

SPECTROSCOPY STAP UPDATE

NEUTRON CHOPPERS UPDATE: COMMON CHOPPER PROJECT

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1. INTRODUCTION

This document describes the current progress of the chopper system related deliverables to instrument teams. The document is structured around 2 major topics for chopper systems:

1. The Common Chopper Project (CCP)

The CCP aims at delivering to the instrument teams turn-key, fully installed, standardized neutron chopper systems under a common platform adhering to ESS requirements & Swedish legislation.

2. CHIC development.

The CHIC is a common chopper control interface for a variety of chopper suppliers to ESS controls. All choppers in the spectroscopy class of instruments will be controlled and monitored through this interface.

The updates in each topic are centered around budget, schedule or technical risk items that have been successfully resolved and on current issues that need addressing.

2. COMMON CHOPPER PROJECT

2.1. General Update

- The neutron chopper team has grown by the addition of a new mechanical engineer/designer Ioannis Apostolidis and our first chopper technician Steen Andersen. Join me in welcoming them to the team!
- **We are currently in intense procurement mode, tenders have been published for:** Low speed disc manufacturing, Low speed disc coating, High speed disc procurement, CHIC 19" crate assembly, wiring and testing, Chopper Control Rack assembly and wiring, spindles and controllers, cabling and design work for new through nut connector for SKF.
- We are pleased to inform you that the QA phase chopper of our common chopper project has reached a significant milestone. We have successfully completed the SKF commissioning and are currently operating at 70Hz planned operating frequency as well as tested our coated disc in the planned overspeed of 77Hz under vacuum $<10^{-5}$ mbar. Orbital fluctuation are well within limits (5-20 μ m, permitted max=200 μ m) as well as external housing vibrations of the system. All the knowhow has already been included in the designs of the MAGIC and subsequent common chopper systems.

- We have progressed further in the development of our in-house NCG coated discs. The discs have undergone balancing successfully at 14Hz and are awaiting to be integrated in the QA phase chopper assembly for full speed and overspeed tests. Our intention, following a barrage of tests, is that we will use completely in-house built chopper disks for the NMX instrument.
- The ESS - SKF framework agreement is now complete. After several rounds of negotiations over 1 year all technical and cost details have been agreed approved by the S2M legal team in France (SKF Canada and S2M have joined earlier this year). A bulk order of spindles, controllers and cables for all first-9 instruments part of the common project has already taken place end of 2020. Deliveries of first spindles are planned in end of April 2021.
- The BIFROST instrument team has joined the CCP in December 2020. The Kick-off meeting has taken place in December with PDR planned in May 2021. We are currently progressing with the preliminary design of the chopper system. Given the high degree of standardization of the common chopper project we were already able to open tenders within 4 months of contract signature. Thanks goes to the BIFROST team for the great collaboration. Tenders are out for:
 - High-speed discs
 - Low speed discs
 - SKF Spindles and drives – ordered and planned delivery Q3 and Q4.
 - Racks
 - CHIC hardware
 - Timing systems
- We have finished building and testing the first production version of the Chopper Integration Hardware (CHIC). The CHIC CDR review (including review of architecture and eplan drawings) has successfully taken place 16th of November. Some modifications have been implemented. We have identified suppliers and are currently preparing for the tender documentation and planned production of 10x CHICs will begin in May 2021. The current production version can be used for the first instrument that requires it (ESTIA or LOKI).

Instrument	Supplier	Contract Signed	Preliminary Design	Detailed Design	In Manufacturing
ODIN	Airbus	Yes	Complete	Complete	Yes
FREIA	ISIS	Yes	In progress		
BEER	-	No			
BIFROST	ESS (Joined Dec 2020)	Yes	In progress, PDR May 12th		Discs, spindles, racks and CHIC in tender
CSPEC	Airbus	Yes	In progress promptly		
DREAM	Julich	Yes	Complete	In progress/near complete	Yes
SKADI	Julich	Yes	Complete	In progress/near complete	
LOKI	ISIS	Yes	Complete	Complete	Yes
NMX	ESS	Yes	Complete	Complete	Yes
ESTIA	PSI	Yes	Complete	In progress/near complete	Spindles in manufacture
MAGIC	ESS	Yes	Complete	Complete	Yes
MIRACLES	Potential Aernova	No/but separate development contract	Conceptual design as well as tests have taken place. Excellent progress by Aernova on new CFRP coated discs		
T-REX	Julich	Yes	To be started after Dream		
VESPA	-	No			
HEIMDAL	ESS	Yes	To be started after BIFROST, MAGIC and NMX are in manufacturing		
Test beamline	MIRROTRON	Yes	Complete	Complete	Near Complete

Common chopper project status

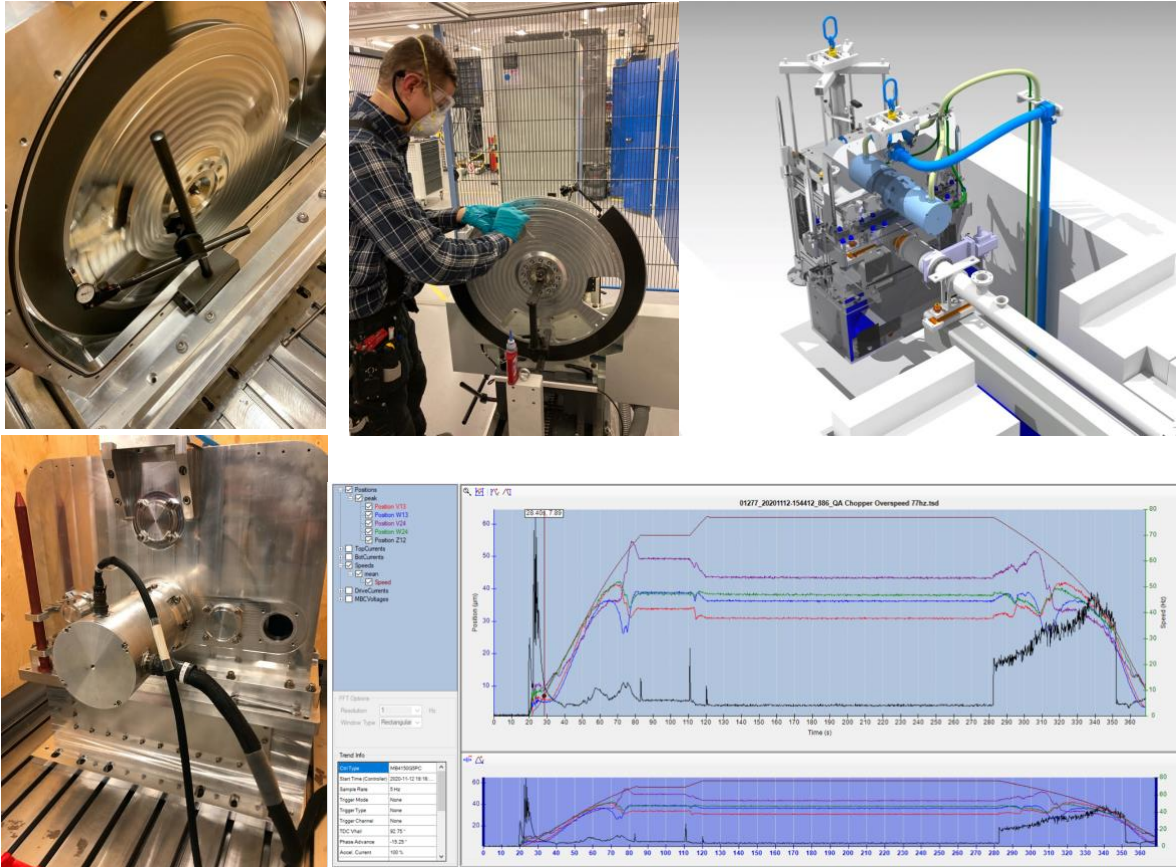


Figure 1. Top left: Run-out QA tests on in-house CCP chopper discs is $\pm 60\mu\text{m}$. Top Centre: NCG coated disc. Balanced at 14Hz and ready for high speed tests. Top right: NMX double chopper with cabling routing. Bottom left: Complete assembly QA phase chopper undergoing vacuum tests/ speed tests. Bottom right: Unbalance response of QA phase chopper under vacuum and up to a speed of 77Hz.

Chopper Controls – CHIC Julich in kind prototype and new ESS production version

- The CHIC Prototype was built and delivered by Airbus in Q42019. We have performed a full testing campaign which resulted in a number of iterations of the prototype code. We have included our own code to allow integration to the ESS. The full vertical integration using an SKF spindle with EPICS including realistic timing system from ICS has been successfully proven in late Q12020. Following the success of the first CHIC we have begun the assembly of a production version of the CHIC for utilisation within the framework of the common chopper project.
- We have finished building the first production version of the Chopper Integration Hardware (CHIC). Several hardware modifications to improve function, durability and reduce cost were implemented.
- We have fully optimised the back plate of the CHIC considering all sensors from the Common chopper. Last modifications were the sourcing and incorporation of low smoke halogen free cables as well as their inclusion in the ESS cable database. Furthermore, we are sourcing radiation hard cables for our temperature and flow switch sensors to be installed in every cooled chopper.

- We have been keeping close contact with Airbus in order to ensure a standardised system irrespective of CHIC supplier making sure that controls of all spectroscopy instruments such as CSPEC are fully compatible with the ESS architecture. Updated costing estimates for CHIC and rack have been also created in order to keep long term costing estimates more accurate.



Figure 2. Left: Final layout of chopper integration controller. Right: Finished assembly of the 1st production model of the CHIC controller.