PAUL SCHERRER INSTITUT

PSI

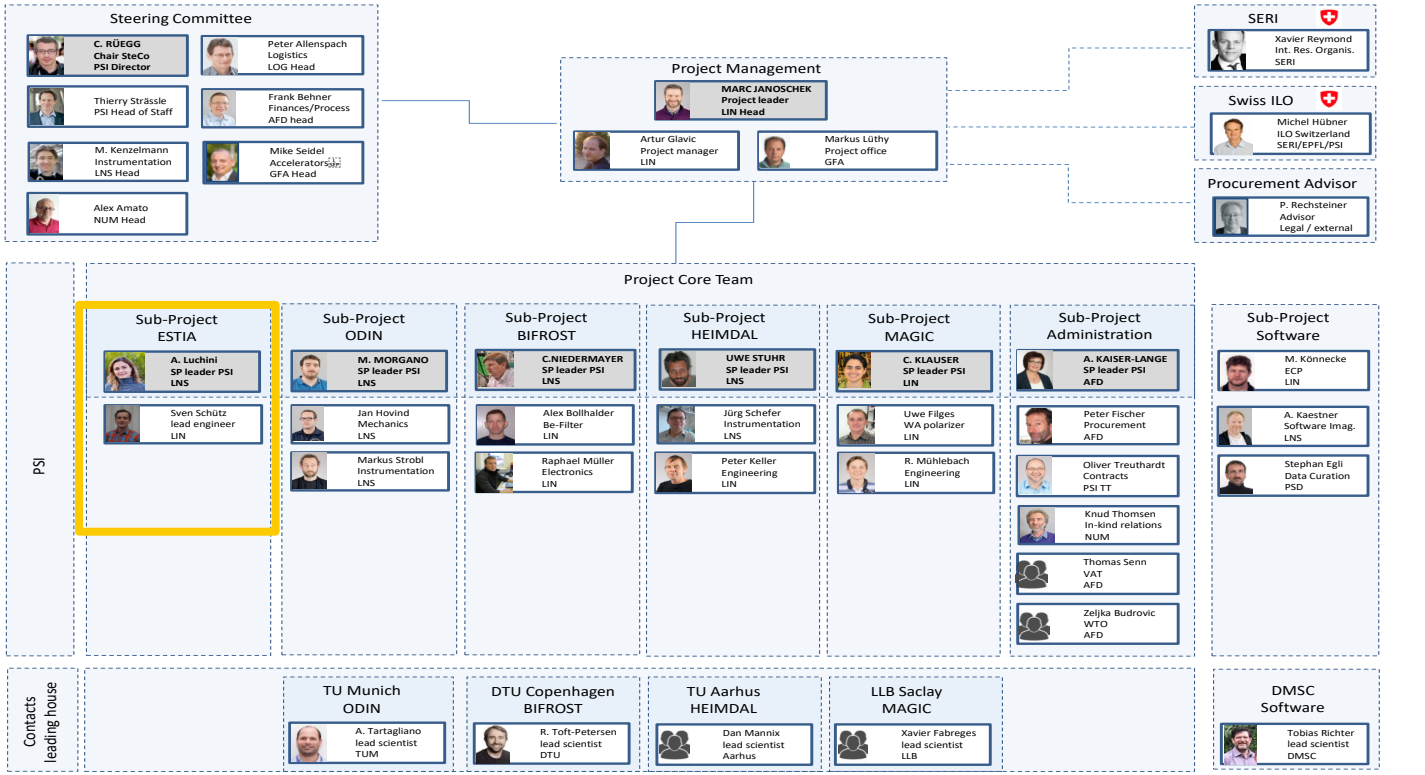
Alessandra Luchini and Sven Schultz :: ESTIA core team :: Paul Scherrer Institute

ESTIA – STAP report

STAP meeting 23/04/2021

Collaboration Structure

PSI-ESS Instrumentation Project Organization

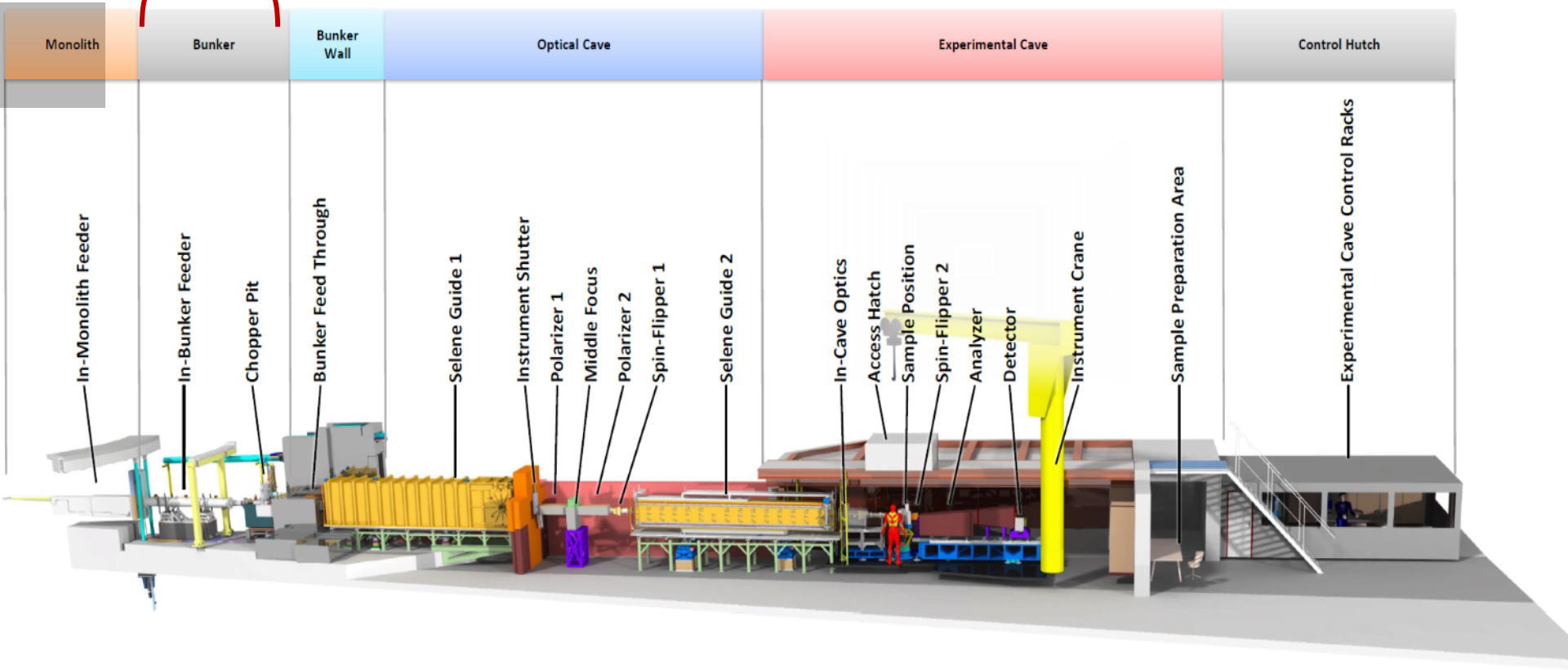


Outline

- General update on project status and progress
- Design of Middle Focus: new concept for the polarizers
- Upcoming tasks

General update

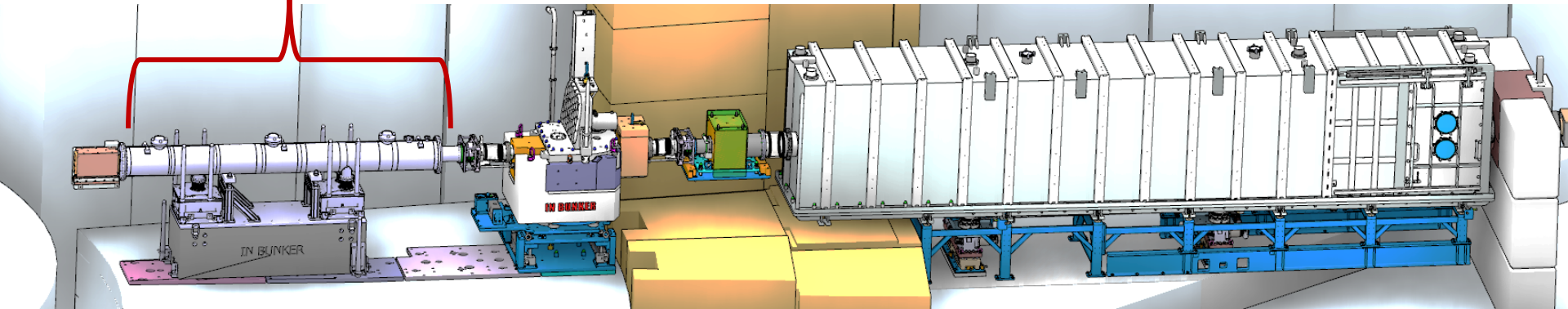
In production



General update

- **In-bunker Feeder, Chopper Pit & Virtual Source**

Feeder support mechanics currently being tested

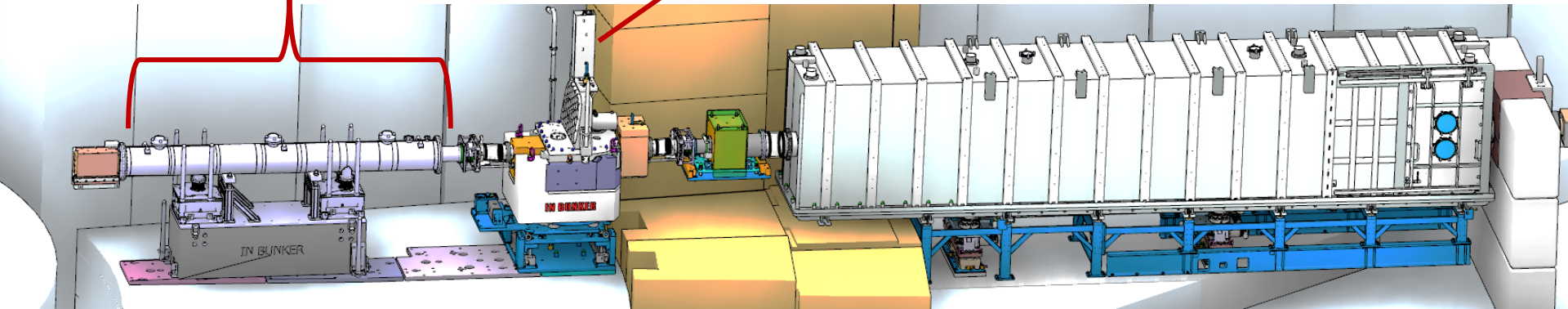


General update – In-buker

- **In-bunker Feeder, Chopper Pit & Virtual Source**

- All parts of the Chopper Pit are in production
- Virtual Source Slit Assembly (VSSA) is in SAT
- Test crate for the VSSA is in production
- In-Beam testing @ PSI planned for July
- Chopper testing @ PSI planned for Sept.

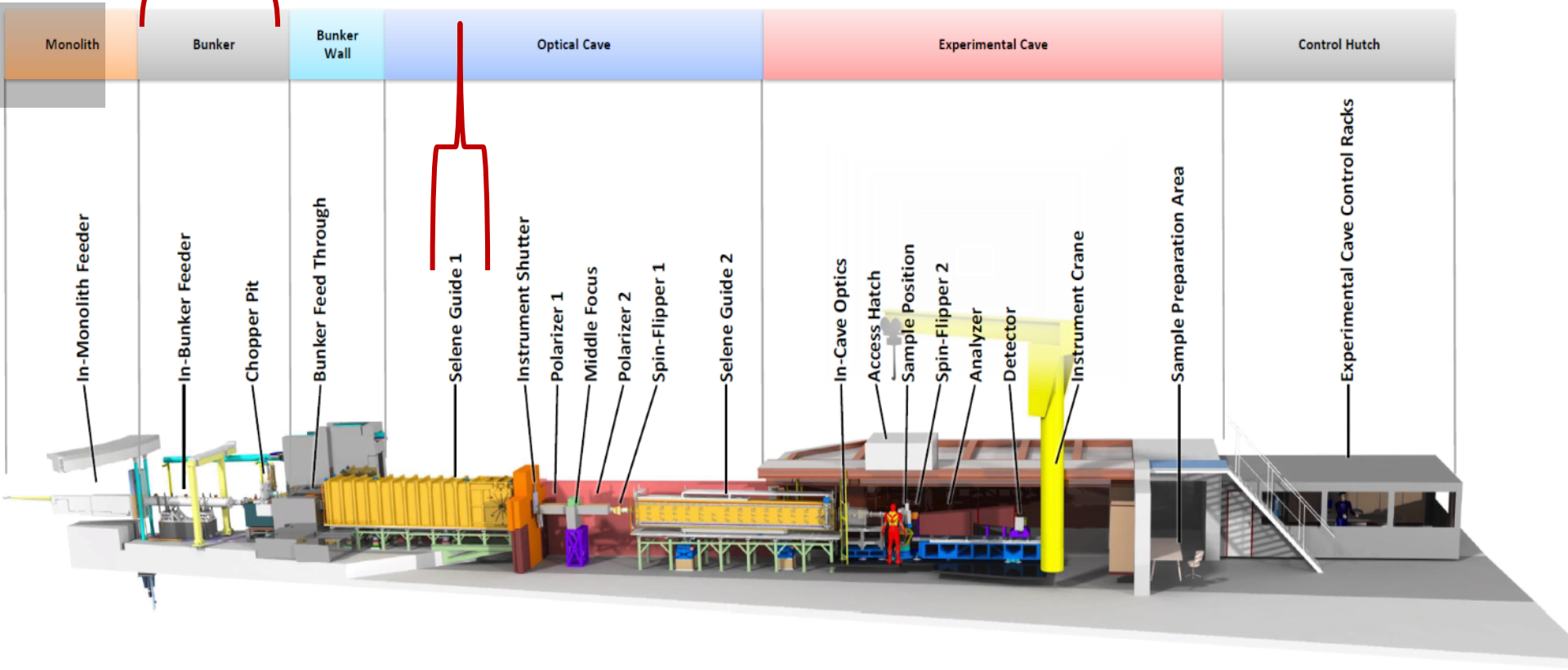
Feeder support mechanics currently being tested



General update

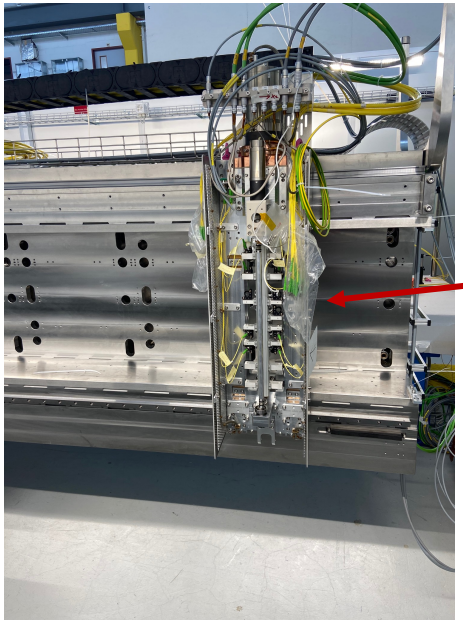
In production

FAT



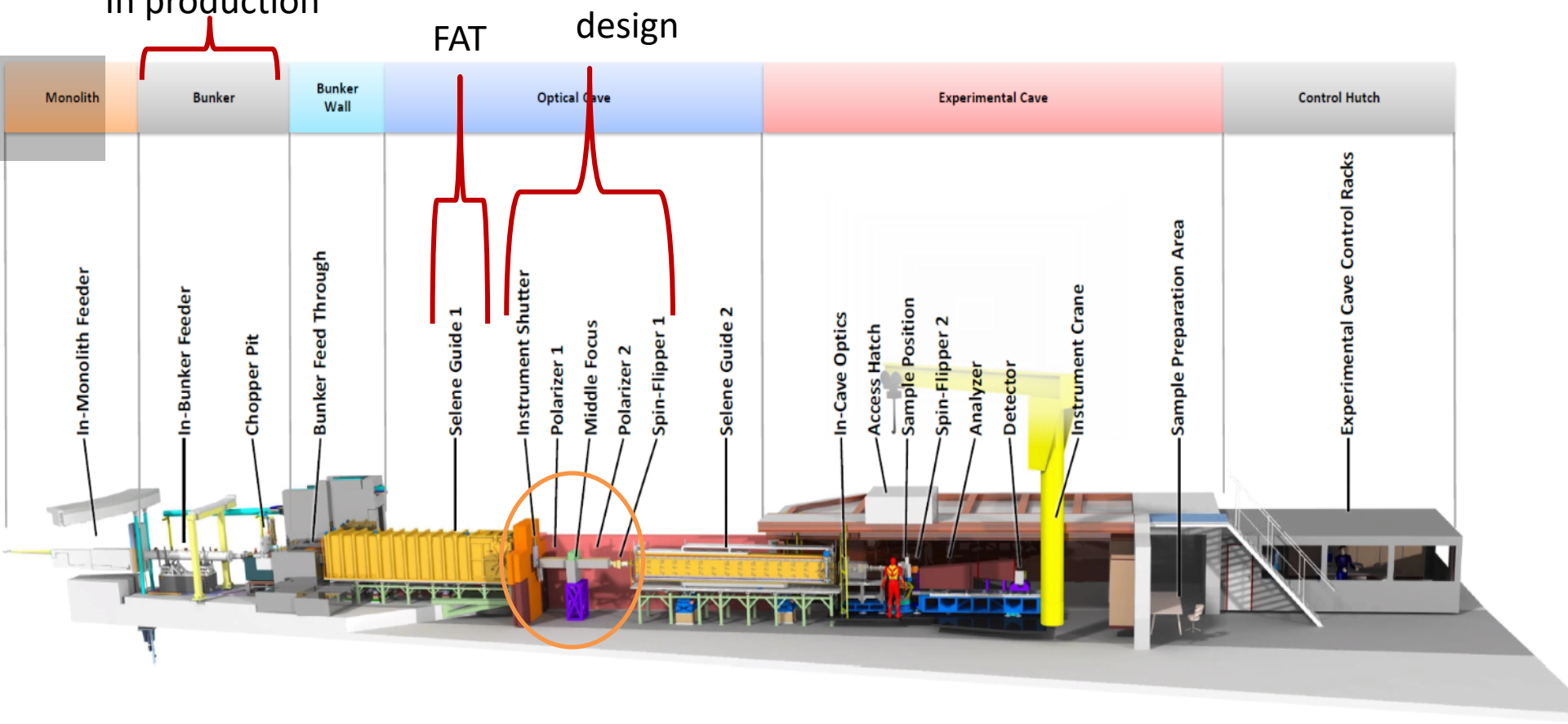
General update – Selene 1

- Initial tests for installation of **Selene Guide 1 carrier**
  - the carrier was delivered to PSI, but further processing is required
  - Preliminary tests for assembly of metrology cart



Metrology cart

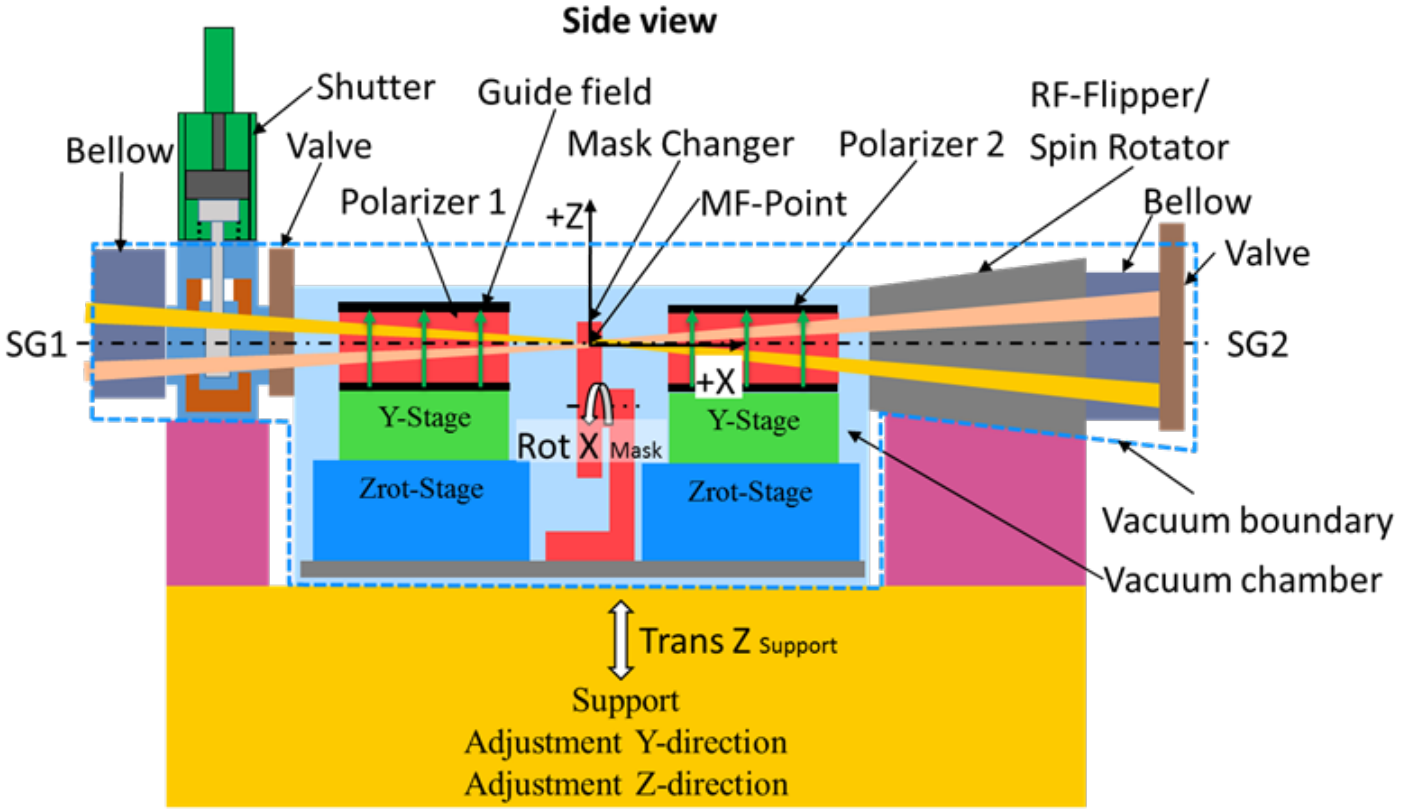
General update



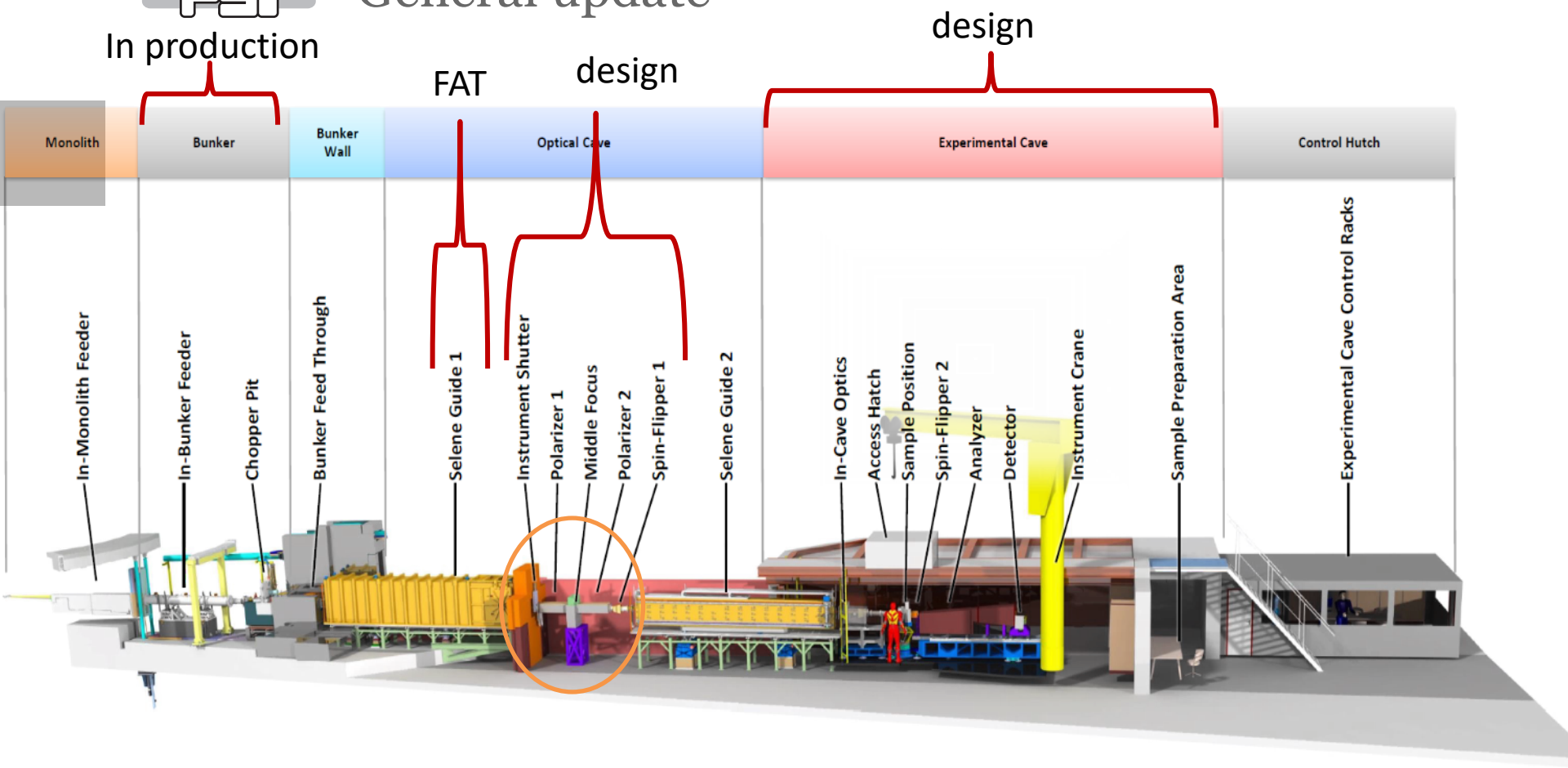
General update – Middle Focus

- The design of **Middle Focus** has started

- Shutter design completed
- Mask Changer design soon to be finalized
- More about the polarizers later…

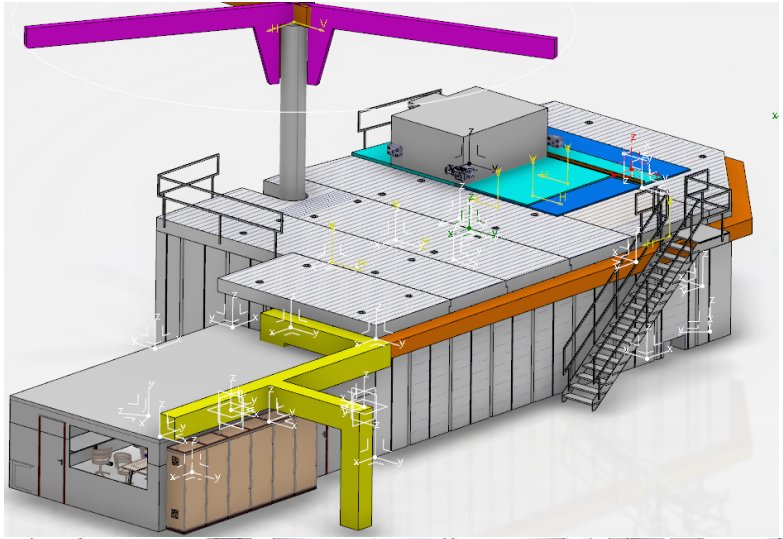


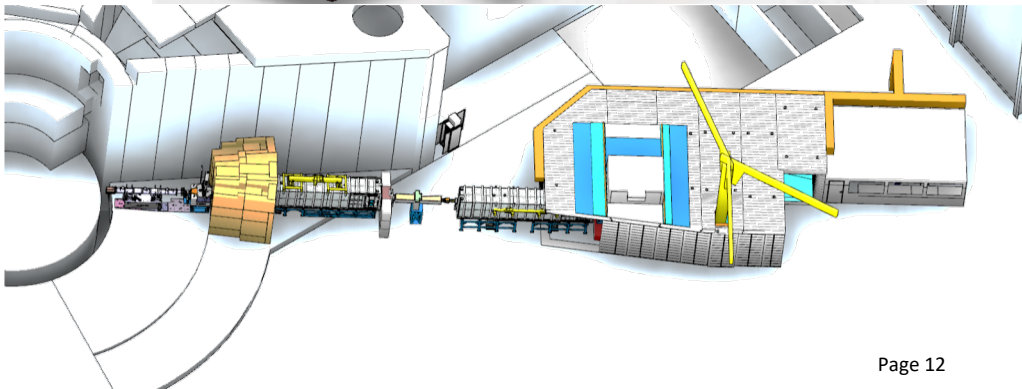
General update



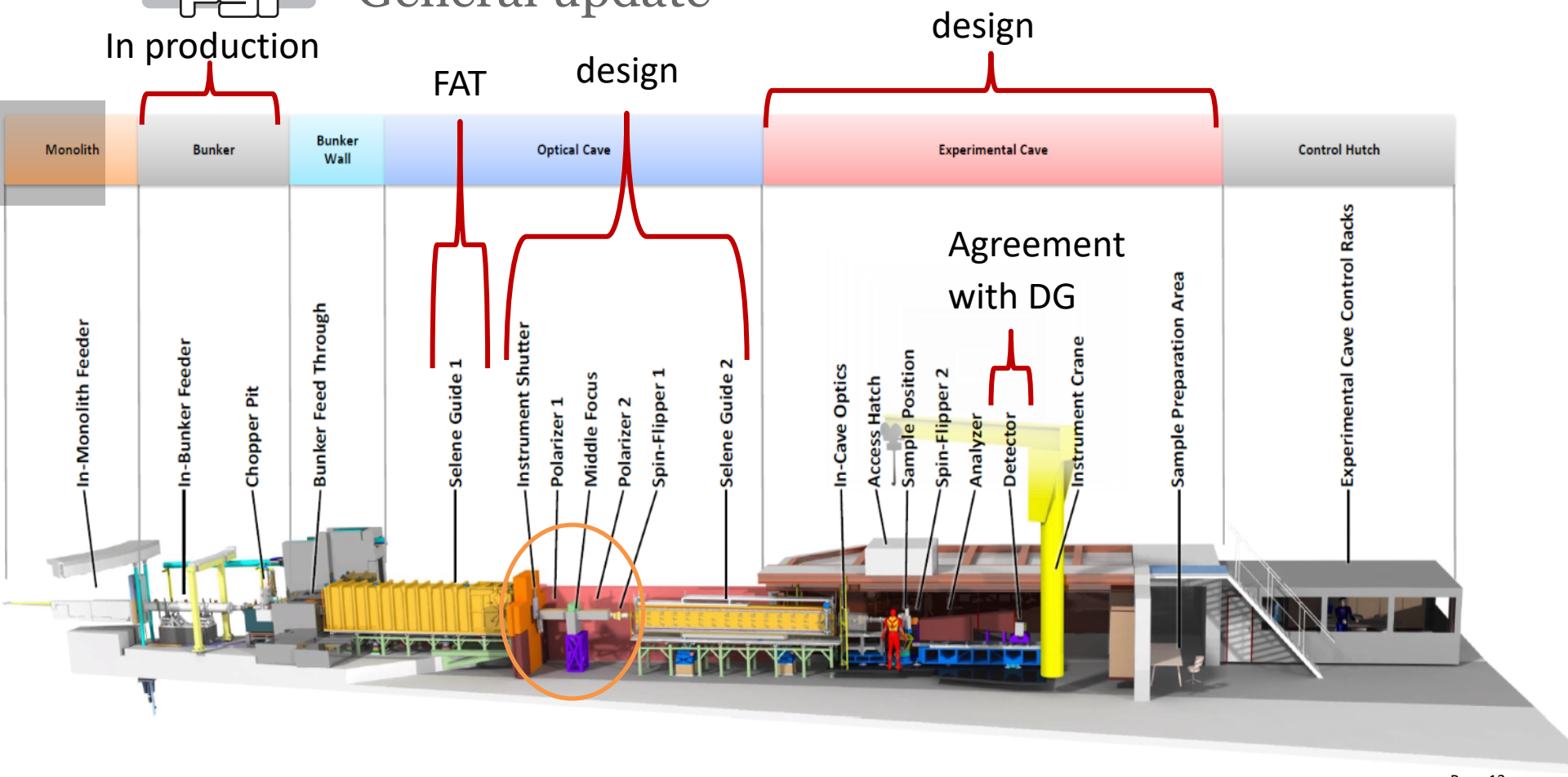
General update – Experimental Cave

- Design of the experimental cave is completed
- Scope transfer for the Experimental Cave to ESS is being assessed
  - PSI does not have the competences to procure building structures for organisations in other countries
  - Requirements on scope transfer PSI → ESS are being clarified



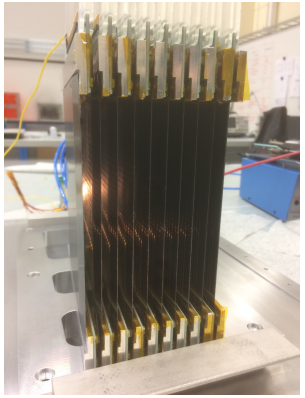


General update

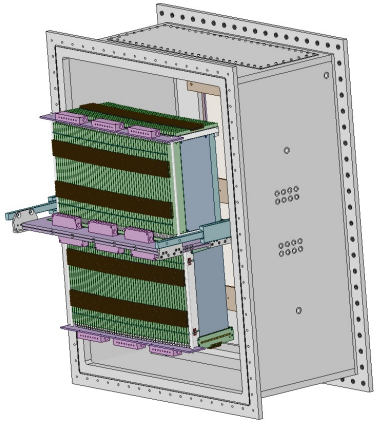


General update - Detector

- Detector budget change request: ESTIA solid/liquid SE budget+ NSS contingency to cover detector extra costs. NSS contingency should cover the costs for ESTIA solid/liquid SE



- Tests of a new detector prototype are planned on AMOR



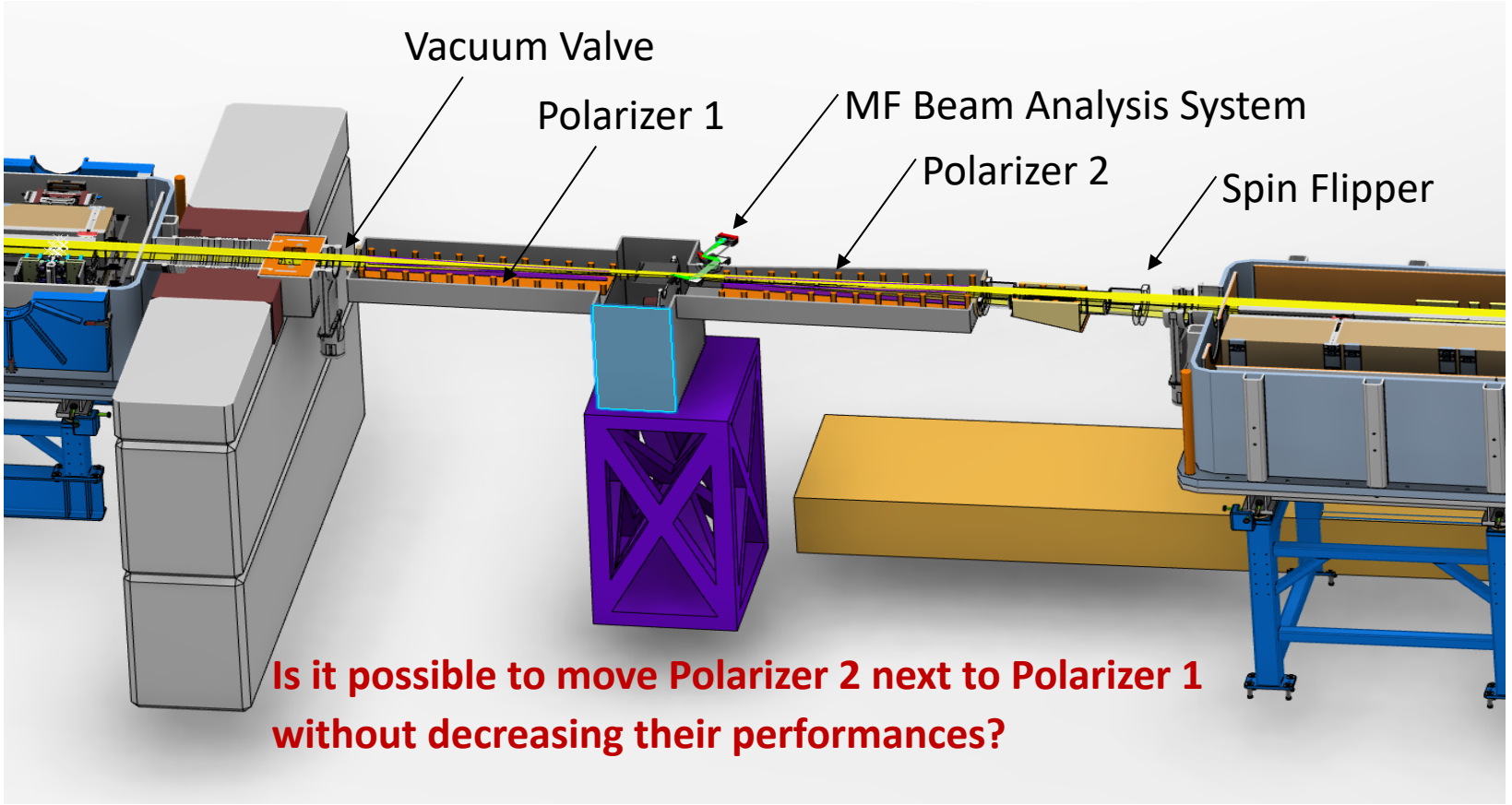
- Detector vessel will be designed to allow a future upgrade to two detectors

Outline

- General update on project status and progress
- **Design of Middle Focus: new concept for the polarizers**
- Upcoming tasks

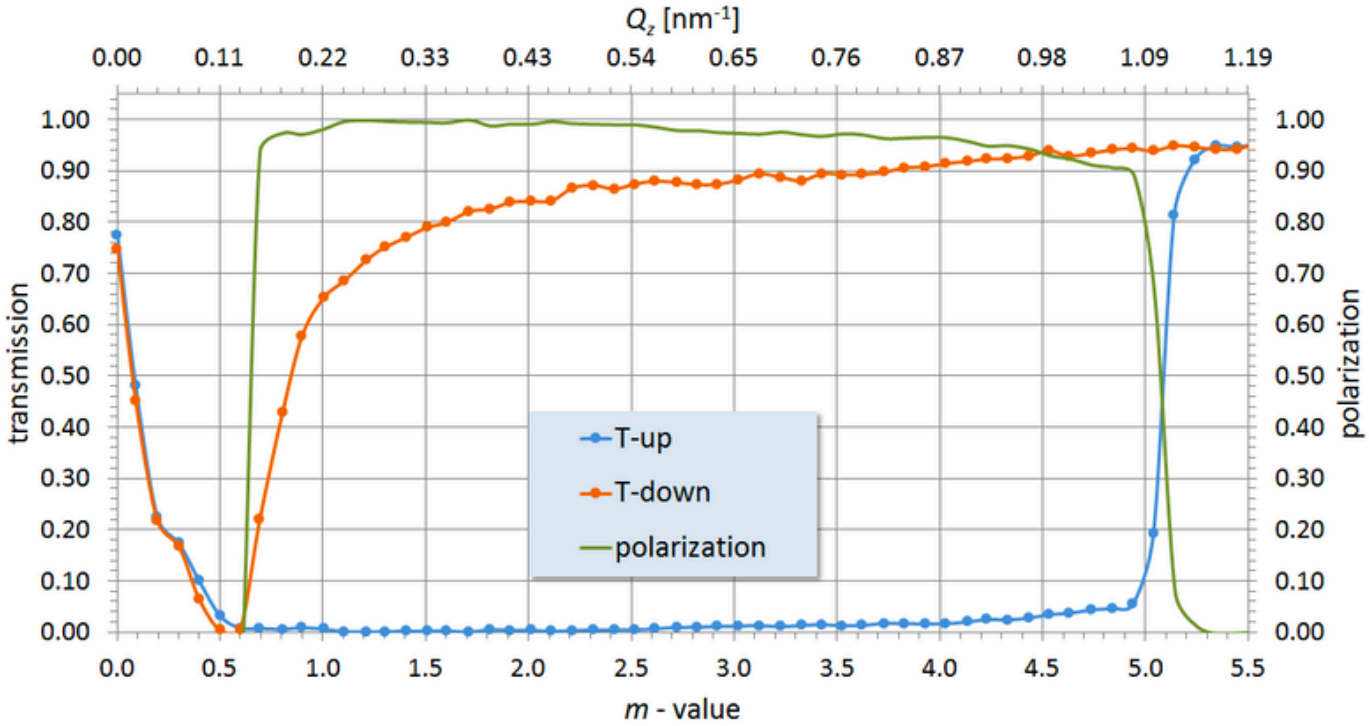
Intial concept

Virtual Source horizontal opening: 5mm and 1.5 mm



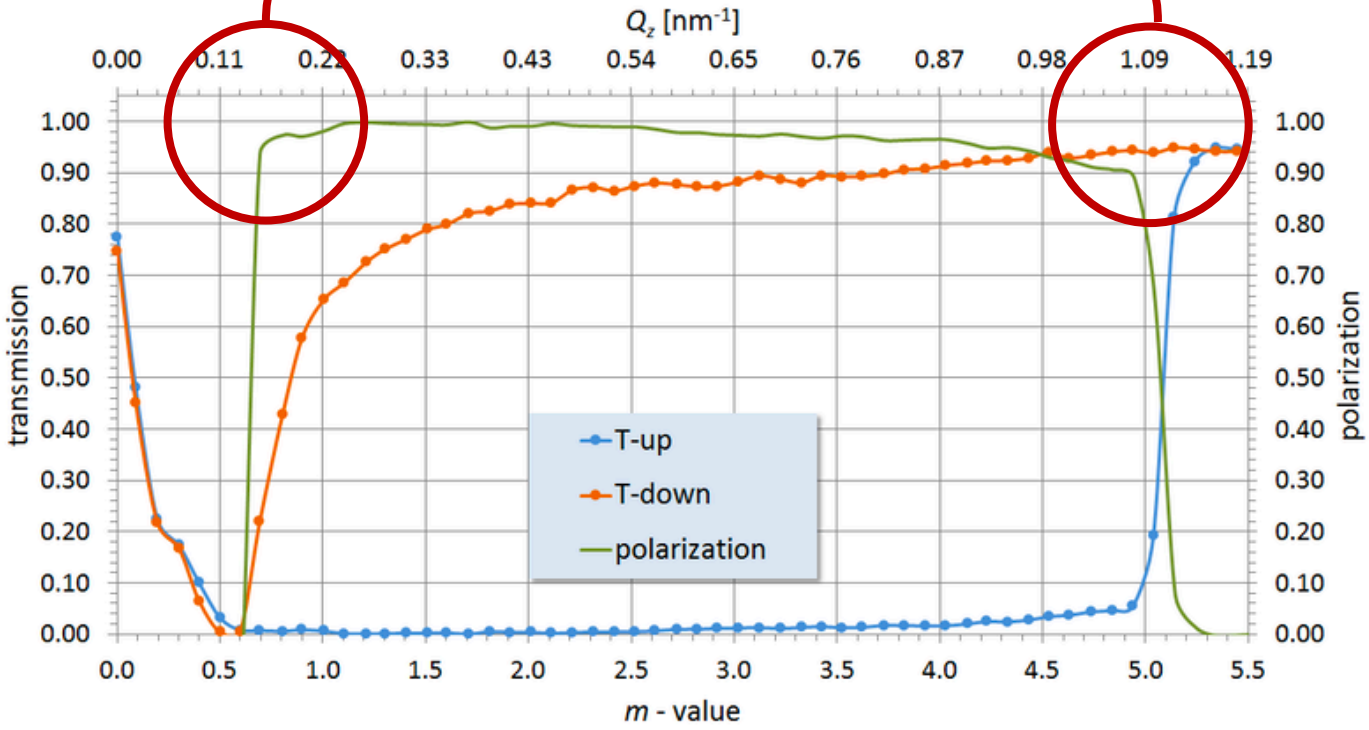
Polarizers

Plot from Swiss Neutronics AG website



Polarizers

In this q range neutrons with spin down are transmitted and neutrons with spin up are reflected



Polarizers

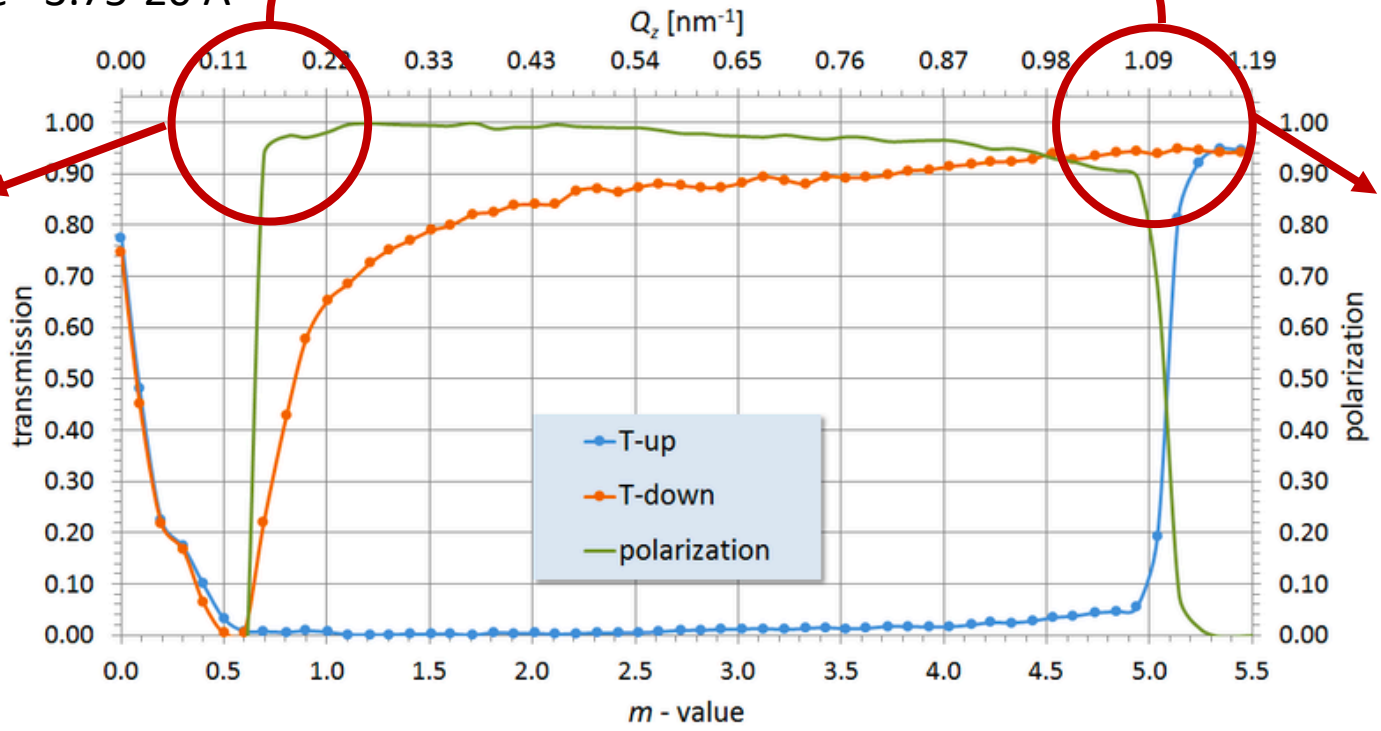
$$q = \frac{4\pi}{\lambda} sin\theta$$

λ range= 3.75-20 Å

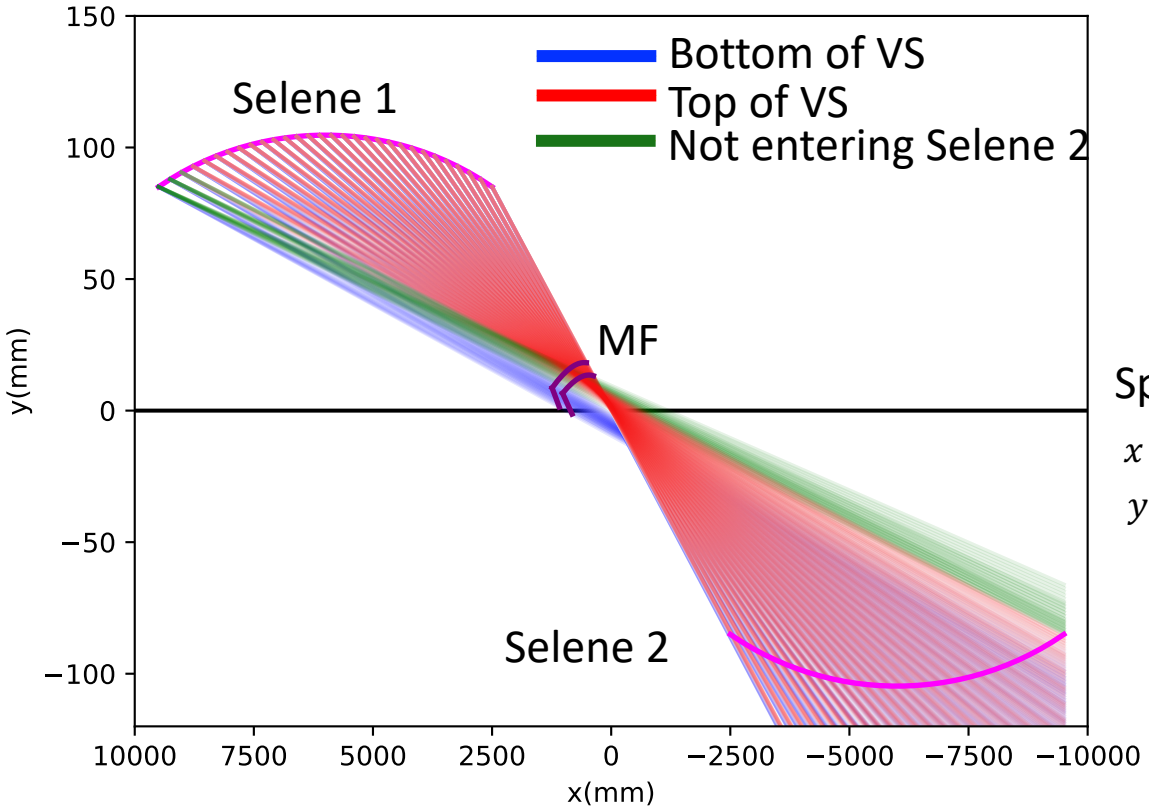
In this q range neutrons with spin down are transmitted and neutrons with spin up are reflected

$\gamma_{min} \approx$ 0.9deg

$\gamma_{max} \approx$ 1.9deg



2 Polarizers – different γ, V-shape



- Virtual Source (VS) = 5 mm
- The simulated rays are equally distributed along VS
- The sizes of the polarizers were calculated as to cover the entire beam

Spiral coordinates:

$$x = ae^{(-b\theta)}\cos(\theta)$$
$$y = ae^{(-b\theta)}\sin(\theta)$$

$$b = \frac{1}{\tan(\gamma)}$$

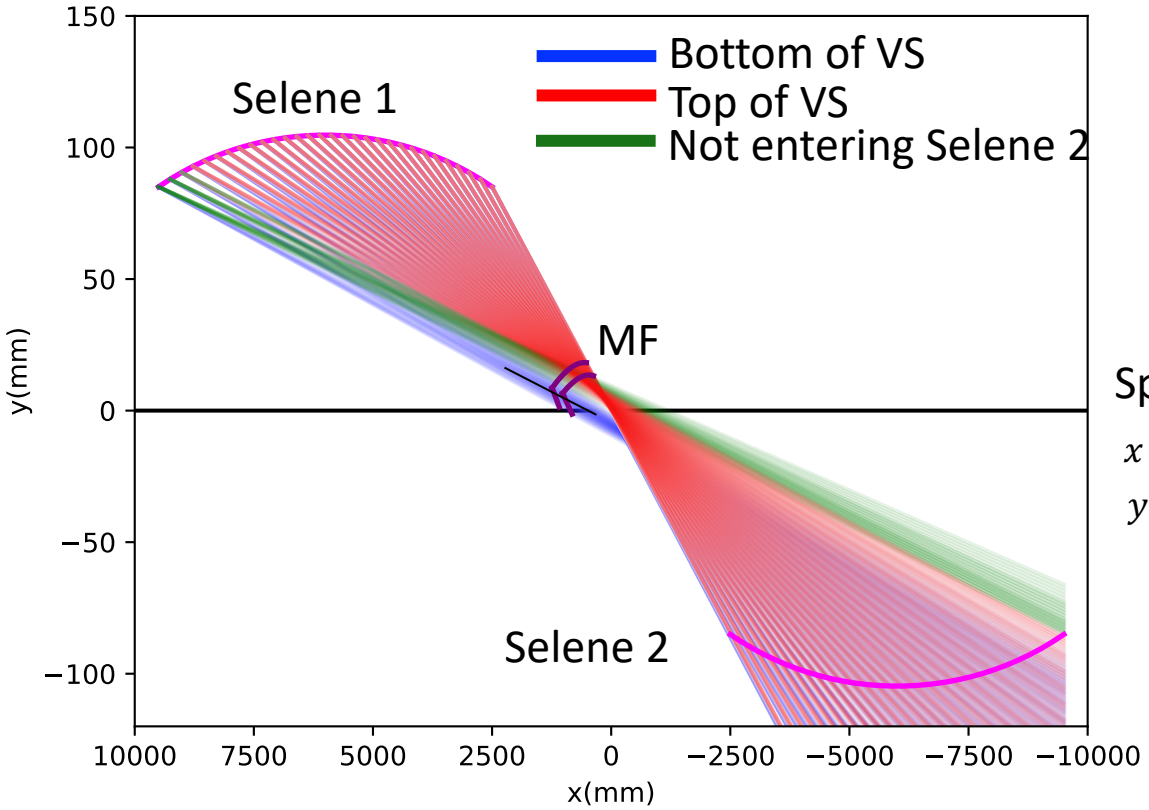
$$\gamma_{Pol1} = 1.65\ deg$$
$$\gamma_{Pol2} = 1.85\ deg$$

spiral

$$t_{Pol1} = 2.28\ deg$$
$$t_{Pol2} = 2.28\ deg$$

linear

2 Polarizers – different γ, V-shape



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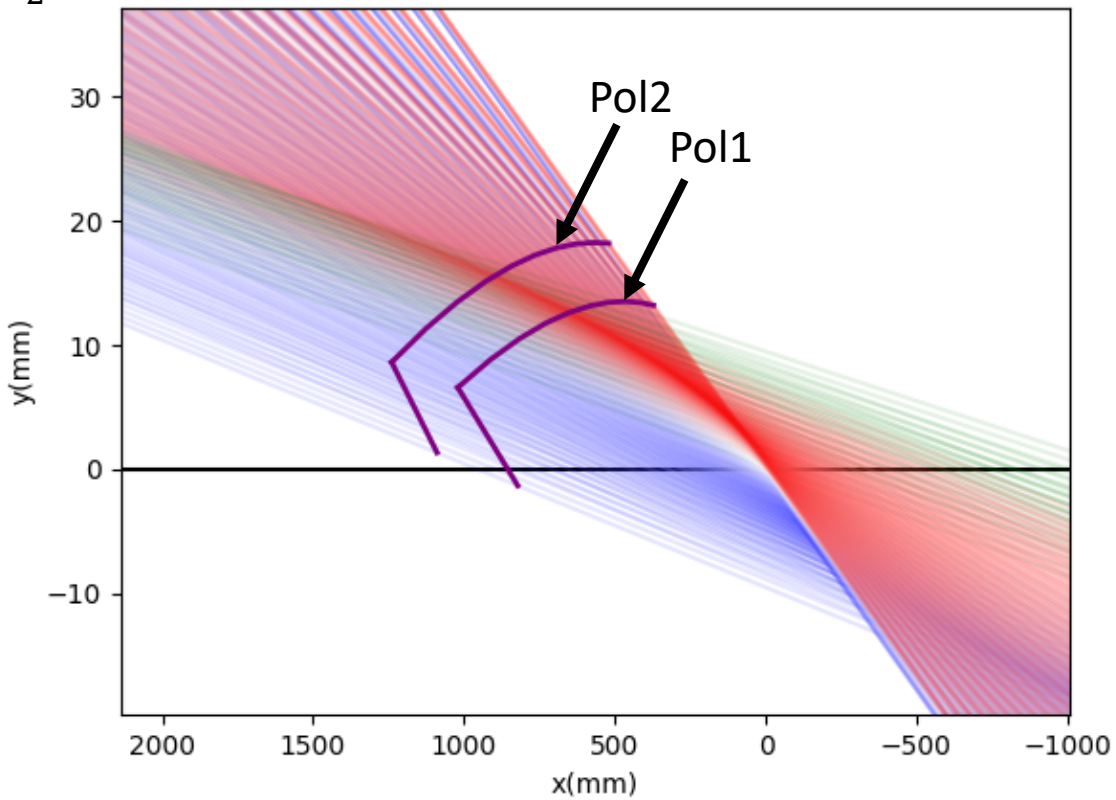
$$\left.\begin{aligned}t_{Pol1} &= 2.28\ deg\\ t_{Pol2} &= 2.28\ deg\end{aligned}\right\}\ \text{linear}$$

2 Polarizers – different γ, V-shape

The distance between Pol1 and Pol2 was set as to have $x_2 < 1300\ mm$



- Virtual Source (VS) = 5 mm
- The sizes of the polarizers were calculated as to cover the entire beam.

$\gamma_{Pol1} = 1.65\ deg$
$\gamma_{Pol2} = 1.85\ deg$ } spiral

$t_{Pol1} = 2.28\ deg$
$t_{Pol2} = 2.57\ deg$ } linear

Pol 1:

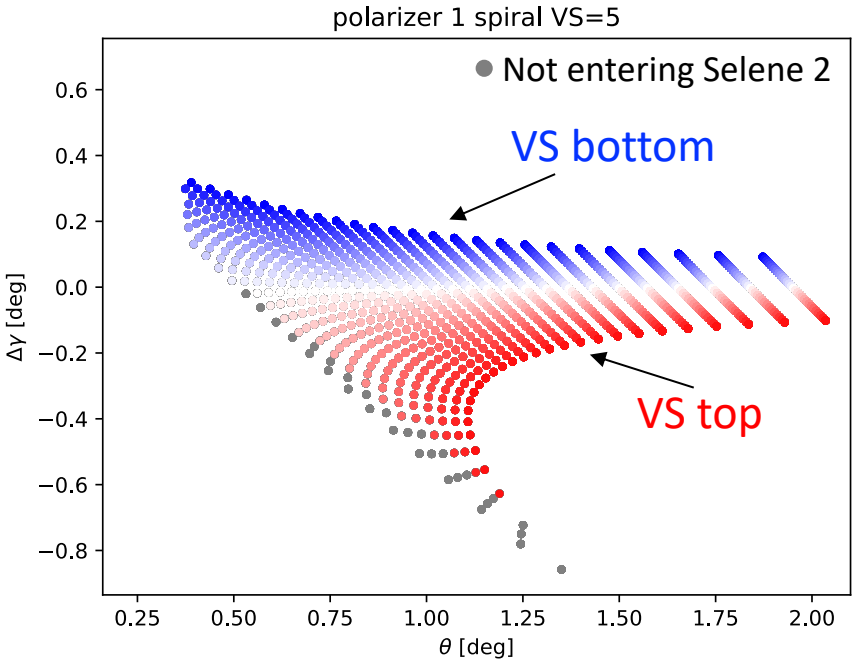
$x_{spiral} = 372 - 1020\ mm;\ y_1 = 13.2\ mm$
$x_{linear} = 1020 - 822\ mm;\ y_2 = -1.3\ mm$

Pol 2:

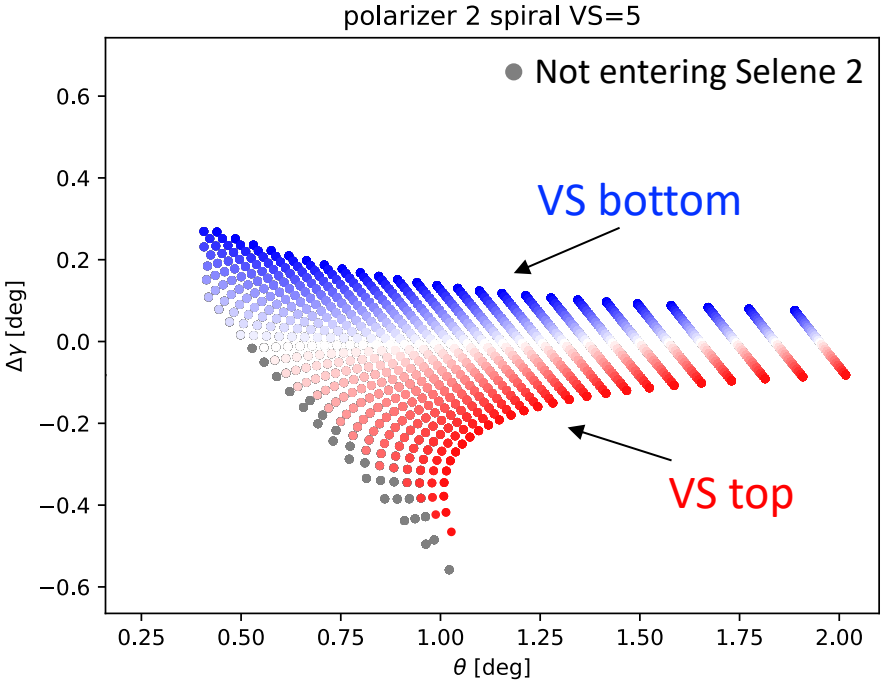
$x_1 = 520 - 1240\ mm;\ y_1 = 18\ mm$
$x_2 = 1240 - 1046\ mm;\ y_2 = 1.4\ mm$

2 Polarizers – different γ, V-shape

$\Delta\gamma$ is the deviation of the actual angle of incidence of the different rays from the theorical γ used for the shape of the spiral segment of the polarizers



$$\Delta\gamma + \gamma < \gamma_{max} \approx 1.9\ deg$$



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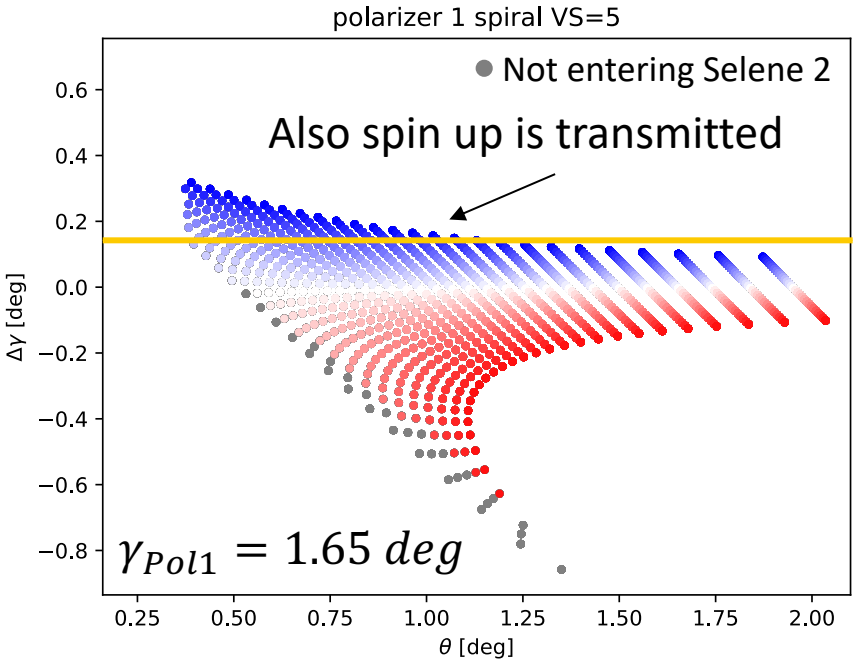

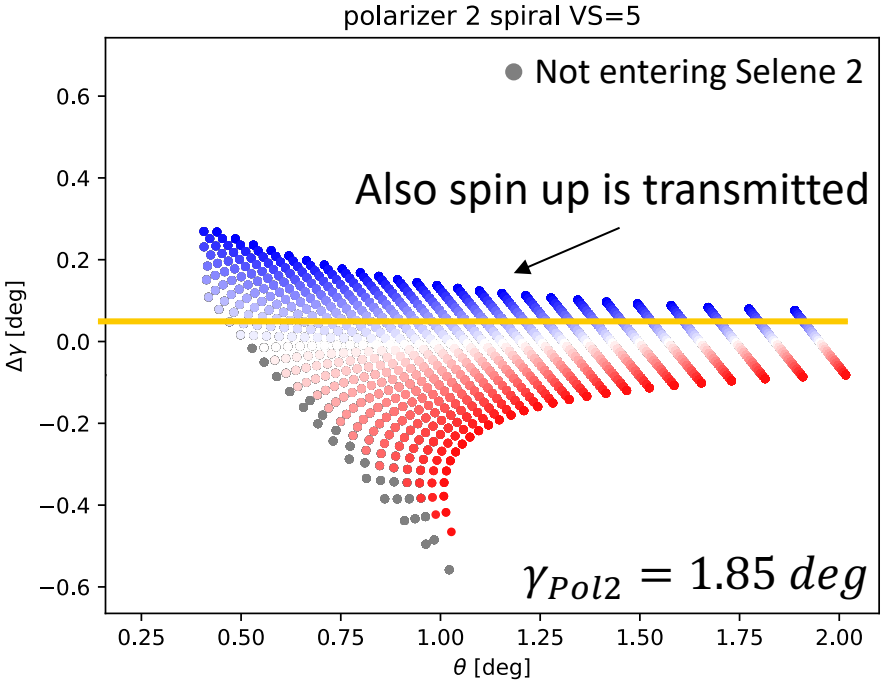

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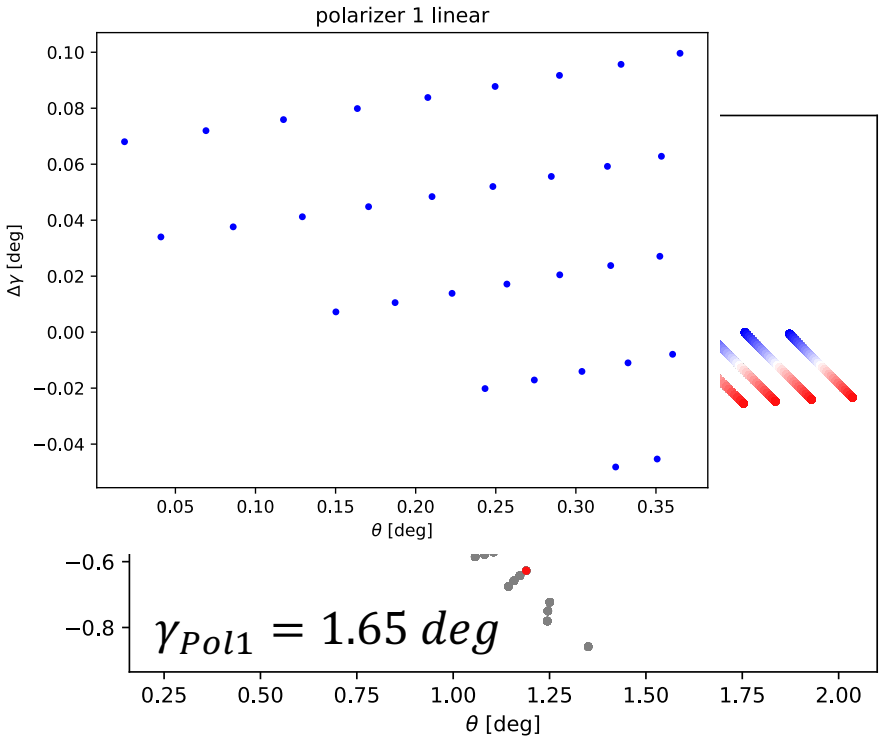
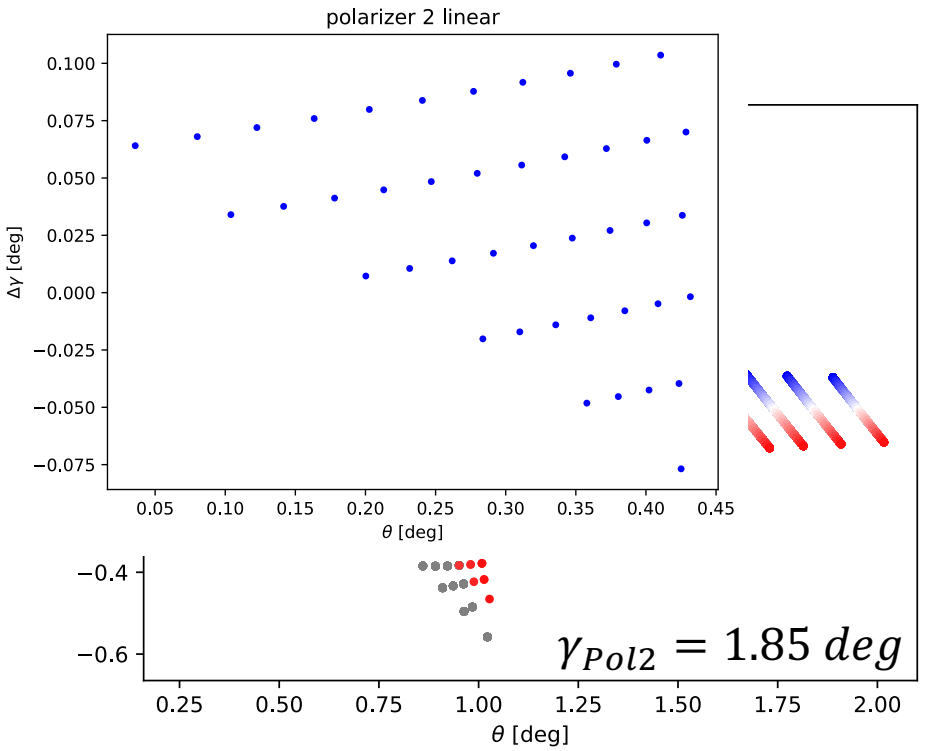
2 Polarizers – different γ, V-shape

$\Delta\gamma$ for the linear part is given by the difference between the angle of incidence and $\gamma = \gamma_{Pol1}$ or γ_{Pol2} which was used to define the inclination of the linear segments





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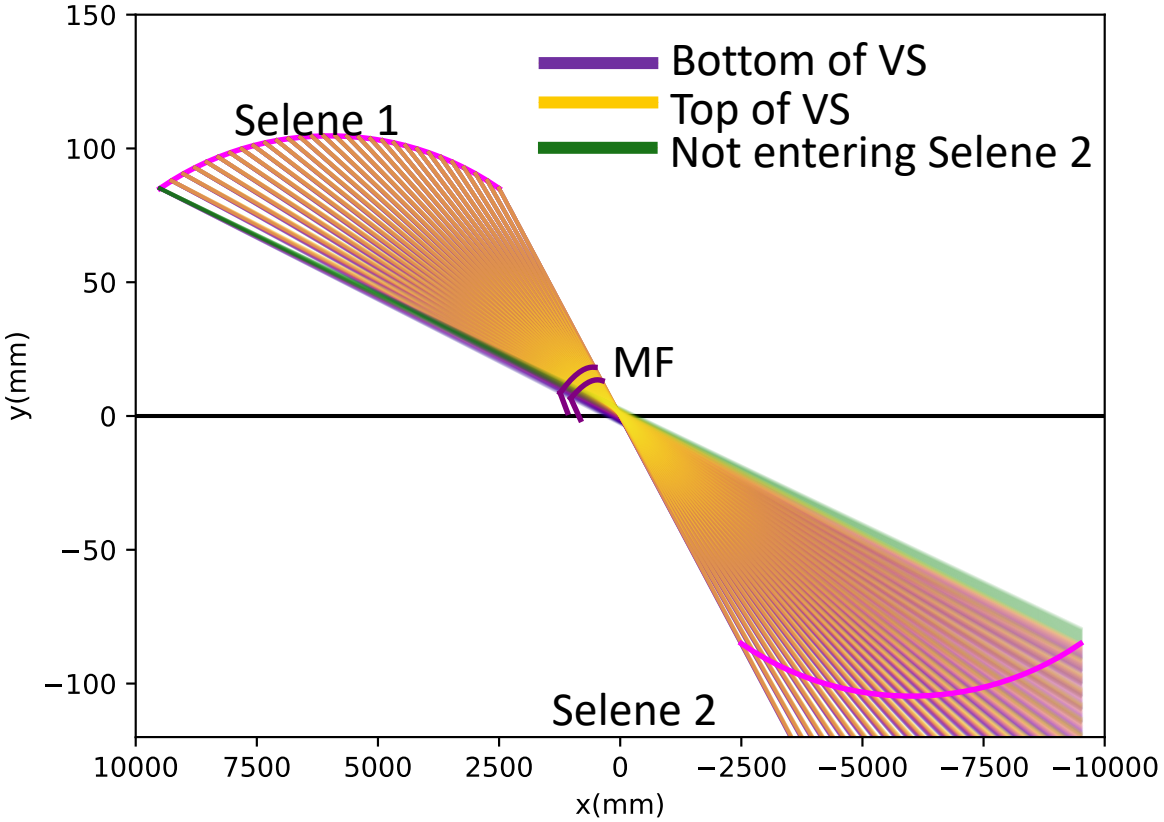

- Virtual Source (VS) = **1.5** mm
- The simulated rays are equally distributed along VS
- Only the spiral section of the polarizers is covered by the neutron beam

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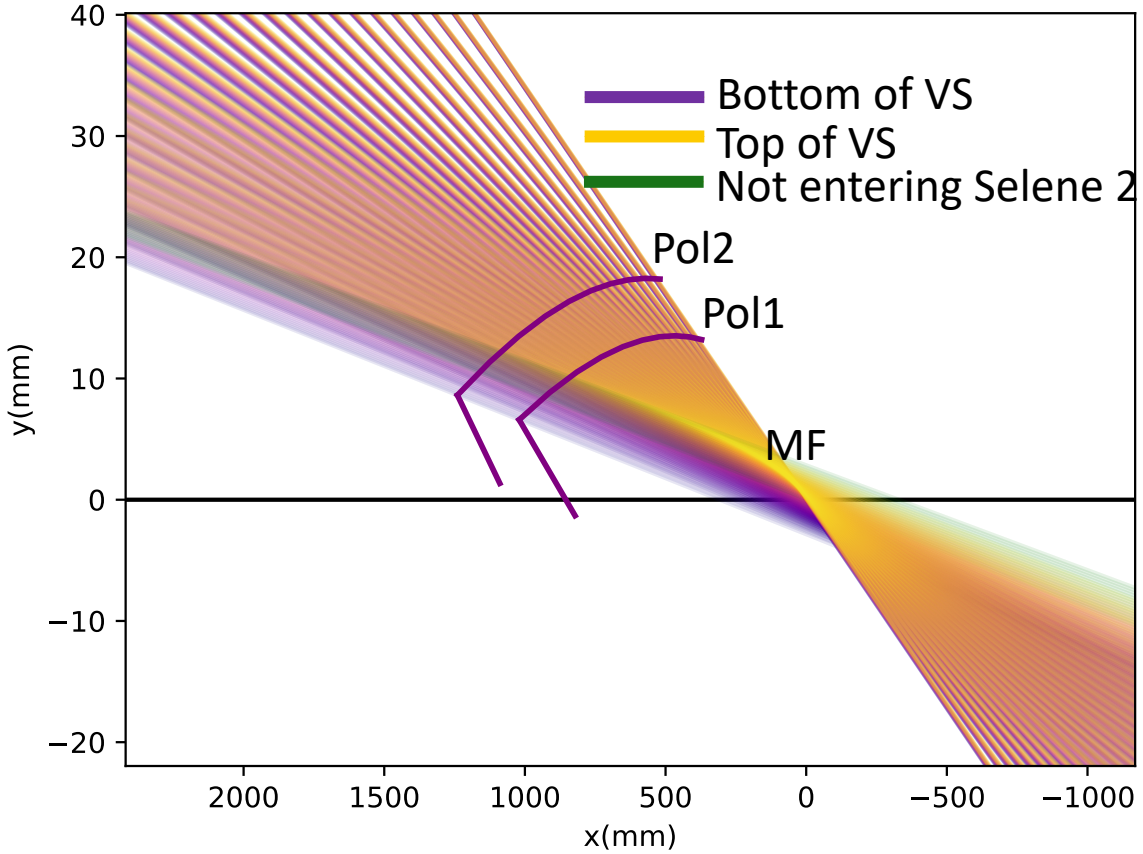

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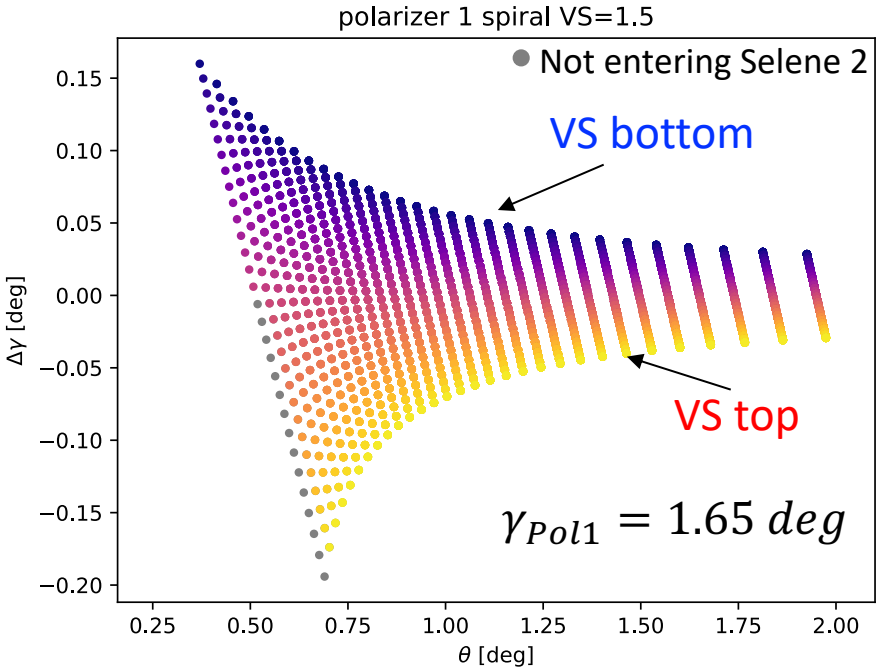
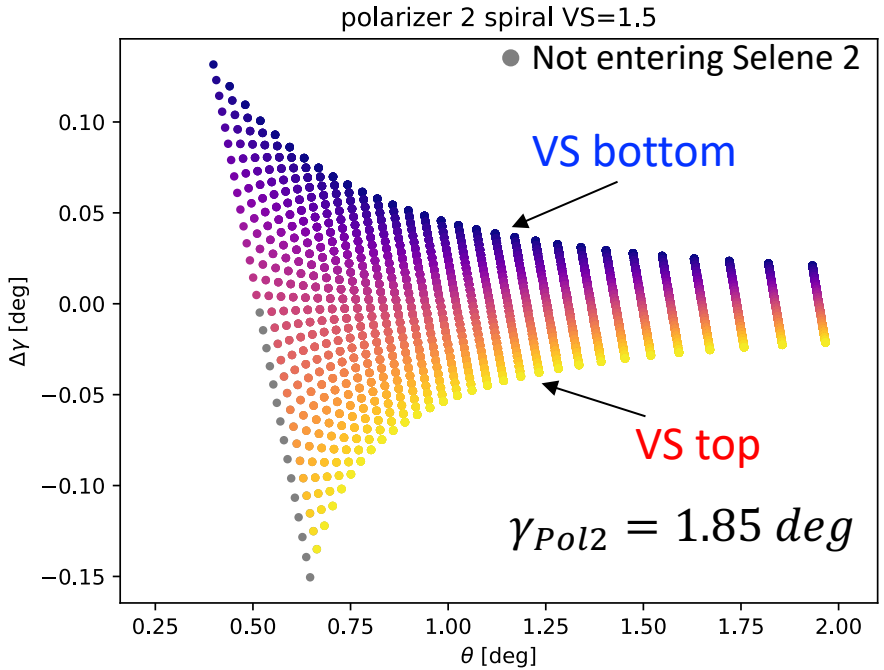


$$\Delta\gamma + \gamma < \gamma_{max} \approx 1.9\ deg$$



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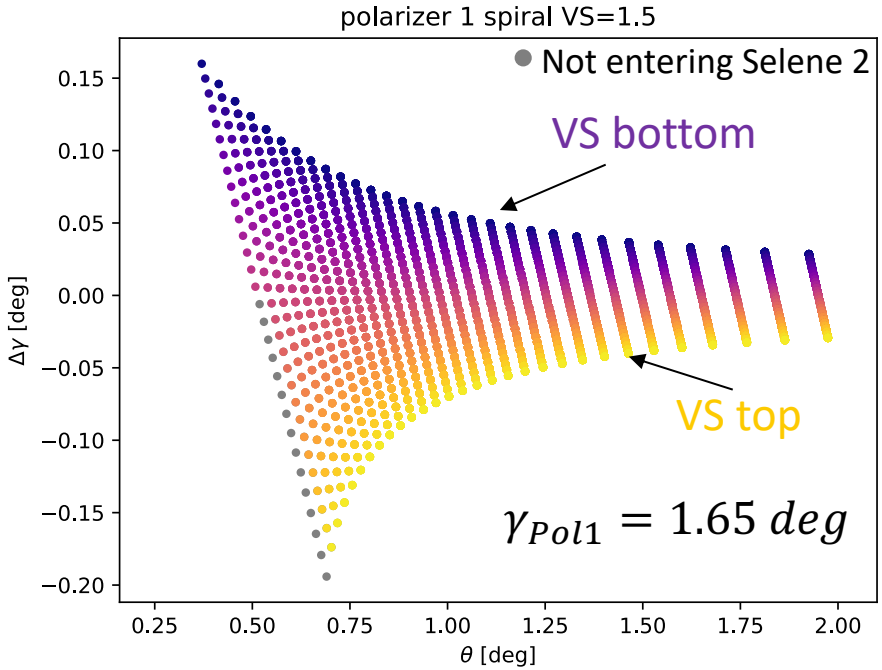

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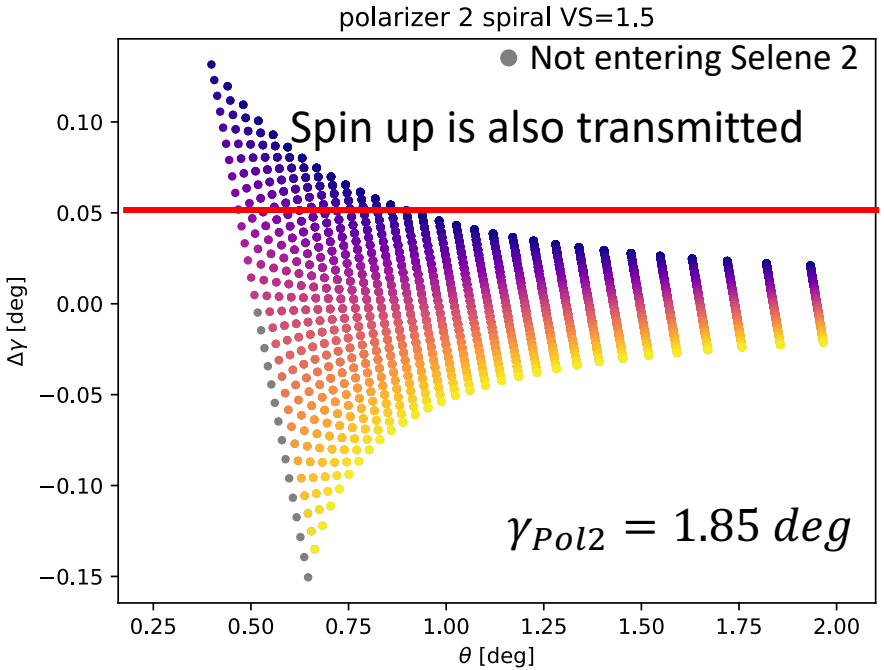

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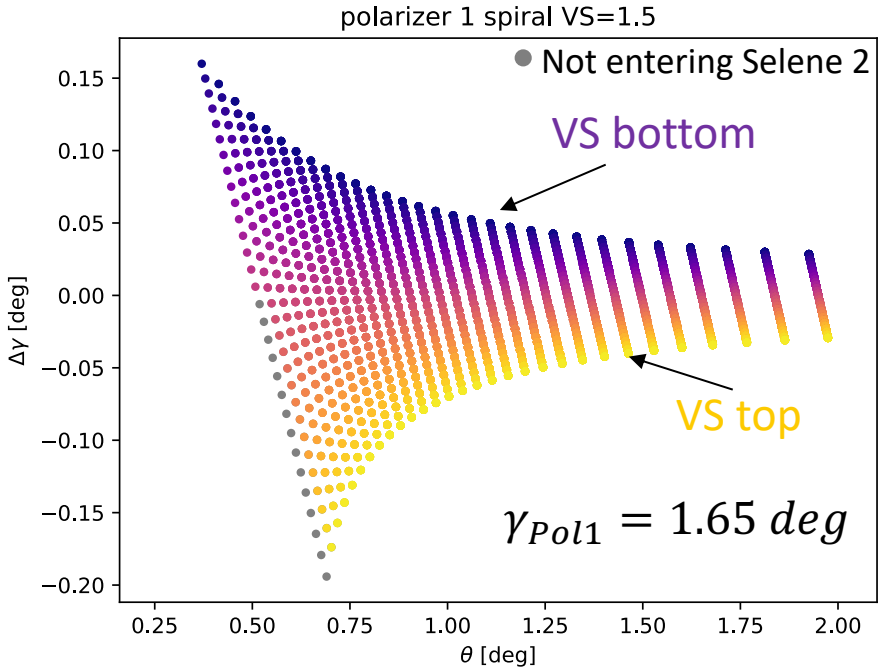

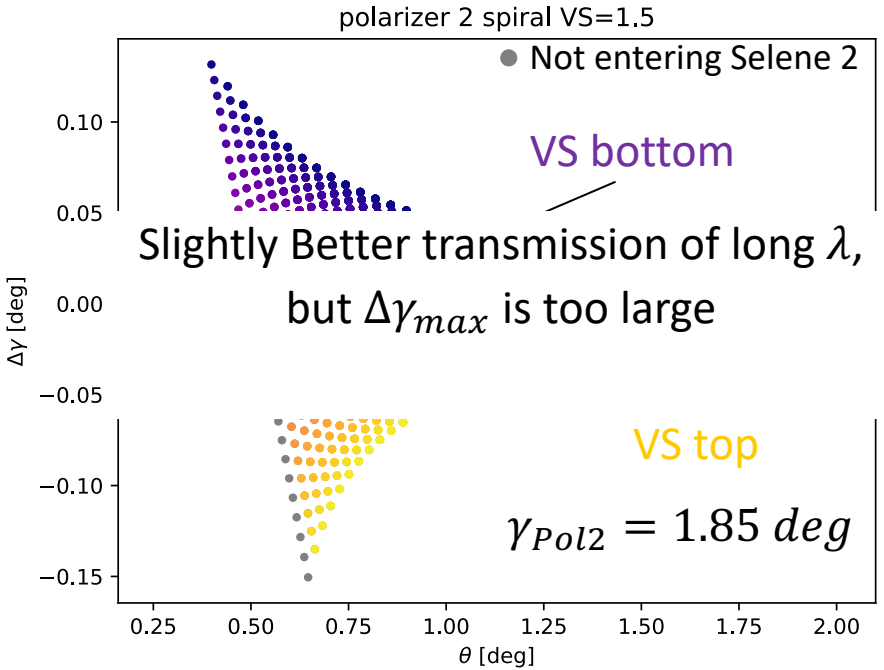

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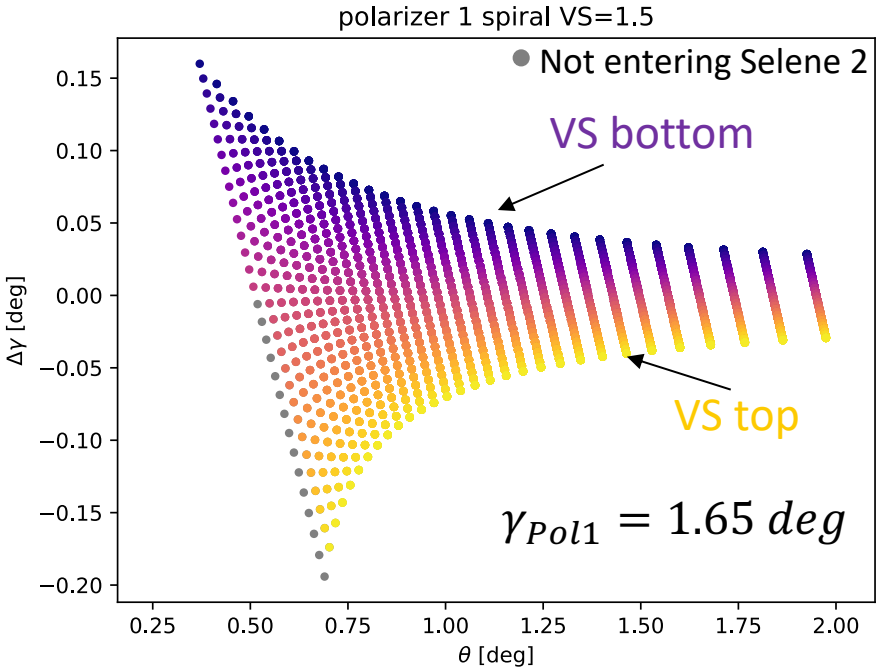

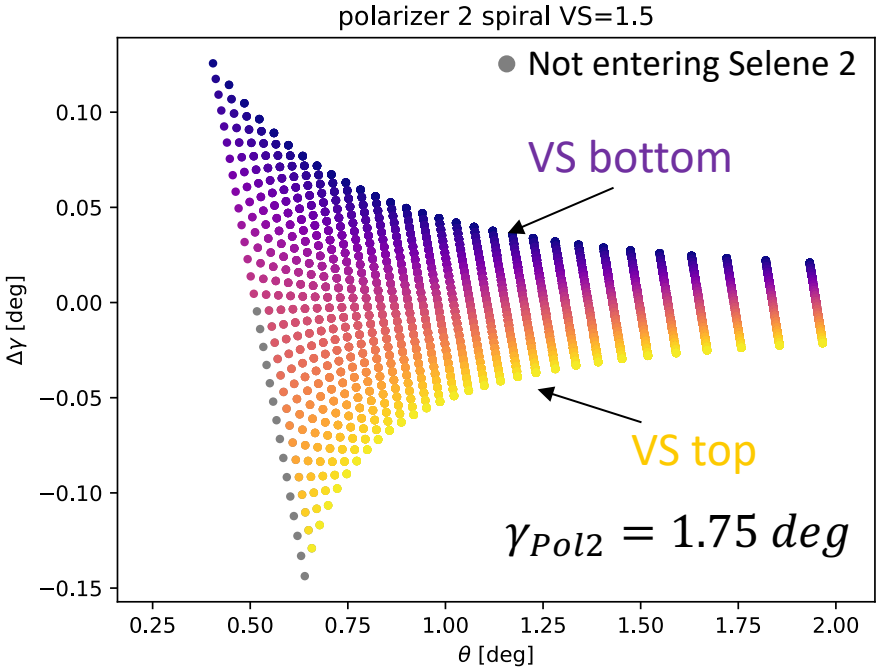

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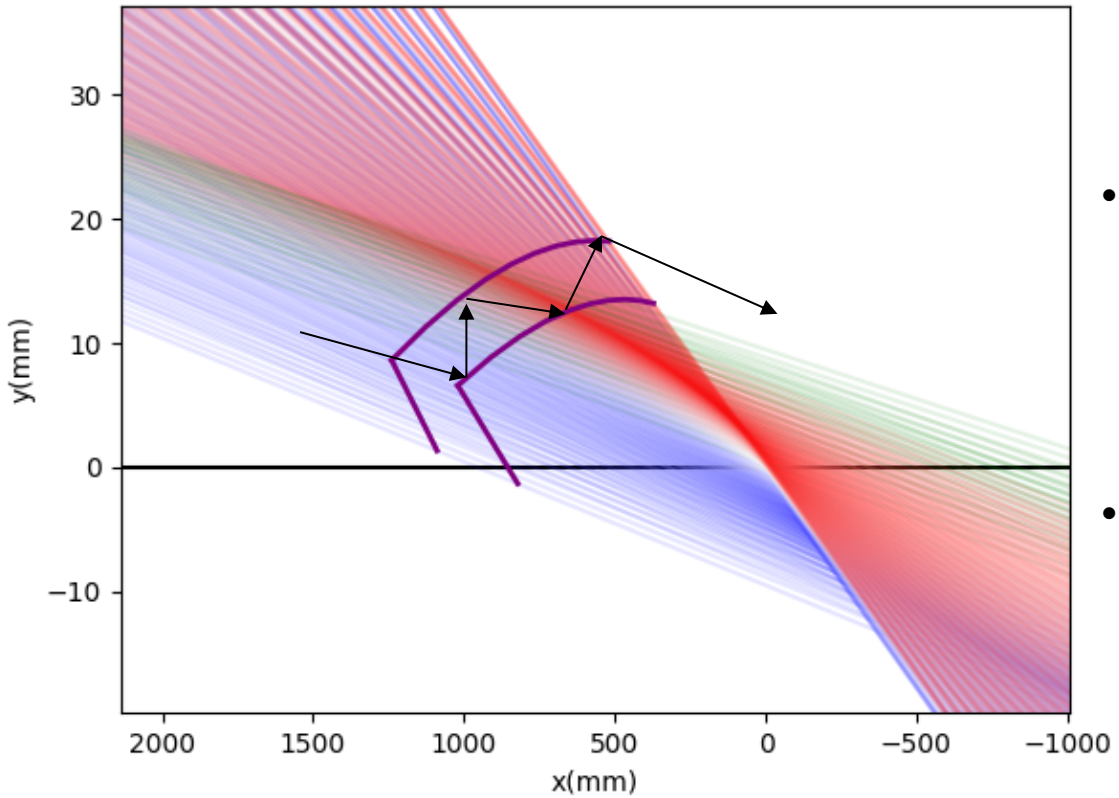
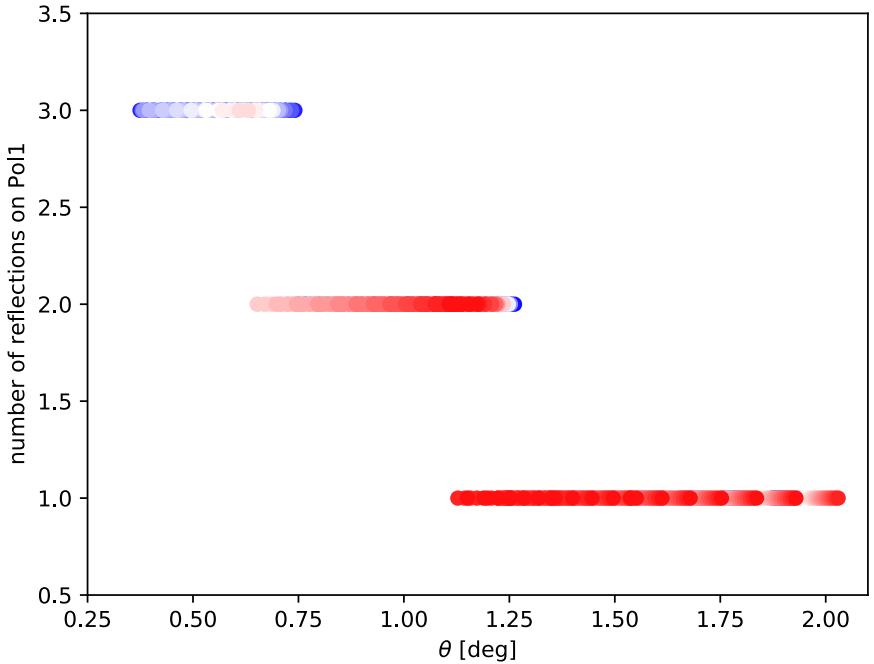
2 Polarizers – different γ, V-shape



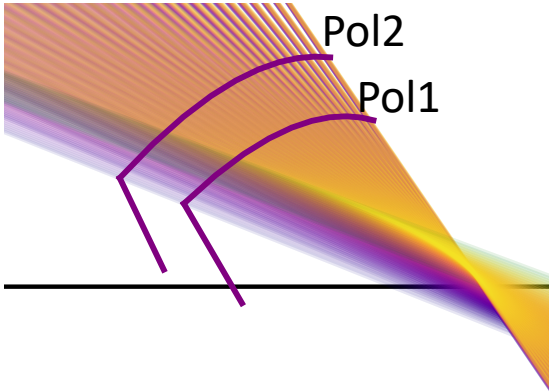
- Since the polarizers are coated on both sides multiple reflections can occur
- Each time that the neutrons encounter Pol1 there is a little probability that neutrons with spin up are transmitted as well
- Multiple reflections can affect the overall beam polarization

2 Polarizers – different γ, V-shape



- Multiple reflections occur only on the spiral segment of Pol1
- No multiple reflections in the linear segment
- The same number of multiple reflections occurs both in the case of VS=5 mm and VS=1.5 mm

Conclusions on polarizers design



- 2 polarizers with V-shape and slighlty different γ are a good option for placing both Pol1 and Pol2 before MF
- This shape of the polarizers allows to obtain acceptable $\Delta\gamma$ for VS=1.5 mm. The estimated $\Delta\gamma_{max} \approx 0.15$ deg (in case of $\gamma_{Pol1} = 1.65$ and $\gamma_{Pol2} = 1.75$) leaves an approx 0.05 deg tollerance for Pol1 and Pol2 is placed with respect to the beam.
- A similar solutions was adopted for the polarizers at AMOR, which are soon to be tested.

Outline

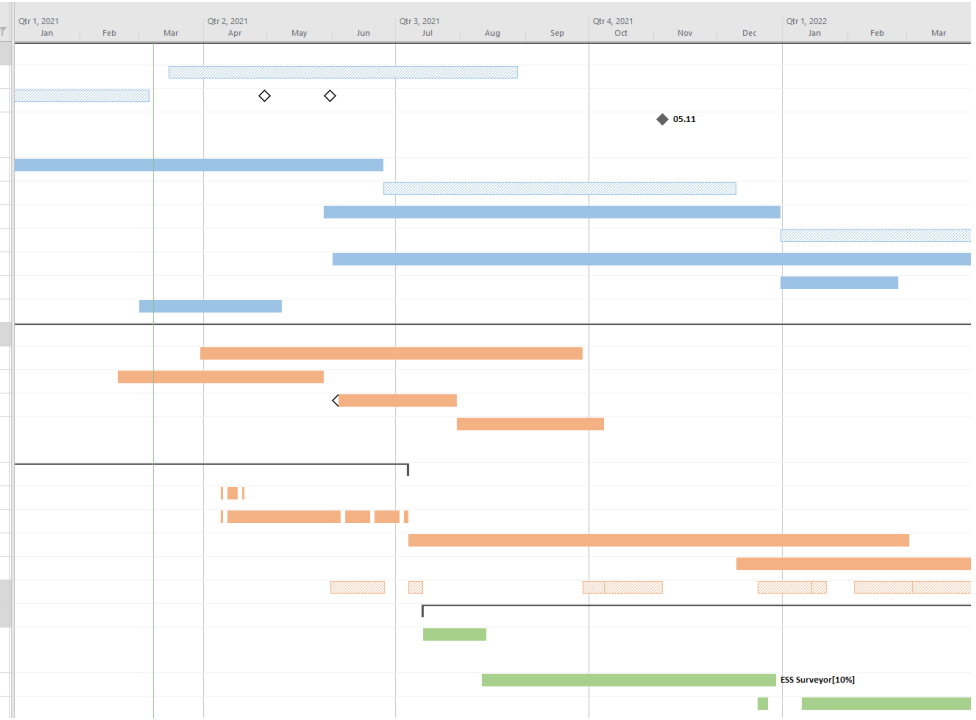
- General update on project status and progress
- Design of Middle Focus: new concept for the polarizers
- **Upcoming tasks**

Upcoming tasks - Schedule Report

Task End > 31.12.2020

Task Start < 01.08.2022

	Phas Statu	Sub Syste	Task Name	Start	Finish
166			**Design & Procurement**	**Tue 01.08.17**	**Fri 30.09.22**
181	PRO	BF	Bunkerwall Feedthrough	Mon 15.03.21	Fri 27.08.21
184	**PRO**	**SG1**	**Selene Guide 1**	**Wed 10.07.19**	**Mon 31.05.21**
192	PRO	SG2	Selene Guide - Deadline for Rework of out of Spec-Segments	Fri 05.11.21	Fri 05.11.21
193	**DES**	**MF**	**Middle Focus**	**Fri 13.11.20**	**Thu 24.06.21**
199	**PRO**	**MF**	**Middle Focus**	**Fri 25.06.21**	**Thu 09.12.21**
202	**DES**	**SSD/**	**Sample Stage and Detector Arm**	**Fri 28.05.21**	**Thu 30.12.21**
206	PRO	SSD/	Sample Stage and Detector Arm	Fri 31.12.21	Thu 28.07.22
207	DES	SEE	Sample Environment (maybe Alex Bollhalder)	Tue 01.06.21	Mon 16.05.22
208	DES		Final TG3 - Documentation	Fri 31.12.21	Thu 24.02.22
218	DES	STRU	InBunker Infrastructure	Mon 01.03.21	Fri 07.05.21
231			**Installation at PSI**	**Mon 20.04.20**	**Thu 12.01.23**
232	**IPSI**	**IBF**	**In-Bunker Feeder**	**Tue 30.03.21**	**Mon 27.09.21**
235	**IPSI**	**CP**	**Chopper Pit Virtual Source**	**Fri 19.02.21**	**Thu 27.05.21**
238	**IPSI**	**CP**	**Chopper Pit Main Body**	**Thu 03.06.21**	**Thu 29.07.21**
244	IPSI	CP	Chopper Pit - Mechanics and Software Commissioning and PSI Systems-Acceptance	Fri 30.07.21	Thu 07.10.21
245	**IPSI**	**SG1**	**Selene Guide 1**	**Mon 20.04.20**	**Tue 06.07.21**
294	**IPSI**		**Vakuumtest Kammer und Carrier**	**Fri 09.04.21**	**Mon 19.04.21**
298	**IPSI**	**SG1**	**Ib. Carrier**	**Fri 09.04.21**	**Tue 06.07.21**
318	**IPSI**	**SG2**	**Selene Guide 2**	**Wed 07.07.21**	**Tue 01.03.22**
326	**IPSI**	**MF**	**Middle Focus**	**Fri 10.12.21**	**Thu 14.04.22**
331	**TPR**		**Transportation to D01/D02**	**Mon 31.05.21**	**Thu 09.02.23**
345			**Installation at ESS**	**Wed 14.07.21**	**Thu 06.04.23**
346	IESS	SG1	Selene Guide 1: placement prior to D02 access	Wed 14.07.21	Thu 12.08.21
354	IESS	SG1	Selene Guide 1: initial setteling time	Wed 11.08.21	Tue 28.12.21
371			D01 Installations	Mon 20.12.21	Thu 06.04.23



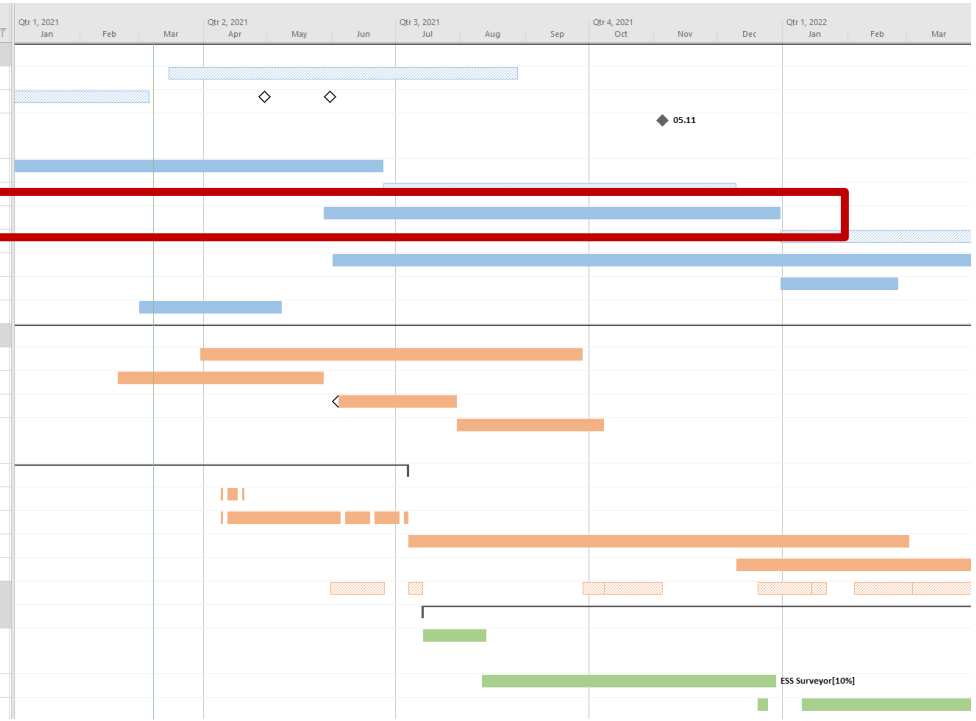
TG5 → 08.2023

Upcoming tasks - Schedule Report

Task End > 31.12.2020

Task Start < 01.08.2022

	Phas Statu	Sub Syste	Task Name	Start	Finish
166			**Design & Procurement**	**Tue 01.08.17**	**Fri 30.09.22**
181	PRO	BF	Bunkerwall Feedthrough	Mon 15.03.21	Fri 27.08.21
184	**PRO**	**SG1**	**Selene Guide 1**	**Wed 10.07.19**	**Mon 31.05.21**
192	PRO	SG2	Selene Guide - Deadline for Rework of out of Spec-Segments	Fri 05.11.21	Fri 05.11.21
193	DES	MF	**Middle Focus**	**Fri 13.11.20**	**Thu 24.06.21**
199	PRO	MF	**Middle Focus**		
202	DES	SSD/	**Sample Stage and Detector Arm**	**Fri 28.05.21**	**Thu 30.12.21**
206	PRO	SSD/	Sample Stage and Detector Arm		
207	DES	SEE	Sample Environment (maybe Alex Bollhalder)	Tue 01.06.21	Mon 16.05.22
208	DES		Final TG3 - Documentation	Fri 31.12.21	Thu 24.02.22
218	DES	STRU	InBunker Infrastructure	Mon 01.03.21	Fri 07.05.21
231			**Installation at PSI**	**Mon 20.04.20**	**Thu 12.01.23**
232	**IPSI**	**IBF**	**In-Bunker Feeder**	**Tue 30.03.21**	**Mon 27.09.21**
235	**IPSI**	**CP**	**Chopper Pit Virtual Source**	**Fri 19.02.21**	**Thu 27.05.21**
238	**IPSI**	**CP**	**Chopper Pit Main Body**	**Thu 03.06.21**	**Thu 29.07.21**
244	IPSI	CP	Chopper Pit - Mechanics and Software Commissioning and PSI Systems-Acceptance	Fri 30.07.21	Thu 07.10.21
245	**IPSI**	**SG1**	**Selene Guide 1**	**Mon 20.04.20**	**Tue 06.07.21**
294	**IPSI**		**Vakuumtest Kammer und Carrier**	**Fri 09.04.21**	**Mon 19.04.21**
298	**IPSI**	**SG1**	**Ib. Carrier**	**Fri 09.04.21**	**Tue 06.07.21**
318	**IPSI**	**SG2**	**Selene Guide 2**	**Wed 07.07.21**	**Tue 01.03.22**
326	**IPSI**	**MF**	**Middle Focus**	**Fri 10.12.21**	**Thu 14.04.22**
331	**TPR**		**Transportation to D01/D02**	**Mon 31.05.21**	**Thu 09.02.23**
345			**Installation at ESS**	**Wed 14.07.21**	**Thu 06.04.23**
346	IESS	SG1	**Selene Guide 1: placement prior to D02 access**	Wed 14.07.21	Thu 12.08.21
354	IESS	SG1	Selene Guide 1: initial setteling time	Wed 11.08.21	Tue 28.12.21
371			**D01 Installations**	Mon 20.12.21	Thu 06.04.23



TG5 → 08.2023

Upcoming tasks – Sample environment

	Delivery date
1) Solid Liquid Cells + Changer (including different sizes and adaptations, pumps, valves)	**ESTIA HC**
2) Warm Bore Cryomagnet 2.5T	**ESTIA HC**
3) Sample changer for solid/air	**ESTIA HC**
4) Small Flow Cryostat + temperature controller	**ESTIA HC**
5) High temperature option adaptation for Small Flow Cryostat	ESTIA FS
6) Duplicates of small flow cryostats	ESTIA FS
7) copies of the solid/liquid cells (small cells/ low Bkg cells)	ESTIA FS
8) High field magnet >5 T, preferably with sapphire windows	ESTIA FS
9) High Voltage electrodes and power supply for samples within small flow cryostat	ESTIA SOUP

Upcoming tasks – Prototypes of solid/liquid cells

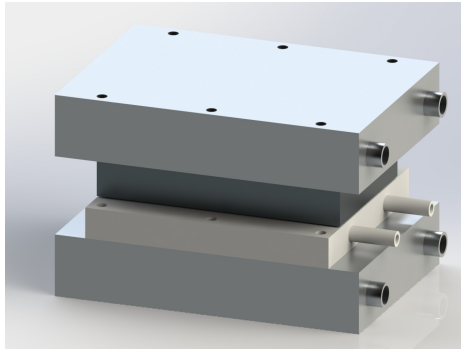
- SrESS3 project in collaboration with Adrian Rennie at Uppsala University for the design and production of prototypes of solid/liquid cells for ESTIA and FREIA

- Main goals: reduce background and improve solvent exchange

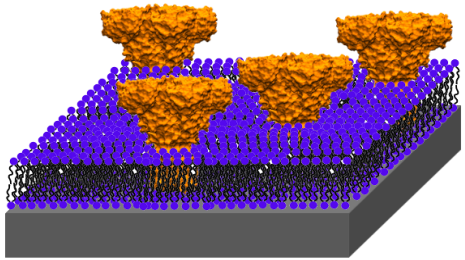
- Specifically for ESTIA:
  - design of small cell (2 x 2 cm substrate) to reduce sample amount
  - Impact of divergent beam on background (to be tested)

Not enough budget for adaquate supplies on ESTIA and FREIA!

Standard solid/liquid cell



Improving NR accessibility to biological samples



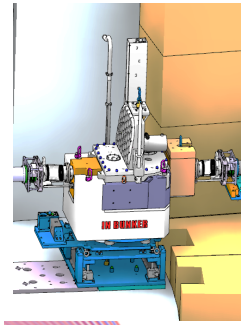
Conclusion

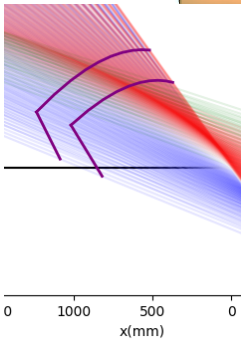
General update:

- **In-bunker Feeder**, **Chopper Pit & Virtual Source** manufacture almost completed and some components are soon to be tested at PSI
- **Selene 1 carrier** needs further processing. Installation at PSI will resume at end of April.
- **Middle Focus** design including the new concept for the polarizers is almost completed
- **Experimental Cave** design is completed. Scope transfer to ESS for the procurement
- **Detector** budget change request. The design of the detector vessel and detector arm can start in May

Upcoming tasks:

- Design of **sample stage** and procurement/design **sample environment** items
- Design of **detector arm** and **detector vessel**



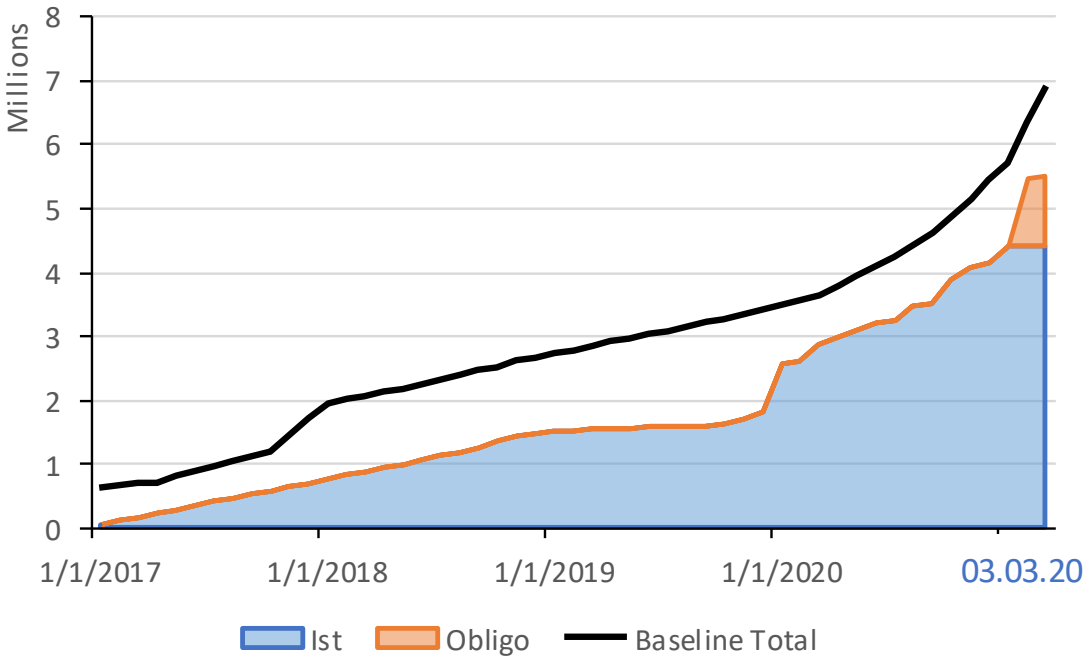


PAUL SCHERRER INSTITUT

Wir schaffen Wissen – heute für morgen

Thank you!

ESTIA – Financial Report



Budget	CHF 15.527 Mio
Ausgaben	CHF 4.426 Mio
Verpflichtet	CHF 6.345 Mio
Verpflichtet in %	40.865