



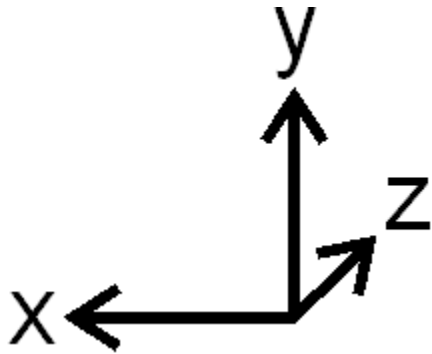
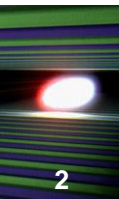
Magnets

XFEL Operator Training



HELMHOLTZ
| ASSOCIATION

Conventions: Dipoles (Incl. Correctors)



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



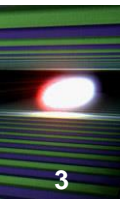
Where does this corrector
deflect the electron beam?

UP

Which sign does its
field/strength/kick have?

+

Conventions: Quadrupoles

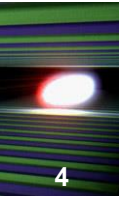


Is this quadrupole
focusing or
defocusing in the
horizontal plane?

DEFOCUSING

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

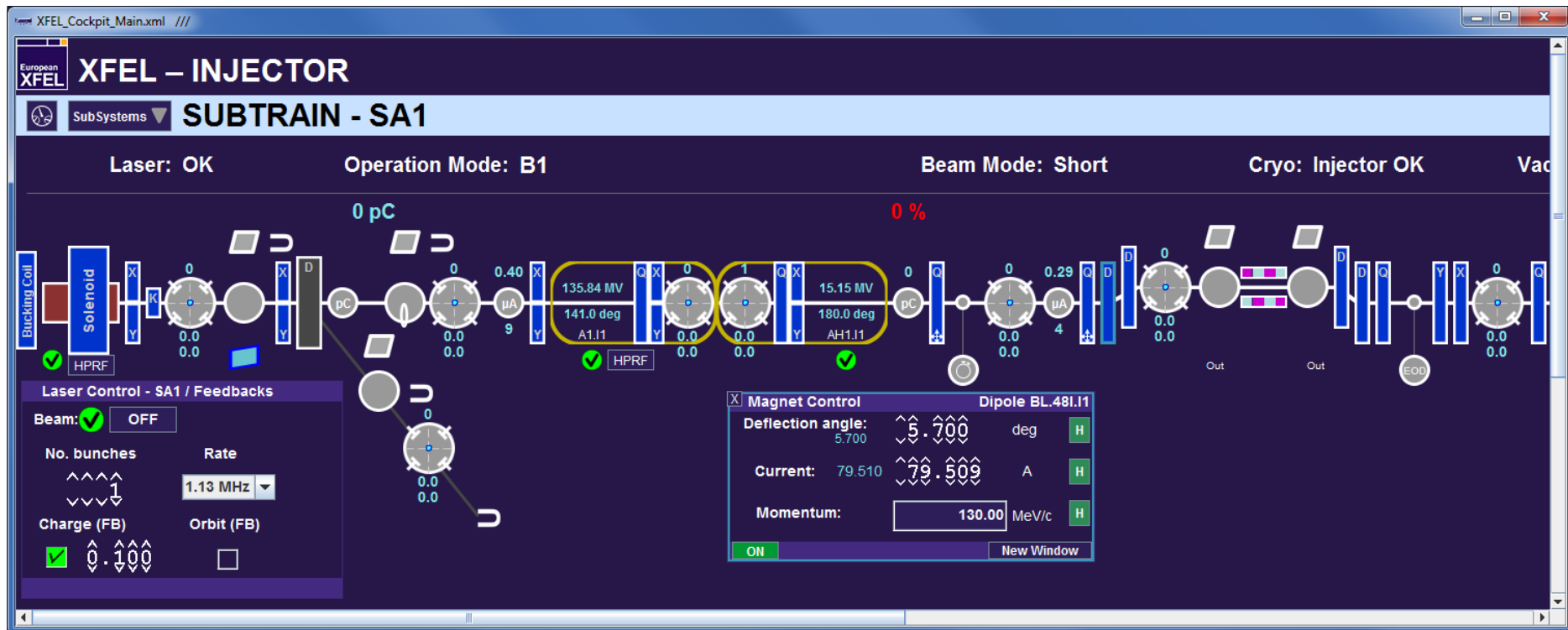
—



- 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.

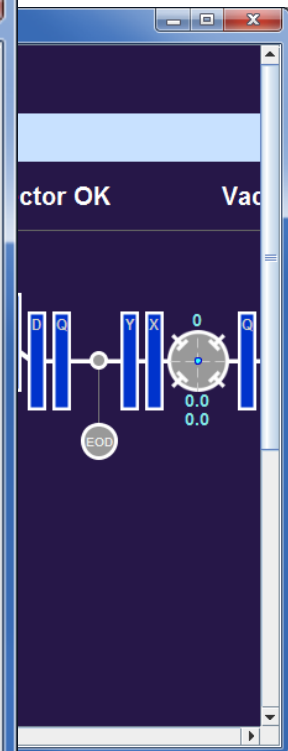
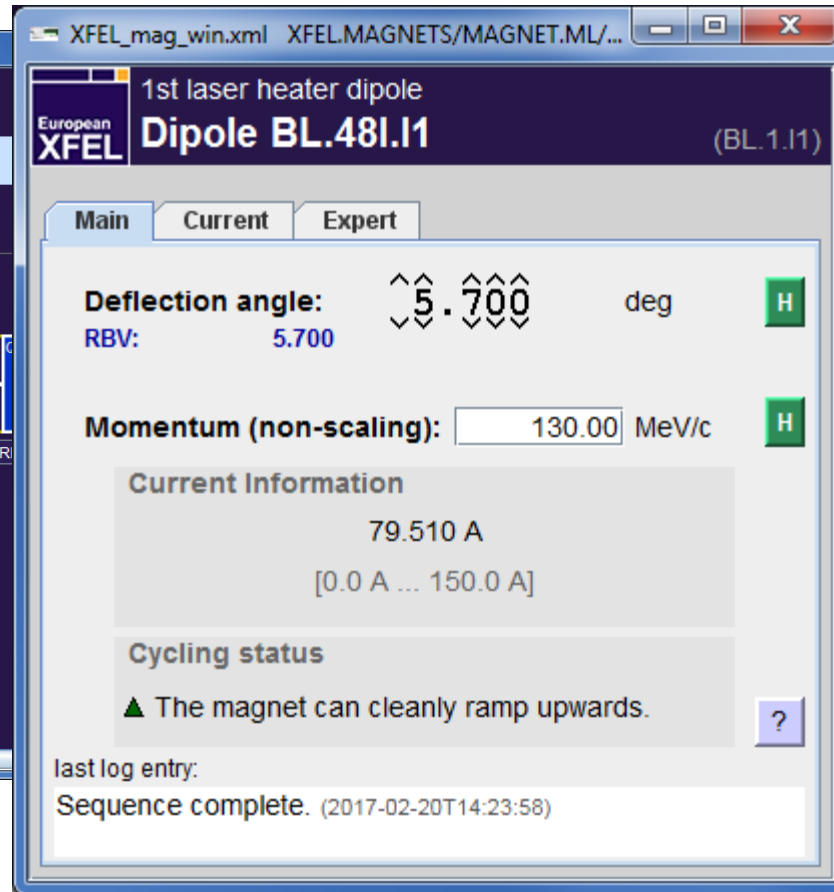
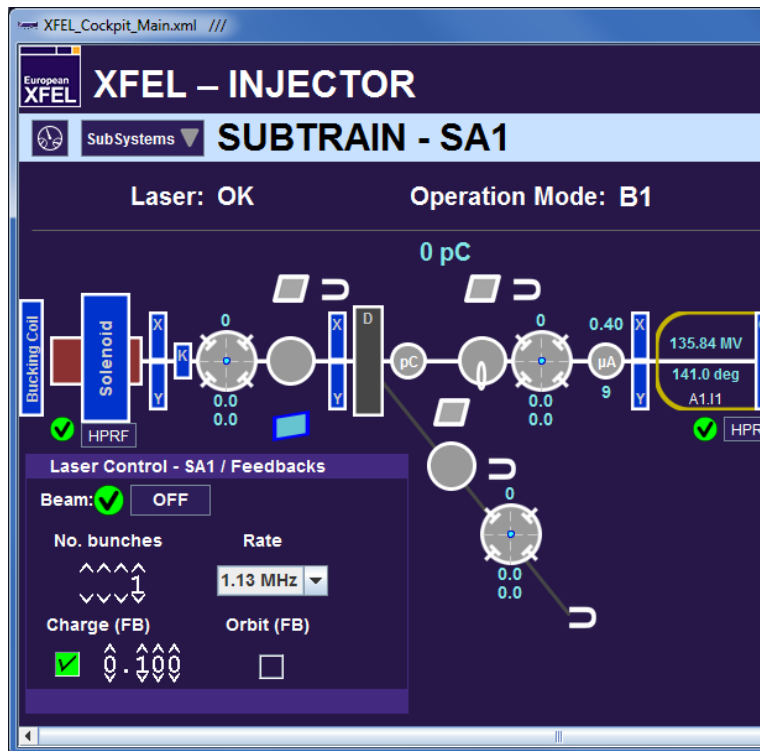
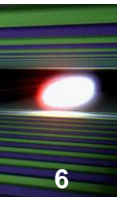
Controlling Magnets... From the Cockpit

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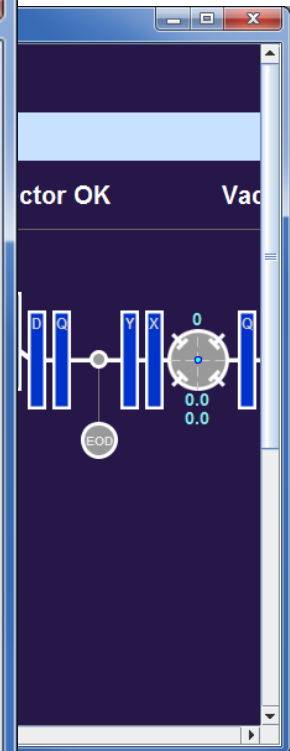
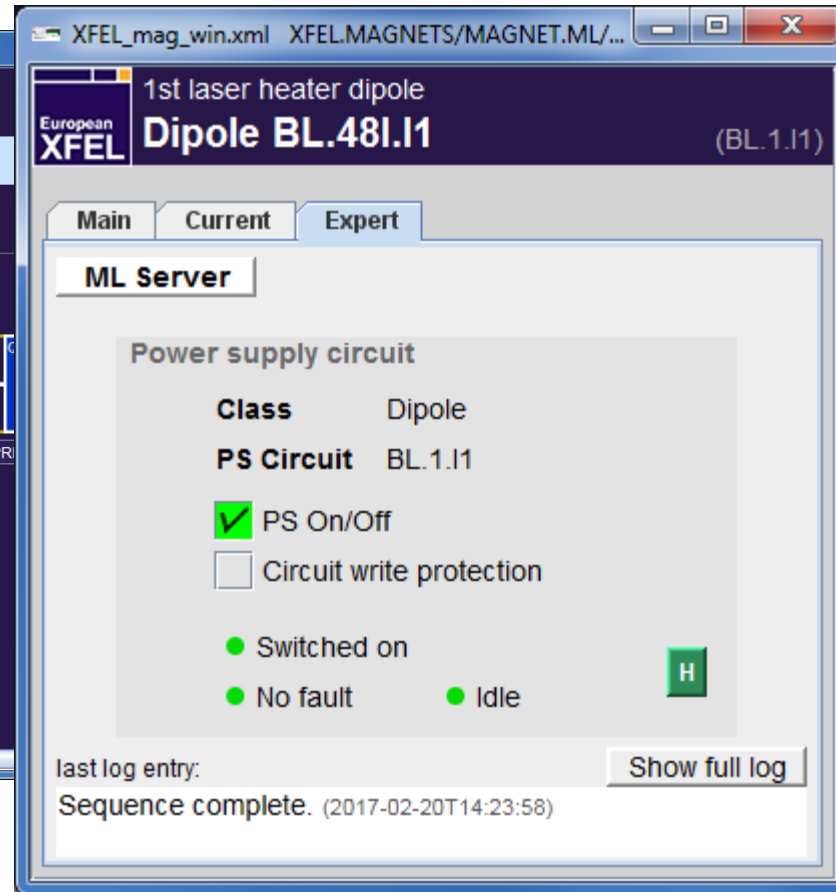
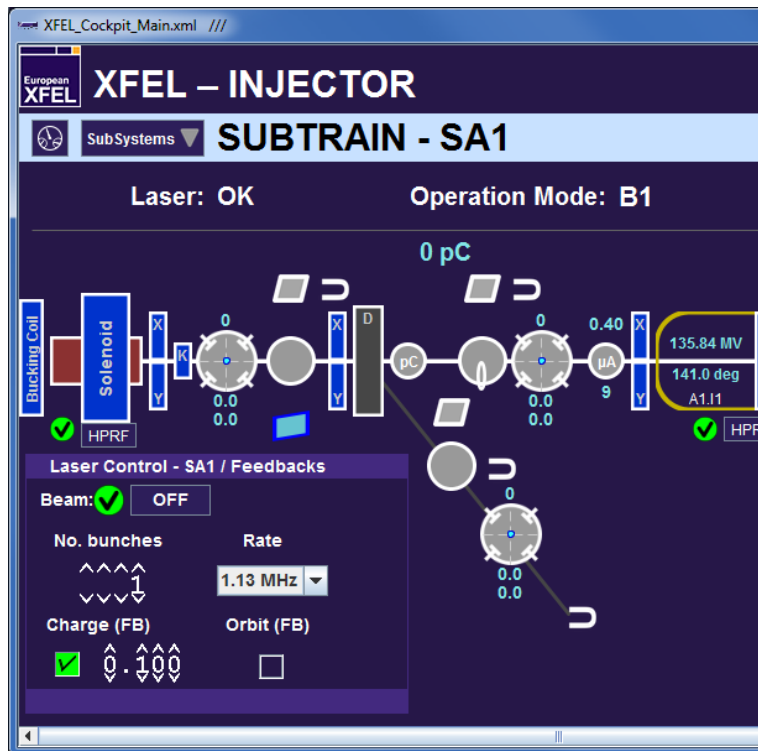
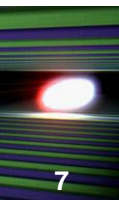


Controlling Magnets... From a Stand-Alone Panel

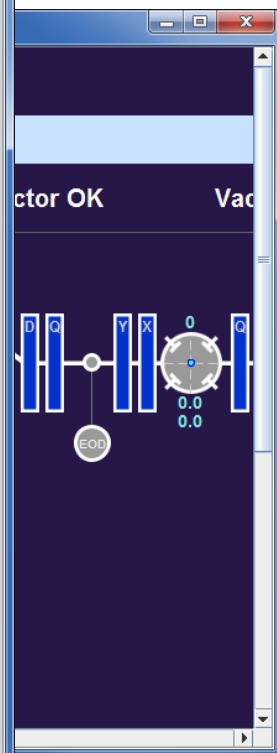
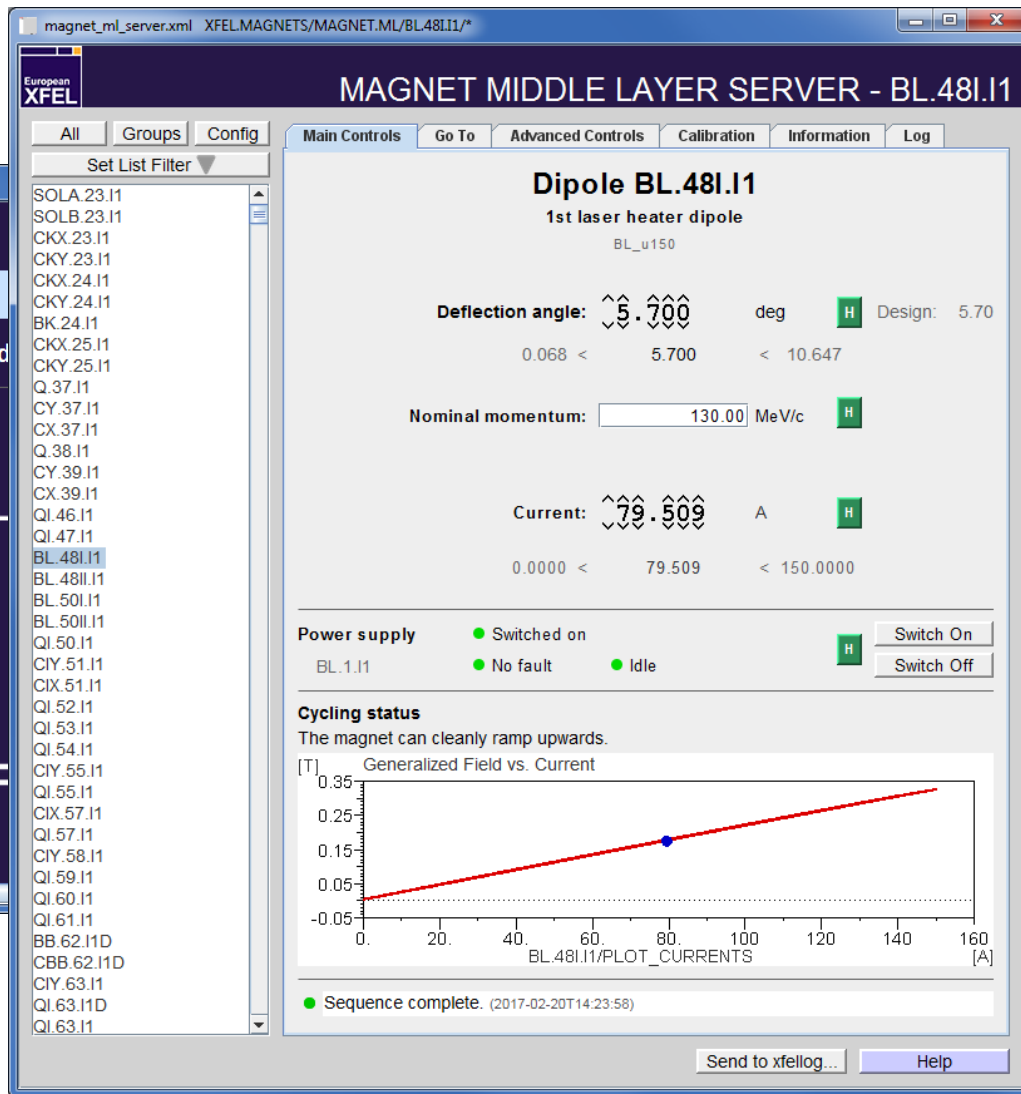
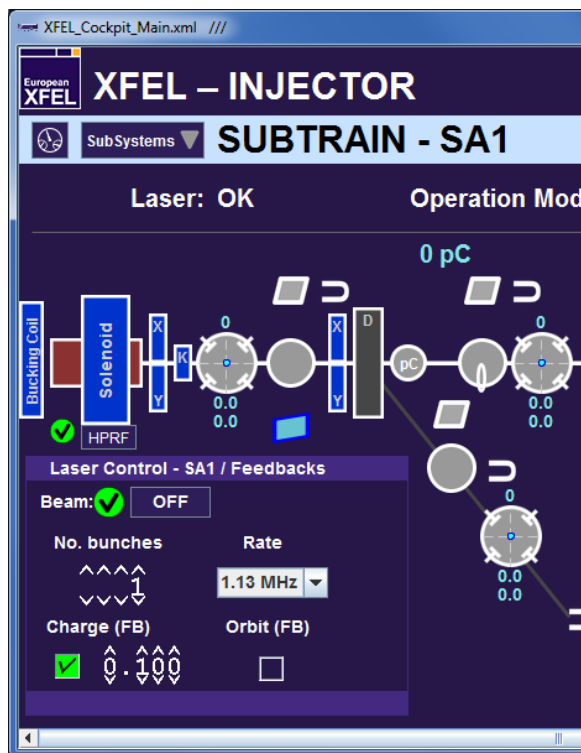
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Controlling Magnets... From a Stand-Alone Panel



Controlling Magnets... From the ML Server Panel



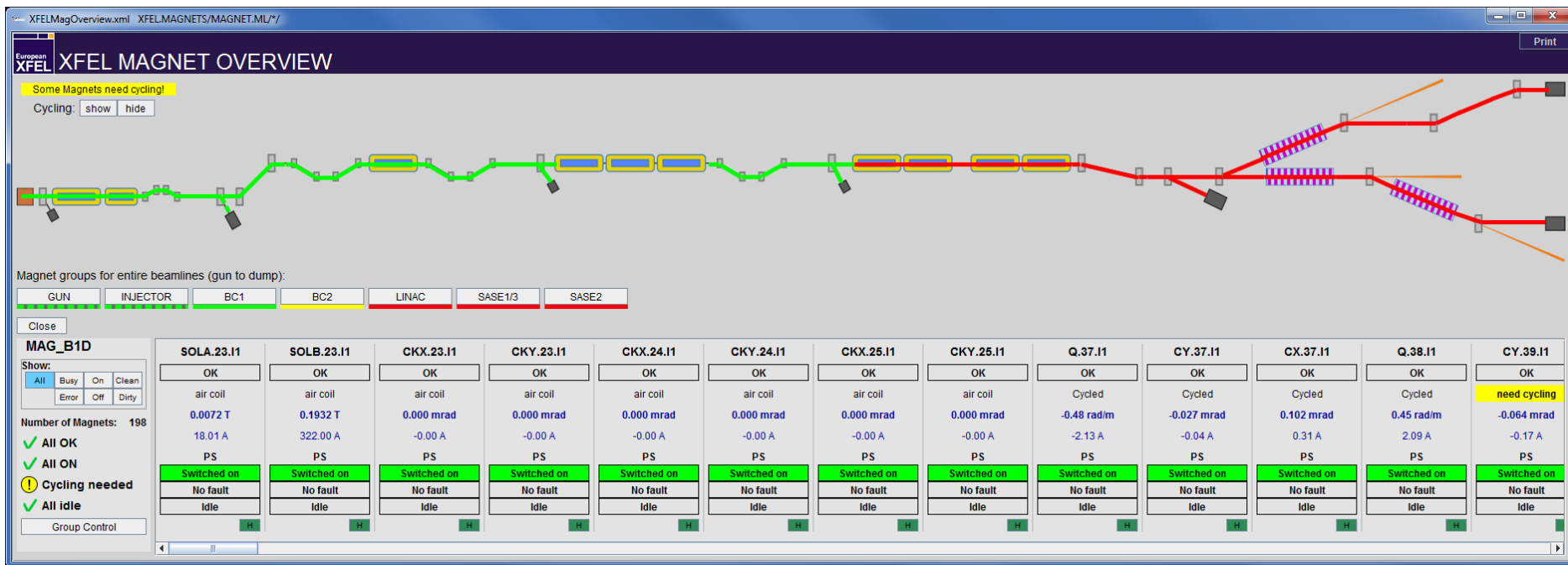
Main Taskbar > Magnets

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The screenshot displays the 'Main Taskbar (XFELMainTaskbar.xml)' window. The interface is organized into several sections:

- Top Bar:** Contains icons for Status, Operations, Procedures, Feedbacks, Automation, Diagnostics, Tools, MPS, Injector, RF, Orbit, Photons, Beam Dynamics, Magnets, Vacuum, Cryo, and Controls.
- Magnets Section:**
 - On the left, a 'Magnets' icon (headphones) is highlighted with a red arrow.
 - To its right, a list of functions: Overview, Magnet Server, and Magnet Energizer.
- Power Supplies Section:**
 - PS Monitoring & Control
 - PS Control (deprecated)
- Kickers Section:**
 - Inj1 Kickers (Exp)
 - Dark Current Kicker (Exp)
- Magnet Overview:** A large panel at the bottom showing a detailed schematic of the magnet layout, with various components highlighted in yellow and green.
- Status Bar:** At the bottom, it shows 'MCSW7BUER07 | 04.07.16 11:12:32 | Operations Mode [Betrachten] | Serveranwahl [Default] | (3)KeineInlDatei'.

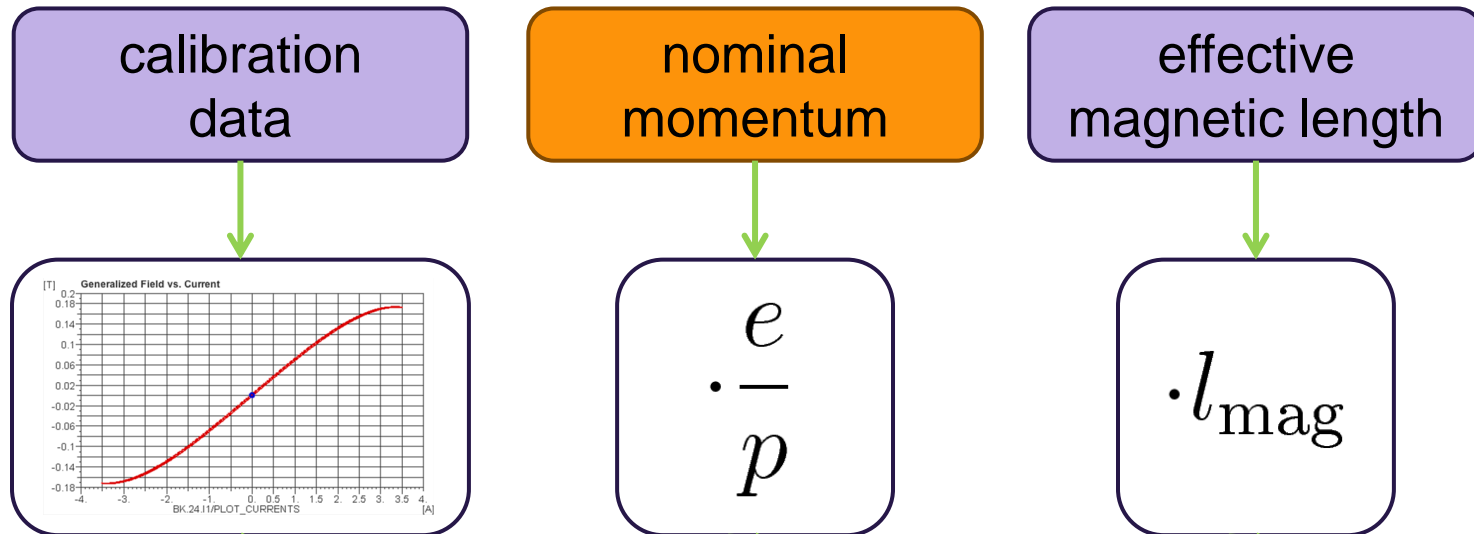
The Magnet Overview Panel



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

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

Magnet ML: Physical Parameters



current

(gen.) field

(gen.) strength

(gen.) kick

Dipole

Quadrupole

Sextupole

Octupole

[B] = T

[g] = T/m

T/m²

T/m³

[1/ρ] = 1/m

[k] = 1/m²

[m] = 1/m³

[r] = 1/m⁴

rad

rad/m

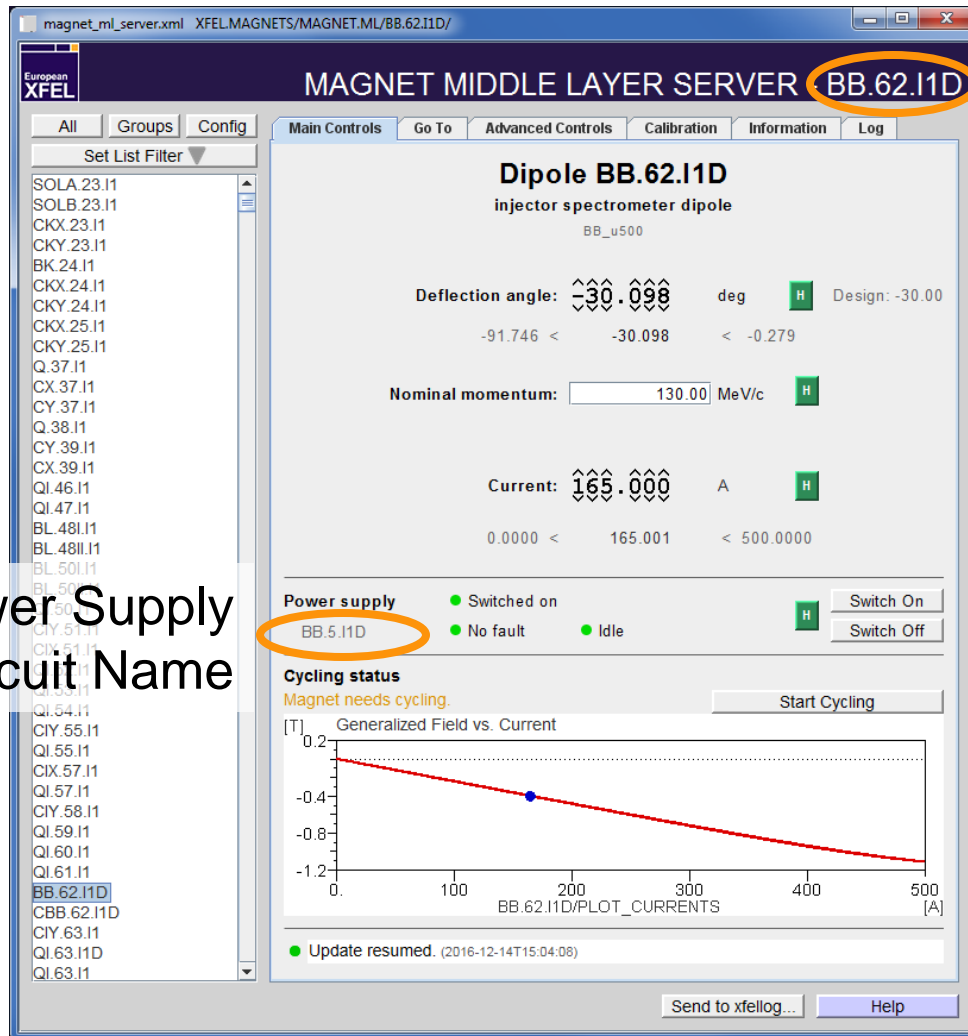
rad/m²

rad/m³

Magnet Middle Layer Server

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Power Supply
Circuit Name



Magnet Name

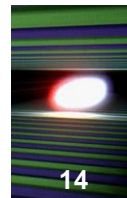
<type>.<zpos>.<section>

- 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:

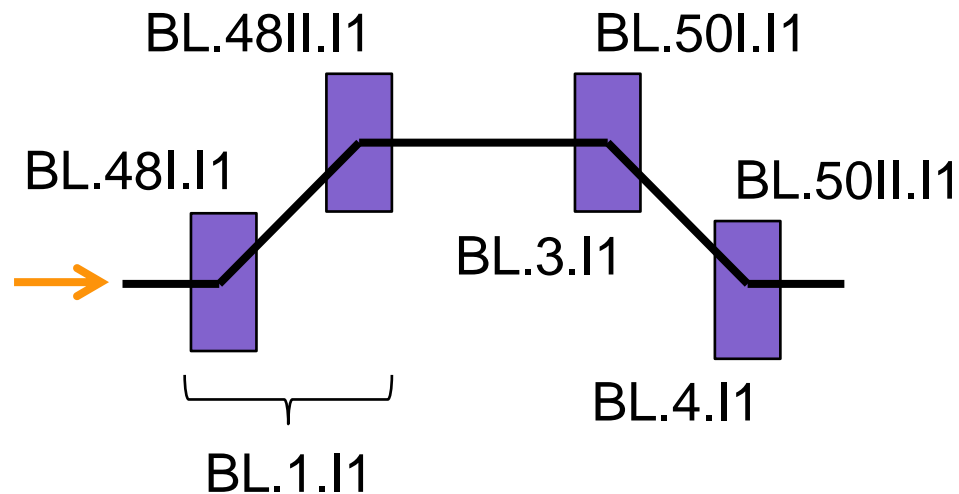
<type>.<ID>.<section>

Many Magnets Can Share The Same Circuit



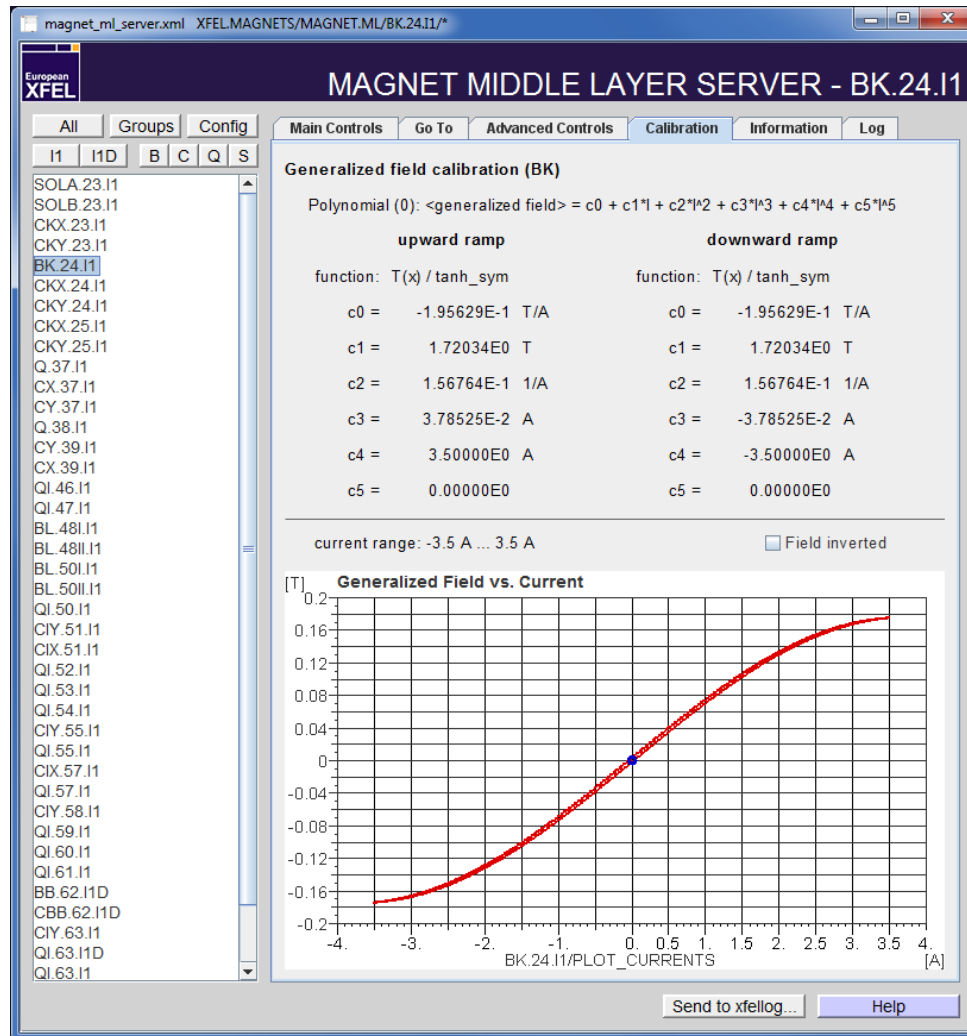
- There is one device for each magnet
- ... even if multiple magnets share the same power supply

Laser Heater Chicane

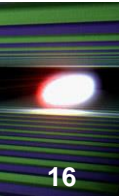


Magnet ML: Calibration & Hysteresis

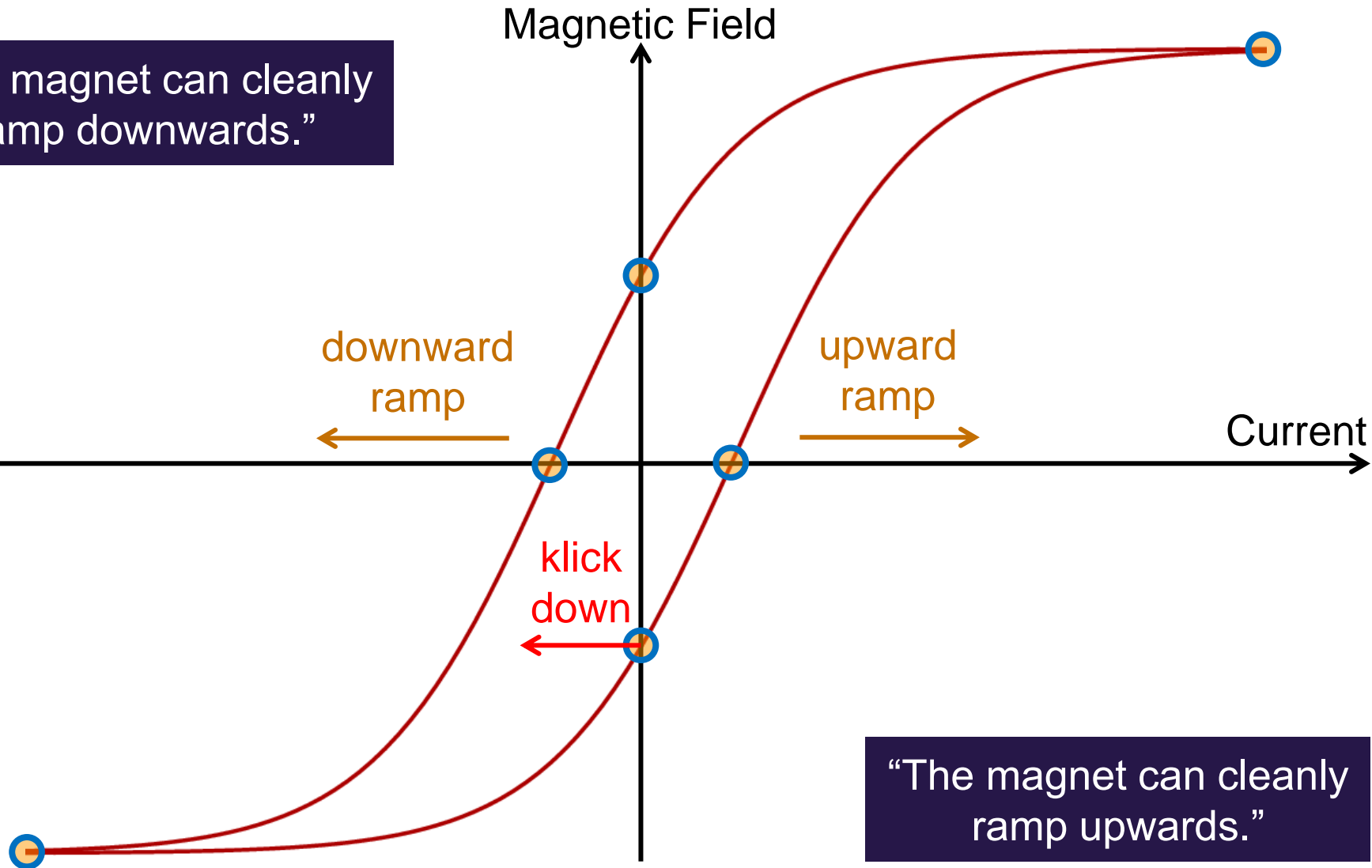
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Dealing with Hysteresis

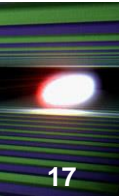


“The magnet can cleanly ramp downwards.”

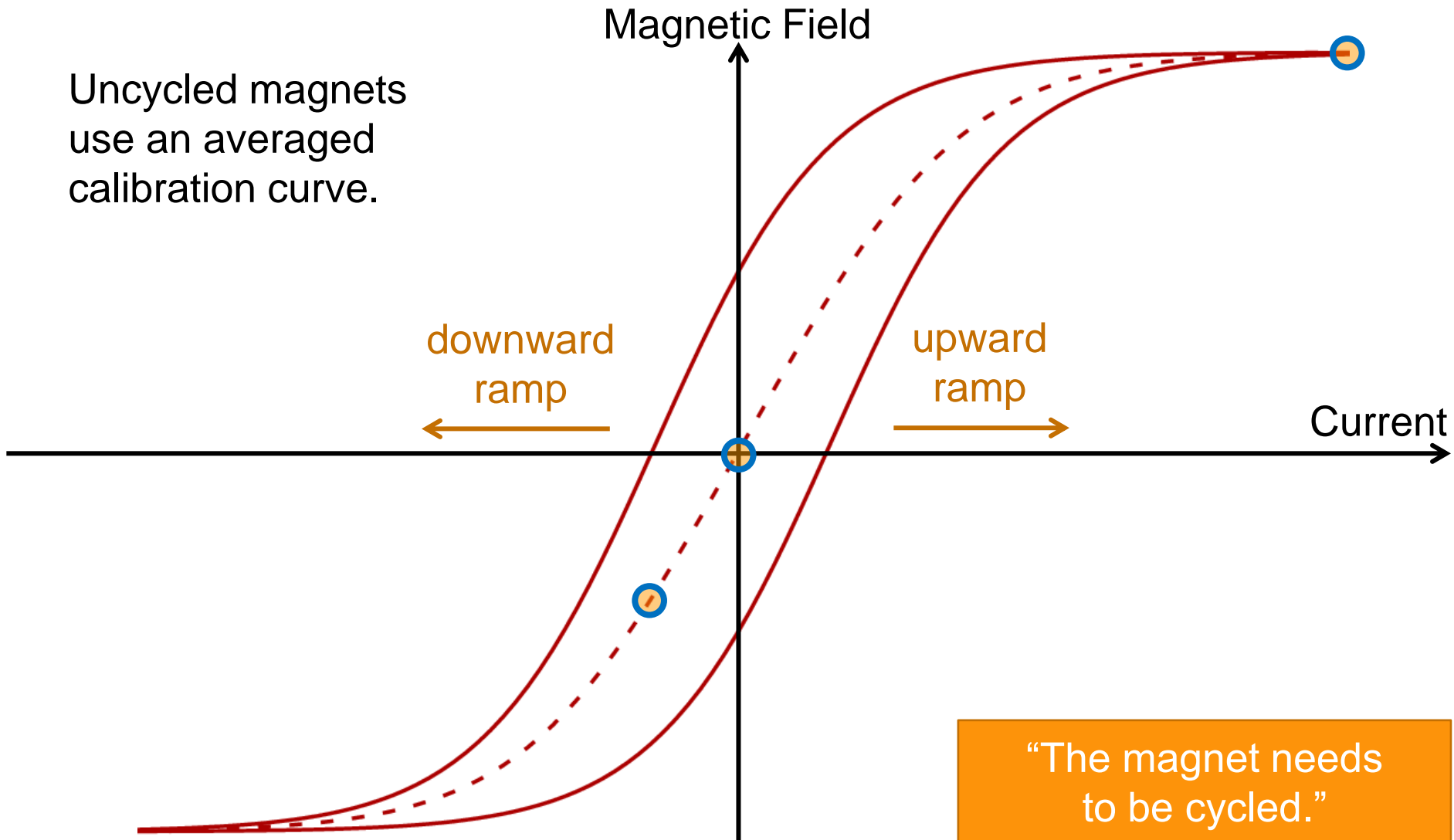


“The magnet can cleanly ramp upwards.”

Dealing with Hysteresis

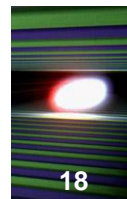


Uncycled magnets
use an averaged
calibration curve.



“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.

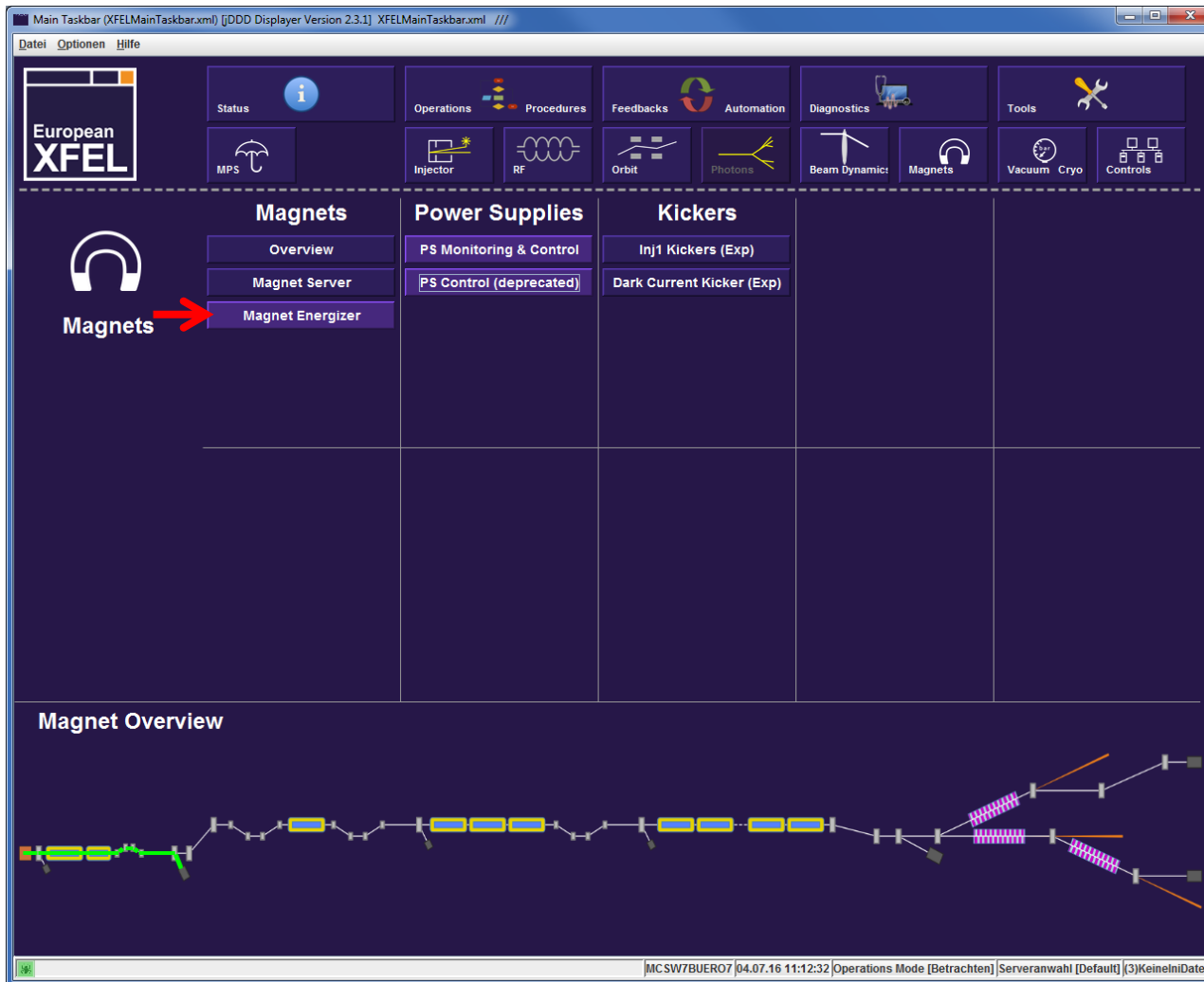
Magnetic Field

Current

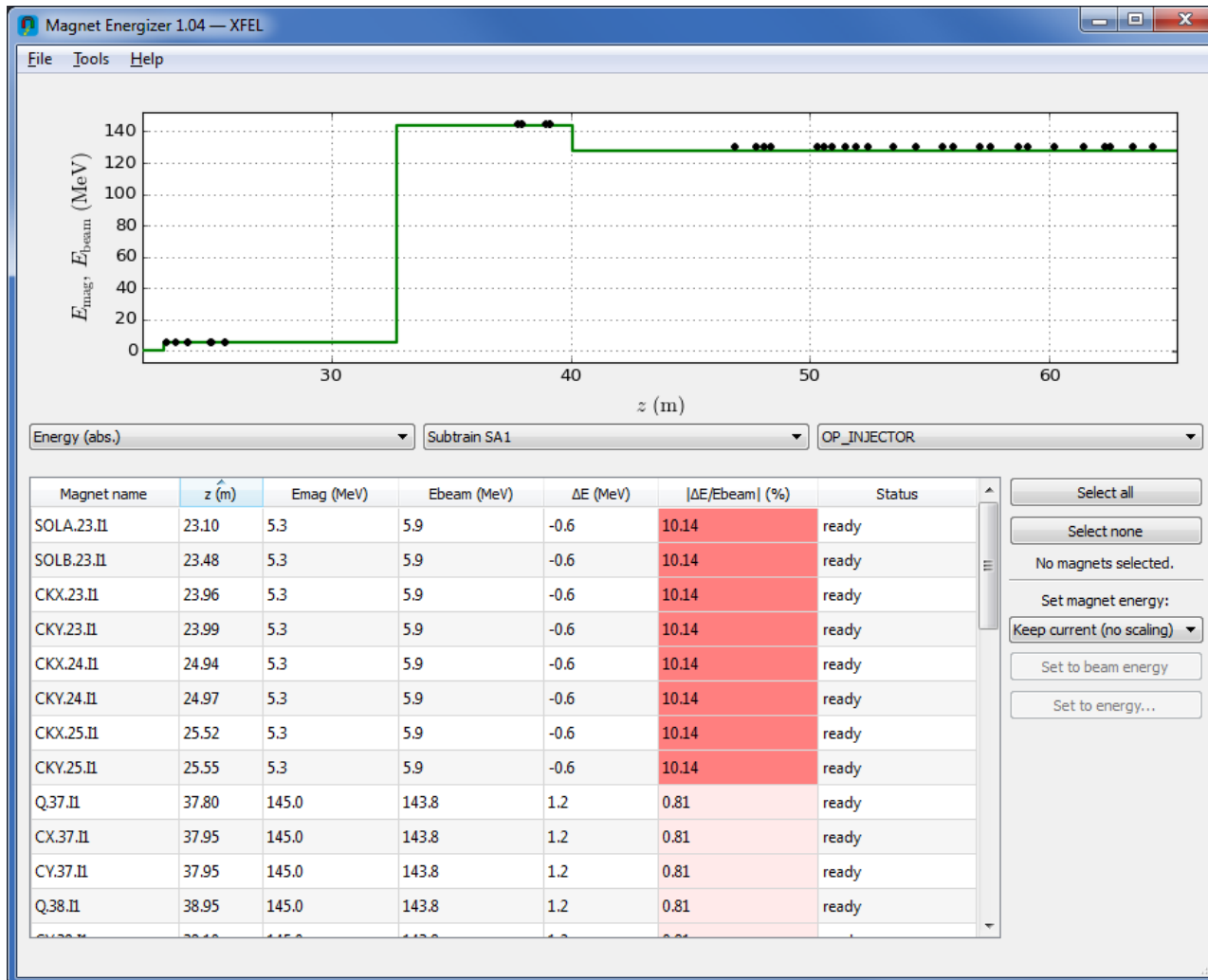
Degaussing (Demagnetization)

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

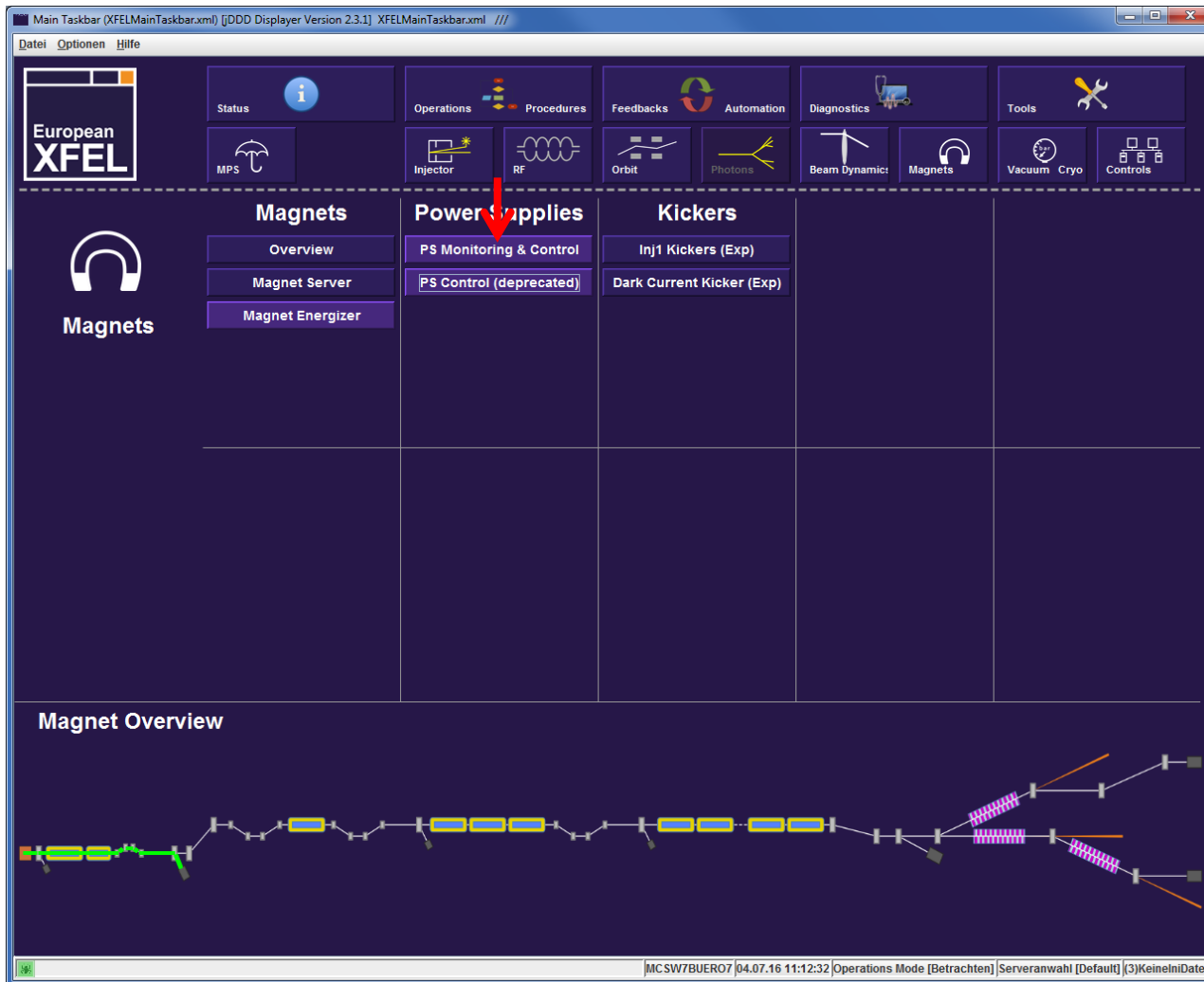
Main Taskbar > Magnets



Magnet Energizer



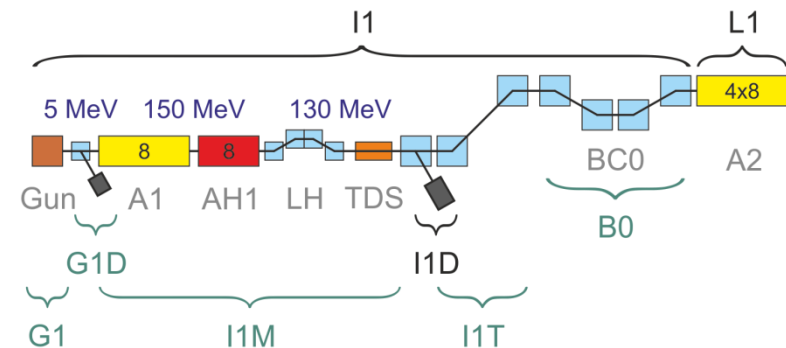
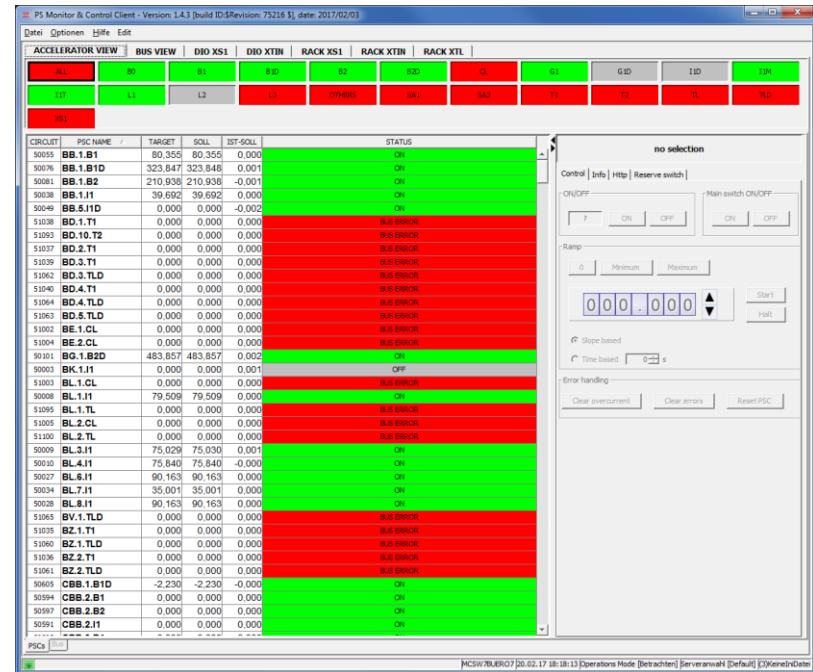
Main Taskbar > Magnets



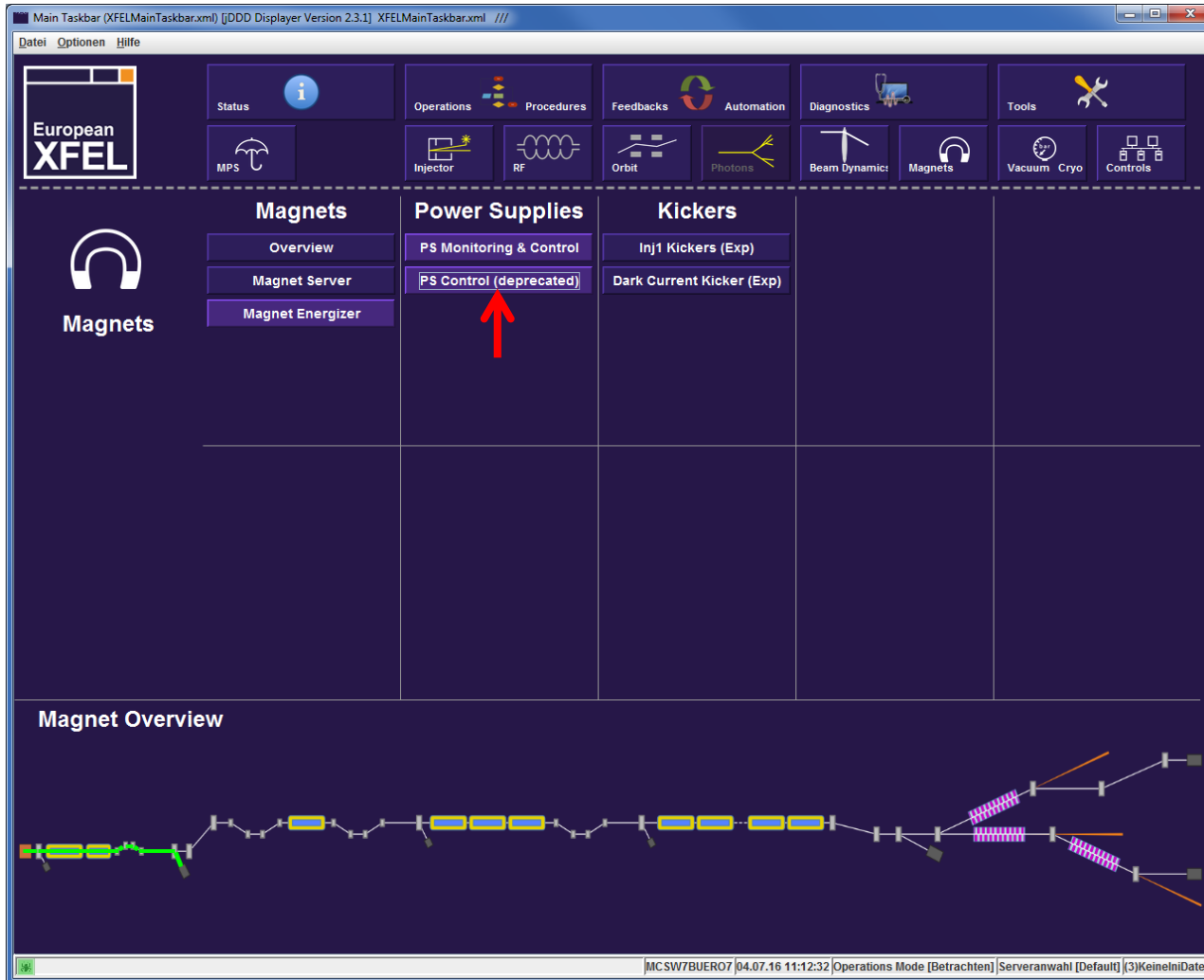
PS Monitor And Control ("PS MoCo")

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- 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

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- 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: Störung	0,0000	0,0000
50034	BL.7.I1	DIO Aus: Störung	0,0000	0,0011
50028	BL.8.I1	DIO Aus: Störung	0,0000	0,0000
50049	BB.5.I1D	Ein	166,3848	-0,0011
50075	QD.26.B1D	DIO Aus: Störung	0,0000	0,0011
50071	QD.20.B1	DIO Aus: Störung	0,0000	0,0008
50072	QD.21.B1	DIO Aus: Störung	0,0000	-0,0004
50073	QD.22.B1	DIO Aus: Störung	0,0000	200,0000
50074	QD.25.B1D	DIO Aus: Störung	0,0000	-0,0008
50060	QD.9.B1	DIO Aus: Störung	0,0000	0,0023
50065	QD.14.B1	DIO Aus: Störung	0,0000	200,0000
50066	QD.15.B1	DIO Aus: Störung	0,0000	0,0004
50067	QD.16.B1	DIO Aus: Störung	0,0000	0,0015
50038	BB.1.I1	DIO Aus: Störung	0,0000	0,0004
50053	QD.3.B1	DIO Aus: Störung	0,0000	-0,0011
50054	QD.4.B1	DIO Aus: Störung	0,0000	0,0008
50055	BB.1.B1	DIO Aus: Störung	0,0000	-0,0004
50082	QD.6.B2	DIO Aus: Störung	0,0000	-0,0019
50083	QD.7.B2	DIO Aus: Störung	0,0000	-0,0011
50077	QD.1.B2	DIO Aus: Störung	0,0000	0,0000
50078	QD.2.B2	DIO Aus: Störung	0,0000	-0,6416
50079	QD.3.B2	DIO Aus: Störung	0,0000	200,0000
50080	QD.4.B2	DIO Aus: Störung	0,0000	-1,5194
50076	BB.1.B1D	DIO Aus: Störung	0,0000	0,0011