NSS project requirements for chopper systems

Science directorate
Instrument technologies division

Neutron chopper group leader

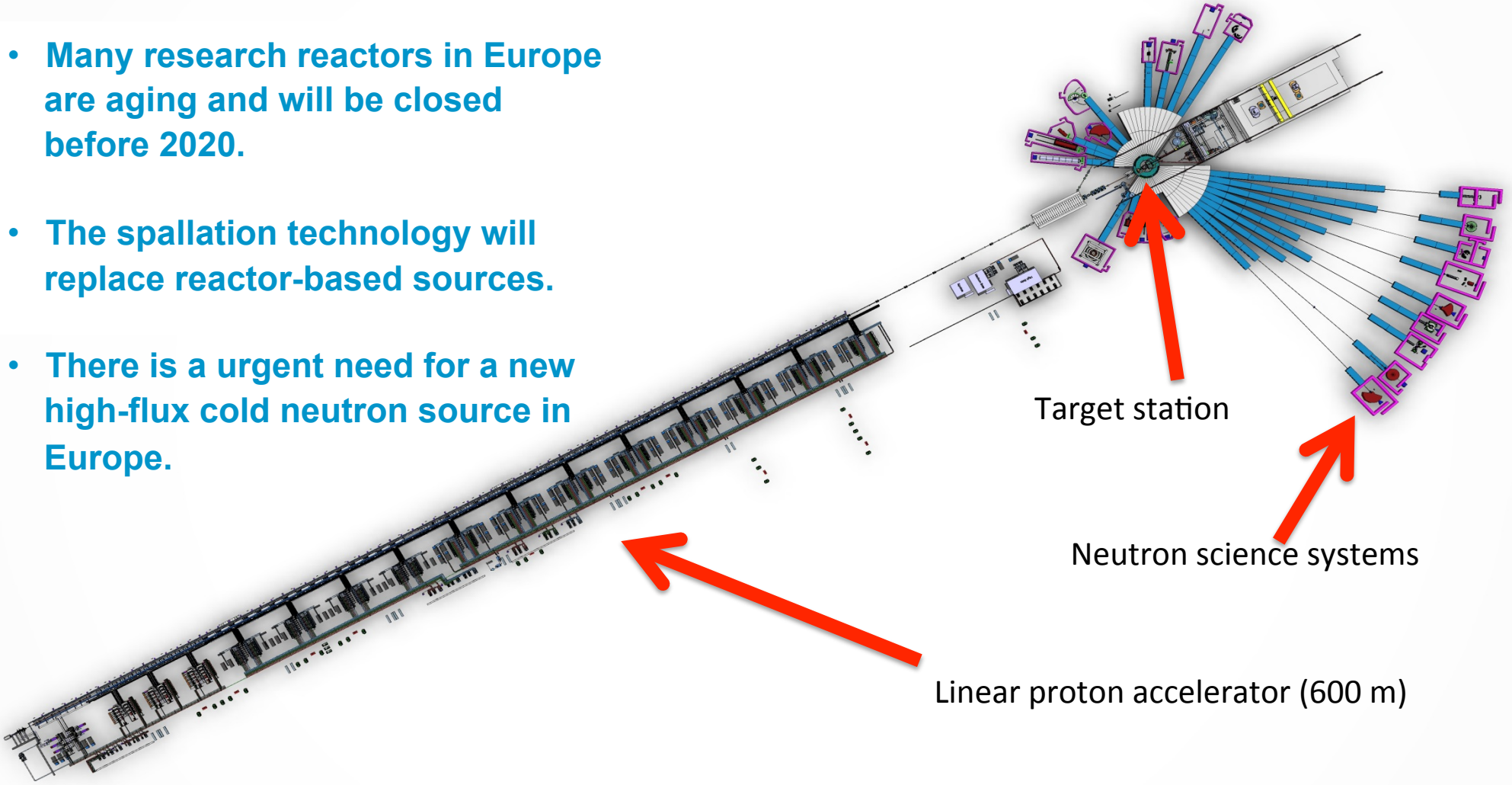
" Strategy, the human attempt to get to desirable ends with available means".

Max McKeown

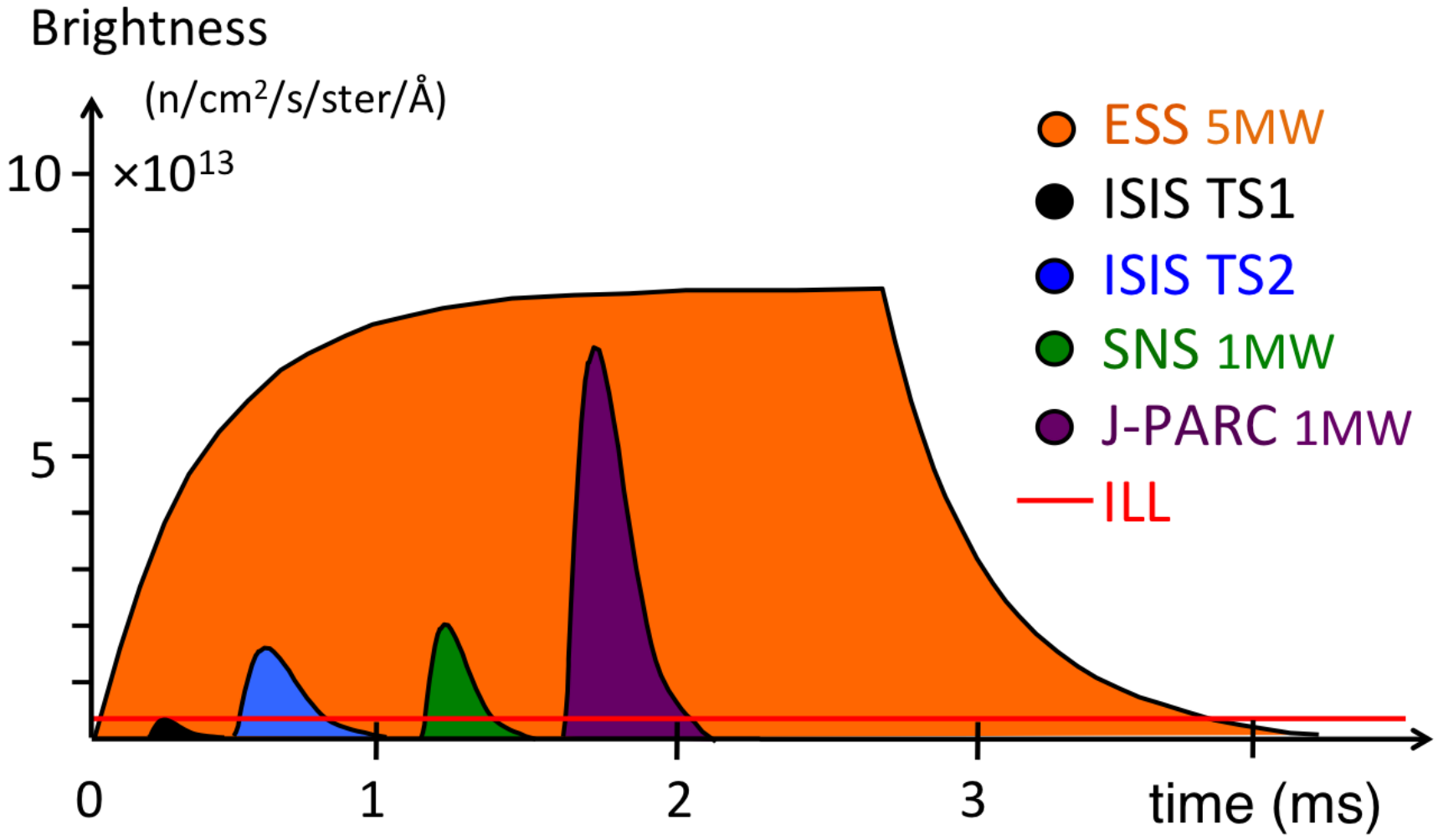
V 4.1

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.**

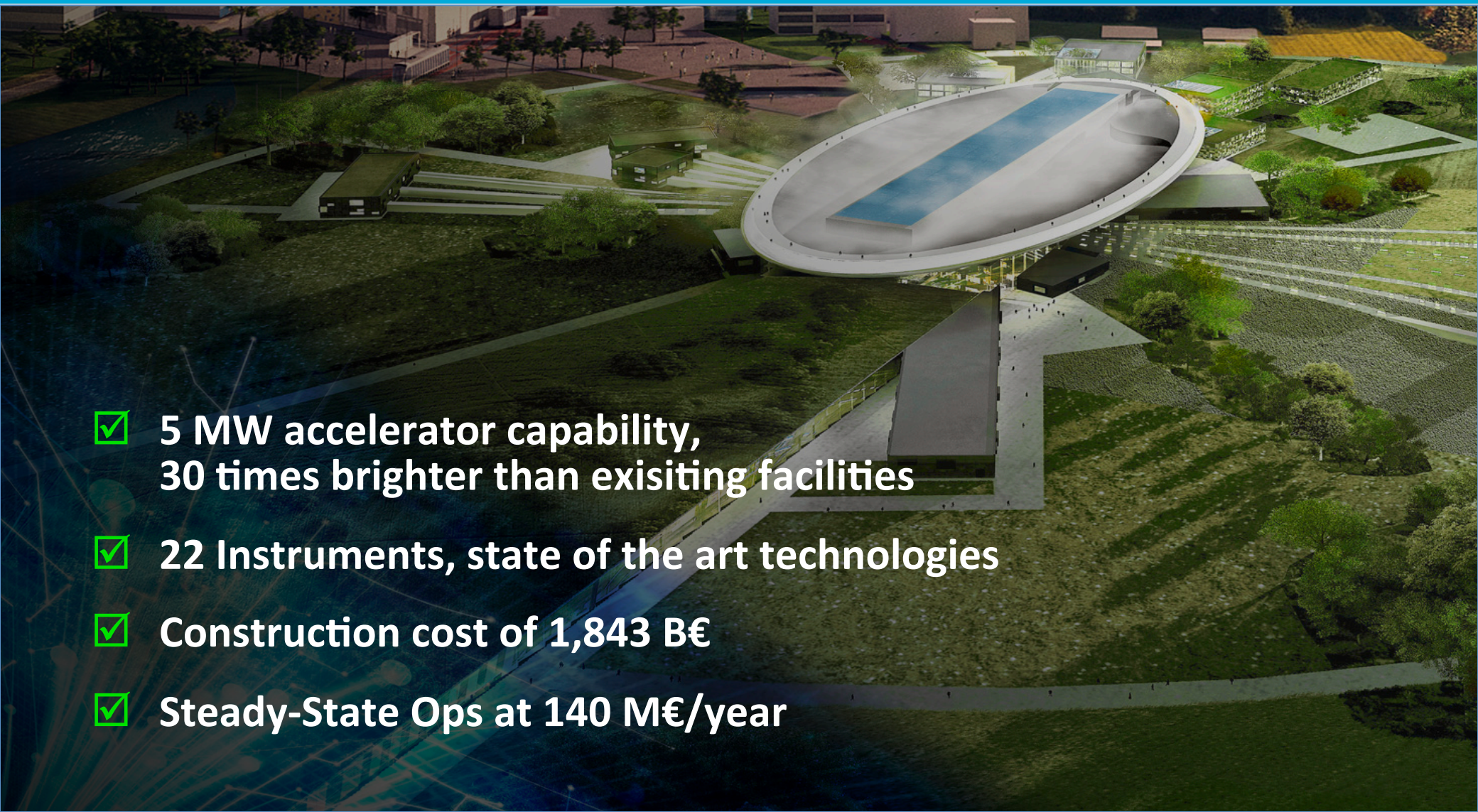


ESS is a Long-Pulse Source



Project Commitments

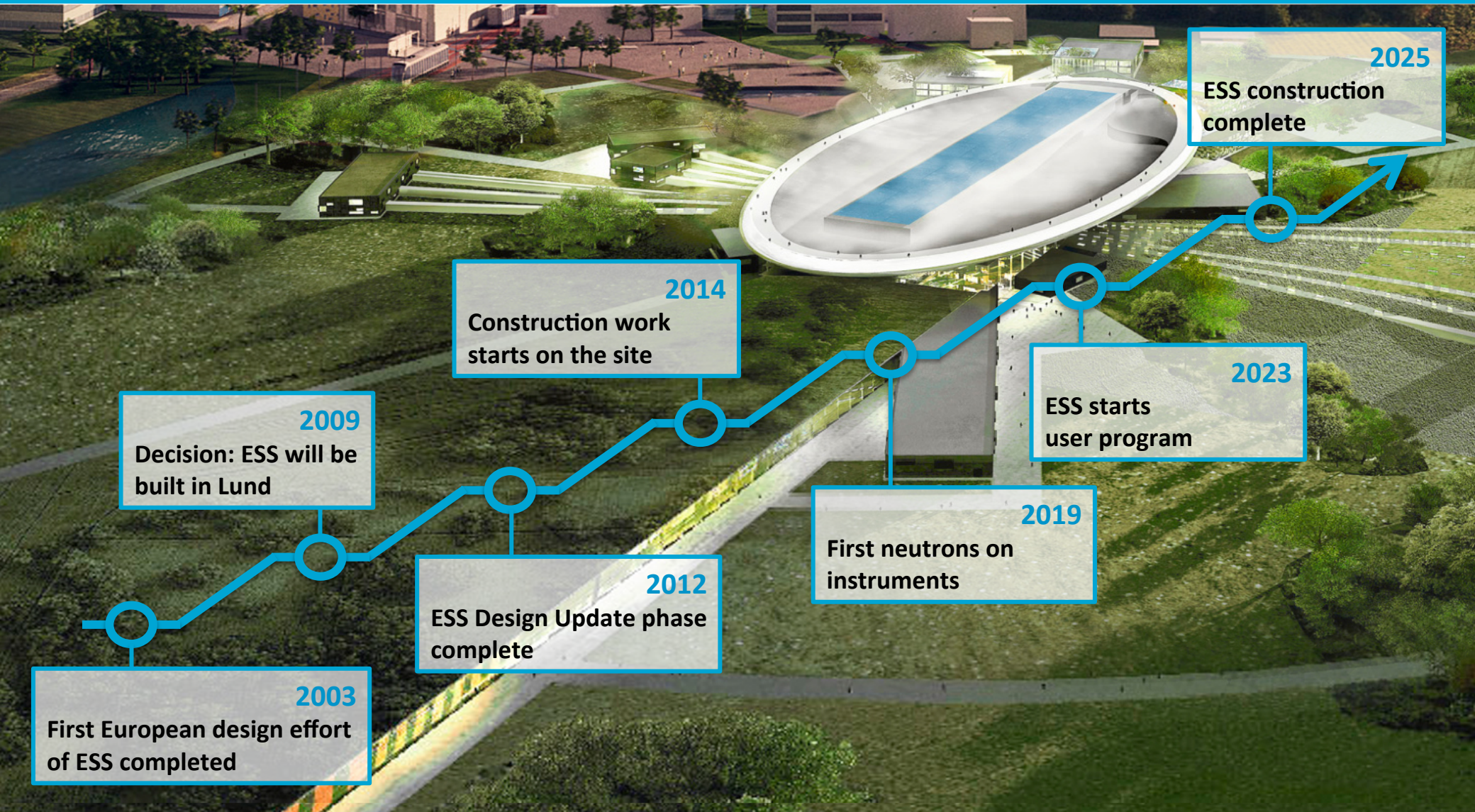
EUROPEAN SPALLATION SOURCE



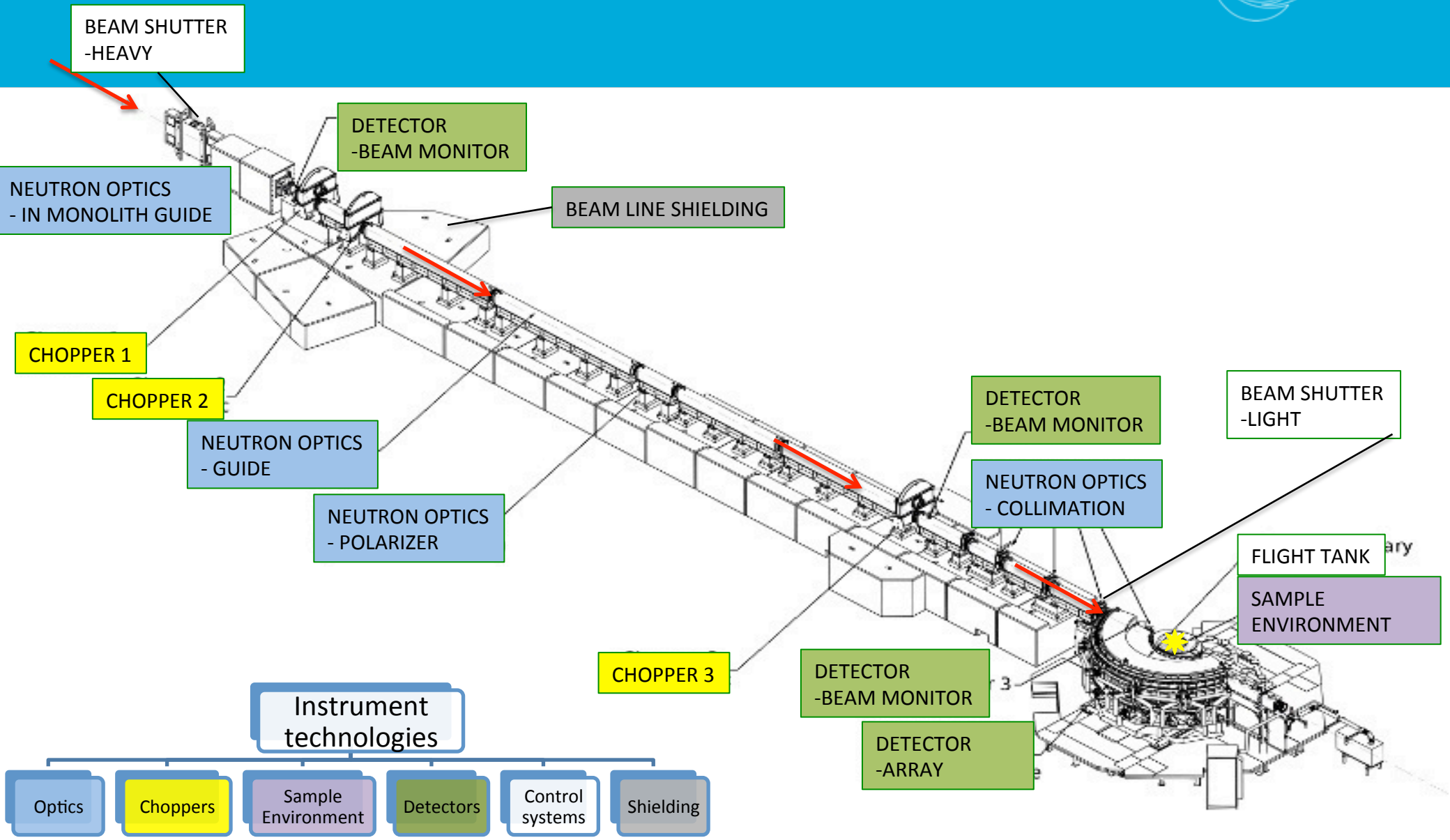
- ☑ 5 MW accelerator capability, 30 times brighter than exisiting facilities
- ☑ 22 Instruments, state of the art technologies
- ☑ Construction cost of 1,843 B€
- ☑ Steady-State Ops at 140 M€/year

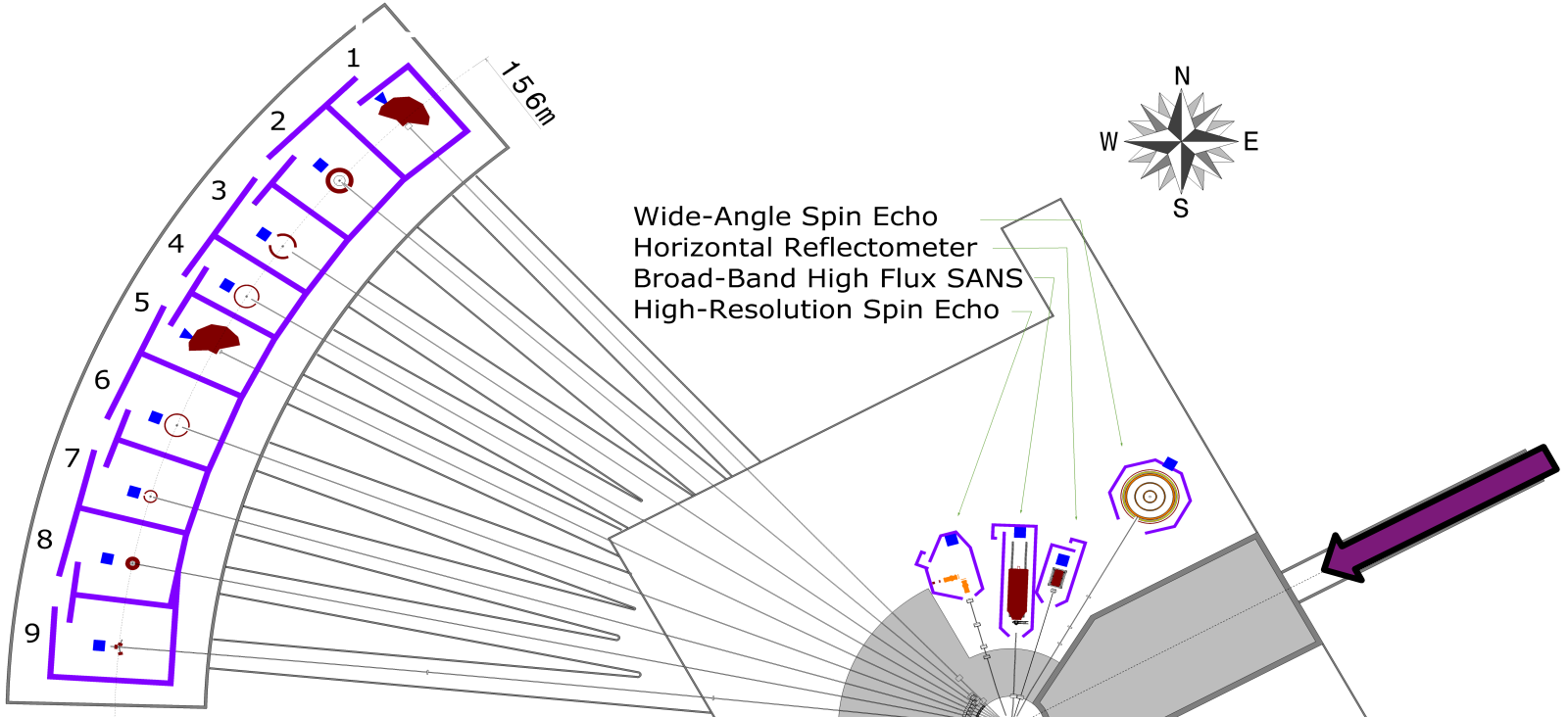
The road to realizing the world's leading facility for research using neutrons

EUROPEAN SPALLATION SOURCE



ESS Instrument technologies





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

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

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

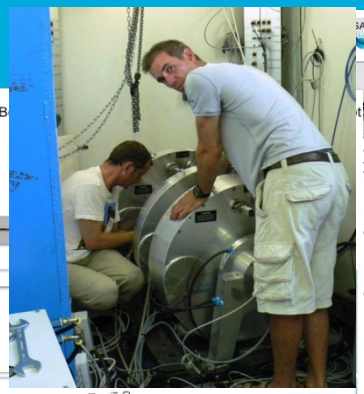
Cake - Cross cut approach

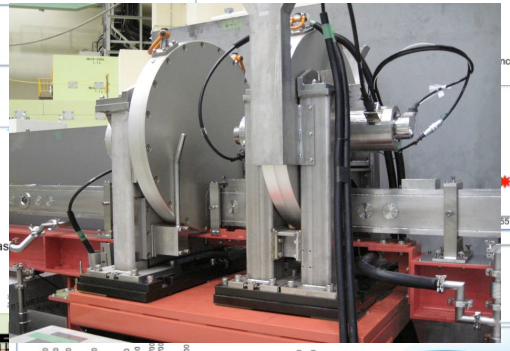
Technology groups assume global responsibility for all equipment of the type across the instrument suite

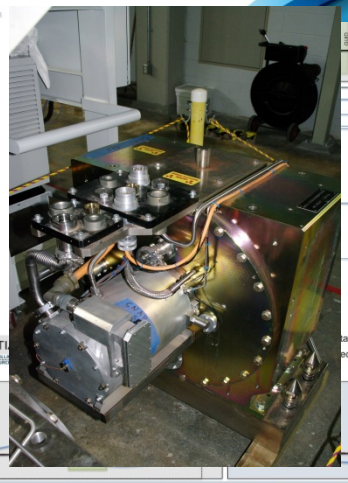
- Equipment standards
- Design and implementation guidelines
- Coordination of technology development
- Procurement
- Putting together build partners and work units
- Maximising in-kind potential.

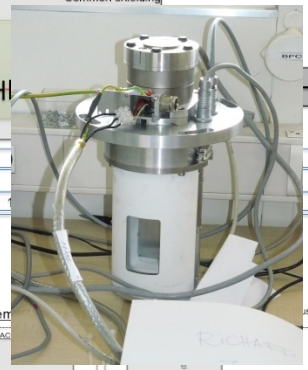
Neutron Chopper Suite

Diversity

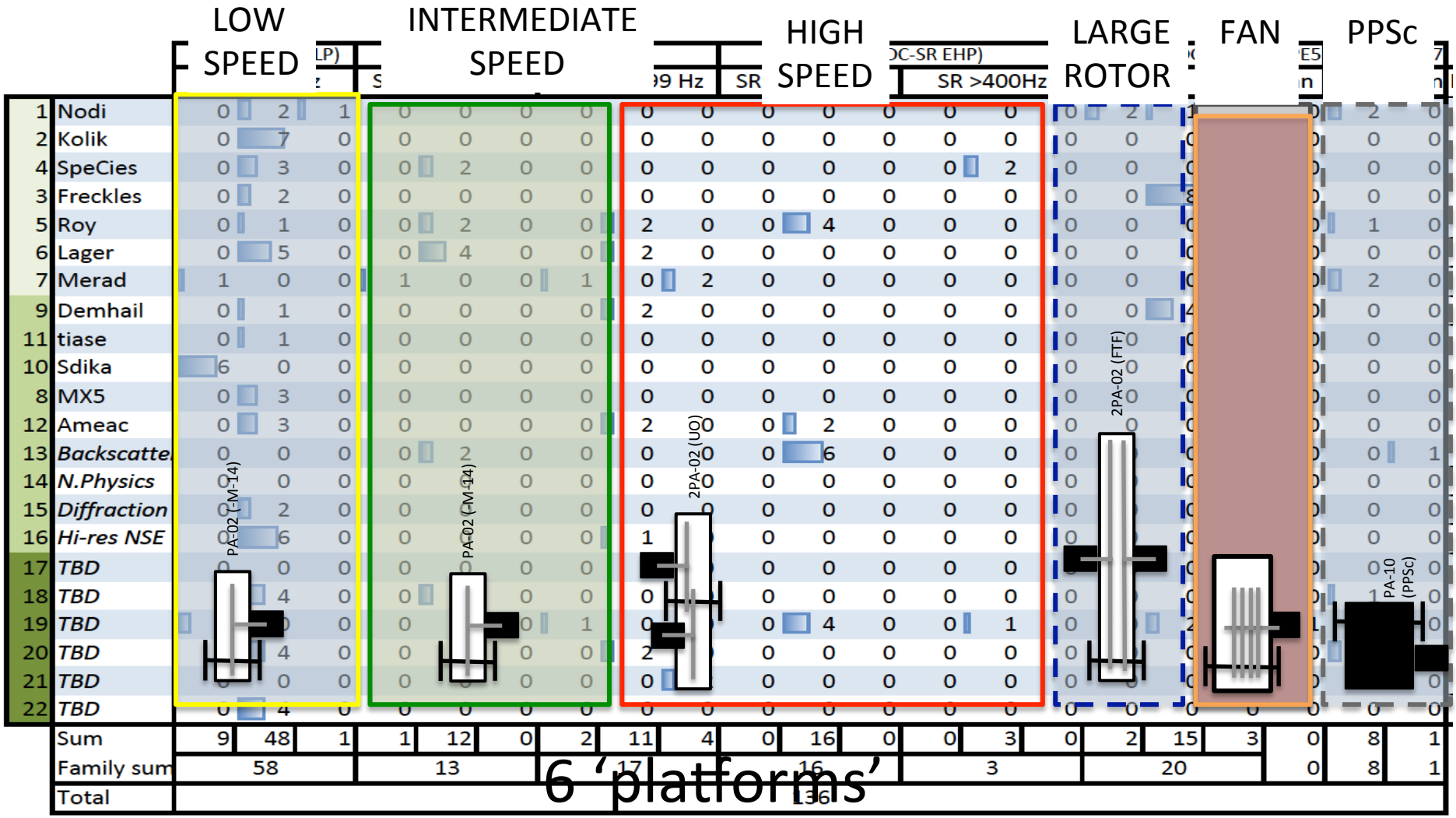








Common component platforms

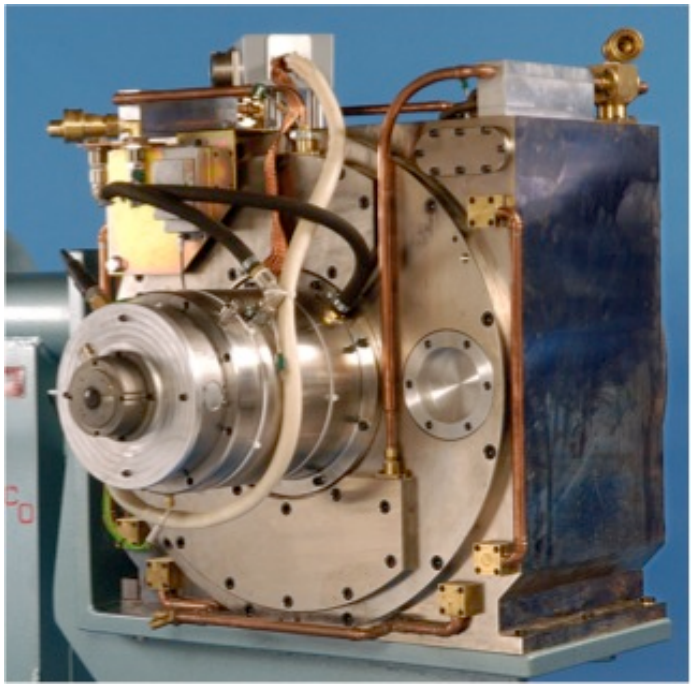


Platforms

Within each platform….

A common mechanical & control architecture.

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

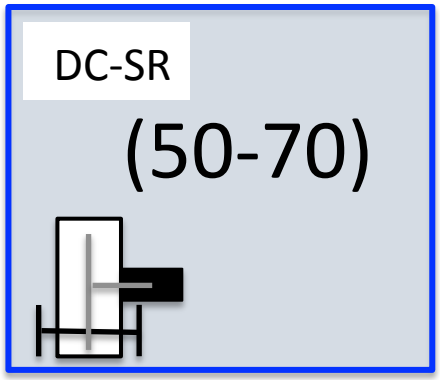


Platform 1
Disc chopper – Small rotor – Low speed

EUROPEAN SPALLATION SOURCE

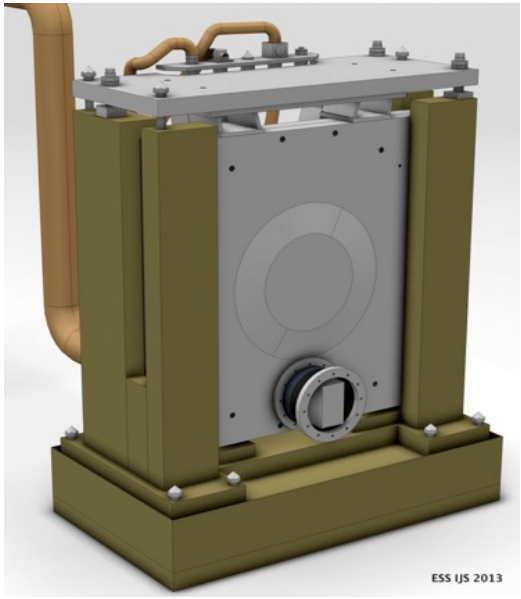
Key requirements

- 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 .

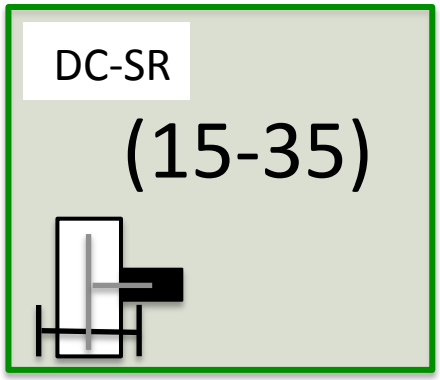
- Rotors materials: Metallic
- Bearings: Magnetic

Platform 2
Disc chopper – Small rotor – Intermediate speed

EUROPEAN SPALLATION SOURCE

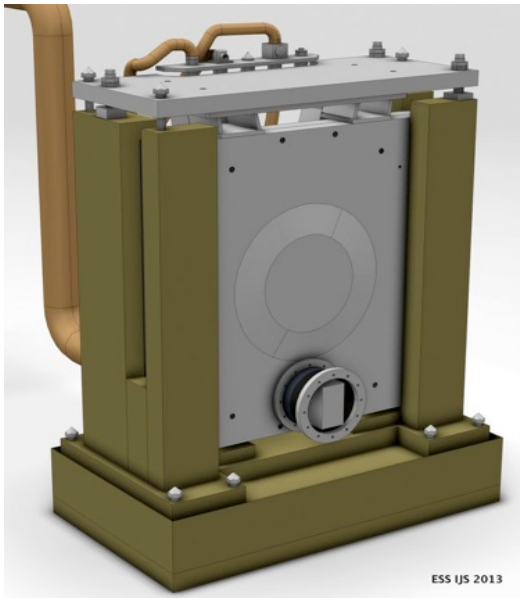
Key requirements

- 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

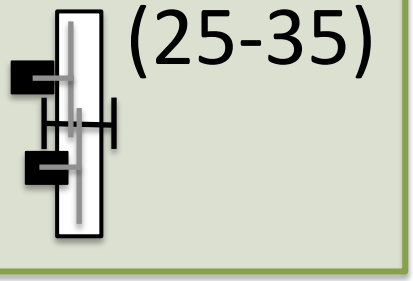
Principal characteristics

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

Enabling Technologies .

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

DC-SR-HP

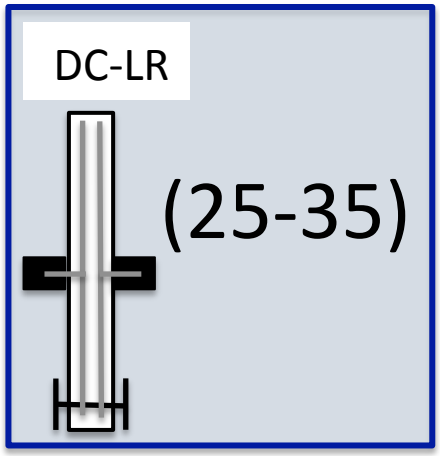


2.PA-1-H-M

Platform 4:
Disc chopper – Large rotor

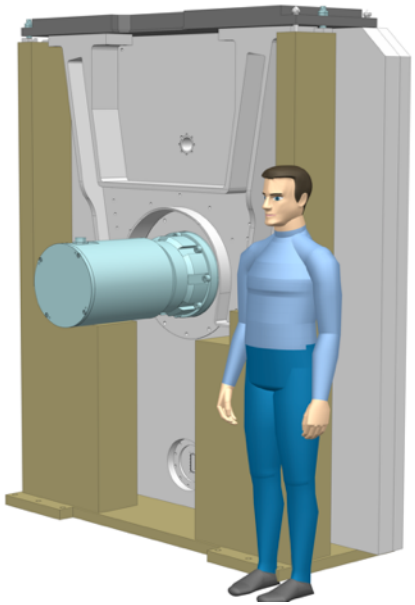
Key requirements

- 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

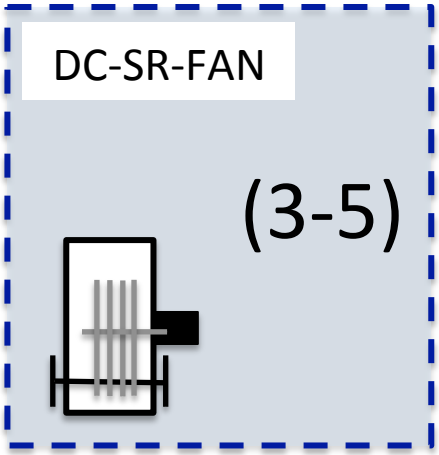
- Rotation speed: (7 - 56 Hz)
- Openings: Variable width, Asymmetric

Principal characteristics

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

Enabling Technologies .

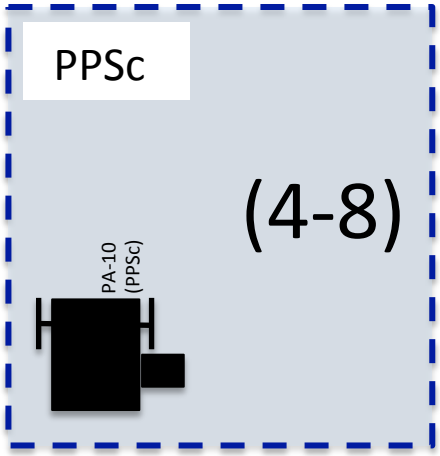
- Rotor material: Aluminium
- Bearings: Contact



Platform 6:
Prompt pulse suppression chopper PPSc

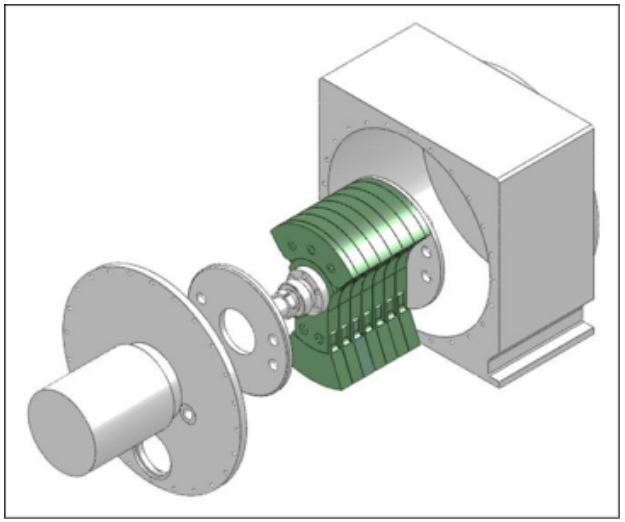
Key requirements

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



Principal characteristics

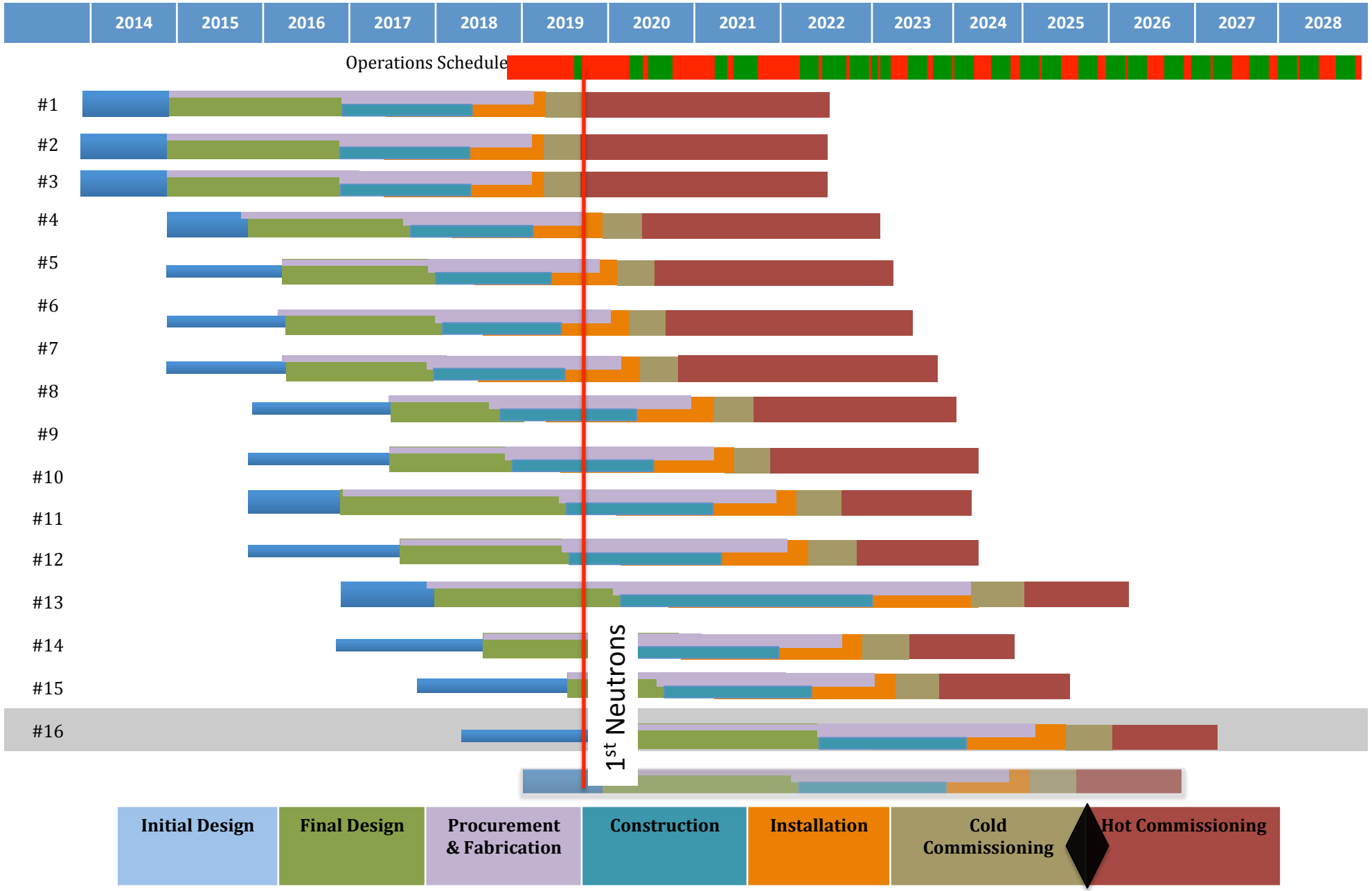
- Type: PA-10-H- (horizontal axis chopper)
- Rotors: 300 – 400 thick , single or double
- Diameter: 500 - 600mm



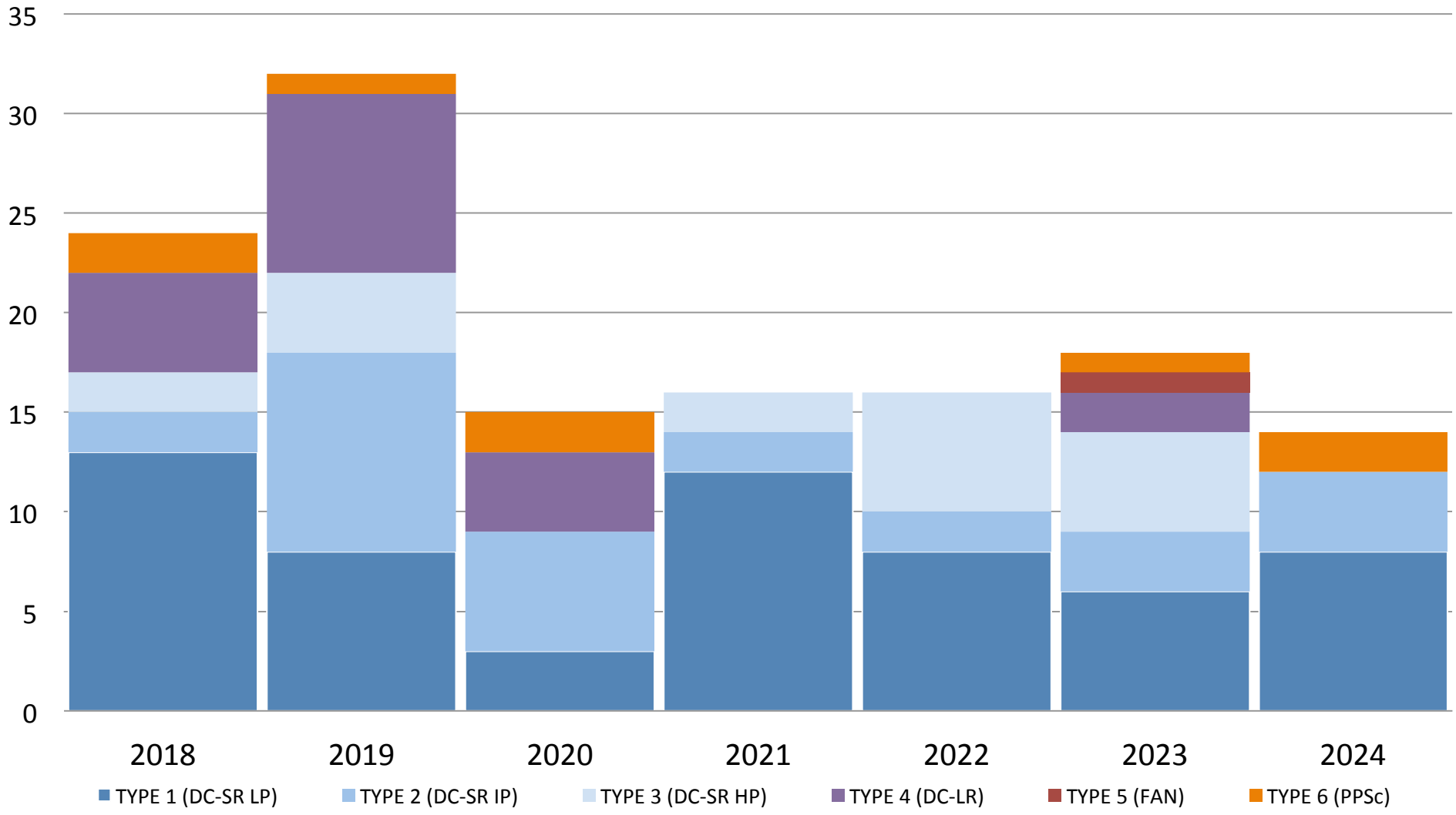
Enabling Technologies .

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

Instrument projects overview



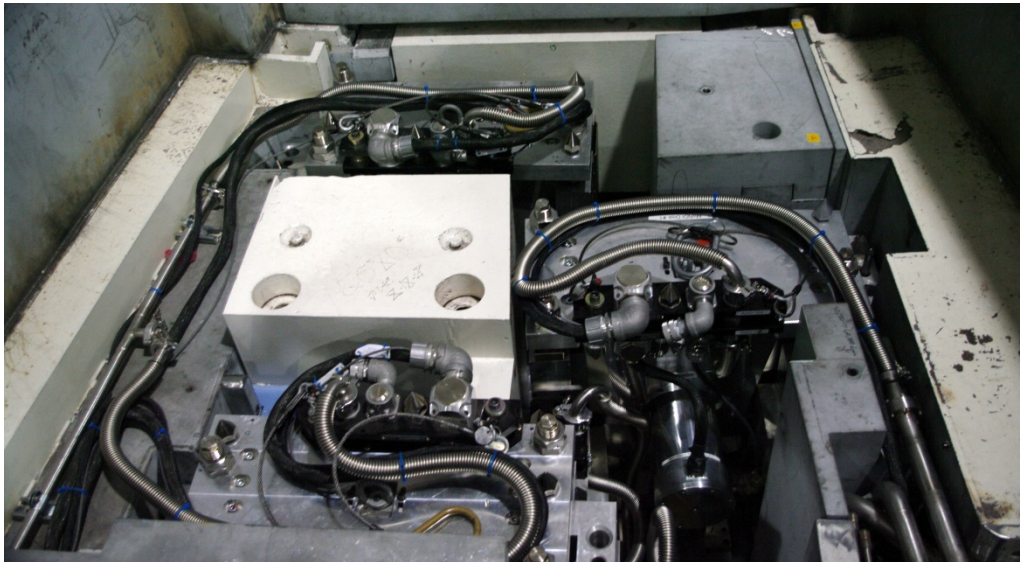
Chopper deliveries p.a.



CHOPPER SYSTEM
ENGINEERING INTEGRATION

Hardware integration

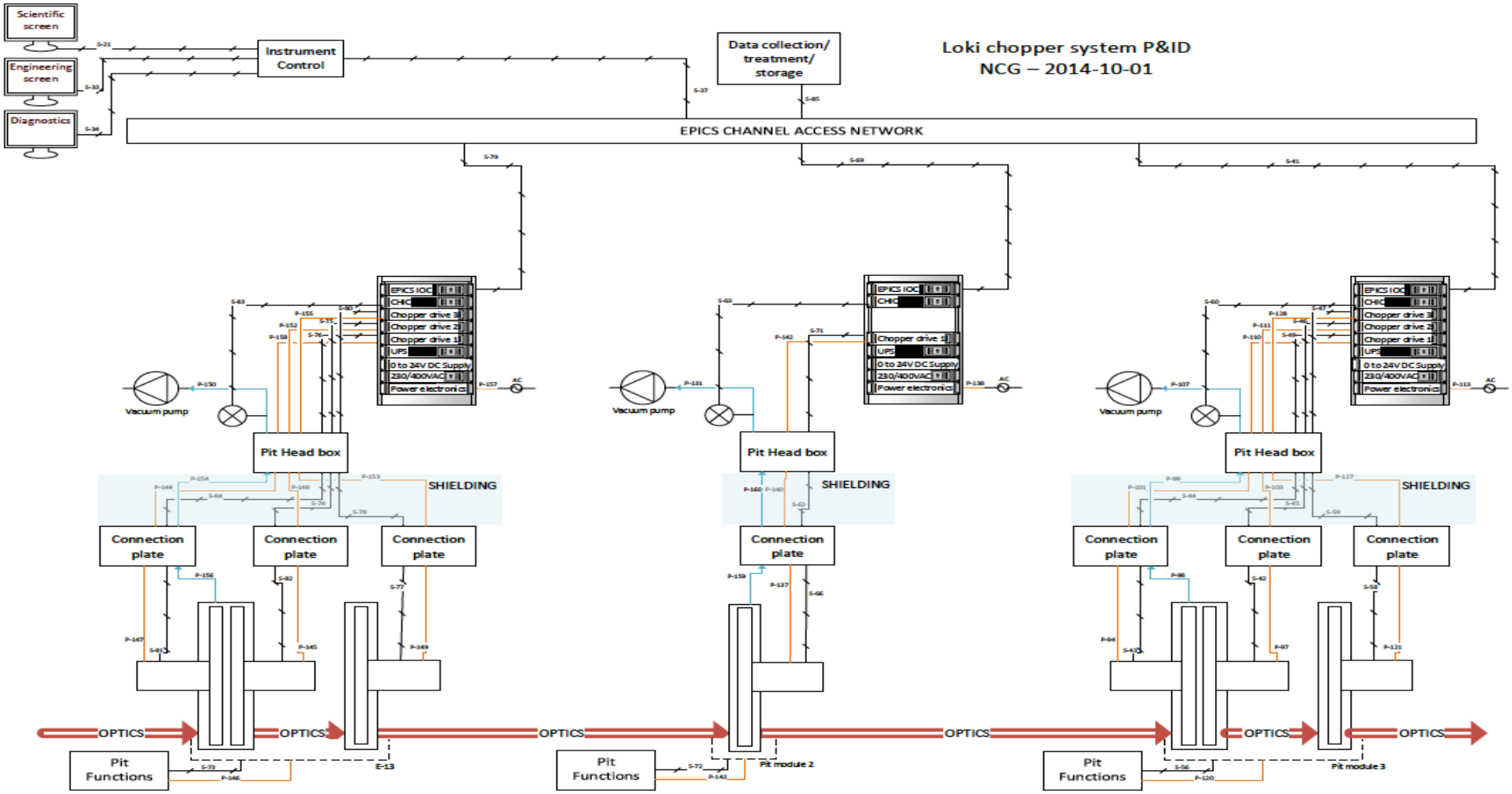
- Integration into instrument control HW (CHIC)
- Instrument control software
- Power
- Cooling systems
- Vacuum systems



Operational interfaces

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

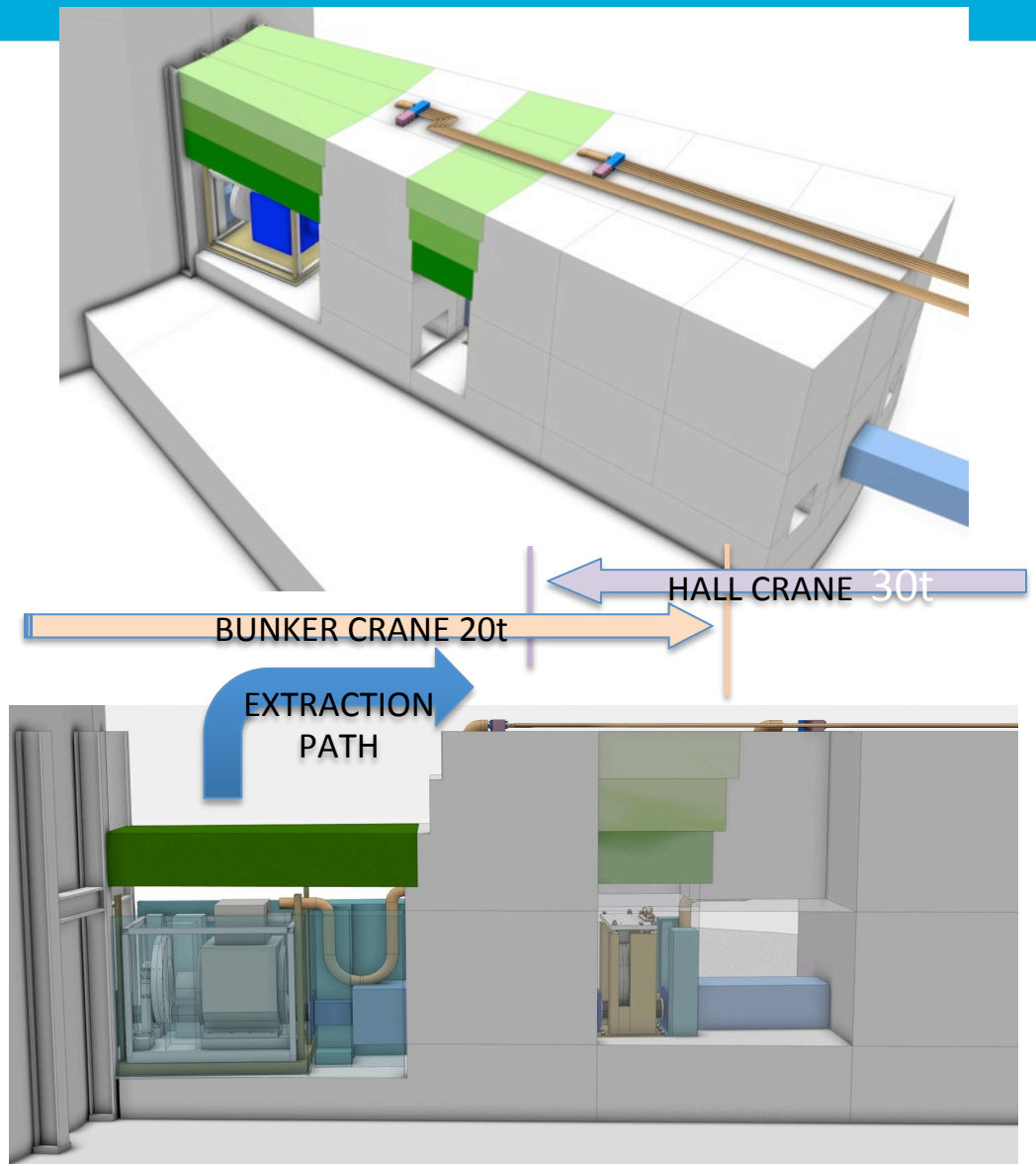
Hardware integration



Integration
- Shielding & utilities

- Design guidelines
  - Equipment recommendations
    - Details of performance, sizes, service
    - Installation concepts
    - Physical Interfaces

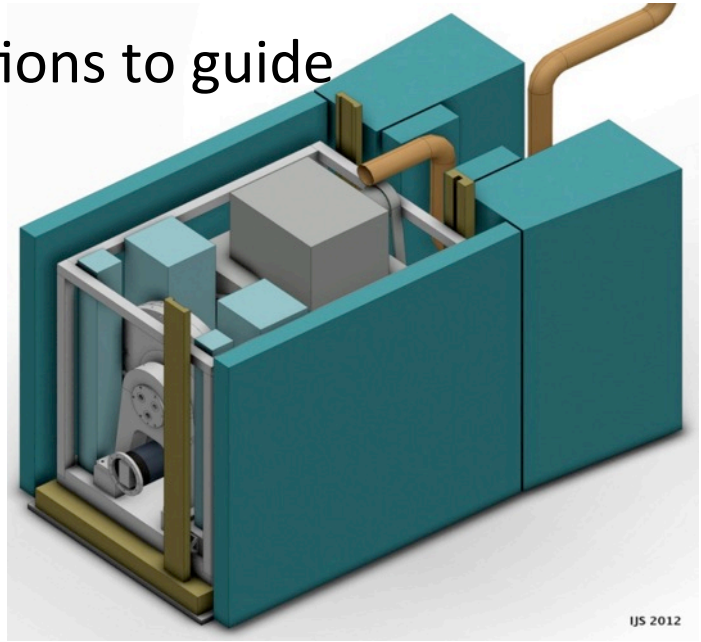
- Facility requirements
  - Provisions for component access
  - Levels of reliability & serviceability
  - Constraints on Installation packaging
  - Definitions of Interface ESS facility systems
    - Control hardware & software
    - MPS & PSS
    - Power, Vacuum, cooling, etc



Integration
- beamline components

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

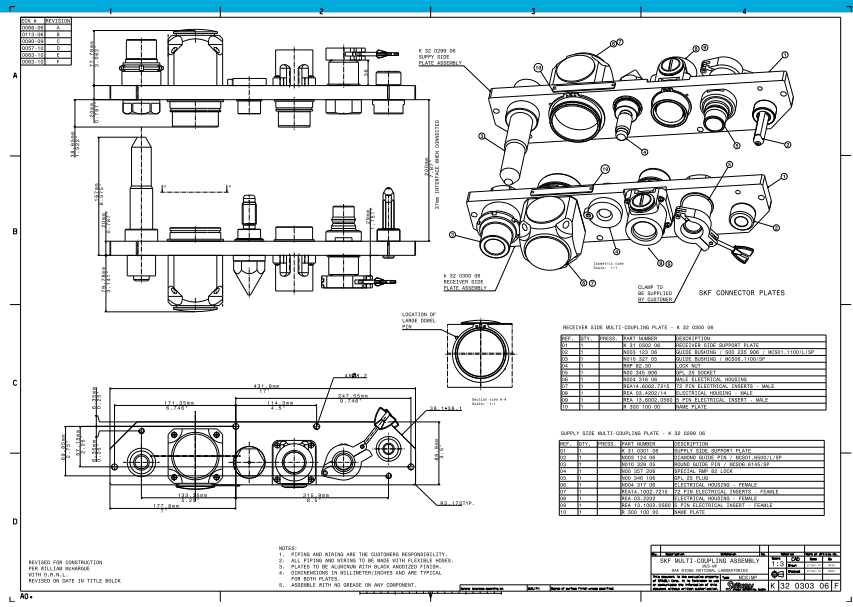
- Windows or Common Vacuum
- Reduced interruptions to guide

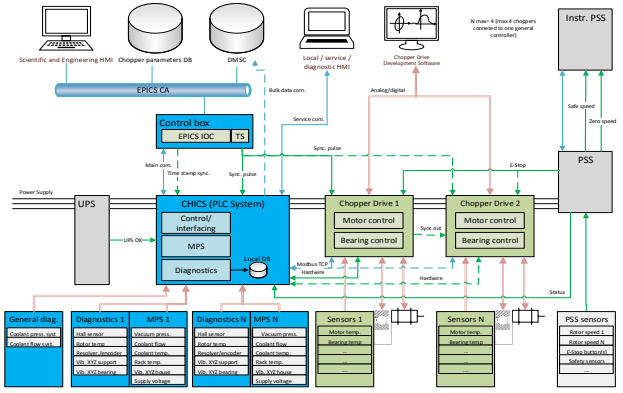


Integration
- Sub system level

Standardised Interfaces

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





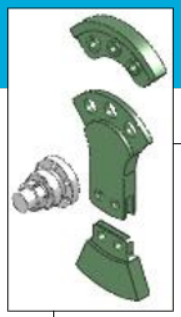
Integration
- component level interfaces

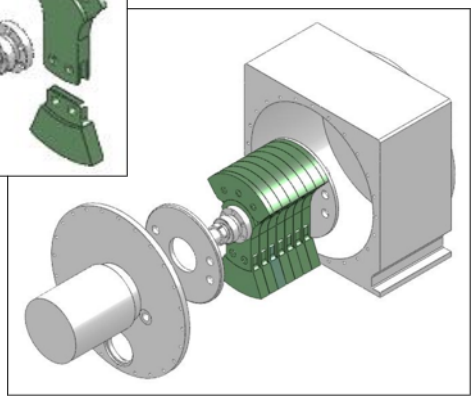
Standard interfaces

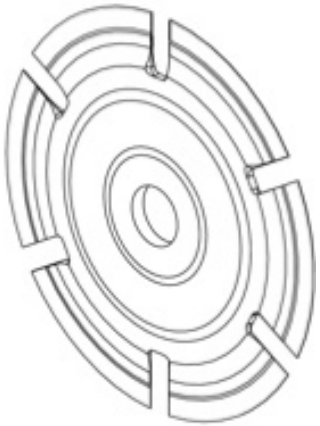
- Spindle – Rotor
- Spindle housing
- Housing support structure
- Beam windows

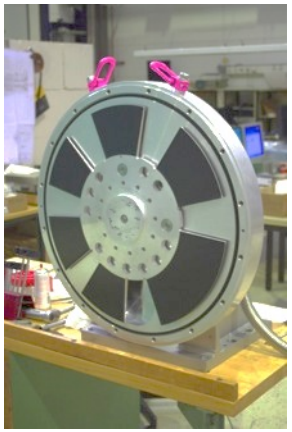
Standard methods

- Absorber coatings
- Seals

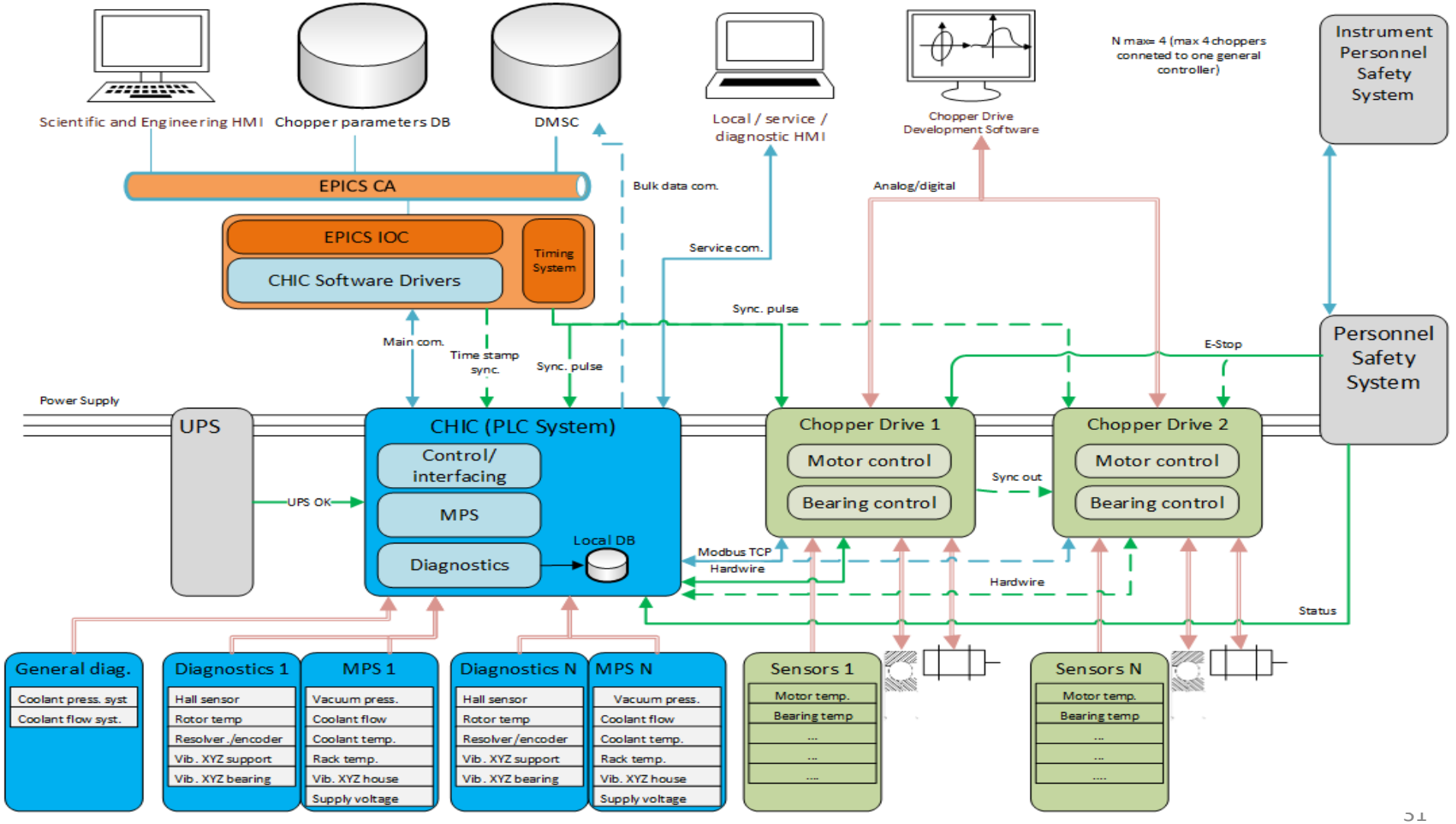








Integration
- Control system



Integration
Choppers as ‘networked devices’

- Parameters
- User interface
- Data logging

ESS CHIC

Machine Protection System

Diagnostics

Control/ Interface

Fieldbus (Modbus TCP/IP)

Time critical signals (Hardwire)

Chopper drive

Machine Protection System

Motion Control

Bearing Control

Sensors

Motor temp

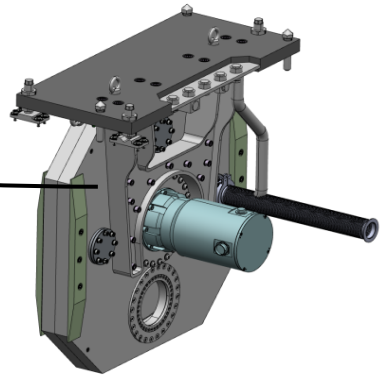
Motor Pos

Bearing temp

MPS Sensors

Vacuum

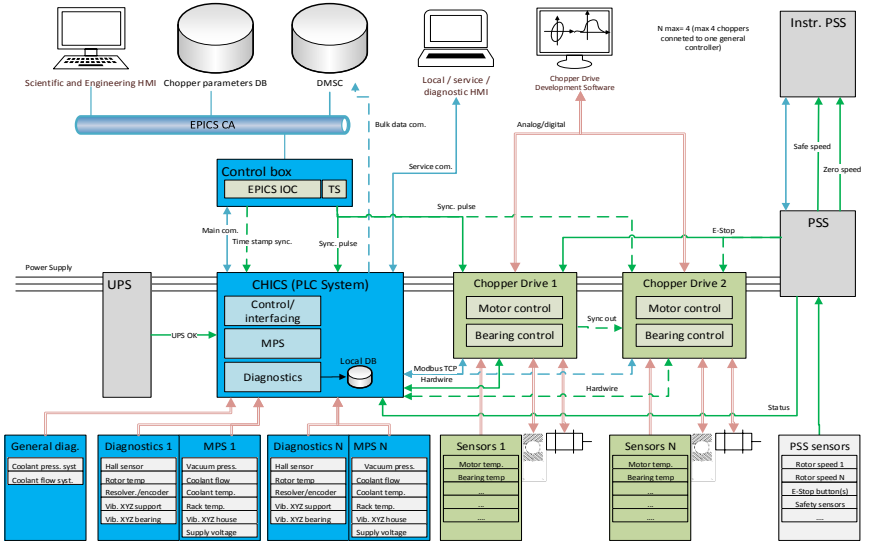
Cooling temp

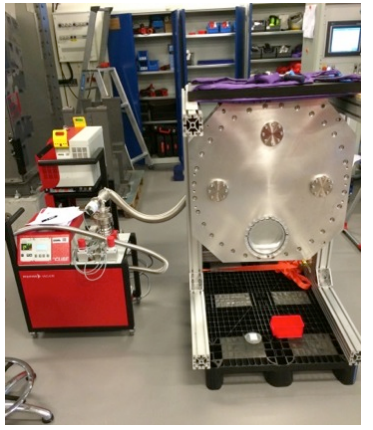


Integration
- Equipment standards

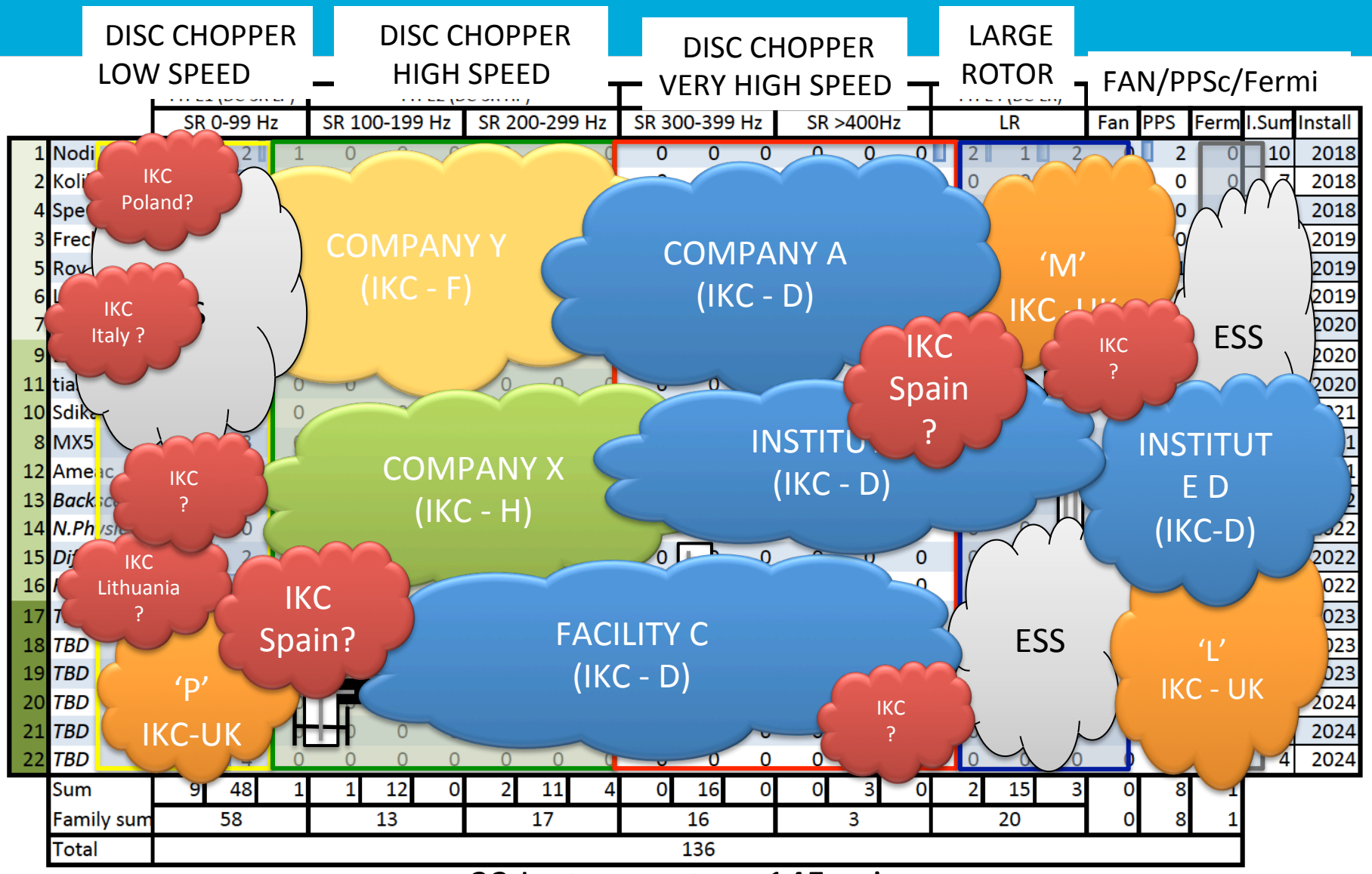
- Equipment standards
  - Required functionalities & performance.
  - Required equipment standards or certification
  - Required interface definitions

- Lists of compatible & tested equipment





A vision of 'Chopper systems' in-kind



22 Instruments ~ 145 axis

EUROPEAN SPALLATION SOURCE

THE END

Thank you for you attention