

# PUMA

## IMPULSE MAGNETIZER



User Manual

Version 1.0.0

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AGICO





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## User Manual Conventions

 **Prohibition** symbol is used to prohibit any action which may cause a loss of properties, damage or injury.

 **Warning** symbol is used to draw a special attention to an important information.

 **Information** symbol is used to give a useful hint or tip for more comfortable work with the instrument.

## PUMA Controls Conventions

**Field**

 START

**Main switch**

Software interface terms.

Software interface buttons.

Hardware controls.

## General Safety Instructions

Before operating the instrument, review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.













**CAN BE  
HARMFUL  
TO PACEMAKER  
WEARERS**




**STRONG  
MAGNETIC  
FIELD**

**Service procedures should be performed by qualified personnel only!**

- ✘ Do Not Operate Without Covers!** To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.
- ✘ Do Not Operate in Wet or Damp Conditions!** To avoid electric shock, do not operate this product in wet or damp conditions.
- ✘ Do Not Operate in an Explosive Atmosphere!** To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.
- ✘ Do Not Disconnect Connectors!** To avoid damage of the instrument never disconnect any connector while the device is ON.
- ✘ Do Not Operate With Suspected Failures!** If you suspect there is damage to this product, have it inspected by qualified service personnel.
- ✘ Ground The Instrument!** The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, it is essential to connect the earth terminal of power cord to the Protective Earth terminal before any inputs or outputs.
- ✘ Do Not Insert Anything into the Holes of Fan!** Do not insert anything into the holes of the fan to avoid damaging the instrument.

-  **Use Proper Power Cord!** To avoid fire hazard, use only the power cord specified for this product.
-  **Check Connectors!** Do not operate the instrument if all connectors are not properly plugged.
-  **Heavy instrument!** Due to the weight of the instrument it is strongly recommended to manipulate it with assistance of another person.
-  **Use Proper Mains Voltage!** Do not operate this product from a power source that is outside of the specified voltage range.
-  **Use Proper Fuses Only!** Do not use fuses which are not specified by the manufacturer. If a fuse with a different characteristics or value is used, the protection is not effective.
-  **Operator's Training!** Operator should be familiar with operation of the instrument and Safety Regulations.
-  **Use Manufacturer's Cables Only!** Other devices can be connected to the instrument via the appropriate cables only.
-  **Do not drop the product and do not expose it to any major shocks!**
-  **Do not operate the product outside the power limits given in the specifications!**
-  **Keep the packaging material out of the reach of children to prevent the risk of suffocation!**

 Unstable or highly disturbed AC power may invoke safety circuits to protect the sensitive electronic parts by switching OFF the instrument or burning inner fuses.

 **Dispose of packaging material immediately according to locally applicable regulations. However, it is recommended to keep the shipping box and inner foams in case of necessity to send the instrument to AGICO for repair.**

## Storage and Transportation

The properly wrapped instrument can be stored and transported at a temperature -20 °C to + 55 °C and relative humidity up to 80 %. The instrument must be stored at suitable place, free of dust and chemical evaporation. **Handle with care!**  
**Instrument is heavy.**





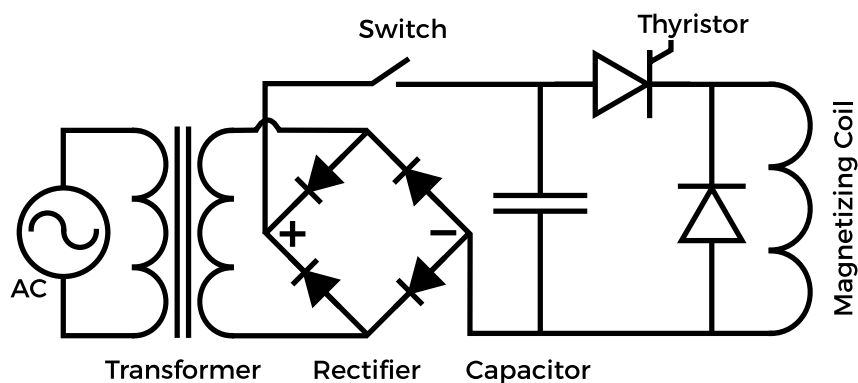
## 1 PUMA Introduction

The **PUMA** is designed as a precise high field **impulse magnetizer**. Inner diameter of magnetization coil is 41 mm which allows to magnetize standard-sized paleomagnetic specimens in any orientation. PUMA enables to impart isothermal remanent magnetization (IRM) to specimens in the wide range of intensities of magnetic fields from 1 mT up to 5 T. The elaborate design of the instrument provides precise setting of the pulse intensity as well as high homogeneity of the field over the entire specimen volume.

### 1.1 Principle of operation

**PUMA** uses the well-known principle of charging high quality foil capacitors designed for pulsed discharge and then discharging them into a magnetizing coil. The principal schematics of the instrument is shown on Fig.1.

The control of the entire magnetization process by the microprocessor ensures precise pulse triggering at voltage which is calculated with respect to the desired pulse intensity and the instantaneous temperature of the magnetizing coil. Accounting for the coil temperature significantly improves the repeatability of the field strength. A number of safety features as well as oversized high grade electrical components ensure the safety and reduce the likelihood of serious malfunction or damage.

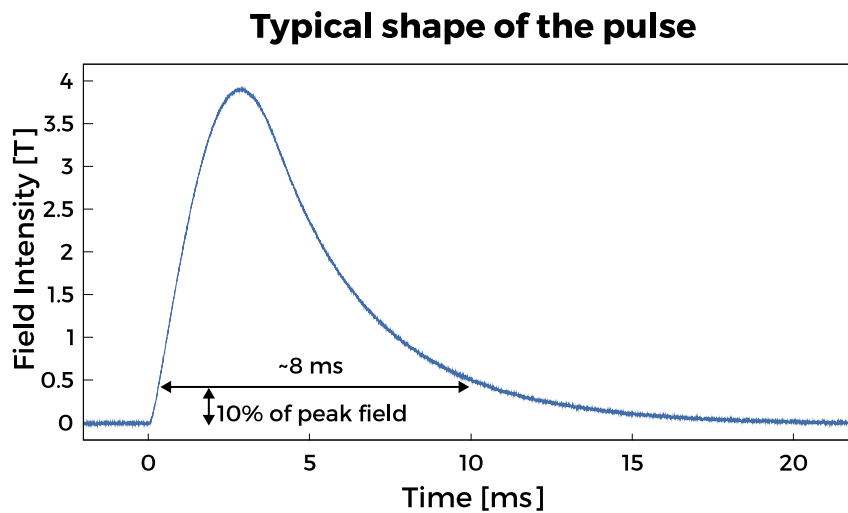


**Figure 1:** Principal schematics of the PUMA

## 1.2 Instrument description

### 1.2.1 Technical parameters

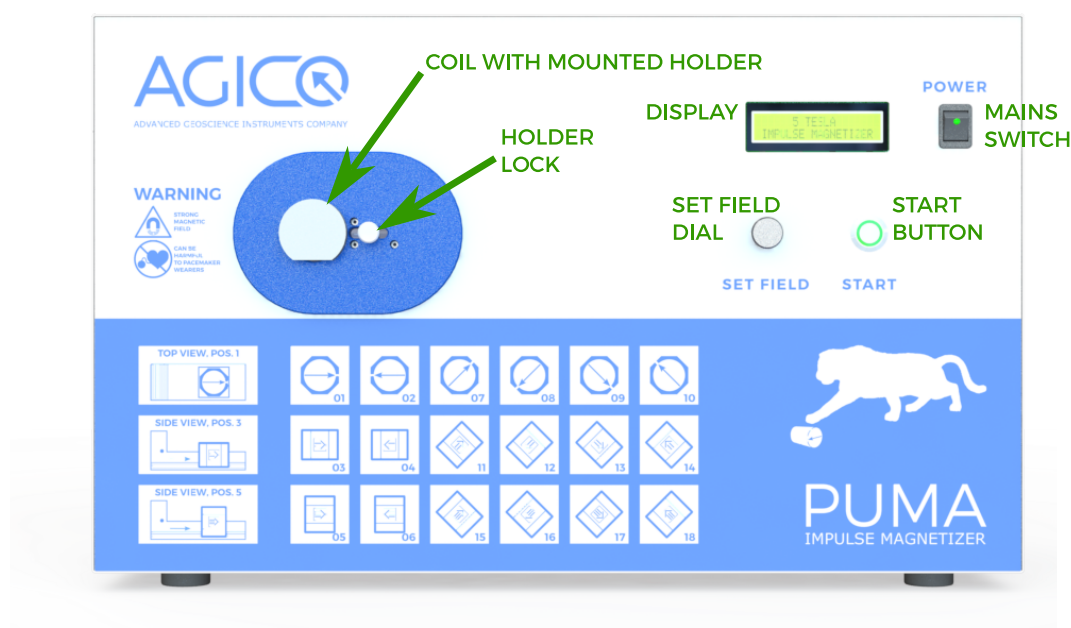
- Dimensions: width×height×depth: 715×435×500 mm (28.2×17.1×19.7 inch).
- Mass: 78 kg (172 lbs).
- Power requirements: 230 V, 10 A or 100-115 V, 20 A
- Magnetic field intensity range: 1-5000 mT.
- Pulse duration: ~8 ms. See. Fig. 2 for definition.
- Field intensity precision: range 1-20 mT  $\pm$  1mT, range 21-5000 mT  $\pm$  5%.
- Field homogeneity: better than 97 % over volume of the specimen.
- Inner coil diameter: 41 mm.
- Specimen size:
  - Cylinder: dia 25.4 mm (+0.5 mm,-1 mm), length 22 mm (+2 mm, -10 mm).
  - Cube: edge of 20 mm or 23 mm.



**Figure 2:** Typical pulse waveform

## 1.2.2 Front and back panel

All instrument controls are located on the front panel (see. Fig.3). These are the **main switch**, **set field dial** for setting the desired field strength, **start button**, **display**, sample **holder lock** and magnetizing coil. Sockets for the power cord and USB-B cable are located on the rear panel.



**Figure 3:** Front panel of the PUMA Impulse Magnetizer

## 1.2.3 Coil cooling

Magnetization coil temperature increases during the high intensity pulses, especially if field is higher than 2T. Active cooling of the coil is provided by four fans on the left and rear of the device. The fans start automatically when the coil temperature is above 40 °C and turn off when the temperature is below 35 °C. If the coil temperature exceeds 90 °C, operation of the instrument is restricted until the temperature drops below 75 °C.

**Warning** Make sure that the ventilation holes are always free with sufficient air access!

### **1.3 Installation of the instrument**

After unpacking, place the unit on a sturdy wooden table with a minimum top size of 60x60 cm. Make sure that the fan outlets on the back and left side of the PUMA are clear. Maintain a distance of at least 15 cm between the fan outlets and any obstruction to allow sufficient air circulation and to ensure adequate cooling of the magnetizing coil.

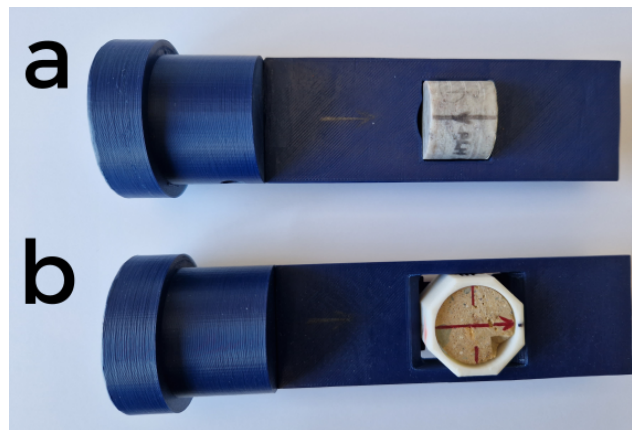
If you want to control the instrument using the supplied software, we recommend installing the PUMA software before connecting the magnetiser to the computer for the first time. Then plug the USB cable and mains cord into the respective connectors. Make sure to connect the power cable to the correct power supply voltage. Connect the USB cable to the computer (if you want to use the PUMA software) and turn on the main switch. The PUMA pulse magnetizer is now ready for use.

## 2 Instrument operation

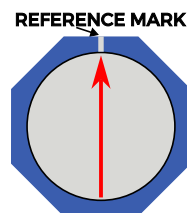
### 2.1 Specimen handling

#### 2.1.1 Cylindrical specimen

Two cylindrical specimen holders are supplied with the instrument, see Fig. 4.



**Figure 4:** Cylindrical specimen holders

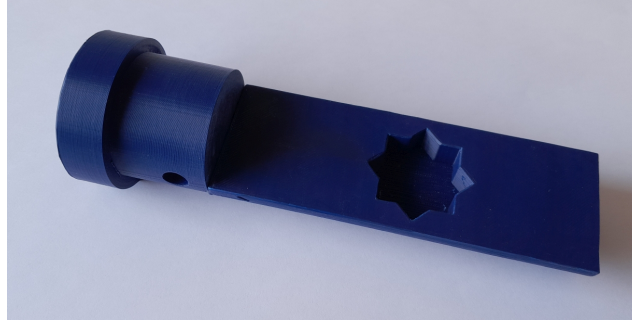


**Figure 5:** Proper orientation of the cylindrical specimen inside the shell

- Holder **A** is one-piece holder for magnetization of cylindrical specimens in the principal specimen axes.
- Holder **B** consists of two pieces (the actual holder and the specimen shell). This design allows magnetization of cylindrical specimens in eighteen directions (see Tab.1 and Fig. 8), a certain sequence of which is necessary to measure the anisotropy of isothermal magnetic remanence. When inserting the specimen into the shell make sure that it is oriented with respect to the reference mark as shown in Fig. 5 and the screw on the side of the shell is tight sufficiently to prevent the specimen from moving.

### 2.1.2 Cubic specimen

Two holders for cubic specimens differ only in their dimensions – 20 or 23 mm cubes, see Fig.6. The positioning of the specimen with respect to the 18 direction design is shown in Fig.9



**Figure 6:** Cubic specimen holder

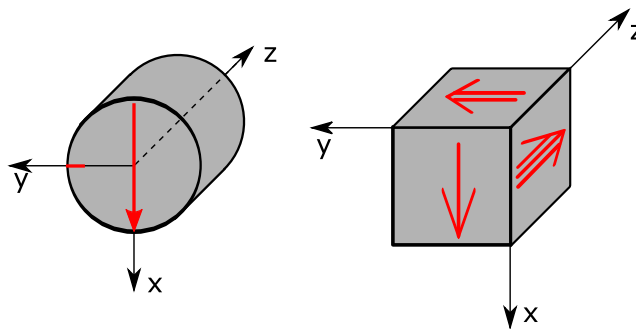
### 2.1.3 Holder Insertion

When specimen is correctly fixed inside the holder, the holder can be inserted into the magnetizing coil. Push the holder lock to the right and slide the specimen holder into the coil. Then release the lock. Make sure that the lock pin slides into the small cavity on the side of the specimen holder. It safely locks the holder with specimen in the correct position inside the coil.

**Warning:** It is necessary to place the locking pin inside the cavity on the specimen holder. If the lock is in a different position, the pulse cannot be triggered.

User mode	Principal axes	A-mode	B-mode	C-mode	D-mode	P-mode	Direction
U1	+x-axis			C1	D1	P3	0/0
U2	-x-axis			C2			180/0
U3	+y-axis			C3	D2	P8	90/0
U4	-y-axis			C4			270/0
U5	+z-axis			C5	D3	P13	0/90
U6	-z-axis			C6			0/-90
U7		A1	B1			P2	45/0
U8		A2				P5	225/0
U9		A3	B2			P4	315/0
U10		A4				P1	135/0
U11		A5	B3			P7	90/45
U12		A6				P10	270/-45
U13		A7	B4			P9	90/-45
U14		A8				P6	270/45
U15		A9	B5			P12	0/45
U16		A10				P15	180/-45
U17		A11	B6			P14	180/45
U18		A12				P11	0/-45

**Table 1:** A scheme of eighteen magnetizing directions with a reference to the magnetizing modes necessary to measure the anisotropy of isothermal magnetic remanence. Directions are presented in specimen coordinate system as declination / inclination. Each pair represents a set of antipodal directions.



**Figure 7:** Specimen marking convention for cylindric and cubic specimens, right-handed coordinate system. Single arrow represents the x-axis of the specimen.



**Figure 8:** 18 orientations of the cylindrical specimen





**Figure 9:** 18 orientations of the cubic specimen

## 2.2 Specimen magnetization

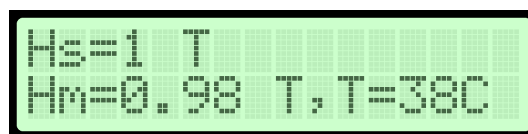
PUMA can be operated directly in the local mode or in remote mode using a PC connected via USB, which brings additional user comfort as well as possibility of more detailed setting of the pulse intensity. Sharing of the set and measured value of the magnetization field with REMA6 software, if running simultaneously on the same PC, is another benefit. Prior to the work in both modes make sure that the mains cord is properly connected and switch on the **mains switch** on the front panel. The instrument is initialized and several self-tests are executed. PUMA is ready for operation when the text **Hs=1T** is shown on the display and the LED on the **start button** turns green.

### 2.2.1 Local mode

After successful initialization of the PUMA, the required intensity of the magnetic field pulse can be set by turning the **set field dial**. Clockwise turning increases the requested peak field value, while counterclockwise turning decreases it in the increments shown in Tab. 2.

Field range [mT]	Increment [mT]
1-20	1
21-50	5
51-200	10
201-500	20
501-2000	50
2001-5000	100

**Table 2:** The increments of the required field when using the set field dial.



**Figure 10:** Typical display screen after the pulse. **Hs** is requested (set) field, **Hm** is measured field and **T** is coil temperature after the pulse in degrees Celsius.

Make sure that specimen is properly mounted in the respective holder and holder is inside the coil with **holder lock** in correct position. To begin magnetization process push the **start button**. **Start button** turns red and charging of the capacitors begins. The charging can be monitored on the **display**. After reaching the required capacitor charge, the pulse is automatically triggered. The actual

value of the pulse intensity (**Hm**) is measured and shown on the display as well as the current temperature of the coil (**T**) see Fig.10.

**Display adjustment** The brightness and contrast of the display can be adjusted by following procedure:

- Switch ON PUMA.
- Press **start button** and hold it for approx. 3 seconds.
- PUMA **display** shows Brightness or Contrast adjustment mode. To switch between Brightness/Contrast adjustment mode shortly press **start button**.
- Adjust Brightness/Contrast using **set field dial**
- To save current setting of the display and return back to normal operation press **start button** and hold it for approx. 3 seconds.

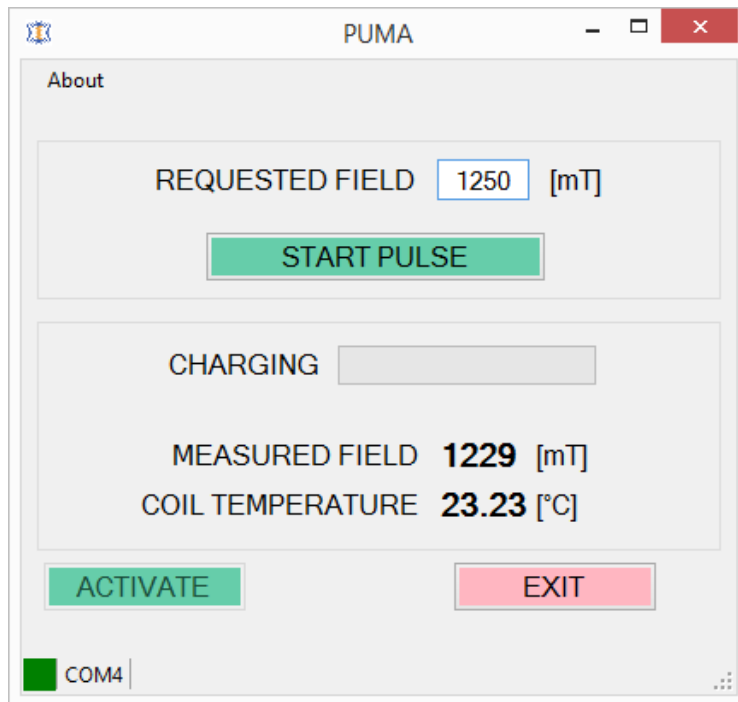
### 2.2.2 Remote mode

#### Software installation

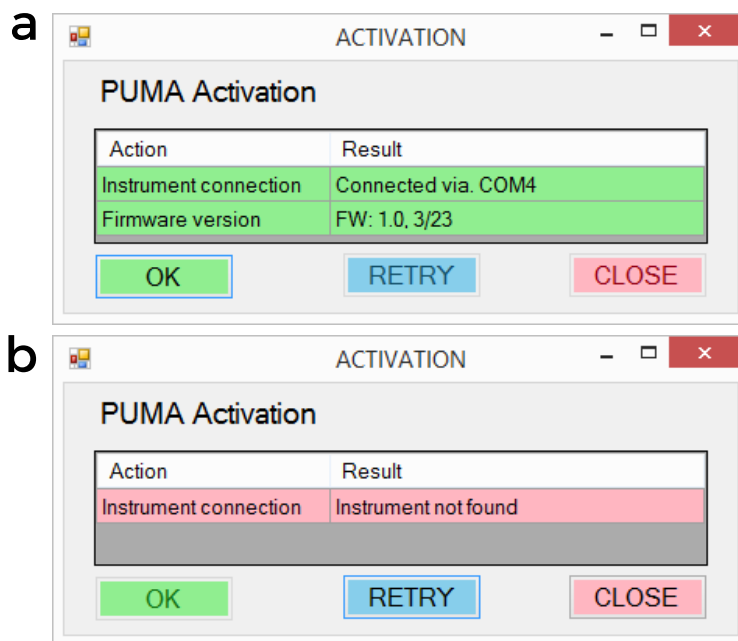
The installation of the complimentary MS Windows® software is straightforward: run installation file *PUMA\_install.exe*, press **OK** buttons and software will be installed into directory *C:\AGICO\PUMA*.

#### Software activation

Make sure that the PUMA is switched on and interconnected with PC via USB cable. Then run the PUMA software. Press **ACTIVATION** button on the main screen (Fig.11) and the activation routine with the pop-up window **ACTIVATION** (Fig.12) is launched. The successful activation as shown in Fig.12A. In this case PUMA is connected via COM4 and firmware version is 1.0 released on March 2023. Press **OK** to return to main screen. The unsuccessful activation result is shown in Fig.12B, in this case check if the PUMA is switched on and USB cable is properly connected and the press **RETRY** to try again.




**Figure 11:** The main screen of the PUMA software.



**Figure 12:** The activation window of the PUMA software. a) successful activation, b) unsuccessful activation of the instrument.

### Magnetization of the specimen

Make sure that the specimen is correctly fixed in the appropriate specimen holder and the holder is inside the magnetizing coil. Fill the **REQUESTED FIELD** text box with the desired value of the magnetization field intensity in [mT] and press **Enter** or hit  button. The capacitor charging process can be monitored on the **CHARGING** progress bar. After reaching the required capacitor charge the pulse is automatically triggered and the PUMA software displays the actual field value in **MEASURED FIELD** [mT] and the coil temperature in **COIL TEMPERATURE** line (see Fig.11). In the case of some malfunction, PUMA returns an error message which is shown by PUMA software as well as visualized on the PUMA **display**. See section 3.2 for a list of error messages with suggestions for their resolution.

## 3 Troubleshooting

PUMA Impulse magnetizer contains plenty of hardware control circuits and software diagnostic tests to prevent any serious damage to the device. Some potential errors and their solution are listed below. The best way to solve the problems with **AGICO** devices is to contact the manufacturer via email address [agico@agico.cz](mailto:agico@agico.cz). Lifetime email support is free of charge, so do not hesitate to contact us with any questions.

### 3.1 Hardware Indicators

#### Color of the **start button**

- **LED** still – Instrument is ready for operation. Button is active.
- **LED** – Capacitor charging: button is inactive, but instrument works.
- **LED** – All other situations: indicates some kind of error. See section 3.2
- **LED LED LED LED LED** – Unspecified error. The error code is shown on the **display** and software. See Tab. 3 for more details.
- **LED** – Instrument is not powered or there is a malfunction of the LED.

#### **Beeper sounds**

- Short beep on start-up: PUMA was activated correctly.
- Series of short beeps during operation: Some error occurred, check display or software.
- Long continuous beep: Serious malfunction of the instrument. Immediately switch off using **mains switch**, wait for about three minutes and then disconnect mains cord! Ask **AGICO** for assistance.

### 3.2 Software Error Messages

Software error messages inform about the actual problems of the PUMA. Table 3 summarizes the recommended troubleshooting steps of the given error.


Error	Solution
ES1 CHARGING TIME-OUT	Capacitors were not sufficiently charged. Usually caused by the low mains voltage. Please check voltage of your power net.
ES2 POWER ERROR	Some voltage is missing. Check fuses according to the sec. 3.3
ES3 GENERAL ERROR	Ask <b>AGICO</b> for assistance.
ES4 LOCK ERROR	Check if the holder is properly mounted and check the holder lock. Try again.
ES5 FIELD ERROR	The field intensity value differs by more than 20% from the set value. Try again. If problem persists ask <b>AGICO</b> for assistance.
ES6 DISCHARGE ERROR	Capacitors were not discharged properly. Try again. If problem persists ask <b>AGICO</b> for assistance.
ES7 FATAL ERROR	Do not use instrument anymore and ask <b>AGICO</b> for assistance.
ES8 TEMPERATURE SENSOR ERROR	Temperature sensor is disconnected or broken. Ask <b>AGICO</b> for assistance.

**Table 3:** List of errors shown by PUMA software or **display**

### 3.3 Fuses

The back panel of the PUMA contains two fuses with ratings T10 A / 250 V (230 V version) or T20 A / 250 V (100-115 V version) . **T** stands for time lag (slow-burn) fuse, 10 A or 20 A indicates maximum current of fuses and 250 V indicates maximum voltage.

If needed the mains fuse can be easily replaced. Switch off the PUMA, wait three minutes then disconnect the mains cable. Use the flat head screwdriver to unlock the socket, then pull out the socket. After replacing the fuse push in the socket and lock it with screwdriver.

-  **Mains cord must be disconnected!** The power switch of PUMA must be turned off and mains cord of PUMA must be disconnected during the fuse exchange.