

NSS project requirements for chopper systems

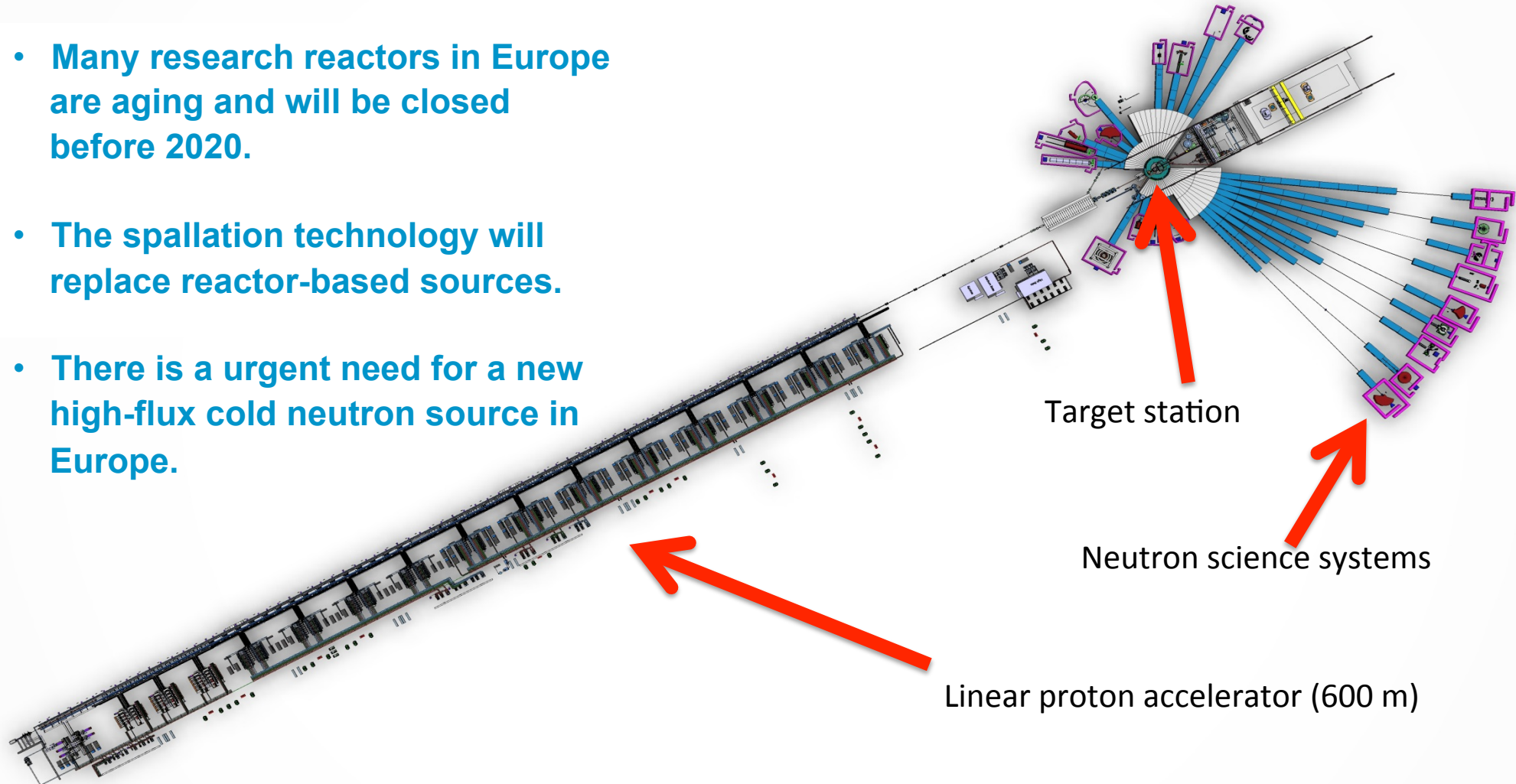
Science directorate
Instrument technologies division
Neutron chopper group leader

“Strategy, the human attempt to get to desirable ends with available means”.

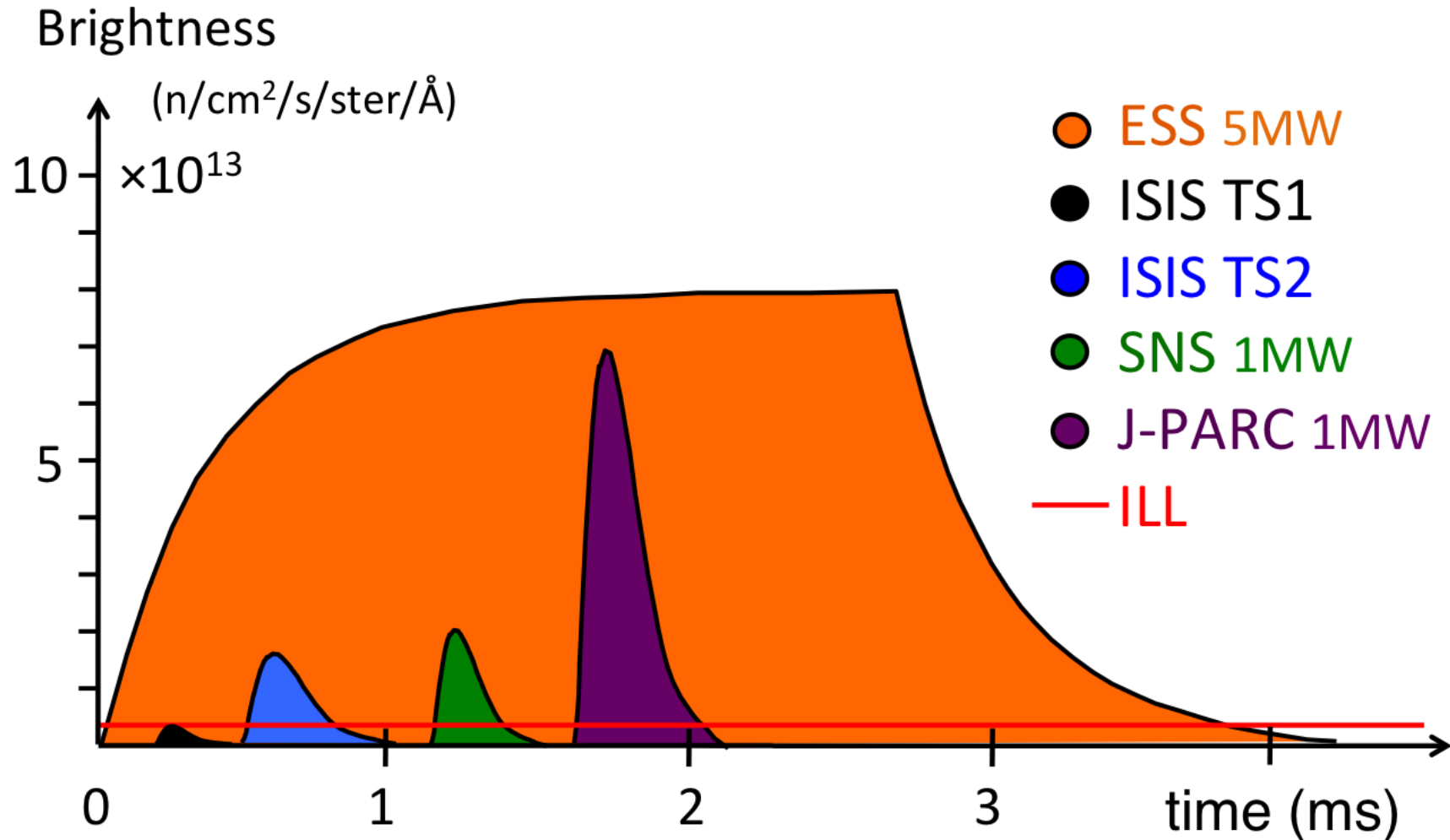
Max McKeown

Spallation: Generating Neutrons for Science


- Many research reactors in Europe are aging and will be closed before 2020.
- The spallation technology will replace reactor-based sources.
- There is a urgent need for a new high-flux cold neutron source in Europe.



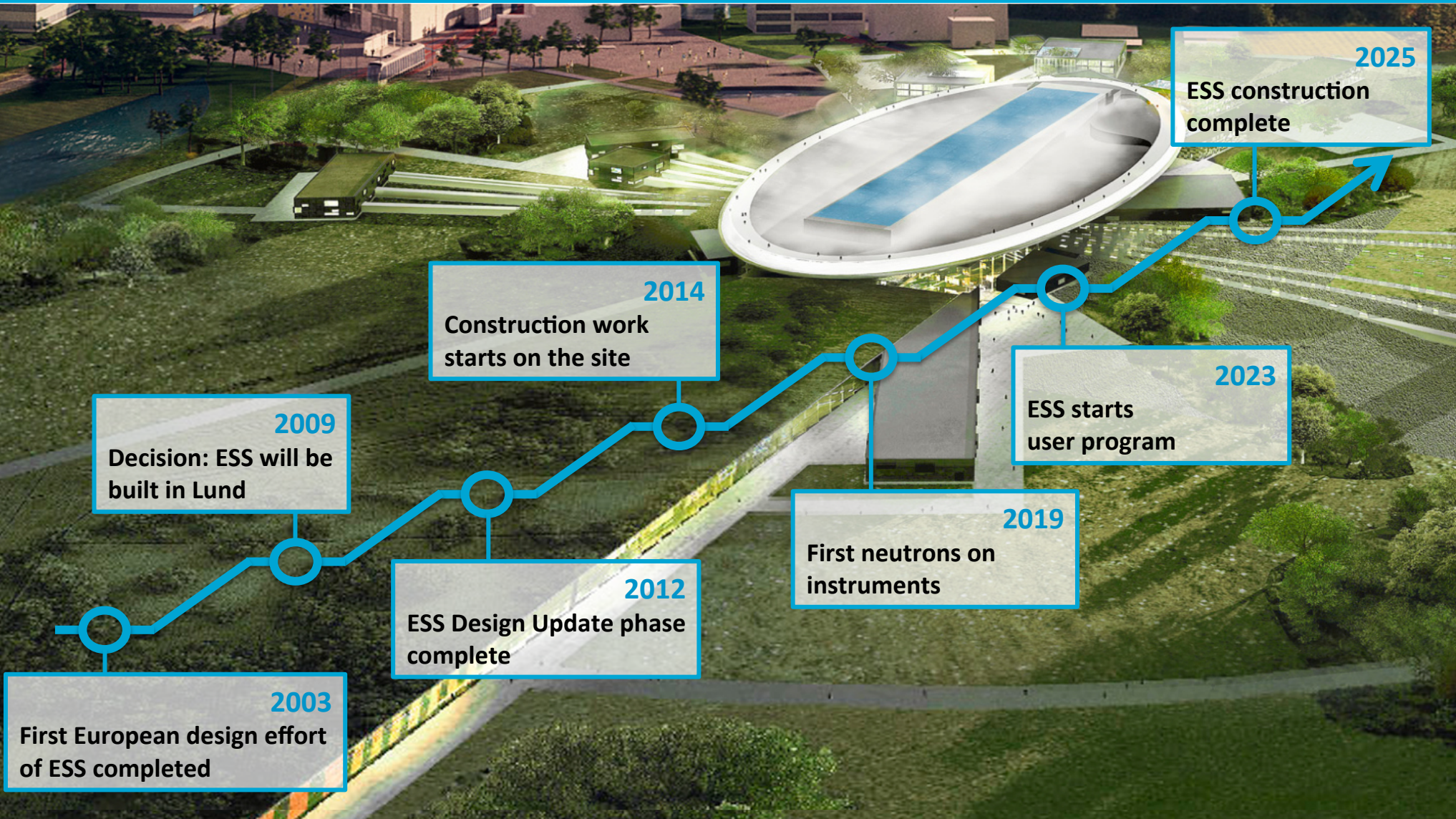
ESS is a Long-Pulse Source



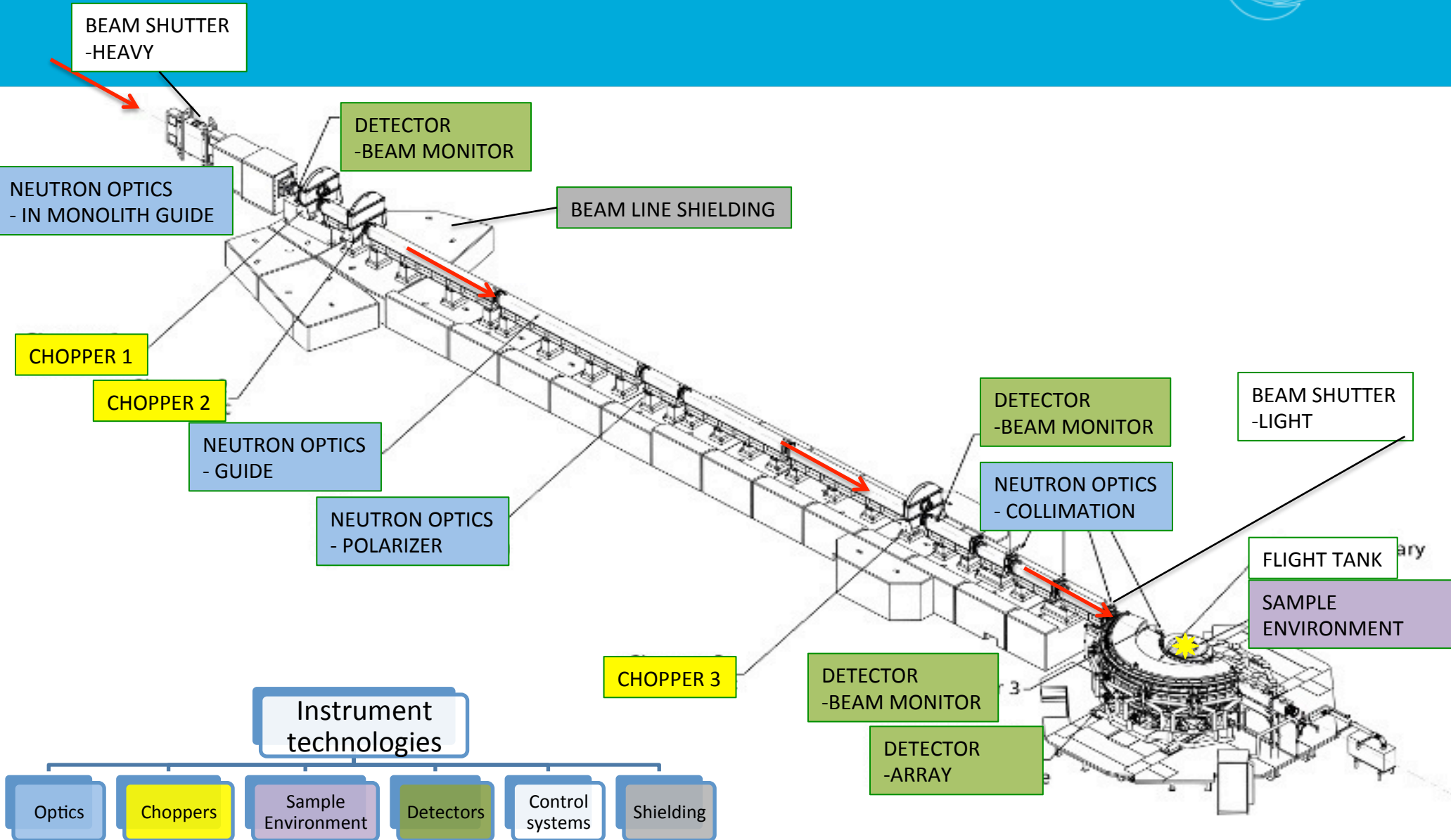
Project Commitments

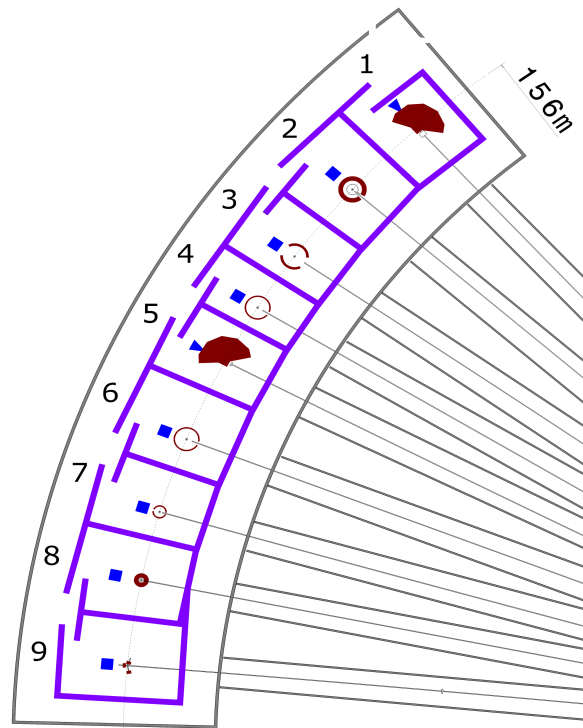
- 
- ✓ 5 MW accelerator capability, 30 times brighter than existing facilities
 - ✓ 22 Instruments, state of the art technologies
 - ✓ Construction cost of 1,843 B€
 - ✓ Steady-State Ops at 140 M€/year

The road to realizing the world's leading facility for research using neutrons

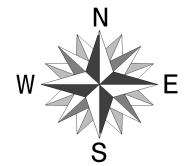


ESS Instrument technologies

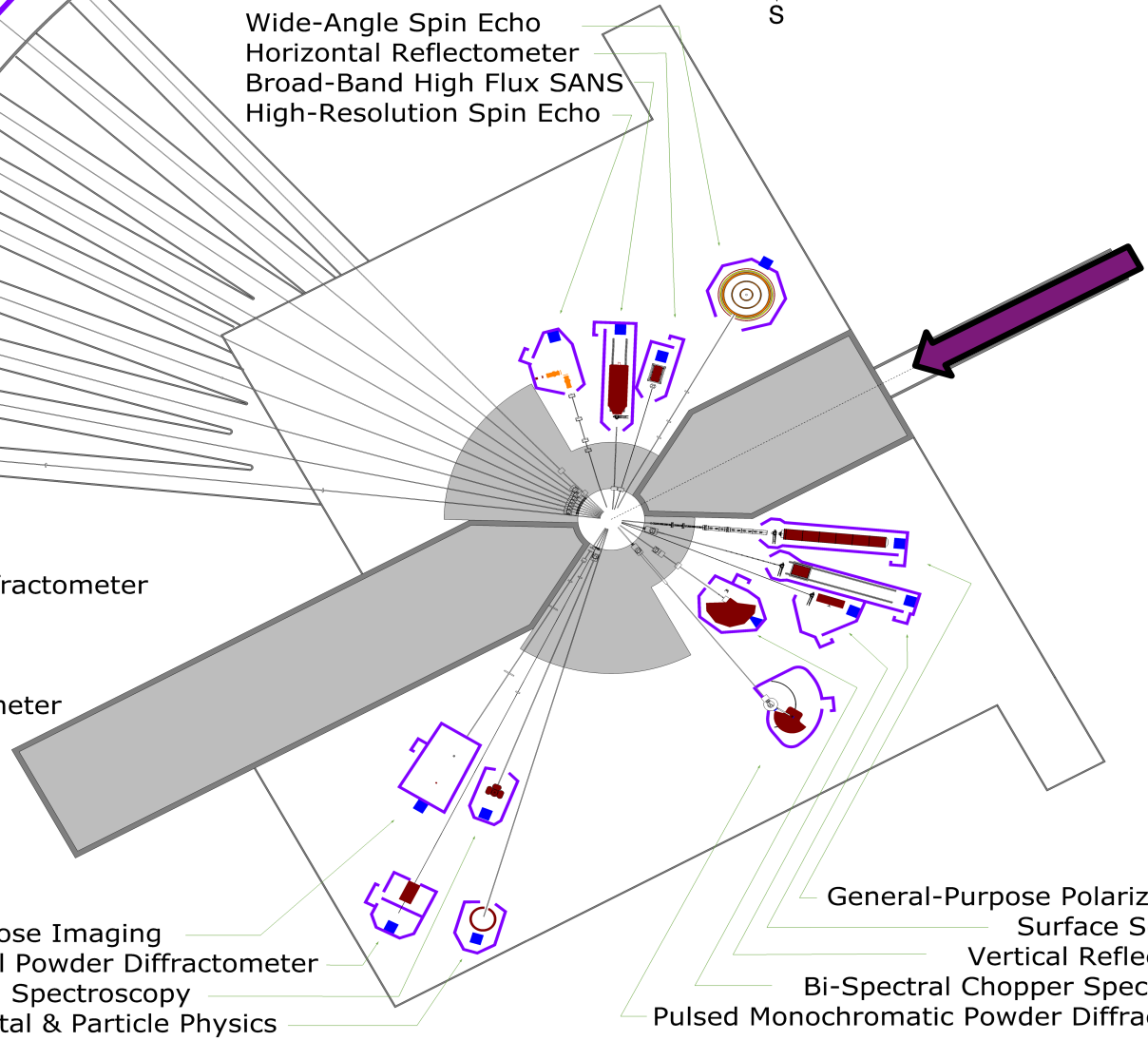




Wide-Angle Spin Echo
 Horizontal Reflectometer
 Broad-Band High Flux SANS
 High-Resolution Spin Echo



1. Cold Chopper Spectrometer
2. Backscattering Spectrometer
3. Materials Science & Engineering Diffractometer
4. Thermal Powder Diffractometer
5. Thermal Chopper Spectrometer
6. Extreme Conditions Instrument
7. Single-Crystal Magnetism Diffractometer
8. Cold Crystal-Analyzer Spectrometer
9. Macromolecular Diffractometer



Multi-Purpose Imaging
 Bi-Spectral Powder Diffractometer
 Vibrational Spectroscopy
 Fundamental & Particle Physics

General-Purpose Polarized SANS
 Surface Scattering
 Vertical Reflectometer
 Bi-Spectral Chopper Spectrometer
 Pulsed Monochromatic Powder Diffractometer

Technology 'Cross cut' Strategy

Cake - traditional approach



Cake - Cross cut approach

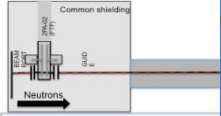
Technology groups assume global responsibility for all equipment of the type across the instrument suite

- Equipment standards
- Design and implementation guidelines
- Coordination of technology development
- Procurement
- Putting together build partners and work units
- Maximising in-kind potential.

Neutron Chopper Suite

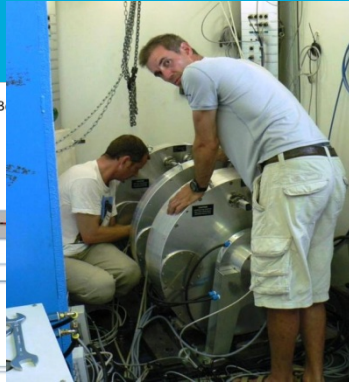
Diversity

CS/ TEMPIS FUGIT Sector: B



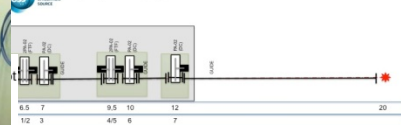
FUNCTION
PULSE SHAPING
NOT PART OF
BUT DO THEY
USED TRIST

NOTES



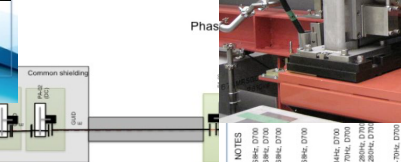
4 x 20 planned similar to term chopper PE-50

JANS-LOKI v3 (Sleipner merge) Schematic Phase 1-Preliminary



12	3	4.5	6	7	12	20
7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	2PRA-02	14Hz DT00		
18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00

17.53	20.71	1
3	4	1
100x40	100x40	40x20



17.53	20.71	1
3	4	1
100x40	100x40	40x20

18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00
7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00
42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00

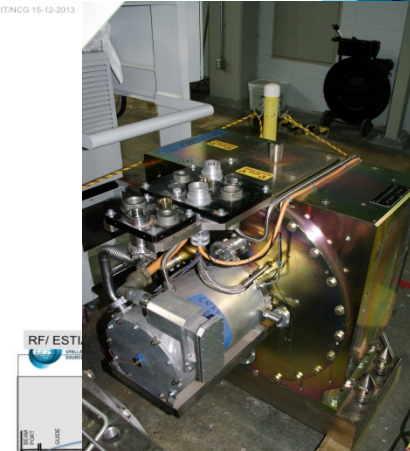


23	31
4	

FUNCTION
SHUTTER
POLARIZING KINK
FRAME OVERLAP
FRAME OVERLAP
RF FLIPPER
FRAME OVERLAP
FRAME OVERLAP

NOTES

IT/NGG 15-12-2013



16.2	52
1	
30x30	

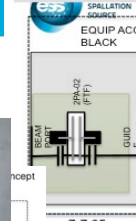
FUNCTION
FRAME OVERLAP

NOTES
14Hz DT00 Mid point of 1st guide

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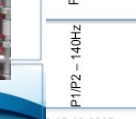
CS/ C-SPEC Schematic



7-7.05	1	2
100x40		

PULSE SHAPING
P1/P2 = 140Hz

15-12-2013



17.53	20.71	1
3	4	1
100x40	100x40	40x20

18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00
7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00
42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00



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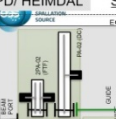
Schematic



7-7.05	1	2
100x40		

PULSE SHAPING
P1/P2 = 140Hz

15-12-2013



17.53	20.71	1
3	4	1
100x40	100x40	40x20

18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00
7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00
42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00



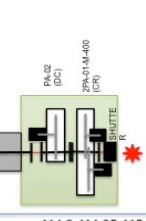
23	31
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RF FLIPPER
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FRAME OVERLAP

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IT/NGG 15-12-2013

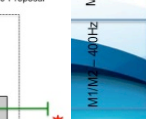
Phase 0-Concept



114.9-114.95-115	5	6	7
40x20			

ME OVERLAP
MONOCHROMAT OR

114.9-114.95-115



114.9-114.95-115	5	6	7
40x20			

18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00	18Hz DT00
7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00	7-14Hz DT00
42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00	42-20Hz DT00



23	31
4	

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FRAME OVERLAP
FRAME OVERLAP
RF FLIPPER
FRAME OVERLAP
FRAME OVERLAP

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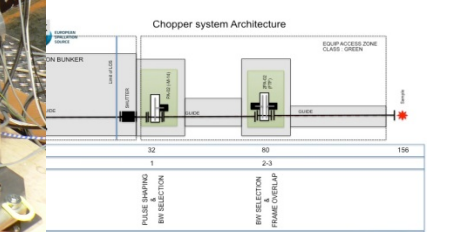


17.53	20.71	1
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FUNCTION
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FRAME OVERLAP
RF FLIPPER
FRAME OVERLAP
FRAME OVERLAP

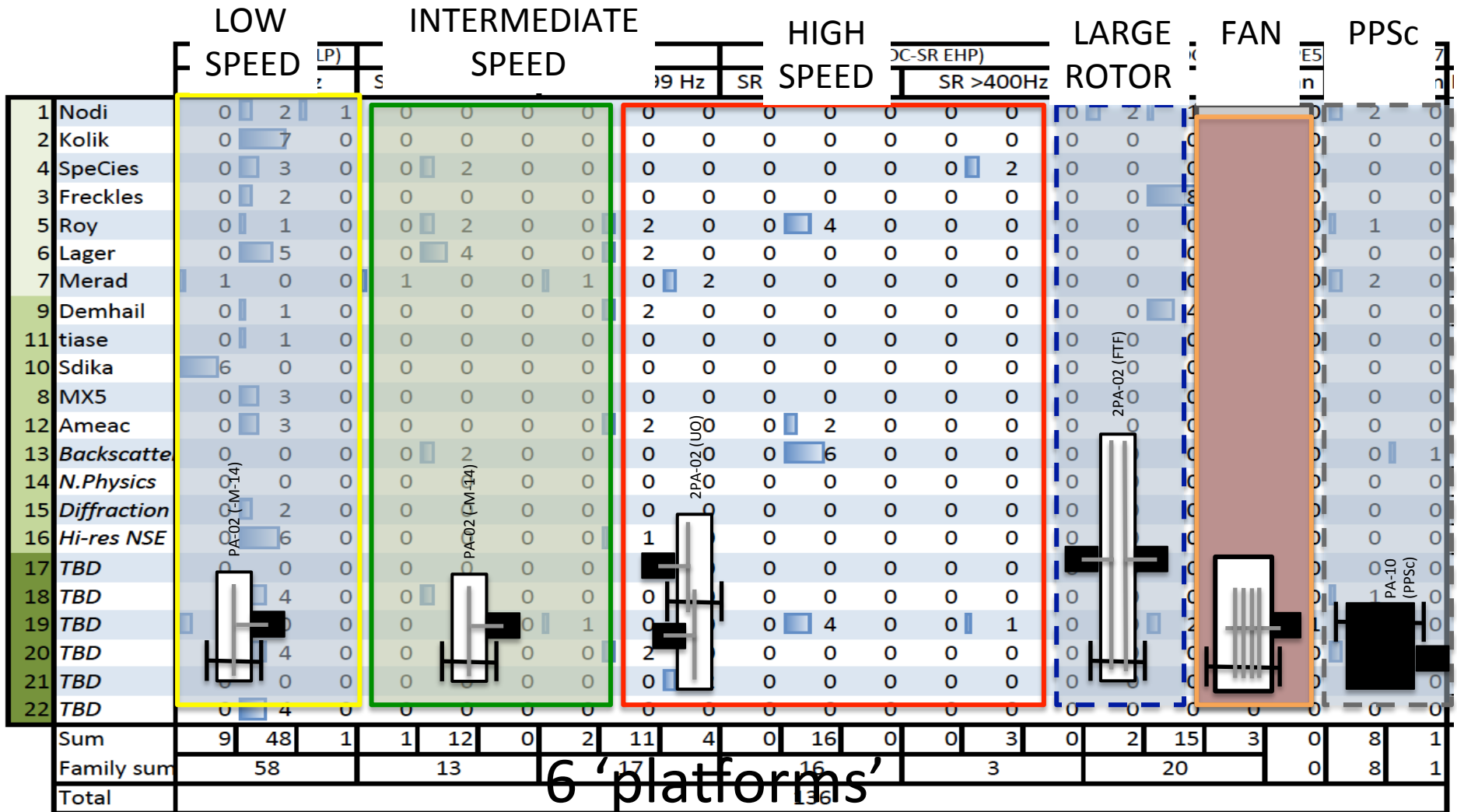
NOTES

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Common component platforms

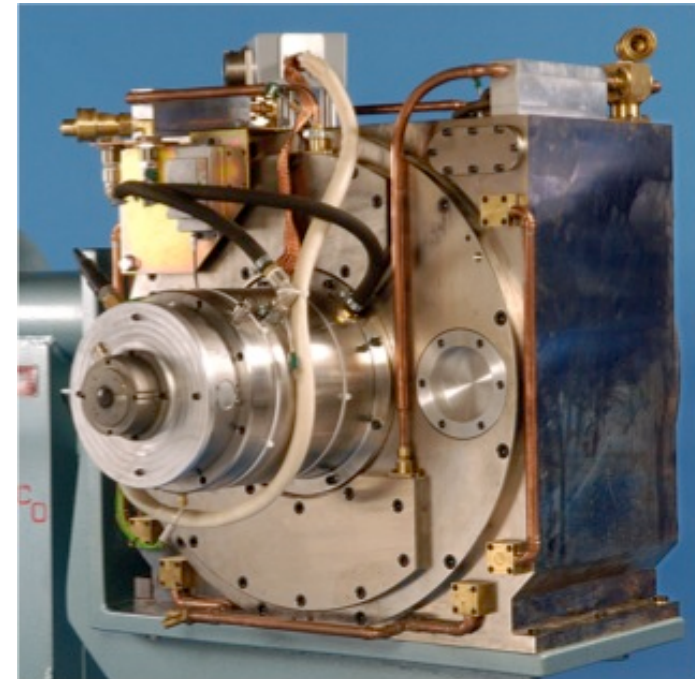


Platforms

Within each platform....

A common mechanical & control architecture.

- Motor & Drive
- Rotor fixation
- Support structures
- Support systems
- Control commands (?)
- Monitoring system
- MPS & PPS functions



Platform 1

Disc chopper – Small rotor – Low speed

Key requirements

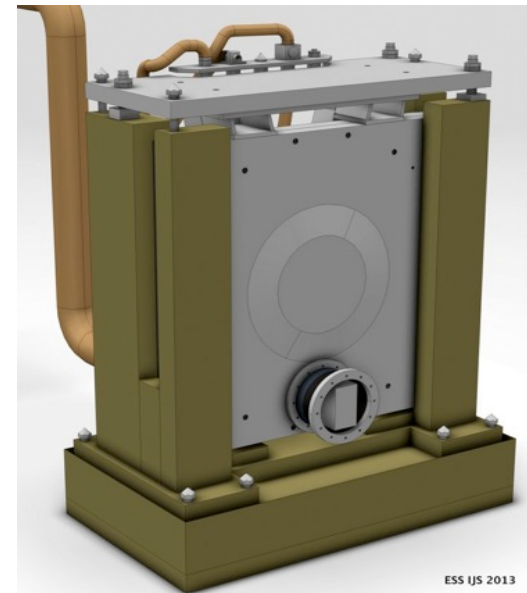
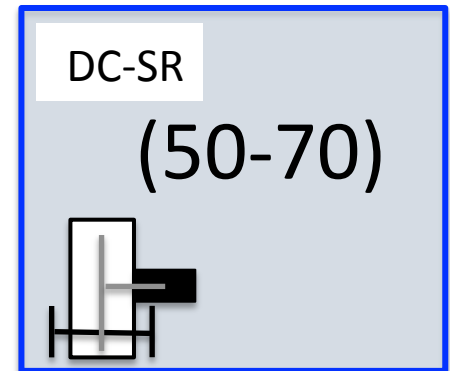
- Rotation speed: Low (7 - 96 Hz)
- Openings: Large
- Attenuation at short wavelengths
- High reliability in radiation environment
- Low lifetime cost

Principal characteristics

- Type: PA-1-H- (horizontal axis disc)
- Rotors : Simple + Robust
- Diameter: 600-800mm

Enabling Technologies .

- Rotors materials: Metallic
- Bearings: Magnetic



Platform 2

Disc chopper – Small rotor – Intermediate speed

Key requirements

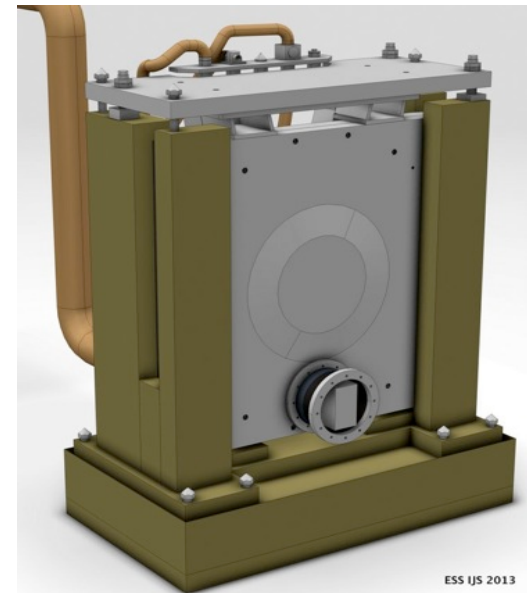
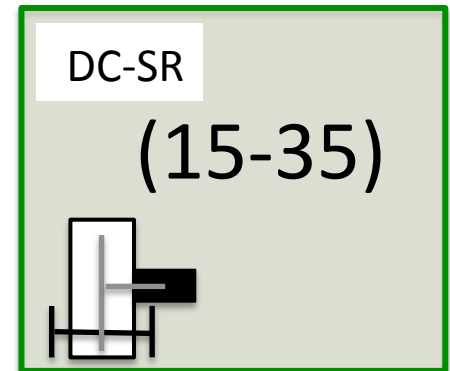
- Rotation speed: (96-192 Hz)
- Openings: (Multiple) Small or Large
- High reliability in radiation environment

Principal characteristics

- Type: PA-1-H- (horizontal axis disc chopper)
- Rotors: Simple or Optimized
- Diameter: 600-800mm

Enabling Technologies .

- Rotor material: CFRP / Alu
- Bearings: Magnetic



Platform 3:

Disc chopper – Small rotor – High speed

Key requirements

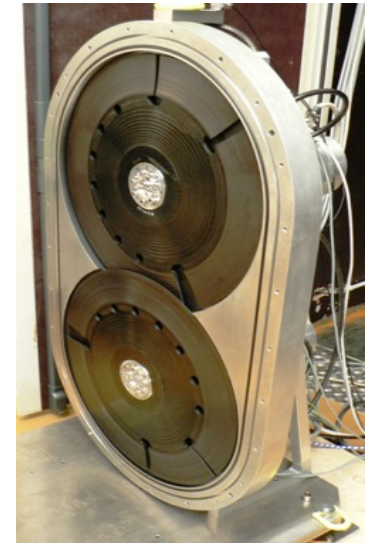
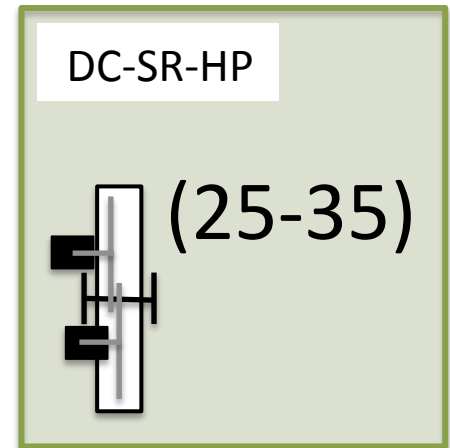
- Rotation speed: 192- 400+ Hz
- Openings: (Multiple) Small
- Minimal guide interruption
- High reliability in radiation environment

Principal characteristics

- Type : PA-1-H- (horizontal axis disc)
- Rotors design: Optimised
- Diameter : 600-700mm

Enabling Technologies .

- Rotor material: CFRP / Ti / MMC
- Bearings: Magnetic



2.PA-1-H-M

Platform 4: Disc chopper – Large rotor

Key requirements

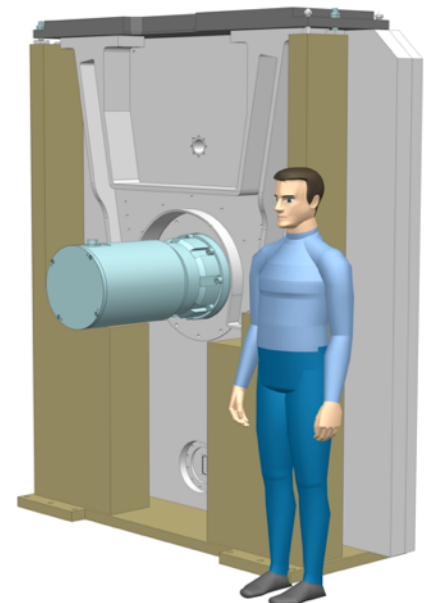
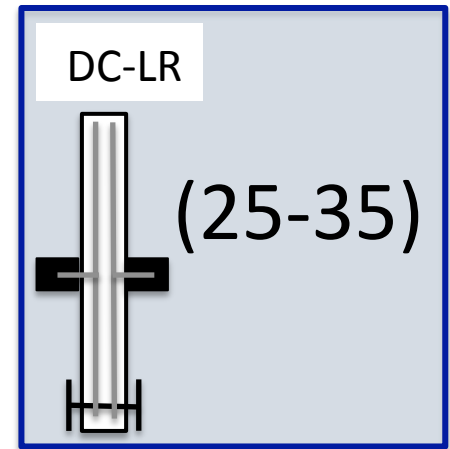
- Rotation speed: (7 - 56 Hz)
- Openings: Multiple V.Large, Asymmetric
- High closing speed
- High reliability in radiation environment

Principal characteristics

- Type: PA-1-H- (horizontal axis disc chopper)
- Rotors: Optimized
- Diameter: 1200 - 2000mm

Enabling Technologies .

- Rotor material: CFRP / Alu
- Bearings: Magnetic or Contact



Platform 5: Disc chopper – Fan

Key requirements

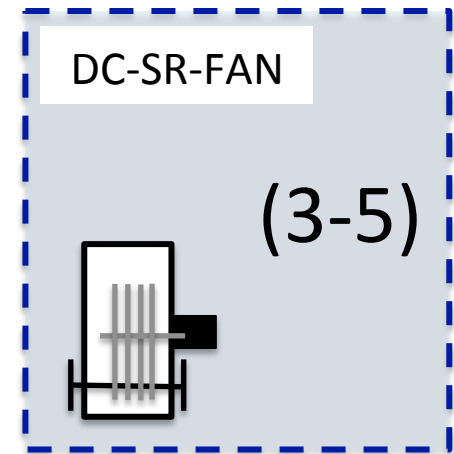
- Rotation speed: (7 - 56 Hz)
- Openings: Variable width, Asymmetric

Principal characteristics

- Type: XPA-1-H- (horizontal axis disc chopper)
- Rotors: multiple concentric 'Fan'
- Diameter: 500 - 800mm

Enabling Technologies .

- Rotor material: Aluminium
- Bearings: Contact



Platform 6: Prompt pulse suppression chopper PPSc

Key requirements

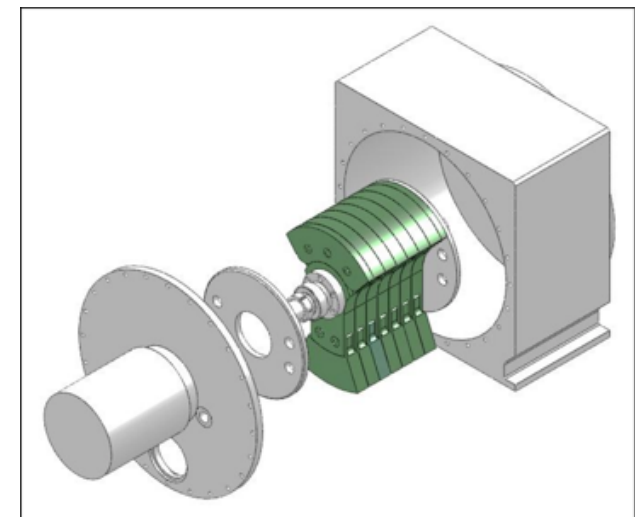
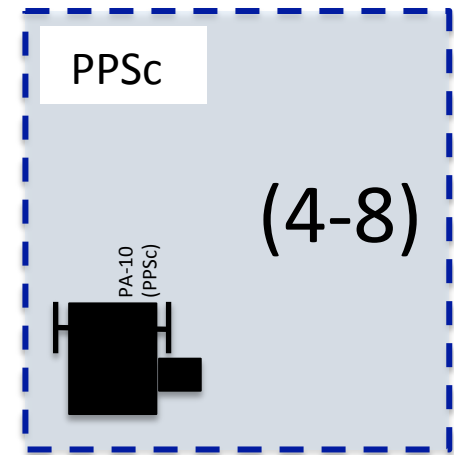
- Rotation speed: (7 - 56 Hz)
- Closure: 3ms, Symmetric or Asymmetric
- Attenuation : 90% @ Prompt pulse energies
- Extreme radiation resistance

Principal characteristics

- Type: PA-10-H- (horizontal axis chopper)
- Rotors: 300 – 400 thick , single or double
- Diameter: 500 - 600mm

Enabling Technologies .

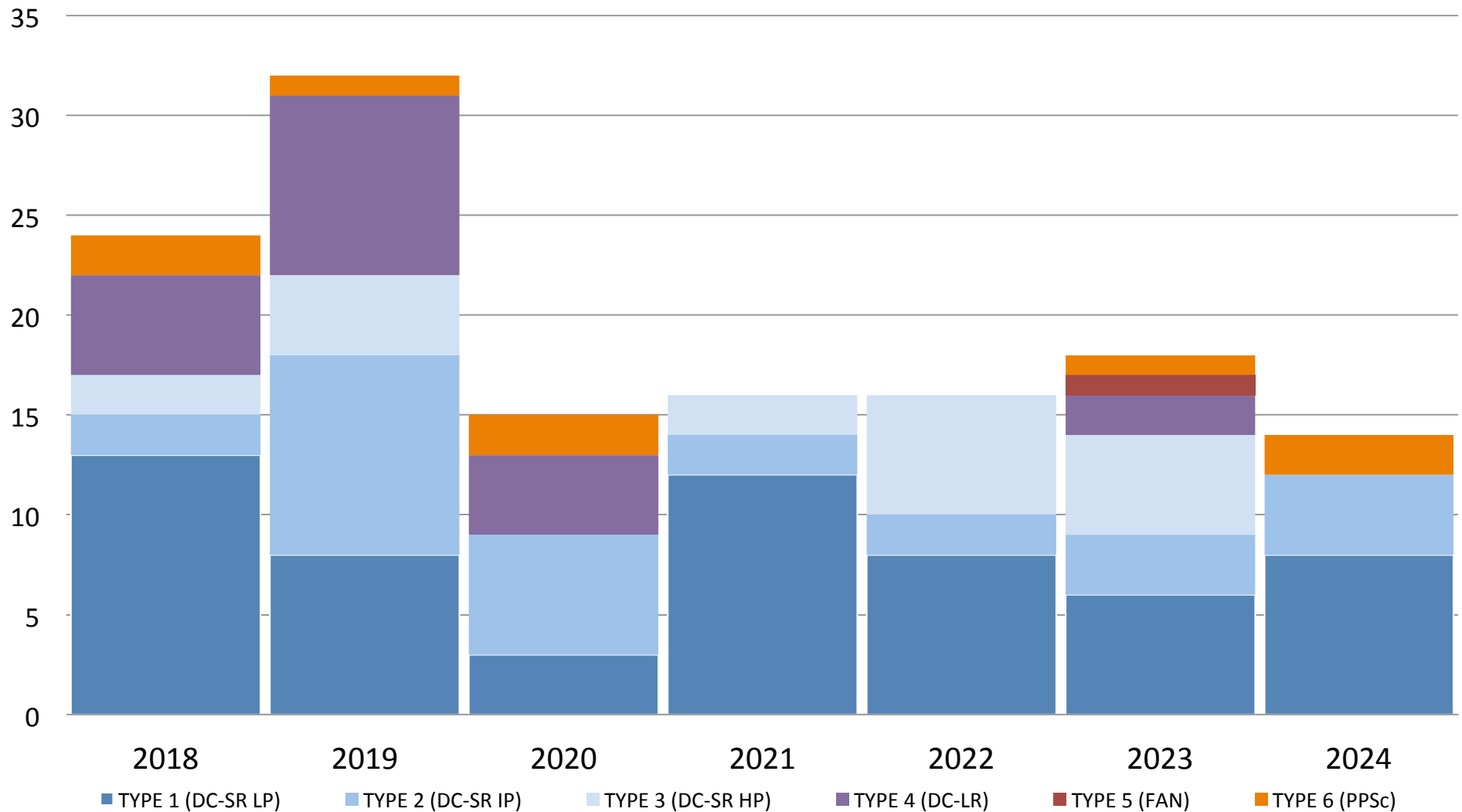
- Rotor material: Nickel alloy / Tungsten
- Bearings: Magnetic



Instrument projects overview



Chopper deliveries p.a.



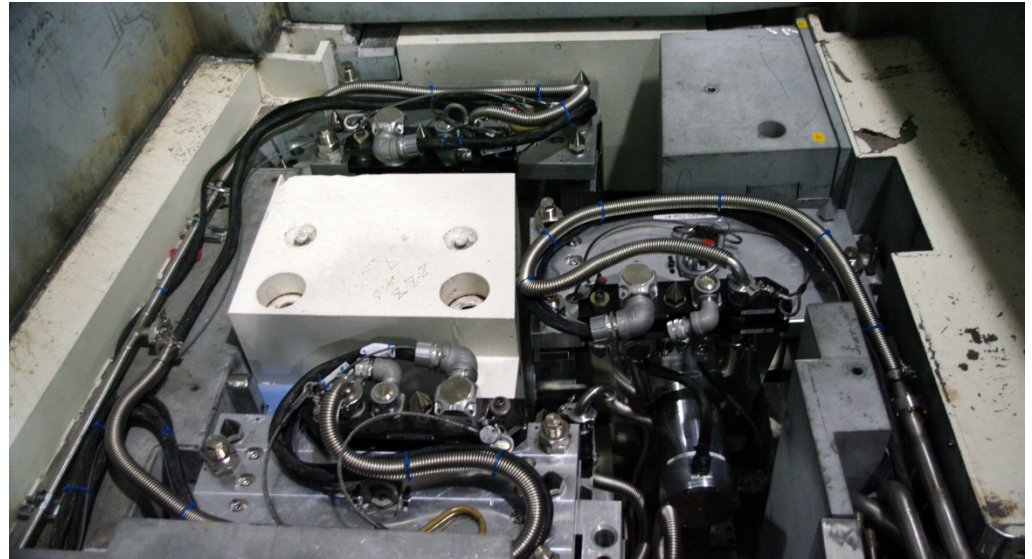
CHOPPER SYSTEM ENGINEERING INTEGRATION

Hardware integration

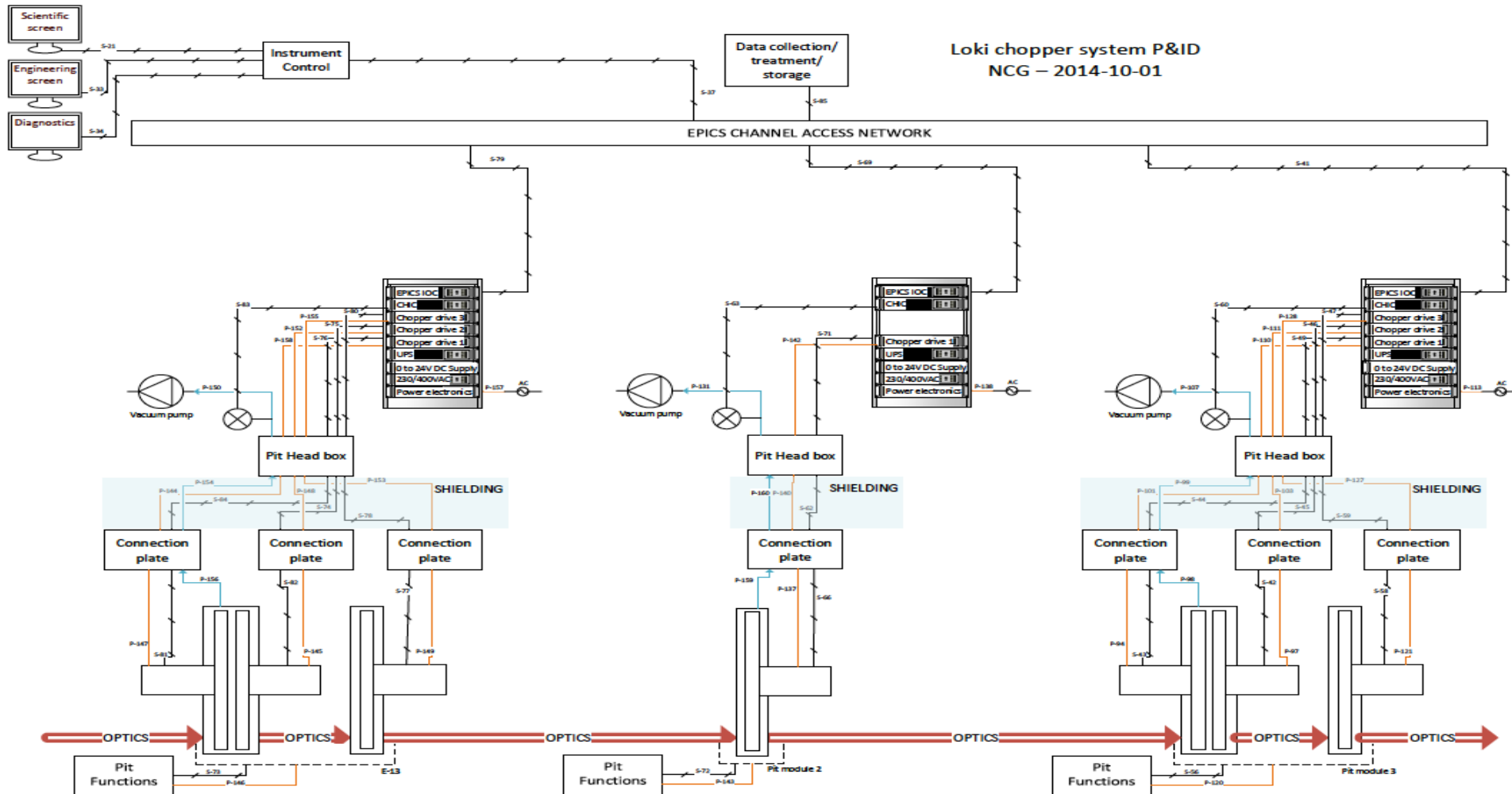
- Integration into instrument control HW (CHIC)
- Instrument control software
- Power
- Cooling systems
- Vacuum systems

Operational interfaces

- Access requirements
 - Instrument support teams
 - Target systems
- Neighboring instruments (!)



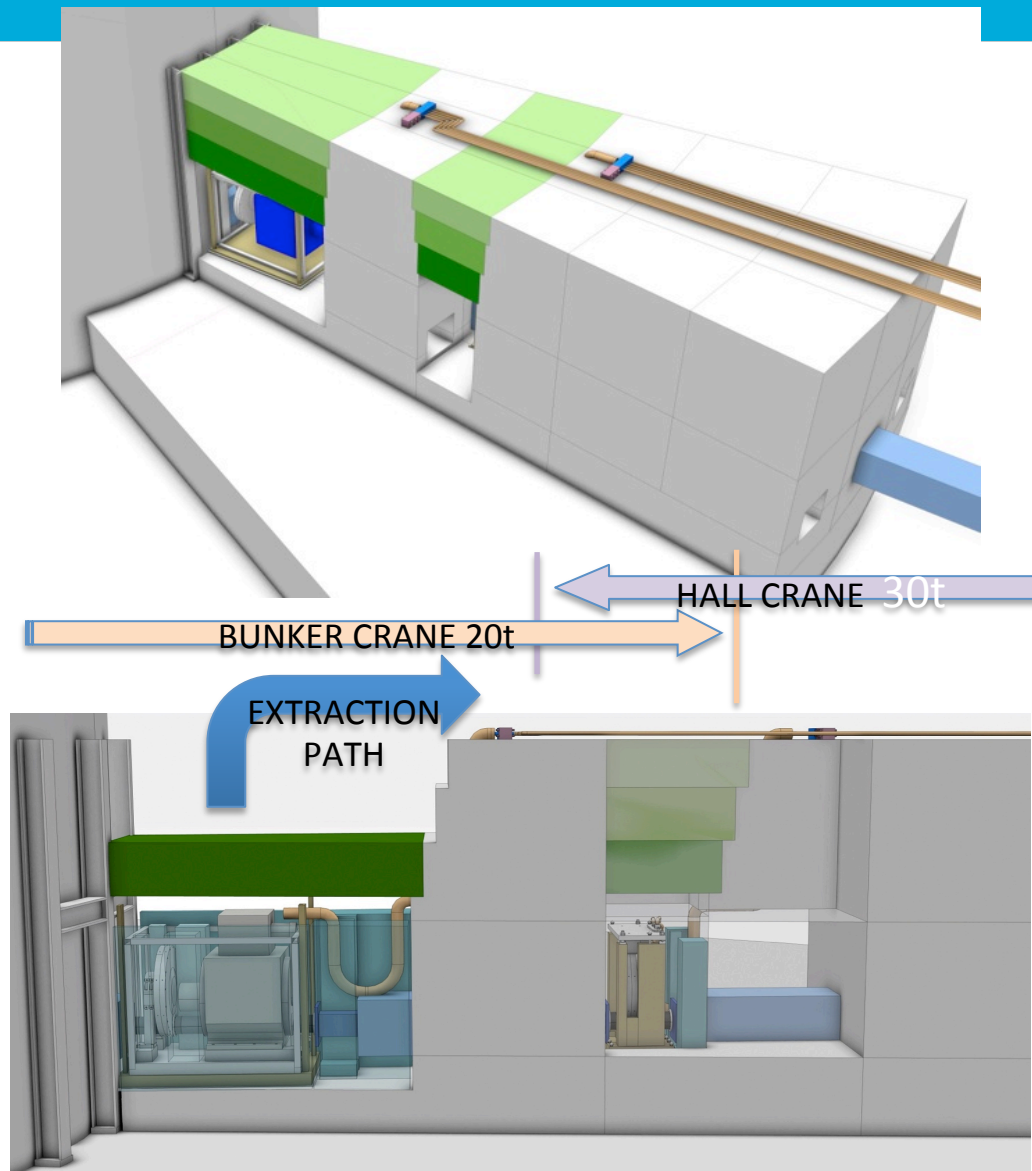
Hardware integration



Integration

- Shielding & utilities

- Design guidelines
 - Equipment recommendations
 - Details of performance, sizes, service
 - Installation concepts
 - Physical Interfaces
- Facility requirements
 - Provisions for component access
 - Levels of reliability & serviceability
 - Constraints on Installation packaging
 - Definitions of Interface ESS facility systems
 - Control hardware & software
 - MPS & PSS
 - Power, Vacuum, cooling, etc

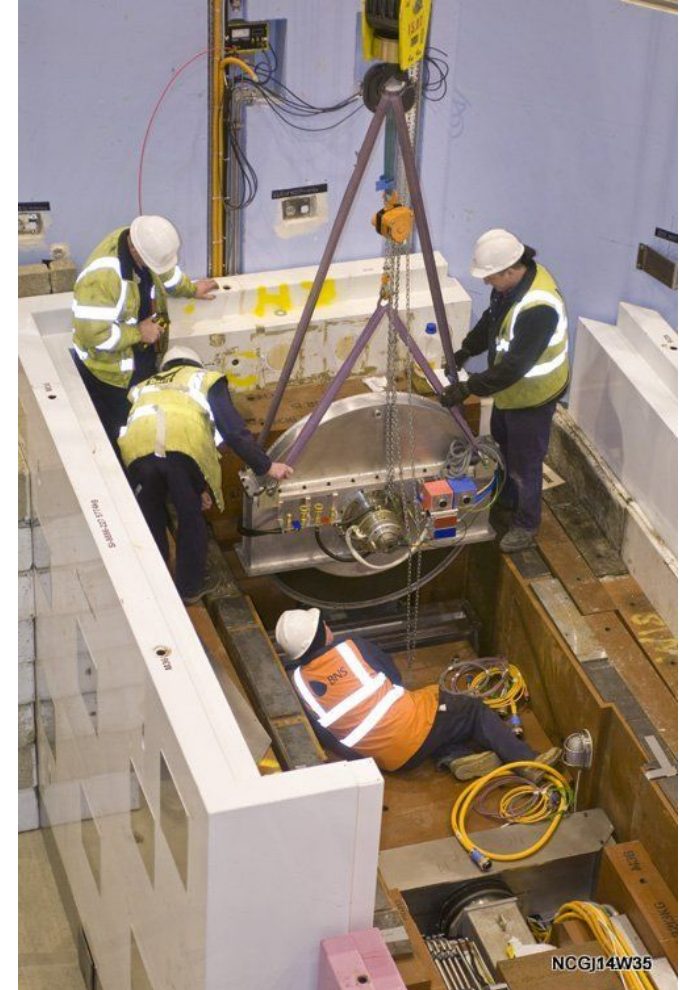
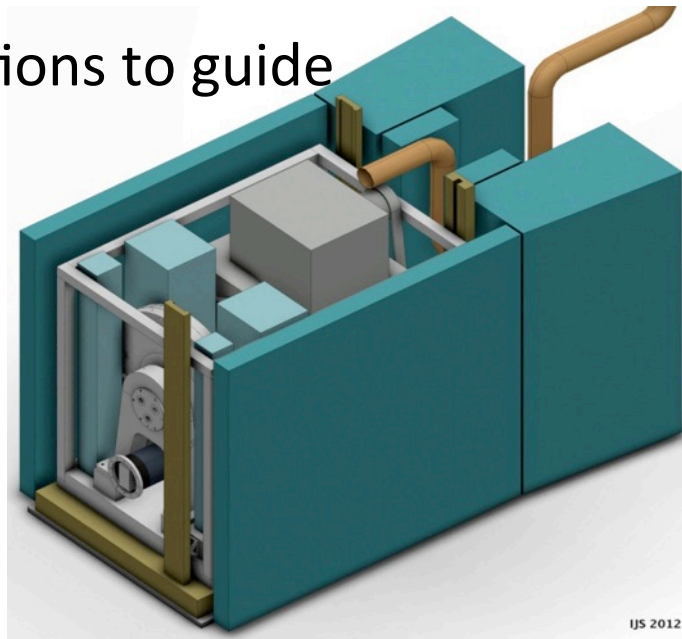


Integration

- beamline components

Evaluation of options to achieve best balance of instrument neutronic performance / serviceability / cost

- Windows or Common Vacuum
- Reduced interruptions to guide

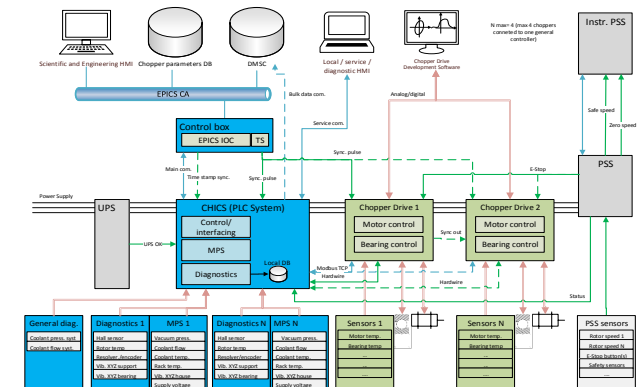
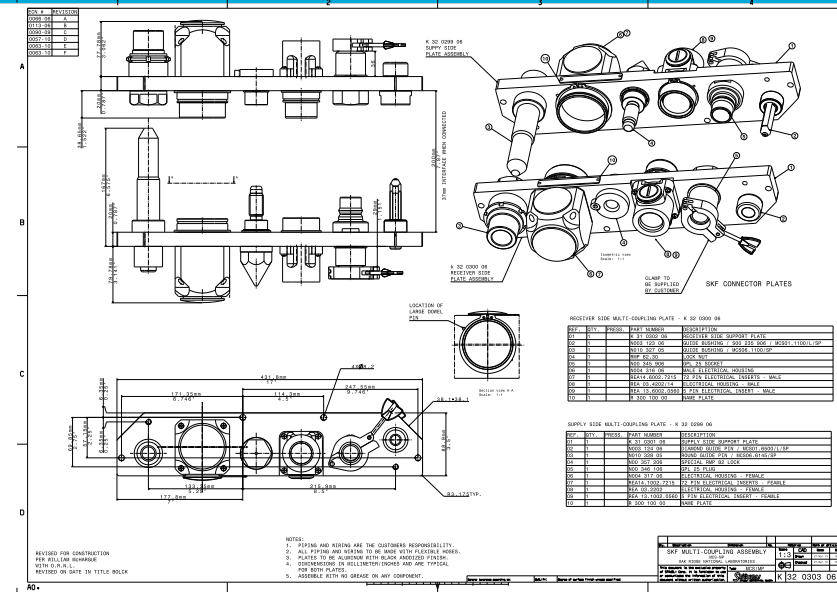


Integration

- Sub system level

Standardised Interfaces

- CHOPPER – GUIDE
- CHOPPER – SHIELDING
- CHOPPER – COOLING
- CHOPPER – VACUUM
- CHOPPER – Control Systems



Integration

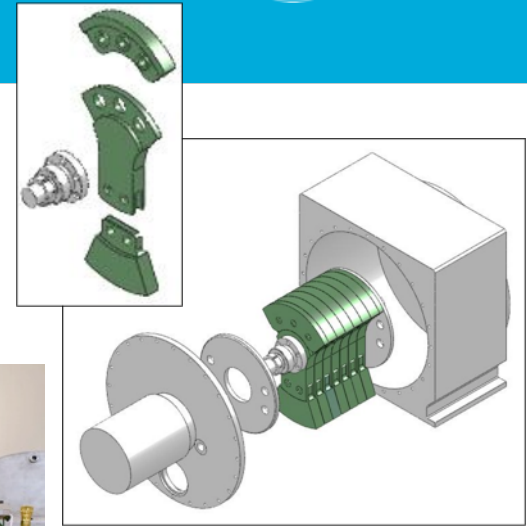
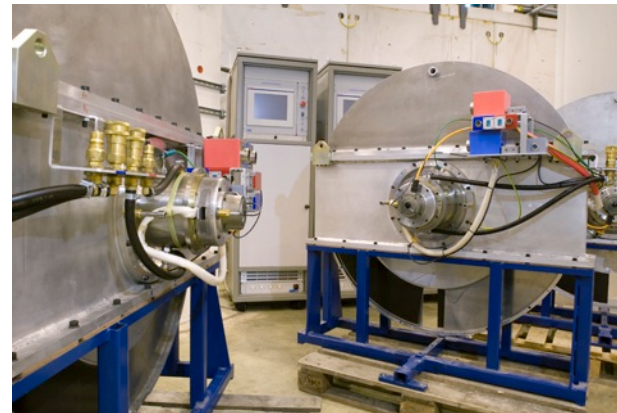
- component level interfaces

Standard interfaces

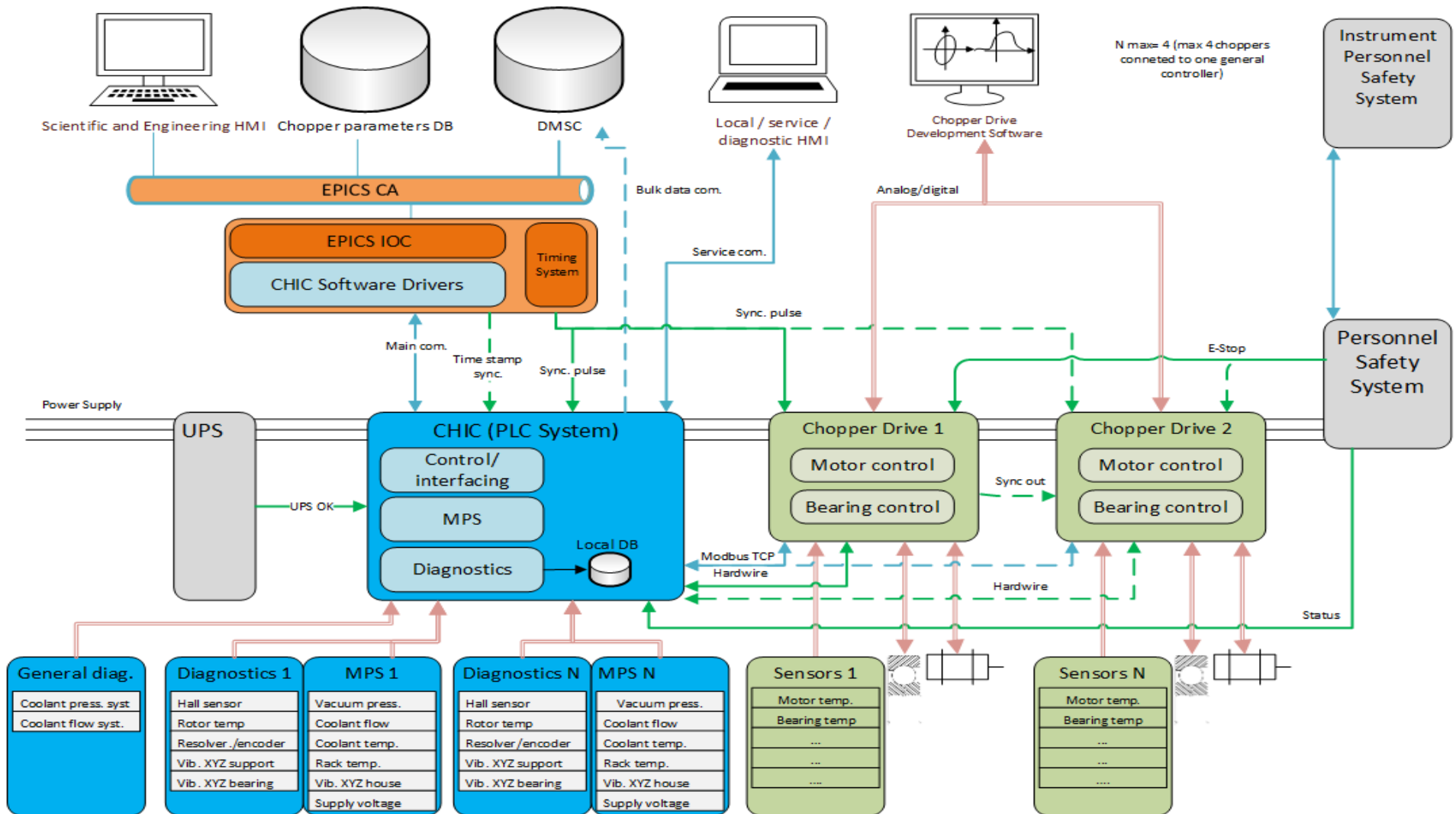
- Spindle – Rotor
- Spindle housing
- Housing support structure
- Beam windows

Standard methods

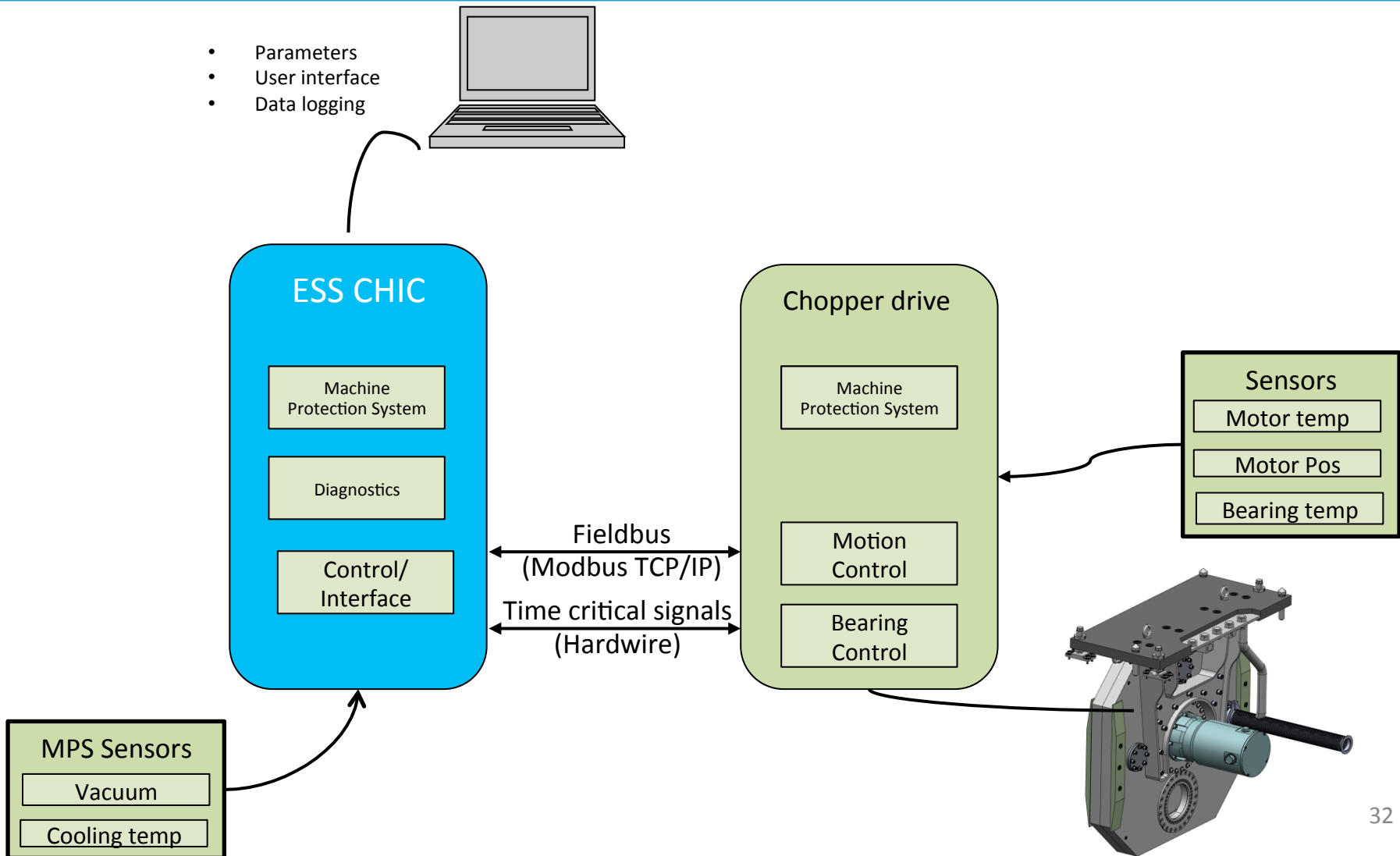
- Absorber coatings
- Seals



Integration - Control system



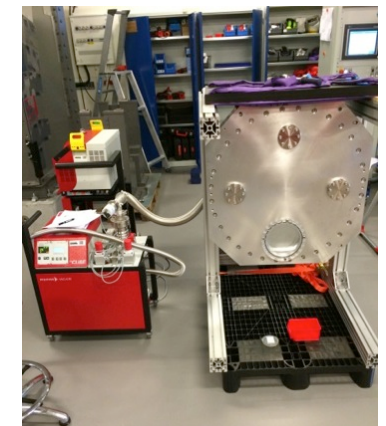
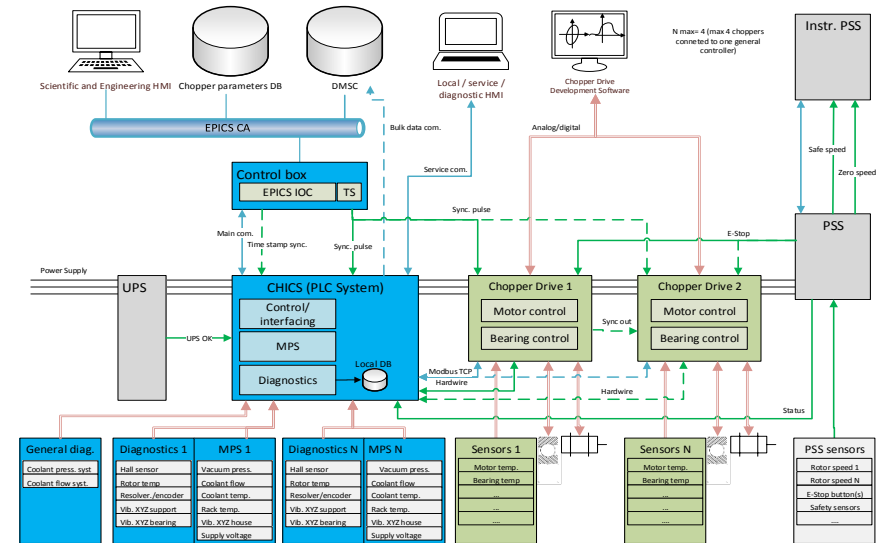
Integration Choppers as 'networked devices'



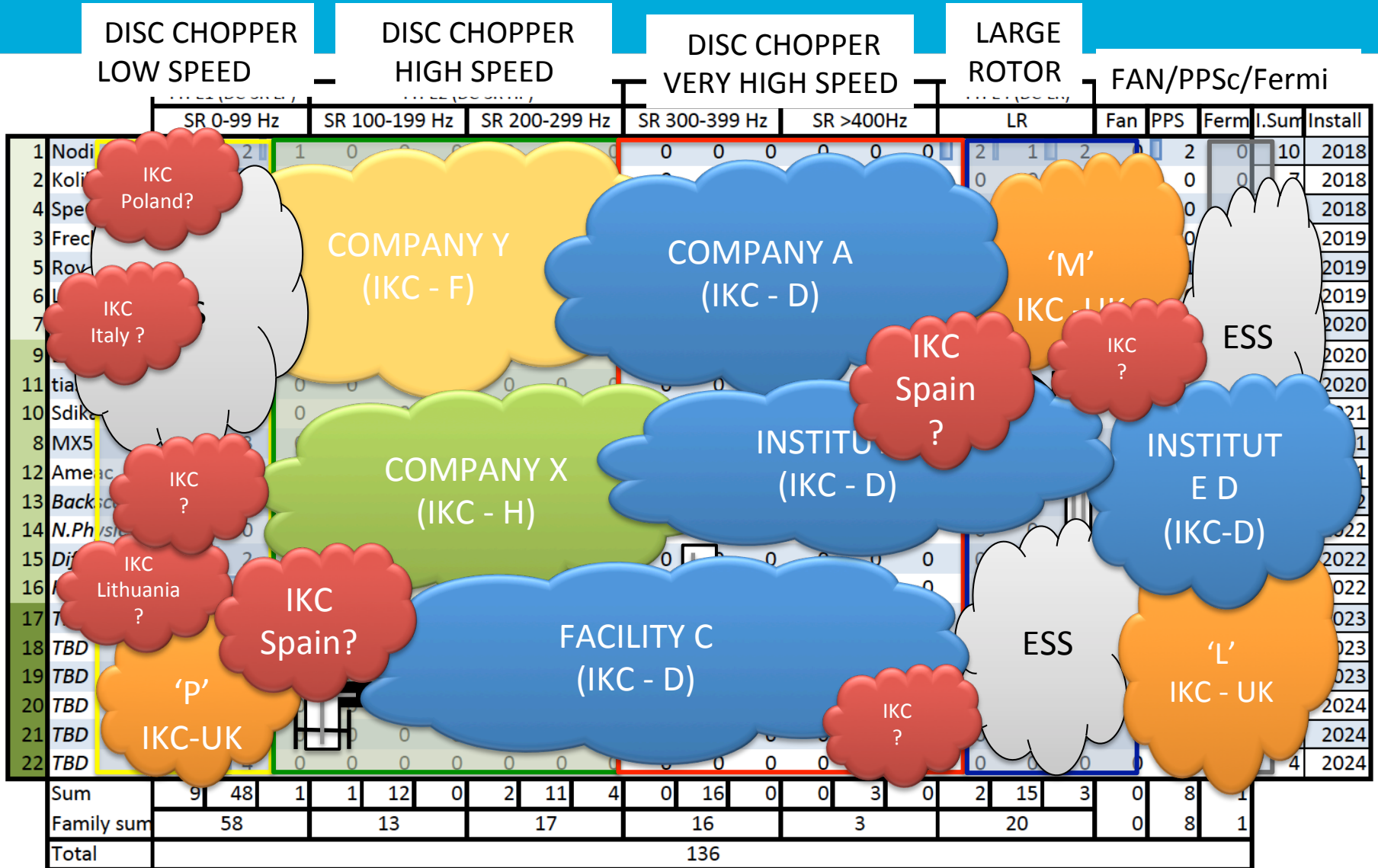
Integration

- Equipment standards

- Equipment standards
 - Required functionalities & performance.
 - Required equipment standards or certification
 - Required interface definitions
- Lists of compatible & tested equipment



A vision of 'Chopper systems' in-kind



22 Instruments ~ 145 axis

THE END

Thank you for you attention