Mark & Wedell A/S

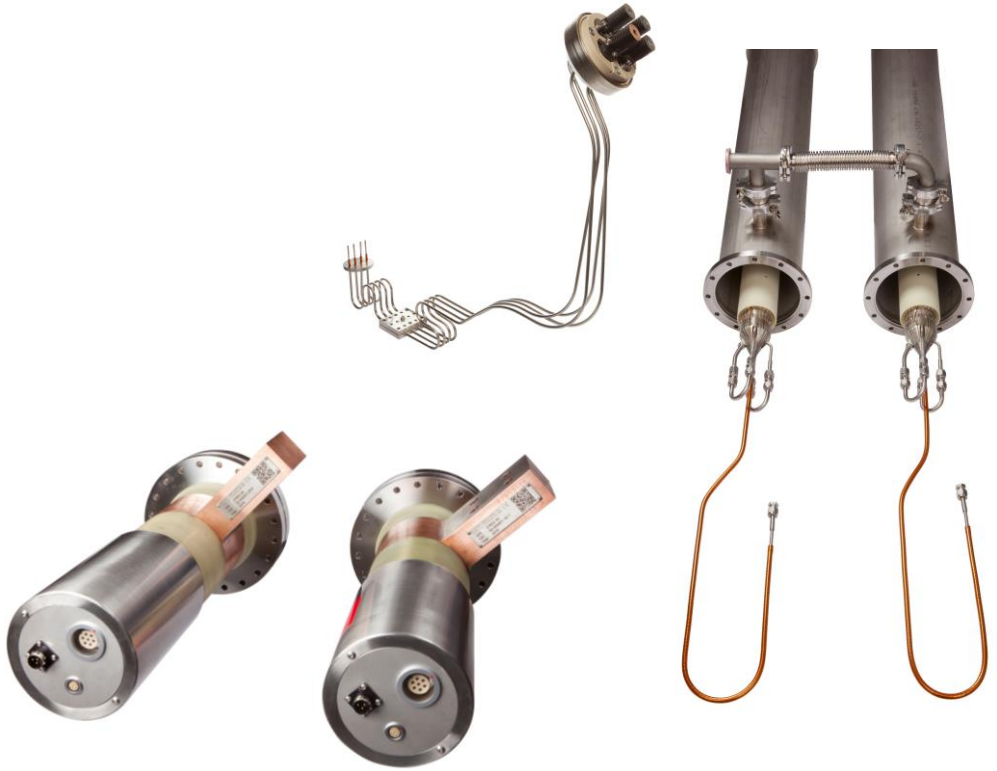
Your trusted engineering partner

Company presentation
Big Science
CERN Promotion

Agenda – Focus on Big Science

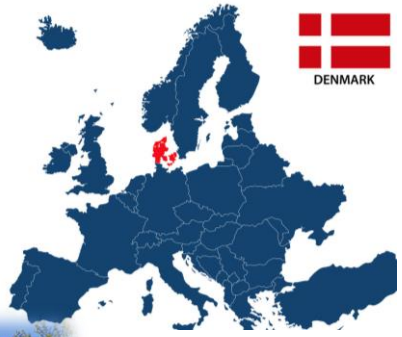
- The Company / Organisation
- The business units / products
- The workshop
- The references

- Q&A



Mark & Wedell A/S – Who We Are

- Founded in 1974
- Complete in-house development, mechanical & electrical engineering, project management and 4,000 m^2 of manufacturing facilities
- Machine, Welding, Metal and Electrical workshops
- 40+ employees
- *ISO 9001:2015 certified*
- ATEX Certified Equipment Supplier



M&W Business Units

M&W – Big Science

Optimised Superconducting Current Leads

M&W JAWO Sampling

- Sampling solutions for production and process industry
- Established in 1984
- 1500+ products delivered
- 300+ sampling solutions installed in 75 countries

M&W Engineering

- Subcontracting and prototype work
- Established in 1974
- 30+ industrial customers - half of which with more than 20 years of business relationship

The Purpose of a Current Lead

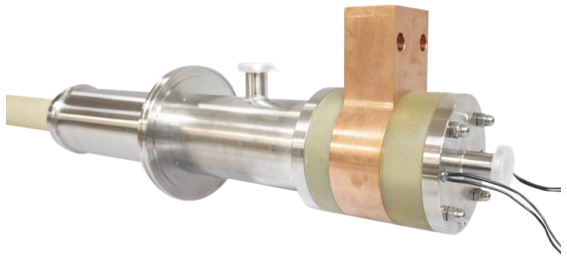
- To supply current in the range 50A – 50kA to a consumer
- Bridging the warm terminal (293k) with the cold terminal (77k / 4,2K)

- Mark & Wedell is specialist in optimising the current lead taking the following into account :

  - Current requirement
  - Heat leak (heat to be removed)
  - Heat leak / generation (losses) to be reduced
  - Coolant availability (type, flow, temp, recovery)
  - Application / Operating hours

  - Over all ROI

Current Lead Product Overview

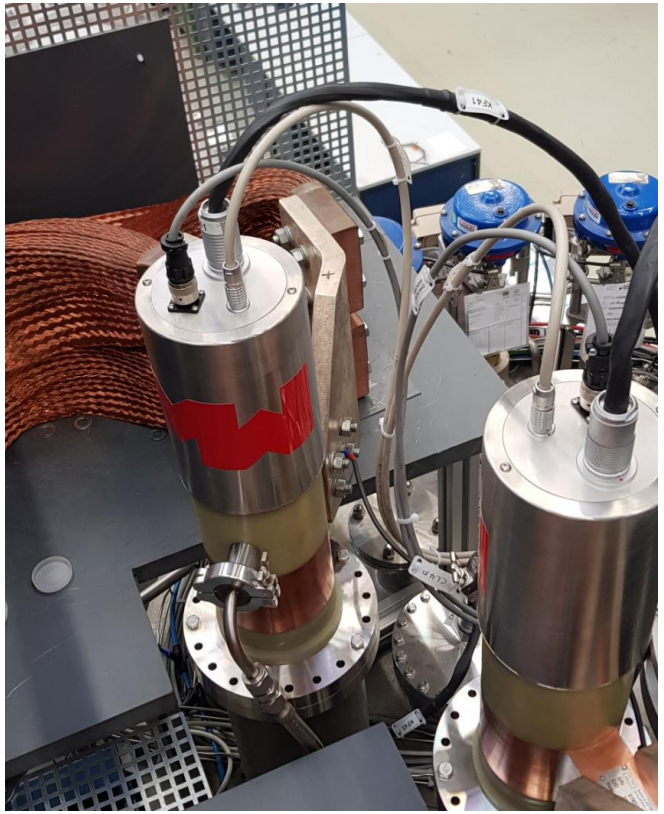
				
	Conduction (CdH)	**Convection (CvH)**	**Convection w. HTS (CvHH)**	**Retrofit (CvHH/CvHNH)**
Current:	• 10-100 A	• 100-30.000 A	• 2.000 -70.000 A	• 2.000-30.000 A
Coolant:	• LHe	• LHe + GHe	• LHe + GHe	• LHe + GHe + LN2
Operation:	• 24/7 (LHC)	• 2-4 weeks/test	• 24/7	• 3-6 weeks/test

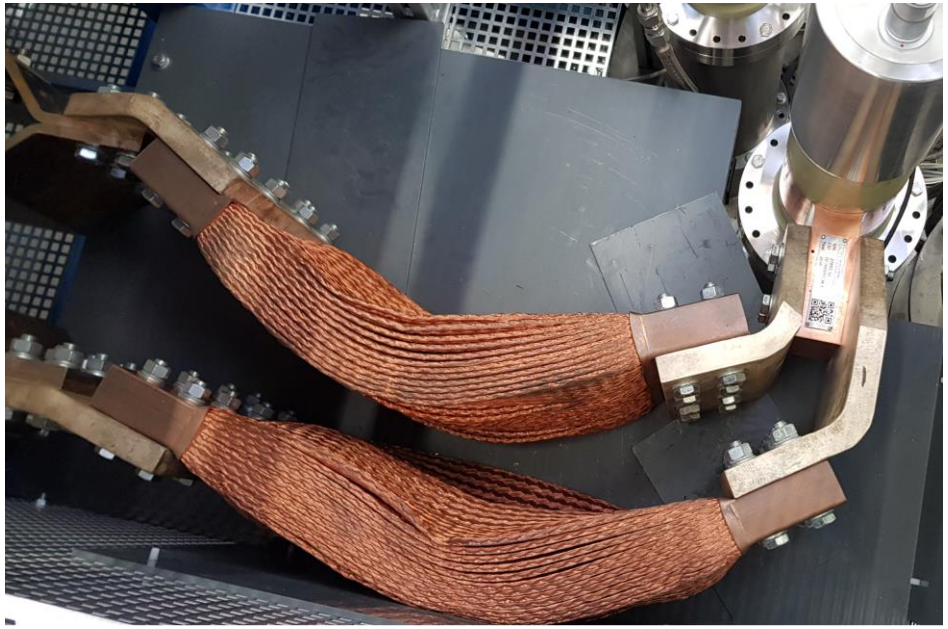
GSI Test Facility

Warm terminals (Cu):

Nominal	14kA
Maximum	17kA

(with 4 heat elements)

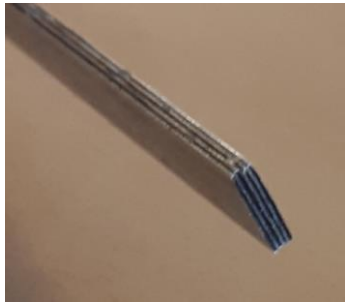




Feed with high capacity flexible copper cables.

Cold terminal:
Superconducting cable based on Niobium, Titanium, Tin
14kA @ 4.2K

Materials



- HTS: BSCCO Type G 2223 :
  - Alloy:
    - Sr (38) 87.62 Strontium
    - Ca (20) 40.08 Calcium
    - Cu (29) 63.55 Copper
    - Bi (83) 209.0 Bismuth
  - Super conducting below 100 K

- LTS:
  - Alloy
    - Nb (41) 92.91 Niobium
    - Ti (22) 47.87 Titanium
    - Nb (41) 92.91 Niobium
    - Sn (50) 118.7 Tin
  - Super conducting below 10 K

- Soldering tin
  - Alloy:
    - Ag (47) 107.9 3.5% silver
    - Sn (50) 118.7 96.5% tin
  - Melting temperature @ 232◦c

Principal Design of 14kA Superconducting Current Leads

Warm terminals (Cu):

Nominal	14kA
Maximum	17kA

(with 4 heating elements)

HTS :

Nominal	14kA
Maximum	17kA

50K GHe / 77K N2

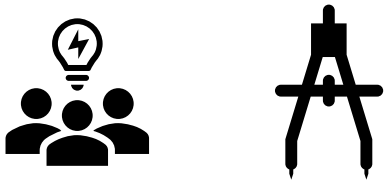
HTS stacked in layers of 3 and soldered to the LTS

LTS :

Nominal	14kA
Maximum	17kA

Superfluid Helium @ 1.9K

The Design of Superconducting Current Leads



<u>Super optimised Current leads</u>

- Design
- Heat exchange
- Efficiency
- Vacuum design
- Current flow
- High voltage isolation
- Self protecting
- Voltage monitoring
- Temperature monitoring

<u>Temperature control</u>

Active / passive temperature

Cooling concepts:

- - He vapor
- - He conversion
- - N vapor

<u>Production and testing</u>

Production
Testing

- Vacuum
- Pressure
- Voltage
- Isolation

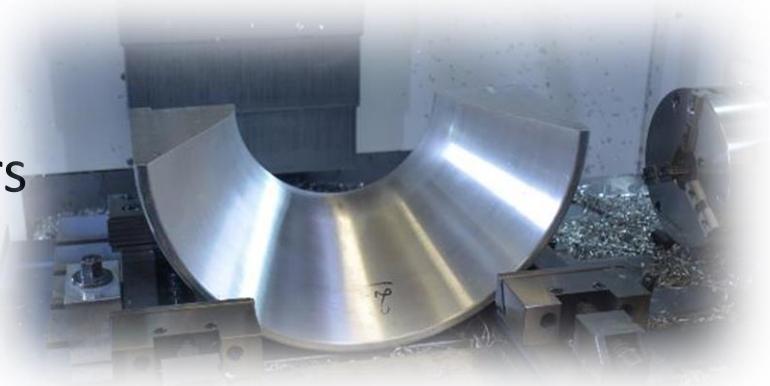
Long-term storage
Others

Mark & Wedell – References Big Science

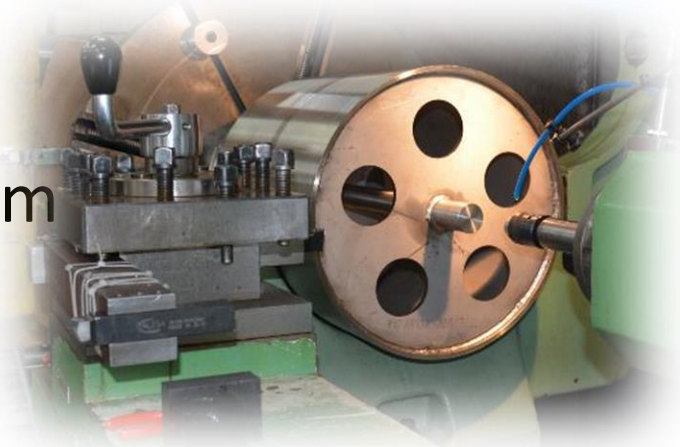
Year	Facility	Experiment	Current	Client	Project	Number of units	M&W Type
1998	CERN	LHC	6.5 kA	CERN	Current Feedthrough Prototype	1 unit	**CvH**
1998	CERN	LHC	13 kA	CERN	Current leads utilising HTS, prototype	1 pair	**CvHH**
2000	CERN	LHC	600 A	CERN	Current leads for magnets test (SAT for magnets)	26 pairs	**CvH**
2000	CERN	LHC	13 kA	CERN	Current leads for magnets test (SAT for magnets)	13 pairs	**CvHH**
2002	CERN	LHC	60 A	CERN	Current leads assemblies for LHC	410 units	**CdH**
2003	CERN	LHC	120 A	CERN	Conductors for current leads prototype	4 units	**CvH**
2004	GSI	SIS100	11 kA	GSI	Current leads	2 pairs	**CvHH**
2011	GSI	SIS100/FAIR	n.a.	GSI	Studie über Stromzuführungen mit HTS	Study report	**n.a.**
2013	GSI	SIS100/FAIR	14 kA	GSI	HTS Stromzuführungen mit Kupferröhen prototype	2 pairs	**CVHH**
2013	GSI	SIS100/FAIR	14 kA	GSI	HTS Stromzuführungen mit Kupferröhen	19 pairs	**CvHH**
2014	GSI	SIS100/FAIR	n.a.	GSI	HV Isolated amplifier for Cernox sensor	40 units	**n.a.**
2016	GSI	SFRS	300 A	ASG Superconductors	Current lead pairs (Prototype)	1 pair	**CvH**
2017	GSI	SFRS	300 A	ASG Superconductors	Current lead pairs (Preseries)	11 pairs	**CvH**
2018	University Up	FREIA	2 kA	Uppsala University	Copper current leads. Testing of HiLumi magnets	2 pairs	**CvH**
2019	GSI	SFRS	300 A	Ellyt Energy	Current leads pairs	23 pairs	**CvH**
2019	GSI	SFRS	300 A	ASG Superconductors	Current leads pairs (1st batch of series)	8 pairs	**CvH**
2019	CEA, Saclay	STAARQ	13 kA	CEA, Saclay	MQ / MQYY magnets for HiLumi. Upgrade /	1 pair	**CvHNH**
2020	GSI	SIS/FAIR	6 kA	GSI	HTS CL for Quadropole (IHEP)	4 pairs	**CvHH**
					Cd = Conduction, Cv = Convection, H = Helium, N = Nitrogen, H = HTS		

Mark & Wedell Engineering

- Mechanical workshop (2.000 m^2)
  - In house development- and construction engineers
- Production in steel, aluminium, brass, copper, plastic, stainless steel, duplex, inconel



- 5 CNC lathe centre, 1.000 x 3.000 mm
- 5 CNC milling centre, 1.600 x 1.000 x 1.000 mm
- Hydraulics
- Assembly



Mark & Wedell Engineering – continued

- Own blacksmith workshop (10 employees)
- Metal sheet works, welding TIG/MIG
- Sheet metal forming by:
  - Cutting, lasercutting
  - Bending
  - Rolling

Mark & Wedell Engineering – continued

- Treatments and cleaning by:
  - Heat treatment (stress relief, hardening)
  - Electrochemical pickling
  - Blasting, ultrasonic cleaning
  - Pulsed electrodeposition, plating, brush plating
  - Painting
- Pressure test, high voltage test, helium leak test
- Documentation and traceability

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