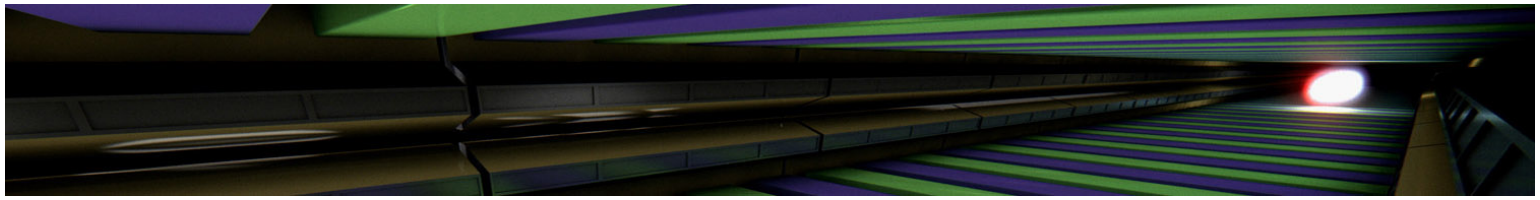
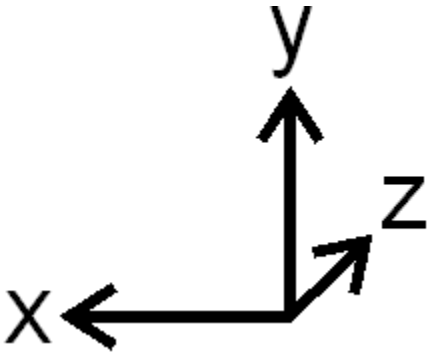


Magnets

XFEL Operator Training

Conventions: Dipoles (Incl. Correctors)



The XFEL has a right-handed coordinate system. *z* points downstream.

Where does this corrector deflect the electron beam?

UP

Which sign does its field/ strength/kick have?

+

Conventions: Quadrupoles

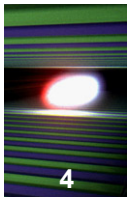
Is this quadrupole focusing or defocusing in the horizontal plane?

DEFOCUSING

What is the sign of its gradient/ strength/ integrated strength?

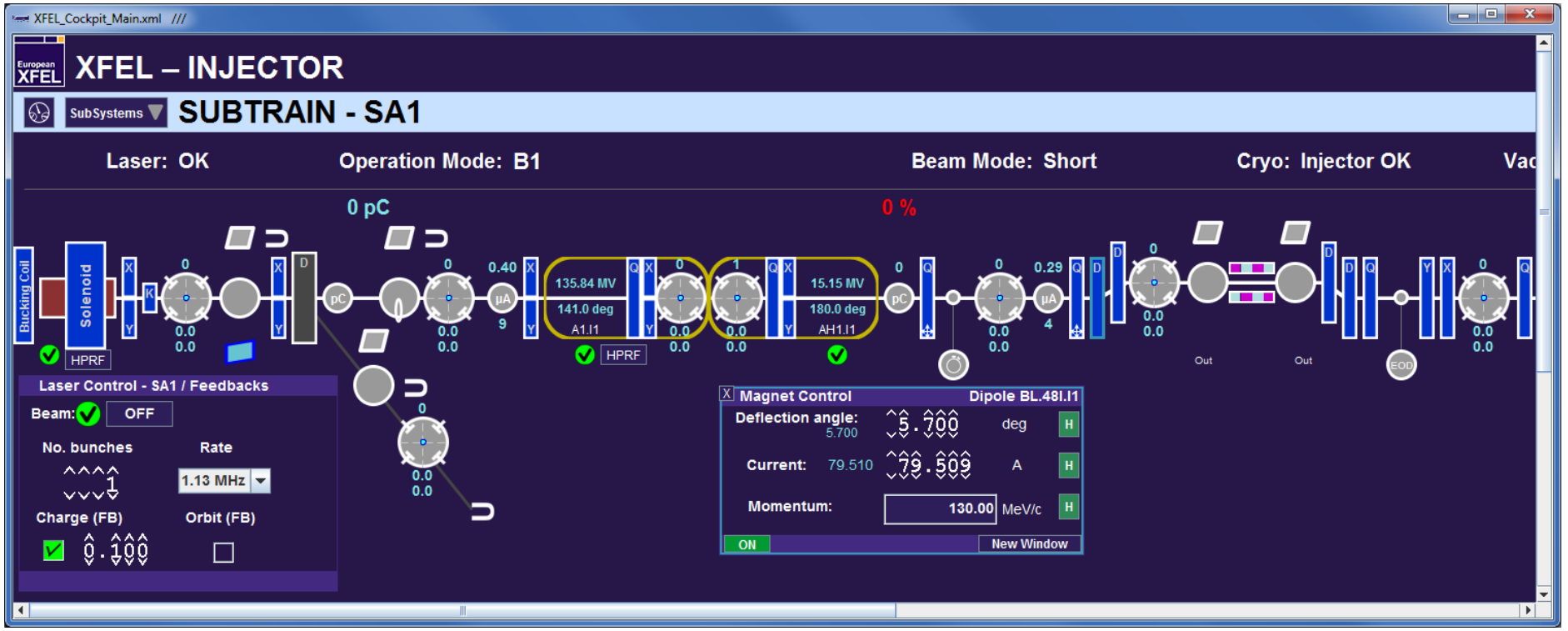
–

Conventions

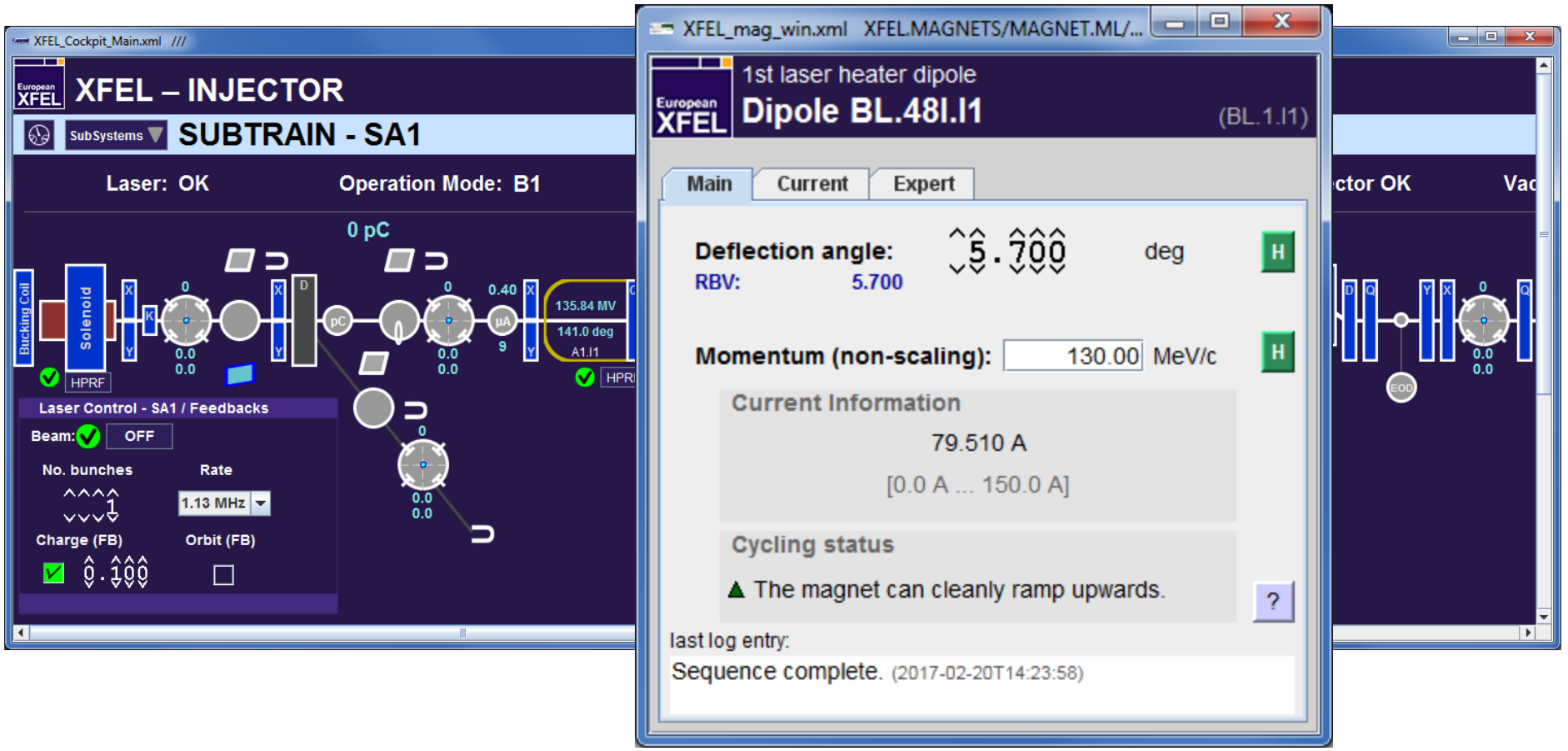


- Dipoles and correctors with a positive field deflect electrons to the left (in positive x direction) or up (in positive y direction).
- Quadrupoles with a positive *generalized* field are horizontally focusing for electron beams.
- Usually, positive fields are driven by positive currents, but there are exceptions.

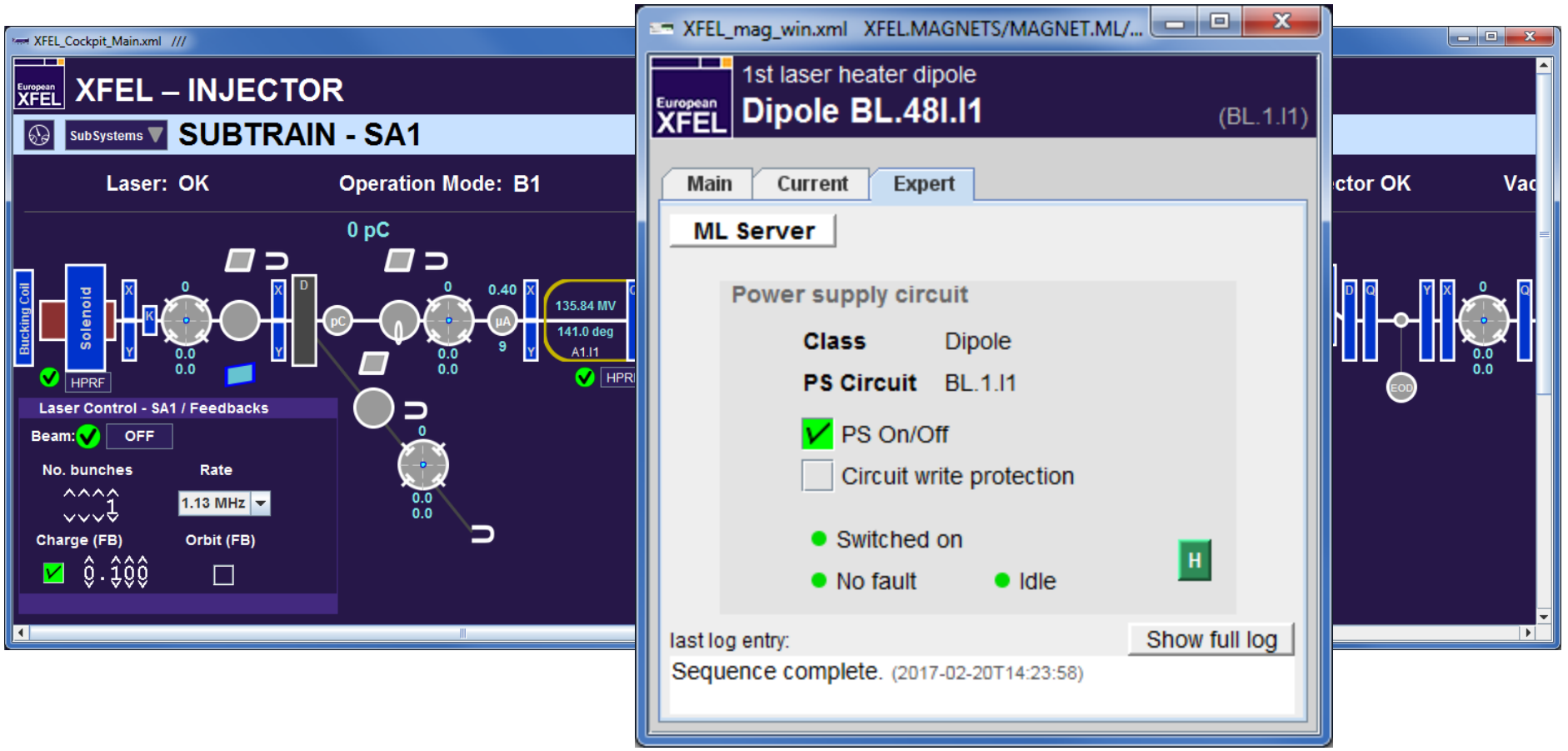
Controlling Magnets... From the Cockpit



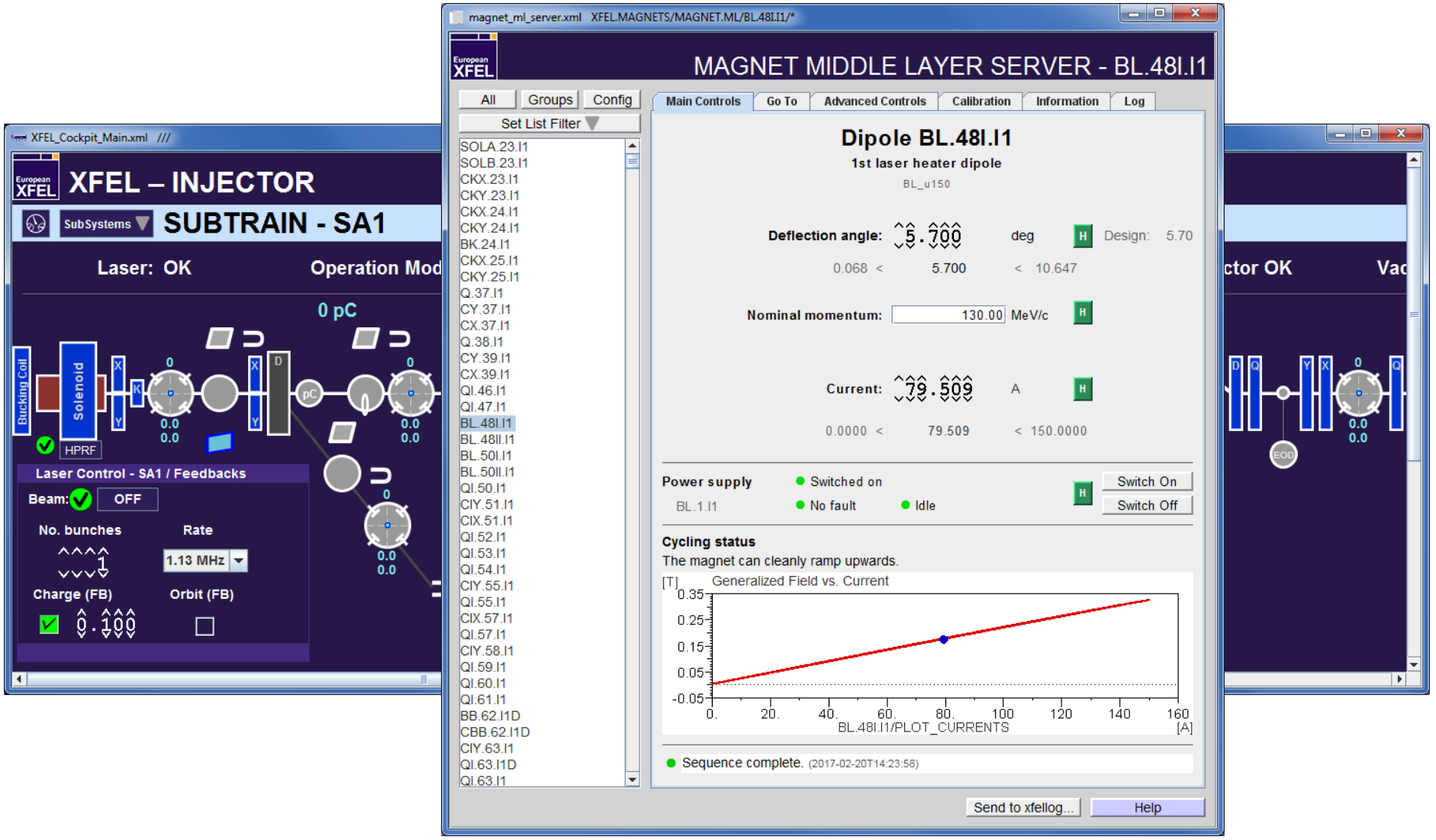
Controlling Magnets... From a Stand-Alone Panel



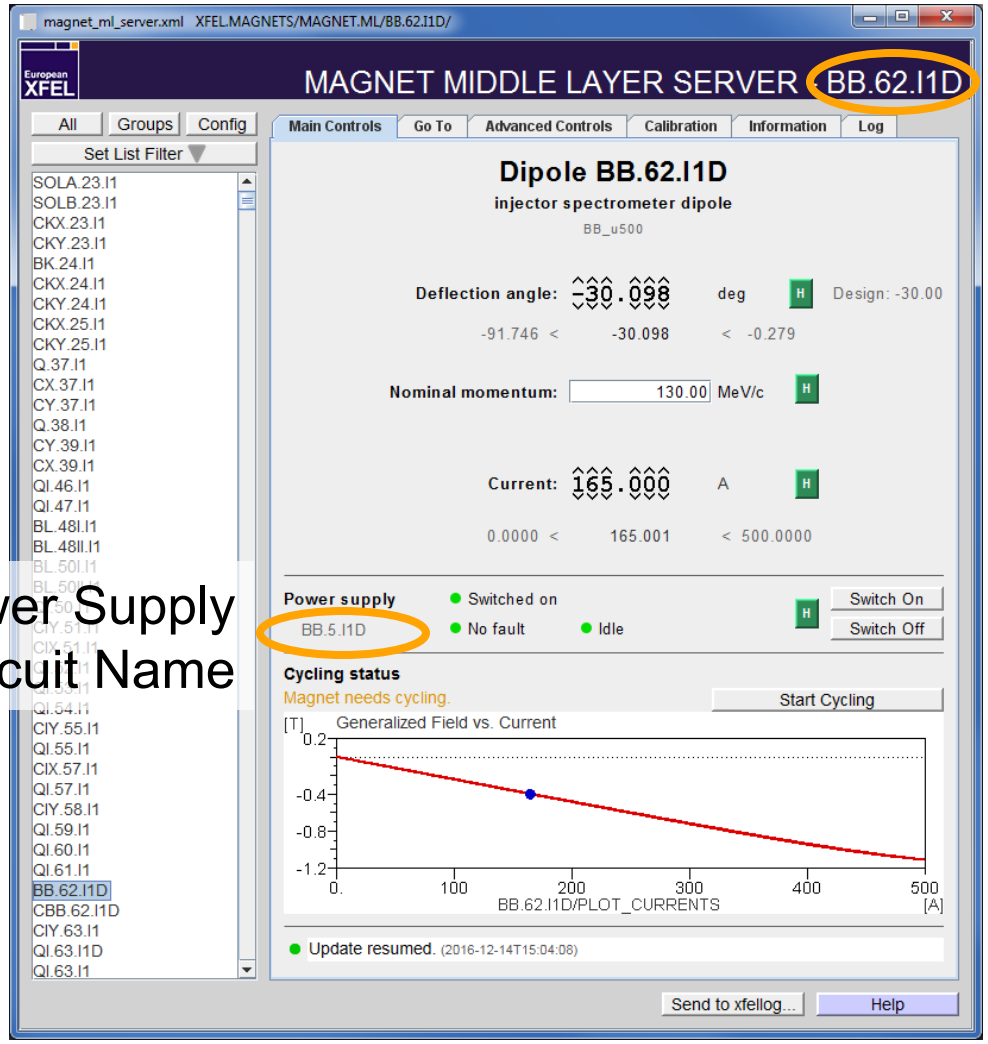
Controlling Magnets... From a Stand-Alone Panel



Controlling Magnets... From the ML Server Panel



Magnet Middle Layer Server



Power Supply Circuit Name

Magnet Name

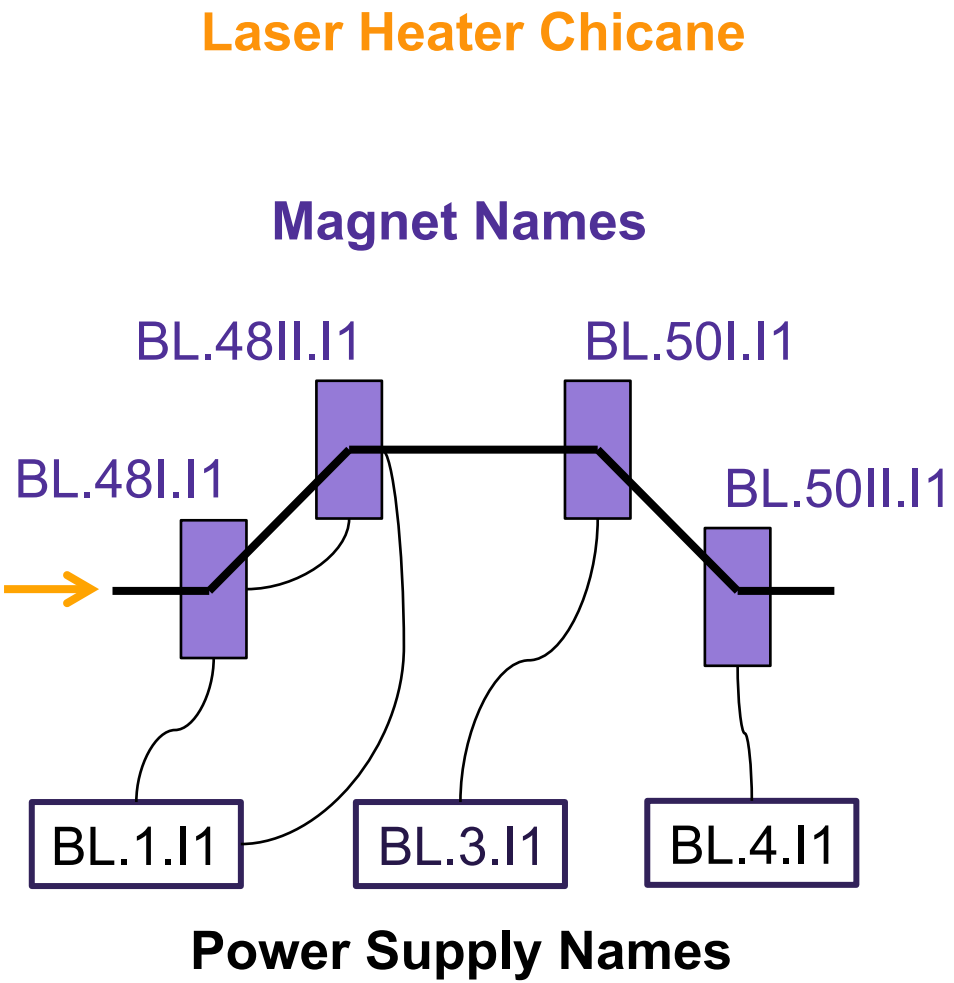
<type>.<zpos>.<section>

- SOL* – Solenoids
- C* – Correctors
- B* – Dipoles
- Q* – Quadrupoles
- S* – Sextupoles
- O* – Octupoles
- CB* – Correction/trim coils on dipoles (additional windings)

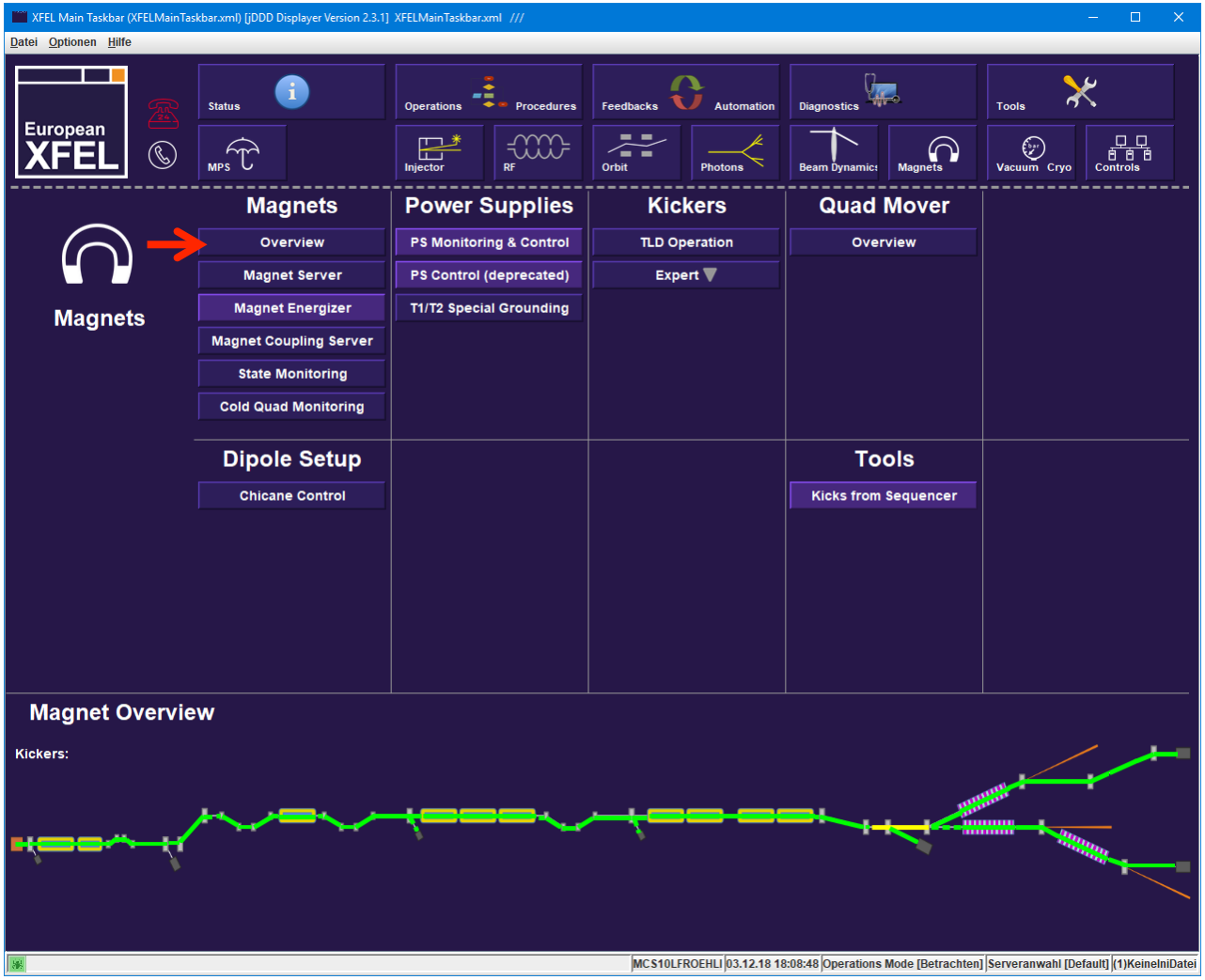
PS circuit names are similar:
<type>.<ID>.<section>

Many Magnets Can Share The Same Circuit

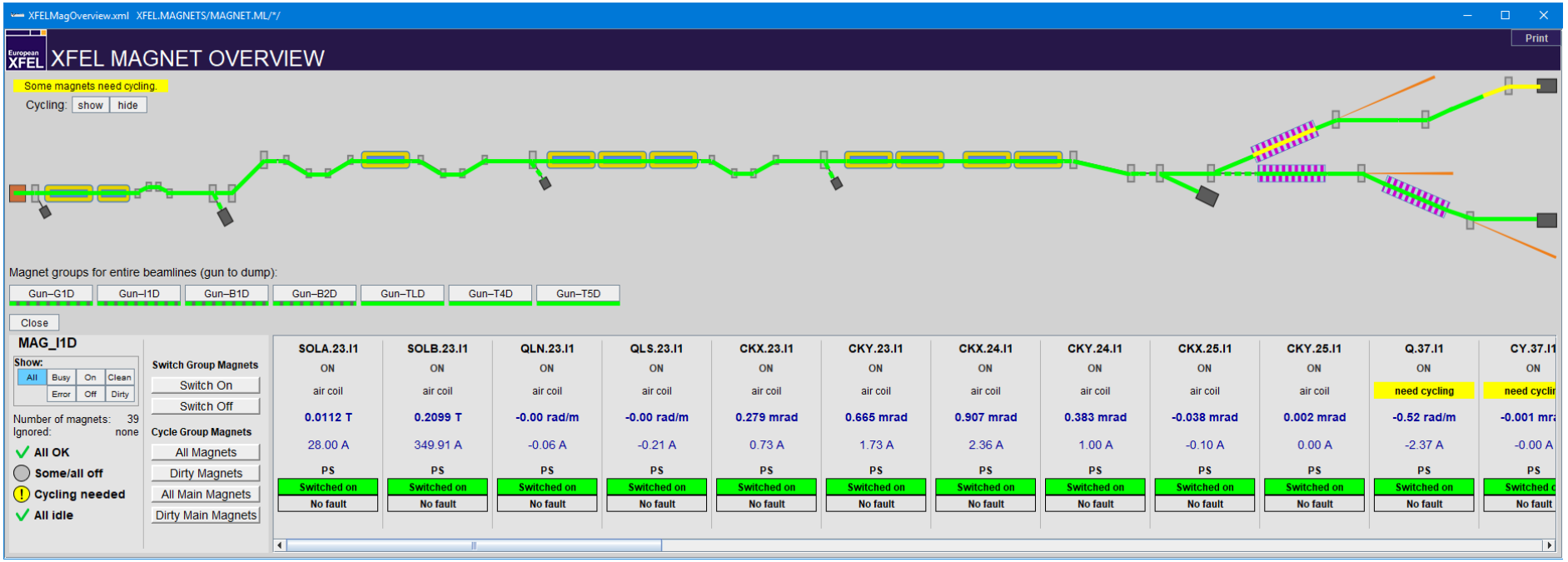
- There is one device for each magnet
- ... even if multiple magnets share the same power supply



Main Taskbar > Magnets



The Magnet Overview Panel



Current, Field, Strength, Gradient, Kick, Momentum, ...

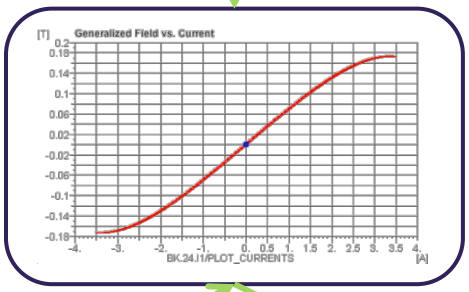
... and other sophisticated words like “hysteresis” and “remanence”!

Magnet ML: Physical Parameters

calibration data

nominal momentum

effective magnetic length



$\cdot \frac{e}{p}$

$\cdot l_{\mathrm{mag}}$

current

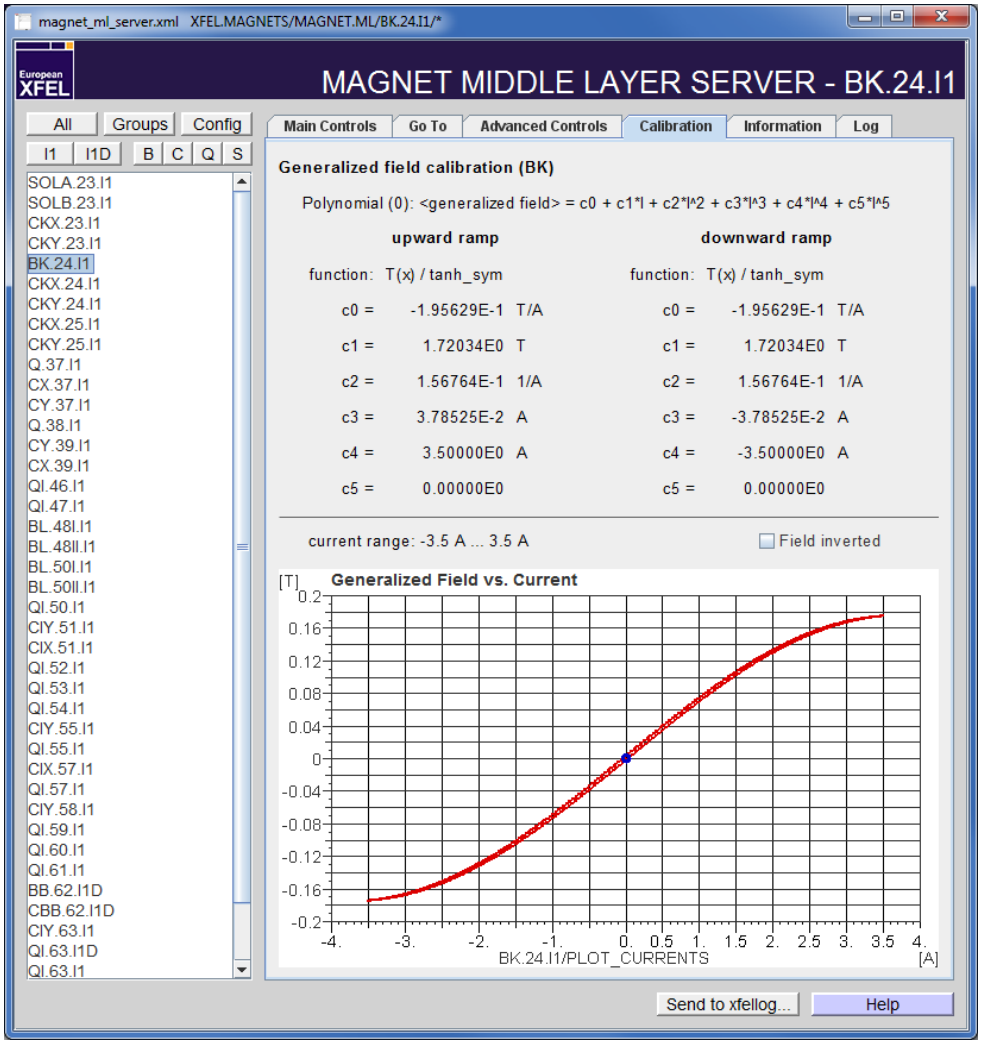
(gen.) field

(gen.) strength

(gen.) kick

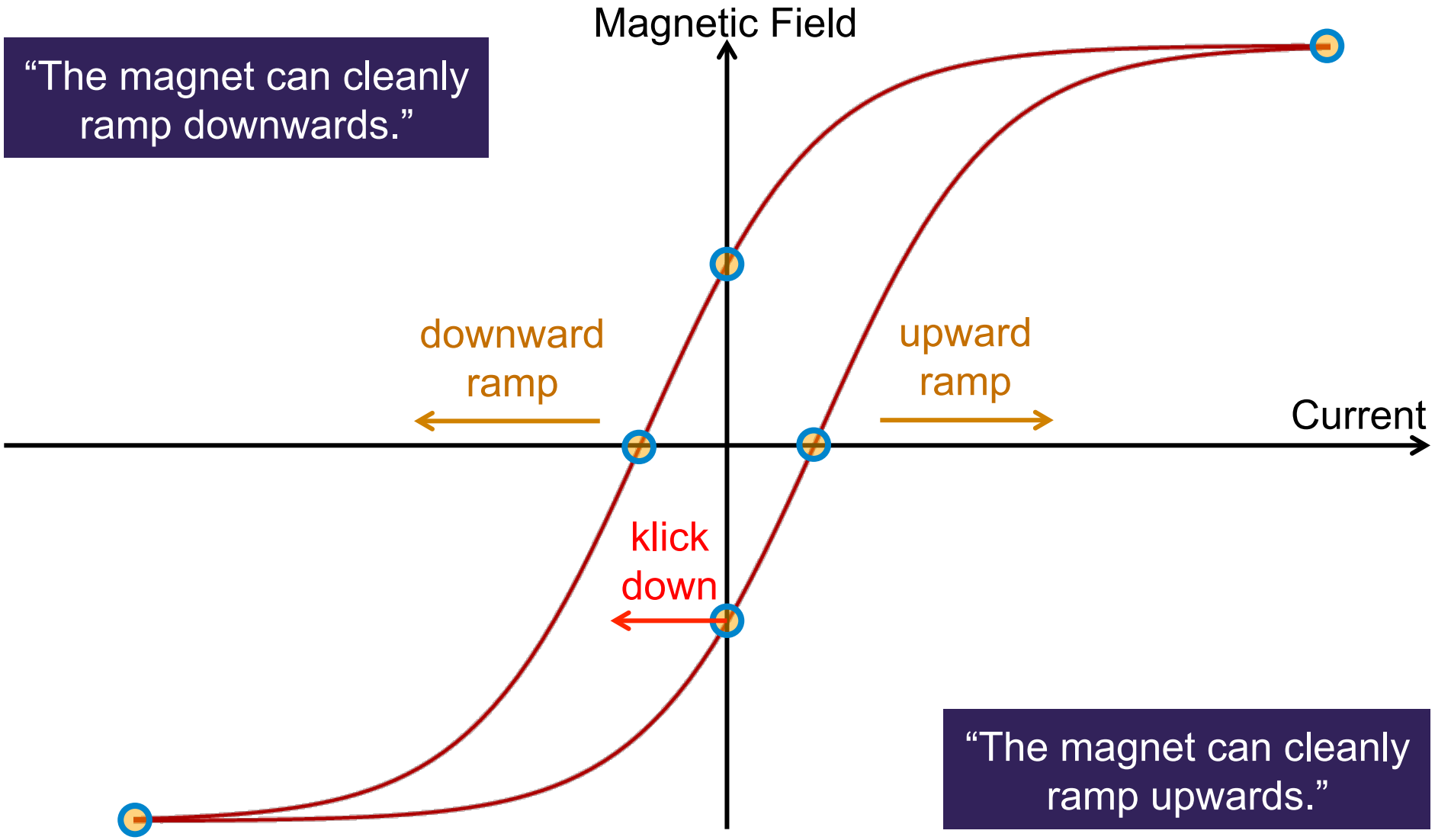
Dipole	[B] = T	[1/ρ] = 1/m	rad
Quadrupole	[g] = T/m	[k] = 1/m²	rad/m
Sextupole	T/m²	[m] = 1/m³	rad/m²
Octupole	T/m³	[r] = 1/m⁴	rad/m³

Magnet ML: Calibration & Hysteresis



Dealing with Hysteresis

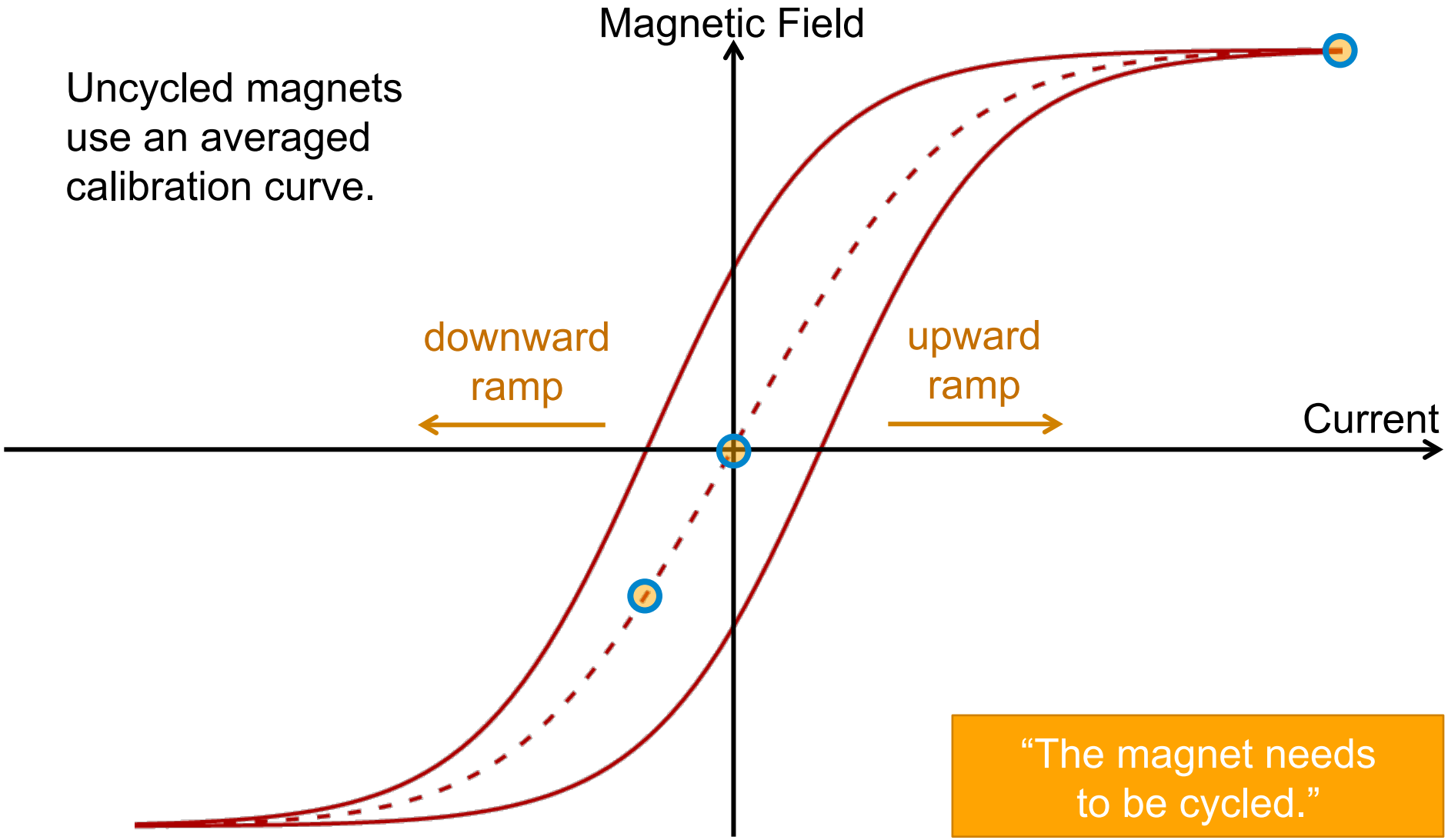
"The magnet can cleanly ramp downwards."



"The magnet can cleanly ramp upwards."

Dealing with Hysteresis

Uncycled magnets use an averaged calibration curve.

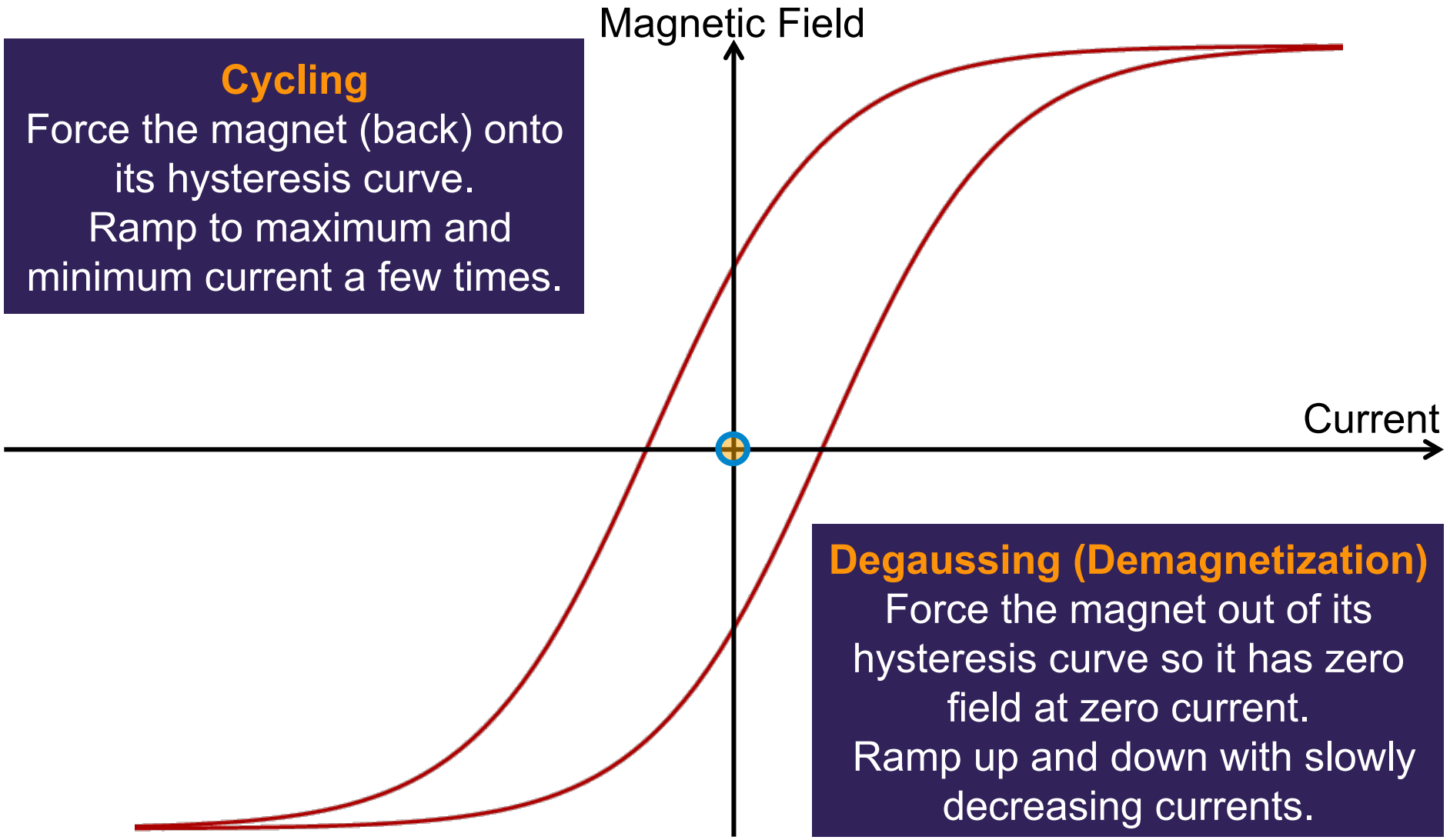


"The magnet needs to be cycled."

Cycling & Degaussing

Cycling

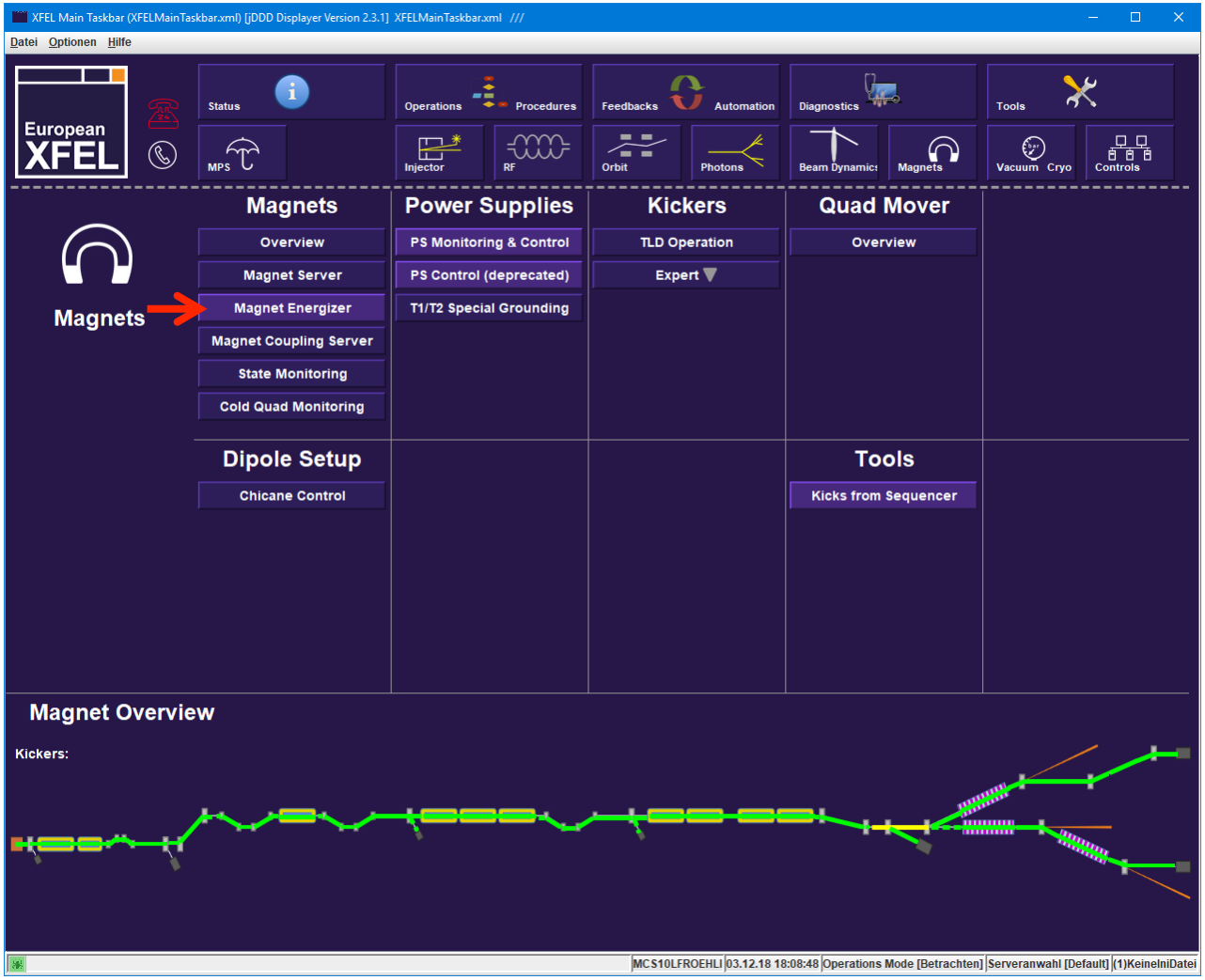
Force the magnet (back) onto its hysteresis curve.
Ramp to maximum and minimum current a few times.



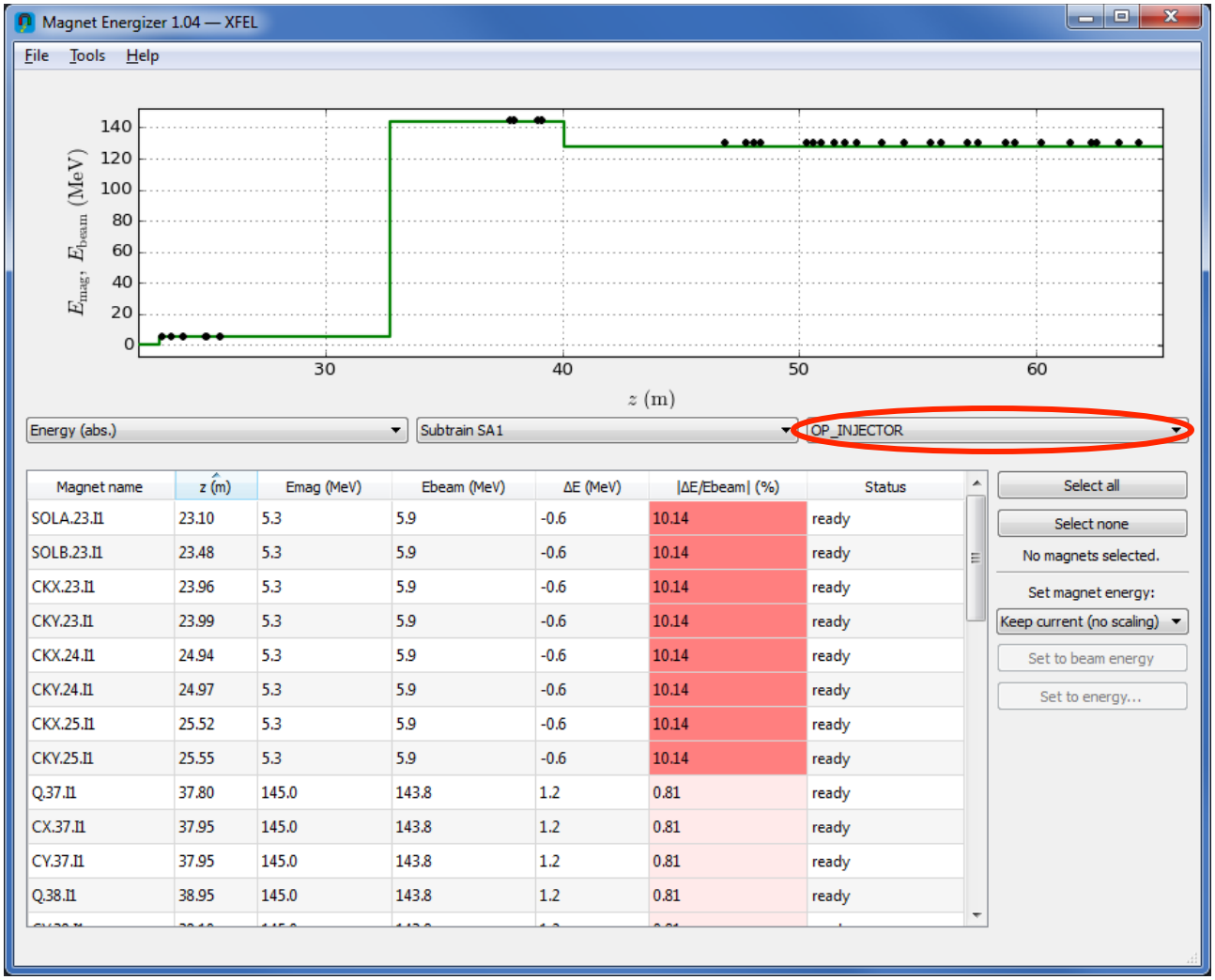
Degaussing (Demagnetization)

Force the magnet out of its hysteresis curve so it has zero field at zero current.
Ramp up and down with slowly decreasing currents.

Main Taskbar > Magnets



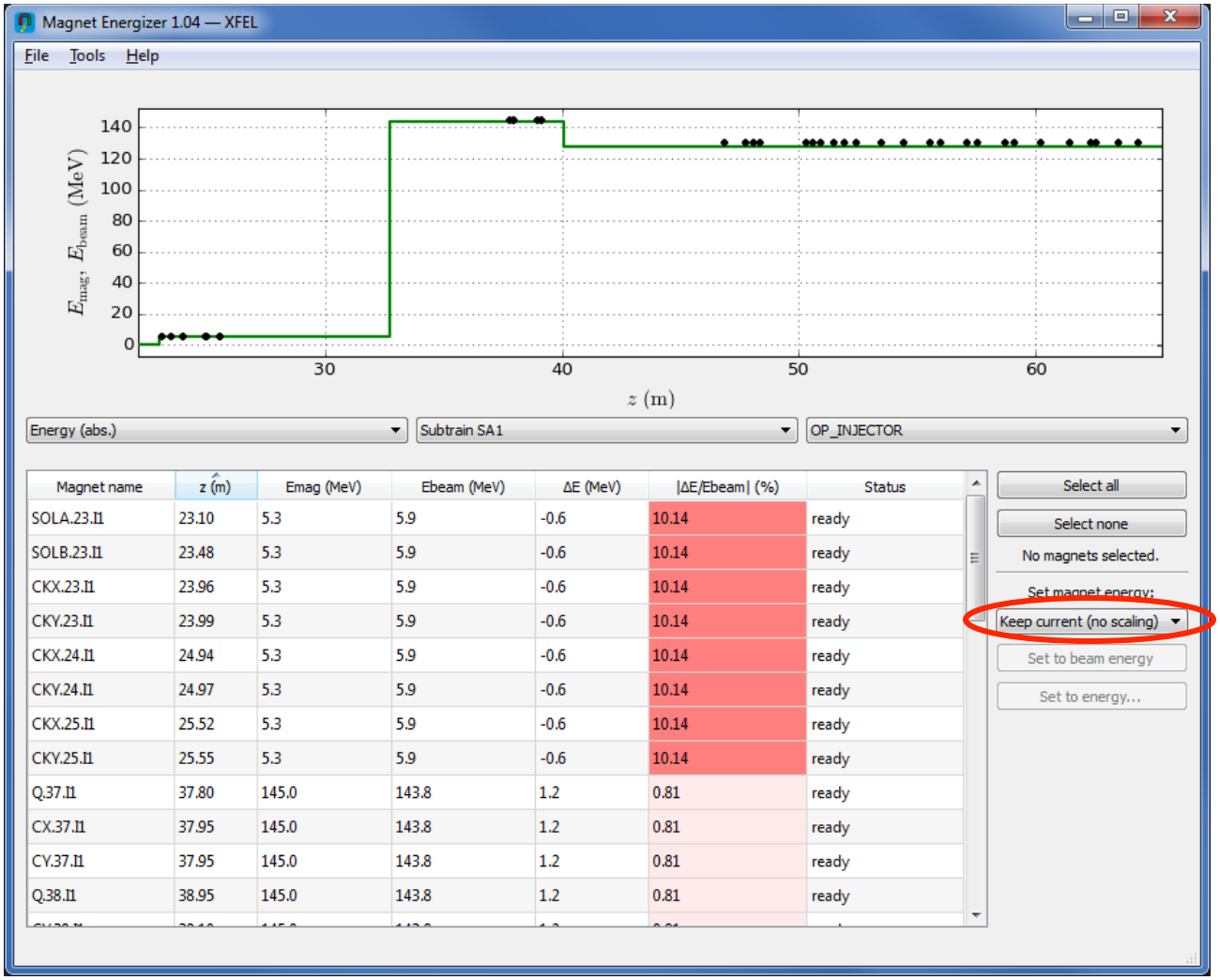
Magnet Energizer



The combobox on the right selects a group of magnets:

- Sections or subsections: I1M, B1, T2, …
- All magnets that need to be **ON** to transport the beam to a certain dump: MAG_I1D, MAG_T4D, …
- All magnets through which the beam **passes** on the way to a certain dump: OP_I1D, OP_T4D, …

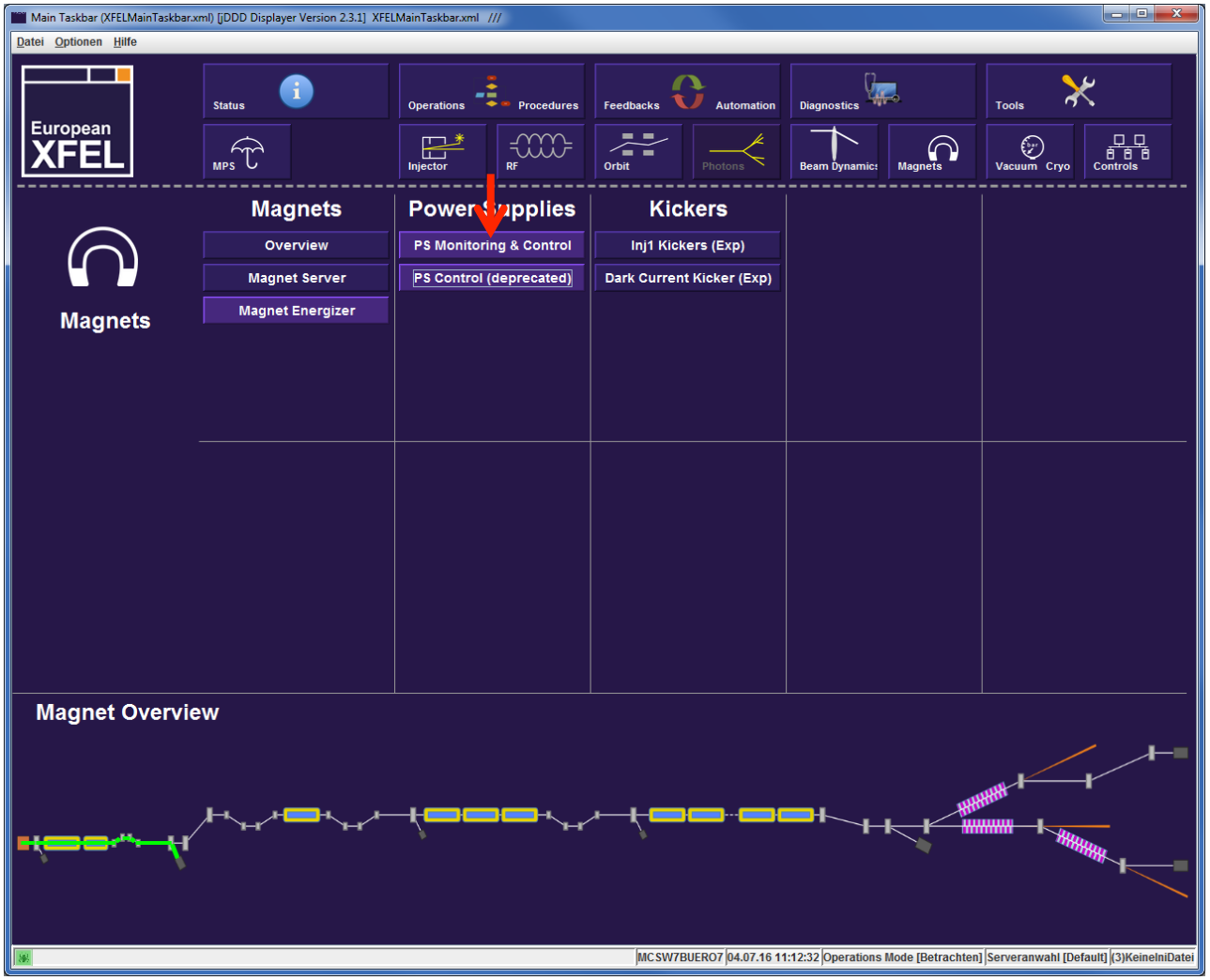
Magnet Energizer



This combobox selects what happens when „Set to beam energy“ or „Set to energy…“ is used:

- **Keep current (no scaling):**
  Only the energy setting is changed, the magnet current stays the same. No impact on the beam, but the calculated kick is different.
- **Keep strenght (scaling):**
  The magnet current is changed so that is has the same effect on a different beam.
  Use this when changing the beam energy.

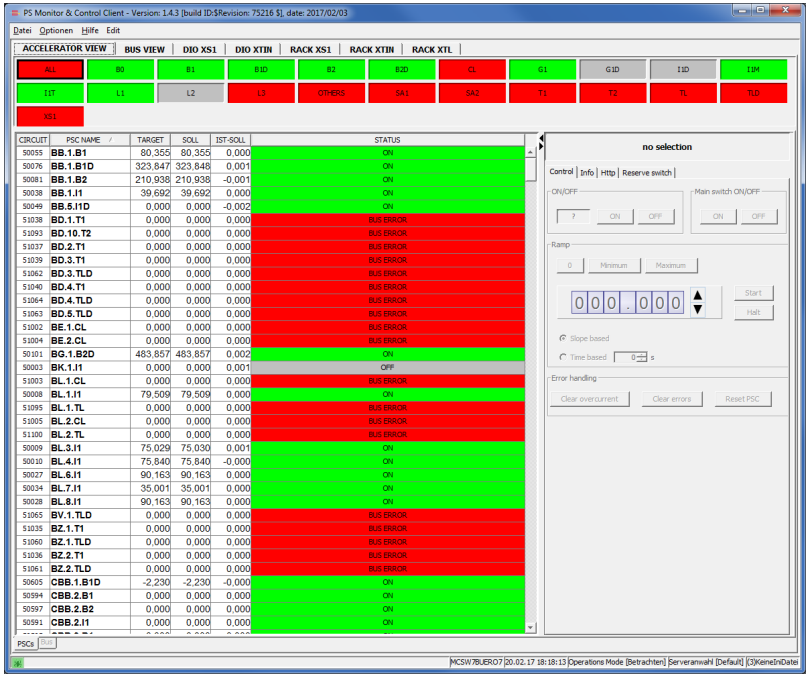
Main Taskbar > Magnets

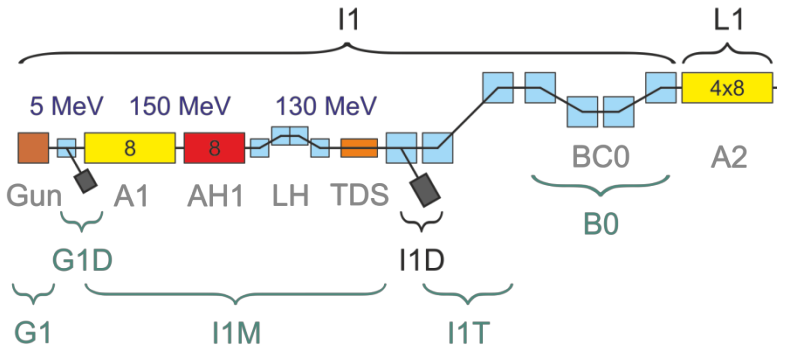


PS Monitor And Control (“PS MoCo”)

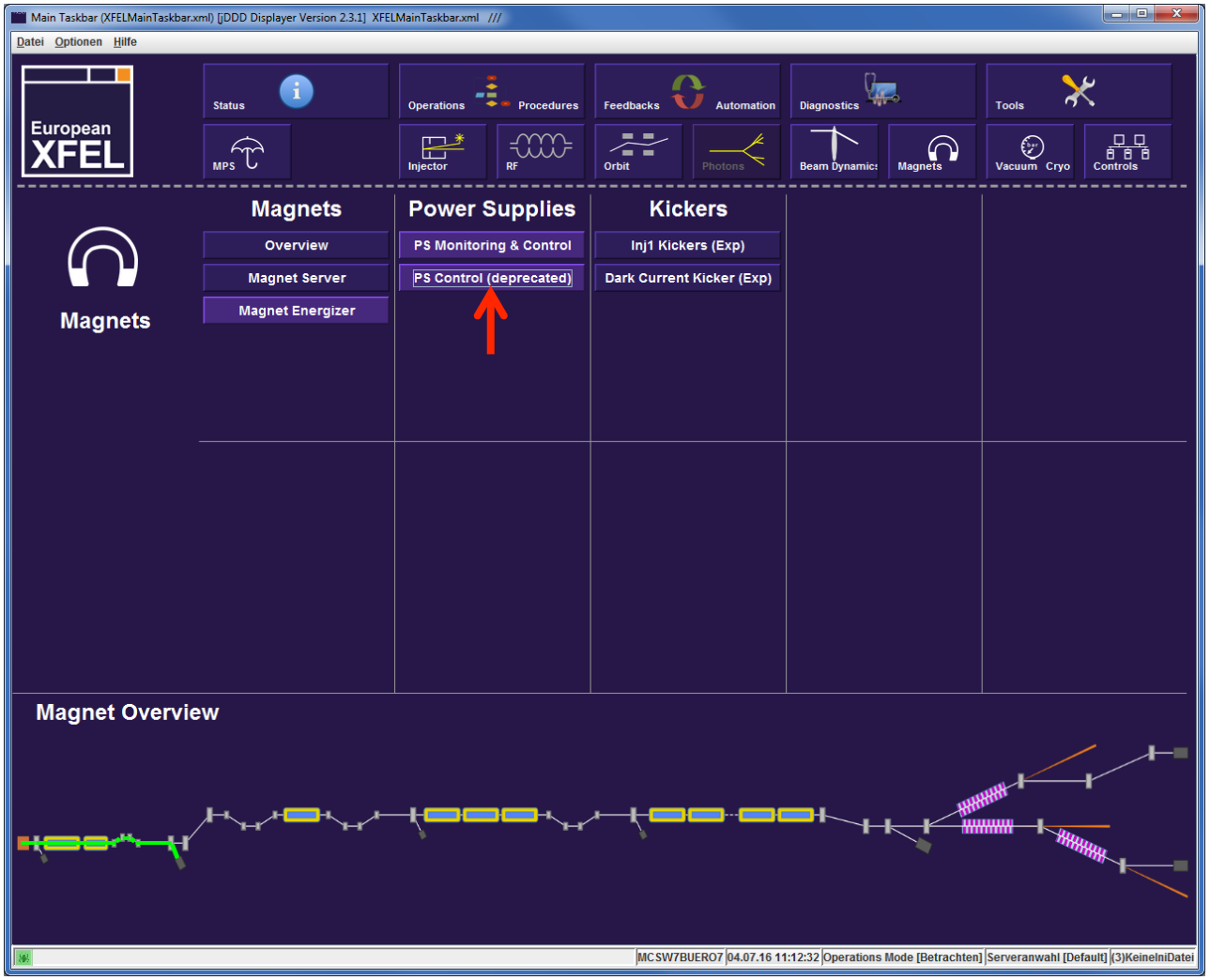
- Low-level view on power supplies
- Uses power supply circuit names
- Has a search function for magnet names, circuit names, and MKK circuit numbers (menu Edit/Search...)

- Use only for troubleshooting or if you‘re part of MKK!





Main Taskbar > Magnets

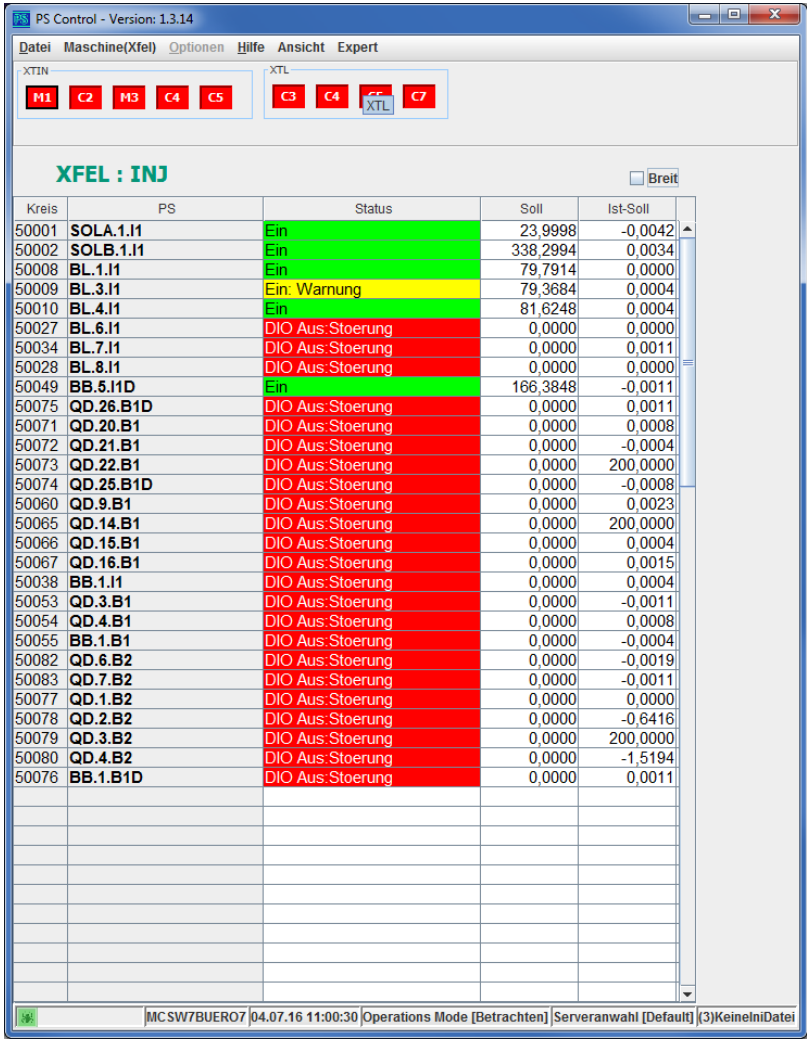


The “Good Old” PS Control

- It handles only “DESY-type” magnets.
- This means: It does not show all magnets.

- **IT DOES NOT SHOW ALL MAGNETS!**

- Please don’t use it – or only as a last resort for troubleshooting, if you know what you’re doing.



Kreis	PS	Status	Soll	Ist-Soll
50001	SOLA.1.I1	Ein	23,9998	-0,0042
50002	SOLB.1.I1	Ein	338,2994	0,0034
50008	BL.1.I1	Ein	79,7914	0,0000
50009	BL.3.I1	Ein: Warnung	79,3684	0,0004
50010	BL.4.I1	Ein	81,6248	0,0004
50027	BL.6.I1	DIO Aus:Stoerung	0,0000	0,0000
50034	BL.7.I1	DIO Aus:Stoerung	0,0000	0,0011
50028	BL.8.I1	DIO Aus:Stoerung	0,0000	0,0000
50049	BB.5.I1D	Ein	166,3848	-0,0011
50075	QD.26.B1D	DIO Aus:Stoerung	0,0000	0,0011
50071	QD.20.B1	DIO Aus:Stoerung	0,0000	0,0008
50072	QD.21.B1	DIO Aus:Stoerung	0,0000	-0,0004
50073	QD.22.B1	DIO Aus:Stoerung	0,0000	200,0000
50074	QD.25.B1D	DIO Aus:Stoerung	0,0000	-0,0008
50060	QD.9.B1	DIO Aus:Stoerung	0,0000	0,0023
50065	QD.14.B1	DIO Aus:Stoerung	0,0000	200,0000
50066	QD.15.B1	DIO Aus:Stoerung	0,0000	0,0004
50067	QD.16.B1	DIO Aus:Stoerung	0,0000	0,0015
50038	BB.1.I1	DIO Aus:Stoerung	0,0000	0,0004
50053	QD.3.B1	DIO Aus:Stoerung	0,0000	-0,0011
50054	QD.4.B1	DIO Aus:Stoerung	0,0000	0,0008
50055	BB.1.B1	DIO Aus:Stoerung	0,0000	-0,0004
50082	QD.6.B2	DIO Aus:Stoerung	0,0000	-0,0019
50083	QD.7.B2	DIO Aus:Stoerung	0,0000	-0,0011
50077	QD.1.B2	DIO Aus:Stoerung	0,0000	0,0000
50078	QD.2.B2	DIO Aus:Stoerung	0,0000	-0,6416
50079	QD.3.B2	DIO Aus:Stoerung	0,0000	200,0000
50080	QD.4.B2	DIO Aus:Stoerung	0,0000	-1,5194
50076	BB.1.B1D	DIO Aus:Stoerung	0,0000	0,0011