Multi-Grid test at SEQUOIA

Anton Khaplanov

On behalf of ESS Detector Group and Collaborators

Horizon 2020 grant agreement 676548

WP 4.3: Large-Area Detectors

The crew

Coordination: Anton

Mechanical design: Isaak; At ILL: Fabien; Pressure Simulations: Ioannis

Welding at EWCON: Ronny

Assembly: Alessio, Isaak, Richard A, Emelie, Pablo, Alexander, Vendula, Nicholai, Edgars;
At ILL: Fabien
Installation: Isaak, Alessio, Anton
Data analysis: Alexander
DMSC data chain: Martin, Morten
Coating: Linköping team
SNS: Matt, Sasha, Victor, and many more.

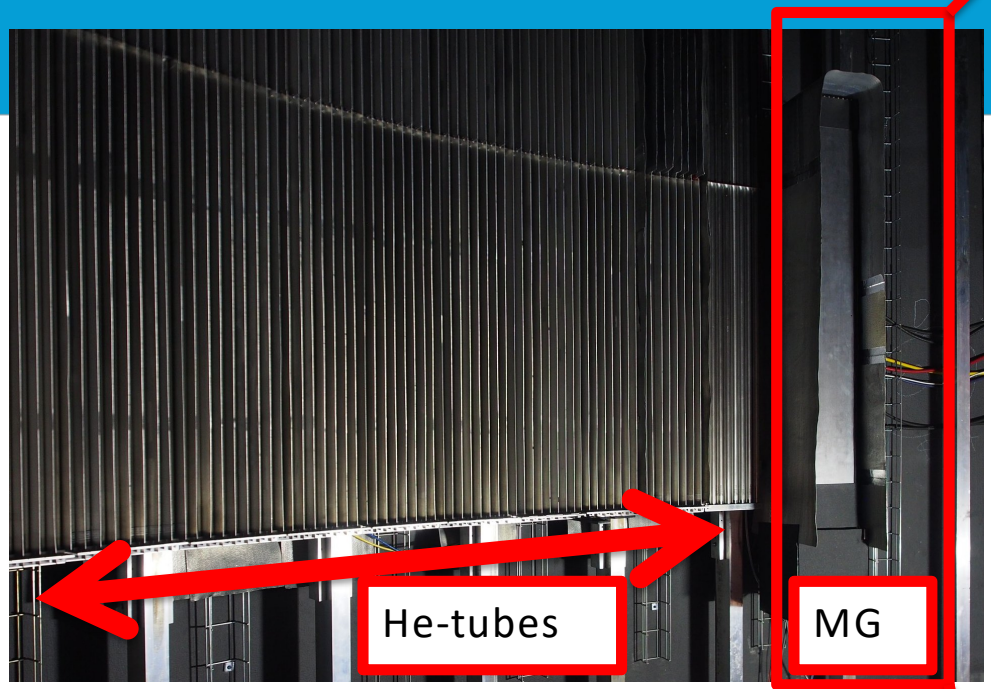
Others involved: Bruno, Victor, Jean-Claude, Richard, Michail, Judith, Anders.

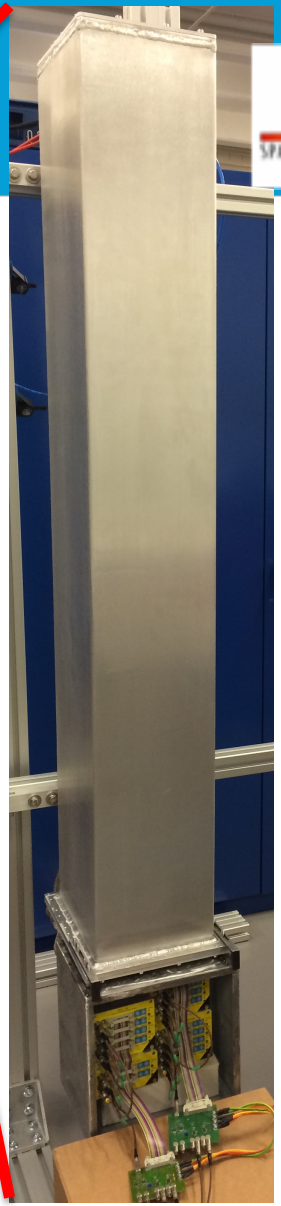
Thanks to: ILL for 7 years of fruitful collaboration
SNS for the opportunity for the beam time

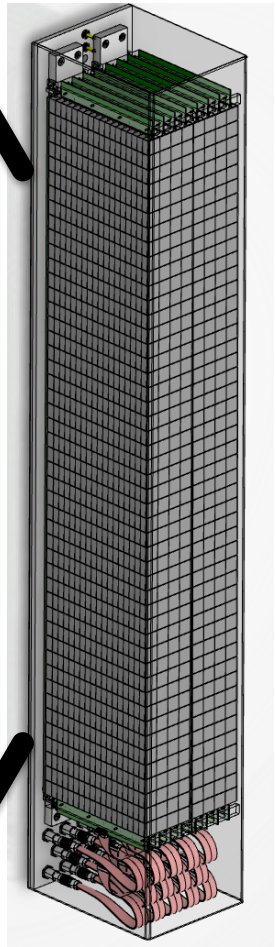
Outline

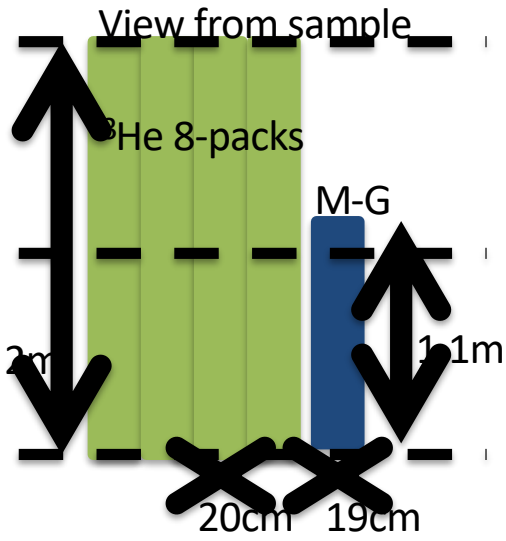
- MG.SEQ definition and design
- MG.SEQ assembly and tests
- MG.SEQ Installation
- MG.SEQ measurements – from last week
- MG.SEQ measurement results to come soon

Previous test – at CNCS



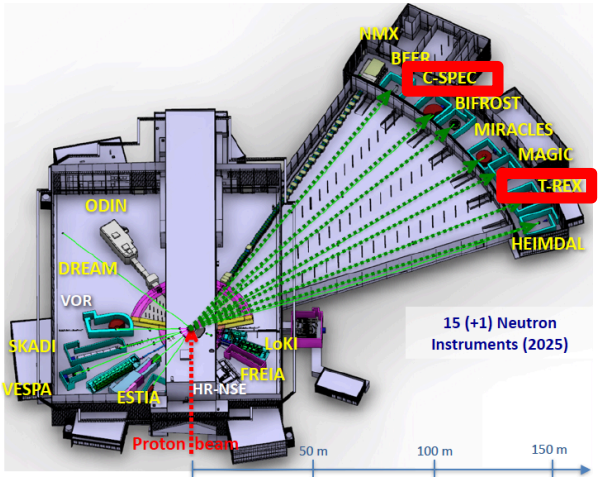






A.Khaplanov et al. *"Multi-Grid Detector for Neutron Spectroscopy: Results Obtained on Time-of-Flight Spectrometer CNCS"* https://arxiv.org/abs/1703.03626 2017 JINST 12 P04030

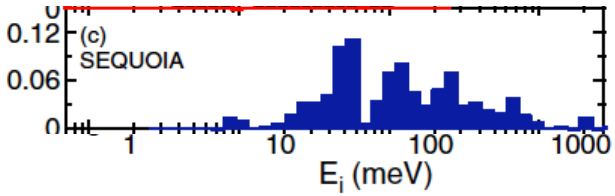
How this test came about



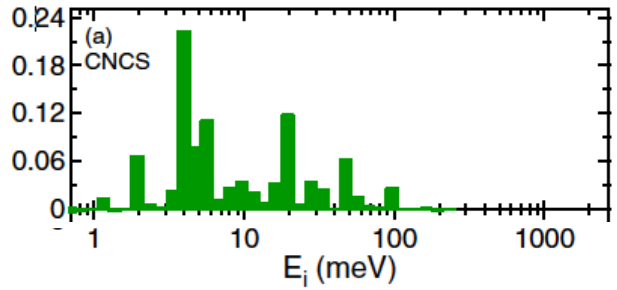
Energy ranges of the first ESS ToF spectrometers

	CSPEC	T-REX
Typical initial λ, Å (meV)	2 to 15 Å (20 to 0.36 meV)	0.7 to 6.4 Å (160 to 2 meV)

Incident energies used at SEQ

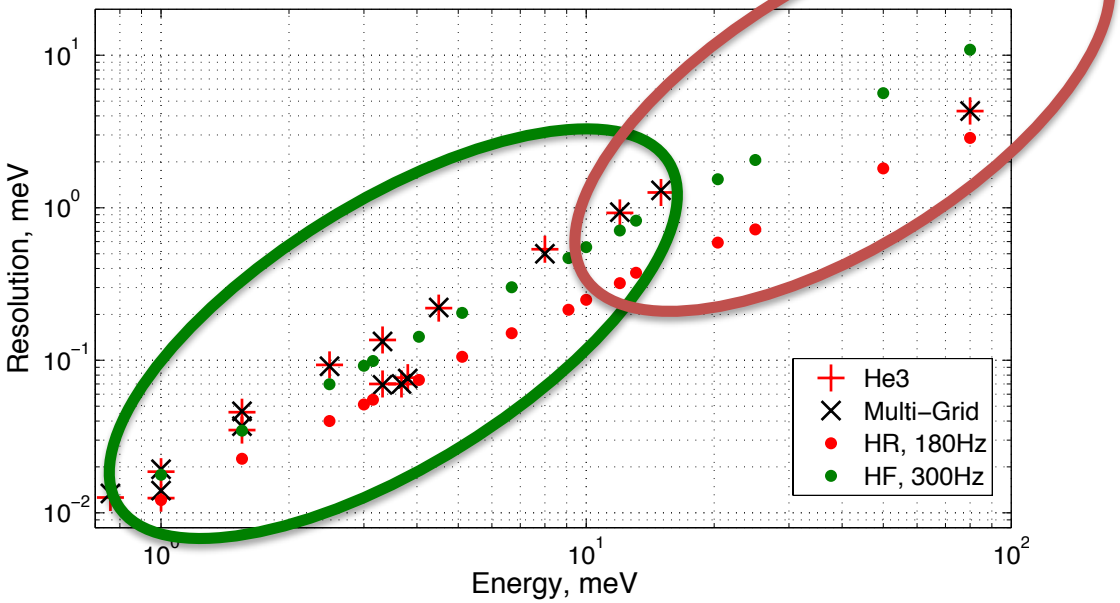


Incident energies used at CNCS



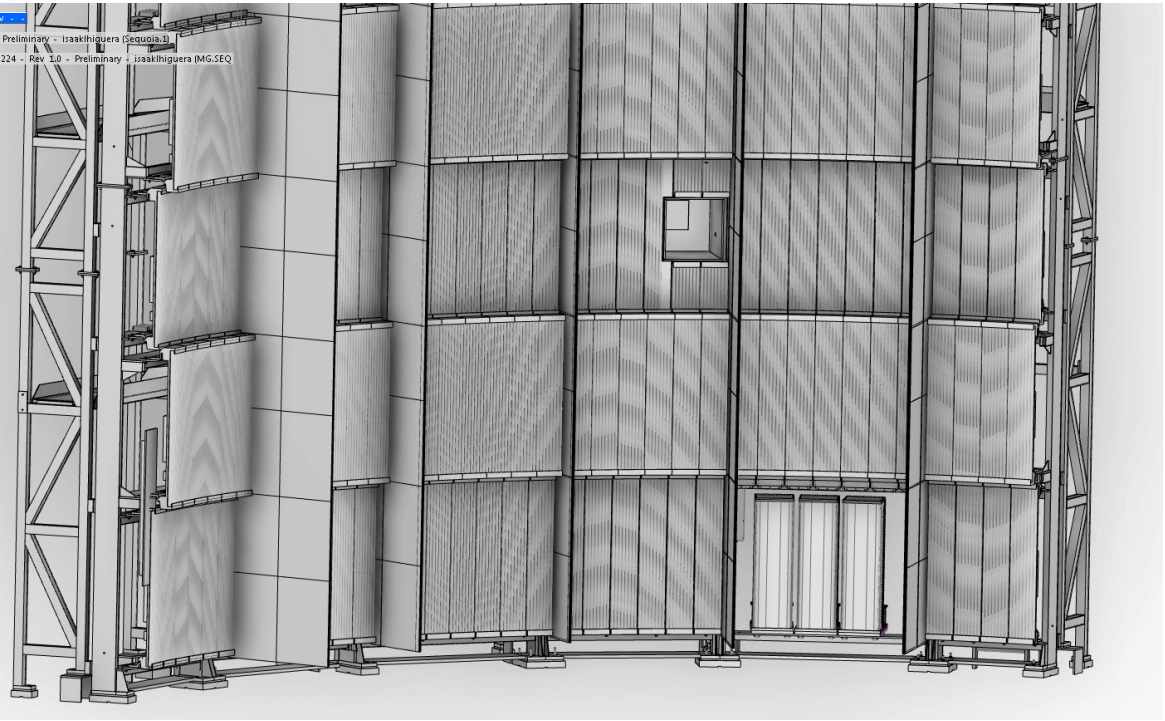
Cold range, 0.76 to 15 meV measured

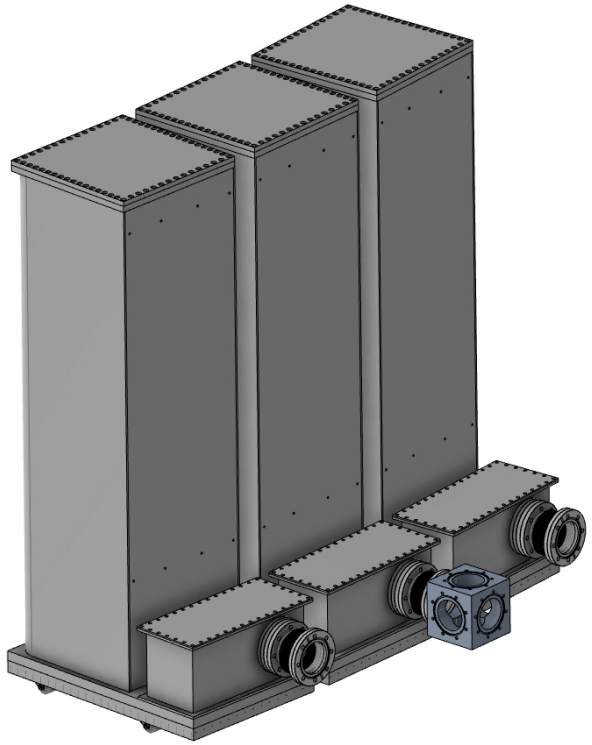
Measurements needed for thermal range, up to 160 meV



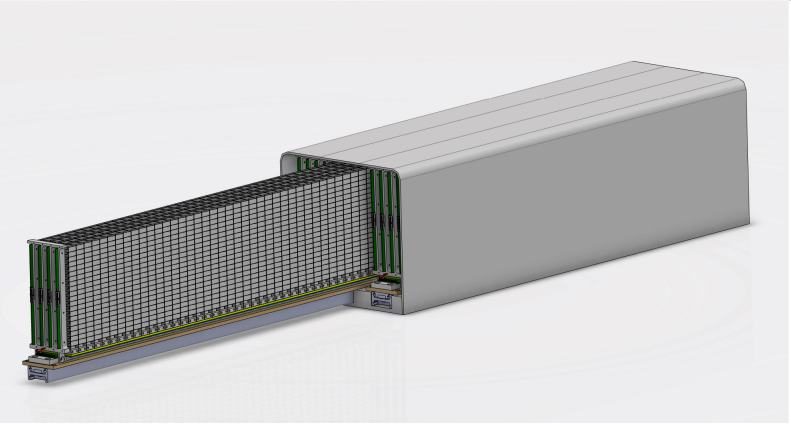
Fitting a Multi-Grid at SEQUOIA

- **Test at 10 to 1500meV**
- **In vacuum**
- **Test resolution, scattering, rate and more**

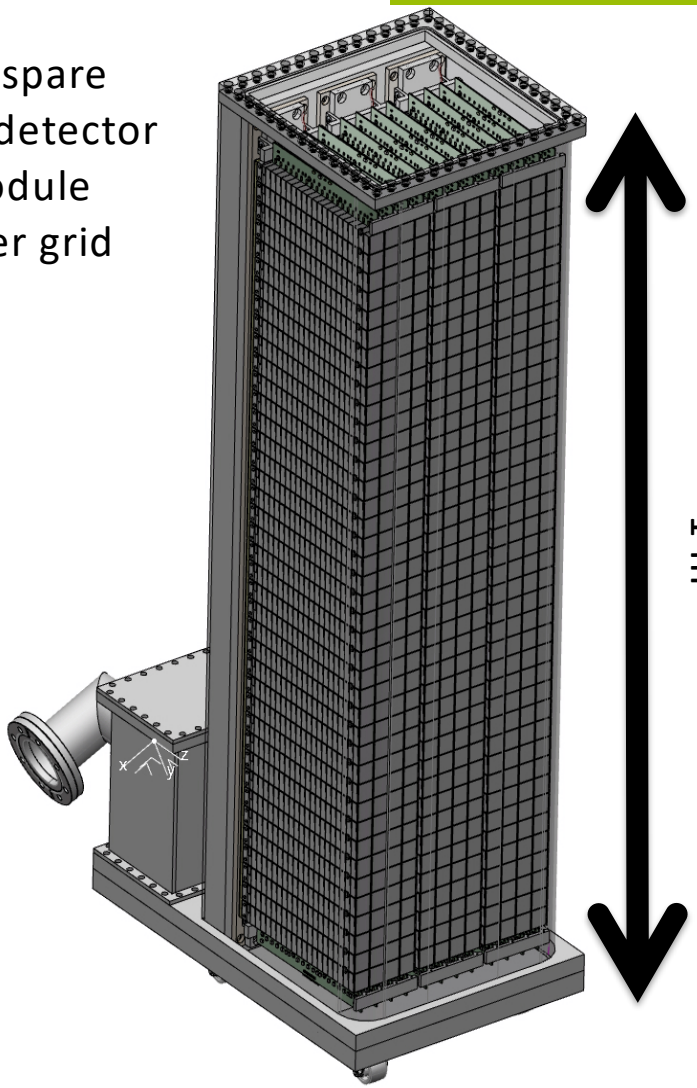


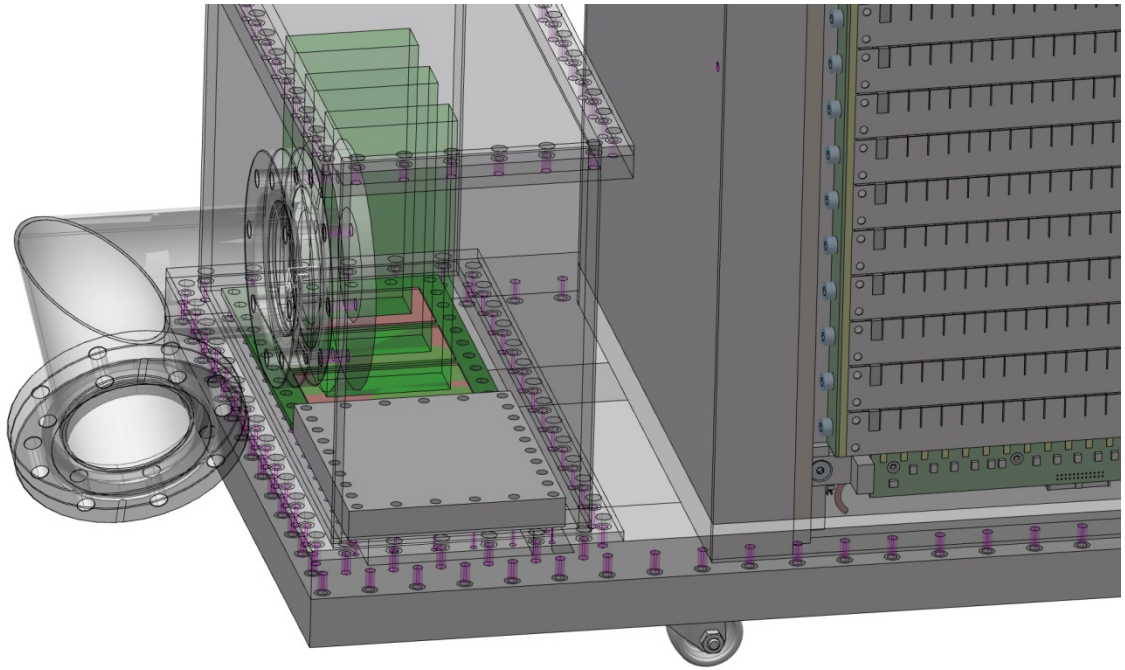


MG.SEQ Design



- 3 detectors + 1 spare
- 3 modules per detector
- 40 grids per module
- 20 cell layers per grid





MG.SEQ Characteristics

Characteristic	Values
Detector area	0.8 m^2
# of grids	360*
# of wires	720
# readout channels	1080*
# voxels	28800
# of $^{10}B_4C$ layers	40
$^{10}B_4C$ on radial blades	Yes + No
# of detectors	3 (+1 spare)
Detector weight	110kg x3

* Assuming 3 “ESS” detectors

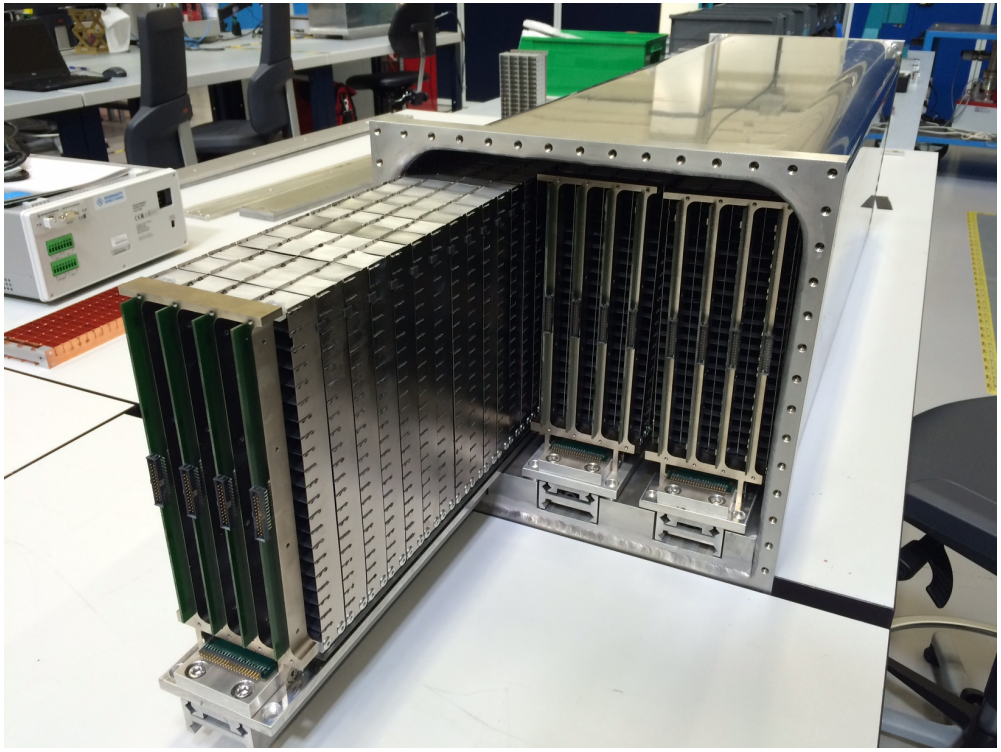
MG.SEQ assembly

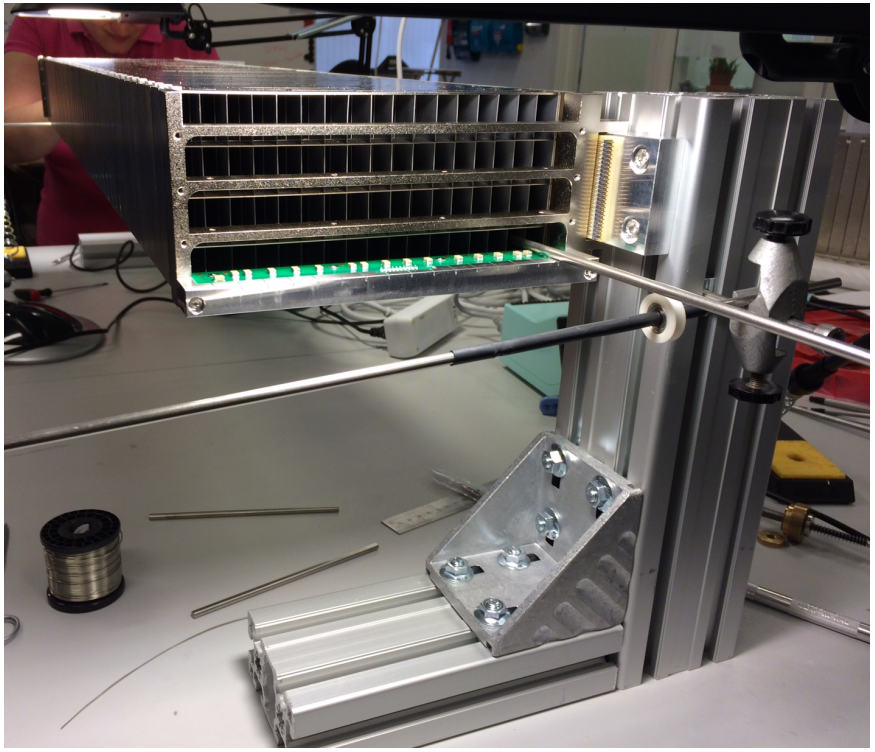
Assembly at Utgård in Lund:

- Grids
- Modules
- Wiring

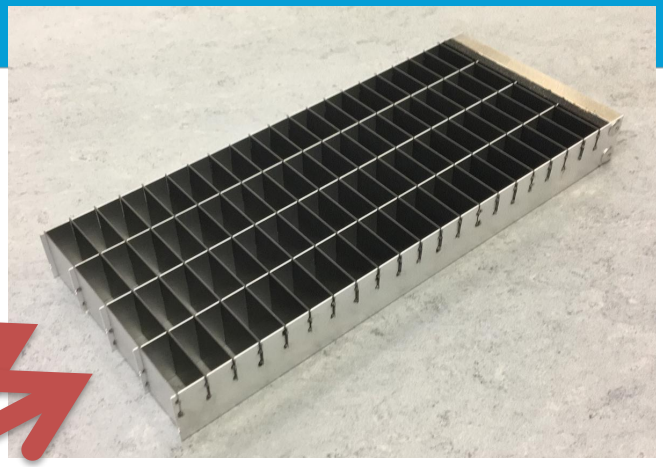
3 detectors:

- Normal blades coated
- Also parallel blades coated
- Wide grids





MG.SEQ – ESS and ILL versions



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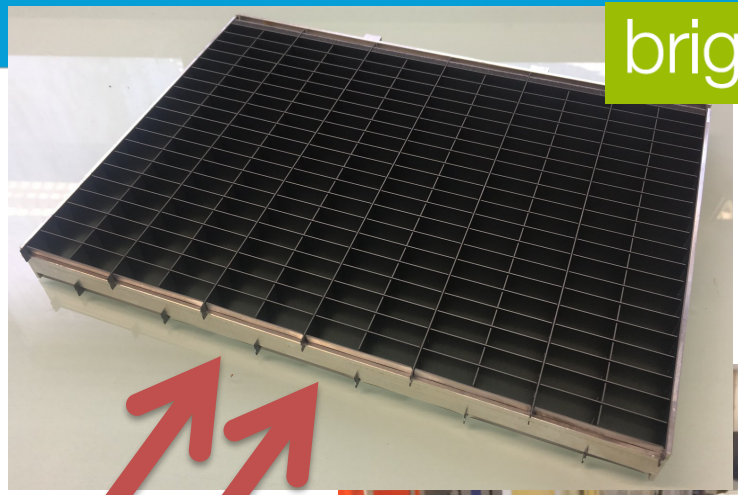

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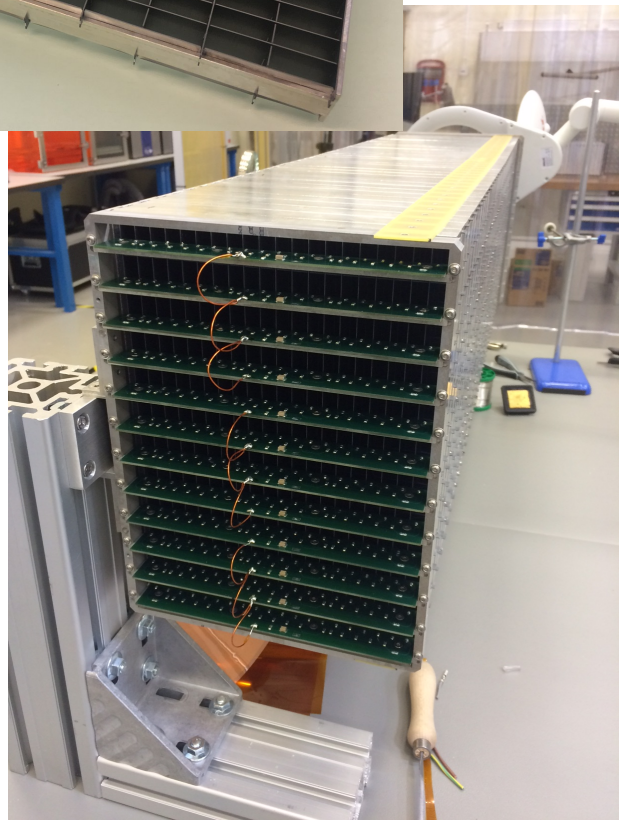
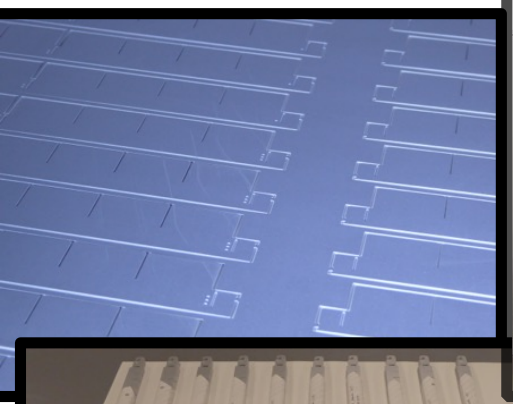
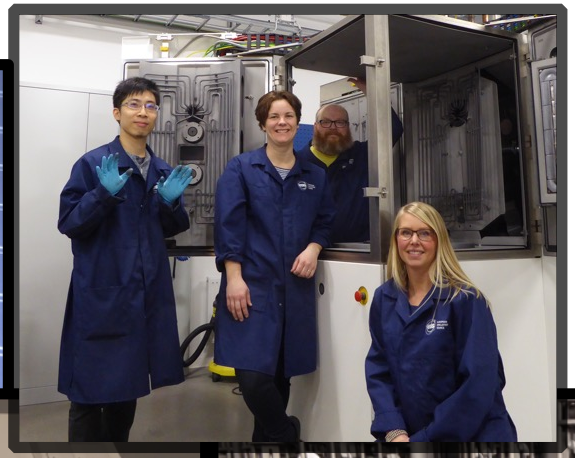
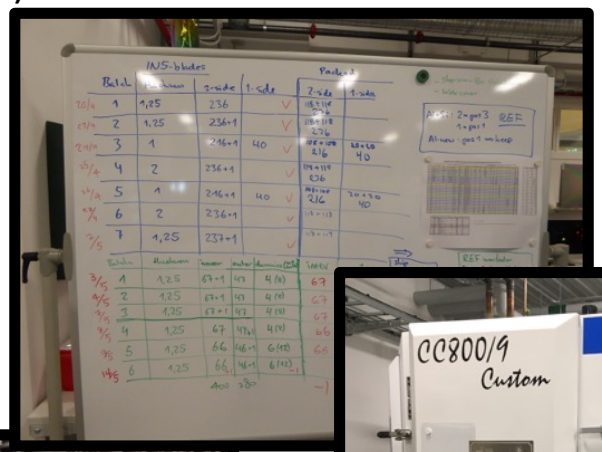


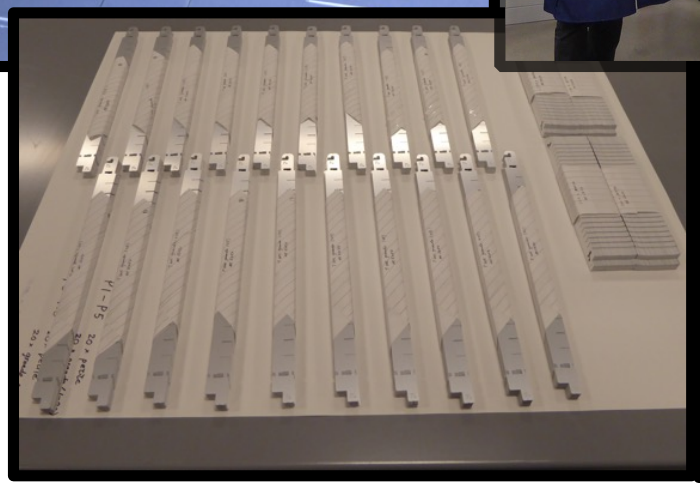
MG.SEQ 10B4C layers

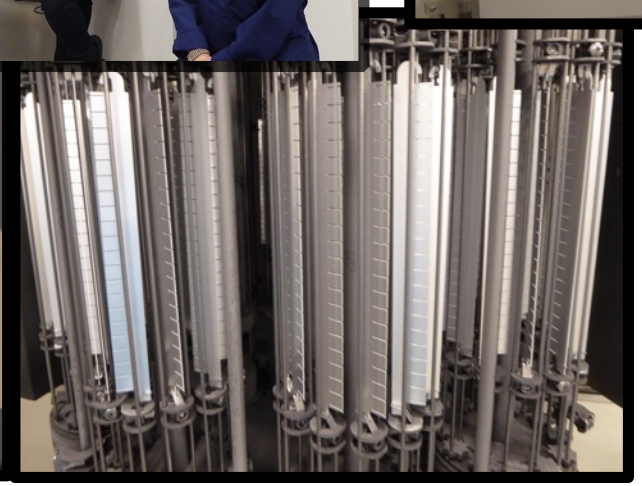
- In total 40 deposition runs during Dec 2017 and April-June 2018
  => 40 days with 1 deposition run per day
- In total 5840 blades of 5 different blade types (IN5-double, Inner, Outer, Grande, Petite)
- Total coated area: 60 m^2 (Total substrate area: 30 m^2)



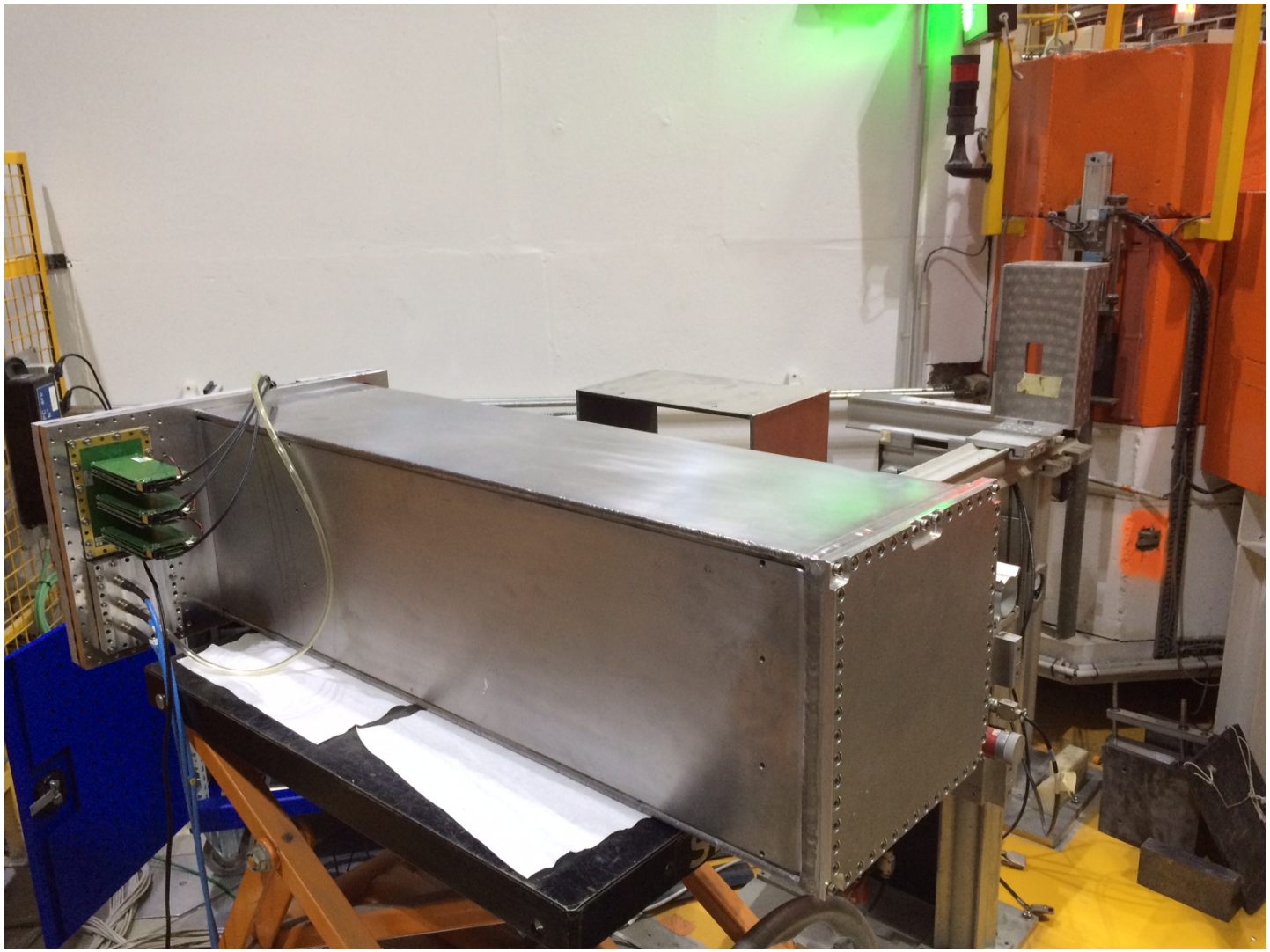








MG.SEQ test at ILL on CT2



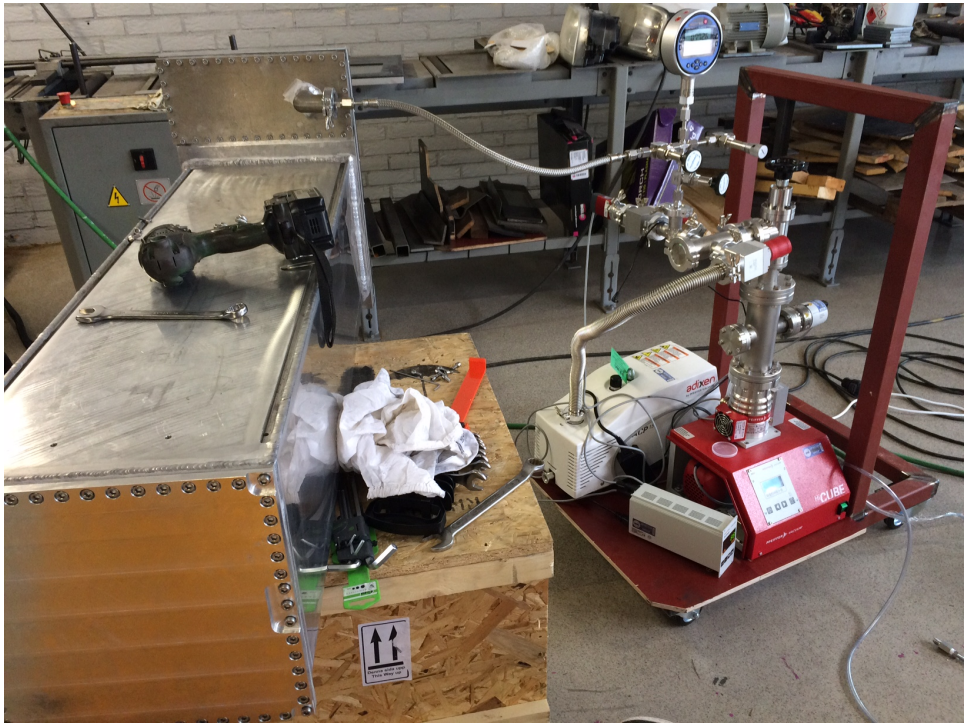
Test with 2.5Å / 12meV continuous beam;

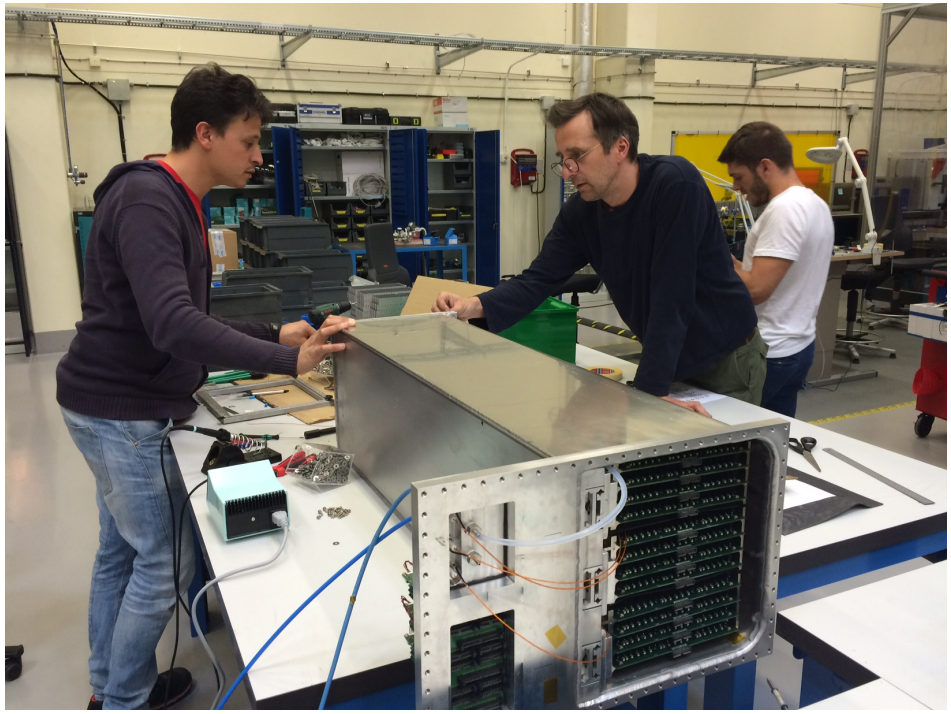
First vacuum tests

MG.SEQ Vacuum and other tests

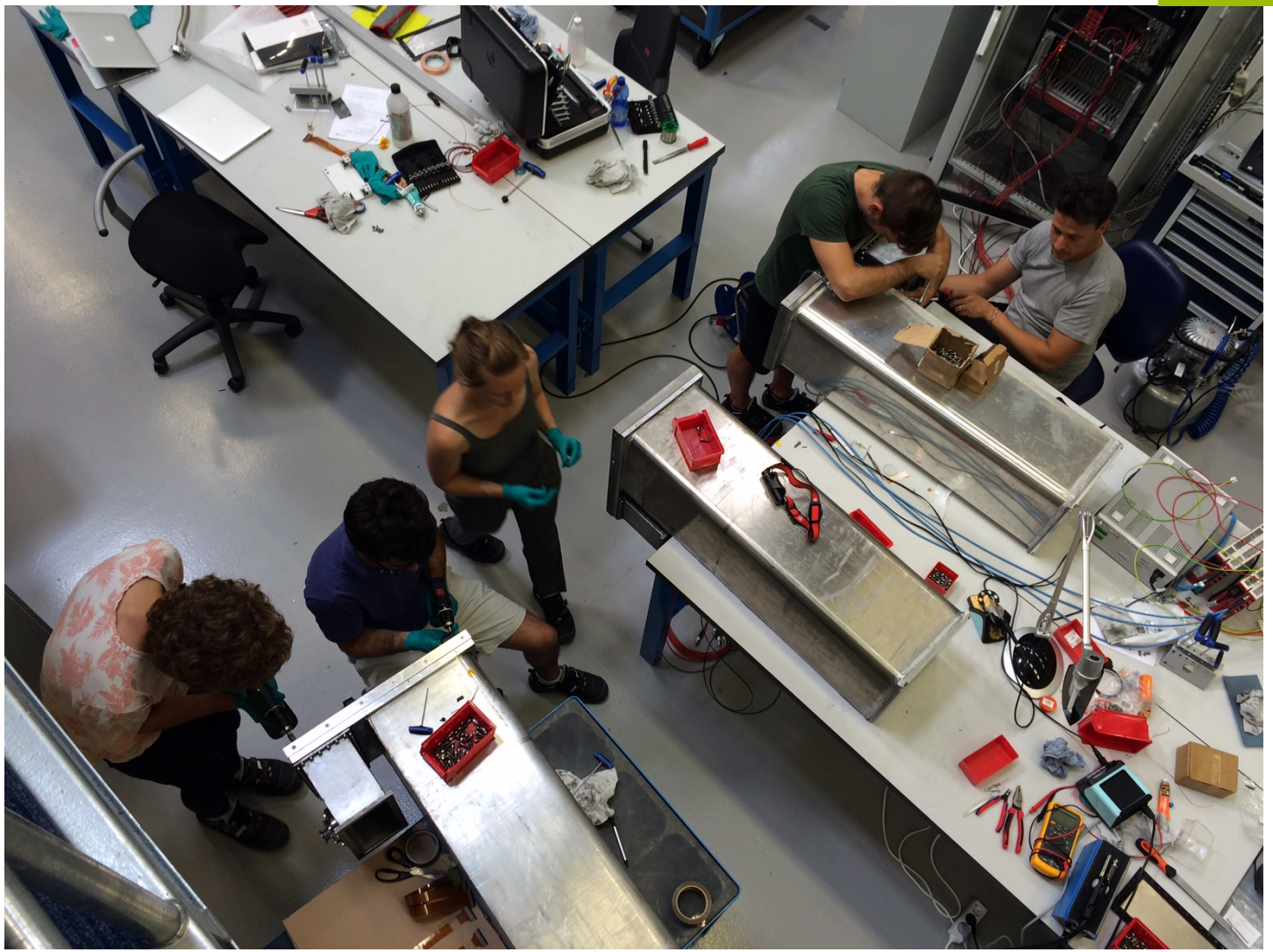
Vacuum / pressure tested at EWCON

Assembly and all other tests at Utgård





The 3 MG.SEQ getting ready

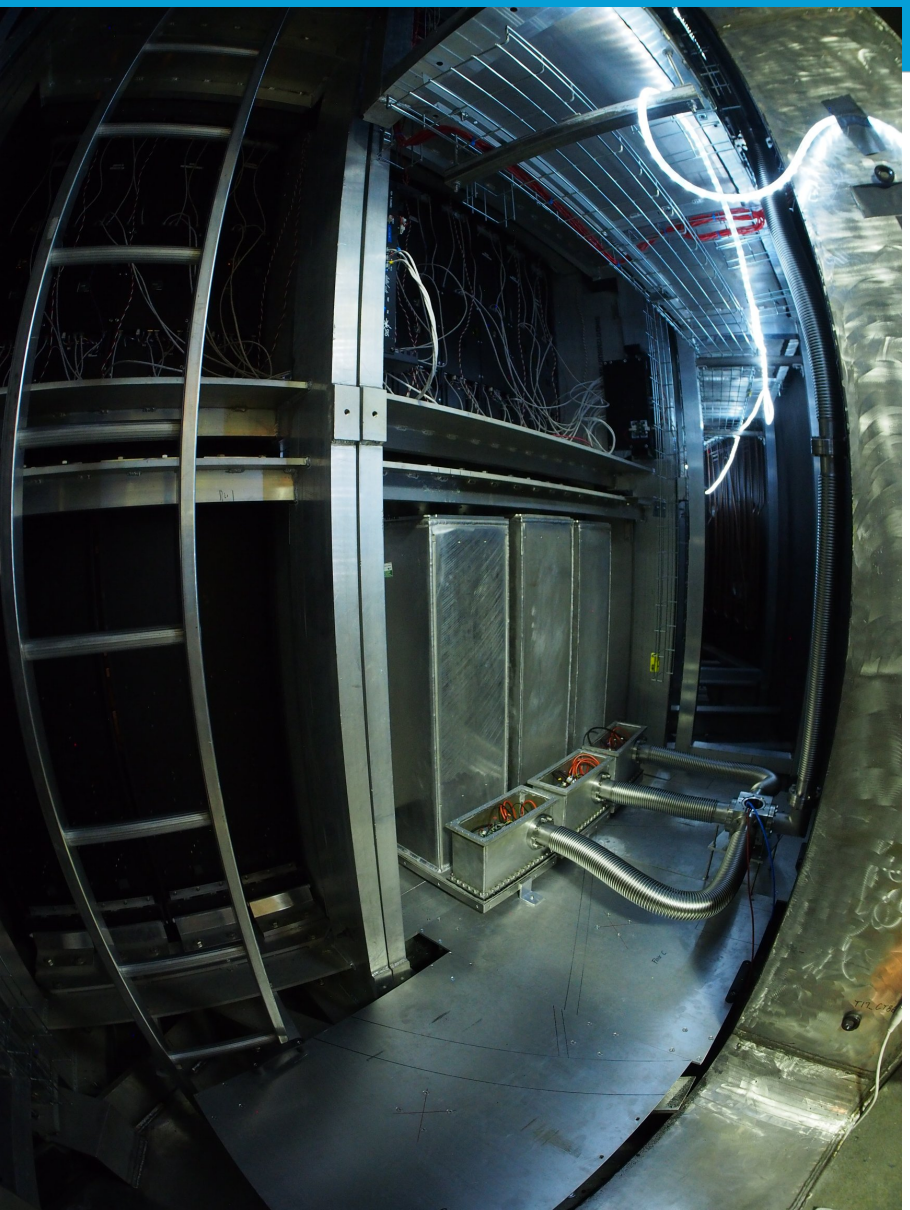


Shipments

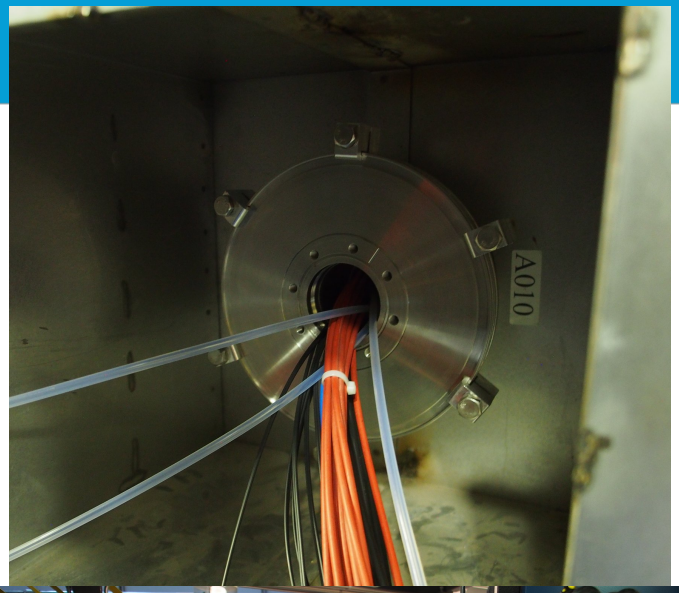
MG.SEQ vacuum test at SNS

Tested in SNS vacuum tank:
Atmosphere in detector,
Vacuum in tank
Reached 1 to $7x10^{-5}$

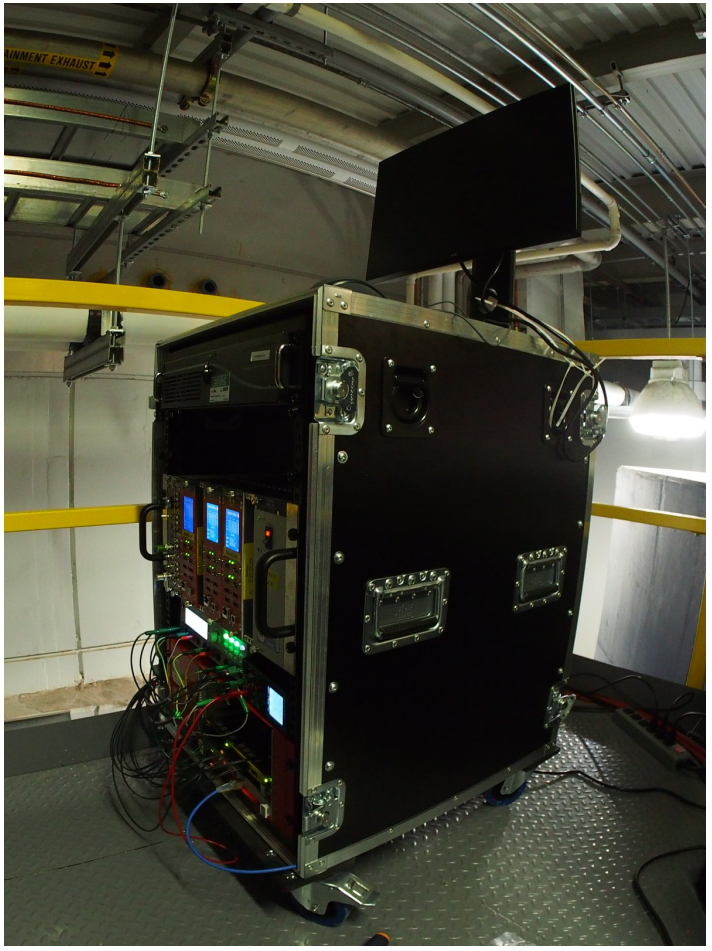
MG.SEQ installed



Outside the SEQUOIA tank



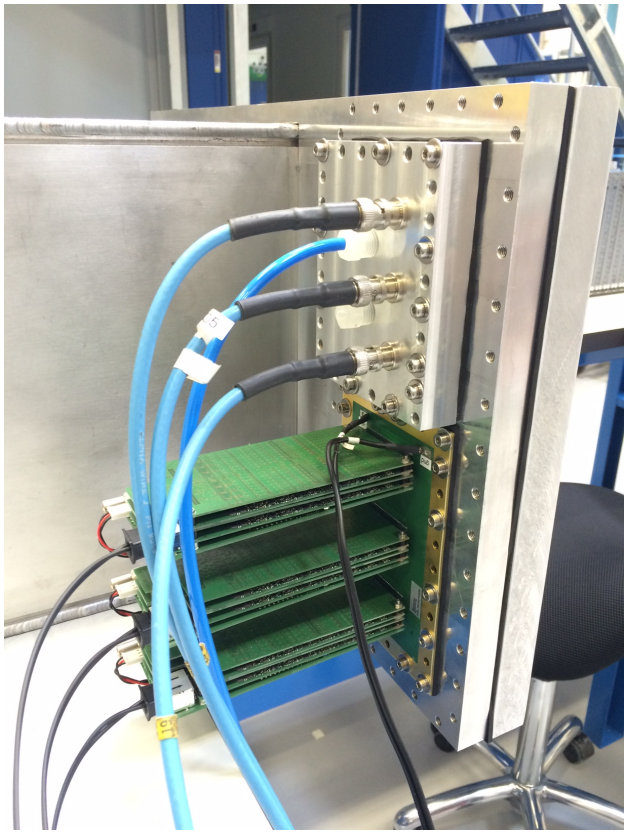
Connections feedthrough
Gas manifold
Back-end, HV, LV



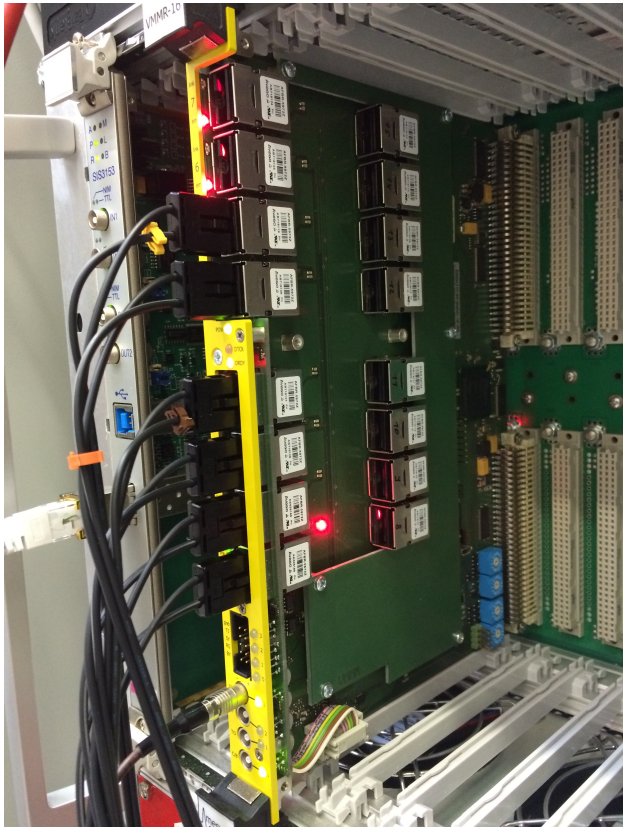
Readout

Detector signal connected with flex PCBs

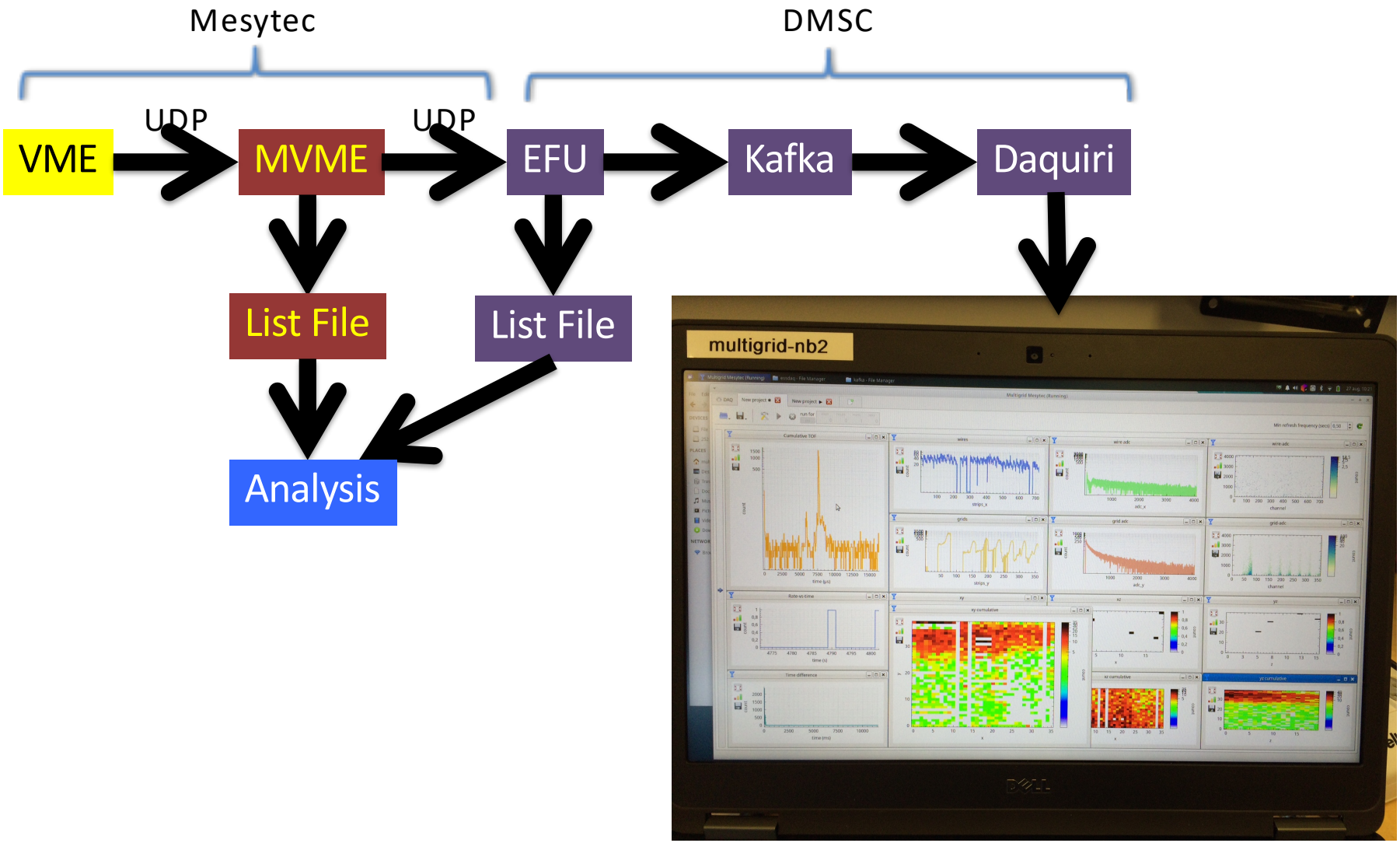
Analogue + Digital Front-end: Mesytec MMR



Back-end: Mesytec VMMR, Struck SIS3153



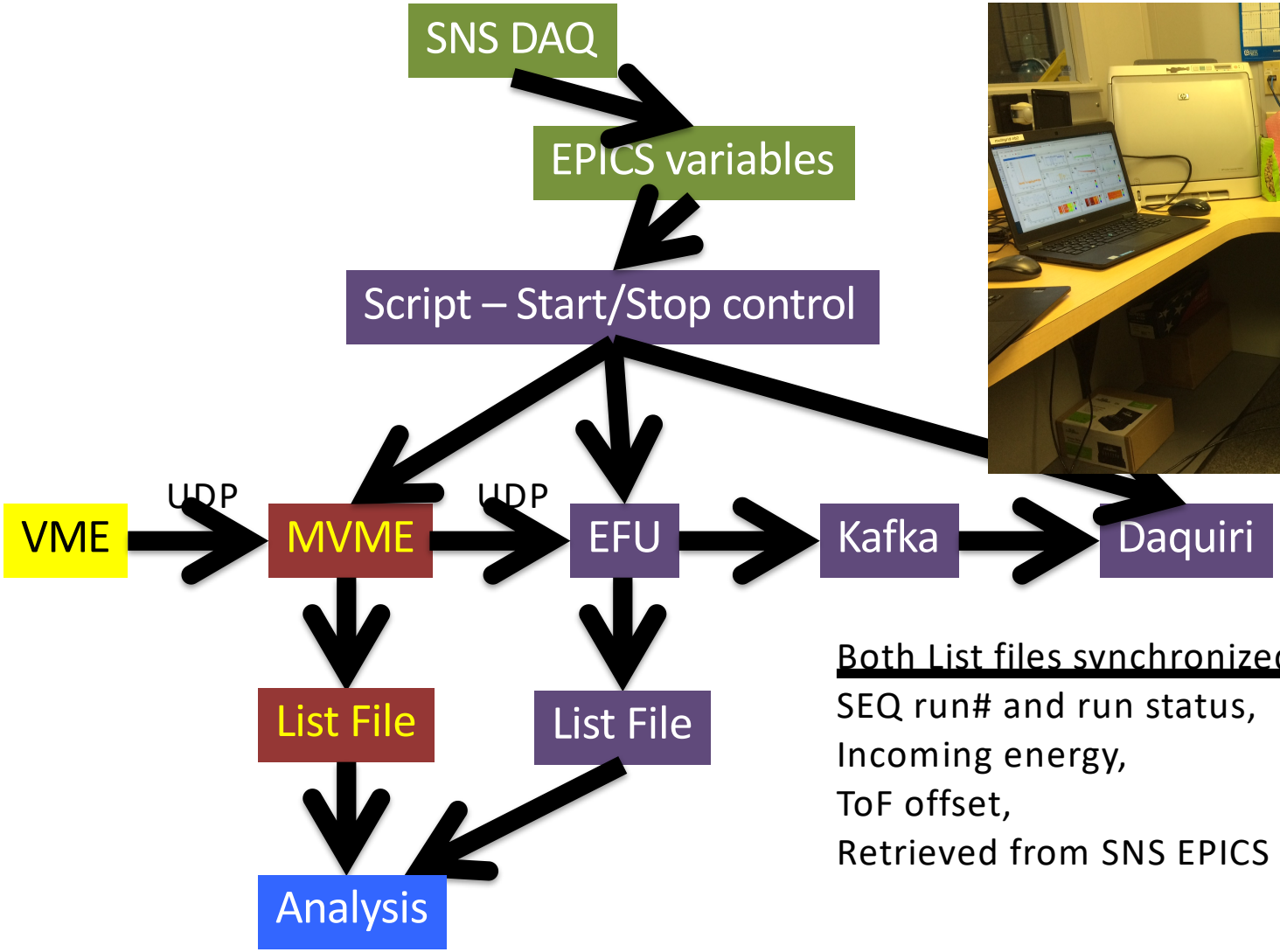
Online visualization



Samples used

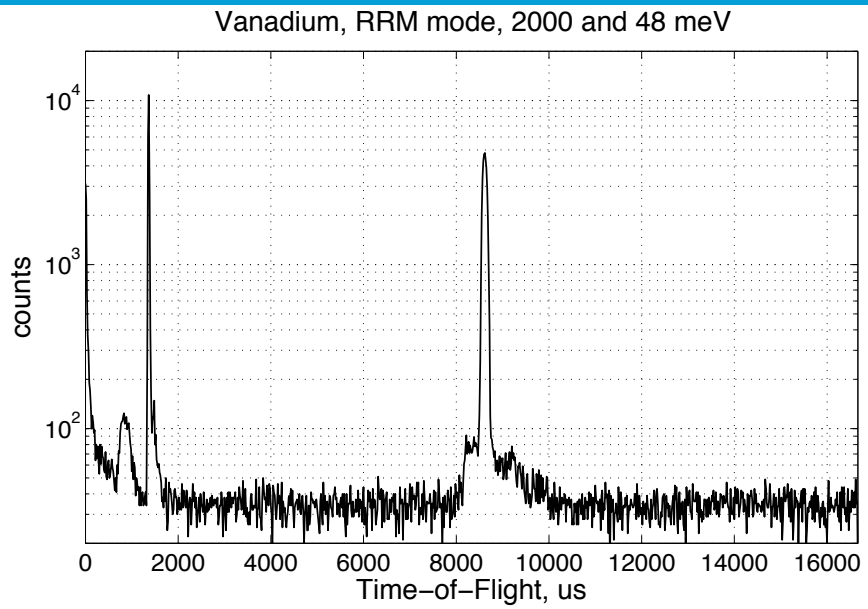
Sample	Setting	Energies, meV	Characteristics
Vanadium	High resolution	2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 225, 250, 275, 300	Elastic peak, resolution, efficiency
Vanadium	High Flux	15, 20, 25, 32, 33, 40, 48, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 225, 250, 275, 300, 350, 400, 450, 500, 600, 700, 900, 1000, 2000, 2500, 3000, 3500	Elastic peak, resolution, efficiency
Vanadium	RRM	120 (20), 300 (31.7), 400 (34), 500 (36.3), 600 (38), 700 (39.6) , 800 (40.8), 900 (41.8), 1000 (42.8), 2000 (48)	2 Elastic peaks
Vanadium	Choppers stopped open	all	High rate
C4H2I2S	High Flux	21, 35, 50, 70, 100, 200, 300, 500	Non-elastic peaks
US	High Flux	70, 120	Fast neutrons
US	White beam	Center at 250	Bragg peaks
H2O	HF/HR	4, 8, 16, 32, 50, 80, 160, 250, 600, 800	Quasielasic scattering
Si powder	HF	20, 36, 60, 250, 600	Rings
Si crystal	HF/white	32 / center at 250	High peak rate

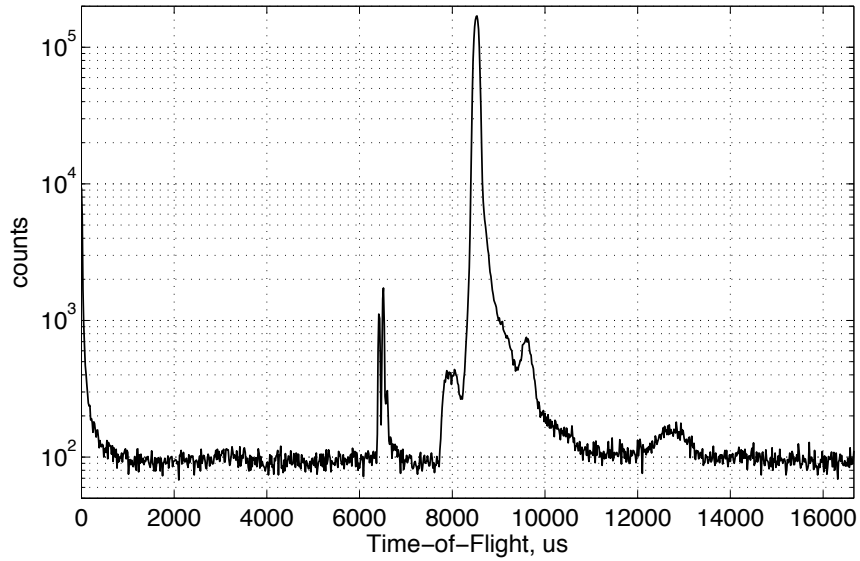
Run control



Both List files synchronized with SNS runs
SEQ run# and run status,
Incoming energy,
ToF offset,
Retrieved from SNS EPICS variables.

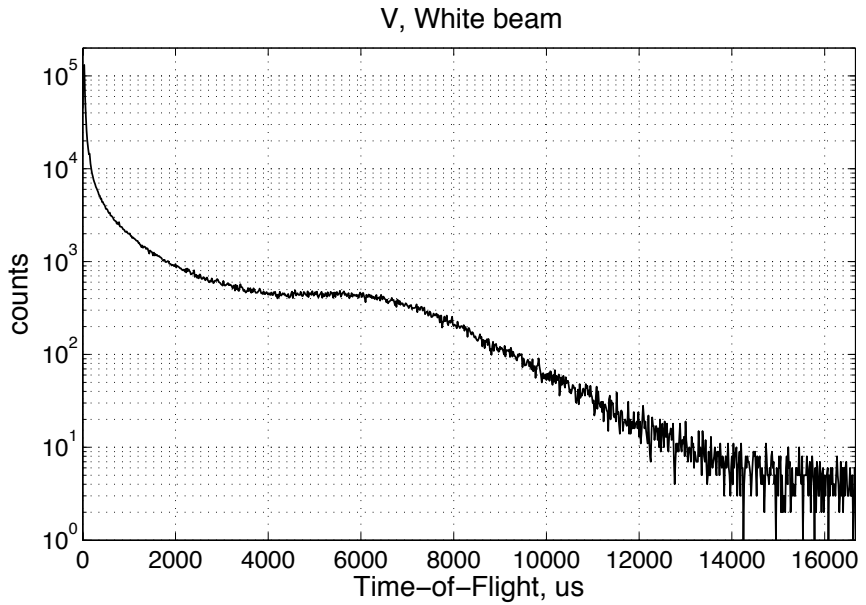
First ToF spectra





Some measurements included RRM settings with 2 incident energies.

RRM will be used heavily in ESS. This was the first time measuring in RRM mode with an ESS detector.



Conclusion

- Final prototype and deliverable of BrightnESS
- Construction and beam time completed
- Advancements and lessons learned in:
  - Vacuum-compatible design
  - Welding
  - Readout
  - Analysis
- Results of analysis to come soon
- These detectors have been the basis of the Brightness deliverable D4.14
  DOI: https://doi.org/10.17199/BRIGHTNESS.D4.14