

The SKF logo is rendered in a bold, blue, sans-serif typeface. The letters 'S', 'K', and 'F' are highly stylized, with thick strokes and sharp, geometric shapes. The 'S' has a distinctive notch at the top right. The 'K' is composed of a vertical stem and a diagonal crossbar. The 'F' has a horizontal top bar and a vertical stem with a small horizontal tick at the bottom. To the right of the 'F' is a registered trademark symbol (®), consisting of the letter 'R' inside a circle. The entire logo is centered horizontally. Two thin red lines with rounded ends frame the logo: one above and one below, both curving downwards at their ends.

SKF®

ESS Chopper Jamboree

November 13-14, 2014

SKF[®]

SKF Neutron Chopper Drive Systems

1.0 – Overview

SKF – The Knowledge Engineering Company



Established: 1907
Sales 2012: 64,575 million SEK
Employees: 46,775
Production sites: 140 in 28 countries

SKF presence: in over 130 countries
Distributors/dealers: 15,000 locations
Global certificates: ISO 14001,
OHSAS 18001

SKF Magnetic Systems

SKF Magnetic Bearings, Calgary
Engineering, sales and service



S2M, Vernon
Engineering, sales and service



S2M Vostok, Moscow
Sales & service



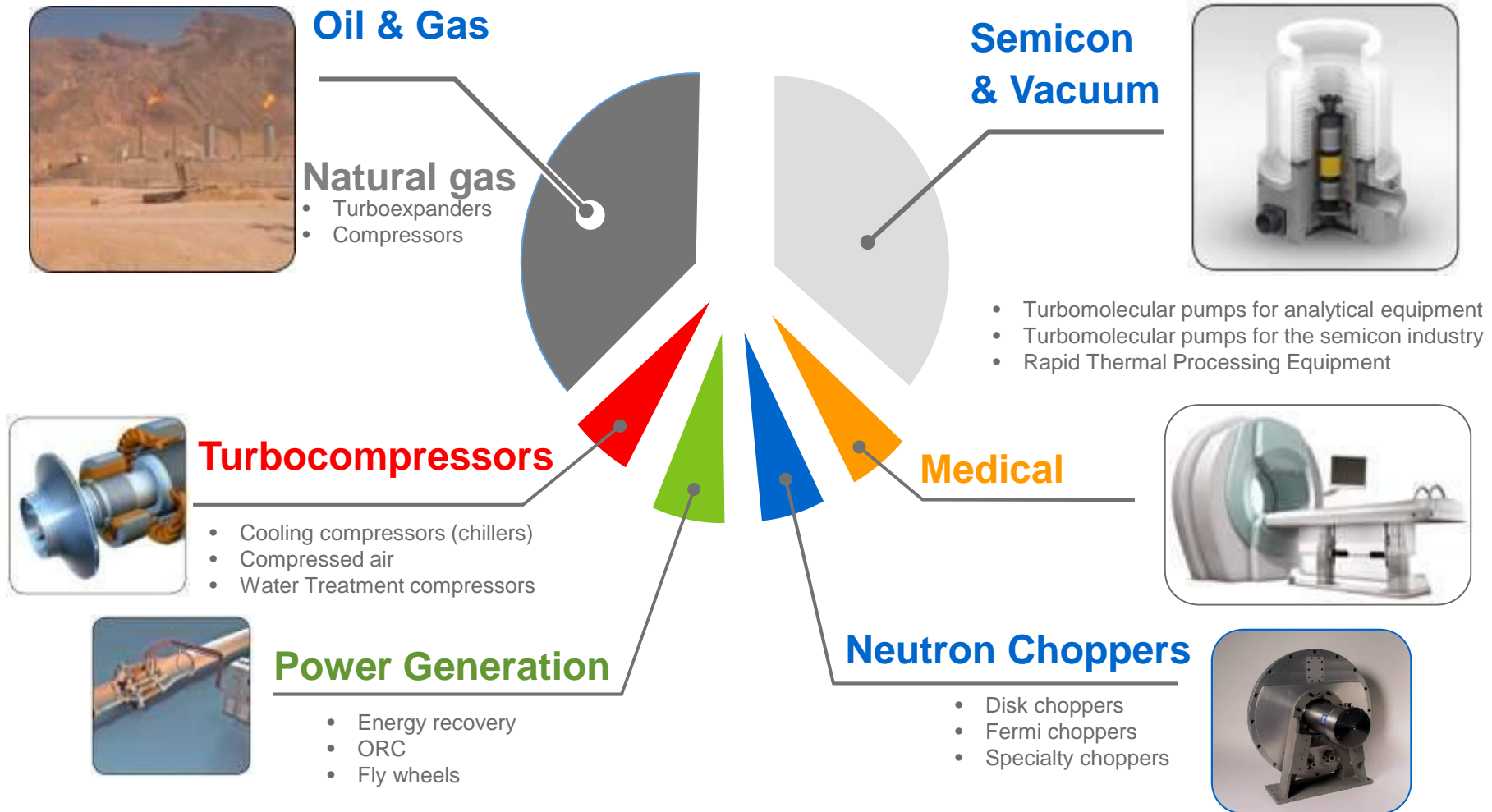
SKF USA, Philadelphia
Sales and service



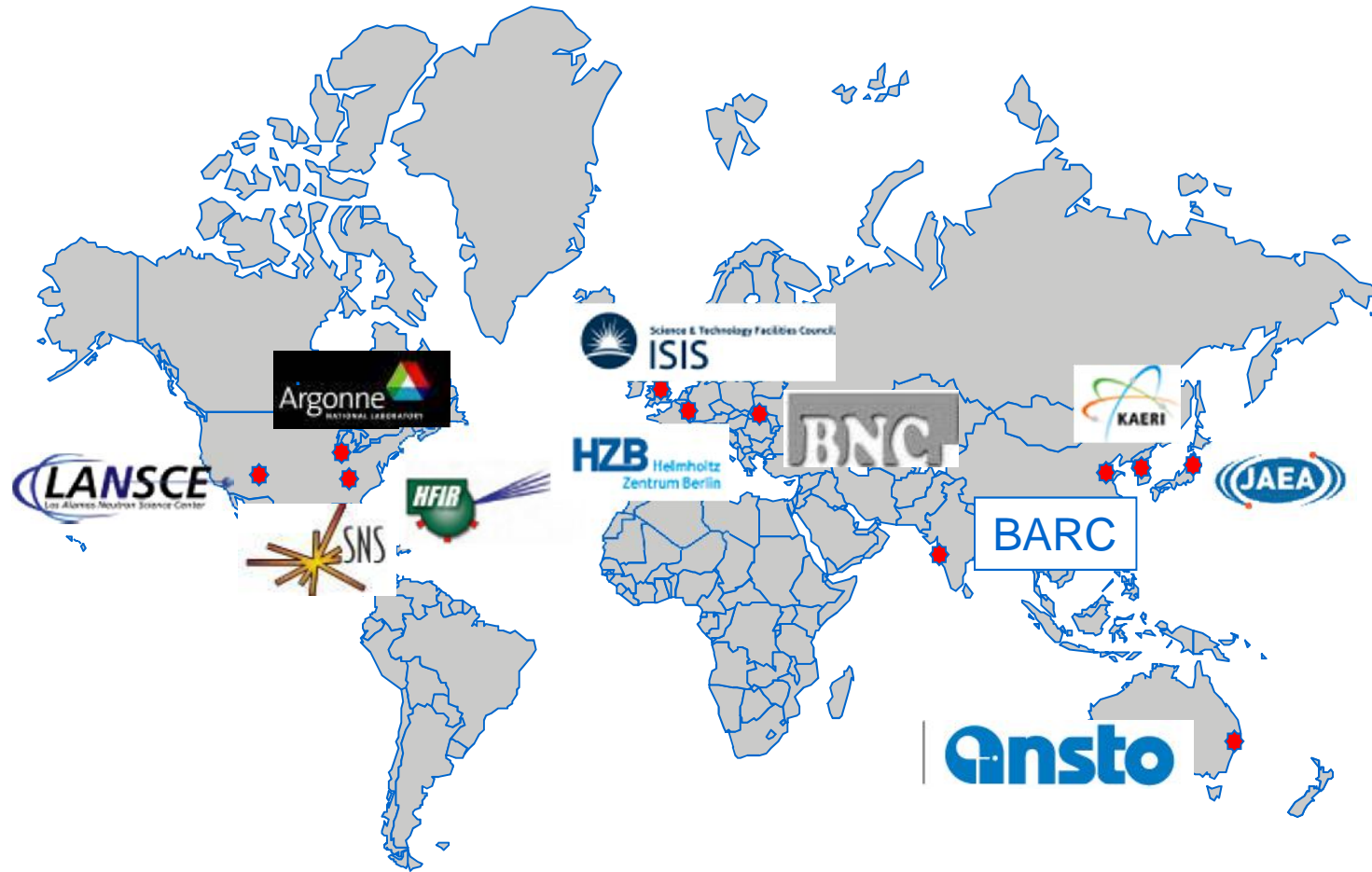
S2M Japan, Tokyo (J/V)
Sales & service

270 SKF employees
specializing in
magnetic bearings

Where to look for Magnetic Bearings



SKF global installations bring experience



92+ neutron choppers delivered and operational

Drives for neutron choppers

SKF offers drives and controls for Fermi, disk and T0 neutron choppers



Fermi (18)



Disk (70)



T0 (4)

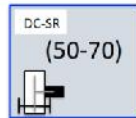
SKF Interest in ESS Chopper Types

ESS Chopper Type

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

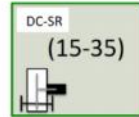


Principal characteristics

- Type: Platform 2
- Rotors: Disc chopper – Small rotor – Intermediate speed
- Diameter: Disc chopper – Small rotor – Intermediate speed

Enabling Technologies

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

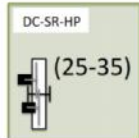


Principal characteristics

- Type: Platform 3
- Rotors: Disc chopper – Small rotor – High speed
- Diameter: Disc chopper – Small rotor – High speed

Enabling Technologies

- 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

SKF Solution



MB4150g5 Magnetic Bearing Controller and Motor Drive



Low Speed g5 Magnetic Bearing Spindle
Operating speed: 0 – 120Hz
Disk mass: 0 – 40kg



High Speed g5 Magnetic Bearing Spindle
Operating speed: 0 – 450Hz
Disk mass: 0 – ~10kg
April 2015

SKF Interest in ESS Chopper Types

ESS Chopper Type

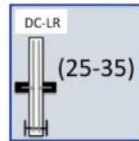
SKF Solution

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 .

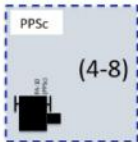
- Rotor material: CFRP / Alu
- Bearings:

Platform 6: Prompt pulse suppression chopper PPSc



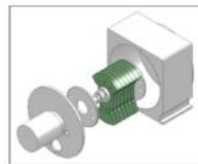
Key requirements

- 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



MB4150g5 Magnetic Bearing Controller and Motor Drive



2 Piece g5 Magnetic Bearing Spindle
 Operating speed: 0 – 120Hz (expandable)
 Payload mass: 0 – 80+kg
 To be developed as required

SKF Interest in ESS Chopper Types

ESS Chopper Type

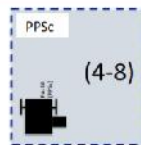
SKF Solution

Platform 6: Prompt pulse suppression chopper PPSc



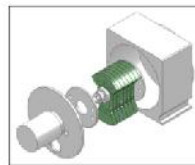
Key requirements

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



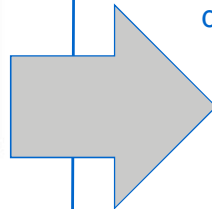
Principal characteristics

- 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



MB8150g5 Magnetic Bearing Controller
Industrial version under development



Motor Drive
To be developed as required



Standard turbo expander bearing cartridge
To be rad hardened for chopper use as required



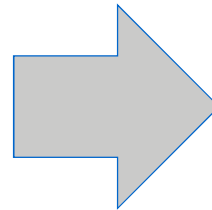
Turbo expander installation.
Over 600 O&G units in the field

SKF experience extends up to 10,000kg rotors at 6000rpm

Spares and Servicing



MB4150g5 Magnetic Bearing Controller and Motor Drive



Spares strategy:

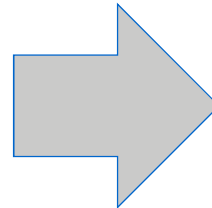
All MB4150g5 controllers are completely interchangeable regardless of the application:

- Low speed disk
- High speed disk
- Large rotor
- PPS_c

When swapping controllers simply load in the correct tuning file and press start



Low/High Speed g5 Magnetic Bearing Spindle



Spares strategy:

All Low/High speed g5 spindles are completely interchangeable for the same type, regardless the application or disk mass.

When swapping spindles load the correct tuning into the controller and press start. A check of performance is recommended.

SKF Neutron Chopper Drive Systems

2.0 – Future Development

Future Development

SKF's development plans for our neutron chopper products:

- High Speed g5 magnetic bearing spindle: April 2015
- 2 piece g5 magnetic bearing spindle: as required
- Radiation hardened turboexpander bearings and motor for PPSc: as required
- Continued development of specialty choppers for other labs: ongoing

Development plans that will improve all magnetic bearing products:

- MBScope customer collaboration model
- Connecting the g5 magnetic bearing controller to SKF @ptitude condition monitoring system

SKF Condition Monitoring – Global Footprint

CMC Total

- 239 employees
- 85 development engineers (36%)
- 46 development engineering contractors

Ft Collins

- 50 employees
- 7 development engineers

Livingston

- 47 employees
- 23 development engineers

Lulea

- 28 employees
- 12 development engineers

San Diego

- 85 employees
- 36 development engineers

Steyr

- 29 employees
- 7 development engineers



- Condition Monitoring Center
- Condition Monitoring Presence

SKF @ptitude Observer

SKF @ptitude Observer



Condition monitoring software for on-line systems with integrated analysis, machine diagnostics and graphical user interface

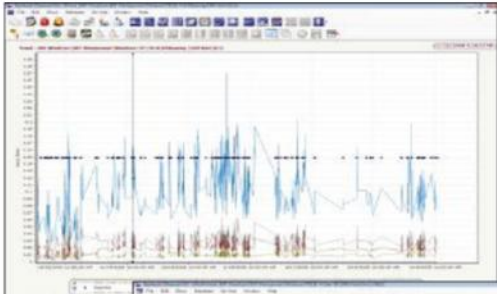


Figure 3. Advanced trend plot.

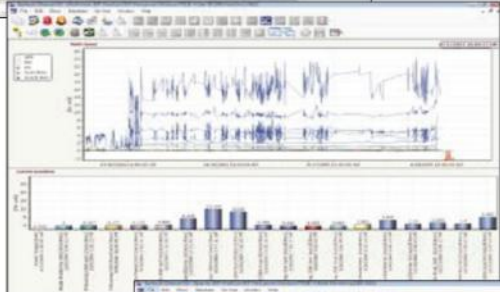


Figure 4 (above). Multi trend plot.

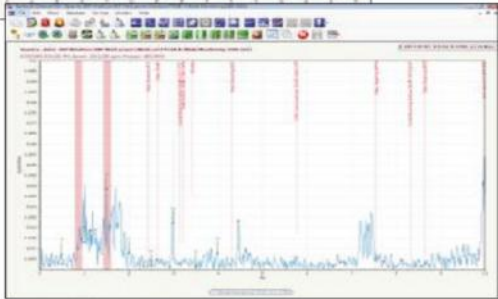


Figure 5. FFT with frequency markers plot.

