

# Research with Neutrons

Disc Choppers



Fermi Choppers



Neutron  
Velocity  
Selectors



All the space you need

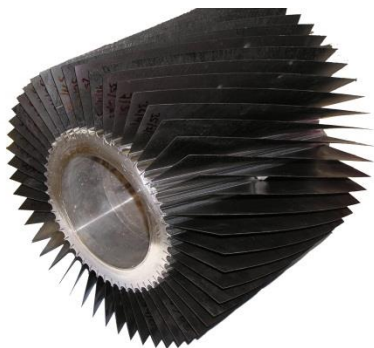
# Heritage



Gas Ultra Centrifuge



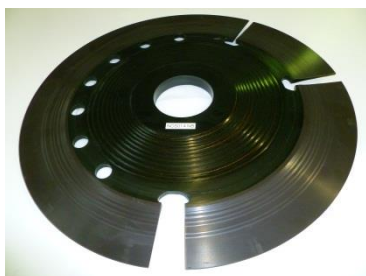
- high speed (60,000 rpm)
- vacuum
- radiation resistant
- magnetic bearings
- carbon fibre tubes



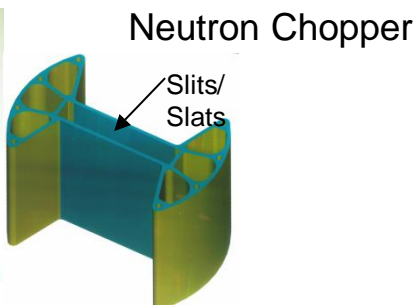
Neutron Velocity Selector



- high speed
- vacuum
- radiation resistant
- hybrid ball bearings
- carbon fibre blades



Disc Chopper



Fermi Chopper

- high speed
- vacuum
- radiation resistant
- hybrid ball or magnetic bearings
- carbon fibre / aluminium disks

# Fermi Chopper

## ▪Housing

*material* aluminium  
*windows*  
*thickness* [mm] *appr. 0.4*  
*material* aluminium foil

## ▪Lightweight Payload Carriers for High Speed

*low risk in case of damage* aluminium with additional absorber coating

## ▪Slit/Slat Package

*slit material* aluminium  
*slat material / absorber* B-10, Gd<sub>2</sub>O<sub>3</sub> (with Epoxy)  
*speed* [rpm] upto 40,000

## ▪Drive

*synchronous brushless motor*  
*phase precision* [°] < ± 0.15

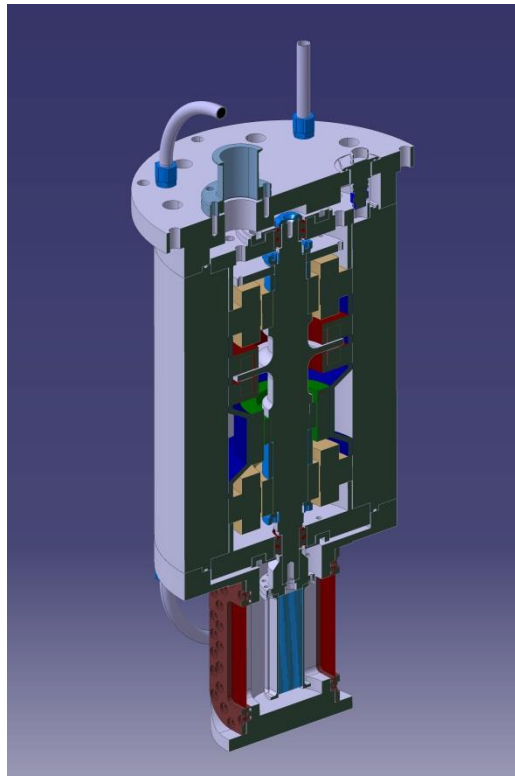
## ▪Bearings

*active magnetic bearings* speed upto 40,000 rpm  
*or hybrid ball bearings* speed upto 22,000 rpm

# Fermi Chopper

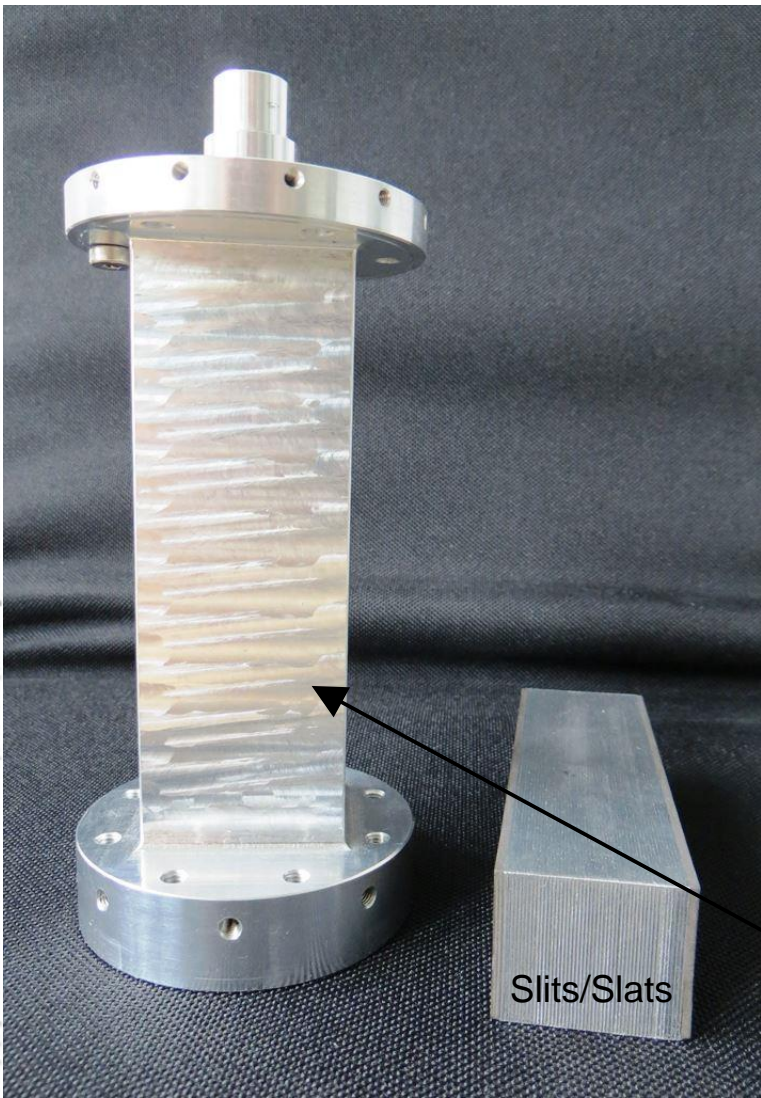


**Magnetic Bearings,  
IN4, ILL  
40,000 rpm**



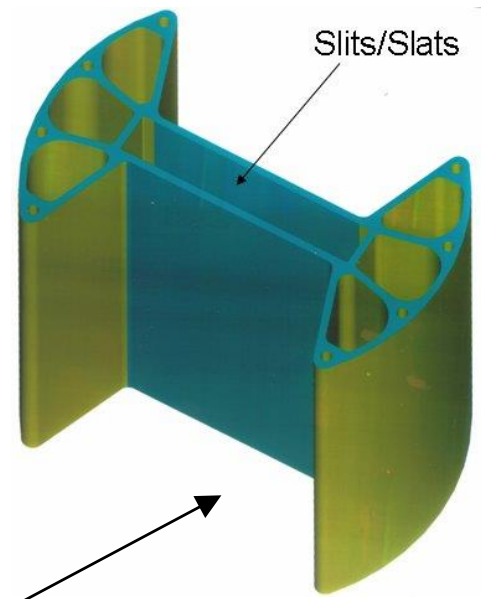
**Hybrid Ball Bearings,  
FOCUS PSI, 23,000 rpm**

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Slits/Slats

Lightweight Payload Carrier



Slits/Slats

FOCUS Fermi Rotor

IN4 Fermi Chopper with 3 interchangeable Rotors for different collimations

# Fermi Chopper



Low Speed Fermi Chopper (6000 rpm) with absorber coated (inside/outside) rotor  
MARIA, FRMII

# Disc Chopper

## ▪ Housing

<i>material</i>		<i>aluminium</i>
<i>windows</i>		
<i>thickness</i>	<i>[mm]</i>	<i>appr. 0.4</i>
<i>material</i>		<i>aluminium foil</i>

## ▪ Disc

<i>material</i>		<i>aluminium or CFRP (carbon fibre re-inforced plastics)</i>
<i>absorber</i>		<i>B-10, Gd<sub>2</sub>O<sub>3</sub></i>
<i>windows</i>		<i>real cut-away windows</i>
<i>speed</i>	<i>[rpm]</i>	<i>upto 24,000 [ f(diameter, window)]</i>
<i>peripheral speed</i>	<i>[m/s]</i>	<i>upto 735</i>

## ▪ Drive

<i>synchronous brushless motor</i>		
<i>phase precision</i>	<i>[°]</i>	<i>better ± 0.1</i>

## ▪ Bearings

<i>active magnetic bearings</i>		<i>5 axes active controlled</i>
<i>speed</i>	<i>[rpm]</i>	<i>upto 30,000</i>
<i>or hybrid ball bearings</i>		<i>ceramic balls</i>
<i>speed</i>	<i>[rpm]</i>	<i>upto 15,000</i>

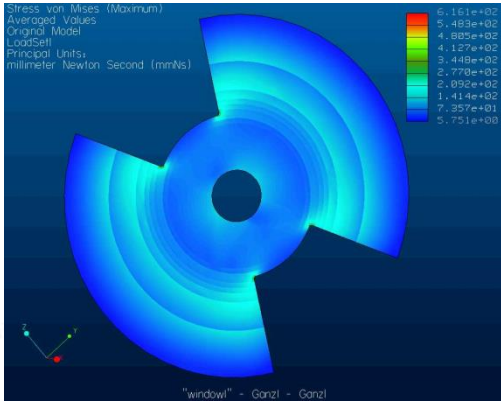
# Disc Chopper: Ball Bearings – Magnetic Bearings – Alu-Discs – CFRP-Discs

Low Speed	Interm. Speed	High Speed	Very High Speed	
0-4000	4000-8000	8000-15000	15000-max.possible	rpm
Yes	Possible	Not Recommended	No	Ball Bearing
Yes	Yes	Yes	Yes	Magn. Bearing
Yes	Possible	Not Recommended	No	Aluminium Disc
Yes	Yes	Yes	Yes	CFRP Disc

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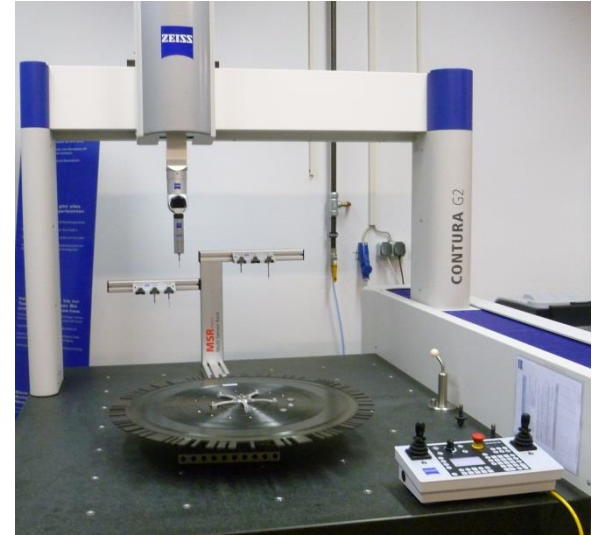
# Disc Chopper: Disc Production Cycle



1-FEM Calculation



3-Spinning Test



4-Verification of Design Data



2-Manufacturing

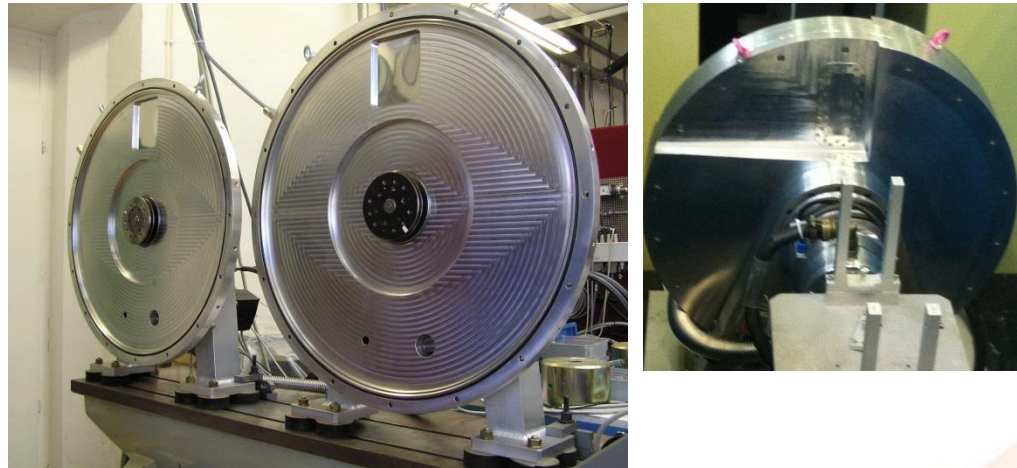
# Single Disc Chopper

Examples:

Housing directly attached to the guide



Housing with aluminium window (0.4 mm)



Fixed mounted in the beam

# Double Disc Chopper

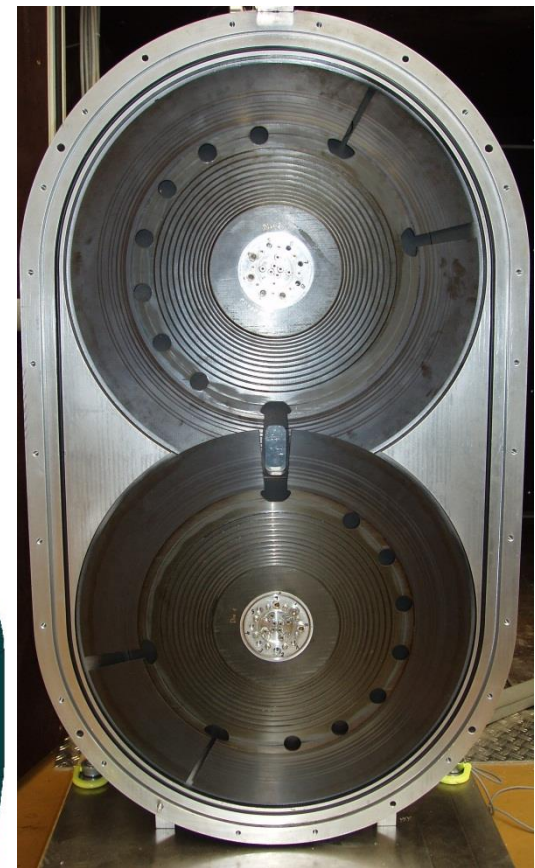
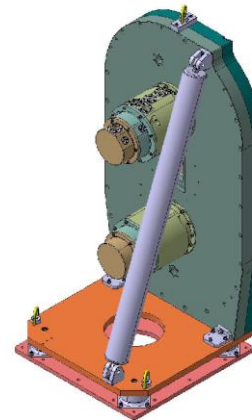


Figaro, ILL  
D33, ILL  
Platypus, ANSTO

V4 SANS, HZB

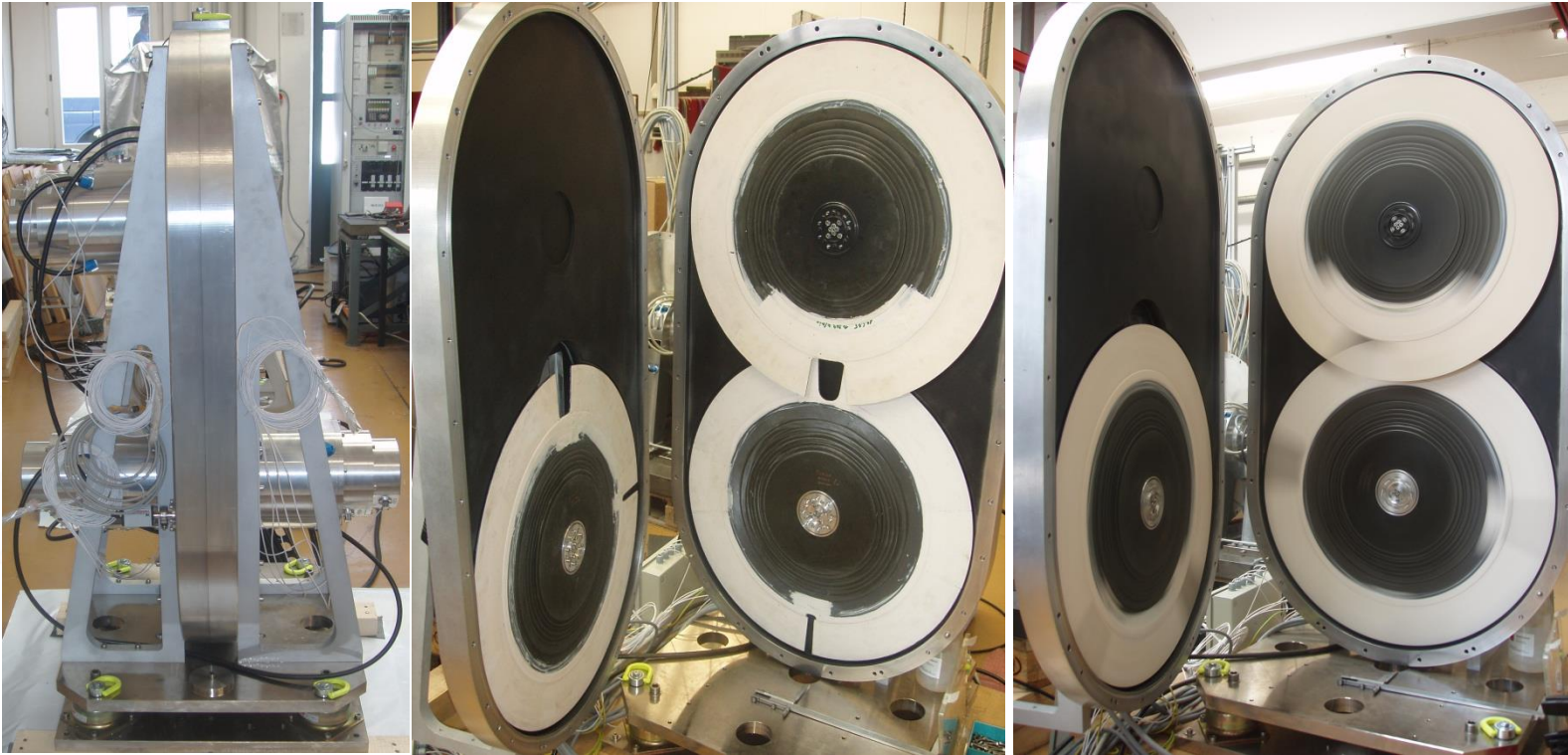


TISANE, ILL  
TOF, KAERI



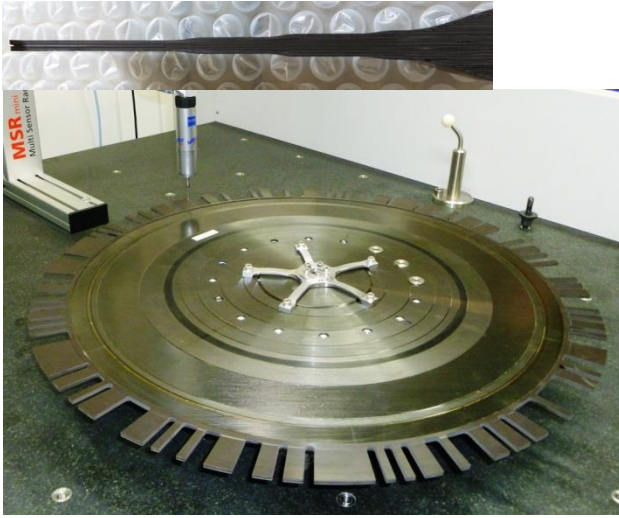
LET, ISIS  
CNCS, SNS

# Triple Disc Chopper

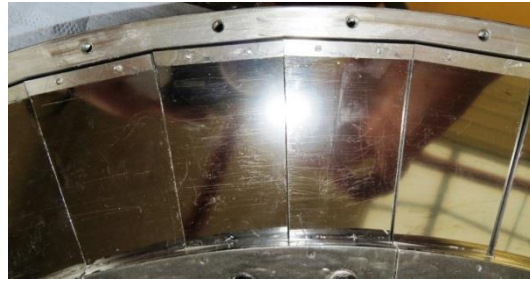


IN500 – upto 12,000 rpm

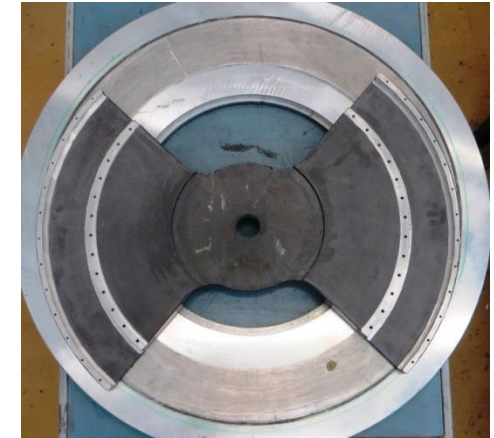
# Special Discs



Correlation Disc, SNS

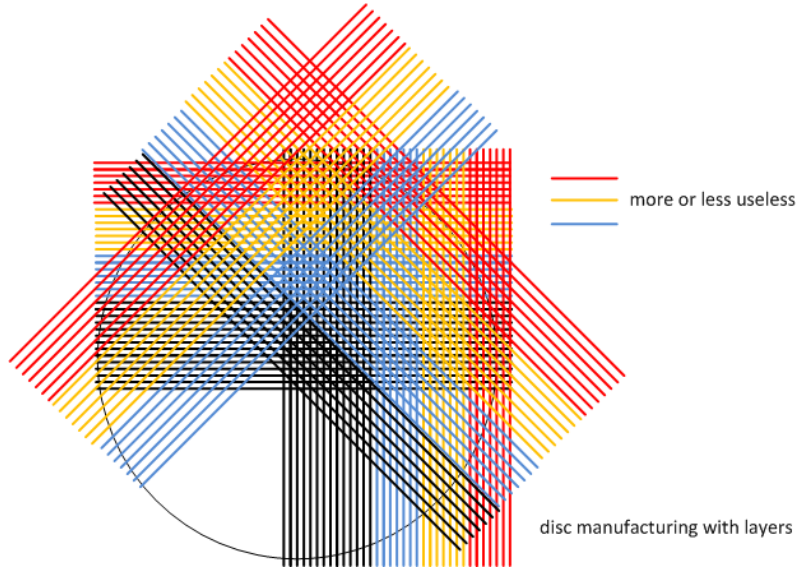


Disc with adjustable Window

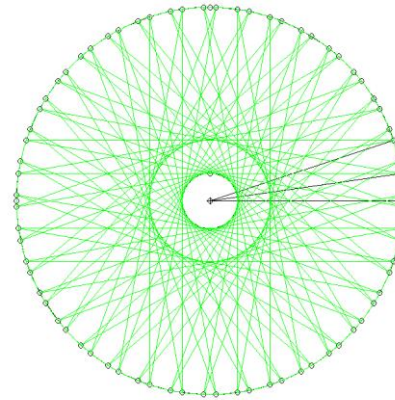


Graphite Disc for Backscattering Instrument

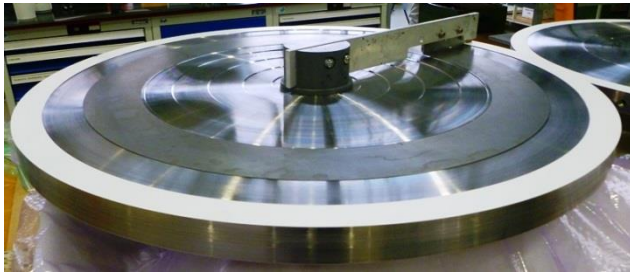
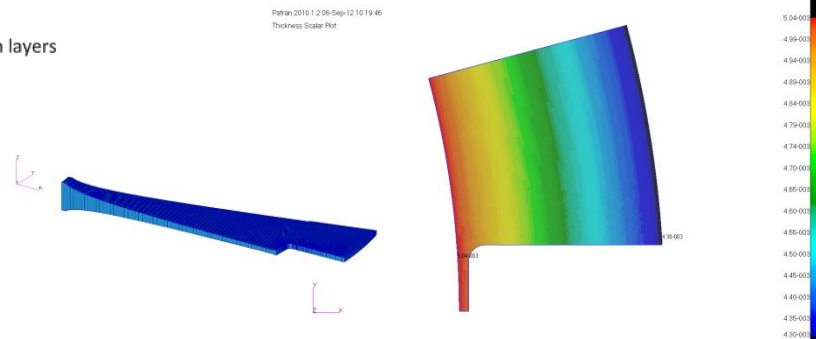
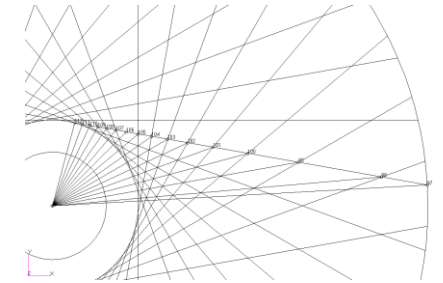
# Disc Development – Filament Winding



quasiisotrope laminate

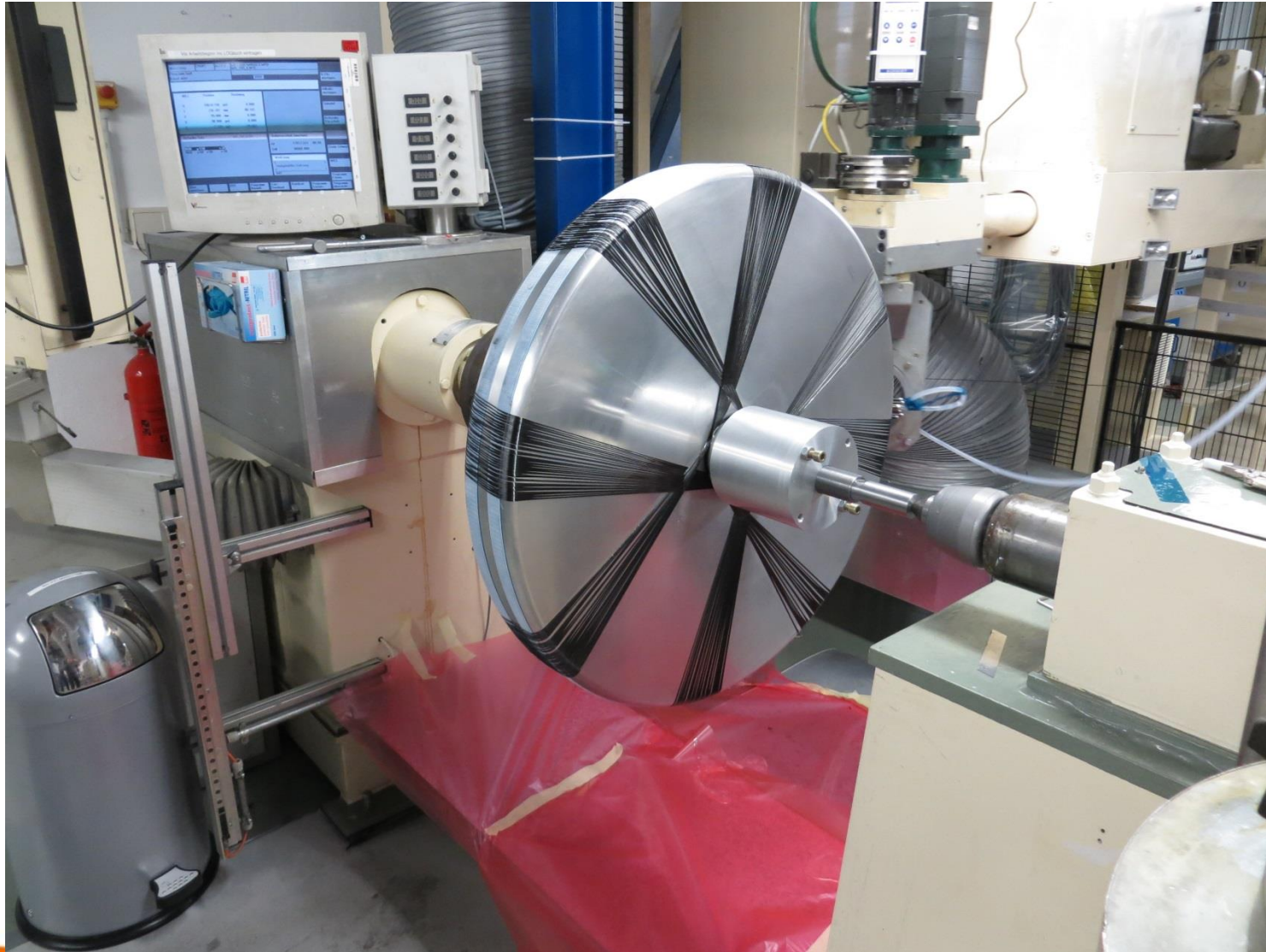


orthotropic laminate



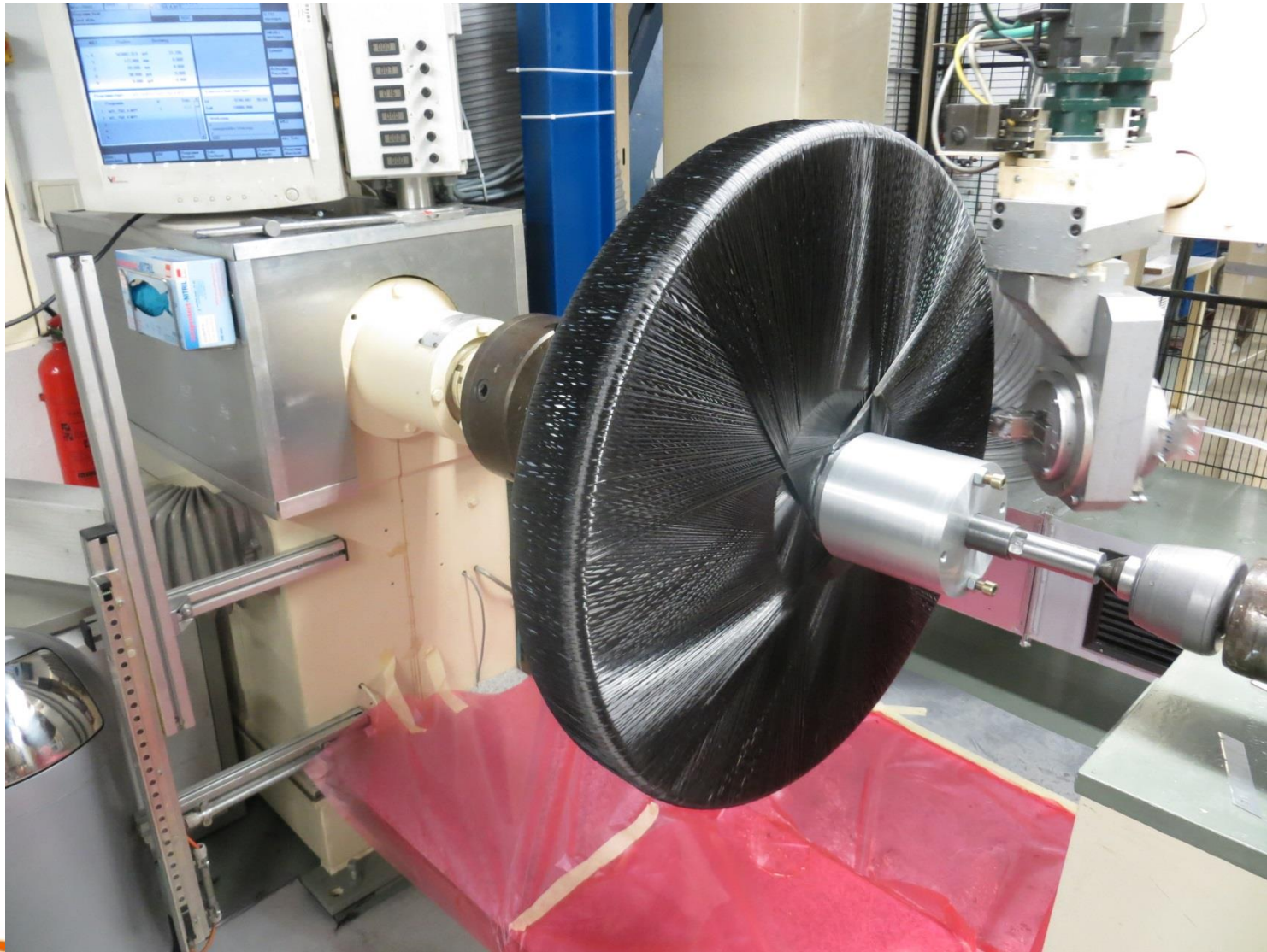
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# Disc Development – Filament Winding



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# Disc Development – Filament Winding



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# Monitoring System



outside - front



outside - back



inside - front



inside - back

## Monitored Data:

- operation vacuum
- cooling water
- disc temperature
- vibrations (ball bearings)
- orbits of the magnetic bearings

## Safety Functions

- stop of the chopper in case of any failure with vacuum, cooling water, disc temperature, vibrations or orbits
- logging of all data in a SQL-database (1s, 10s, 60s) with garbage collector
- monitoring the orbits of each magnetic bearing axle relatively to tuning
- adjusting of orbit limits of the magnetic bearing axes according speed and disc tuning

## Characteristics

- Beckhoff System with realtime operation system
- Ethercat for internal communication between Main Module and IO-modules
- IO-modules with own processor for data acquisition
- Windows OS for visualisation

# Research with Neutrons

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