T-REX
Instrument Project

75%

Nicolò Violini, Lead Scientist

Marcel Serwe, Lead Engineer
Mario Koenen, Project Engineer
Teddy Kozielewski, Project Engineer

25%

Andrea Orecchini,
CNR Work-package scientific responsible

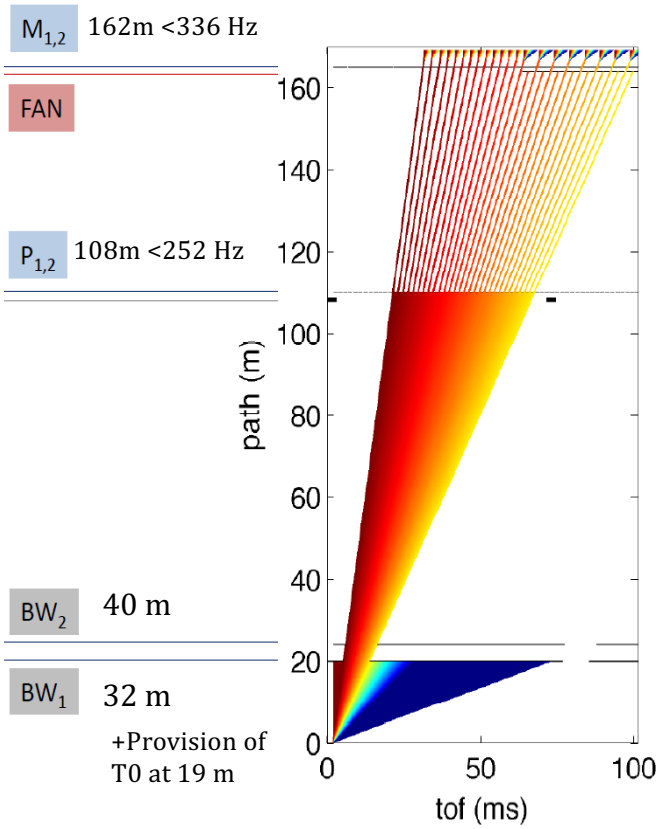
STAP meeting – T-REX, 3rd – 4th May 2022

Outline

- Project status overview
- Design Highlights
- Delays
- Challenges
- Risks

T-REX unique with 5D mapping

Polychromatic experiments



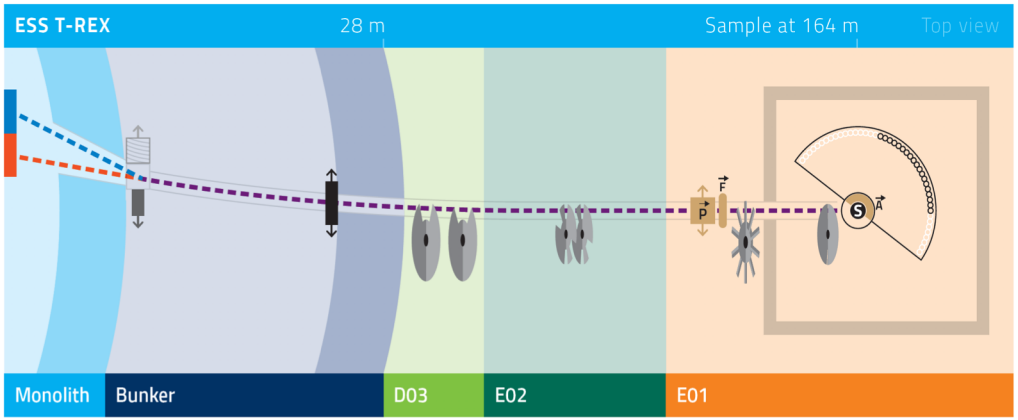
2 meV < Ei < 160 meV
@ 2MW ESS:
(3x 4-SEASONS, 6xIN5) x n.of useful RRM spectra

Bispectral:
- Neutron guide optimised for thermal
- Cold extraction does not compromise thermal

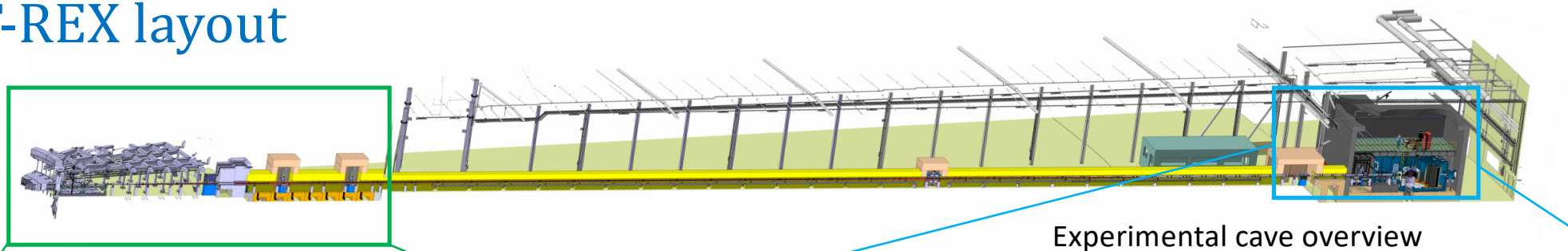
Chopper cascade:
- Flexible configuration
- Resolution → flux
- < 24 RRM pulses

XYZ Polarisation Analysis

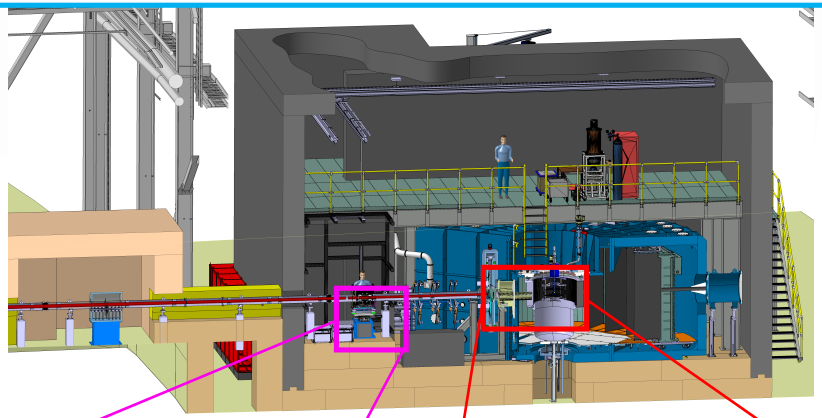
40 % detector coverage day-1



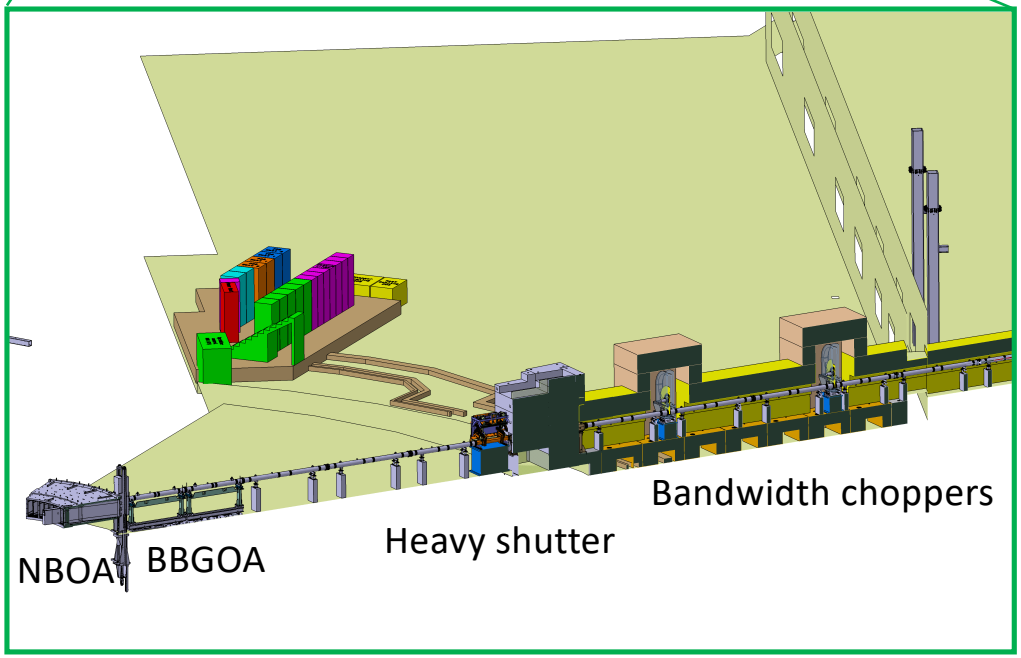
T-REX layout



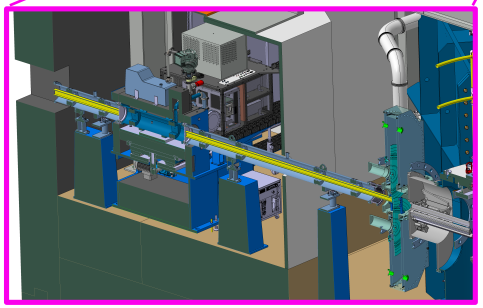
Experimental cave overview



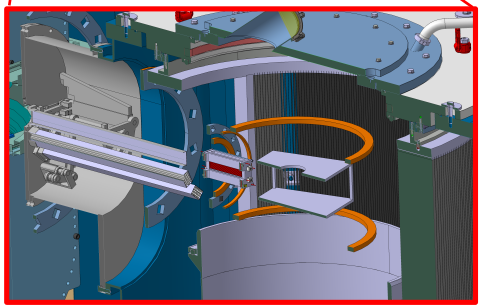
In-bunker + D03 building



polarizers



Primary collimator



Critical path/MS of T-REX project

TGs

	TA	New expected
TG3	Apr 22	Oct 23
TG4	Dec 24	Dec 25
TG5 documentation	Apr 25	Apr 26
TG5	Jun 25	Jun 26

Project MS
FZJ
CNR

Boundary conditions:

The TGs Milestones are estimated assuming the following resources assigned/dedicated to the project for the entire duration

FZJ	**1 scientist** **2 designers** **2 project engineers (ZEA-1)** **0.4 project engineer (JCNS)**	**YES** **NO (only 1)** **NO (only 1)** **YES**
CNR	**1 scientist** **1 project engineer**	**YES** **NO**

T-REX sub-projects overview

	Partner	Design	Manufacturing	Installation
Background Chopper	CNR	tbd	tbd	tbd
NBOA	FZJ	S-DH	S-DH	ESS
Neutron guide inside bunker + BWI	FZJ	S-DH	S-DH	S-DH
BBGOA	FZJ	tender	tender	ESS
Collimators and slits	CNR	CNR	tbd	tbd
Neutron Guide Outside Bunker	FZJ	S-DH	S-DH	S-DH
Monitors	CNR	tbd	tbd	tbd
Beamline Shielding (calculations)	FZJ	n.a.	n.a.	n.a.
Beamline Shielding (actual shielding blocks)	CNR	tbd	tbd	tbd
Polarization Equipment	FZJ	FZJ	FZJ	tbd
Beam Shutter	CNR	CNR	tbd	tbd
Fast Choppers	FZJ	FZJ - ZEA	FZJ - ZEA	FZJ - ZEA
Secondary Collimator	CNR	tbd	tbd	tbd
Fan Chopper	FZJ	FZJ - JCNS	FZJ - JCNS	tbd
Experimental cave	CNR	tender	tender	tender
Detector Vessel	FZJ	FZJ – ZEA-1	tender	FZJ
Beamstop	CNR	tbd	tbd	tbd
Neutron Detector	FZJ	ESS - DG	ESS - DG	ESS-DG
Prototype Detector Box	FZJ	FZJ – ZEA-1	KRESS	tbd
Experimental Cave (infastructure)	FZJ	FZJ – ZEA-1	tender	tender
Control Hutch & Sample Preparation Area	FZJ	tender	tender	tender
Sample Environment	FZJ	tender	tender	ESS - SAD
MCA	FZJ	FZJ - JCNS	FZJ - JCNS	FZJ - JCNS
Utilities distribution	FZJ	ESS	ESS	ESS
PSS	FZJ	ESS	ESS	ESS

Project MS
FZJ
CNR

In progress:

Neutron guide

- NBOA: FAT in progress, reflectivity measurements done
- In bunker components:
  - In-bunker guide: final engineering design in progress @ S-DH
  - Shutter: design completed by CNR
  - Documentation for sTG3 in preparation
- Out-of-bunker guide: contract assigned to S-DH, kick-off on 01.04.2022
- Primary collimator: mechanical design in progress at CNR, complex interfaces

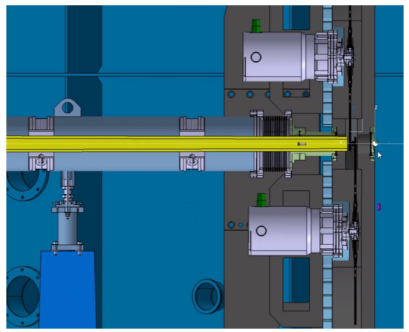
Project MS
FZJ
CNR

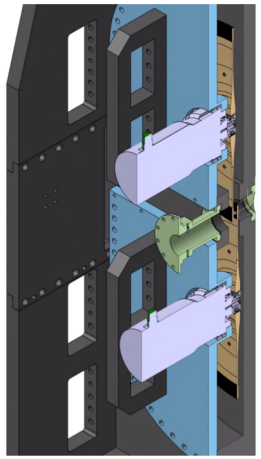
Choppers

- Fast choppers: designer to be assigned to the work-package
- FAN chopper: looking for a mechanical engineer to start the design

Polarization

- Cold neutrons polarizer ready for CTV (vendor identified)
- Thermal neutron polarizer ready for IDR
- Laser lab ready for IDR
- Guide field: field calculations in progress
- Guide exchanger unit: ready for IDR
- Adiabatic spin rotation: calculations in progress
- PASTIS unstarted





3D of the M-chopper showing the interface

In progress:

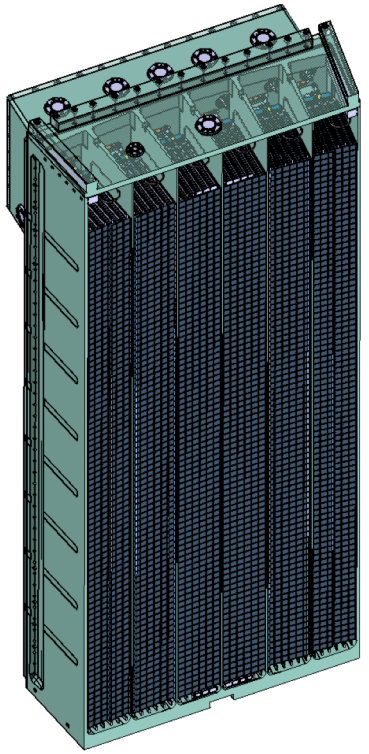
Shielding

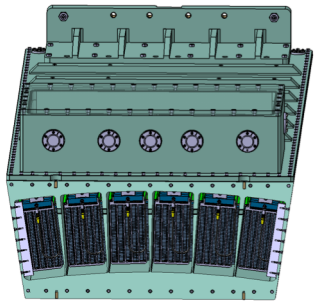
- Beamline shielding: collating offers, neutronics calculations ongoing
- Cave: design review in preparation

Detectors

- Detector vessel: procurement in progress (second tender)
  open from 01.04.2022 to 23.05.2022
- Detector box: manufacturing tender assigned to KRESS
  raw material delivered to KRESS on 21.04.2022
  (6+ m manufacturing)

Project MS
FZJ
CNR



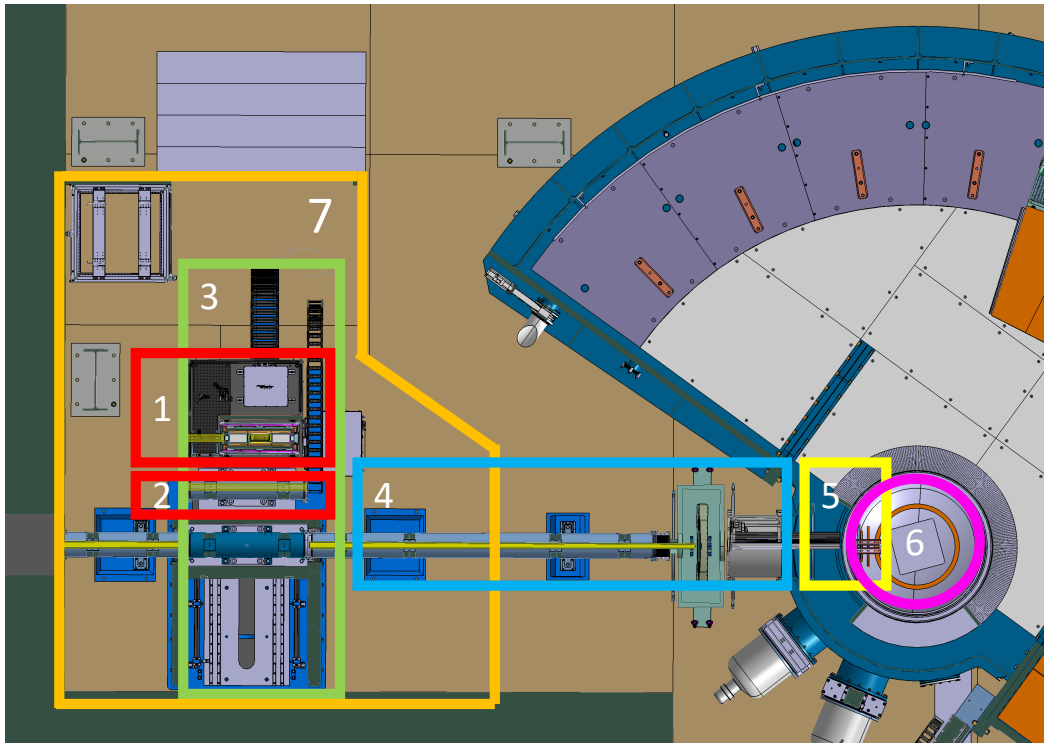


Unstarted:

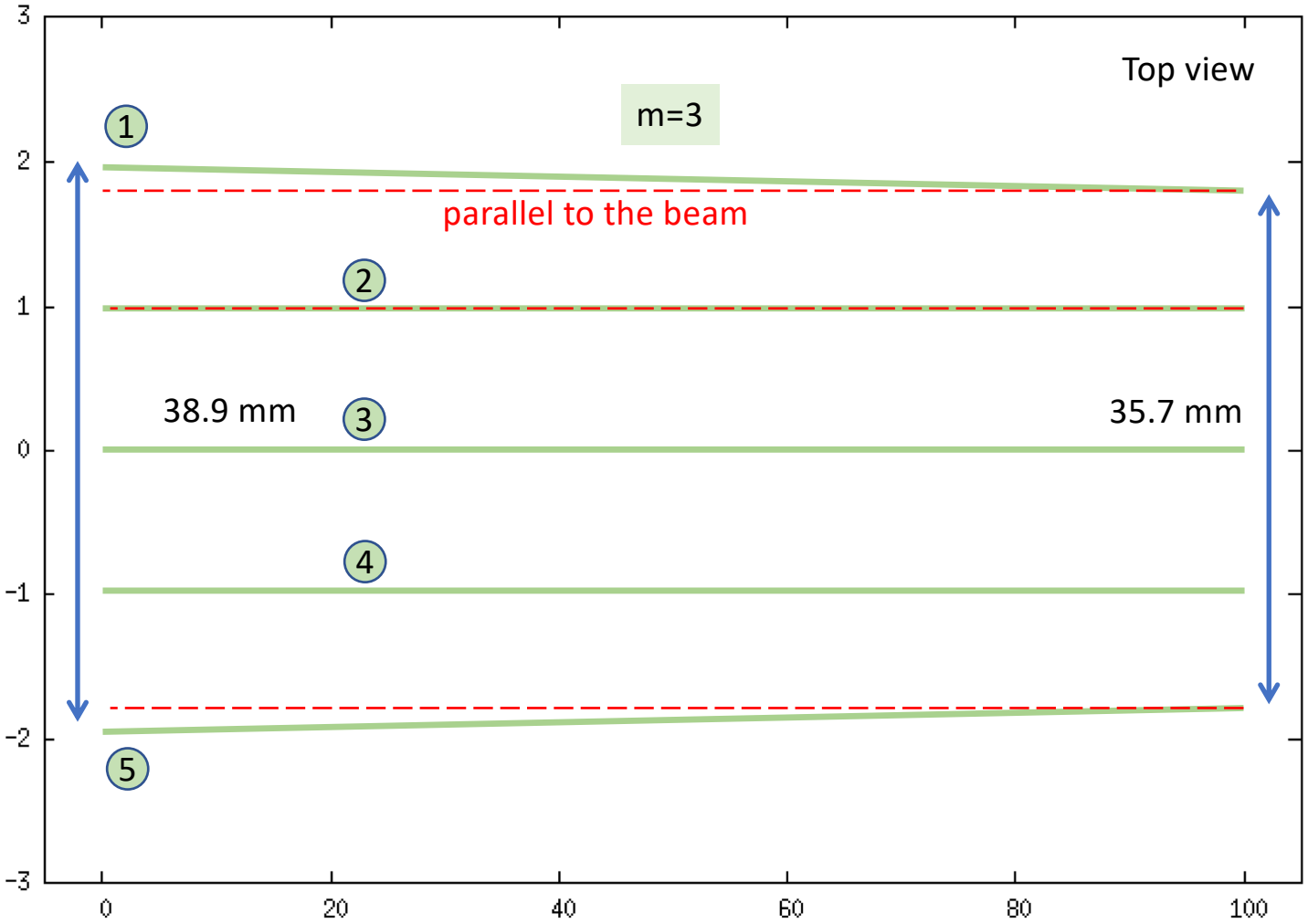
- Bandwidth choppers (common project?)
- Secondary collimator
- Sample environment
- Multi-GRID detector (?)
- Beamstop (and get-lost tube)
- Instrument hutch and sample preparation
- PSS (kick-off requested)
- Utilities

Design highlight: polarization equipment

1. Thermal polarizer
2. Cold polarizer
3. Guide exchange unit
4. Guide field (spin holding)
5. Adiabatic field (spin rotation)
6. PASTIS setup
7. Laser lab

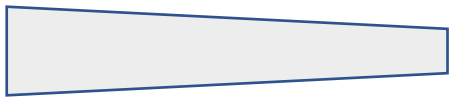


Cold neutrons polarizer simulations



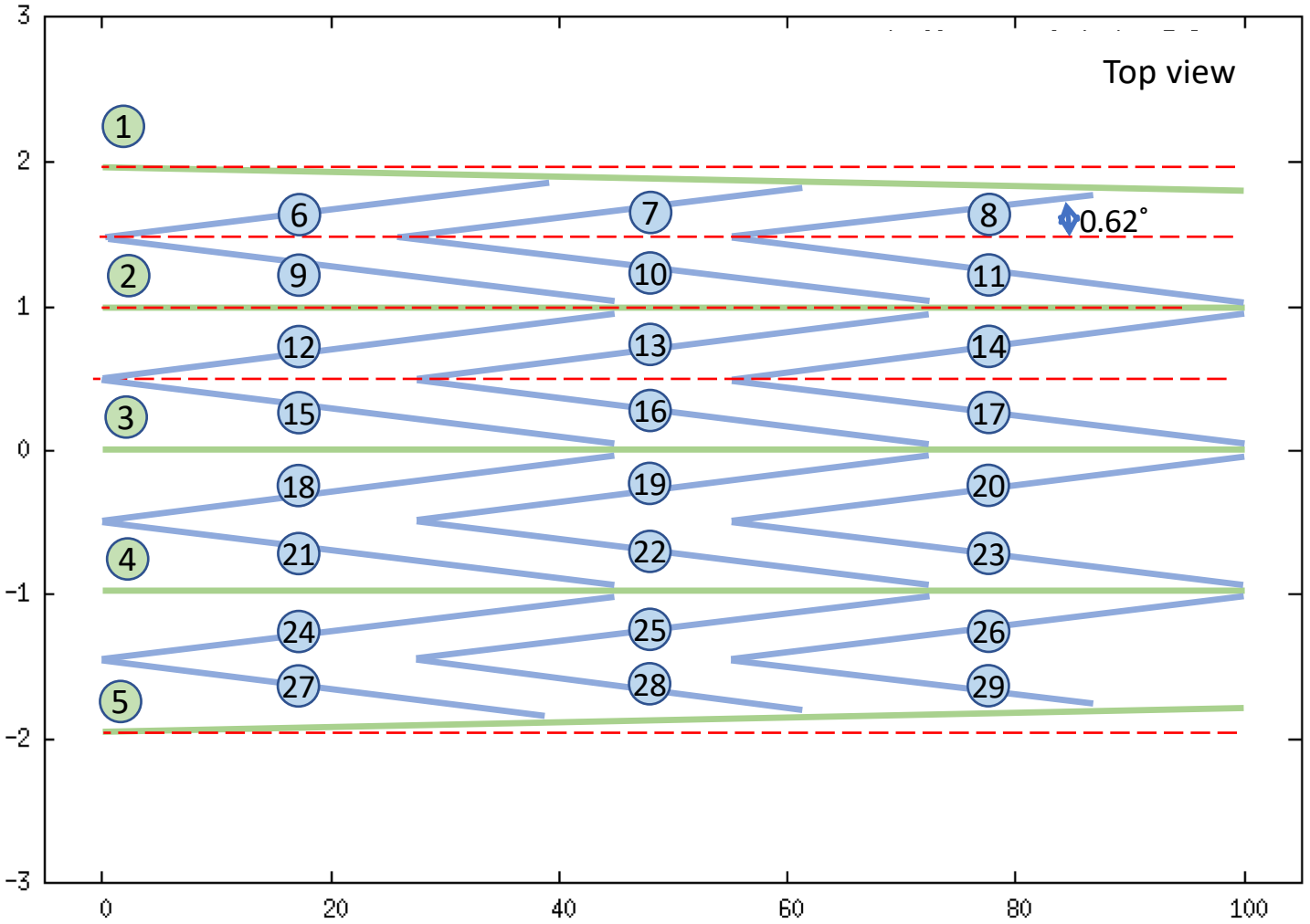
- 5 mirrors
- Mirrors lenght = 100 mm
- Borkron substrate 0.3 mm
- Fe/Si mirrors m=3
- Mirrors coated on both sides
- Mirrors 1 and 5 inclined by 0.092 deg in the horizontal plane
- Mirrors 2, 3 and 4 parallel

49.1 mm 46.1 mm



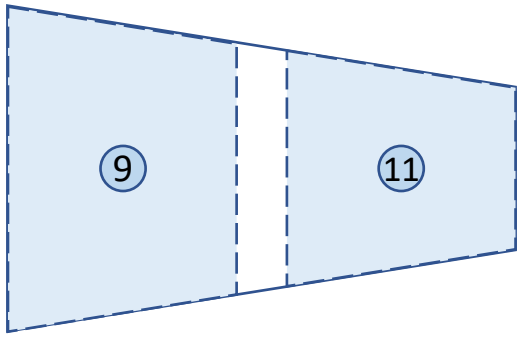
Tapered profile on the vertical plane
Tapering angle = 0.086 deg

Cold neutrons polarizer simulations



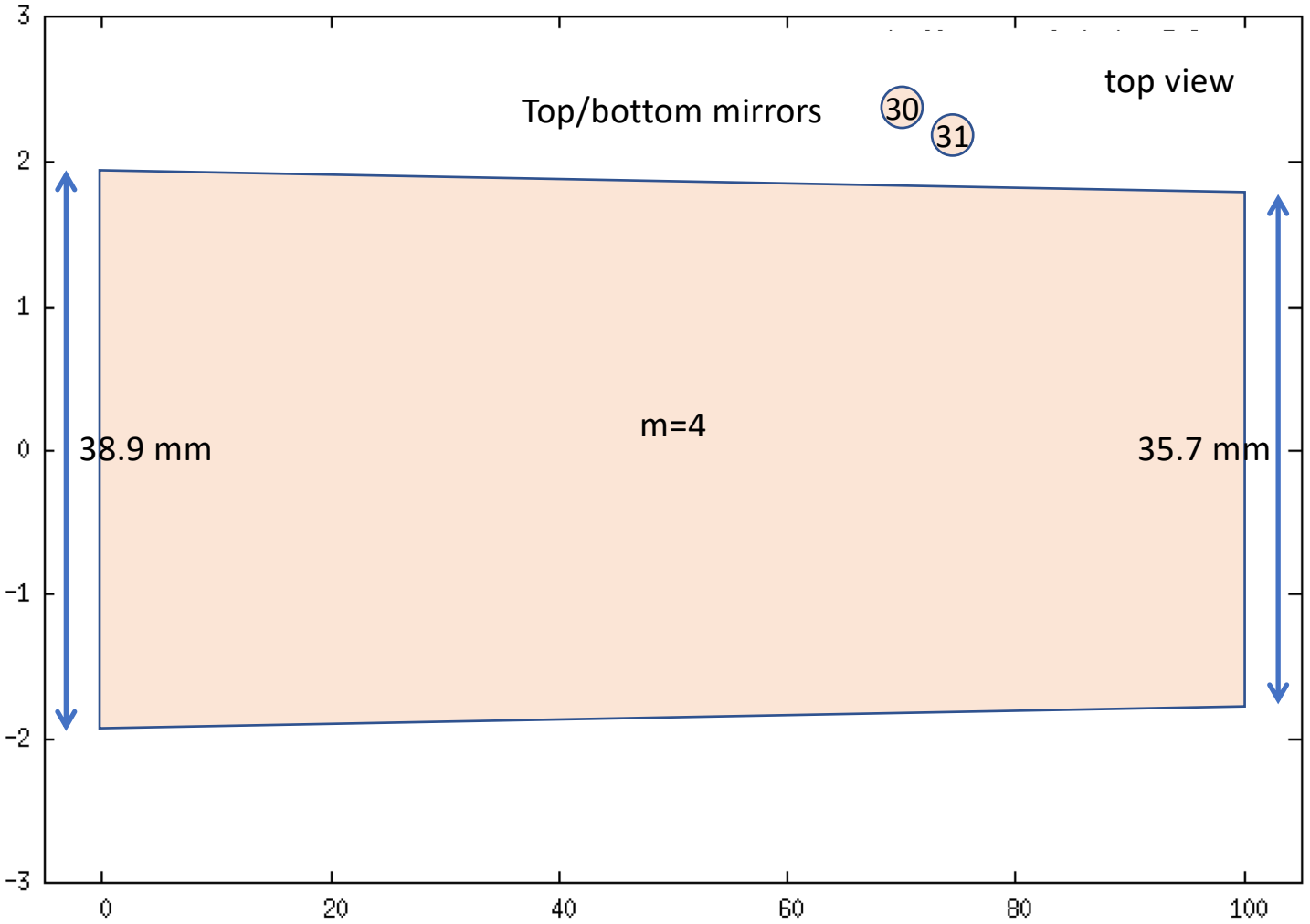
All mirrors are inclined by 0.62 deg with respect to the parallel (red dashed line)

Mirrors 6, 7, 8, 27, 28 and 29 are shorter
to cope with the tapered profile



Example of tapered profile on the vertical plane (exagerated) for mirrors 9 and 11.
Tapering angle = 0.086 deg

Cold neutrons polarizer simulations



Tapering angle =

- 2 mirrors
- Mirrors length = 100 mm
- Borkron substrate 0.3 mm
- Fe/Si mirrors m=4

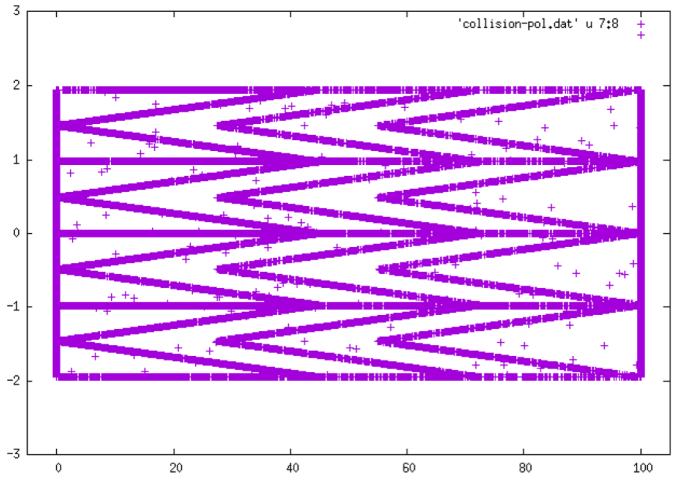
Inclination angle deg

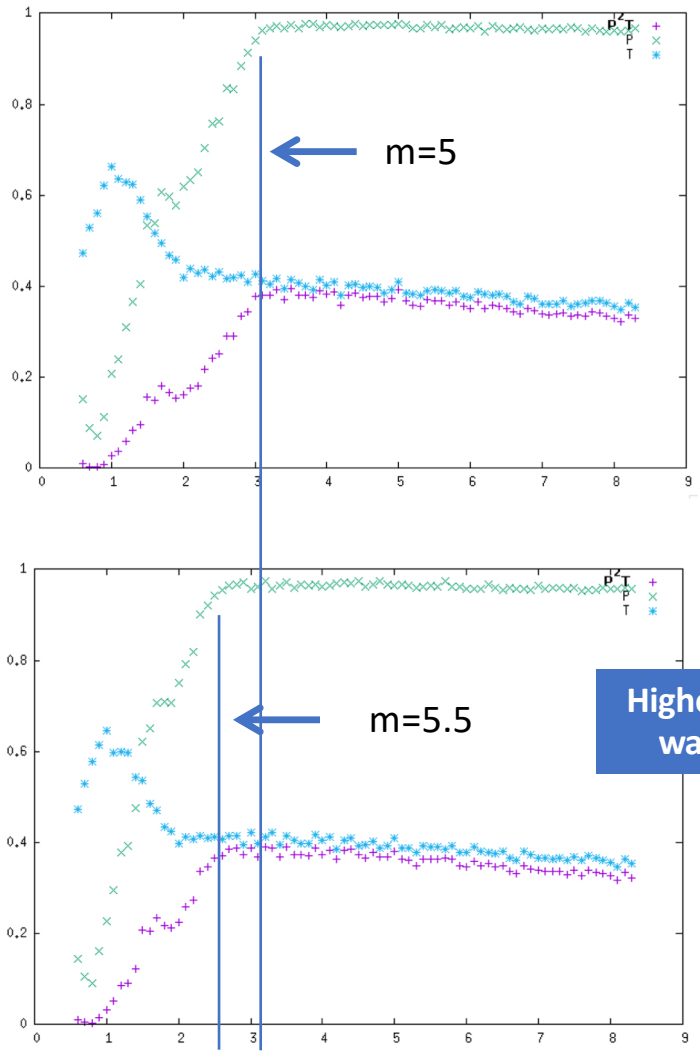
Cold neutrons polarizer simulations

Left-right sides	Inner layers	Top bottom
m=3	m=3	m=4

θ [deg]

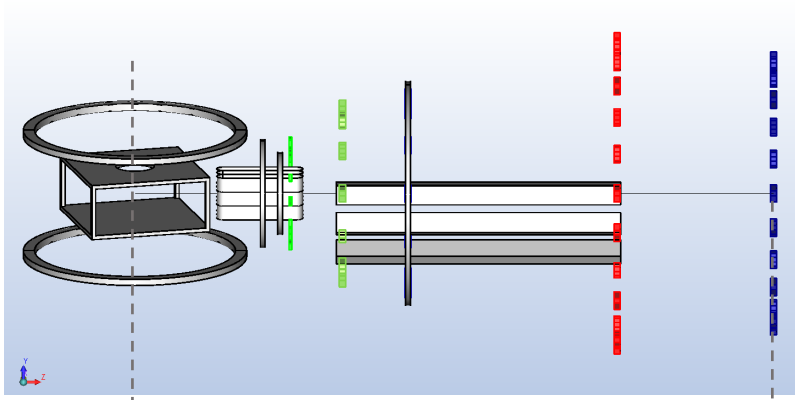
L	4V
60	0.46
50	0.56
45	0.62
40	0.70
30	0.93

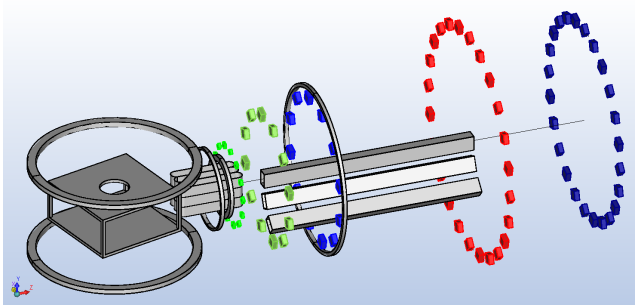




Higher P at short wavelenghts

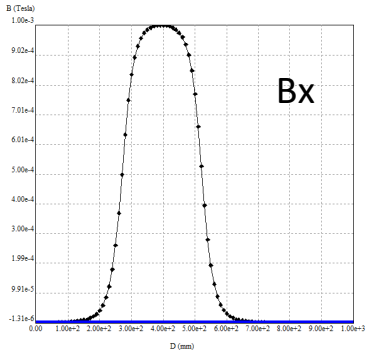
Modelling the magnetic field components

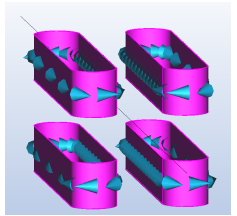


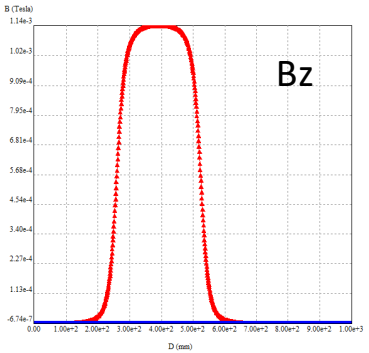


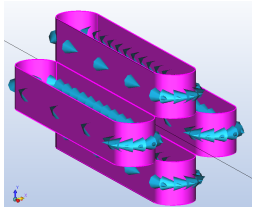
5 Mandhala rings & 4 solenoids & 8 racetrack coils

racetrack coils configurations
for vertical and transverse field





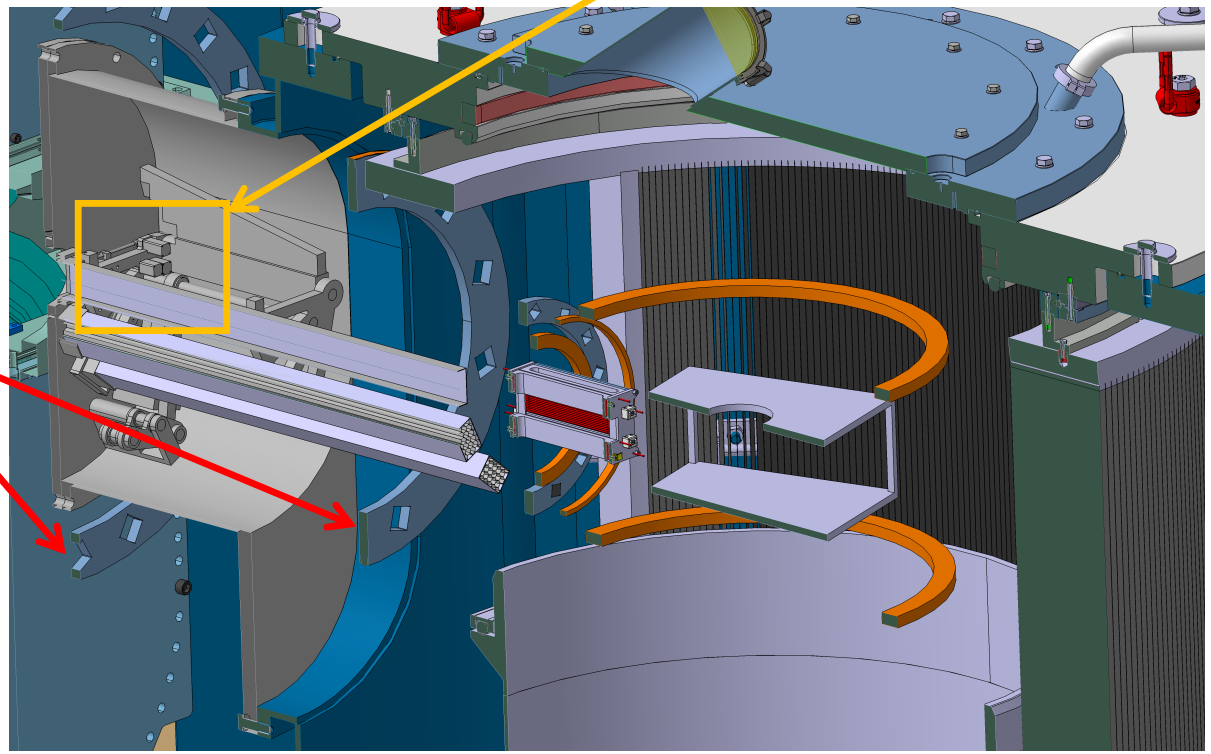


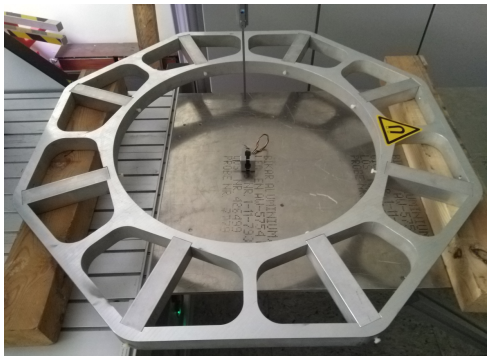


Measurements of field distortion by motors in the collimator

Primary collimator features various motors inside the field

Halbach rings





Project challenges:

1. **Finding an engineer** for the CNR work package
   Status: talking to potential candidates, NSS is involved

2. FZJ engineering **personnel re-assigned** to other projects
   Status: Designer (Oliver) starting again while finishing up the NBPI project

3. Changed **Project Lead Engineer**
   Status: the project Lead Engineer changed already two times (training, handing-over, etc.)

4. **Overrunning costs** due to personnel and materials
   Status: FZJ secured extra-funding from the BMBF to keep the project running. EAC still being monitored

5. **Detector** delivery agreement missing
   Status: draft agreement circulated in Jul-21, waiting for reply from the ESS

6. Getting an offer for the **common shielding**
   Status: needs to update the offer on ESS side

7. **Detector vessel procurement** restarted after 1+ year
   Status: tender opened on 01.04.2022 till 23.05.2022

Technical challenges:

1. **Primary collimator interfaces** with magnetic field and M-chopper are complex
   Status: team of experts working close together
   major challenges with the guide field concept and the guide alignment

2. Defining **Vacuum tests** for the Detector Vessel
   Status: needs dedicated discussion with ICS-ESS

3. Magnetic requirements for the **drive of the secondary collimator**
   Status: requires investigations on the vendor's side, currently ongoing

4. **HEIMDAL and T-REX** are very close to each other in the first few meters of guide.
   Status: working together on reducing dimensions, changing positions of the lifting points and lifting concept, S-DH working on this

Are you experiencing any delays and why?

Component	Description	When delay happened / for how long
Neutron guide	Procurement delayed by the ESS	Documentation submitted on 27.05.2020 and approved on 27.10.2020
	Procurement delayed by FZJ	Tender docs released in Apr.2021 (only in-bunker) and Jan.2022 (out-of-bunker)
Detector Vessel	Procurement delayed by the ESS	Doc submitted on 06.07.2018 and approved on 04.08.2020
	Tender failed	First tender concluded in 2020 Published again in Feb 2022
	Discussion of magnetic requirements with the ESS	From Oct.2020 to Sep.2021
	Discussion with suppliers	From Aug 2020 to Feb 2022
Fast Choppers	Procurement delayed by the ESS	Doc submitted on 25.09.2019 and approved on 27.05.2020
	Procurement delayed by FZJ	Assigned to ZEA-1 in Sep.2021
	Design delayed by FZJ	ZEA-1 designer starting in May.2022
MG Detectors	Undefined sub-project, timeline and specs	Agreement missing (draft ready since July 2021)
CNR engineer	The required professional profile is difficult to find in outsourcing	Jan-Dec 2021

Summary of installation plan

Foreseen installation plan:

2022:
NBOA.
Status: FAT in progress, reflectivity measurements done

2023:
in-bunker components
- S-DH: neutron guide + support
- CNR: heavy shutter

Status: sTG3 scheduled in May-22

2024:
Installations in D03/E02:
- S-DH: neutron guide
- CNR: shielding

The order of installation sis clear and agreed: (1) bottom parts of the shielding + support, (2) neutron guide, (3) upper parts of the shielding

Preinstallations at FZJ:
- Detector Vessel vacuum integration
- Mechanical integrations of collimators, gate valve, detector support structure, detector box.

2025:
installations in E01 + choppers in D03/E02
The actual schedule will be more precise as we go

More details provided in attachment

Project Risks

6	Detector performance requirements may not be met	As a result of the Detector not being a proven technology, but a development still in progress	There is a risk that the detectors performance will not meet the expected requirements	Resulting in a reduced instrument performance	Quality	ESS	Open	**Very high**	**Very likely**	**25**
7	Increasing costs of materials (Detector Vessel)	As a result of the inflation and interrupted supply chain due to the Pandemic	There is a risk that the costs of materials will increase significantly (Detector Vessel)	Resulting in increased costs of the components (Detector Vessel)	Cost	FZJ	Open	**High**	**Likely**	**16**
8	Increasing costs of materials (Beamline shielding)	As a result of the inflation and interrupted supply chain due to the Pandemic	There is a risk that the costs of materials will increase significantly (Beamline Shielding)	Resulting in increased costs of the components (Beamline shielding)	Cost	CNR	Open	**High**	**Likely**	**16**
9	Increasing costs of materials (Experimental cave)	As a result of the inflation and interrupted supply chain due to the Pandemic	There is a risk that the costs of materials will increase significantly (Experimental cave)	Resulting in increased costs of the components (Experimental cave)	Cost	CNR	Open	**High**	**Likely**	**16**
10	Instruments EAC (2020) significantly higher than CBV	As a result of inflation, CBV in 2013, personnel costs higher than ESS CBV, delays from ESS side, etc	There is a risk that the projects will cost significantly higher than expected	Resulting in missing budget for the project and/or project termination	Cost	FZJ	Escalated	**Very high**	**Very likely**	**25**

More details provided in attachment

Thank you for your attention