3]V. Maulerova. Vanadium-based neutron-beam monitor. Master Thesis, Lund University, 2019
[4] Helmholtz-Zentrum Berlin European Spallation Source. https://www.helmholtz-berlin.de/user/experimental-infrastructures/instruments-neutrons/index_en.htmlAccessed: 2019-04-03
[5] V. Maulerova. Vanadium-based neutron beam monitor. ArxiV: 2002.10108