EUROPEAN SPALLATION SOURCE

ESS Engineering Days
ESS neutron chopper group

Information for Instrument teams commencing Phase 1

Iain Sutton,
Group leader,
on the behalf of the Neutron Chopper Group

www.europeanspallationsource.se
2 June 2015

Presentation Plan

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- Intro
- Work flow in Phase I
- Engineering activities
- Project activities
- Interfaces
- Standards
- Wrapping up

ESS Instrument technologies

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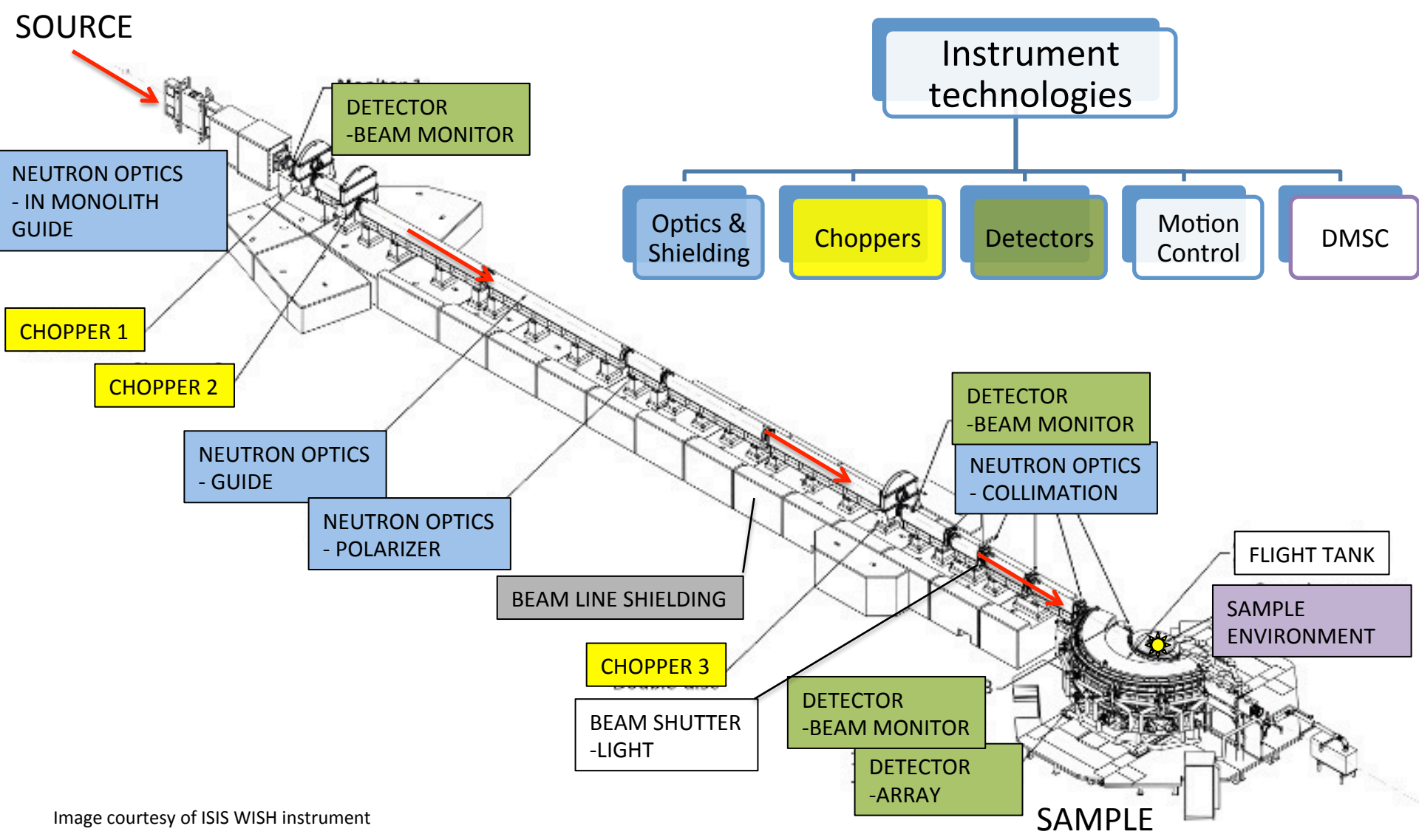

Image courtesy of ISIS WISH instrument

Diversity

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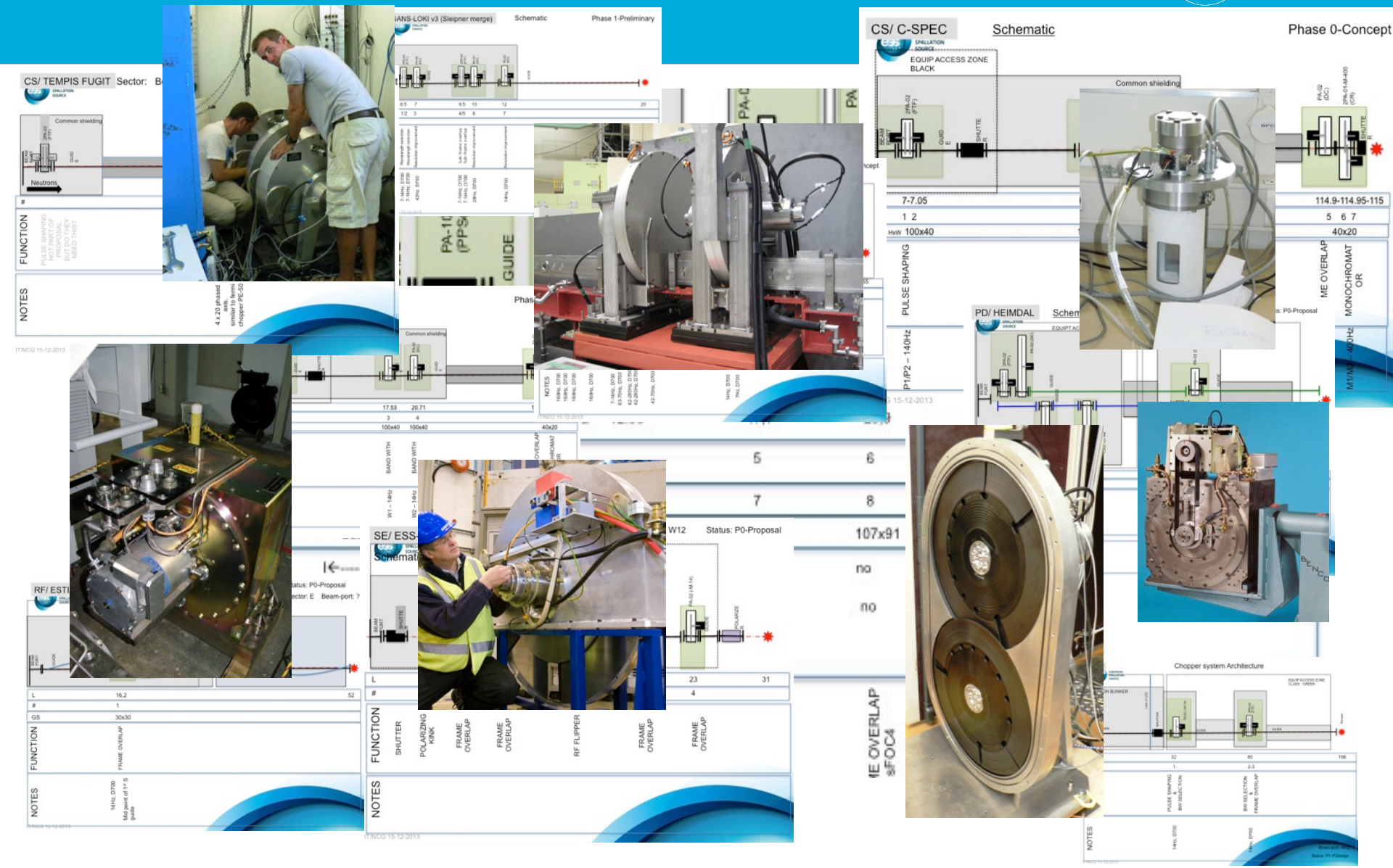

SUPPORT
ENABLE
INTEGRATE

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DAREK
PPSc

ERIK
Mech integration

NICKLAS
Control Eng

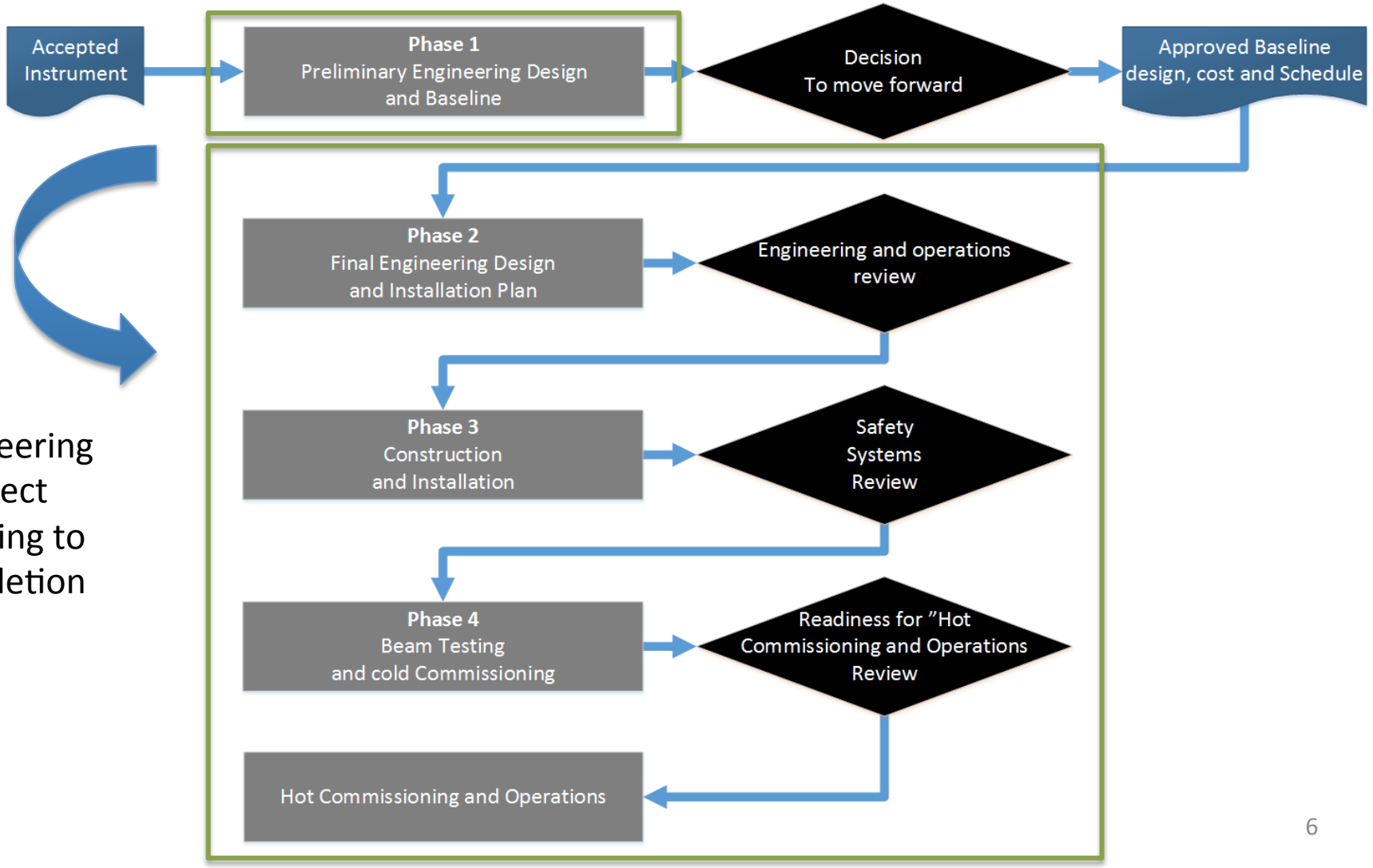
IAIN
Paperwork

MARKUS
Disc Choppers

NIKO
Hybrid

GABOR
Mech Eng

The Instrument Construction process



Engineering + Project planning to completion

Phase I - Preliminary design from proposal to project…

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PRELINIMARY DESIGN PHASE

<TG2>

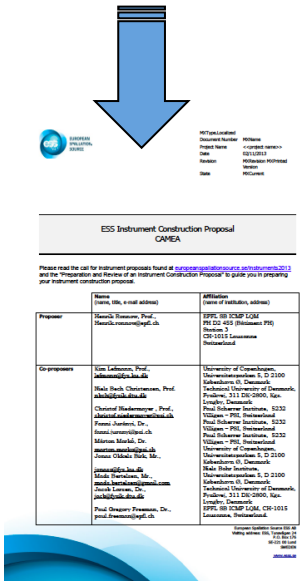
Exploration of Requirements

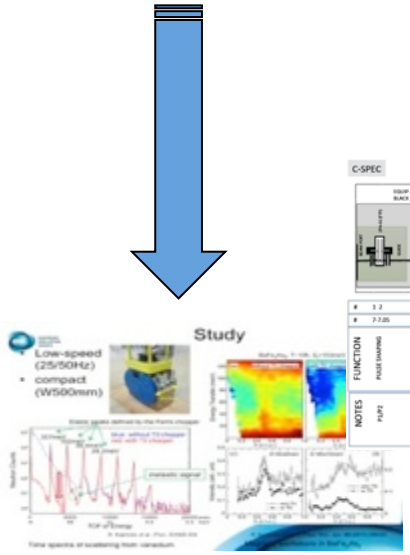
Functional analysis

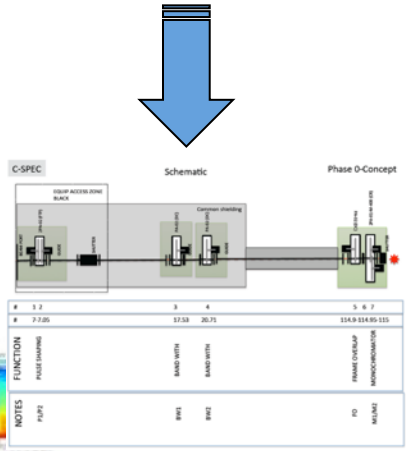
Concept generation and evaluation

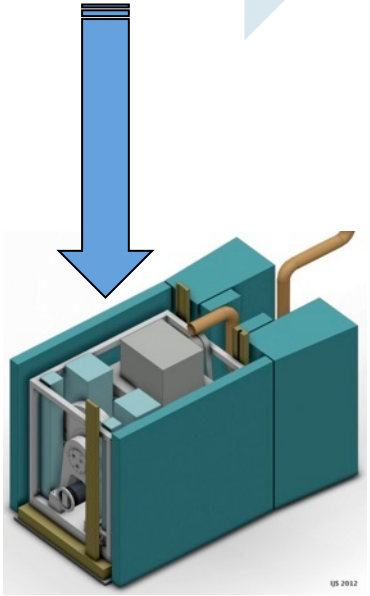
Concept development

Design report
Project plan
Toll gate 2







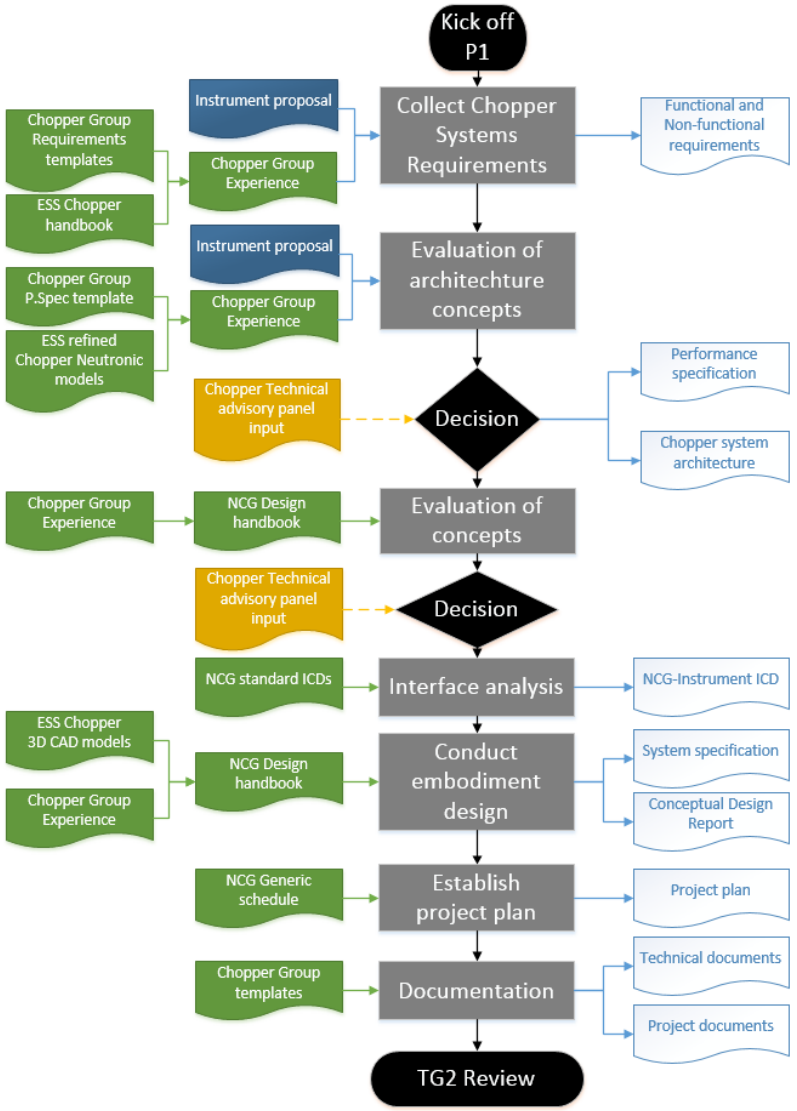


Phase I Workflow

Key areas of support & guidance

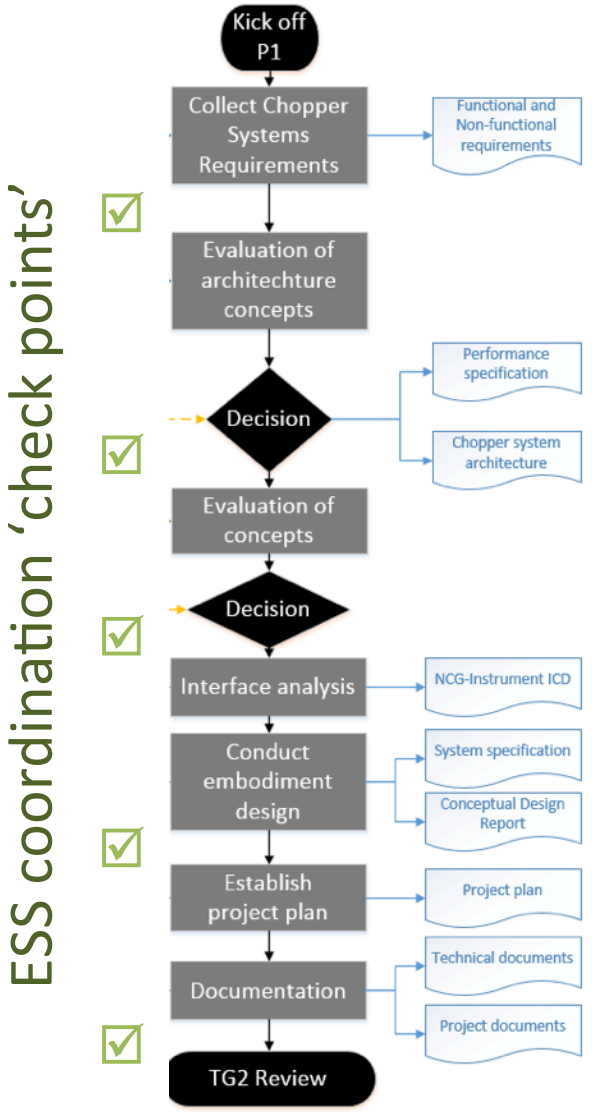
- Chopper documents
  - Standards & requirements
  - Interfaces
  - Strategies
  - Guidelines

- Design support
- Basic CAD models
- Neutronic Simulation



‘check points’

- Regular meetings to coordinate with internal activities and receive input.
- Check points along the design process at major decisions to ensure that chosen solution is compatible with ESS standards & requirements.



Answer the question !

- Is it technically feasible to construct a chopper system meeting the stated performance requirements and which can be operated and maintained during the service life of the instrument ?

Design report

- Can this be done with the instruments budget and schedule constraints and at an acceptable level of risk ?

Project plan

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SUPPORT
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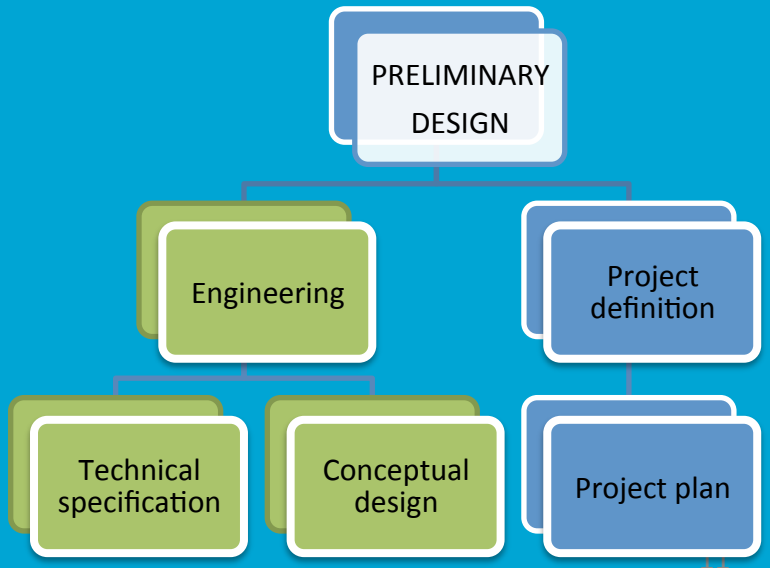
- SUPPORT to INSTRUMENTS

Preliminary Design Phase
- Engineering support



Activitiy 01
Requirements collection

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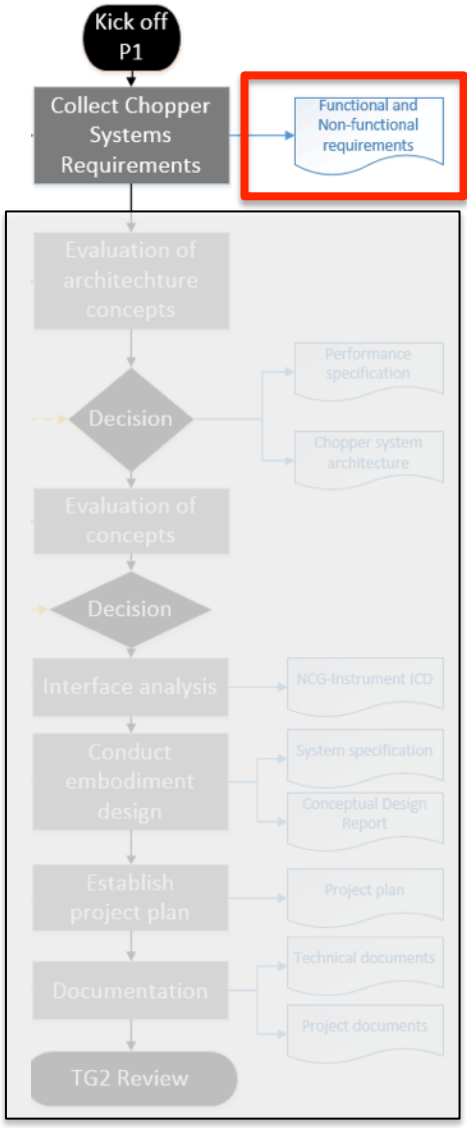
FUNCTIONAL REQUIREMENTS

- The neutron chopper system shall transmit a wavelength band of neutrons selected from all incident wavelengths.
- Wavelength shall be selectable within the range of 1.8Å to 22Å.
- The neutron chopper system shall block attenuate the transmission of neutrons outside of selected wavelength band.

OPERATIONAL REQUIREMENTS

- The chopper system shall be functionally and operationally compatible with chopper support systems at the facility.
- Compatibility with ESS interfaces
- Equipment accessibility
- Equipment RAM
- Certification
- Compatibility with target operating costs
- Environmental protection
- Decommissioning



Activity 02
Establish of a baseline architecture

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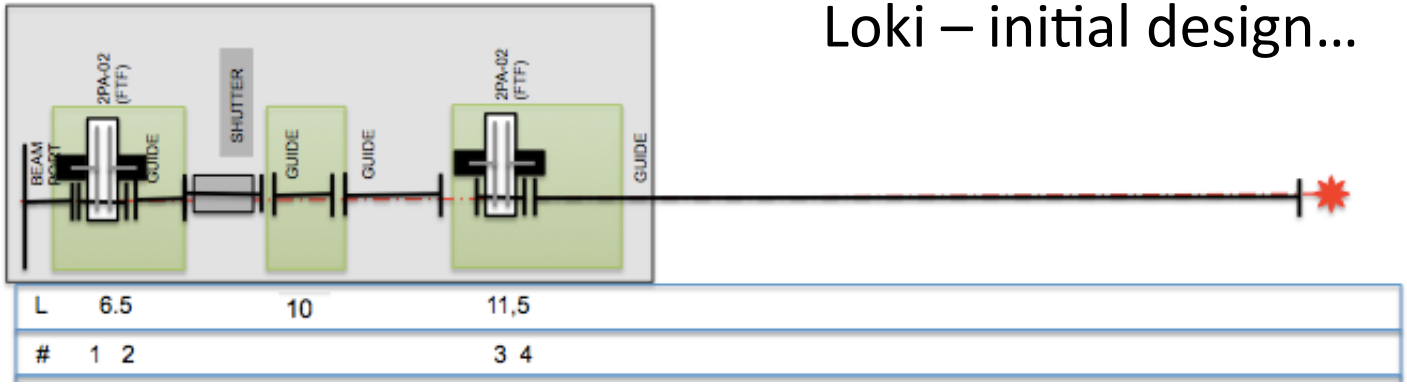
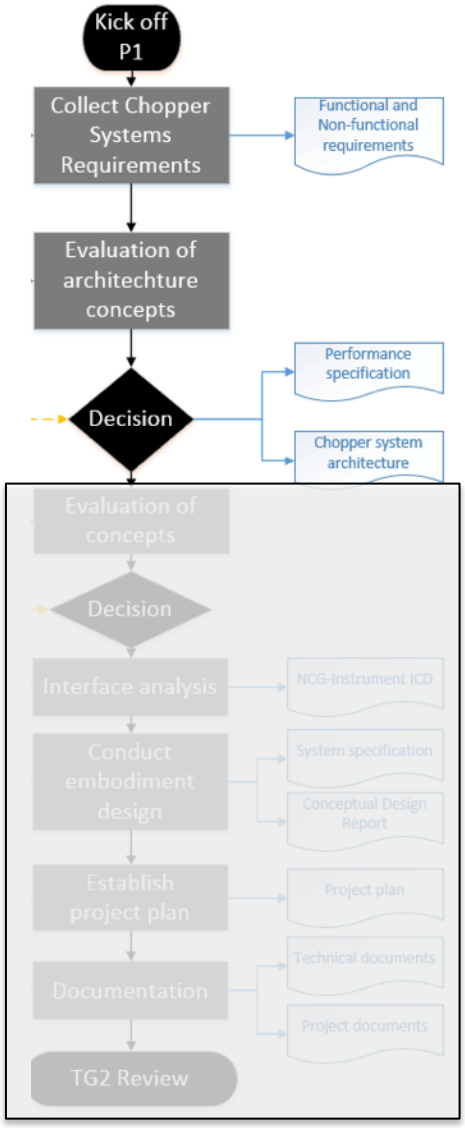


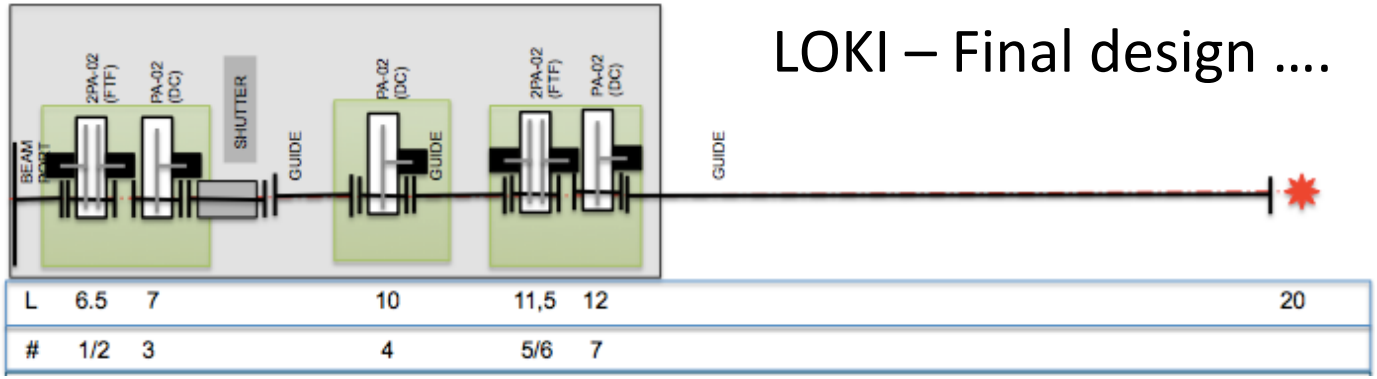
Loki – initial design…



Establish the ‘architecture’ of the instrument chopper system such that it may be

- A common reference for all parties
- Simulated
- Explored and Improved!

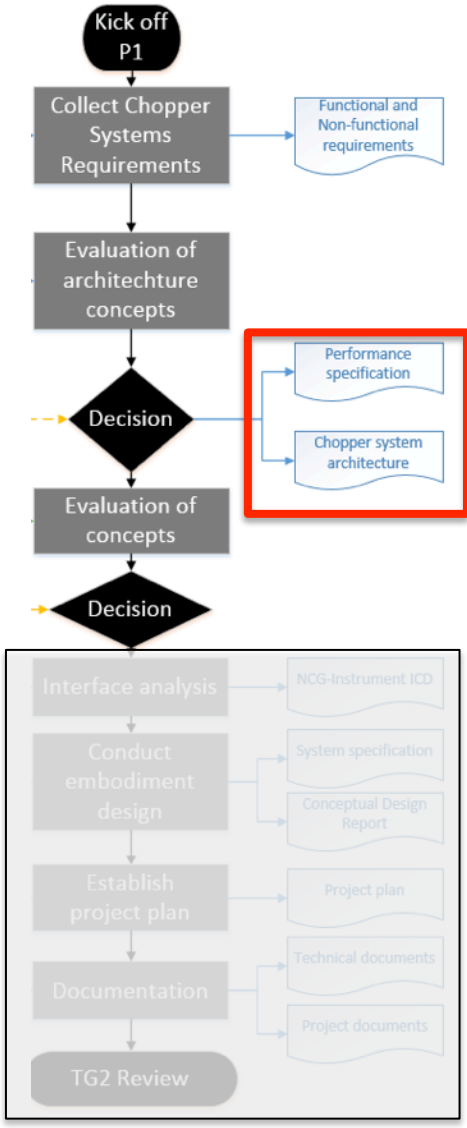
Activity 03
Evaluation of functional variants



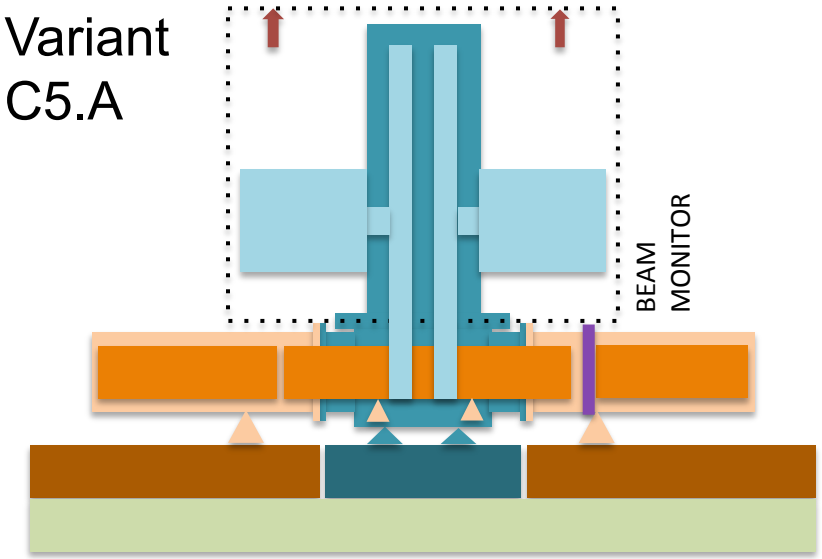
LOKI – Final design ….

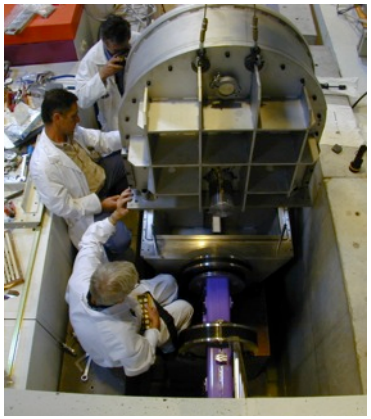
- Explore variants
- Include facility operational requirement and constraints
- Interfaces
- Explore instrument upgrade & staging approaches
- Develop rough costing
- Establish performance specification
- Simulate performance

Evaluate & select within the team the best overall concept for instrument overall.

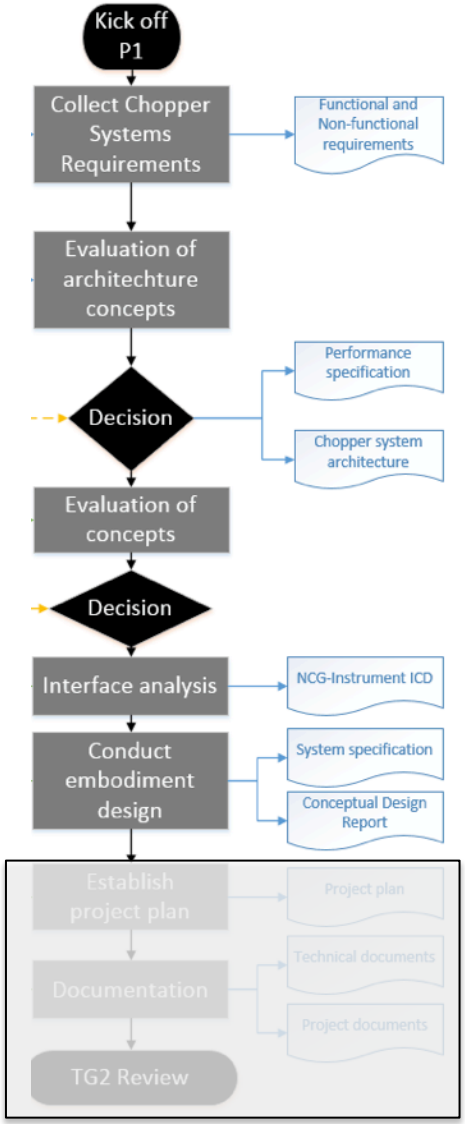


Activity 04
Implementation



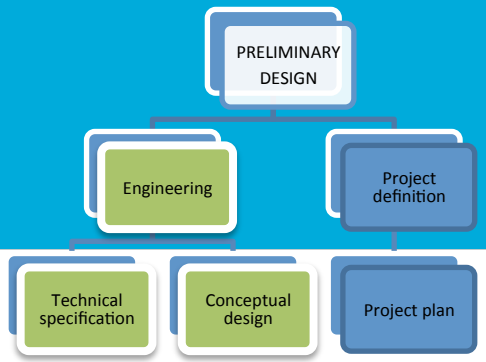


EXAMPLE of C5A from ILL IN5



- Consider ‘operational aspects’
  - Installation
  - Maintainability
  - Mechanical and service interfaces
- Packaging
- Failure & Spares

Activity 05
Documentation

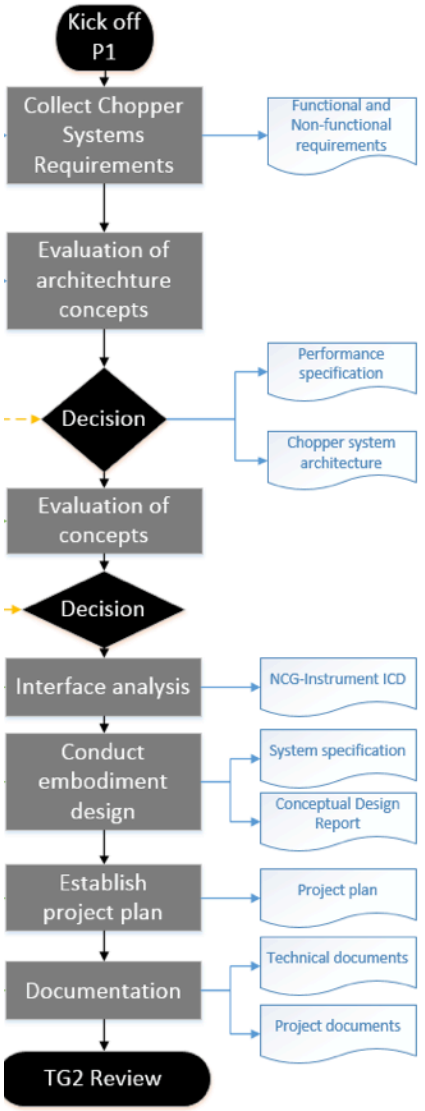


EUROPEAN SPALLATION SOURCE

Chopper System Overview
Chopper System Functional Requirements
Chopper System Operational Requirements
Chopper System Specification
Chopper System Conceptual Design Report
Chopper System Supply Project Plan
Chopper System Risk Analysis

A1 - Product Breakdown Structure (PBS)
A2 - Project Schedule
A3 - Work Unit Spreadsheet
A4 - Chopper Work Unit Definition

'Technical' documents



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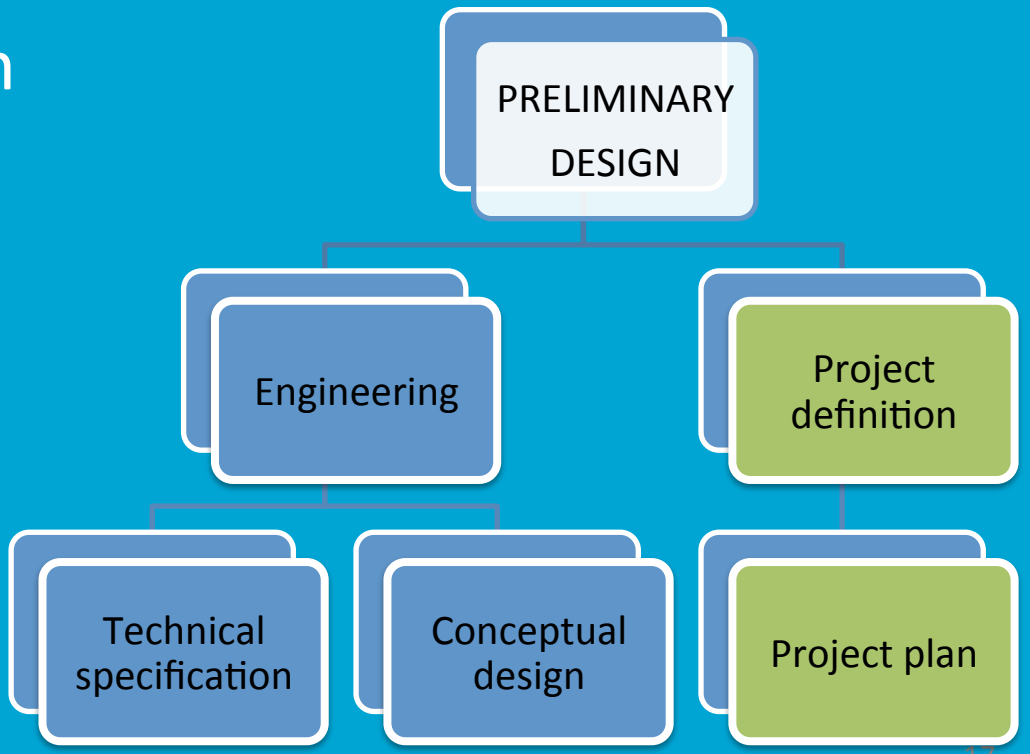
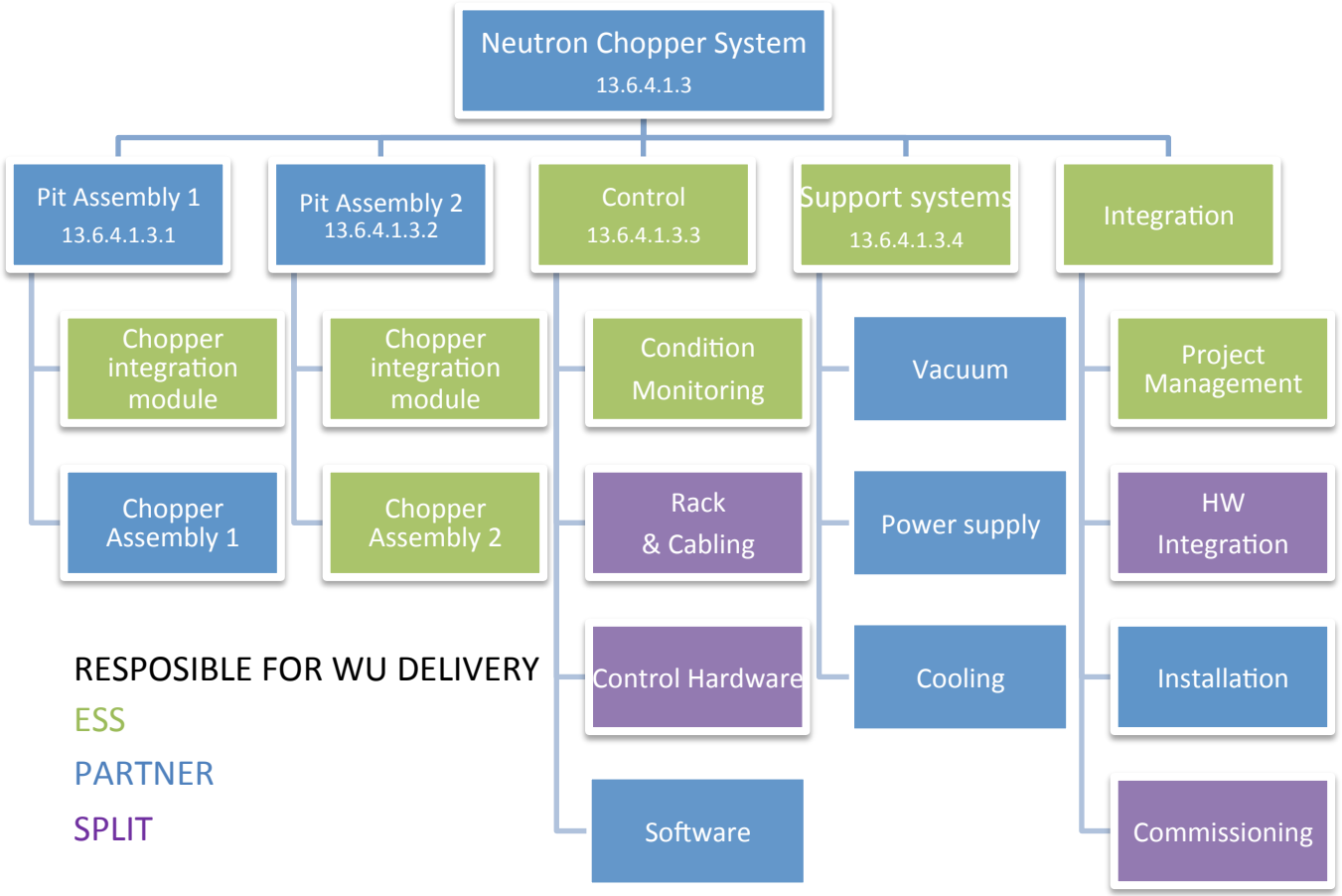
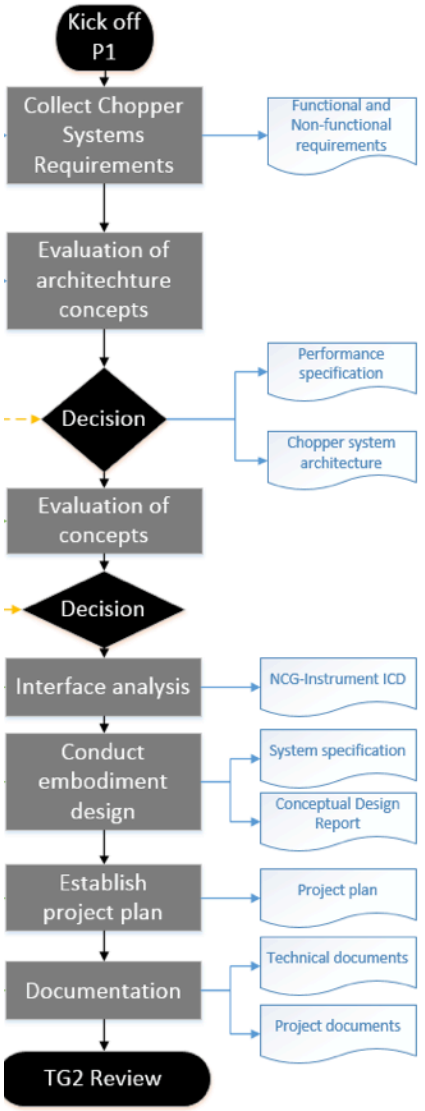
Phase I
Preliminary design
Project documentation



Phase I
Chopper systems Project plan
- WBS





Phase I
Chopper systems project plan
- Schedule till completion

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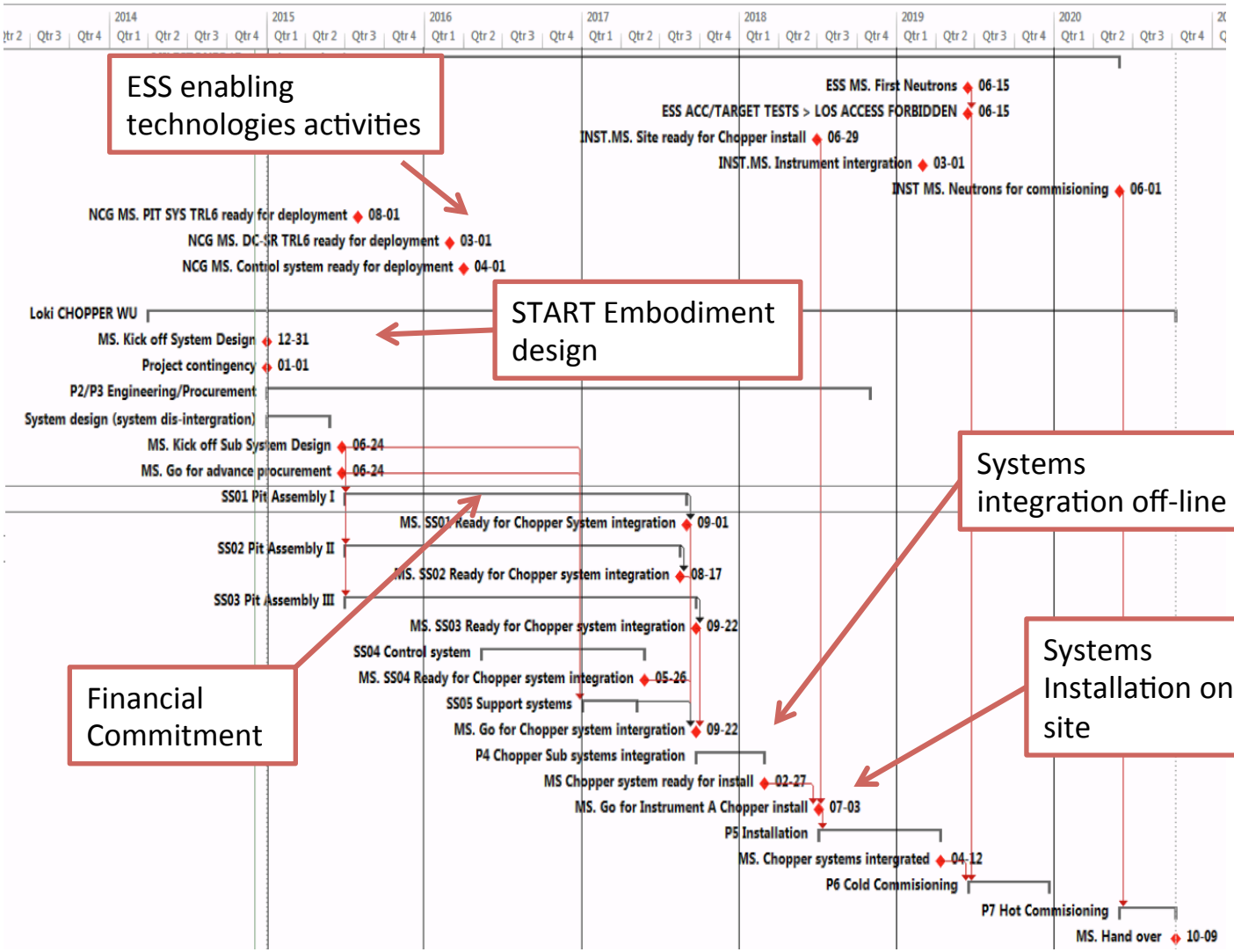

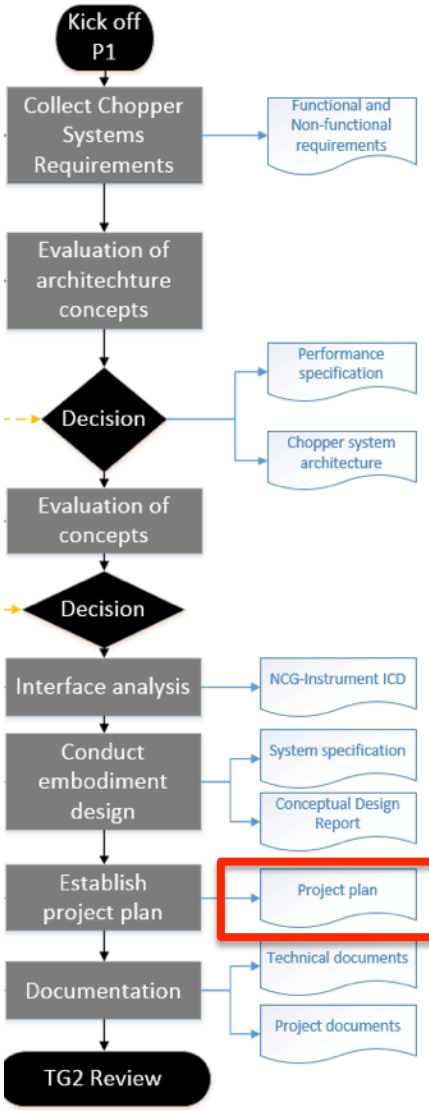

Phase I
Chopper systems project plan
- resource estimates

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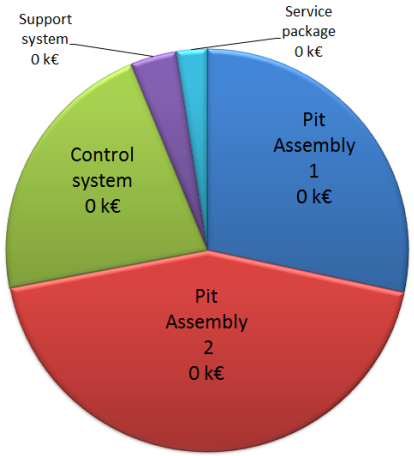
Establish resource budgets

- Hardware cost estimates
  - Direct costs
  - Indirect costs
- Manpower estimates
  - Direct manpower
  - Indirect

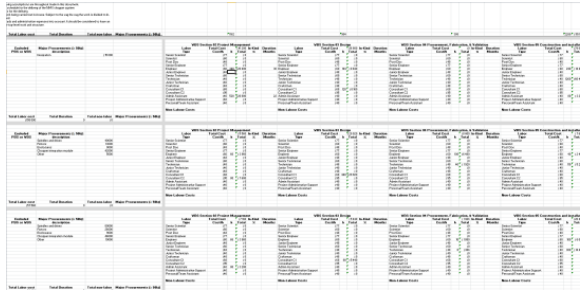
Including on-site activities!

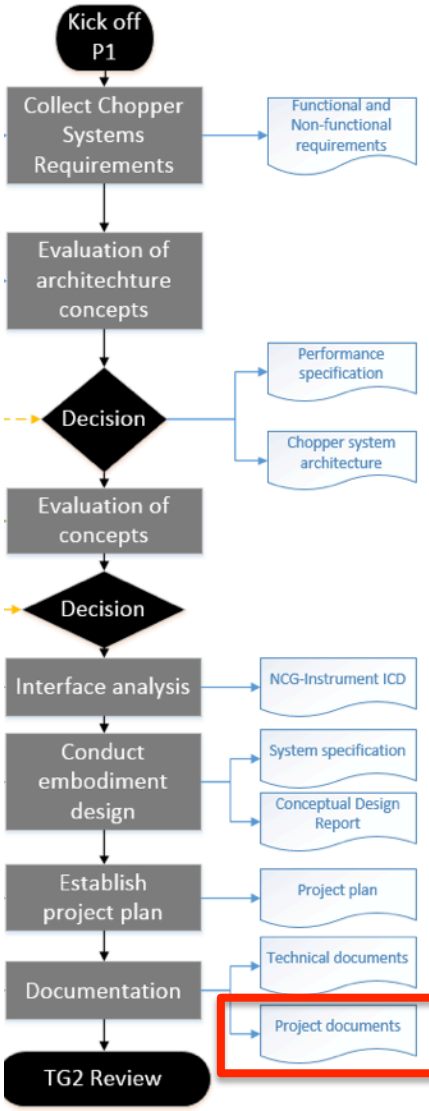
- Integration
- Installation
- on-site service connections



Resource \ WBS Section	WBS S02 Prj Man	WBS S03 Design	WBS S04 Procurement	WBS S05 Install	WBS S06 Cold Comm	Total
Engineer (h)	000	000	000	000	000	0000
Technician (h)			0000	000	000	0000
Consultant (h)		000				000
Admin (h)	000					000
Total	**0000 h**	**000 h**	**0000 h**	**000 h**	**000 h**	**0000 h**
Manpower cost	**00 k€**	**00 k€**	**000 k€**	**00 k€**	**00 k€**	**00 k€**

Estimated error bar is -30 % to +30%





Phase I
Chopper systems project plan
- RAM & Risk

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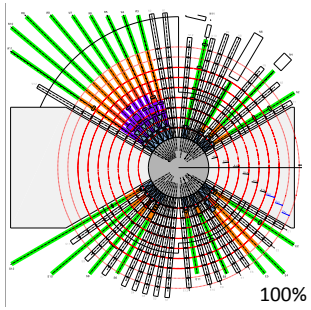
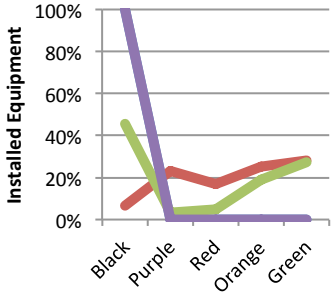
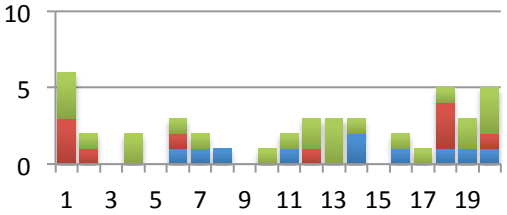
Technical risks
- Failure mode analysis
- Safety assessments
- Reliability-Availability & Maintainability assessments
- Operating strategy

Project risks
- Schedule risk
- Critical component supply

Ensure compliance with operational requirements and strategies

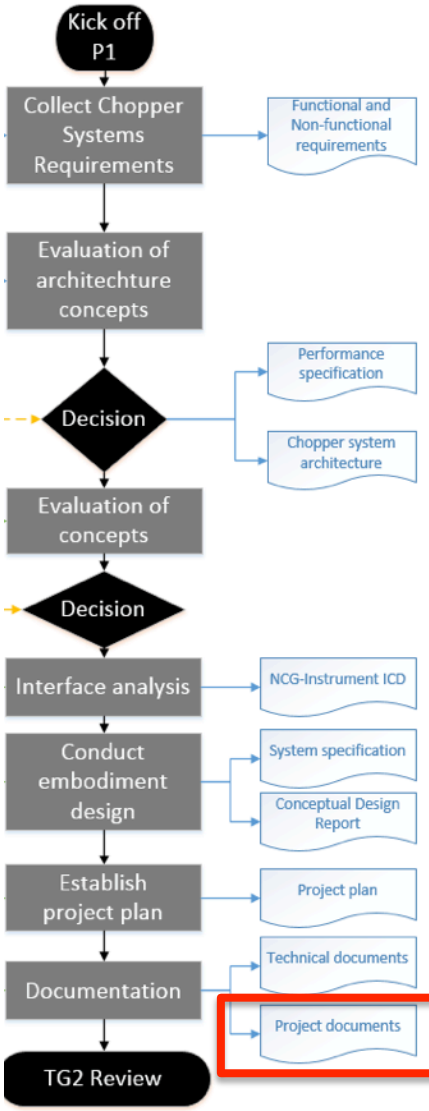






RISK LIST LOKI CHOPPER SYSTEM

ID	Raised by	Date raised	Category	Description	Pro.	Imp.	Score	Consequence	Action(s)	Owner
1 EN		10/20/14	Design	Delays on choice of in-kind design partners	4	2	8	Delay to project	Early focus on design resources	NCG
2 EN		10/20/14	Design	Design issues getting access to horizontal split flange	3	4	12	Design change, potentially performance drop	Early design focus in detailed design	NCG
3 EN		10/20/14	Design	Design budget cut	4	3	11	Uncertainty in installed equipment	Front load detailed design	Instrument
4 EN		10/20/14	Design	New rotor design failure	2	5	10	Delay to project	Build prototype during 2015 and test on technology demonstrator	NCG
5 EN		10/20/14	Design	ESS small rotor integration study delay	1	5	5	Delay to project	Assist small rotor project	NCG
6 EN		10/20/14	Design	Interface and scope of work is unclear	3	4	12	Rework and/or duplication of effort	Push for finalization of interface control documents early on 2015	Instrument
7 EN		10/20/14	Design/Procurement	Choice of in-kind partners is removed from NCG	3	5	15	Quality issues/standardization issues	None	Management
8 EN		10/20/14	Design/Procurement	Package ownership removal	2	5	10	Installation/quality/standardization issues	None	Management
9 EN		10/20/14	Procurement	Unable to buy key components in bulk	4	3	12	Extra cost	Decision for procurement early in project	Instrument
10 EN		10/20/14	Integration	Lab-space not available for integration	1	4	4	Delay to project	Move integration space to halo or other temp. space (tent?)	NCG
11 EN		10/20/14	Integration	Guides for chopper integration is not delivered	4	3	12	Delay to project/quality issues	Run integration without guides	Optics
12 EN		10/20/14	Installation	Not enough installation personnel	5	1	5	Delay to project/quality issues	None	Instrument
13 EN		10/20/14	Installation	No access to halo in time for installation	2	5	10	Delay to project/quality issues	None	CF
14 EN		10/20/14	Installation	No access to beam port on schedule	4	3	12	Delay to project/quality issues	None	Target
15 EN		10/20/14	Installation	Beam guide insert not ready	3	2	6	Delay to project/quality issues	None	Optics
16 EN		10/20/14	Installation	Target/accelerator tests during installation	1	2	2	Delay to project/quality issues	None	Target
17 EN		10/20/14	Installation	Late delivery of long-lead-time components	2	2	4	Delay to project/quality issues	Investigate long-lead-time purchases early	NCG
18 EN		10/20/14	Installation	Infrastructure failure during installation	1	4	4	Delay to project/quality issues	None	CF
19 EN		10/20/14	Commissioning	ICS control system/timing access delay	2	5	10	Delay to project	Have ICD ready	ICS
20 EN		10/20/14	Commissioning	DMSC chopper control delay	4	1	4	Delay to project	Have ICD ready	DMSC

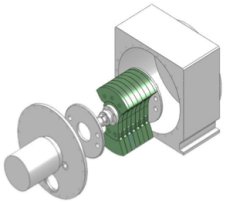


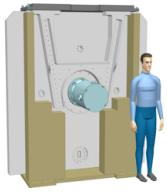
Phase I
Chopper systems project plan
Procurement plan

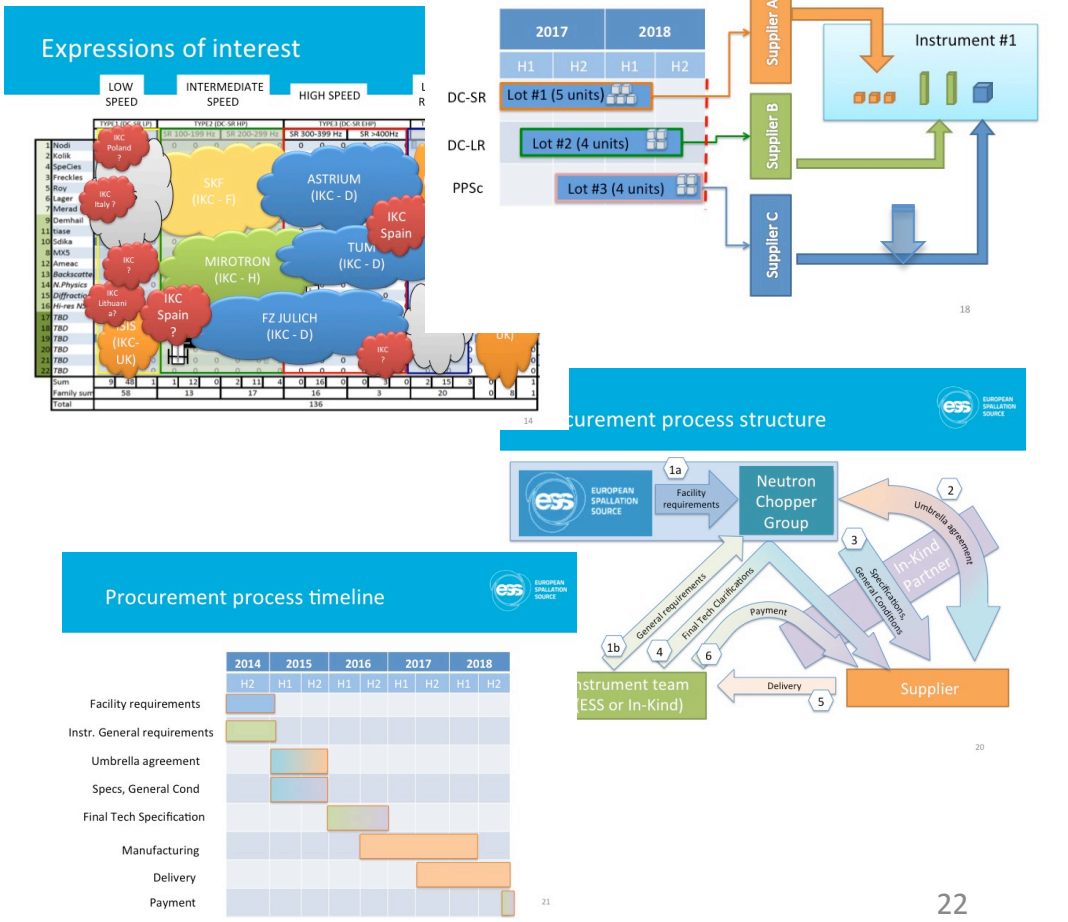
Finding the right partners for getting the job done

Horizontal in-kind

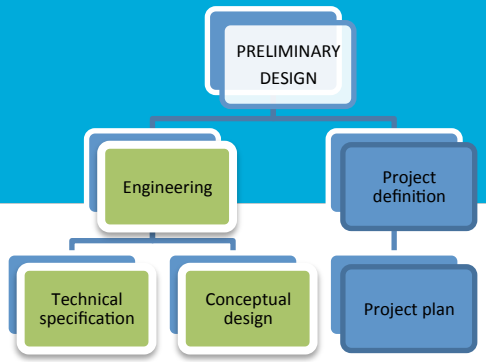
- Supplier framework agreements
- Access to mutualized development projects.
- Access to experience







Project activities
Documentation



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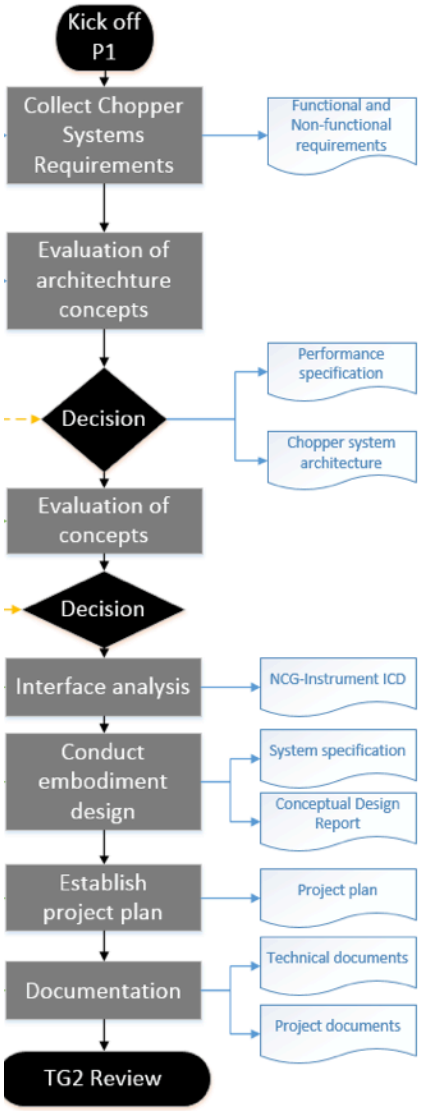
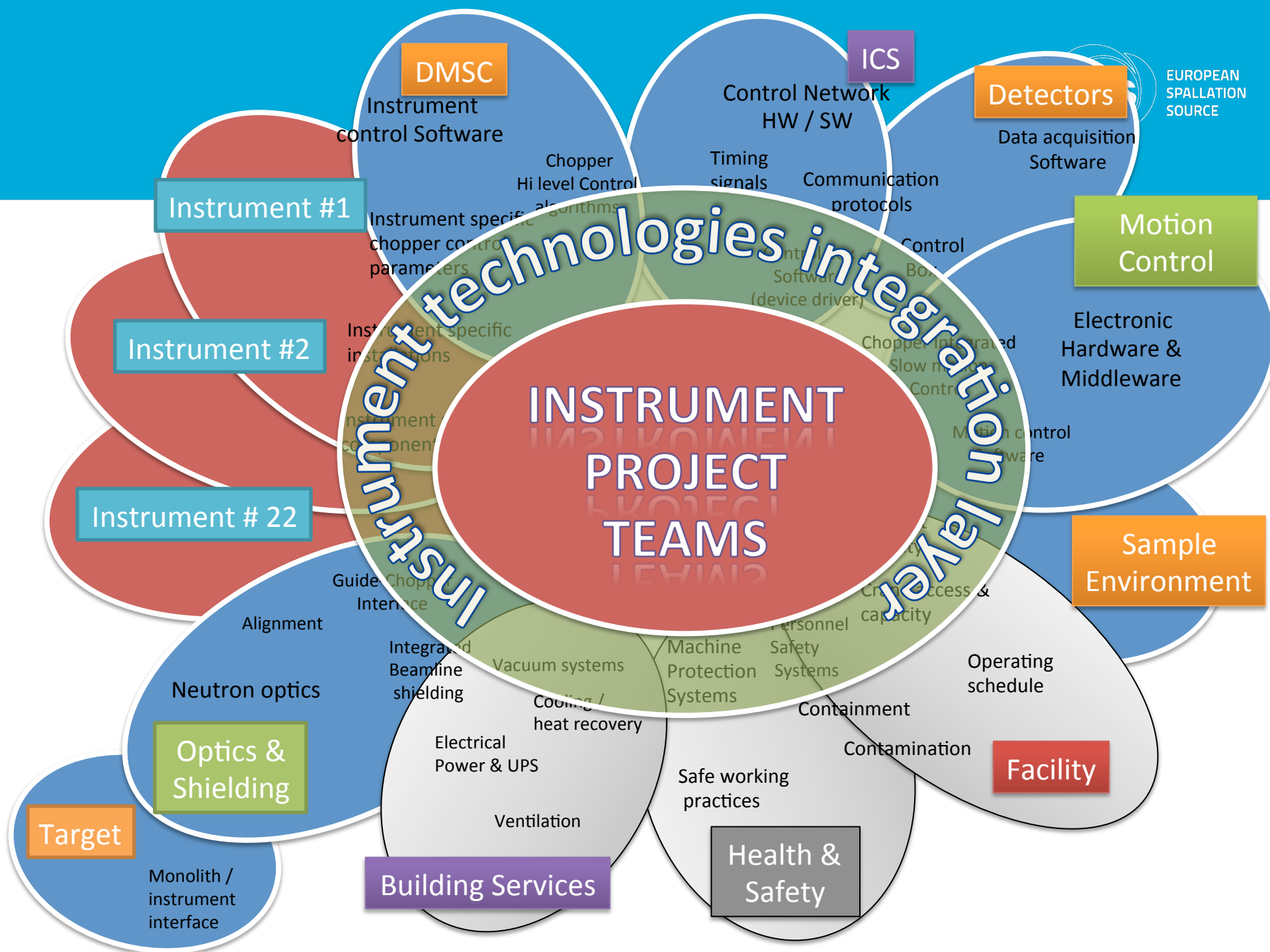
'project' documents




EUROPEAN SPALLATION SOURCE
DMSC
Instrument control Software
ICS
Control Network HW / SW
Detectors
Data acquisition Software
Instrument #1
Instrument #2
Instrument # 22
Instrument technologies integration layer
INSTRUMENT PROJECT TEAMS
Motion Control
Electronic Hardware & Middleware
Sample Environment
Optics & Shielding
Neutron optics
Alignment
Target
Monolith / instrument interface
Building Services
Electrical Power & UPS
Ventilation
Vacuum systems
Cooling / heat recovery
Machine Protection Systems
Personnel Safety Systems
Safe working practices
Health & Safety
Containment
Contamination
Facility
Operating schedule
Timing signals
Communication protocols
Chopper Hi level Control
Control
Guide
Alignment
Beamline shielding
capacity

Neutron Chopper System
Interface configuration definitions

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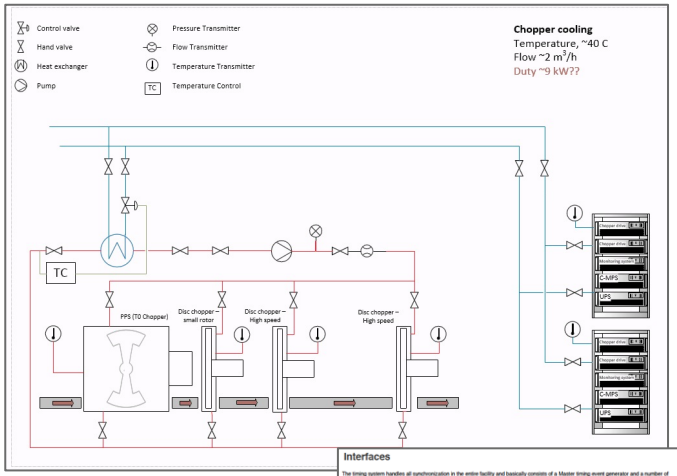
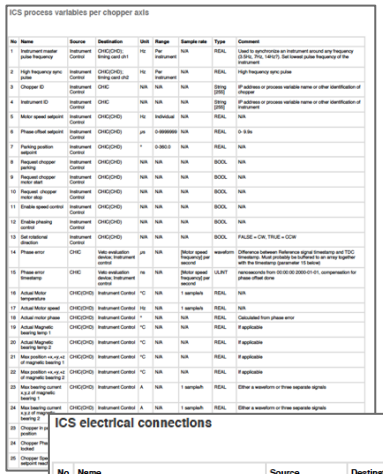
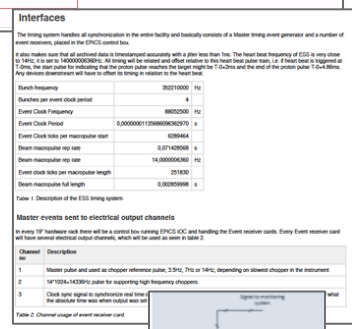
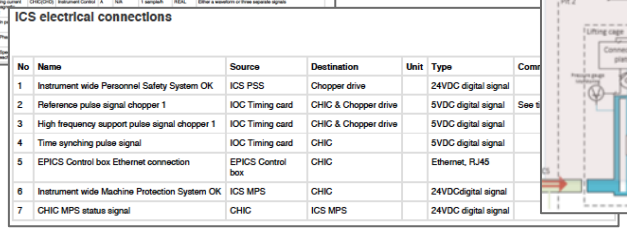
- ICD NCG-CF
- ICD NCG-Cooling
- ICD NCG-Motion Control and Automation
- ICD NCG-Health and safety
- ICD NCG-Optics
- ICD NCG-Shielding
- ICD NCG-Vacuum
- ICD NCG-DMSC
- ICD NCG-ICS EPICS SW
- ICD NCG-ICS Machine Protection System
- ICD NCG-ICS Personnel Safety System
- ICD NCG-ICS Timing System Network
- ICD NCG-CHiC-Drive
- ICD NCG-Detectors
- ICD NCG-Sample station
- ICD NCG-Target Station

Draft releases Q3 2015

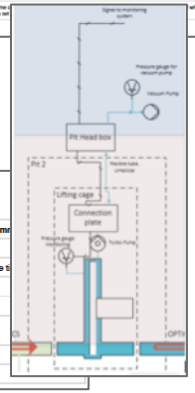



ICS process variables per chopper axis


Interfaces


ICS electrical connections

No	Name	Source	Destination	Unit	Type	Comm
1	Instrument wide Personnel Safety System OK	ICS PSS	Chopper drive		24VDC digital signal	
2	Reference pulse signal chopper 1	IOC Timing card	CHIC & Chopper drive		5VDC digital signal	See t
3	High frequency support pulse signal chopper 1	IOC Timing card	CHIC & Chopper drive		5VDC digital signal	
4	Time synching pulse signal	IOC Timing card	CHIC		5VDC digital signal	
5	EPICS Control box Ethernet connection	EPICS Control box	CHIC		Ethernet, RJ45	
6	Instrument wide Machine Protection System OK	ICS MPS	CHIC		24VDCdigital signal	
7	CHIC MPS status signal	CHIC	ICS MPS		24VDC digital signal	

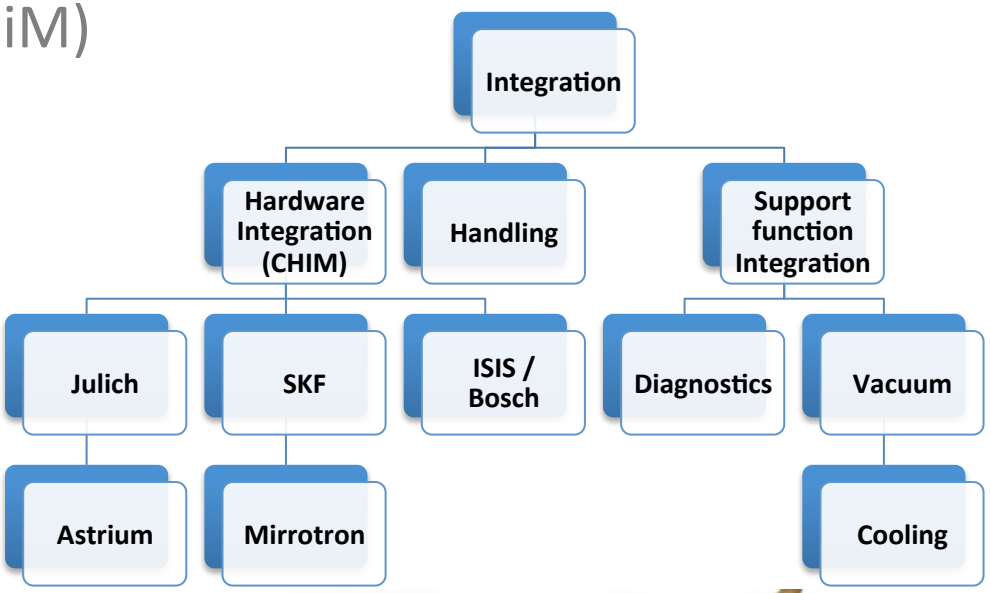


PHYSICAL INTEGRATION

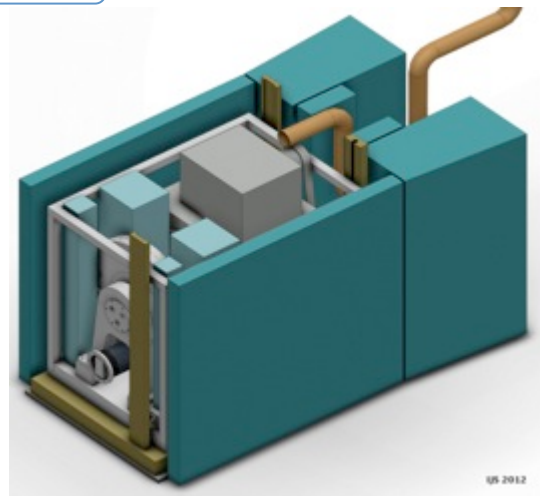
Chopper Integration modules (CHiM)

Includes elements of

- Services (Vac, Cooling)
- Neutron Optics
- Vacuum housings
- Local shielding
- Support structures
- Beam monitor
- Safety functions



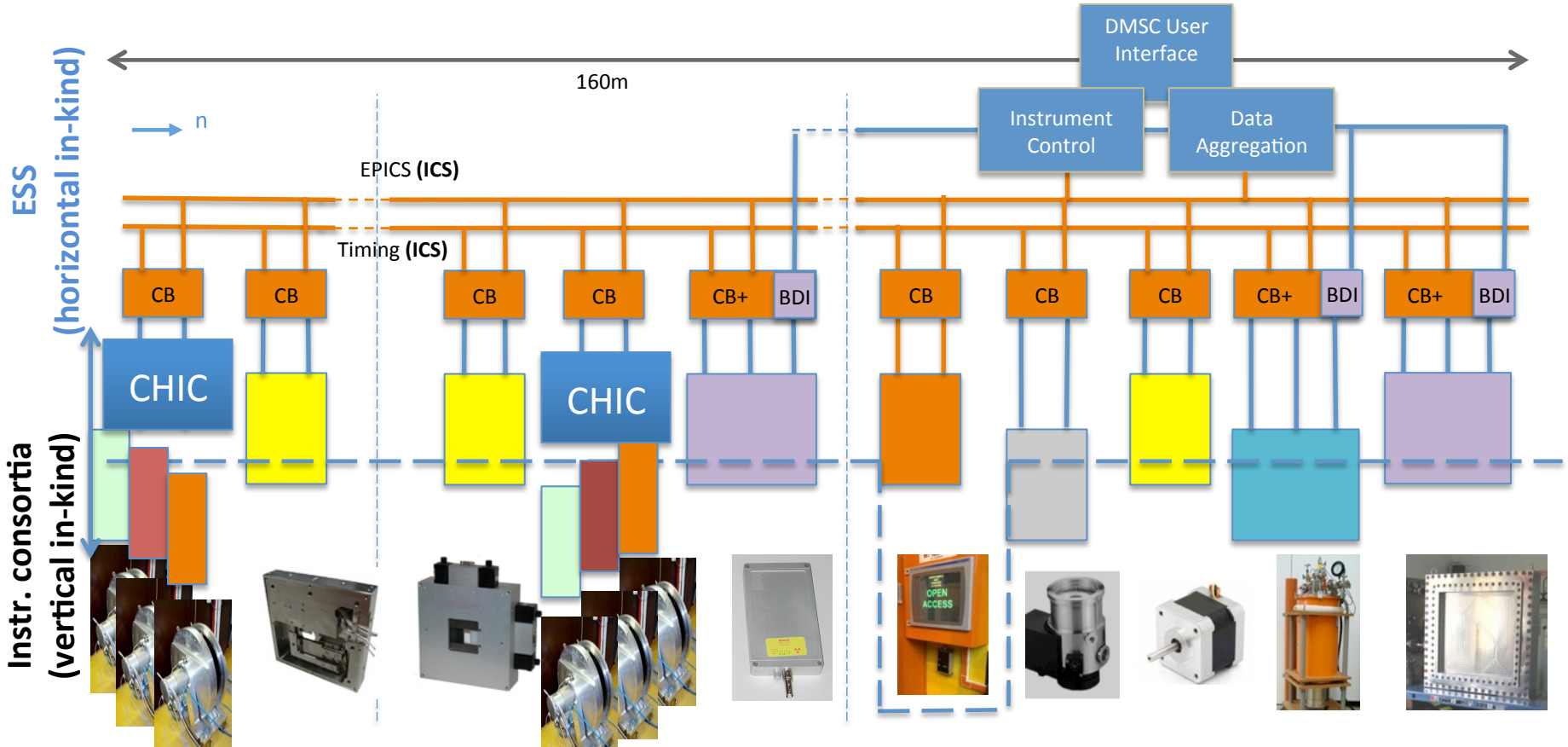
A coherent approach to implementation across the instrument suite, ensuring reliable high performance and operational serviceability



Implemented through
Published GUIDELINES & STANDARDS

Chopper Control : Modular Instrument Control Concept

- Flexibility in how partners contribute to the instrument
- Flexibility in how instruments consortia distribute their shares
- Flexibility in how much in-kind partner contributes to the control electronics



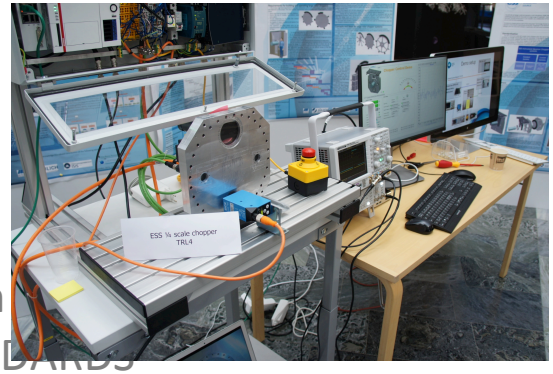
ESS STANDARDS
Chopper control systems & Condition monitoring

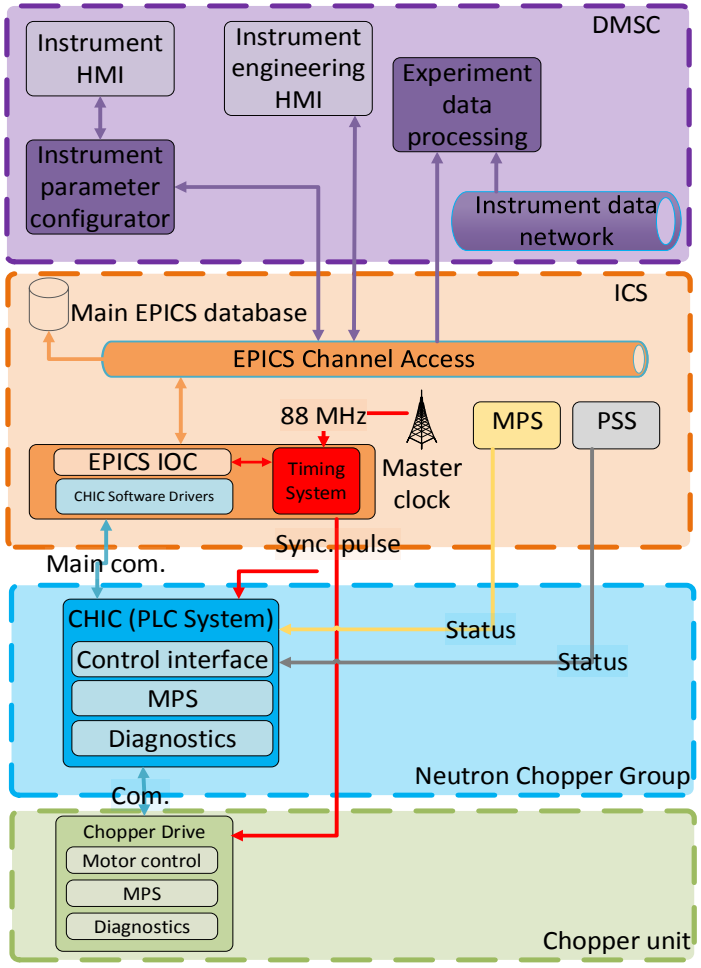
CHOPPER INTEGRATION CONTROLER (CHiC)

Hardware & Software Integration (EPICS) between suppliers chopper units and 'the facility'

- Instrument control system DMSC via ICS
- Instrument level Personal Safety Systems
- Machine Protection Systems

ESS Standard Condition monitoring & Diagnostics system





Implemented through:

- Development of Integration
- Hardware & Software STANDARDS

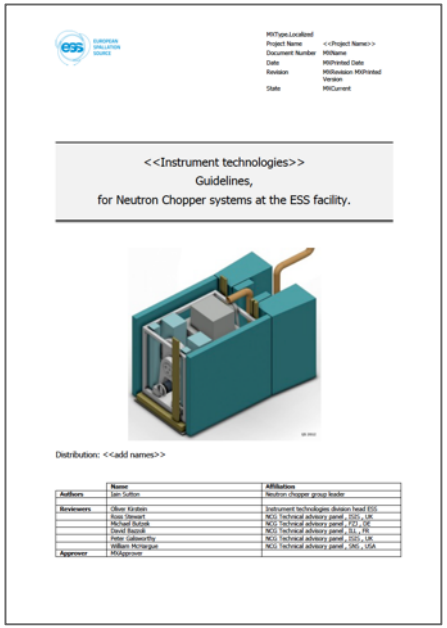
ESS Technical standards, Neutron chopper systems

EUROPEAN SPALLATION SOURCE

Chess #	Title
ESS-0034249	Neutron chopper systems, Guidelines
ESS-0034248	Neutron chopper systems, Concept of operations
ESS-0034247	Neutron chopper systems, Standards & Requirements
ESS-0034263	Neutron chopper systems, Strategy for design, manufacture and integration
ESS-0034262	Neutron chopper systems, Strategy for procurement
ESS-0034261	Neutron chopper systems, Strategy for installation, commisioning and early operation
ESS-0034260	Neutron chopper systems, Strategy for normal operation
ESS-0034259	Neutron chopper systems, Strategy for decommisioning and disposal
ESS-0034258	Neutron chopper systems, Standard component list

ESS requirements, specification and equipment standards

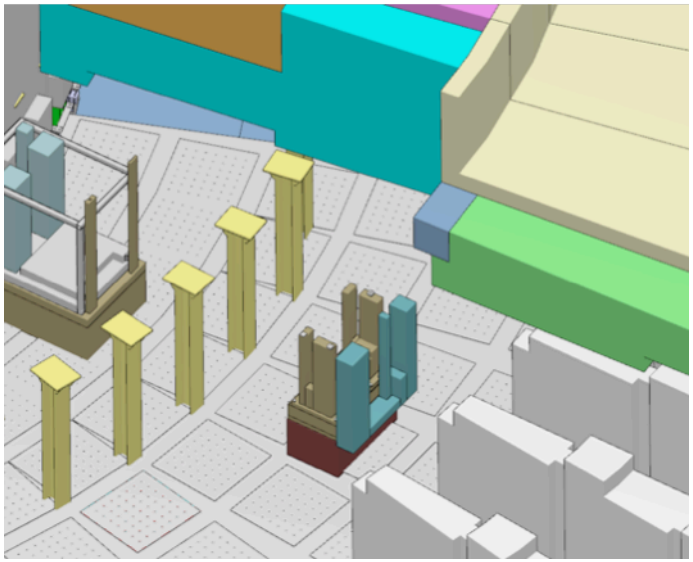
- Facility requirements
  - Safety & security
  - Legislation
  - Certification
  - Quality assurance
  - ….
- Operational requirements
  - Reliability
  - Availability
  - Maintainability
  - Transportability
  - ….



ESS Document :ESS0034247

Neutron chopper systems Strategies

- Neutron chopper systems, during instrument design, construction and integration
  - ESS Document :ESS0034263
  - Draft release Q3 2015
- Neutron chopper systems, during instrument installation, commissioning and early operation
  - ESS Document :ESS0034261
  - Draft release Q4 2015
- Neutron chopper systems during instrument normal operation
  - ESS Document :ESS0034260
  - Draft release Q3 2015
- Neutron chopper system during decommissioning and disposal
  - ESS Document :ESS0034259
  - Draft release Q1 2016

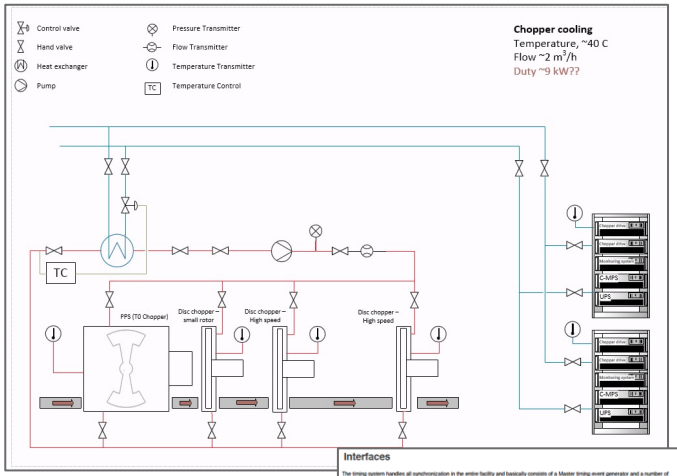


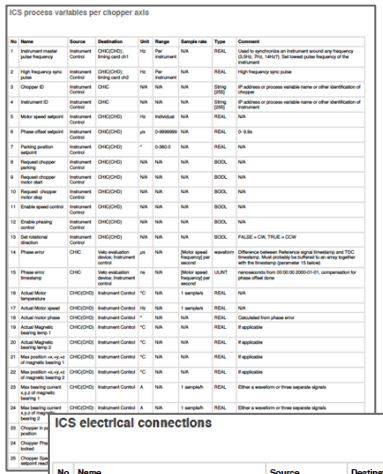
Neutron Chopper System
Interface configuration definitions

EUROPEAN SPALLATION SOURCE

- ICD NCG-CF
- ICD NCG-Cooling
- ICD NCG-Motion Control and Automation
- ICD NCG-Health and safety
- ICD NCG-Optics
- ICD NCG-Shielding
- ICD NCG-Vacuum
- ICD NCG-DMSC
- ICD NCG-ICS EPICS SW
- ICD NCG-ICS Machine Protection System
- ICD NCG-ICS Personnel Safety System
- ICD NCG-ICS Timing System Network
- ICD NCG-CHiC-Drive
- ICD NCG-Detectors
- ICD NCG-Sample station
- ICD NCG-Target Station

Draft releases Q3 2015

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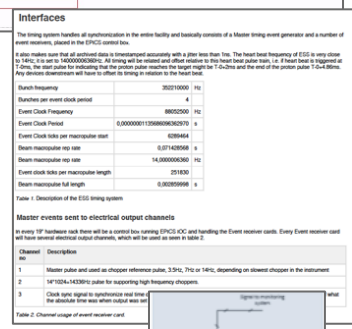
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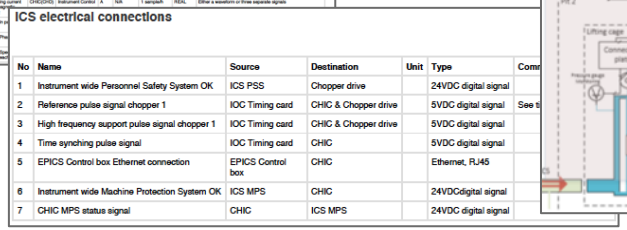
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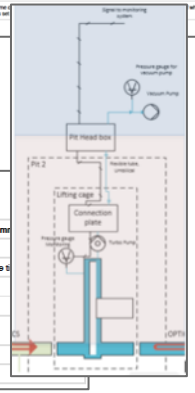
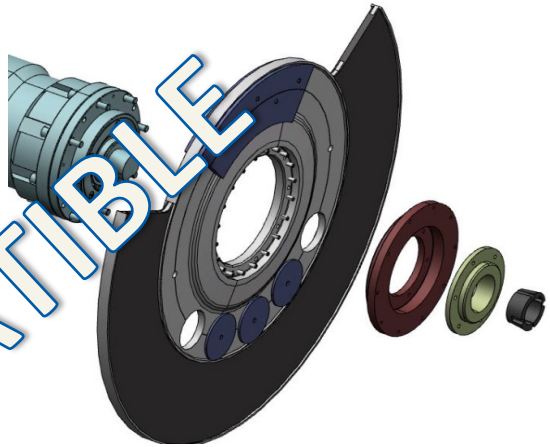
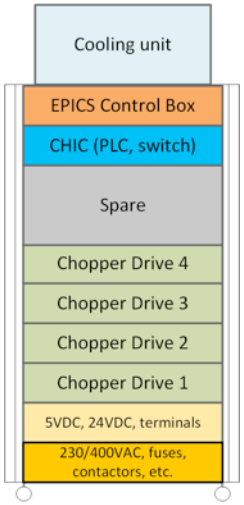


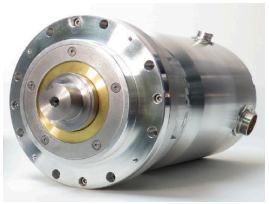
Standard components

- Component specifications
  - Control racks
  - UPS systems
  - Cooling systems
- Component recommendations
  - Sensors
  - Motors
  - Cables
  - Seals
- Material recommendations
  - Materials for construction
  - Beam windows
  - Pressure housings

ESS Document :ESS0034258



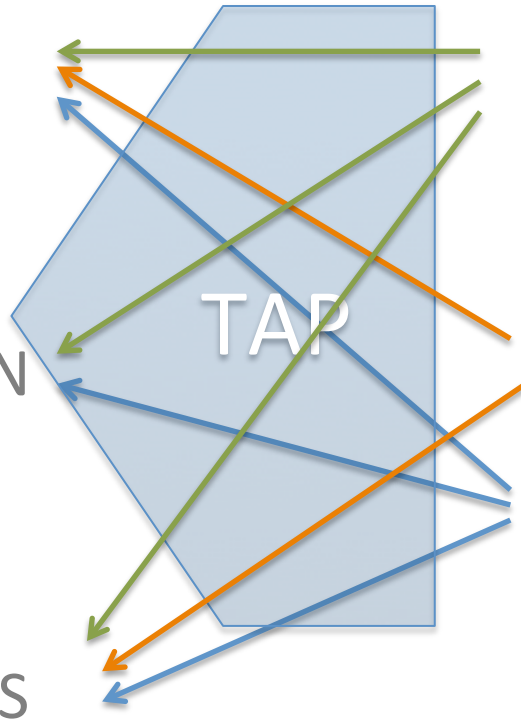




ESS COMPATIBLE

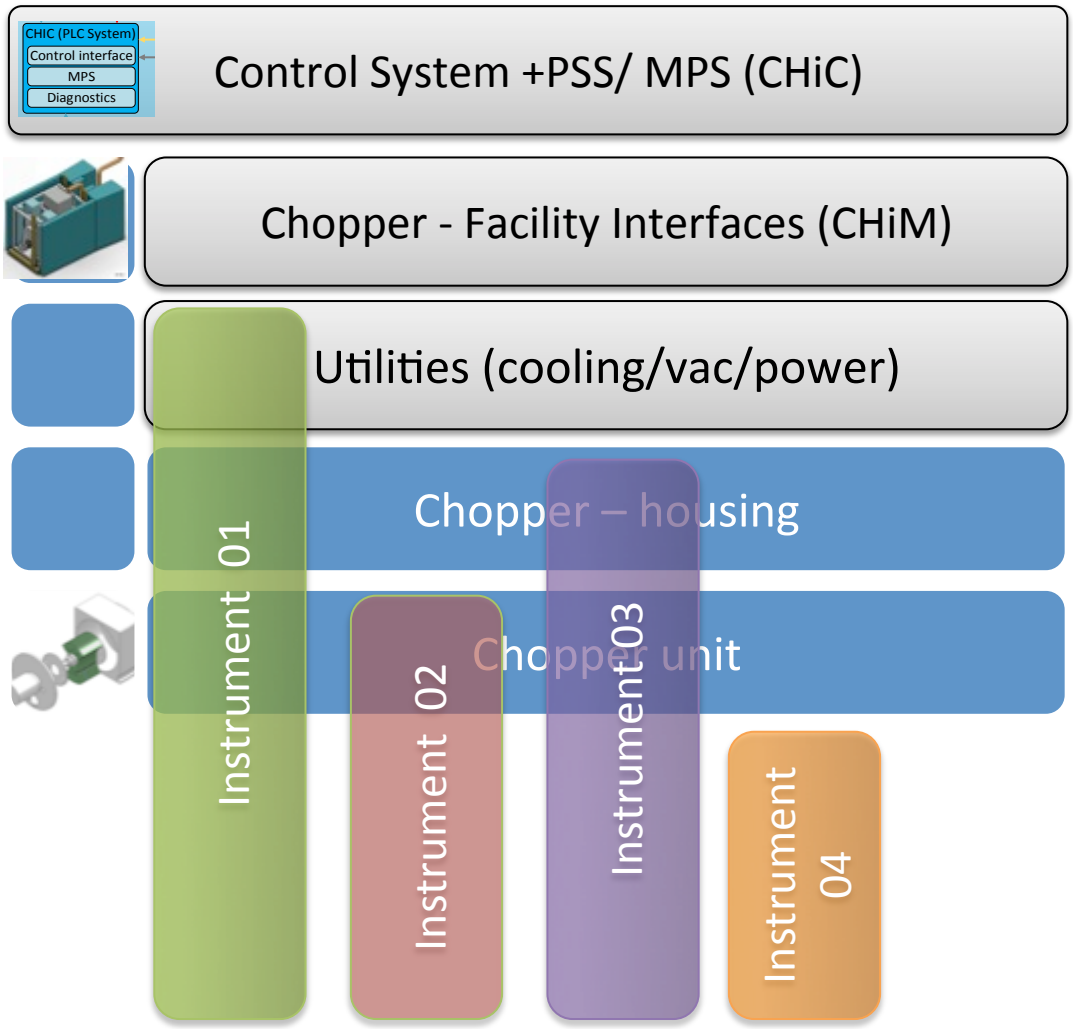
PARTNER PARTICIPATION

- STANDARDS DEFINITION
  - Test Protocols
  - Materials
  - Solutions
- EQUIPMENT VALIDATION
  - Performance
  - Irradiation
  - Endurance
- PROCUREMENT OPTIONS
  - Chopper units
  - Spindles
  - Rotors



SUPPLIER FORUM

HORIZONTAL & VERTICAL



< - ESS HW/SW

< - HW or Design

< - Interface Specification
Some ESS supply

<- ESS Interface specification

<- ESS Equipment standards & interface specification

EUROPEAN SPALLATION SOURCE

ESS INSTRUMENT TECHNOLOGIES

- SUPPORT
- ENABLE
- INTEGRATE

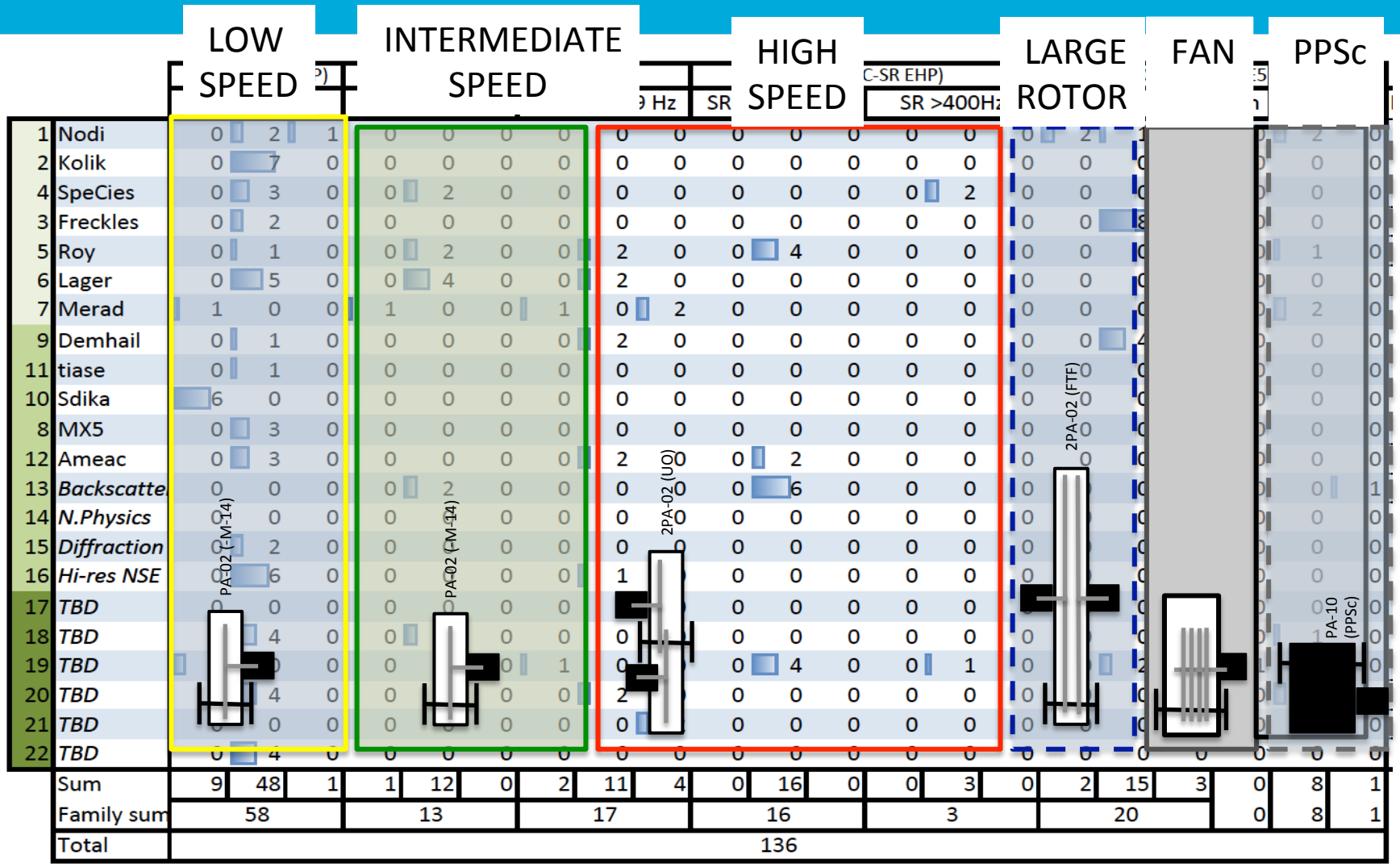
END

Thank you for your attention

Frame work agreement summary

- ESS negotiates of framework agreement with suppliers and funding partners.
- ESS tenders and puts in place frame work agreements for batches of equipment in a strategic manner.
- Several sources would remain open for each type of equipment.
- Purchases under the negotiated conditions may be made by any instrument group within the project from suppliers under the frame work agreement.
- Payments are made by funding partners to the suppliers.

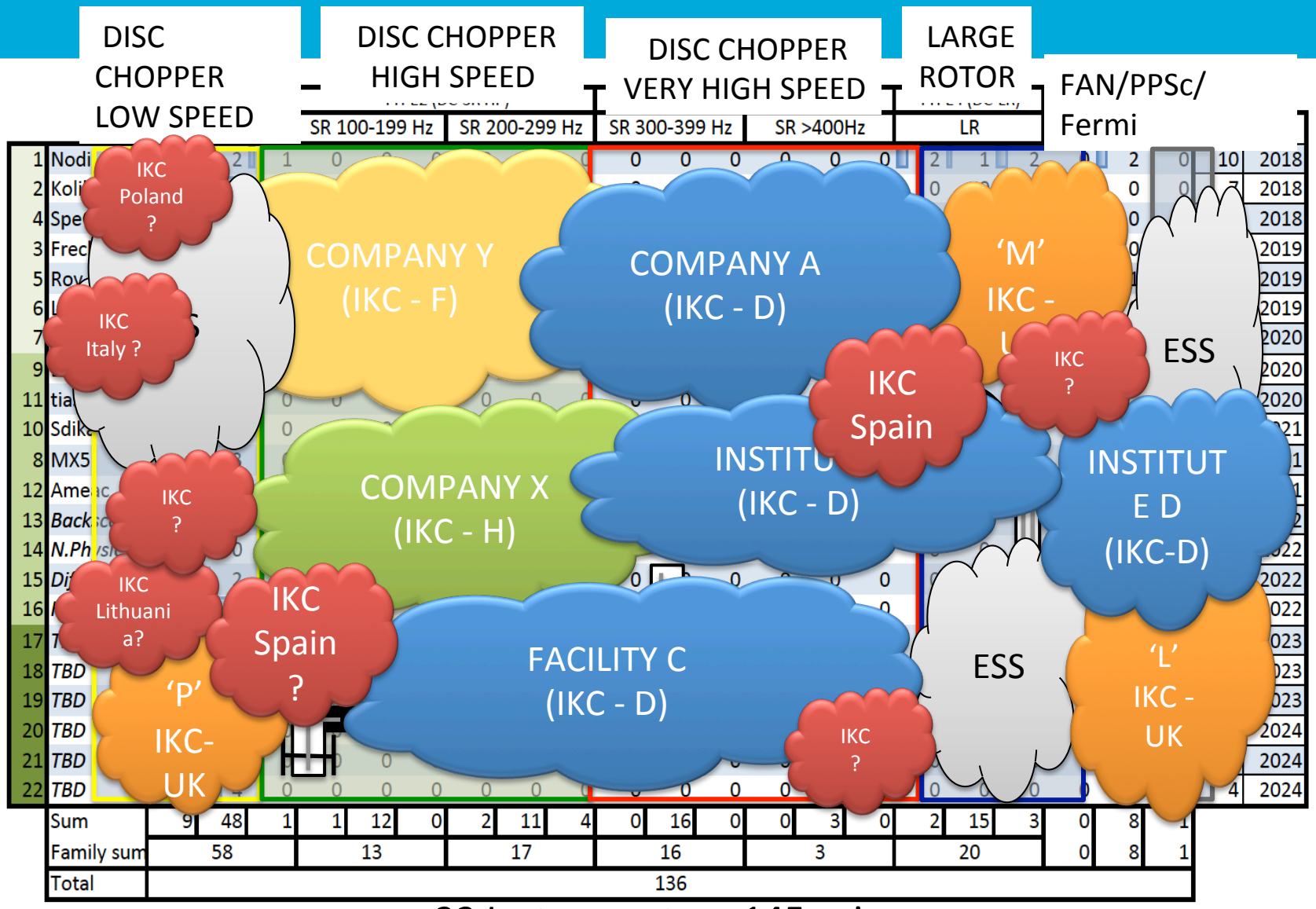
ESS
Overview of the suite of neutron choppers



1	Nodi	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1		2	0				
2	Kolik	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
4	SpeCies	0	3	0	0	2	0	0	0	0	0	0	0	0	0	2	0			0	0				
3	Freckles	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0				
5	Roy	0	1	0	0	2	0	0	2	0	0	4	0	0	0	0	0			1	0				
6	Lager	0	5	0	0	4	0	0	2	0	0	0	0	0	0	0	0			0	0				
7	Merad	1	0	0	1	0	0	1	0	2	0	0	0	0	0	0	0			2	0				
9	Demhail	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0			0	0				
11	tiase	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
10	Sdika	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
8	MX5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
12	Ameac	0	3	0	0	0	0	0	2	0	0	2	0	0	0	0	0			0	0				
13	*Backscatte*	0	0	0	0	2	0	0	0	0	0	6	0	0	0	0	0			0	0	1			
14	*N.Physics*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
15	*Diffraction*	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
16	*Hi-res NSE*	0	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0			0	0				
17	*TBD*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
18	*TBD*	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0			1	0				
19	*TBD*	0	0	0	0	0	0	1	0	0	0	4	0	0	1	0	2			1	0				
20	*TBD*	4	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0			0	0				
21	*TBD*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0				
22	*TBD*	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
	Sum	9	48	1	1	12	0	2	11	4	0	16	0	0	3	0	2	15	3	0	8	1			
	Family sum	58			13			17			16			3			20			0	8	1			
	Total	136																							

6 ‘platforms’ ~150 Choppers

A vision of 'Chopper systems' in-kind



22 Instruments ~ 145 axis