


BSPS

- Bruker Site Planning Suite
Hardware Manual
Version 01



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This manual was written by

M. Weller, J. Güntensperger, R. Petry

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For further technical assistance for this product, please do not hesitate to contact your nearest BRUKER dealer or contact us directly at:

Bruker Corporation
Industriestrasse 26
CH-8117 Faellanden
Switzerland
Phone: + 41 44 825 9111
FAX: + 41 44 825 9696
E-mail: magnetics@bruker.ch
Internet: www.bruker.com

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1 Introduction

This manual covers all hardware related issues of the Bruker Site Planning Suite BSPS. It provides instrumentation description, instructions for assembling and disassembling the BSPS hardware, the list of spare parts and a troubleshooting guide.

The software to operate the BSPS is not covered in this manual. The BSPS software and the installation instruction can be downloaded from http://teamsites.bruker.org/BBIO_Bruker_Siteplanning_Suite/Software_Download.

For further reading on several topics related to BSPS see http://teamsites.bruker.org/BBIO_Bruker_Siteplanning_Suite.

It is not the scope of this manual to define procedures on how to measure. Measurement procedures are subject to the site planning manuals that exist for various NMR/MRI configurations.



The BSPS hardware (Base Package) consists of 12 sensors, data acquisition electronics, a laptop PC and accessories. BSPS options are planned to be available in the future. The following table lists the order numbers of the complete BSPS base package. Available keyboard layouts are indicated by the suffix US, DE and CH. The list of spare parts and order numbers can be found in [Spare Parts](#) [27].

Description:	Order Number:
BSPS Base Package US KPL	Z143734
BSPS Base Package DE KPL	Z146424
BSPS Base Package CH KPL	Z146423

Table 1.1: Order numbers of the complete BSPS base package

2 Hardware

2.1 Data Acquisition Electronics

The entire data acquisition electronics is a third-party product. It is based on the platform Compact Data Acquisition (cDAQ) of National Instruments (<http://www.ni.com/data-acquisition/compactdaq>).

The configuration of the cDAQ platform for the BSPS is as follows:

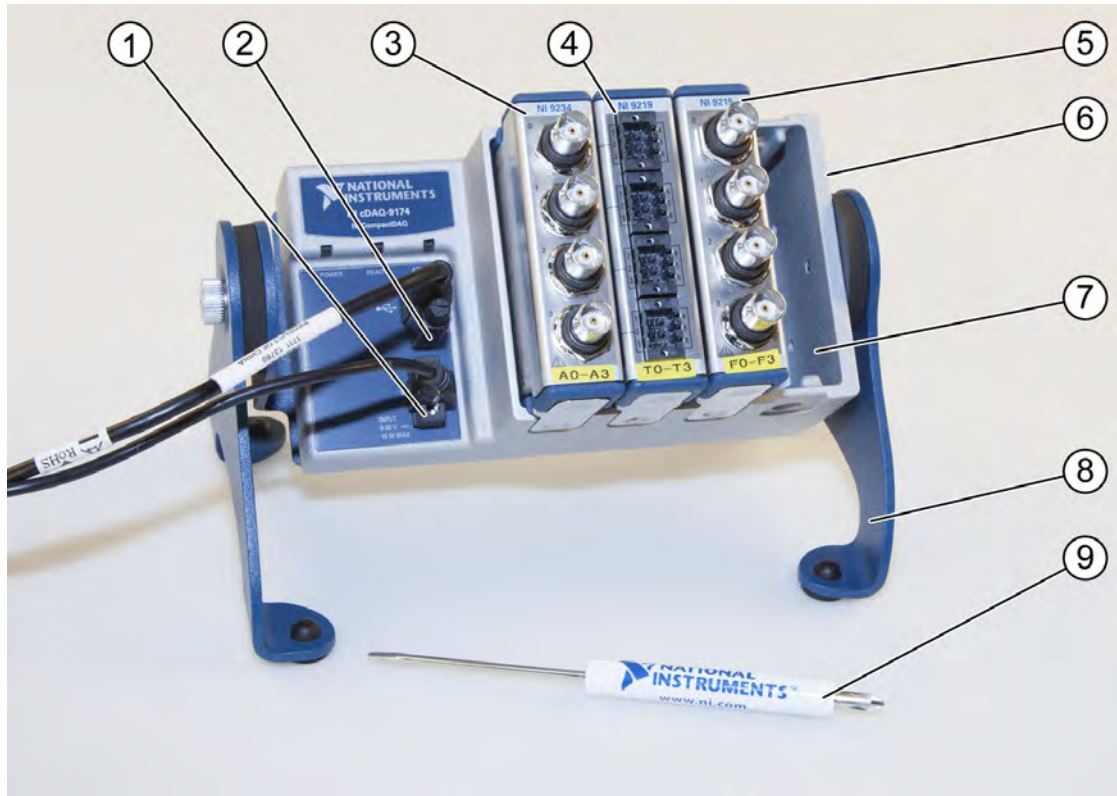


Figure 2.1: Configuration of the cDAQ platform

1	Power Supply Plug	2	USB Plug
3	cDAQ Module 9234	4	cDAQ Module 9219
5	cDAQ Module 9215-BNC	6	Earthing connection at the cDAQ Chassis
7	cDAQ Chassis with 4 slots	8	Desktop Mounting Kit
9	NI Screwdriver		



The BSPS hardware is compatible to 100 – 240 VAC, 50 – 60 Hz.

cDAQ 9174 Slot	Module	Use	Website
1	NI 9234	Accelerometer	www.ni.com
2	NI 9219	Temperature Sensor	www.ni.com
3	NI 9215-BNC	Magnetic Field Sensor	www.ni.com
4	Not connected	Not in use	

Table 2.1: Modules of the data acquisition electronics

For more information refer to the supplier's manuals.



A grounding connection of the DAQ platform with the surface (isolated from the accelerometer) may enhance the signal quality.

For more information refer to the manual of the cDAQ chassis (NI 9174) and of the cDAQ module (NI 9234).

SAFETY INSTRUCTIONS

Do not put the cDAQ platform near a heating installation, ventilation system or cooling unit.

Temperature drifts and oscillations may cause errors in the measurement. Further information on offset and gain drifts are available in the manuals of the cDAQ modules.

2.2 Sensors

All sensors and cable labels of the BSPS hardware follow a unique labeling scheme. This allows a quick and reliable identification of sensors and data acquisition channels in the documentation (photographs), in exported figures and in the curves displayed in the BSPS software.

Sensor label			cDAQ channel	Color code
Accelerometer	Temperature sensor	Fluxgate		
A0	T0	F0	0	Red
A1	T1	F1	1	Green
A2	T2	F2	2	Blue
A3	T3	F3	3	Violet

Table 2.2: Sensor labels and data acquisition channels

2.2.1 Accelerometer

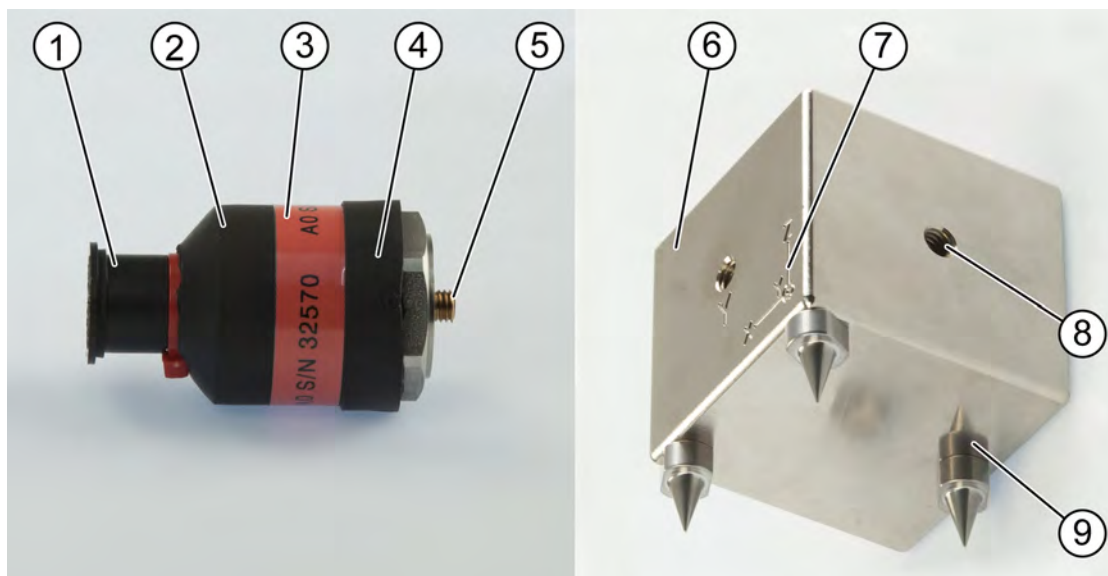


Figure 2.2: Accelerometer and sensor mounting cube

1	Sensor socket	2	Accelerometer
3	Sensor label	4	Rubber protection
5	Sensor mounting stud 1/4-28 to M6x1 x 8.6 mm long, BeCu with shoulder	6	Sensor mounting cube
7	Coordinate system	8	Mounting thread (M6x1)
9	Carpet needle		

Description	ID Number	Website
Accelerometer	393B12	www.pcb.com/products.aspx?s=393B12
Mounting stud	M081A61	www.pcb.com/products.aspx?s=M081A61
Cable	IMI 052BR015AC	www.imi-sensors.com

The accelerometer sensor setup is based on third party products from PCB Piezotronics (www.pcb.com and www.imi-sensors.com), National Instruments data acquisition electronics and on internal developments for the sensor mounting.

The sensors are *IEPE* based sensors (*ICP* is the corresponding registered trademark of PCB's IEPE sensors). IEPE sensors have built-in signal amplification, which considerably enhances signal to noise ratio and sensitivity.

The system can detect the acceleration at frequencies between 0.15 Hz to 1 kHz in a range of $\pm 4.9 \text{ m/s}^2$ (10 % variation depending on calibration constant) with a resolution of $1 \mu\text{m/s}^2$. Depending on the selected bandwidth the actual noise floor lies considerably lower than this due to oversampling. The accuracy of the measurement depends on the frequency range, degree of transversal acceleration and on temperature (see also specification sheet in the sensor manual). Under ideal conditions, the accuracy is better than 1 % of the measured value. Using the sensor mounting cube allows to measure 3 perpendicular directions (X, Y, Z).

For detailed technical data and other general information on applications of seismic accelerometers it is referred to the PCB website (http://www.pcb.com/TechSupport/Tech_Accel).

Delayed start of data acquisition



Due to a settling effect, the accelerometers produce a signal during typically the first 60 seconds after system setup, which is not the result of the actual acceleration, but is caused by the initialization of the sensor electronics. This requires a resetting of the data acquisition. It is important to follow the time signals of the accelerometers for the first 1–2 minutes in order to observe, when the sensors are ready for the actual measurement. Usually when doing several measurements in a row without unplugging sensors, this effect only happens when starting the acquisition for the first time.

SAFETY INSTRUCTIONS

During transport the sensor mounting cube may damage the components in the sensor case.

Always keep the sensor mounting cube fixed in the sensor case using the foam cover with the integrated cylinder. Always pack all recommended components into the sensor case. This provides the required stability to the protection foam.

SAFETY INSTRUCTIONS

Do not expose seismic accelerometers to heavy shocks.

Find more information in the third party manual.

Electrical grounding is crucial for the quality of the data.



Never put the sensors or the sensor mounting cube on metal surfaces without electrical isolation during measurements. Use a layer of masking tape below the sensor or the sensor mounting cube.

The data obtained from accelerometers may drastically vary, if the floor is loaded by a heavy weight or if it is not.



Details on the structure/making of the floor are required for correct interpretation of the accelerometer data.

Sensor mounting on rough surfaces.



Use petro wax as bonding material (<http://www.pcb.com/Products.aspx?m=080A24>). Use double-faced adhesive tape on hot or very cold surfaces, where petro wax does not work.

Cable fixation



Use adhesive tape to fix both ends of the signal cables of accelerometers. The signal cables should not move or wiggle.

**Sensor fixation**

At the end of a measurement check if the sensors are still fixed properly. If not, repeat the measurement or discard it.

**Crosstalk**

Do not lay cables in parallel close to each other or rolled up. It may lead to crosstalk.

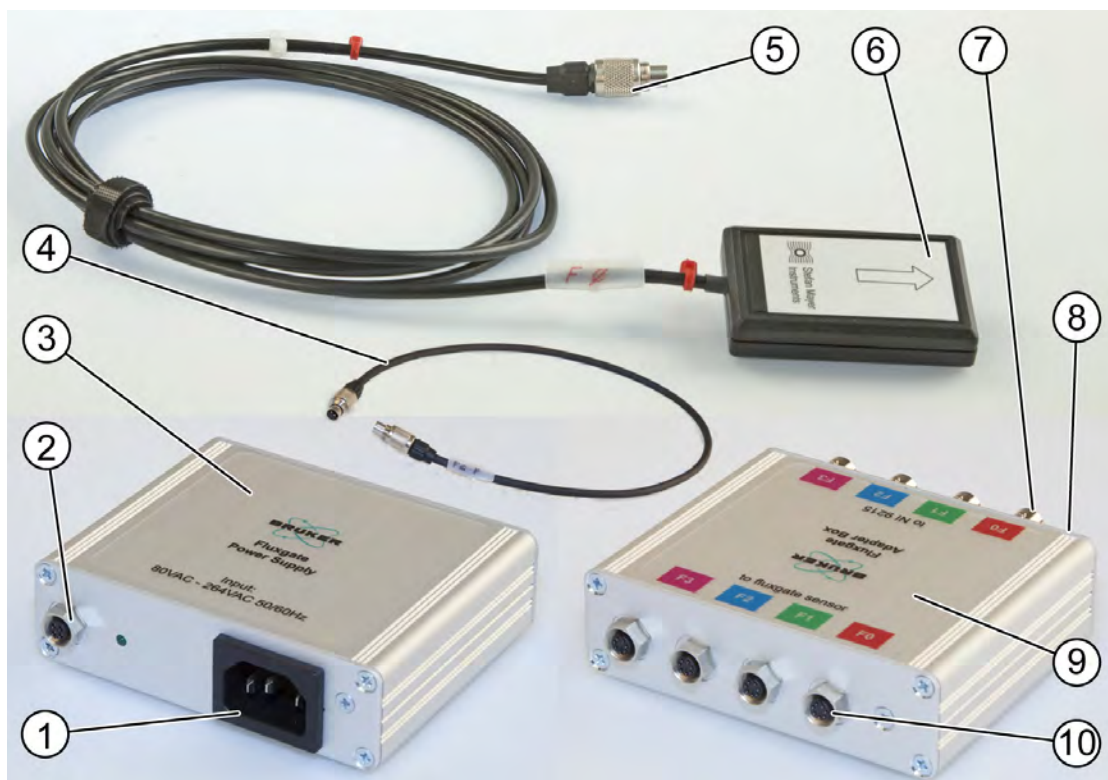
2.2.2 Magnetic Field Sensor

Figure 2.3: Magnetic field sensor setup

1	80 – 264 VAC 50/60 Hz	2	Power OUT (+ 12 V, – 12 V, 0 V)
3	Power supply	4	Power supply cable
5	Sensor plug	6	Fluxgate sensor
7	Signal socket (to NI 9215)	8	Power IN (+ 12 V, – 12 V, 0 V)
9	Fluxgate adapter box	10	Sensor socket

The magnetic field sensor assembly is based on a *fluxgate* magnetometer with integrated amplifier and filter (www.stefan-mayer.com), a wiring box and an ultra-stable power supply (www.trenew.ch). All components are customized for the BSPS. The data acquisition is performed with a 16-bit NI 9215-BNC cDAQ module (see [Electronics \[7 \]](#)).

The system can detect the magnetic field component along the direction of the sensor* from DC to 1 kHz in a range of $\pm 100 \mu\text{T}$ with a resolution/accuracy of 3 nT. The actual noise floor is less than 0.1 nT. Using the sensor support allows to measure 3 perpendicular directions of the magnetic field (X, Y, Z).

* see Fig. 2.3, No. 6: Arrow on the sensor represents the measurement direction.



Cable length

The BNC cable between fluxgate adapter box and NI 9215 is 1 m long. It can be extended with standard BNC cables.



Magnetic materials

Mounting the fluxgate sensor in close proximity of ferromagnetic or paramagnetic material will distort the measurement.



Fluxgate sensor saturation

Mounting the fluxgate sensor in an external field higher than $\pm 100 \mu\text{T}$ ($\pm 1 \text{ G}$) in the direction of the fluxgate sensor will saturate the sensor (e.g. when measuring close to an unshielded magnet). Thus, the fluxgate sensor will lose sensitivity to any changes of the magnetic field.



Shielding effects

Mounting the fluxgate sensor close to electrically conducting objects (metals) will distort the AC components of the magnetic field.

The following table provides the conversion between magnetic induction and magnetic field strength in the measuring range of the fluxgate sensor.

Magnetic Induction B	Magnetic Induction B	Magnetic Field Strength H	Proton Resonance Frequency
100 μT	1 G	79.58 A/m	4256 Hz
10 μT	100 mG	7.958 A/m	425.6 Hz
1 μT	10 mG	795.8 mA/m	42.56 Hz
100 nT	1 mG	79.58 mA/m	4.256 Hz
10 nT	100 μG	7.958 mA/m	425.6 mHz
1 nT	10 μG	795.8 $\mu\text{A/m}$	42.56 mHz

Table 2.3: Conversion between magnetic induction and magnetic field strength

The absolute earth magnetic field ranges from 250 mG to 650 mG.

2.2.3 Temperature Sensor

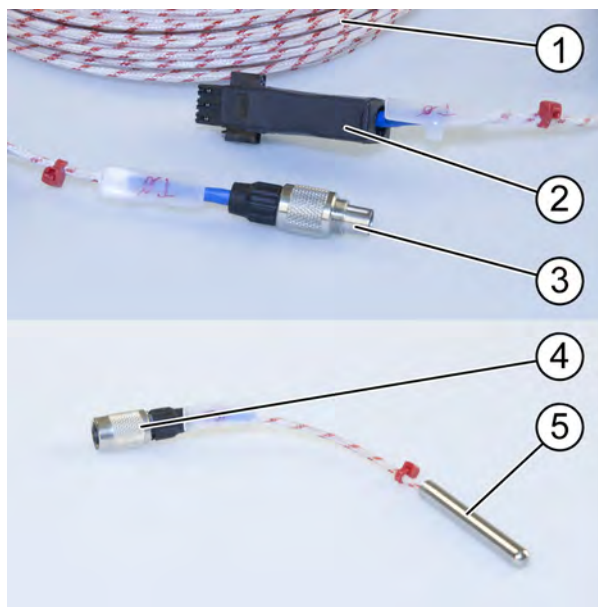


Figure 2.4: Pt100 Sensor and Connector to NI 9219

1	10 m cable	2	Connector to module NI 9219
3	4 pin connector (male)	4	4 pin connector (female)
5	Pt100 sensor		

The temperature sensors of the BSPS are based on class A *Pt100* 4 wire *RTDs* from Watlow (www.watlow.com). Class A Pt100 sensors are characterized in the standard DIN/IEC 60751 or by IEC751. At room temperature, the absolute temperature error is approx. 0.2 K. The usual drift of the absolute temperature accuracy indicated by producers is less than 0.05 K / year.

Together with the 24 bit data acquisition module NI 9219 (see [Electronics \[7 \]](#)) in high resolution mode, one can measure relative temperatures (temperature changes) with an accuracy of at least 0.03 K. The actual noise on the temperature signal is less than 1 mK.

Placement of the temperature sensors



The placement of the temperature sensors must be carefully reflected to avoid wrong interpretation. It is important to know that the sensor temperature is affected by solid state conduction, gas convection and irradiation. Thus, it is very important to have a detailed documentation of how the sensors are placed in an experiment.

3 Assembly

SAFETY INSTRUCTIONS

Protect the sensors from damage.

It is good practice to first arrange all accessories (tripod, cables, electronics, etc.) before mounting the sensors.

NOTICE

Documentation of measurements

Measurements without documentation are of little value. Therefore, make sure to have all necessary information recorded, before setting up the sensors at a new spot or before repeating the measurement under different environmental conditions. Use the provided tools in the BPS software for documentation (measurement title and description, lab journal).



Temperature equilibrium

Let the device adapt to ambient temperature before starting measurements.

3.1 NI cDAQ Platform

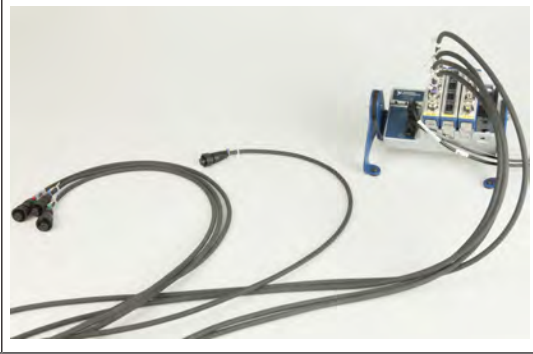
- Unpack the data acquisition electronics without powering yet.



To connect more easily the cables to the cDAQ platform the modules can be unplugged from the cDAQ chassis. Ensure to put the modules back into the same slot (see table 2.2).

3.2 Accelerometers

- Prepare the signal cables between the accelerometers and the cDAC platform.
- Check that the distances fit the cable lengths.



SAFETY INSTRUCTIONS

Do not mix up the modules.

Ensure to connect the fluxgate signal cables (F0 – F3) to module 9215. Ensure to connect the accelerometer signal cables (A0 – A3) to module 9234.

- Connect the accelerometer signal cables to module 9234.
- Care for the channel numbers on the module and on the labels of the signal cables (see table 2.2).



SAFETY INSTRUCTIONS

Check the threads when inserting the mounting stud.

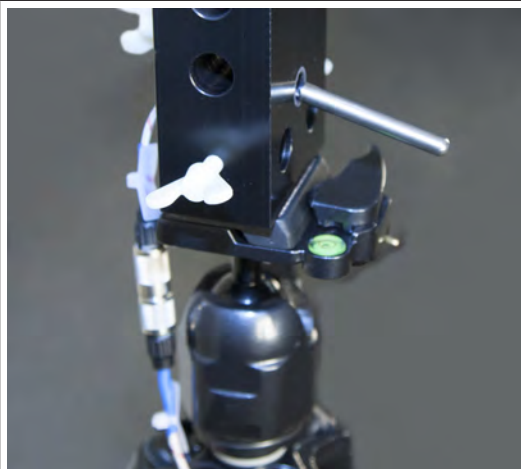
Attach the M6 screw thread to the sensor mounting cube and the 1/4-28 screw thread to the accelerometer.

- Attach the three accelerometers to the sensor mounting cube.
- Connect the signal cables to the accelerometers.
- Care for the color labels on the accelerometers and on the signal cables.
- Optional: use the fourth accelerometer for measurements at a different spot.
- Use adhesive tape to fasten the signal cables on the floor within short distance to the sensor.



3.3 Magnetic Field Sensors

- Identify measurement spots in the lab; define +X and +Y direction. Z is always vertical.
- Place the tripod with the sensor support at the spot of the planned magnet system.
- Adjust the height of the sensor support to the height of the planned magnetic center.
- Use the spirit level to adjust the vertical position of the sensor support.



- Connect the fluxgate signal cables (BNC) to the fluxgate adapter box.
- Connect the fluxgate adapter box and the fluxgate power supply without powering yet.
- Care for the color labels on the fluxgate adapter box and on the signal cables.

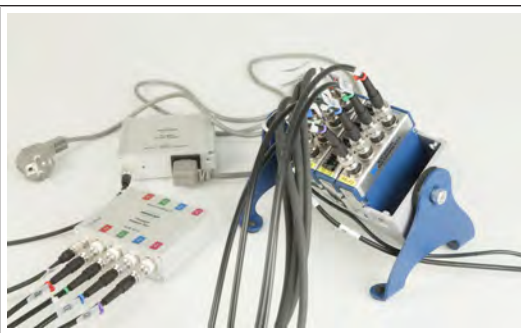


SAFETY INSTRUCTIONS

Do not mix up the modules.

Ensure to connect the accelerometer signal cables (A0 – A3) to module 9234. Ensure to connect the fluxgate signal cables (F0 – F3) to module 9215.

- Connect the fluxgate signal cables (BNC) to the module 9215 in the cDAQ platform.
- Care for the channel numbers on the modules and on the labels of the signal cables (see table 2.2).



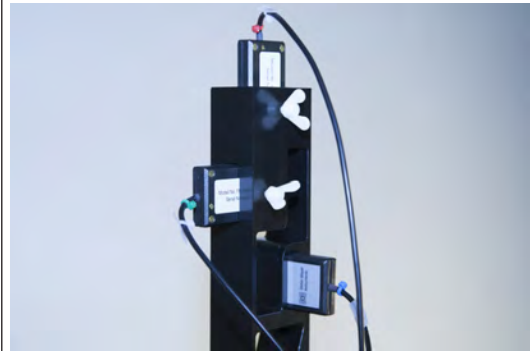
To connect more easily the cables to the cDAQ platform the modules can be unplugged from the cDAQ chassis. Ensure to put the modules back into the same slot (see table 2.2).

SAFETY INSTRUCTIONS

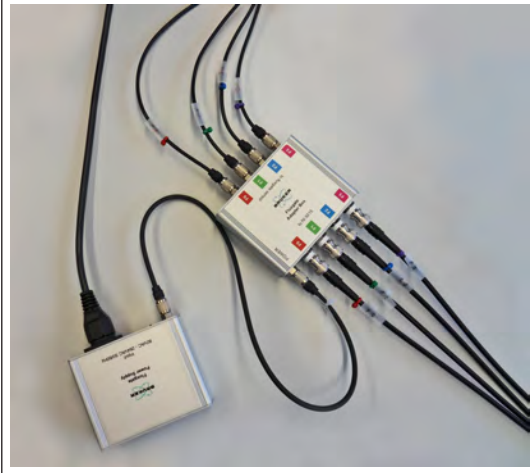
Protect the casing of the fluxgate sensor from damage.

Always attach the white plastic screws gently into the sensor support.



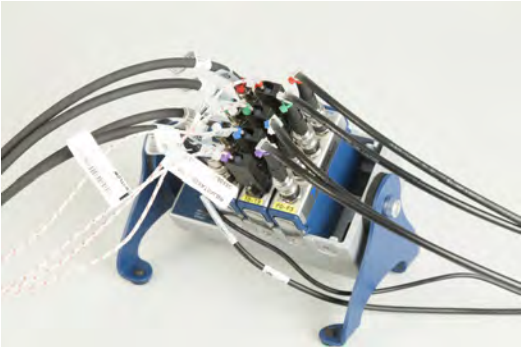
- Use the white plastic screws to attach the fluxgate sensors in the sensor support.
- Use Velcro® fastener or adhesive tape to fix the cables to the tripod.



- Connect the fluxgate signal cables to the fluxgate adapter box (BINDER connectors).



3.4 Temperature Sensors

<ul style="list-style-type: none"> • Connect the temperature sensors to the 10 m signal cables. • Check for the color labels on the temperature sensors and on the signal cables. 	
<ul style="list-style-type: none"> • Place the temperature sensors at the spot of the planned magnet system (in the sensor support) and on other locations of interest. • Check that the distances fit the cable lengths. 	
<ul style="list-style-type: none"> • Connect the signal cables of the temperature sensors to the module 9219. 	



To connect more easily the cables to the cDAQ platform the modules can be unplugged from the cDAQ chassis. Ensure to put the modules back into the same slot (see table 2.2).

3.5 Power ON

- | | |
|---|--|
| <ul style="list-style-type: none">• Plug in the power cables of the cDAQ platform and of the fluxgate power supply.• Install the laptop and connect the cDAQ via USB interface.• Start the BSPS software. | |
|---|--|

NOTICE

Documentation

Take pictures in the laboratory to record the measurement setup.

Make sure the coordinate systems on the sensor support and on the sensor mounting cube can be recognized in the documentation.

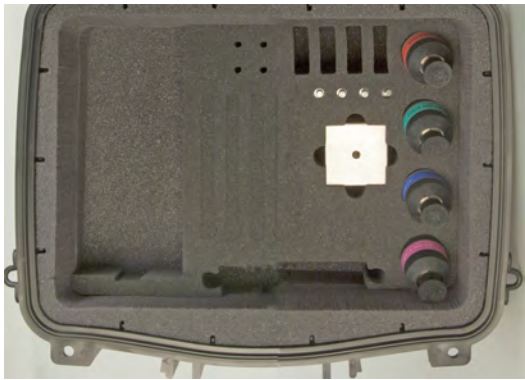

Ensure that the positions of all sensors can be clearly identified via color tags or via attached labels.

4 Disassembly

SAFETY INSTRUCTIONS

Protect the sensors from damage during transport.





To disassemble the site planning suite hardware first remove the sensors from the sensor support and from the sensor mounting cube. Store the sensors in the sensor case.

<ul style="list-style-type: none"> • Unplug the power cables from the cDAQ, and from the fluxgate power supply. 	
<ul style="list-style-type: none"> • Unplug the signal cables from the accelerometers. • Unscrew the accelerometers from the sensor mounting cube. Keep the mounting studs attached to the accelerometers. • Pack the sensors, the sensor mounting cube and the carpet needles in the sensor case. 	
<ul style="list-style-type: none"> • Place the foam cover with the integrated cylinder in the sensor case in such a way, that the cylinder is on top of the sensor mounting cube. 	

SAFETY INSTRUCTIONS

During transport the sensor mounting cube may damage the components in the sensor case.

Always keep the sensor mounting cube fixed in the sensor case using the foam cover with the integrated cylinder. Always pack all recommended components into the sensor case. This provides the required stability to the protection foam.

<ul style="list-style-type: none">• Unplug the temperature sensors and put them in the sensor case.	
<ul style="list-style-type: none">• Unplug the fluxgates and remove them from the sensor support.• Put the fluxgates in the sensor case.• Use Velcro® fasteners to properly tie up cables.	
<ul style="list-style-type: none">• Unplug all cables from the cDAQ except USB cable and power supply.• Loosen the screws at the legs of the cDAQ platform and turn the legs upside down.• Pack the cDAQ platform including all modules, USB cable and power supply in the sensor case.• Check again, that the sensor case is packed completely and properly.	
<ul style="list-style-type: none">• Clean up all other material. Use Velcro® fasteners to tie up cables.	

- Remove all white plastic screws from the sensor support.
- Pack the tripod, the sensor support and the white plastic screws into the tripod bag.



Use the laptop bag to pack

- the laptop,
- the fluxgate electronics,
- all remaining cables of the fluxgate electronics,
- all cables of the temperature sensors,
- all cables of the accelerometers,
- the power cables.



5 Troubleshooting

Problem	Solution	Who
Sensor is not working	Exchange the channels to track the problem (sensor or electronics).	Bruker Service
NI hardware is broken	Try to get help from the local service of NI.	Third party supplier
Electronics is not working	Power OFF the cDAQ. Power ON and try again. Check configuration in the BSPS software.	Bruker Service
Fluxgates are saturated	Rearrange the fluxgate sensor at a different spot of lower magnetic field.	Bruker Service
Accelerometer give unexpected signals	Check accelerometers pairwise by screwing them to opposite sites of the sensor mounting cube and measure a sample.	Bruker Service
Things are not handy or you miss something in the BSPS hardware.	Report your critics to the BSPS teamsite (see below).	Bruker Service


Other problems/solutions may already be reported on the website http://teamsites.bruker.org/BBIO_Bruker_Siteplanning_Suite.

Please make sure you report your troubleshooting case there as well. The future improvement of the BSPS profits from the feedback of the users and it helps your colleagues in troubleshooting.

6 Spare Parts


All BSPS parts are listed with their part number. In case of damage or loss, spare parts can be ordered with the Bruker part number. If you need assistance, do not hesitate to contact Bruker BioSpin AG ([Contact \[p. 33\]](#)).

6.1 PC


Description	Part No.	Picture
Notebook with US keyboard	1824296	n/a
Notebook with DE keyboard	1824295	n/a
Notebook with CH keyboard	1824294	n/a
Mouse	1824297	n/a
Laptop bag	1823949	

6.2 Sensor Case

Description	Part No.	Picture
Sensor protection case	1820394	
Foam material base	Z144646	
Foam material top	Z144647	

Description	Part No.	Picture
Foam material column	Z144648	

6.3 NI cDAQ Platform

Description	Part No.	Picture
Compact DAQ Chassis NI 9174	1820395 includes: 1820392 and 1820398	
USB cable, 2 m, with lock screw	1820392 Included in 1820395	n/a
Power Supply 100 – 240 VAC 47 – 63 Hz	1820398 Included in 1820395	
Power cable Schuko / APP	47357	
Desktop Mounting Kit	1820397	




6.4 Accelerometer

Description	Part No.	Picture
Vibration cDAQ module NI 9234	1821400	
Accelerometer	1820400	
Signal Cable	1820393	
Sensor Mounting Stud 1/4 - 28 to M6x1 x 8.6 mm long, BeCu with shoulder	1820399	
Sensor Mounting Cube	Z143766	
Carpet Pin	Z143738	

6.5 Magnetic Field Sensor

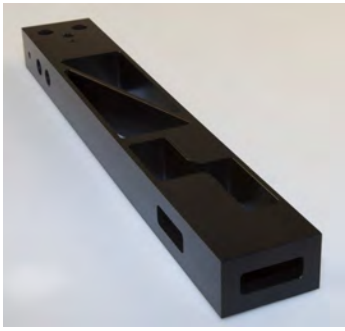


Description	Part No.	Picture
Magnetic field cDAQ module NI 9215 BNC	1821401	
Fluxgate	1820626	
BNC Cable	1823945	
Fluxgate adapter box	1822754	
Power Supply 80 – 264 VAC 50/60 Hz	1822679 Includes 12 V cable and power cable Schuko / APP	
		

6.6 Temperature Sensor

Description	Part No.	Picture
Temperature cDAQ module NI 9219, including 4 module sockets	1820396	
Temperature RTD sensor, including cable (10 m)	1821402	
Female connector	1821398	
Male connector	1821399	
NI Adapter plug / strain relief	1820391	

6.7 Sensor Support

Description	Part No.	Picture
BSPS Tripod	1823513	
BSPS Tripod Bag	1826037	

Description	Part No.	Picture
Sensor Support	Z145921	
Screwed End	Z145920	
Butterfly Screw PE	1826850	

6.8 Accessories

Description	Part No.	Picture
Cable label	1821396	
Velcro® fastener, (hook and loop), 100 pcs.	1821397	

7 Contact

Manufacturer:

Bruker BioSpin AG
Industriestrasse 26
CH-8117 Faellanden
Switzerland

Phone: + 41 44 825 91 11

Fax: + 41 44 825 96 96

http://teamsites.bruker.org/BBIO_Bruker_Siteplanning_Suite

E-mail: find email contact on the BSPS teamsites

Please refer to the Internal Order No. in all correspondence regarding the Bruker Site Planning Suite or components thereof.

Glossary

cDAQ

Data acquisition electronics on a flexible platform (Compact Data Acquisition) made by National Instruments.

Fluxgate

A handheld device to measure weak magnetic fields, typically AC fields from power lines or residual magnetic fields.

ICP[®] Sensor

An ICP (integrated circuit piezoelectric) sensor is a device to measure dynamic pressure, force, strain, or acceleration.

IEPE

Integrated electronics piezoelectric

Pt100

A temperature sensor based on a Platinum resistor with 100 Ohms nominal resistance at 0 °C.

RTD

Resistance thermometer (also: resistance temperature detector, or RTD) is used to measure temperature by correlating the resistance of the RTD sensor with temperature.





Bruker Corporation

info@bruker.com
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