Innovative ring spinning technology: Feasibility tests with high-speed superconducting magnetic bearing

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1. Principle of Ring Spinning Technique
2. SMB development, HTS Bulks and Tapes
3. Application and Feasibility Tests
4. Conclusion

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HTS production: >1 ton precursor materials per year ATZ GmbH

Powder, Targets (55%)
Y, Dy, Gd, Sm, BZO

Sintered Components (5%)
high density, max. 92%

REBCO bulks (40%)
single, multi-seed, melt textured

2nd generation CC
high in-field I_c
mech. strength
low AC loss, doping

thin film

L~27 500 km !
4 mm; 1 µm

screening

HTS bulk material

high Jc
trapped field B
mech. strength
robust
long term stab.

Bulk devices

HTS bearings
Mobile cryostats
Motor elements
Space application

Innovative solutions should be simple and robust !
Cryostat deficits !

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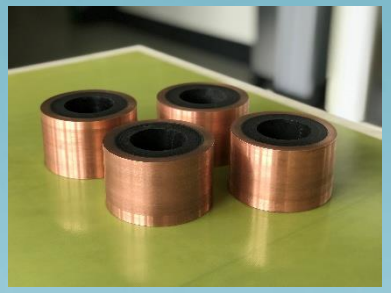




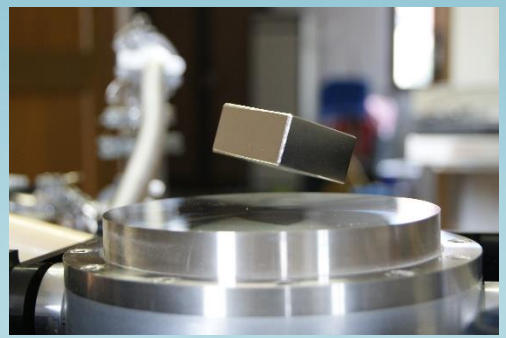
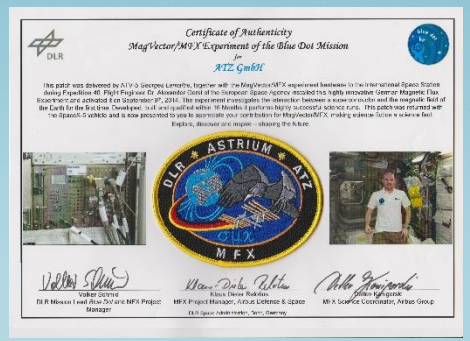

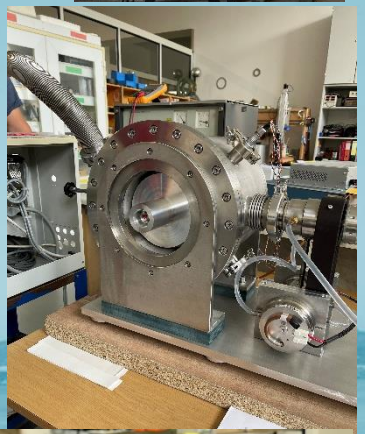




HTS applications made by ATZ since 34 years

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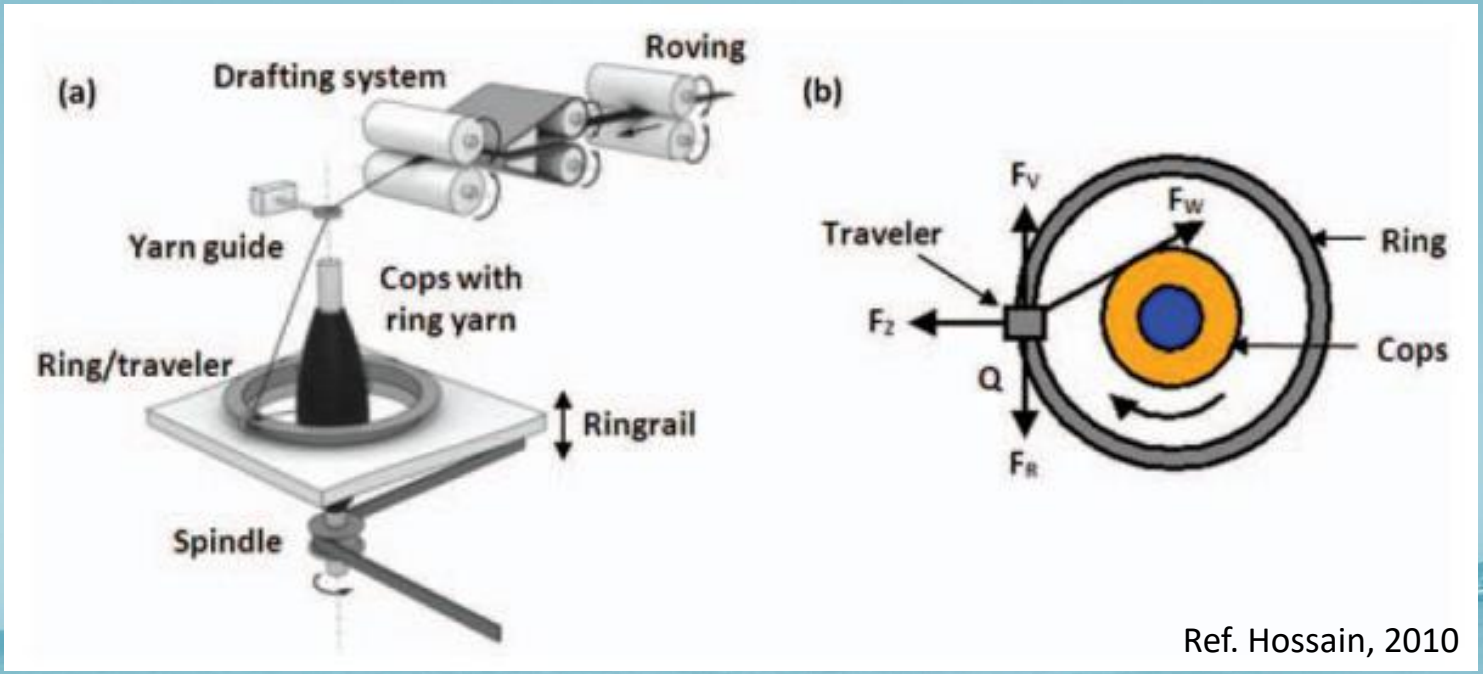
iv Supra - ZIEHL Workshop 16. - 17. April 2026, Berlin

1. Principle of Ring Spinning Technique



Ref. Hossain, 2010

Background:

Ring- spinning is the most widely spread spinning technique for yarn production.

The productivity is correlated with a ring/traveler system spinning high-twist yarn on the rotating spindle.

The maximum production is limited by the traveler speed of about 40 m/s at maximum. High speed causes heat generation due to friction.

A new concept utilizes the contact- and frictionless operation of a superconducting magnetic bearing (SMB) to replace the conventional mechanical / travler technique.

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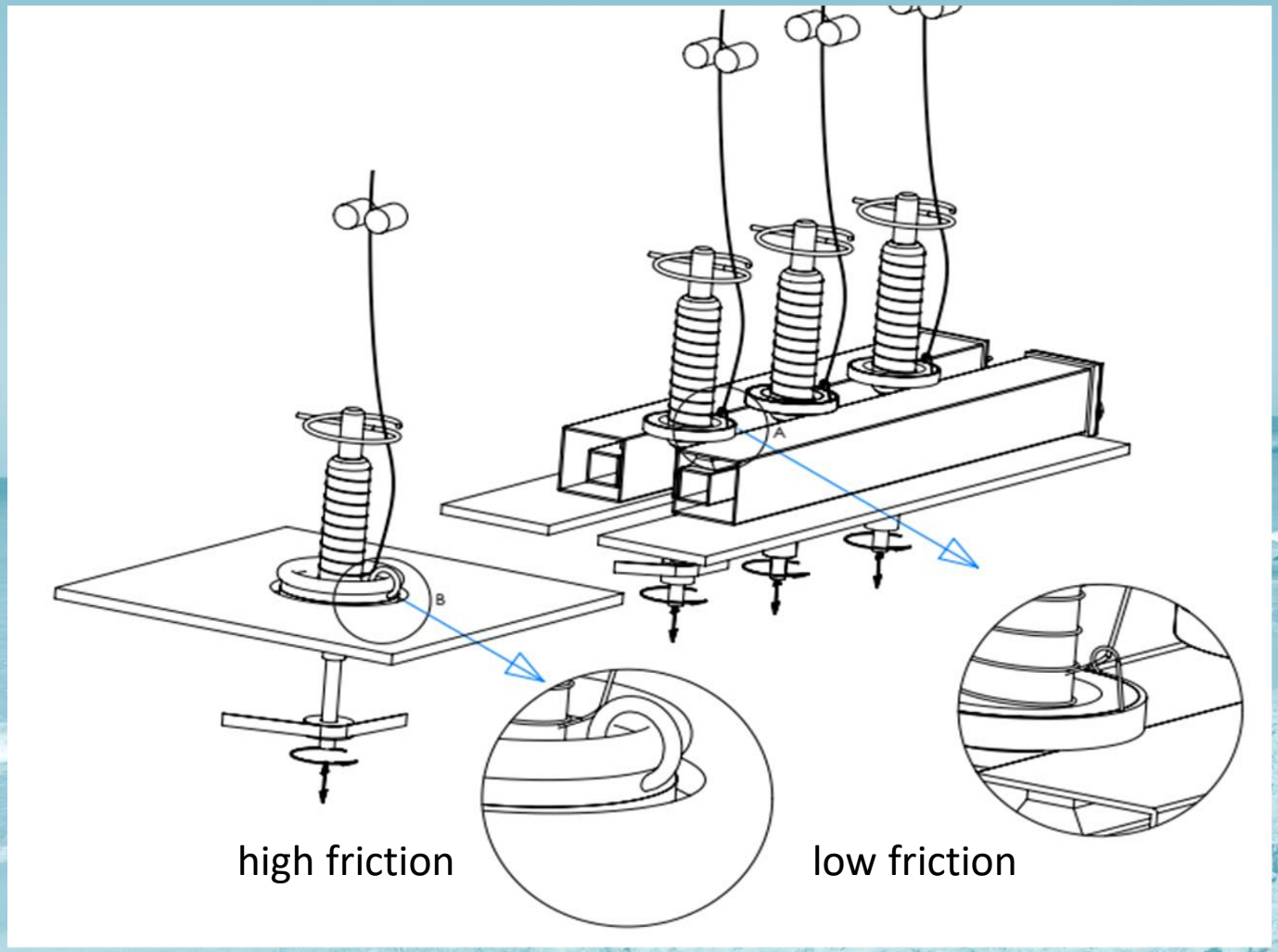
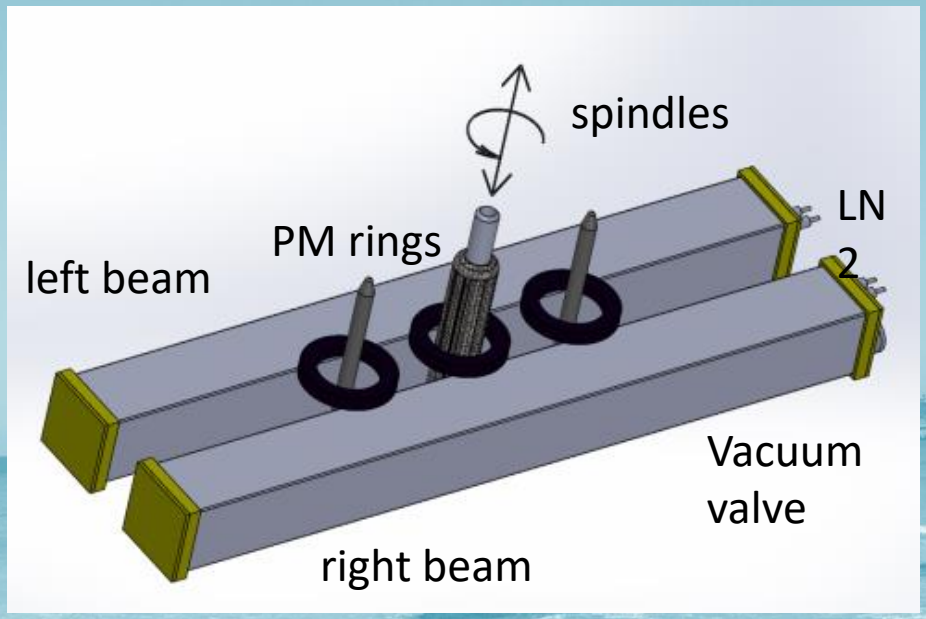
2. SMB development:
2.1. Comparison of conventional and SMB ring spinning



2.2. Double beam structure



Improved technical features:

- Compact design and structure. linear set-up, „plug and play“
- Lightweight
- Flexible application, easy installation
- Vacuum thermal insulation, radiation blocking
- Fast cooling by LN2, low cooling consumption

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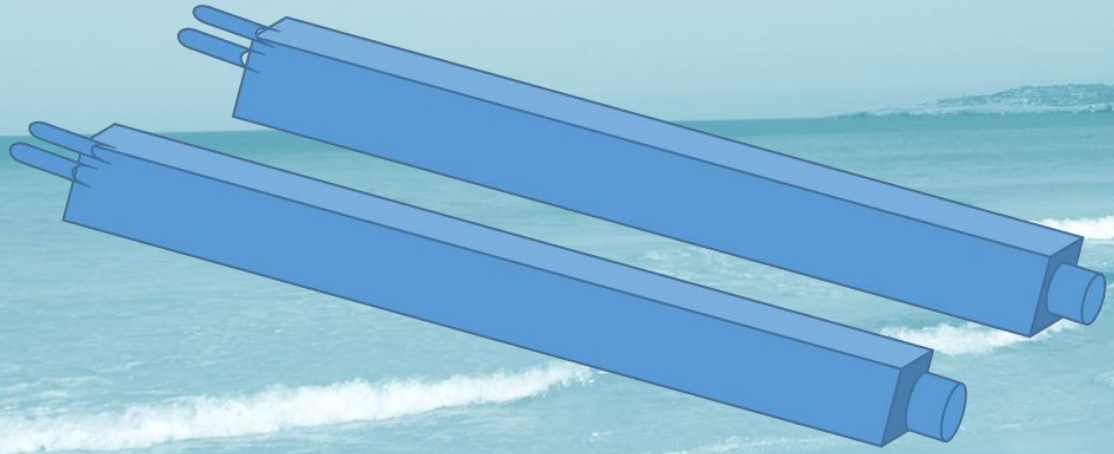
1 m cryostat with stacked tapes

Parameters
- 400 ml LN2, operational time 10 hours
- Low thermal losses <, 1.5 W
- Vacuum insulation + superinsulation



Design: Double vacuum cryostats

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3. Applications and Feasibilty Tests:

3.1. Design

- Linear set up, modular “plug and play”, 7 spindles per meter
- Bulk superconductors (YBCO); reduced machining time
- Variable space for the yarn spindles , 40 … 60 mm
- Parallel cryostat design, even for larger lengths
- Present speed max. 52.000 rpm; armed PM rings
- Integrated damping and braking system
- *Advantages of the double tube (Tube-in-tube TT) construction*

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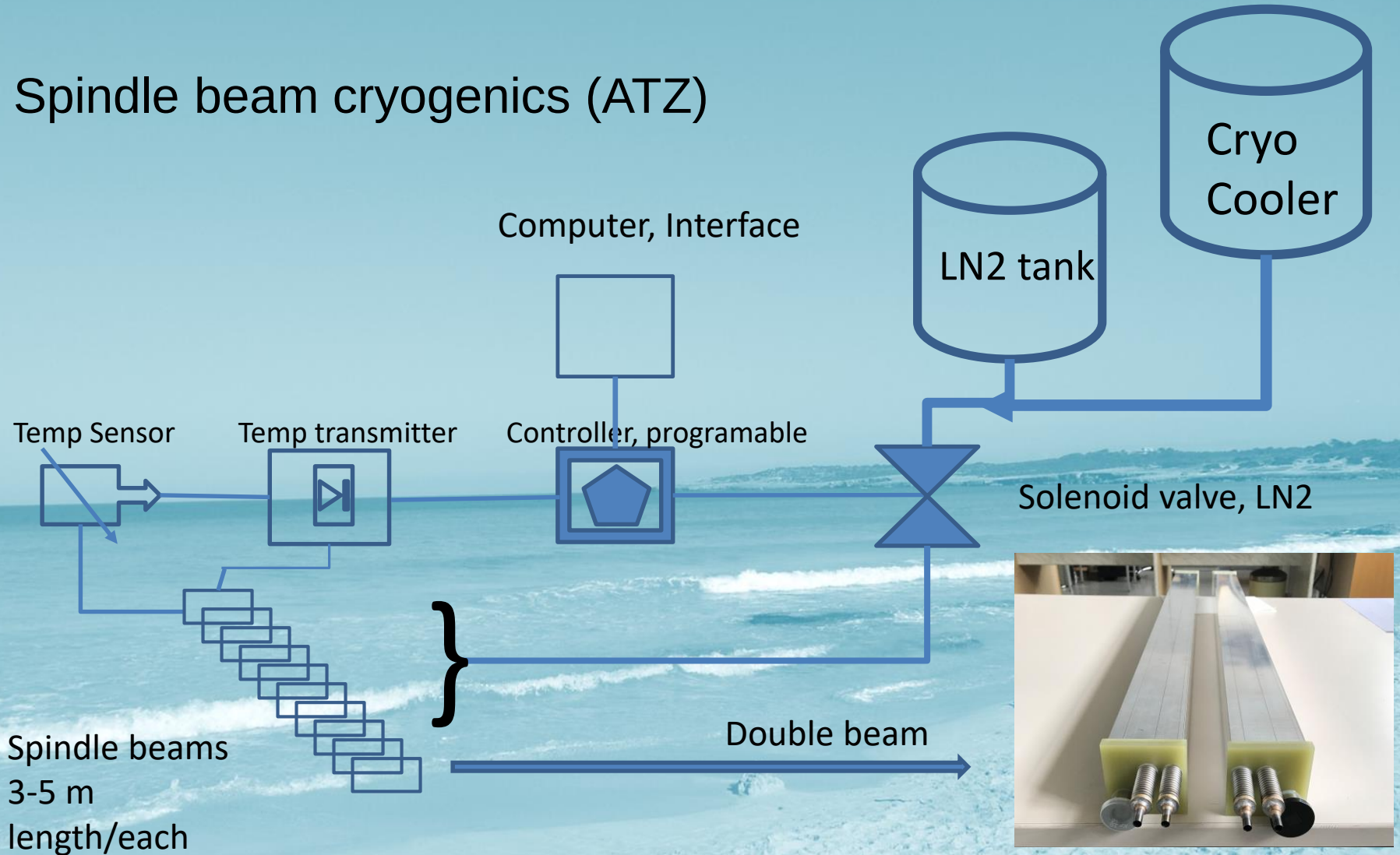
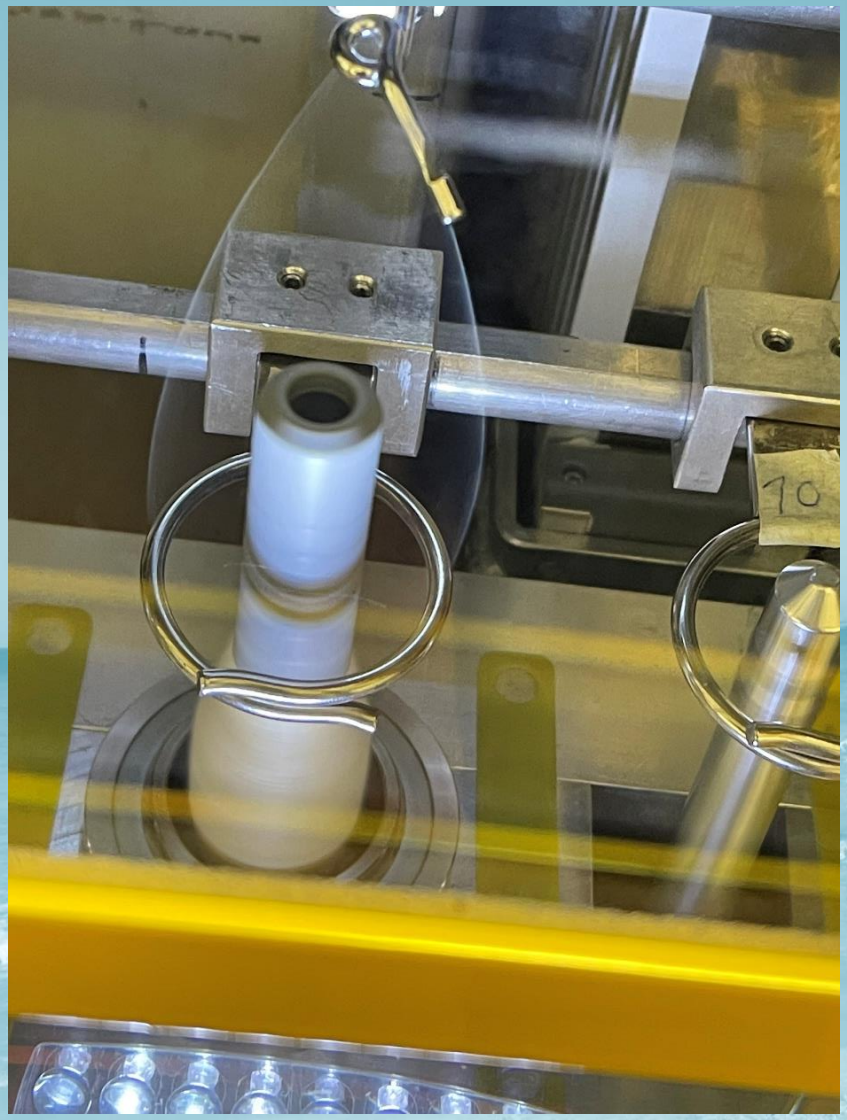
3.2. Cryogenics

- LN2 cooling in vacuum cryostats; T =77 K
- Perfect thermal vacuum insulation 2x10E-5 mbar, super-insulation
- Rotor damping for centrifugal stability
- Cooling -down RT→ 77 K; 20 minutes, LN2 consumption 3 l/m beam
- LN2 storage 0.5 l LN2/m per beam
- LN2 operation consumption 60 ml LN2/h per meter and beam

Spindle beam cryogenics (ATZ)



3.3. High-speed feasibility test (damping)



Prelimenary max. spindle speed results (2026):

ATZ / SAURER Fellbach/Stuttgart - SMB	52 000 rpm ☺ + higher
ATZ / ITM Dresden - SMB	42 500 rpm
Conventional ring spinning systems	15-18 000 rpm

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3.4. Modified ring spinning machine SAURER Corp. Stuttgart

4. Conclusion

- Conventional ring spinning is **limited by the ring–traveler friction**, which restricts spindle speed typically below ~20,000 rpm.

- **SMB (Superconducting Magnetic Bearing) spinning removes this friction**, allowing experimental spindle speeds **up to ~60,000 rpm** and potentially **double or triple the yarn productivity** while lowering energy consumption.

- SMB systems in ring spinning could significantly increase the textile **yarn quality and production efficiency**, but **industrial-scale adoption is still challenging** due to engineering complexity and initial cost factors.

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