

The ISIS Neutron Chopper Suite: From Development to Operations +

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Peter Galsworthy
ISIS Design Division
Instrument Design Group
Neutron Chopper Design Section Leader



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The ISIS Target Station 2 Chopper Suite: From Development to Operations

- Background and history to 2005
- Target Station 2 chopper developments
 - Mechanical
 - Power and Control
 - Timing system integration
- Installation and operational experiences
- The future



Rutherford Appleton Laboratory



Harwell Science and Innovations Campus



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Two Target Stations



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Choppers at ISIS

- 28 operational neutron beamlines
- 42 operational choppers
 - 11 T_0 choppers
 - 28 disc choppers (including 4 high speed) : 37 Drives
 - 4 Fermi choppers
- In-house design, installation & operational support



Chopper History at ISIS

- 1984 – first neutrons produced
- Facility officially opened in 1985
- Instruments included HET (T_0 + Fermi)
- By 1990, chopper designs were mature (HRPD, IRIS, LAD etc.)



80s/90s Technologies

- T_0 and disc choppers
 - 50Hz, belt drives
 - Polaron-Cortina thyristor drives, ABB motors
 - Analogue control systems
 - Rotating seals, oiled bearings
 - ‘Analogue’ timing control
- Fermi choppers
 - Forschungszentrum-Jülich
 - 600Hz
 - Analogue power supplies
 - ISIS slit packages (~50mm)



1990s

- Inverter control for Fermi choppers
 - MAPS instrument
- IGBT drives for T_0 and disc choppers
- Development of solid state inverter drives
 - Bosch-Indramat
- Major upgrade to timing hardware
 - PLD technology

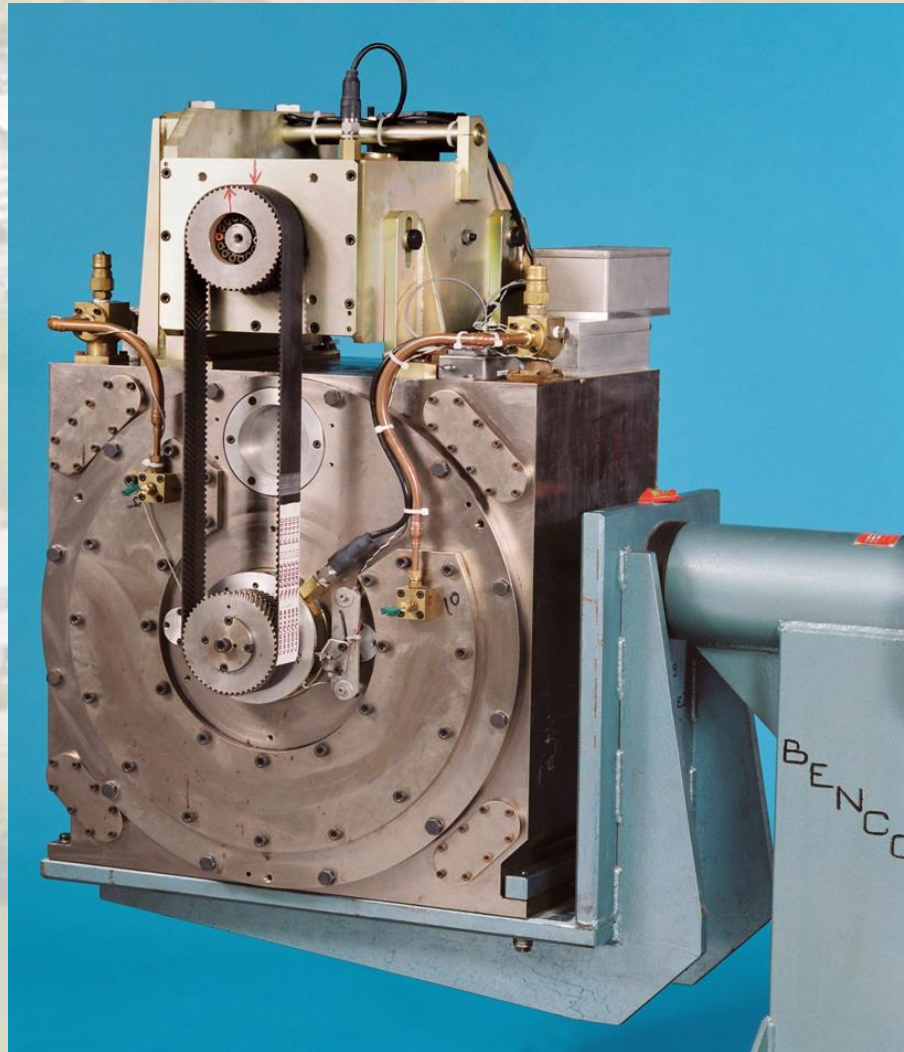


2000 - 2005

- 100Hz T_0 chopper
 - Higher level of balance
- Higher positional accuracy
- Direct drive
 - Water-cooled asynchronous motors
 - No belt, no coupling
- Condition monitoring implemented
- Improved handling and maintenance techniques
- Counter-rotating disc chopper
- Large Fermi slit packages (~80mm)



100Hz T_0



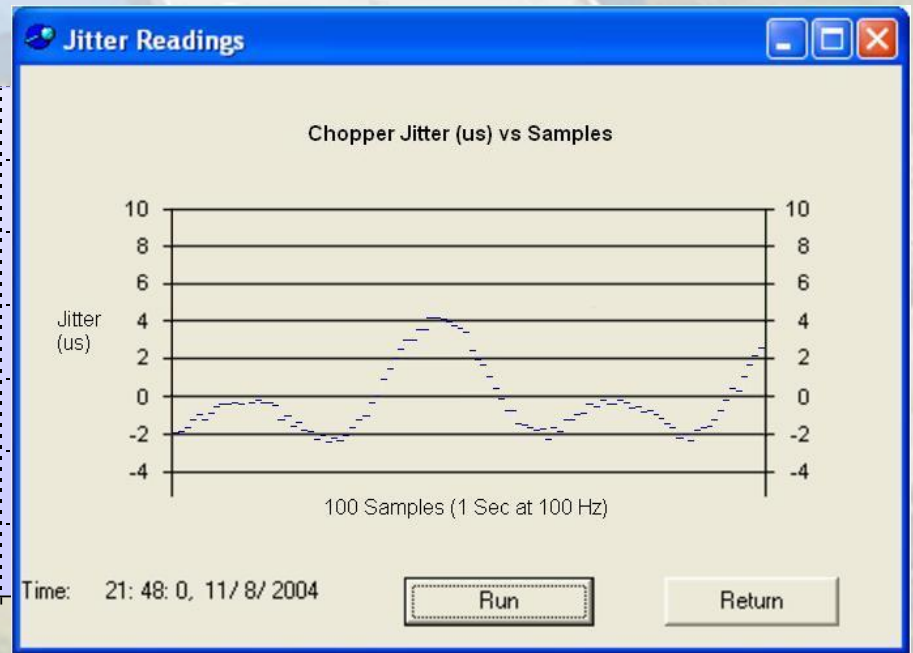
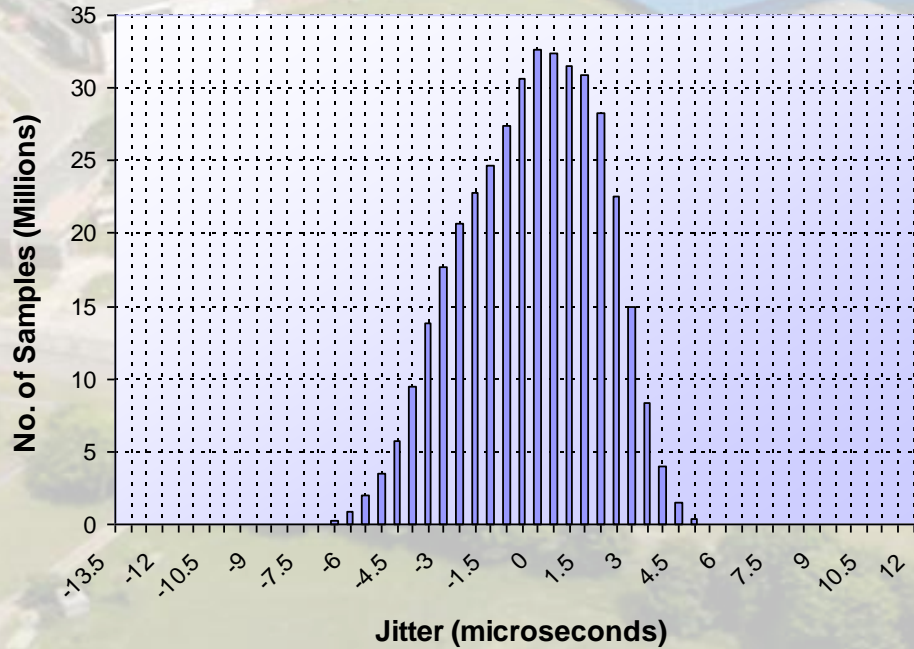
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100Hz T_0

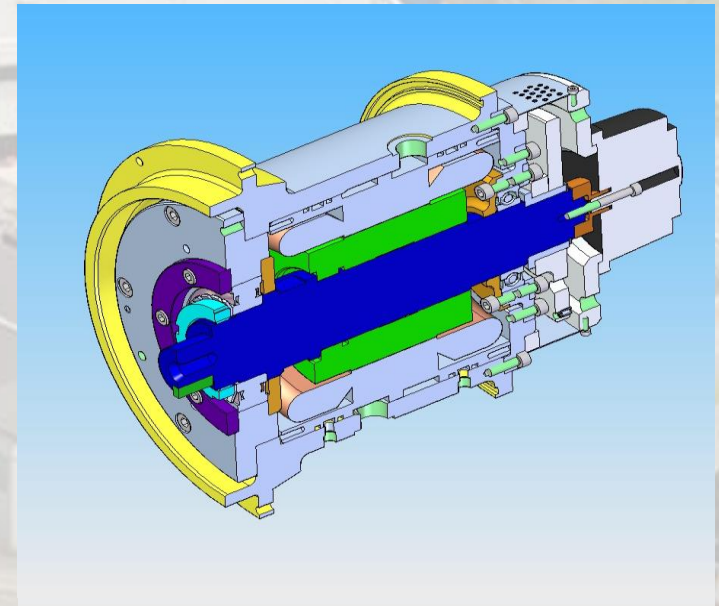
100Hz Chopper:
45 day jitter monitoring

100Hz Chopper:
Jitter over 1 second period

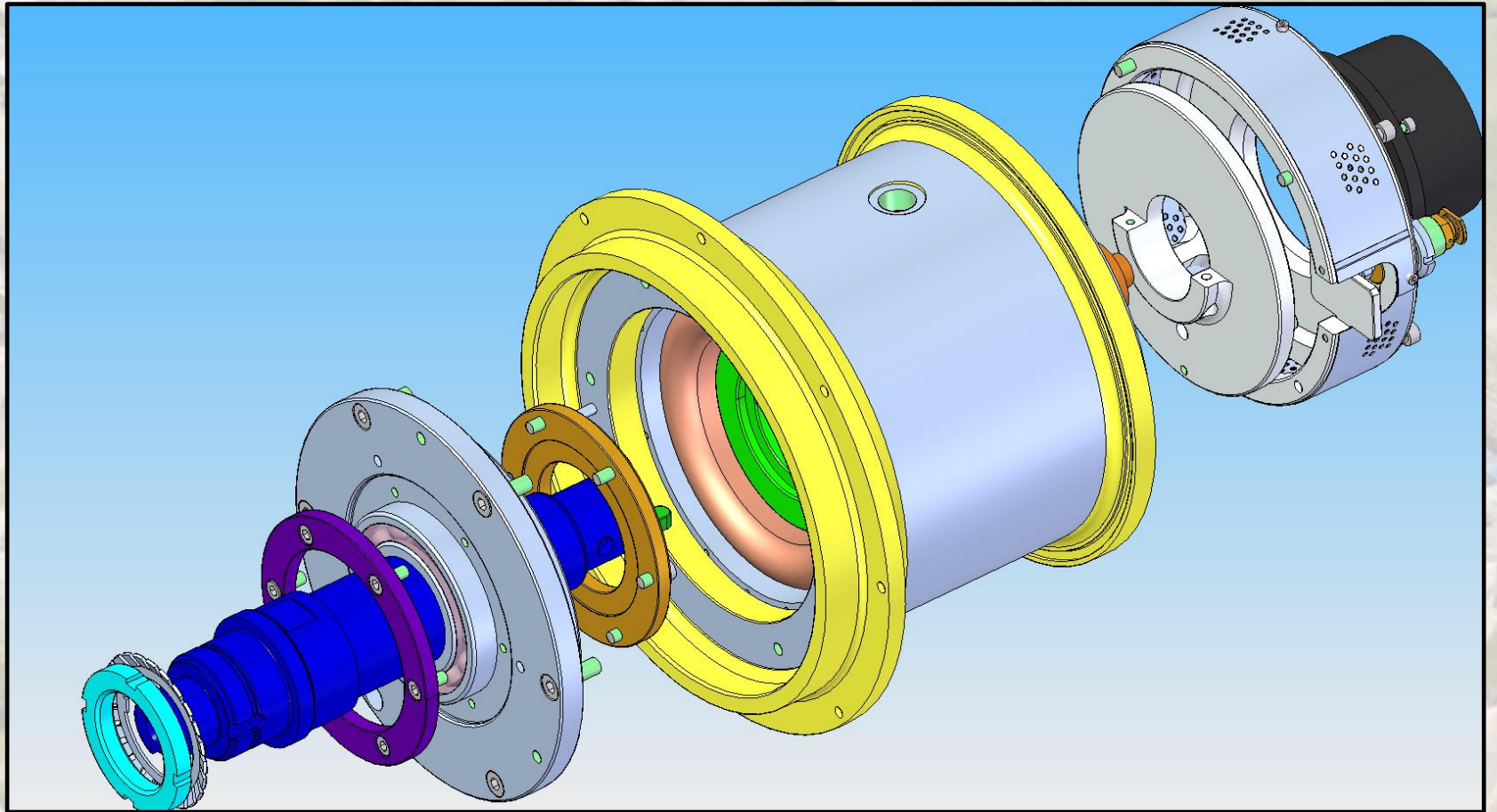


Direct Drive

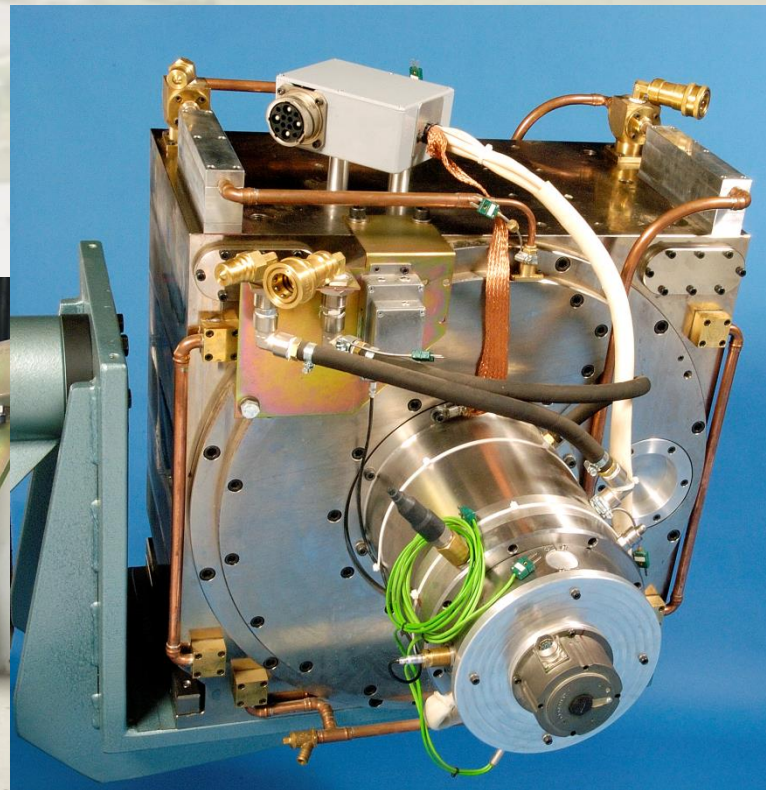
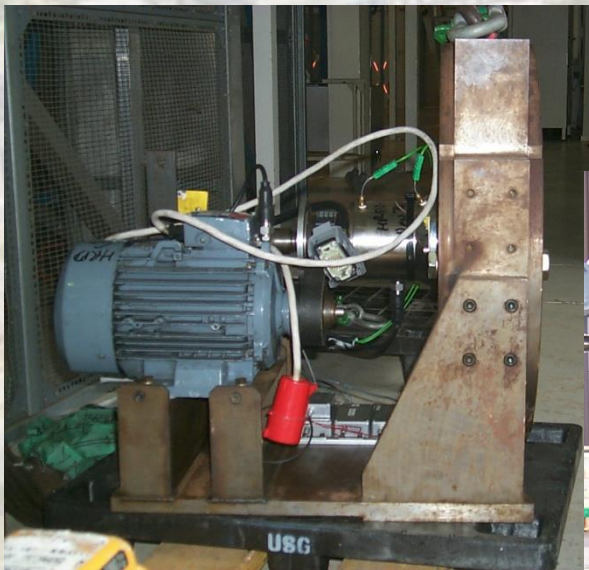
- Modular design
- Secondary bearing surfaces
- Higher positional accuracy
- Longer runtime between maintenance
- Shorter maintenance time
- Fewer wearing components



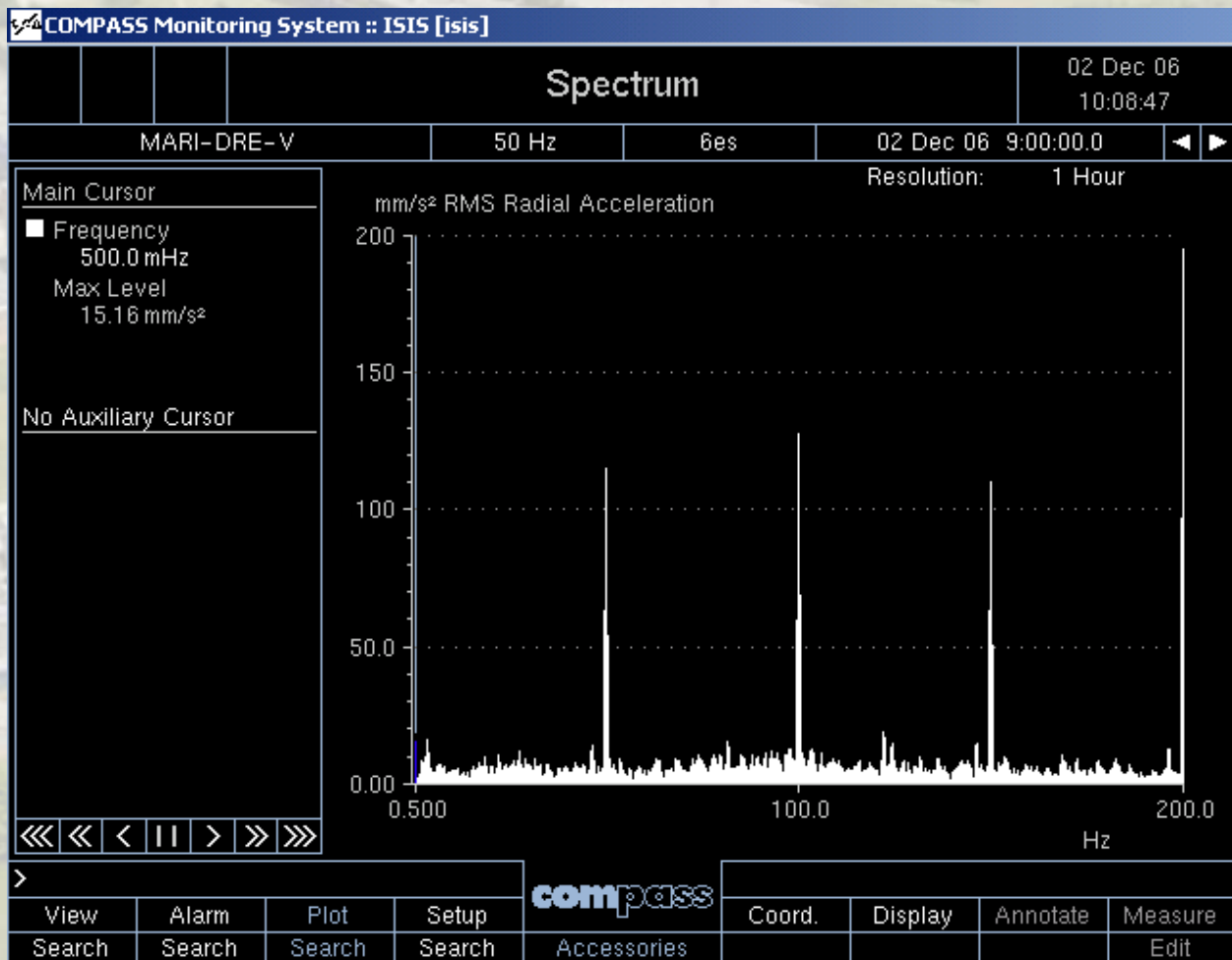
Motor Assembly



Direct Drive Choppers



Condition Monitoring - FFT



2005: TS2 Developments

3 drivers for change:

- Specification
- Design Risk Assessment
- Obsolescence



Specification

- Timing buses
- 10Hz rep. rate
- Chopper speed and beam size
- High speed
- Undefined disc aperture size
- Counter- *and* co-rotation



Obsolescence

- Bosch-Indramat upgrades
- Fibre optics
- Diagnostics / GUIs
- PC networking
- Condition monitoring
 - Improved measurement technology
 - Improved analytical techniques
 - Improved hardware
 - Object-oriented software



Implementation Design (Changes from “the standard”)

- Modular approach and basic principles applied
- Science drove the detailed specifications:
 - Silicon beam windows
 - Large disc
 - Thick discs
 - Combined T0 / disc assemblies
 - “Commissioning Discs”
 - Beamline interface / guides under vacuum
 - Accommodate beamline components e.g. monitors & jaws
 - Local shielding geometry



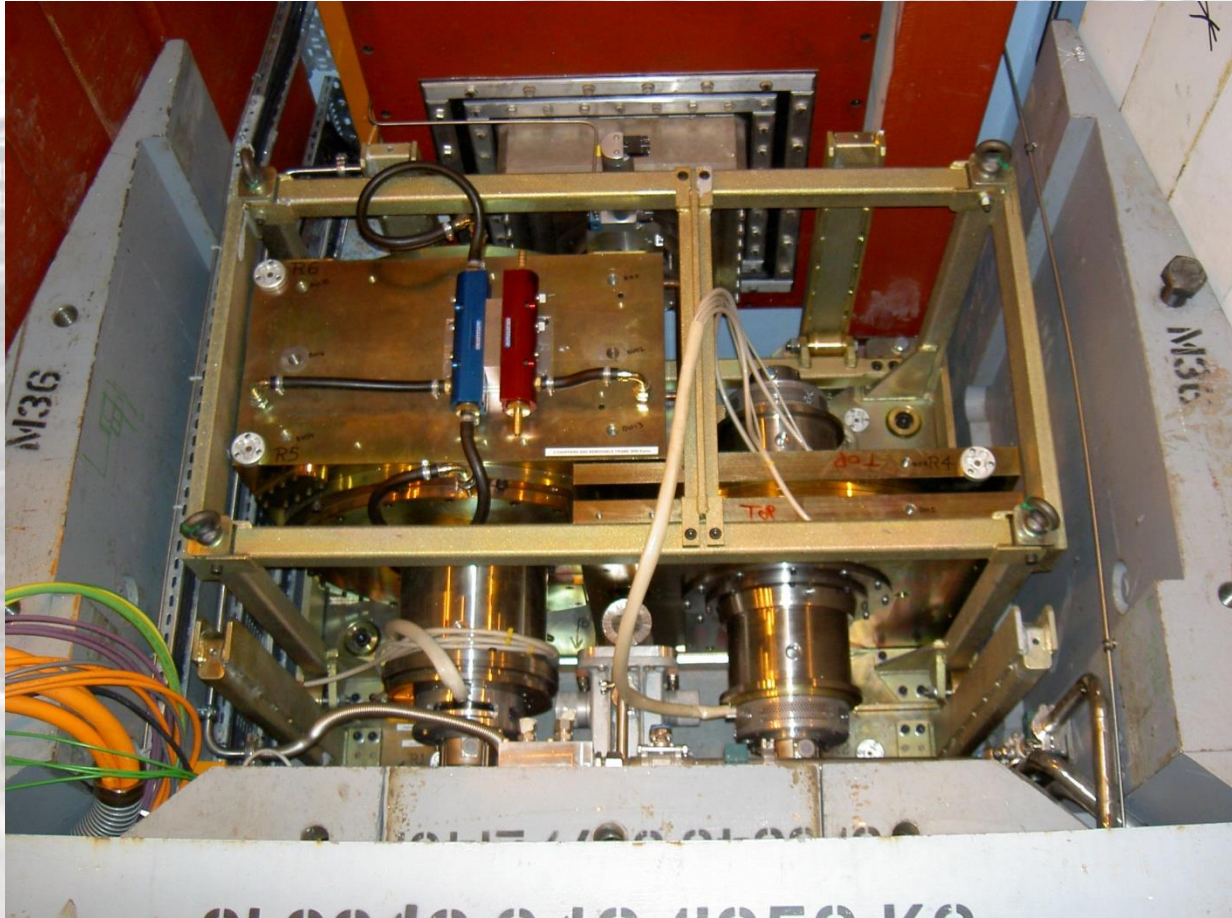
Large Disc Choppers



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Combined Chopper Assembly



Power and Control Systems



Cortina



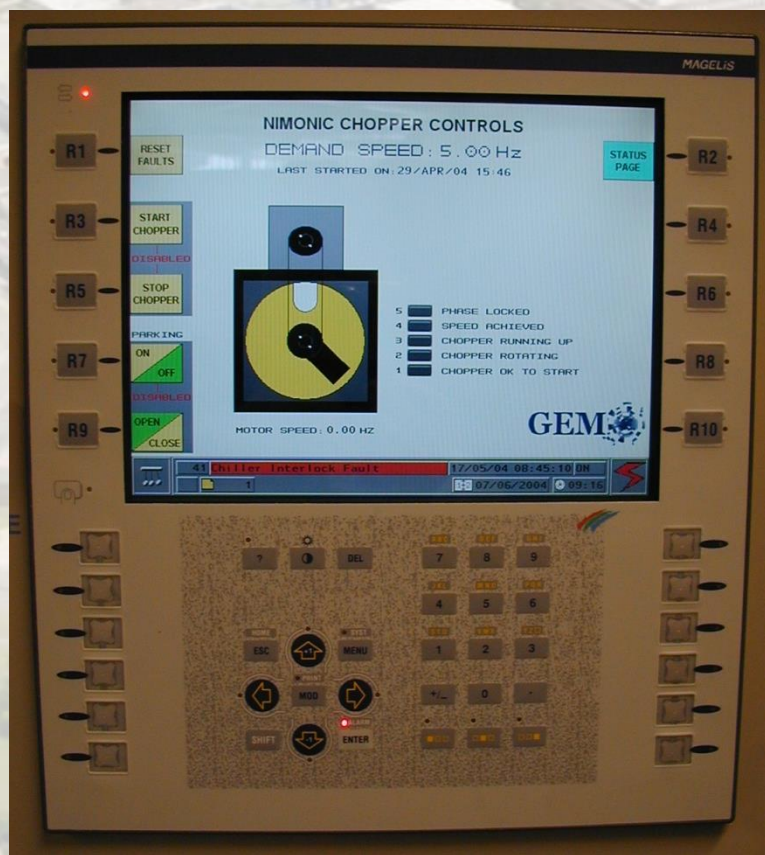
DiAx04 (Indramat)



IndraDrive



Power and Control Systems



Complex keypad



Touchscreen



Power and Control Systems

DOUBLE DISK CHOPPER CONTROLS

START CHOPPER

STOP CHOPPER

PARKING

ON OFF

DISABLED

OPEN CLOSE

5 4 3 2 1

TARGET

9.9 Hz

9.6 Hz

DMD : 10.0 Hz

DMD : 10.0 Hz

5 4 3 2 1

START CHOPPER

STOP CHOPPER

PARKING

ON OFF

DISABLED

OPEN CLOSE

CONTROL PAGE

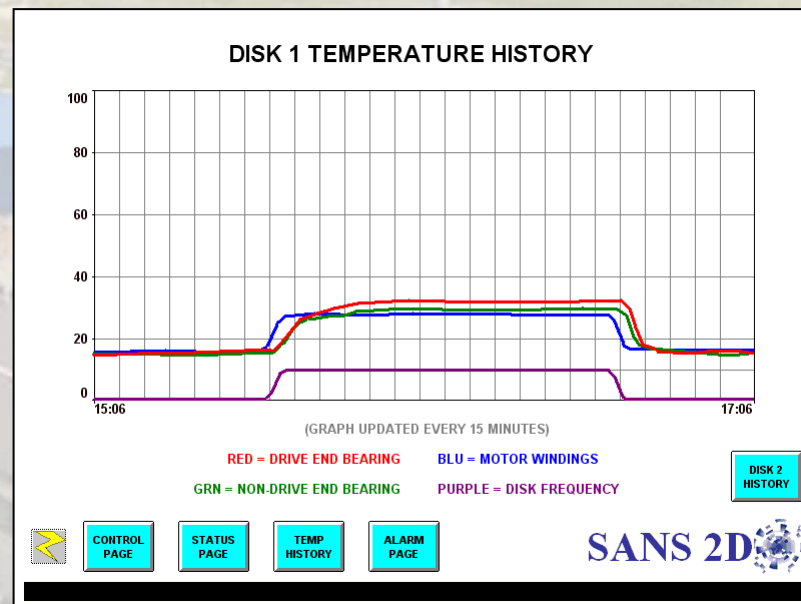
STATUS PAGE

TEMP HISTORY

ALARM PAGE

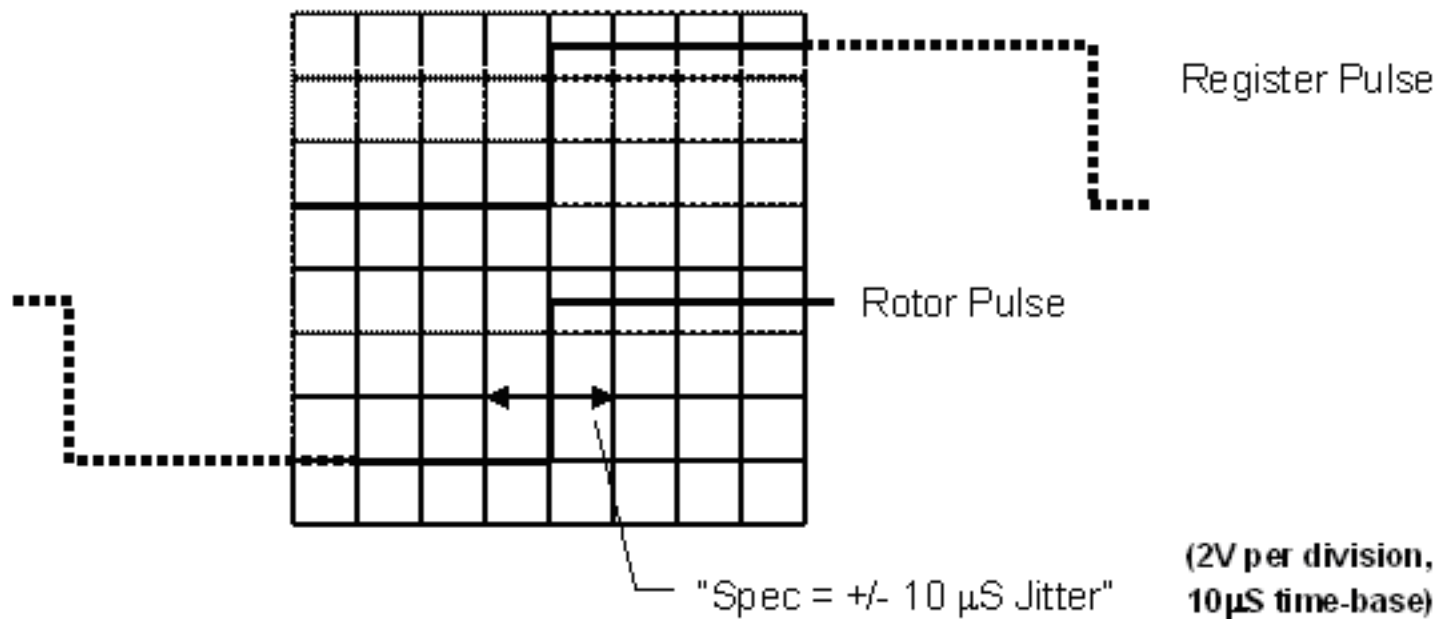
SANS 2D

16/04/2007 16:50:01 DISK1 LOCAL MODE - use screen controls



Power and Control Systems

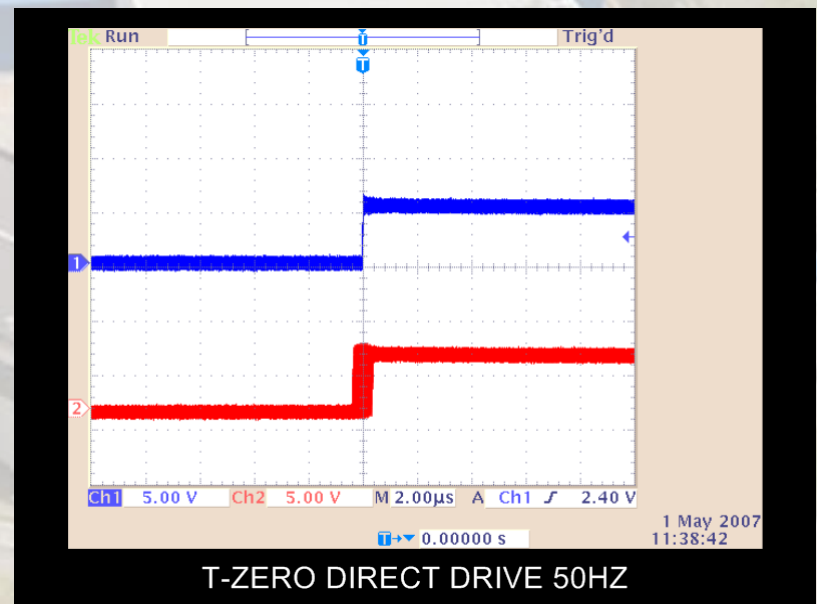
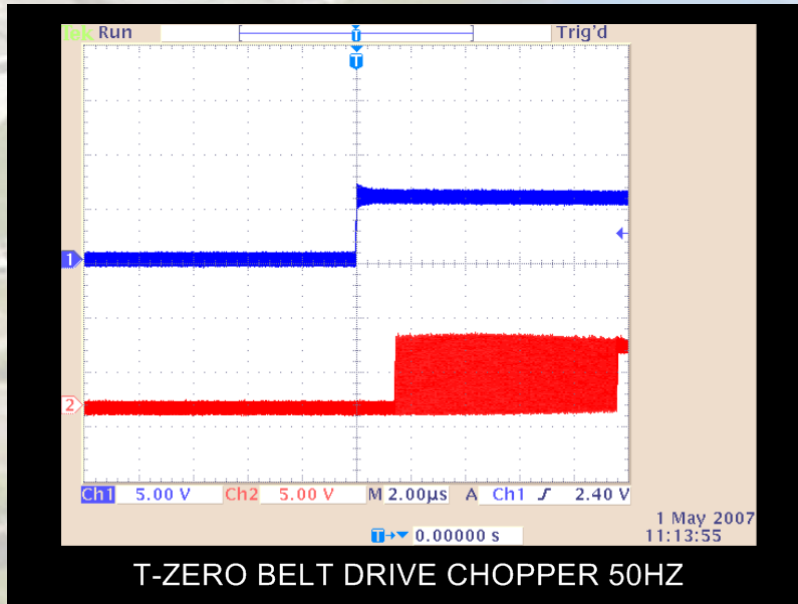
Accuracy Specification



Results – 50Hz

DiAx04 Belt Drive:
 $\pm 4\mu\text{S}$, $5.8\ \mu\text{S}$ Offset

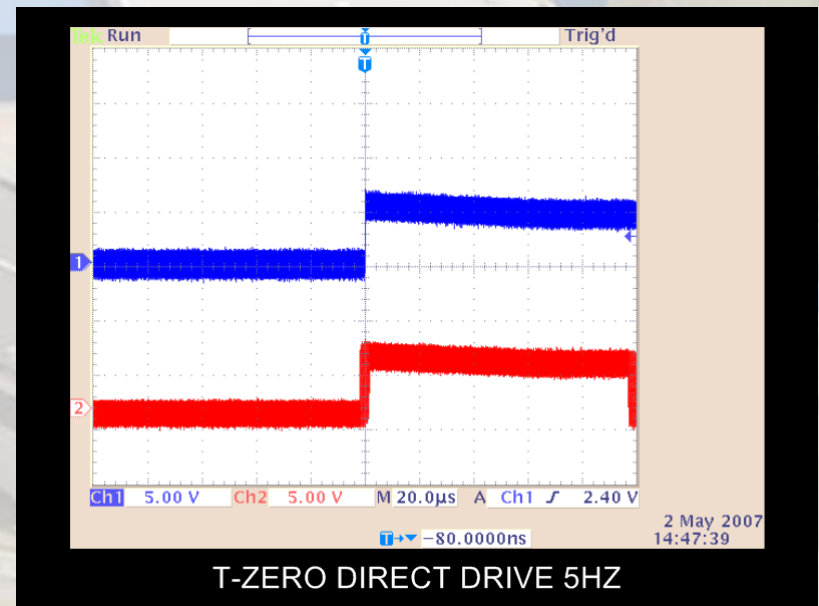
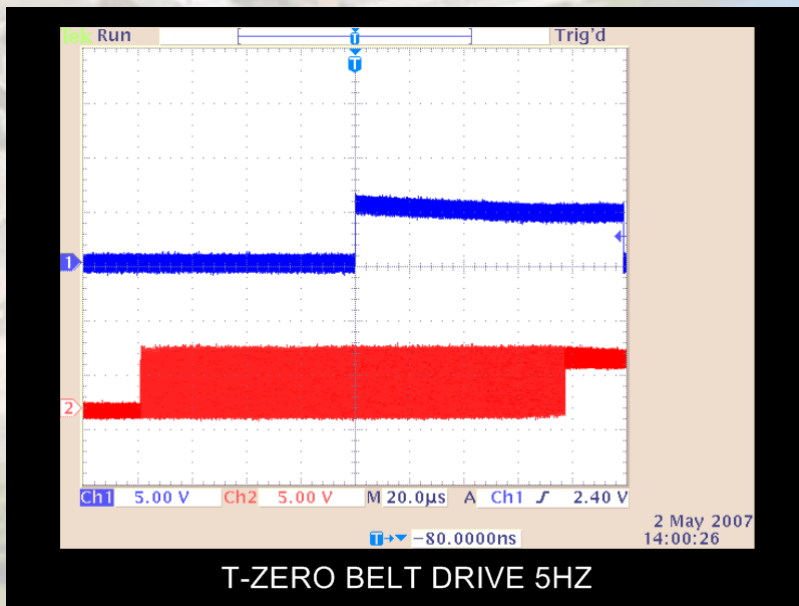
IndraDrive Direct Drive:
 $\pm 400\text{nS}$, NO Offset



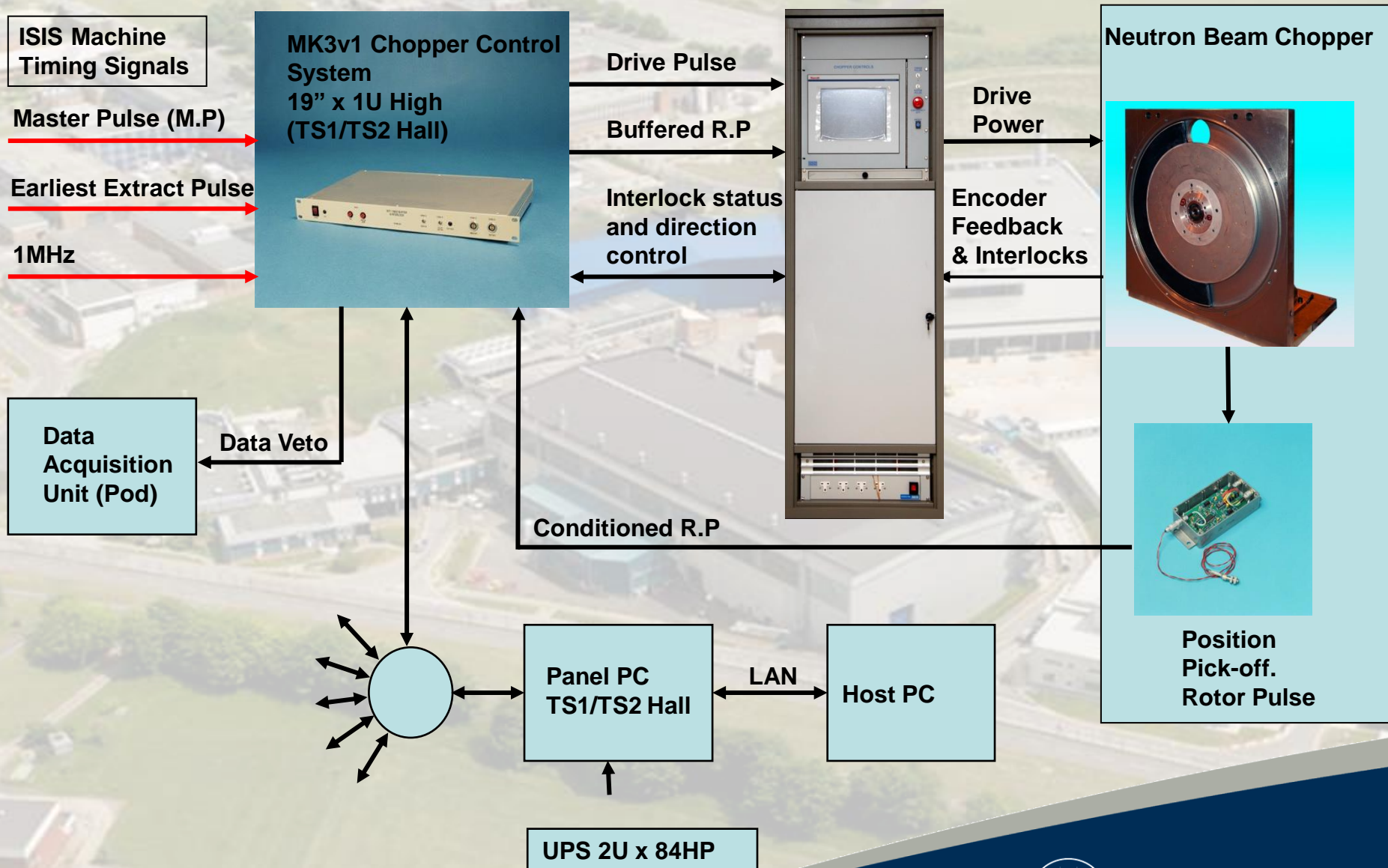
Results – 5Hz

DiAx04 Belt Drive:
 $\pm 80\mu\text{S}$

IndraDrive Direct Drive:
 $\pm 2\mu\text{S}$



Chopper Timing Control System



Operation

- SANS2D, POLREF, INTER, OFFSPEC and WISH
 - Excellent operation and performance
 - Over 5 years operating without problem
 - First choppers removed 12 months ago for routine bearing change
 - determined by condition monitoring
- LET
 - All choppers perform well
 - including 2 × 150Hz, 2 × 300Hz
 - Instrument technically highly complex
 - Choppers meet challenging specifications
 - Compromised access and interface arrangements
 - Mechanical, electrical and software issues were resolved
 - We relied on supplier expertise to fault-find



The Team

- Multi-disciplinary Engineering
 - Mechanical, Electrical, Electronic, Process, Operations
- Multi-functional
 - Development
 - Design and manufacture
 - Assembly
 - Installation and testing
 - Operational support
 - Project management
- From different management groups
 - Design Division
 - Instrument Operations Group
 - Accelerator Engineering Group
 - Technology Dept.



Key Points for ISIS

- Modular design in all respects
- Flexibility to meet specification detail
- In-house development
- Specialist collaborations
- Condition monitoring
- Obsolescence programmes
- Dedicated, established team



The ISIS Chopper Team



Erik Johnson
Tim Carter
Doug Whiting
Paul Chorley
Adam Davis
Peter Dawson

Clive Smith
Mike Brind
Kevin Allen
Simon Rutter
Steve Wakefield
Peter Galsworthy



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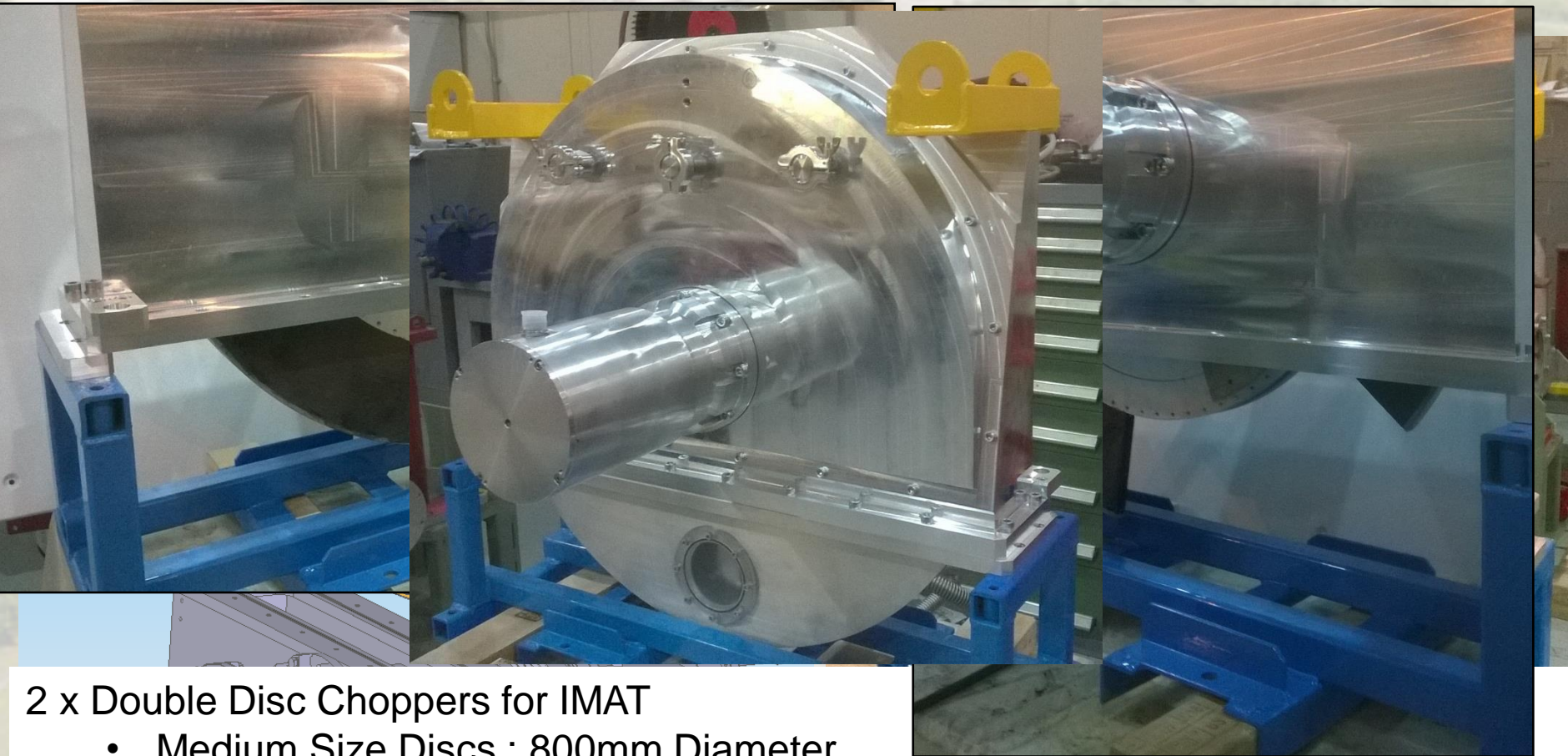
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The Present

- Target Station 2 Phase 2
 - 3 of 4 new instruments have choppers
 - ZOOM Double Disc + Si window **Ready for Installation**
 - LARMOR combined T_0 & Double Disc Assembly : **Installed and Commissioned**
 - IMAT 2 x Double Disc **(In Test)** + T_0 **(In Manufacture)**, fully vacuum integrated :
- Fermi
 - Material and package design
- Blocking materials
- Drive obsolescence (Cortinas + Bosch-Indramat)
- Timing control obsolescence



The Present

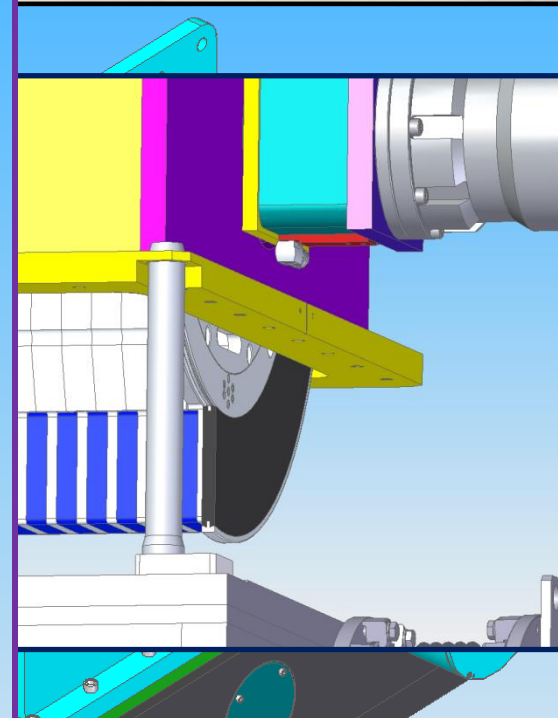
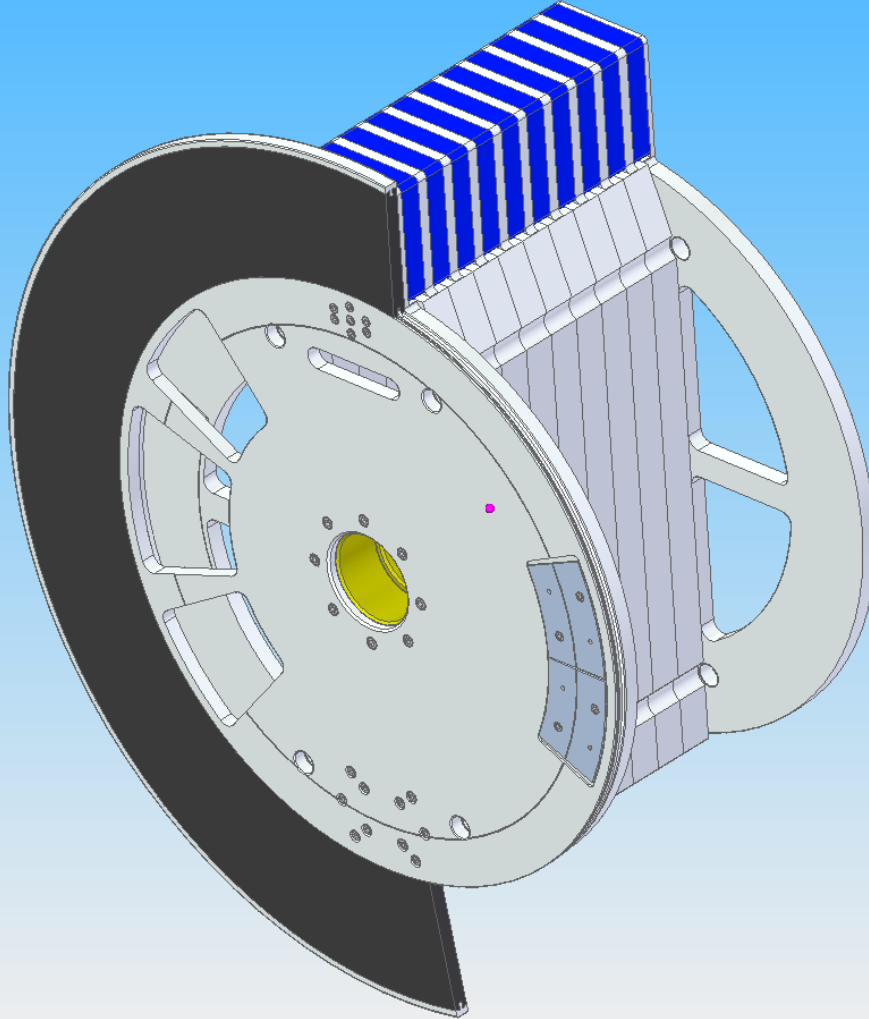
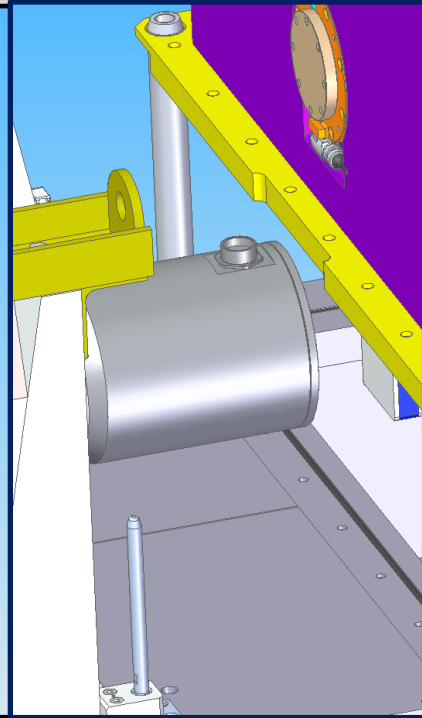


2 x Double Disc Choppers for IMAT

- Medium Size Discs : 800mm Diameter
- New SKF Magnetic Bearing High Capacity Drives
- Internal Vacuum same as Beam Guide Vacuum : No Windows



The Present



- 1 x T-Zero Chopper
- Large Size A
- Rotor mount
- New SKF M
- Internal Vac

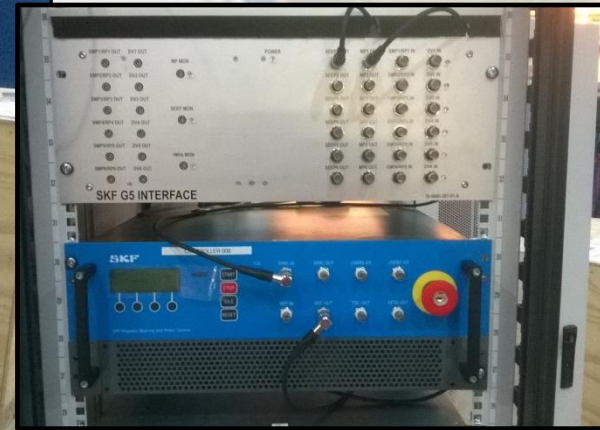
No Lubricate : Long Life
ndows



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The Present



The Present



TOSCA gets a New Double Disc
Chopper



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Thank You

ANY
QUESTIONS
?



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