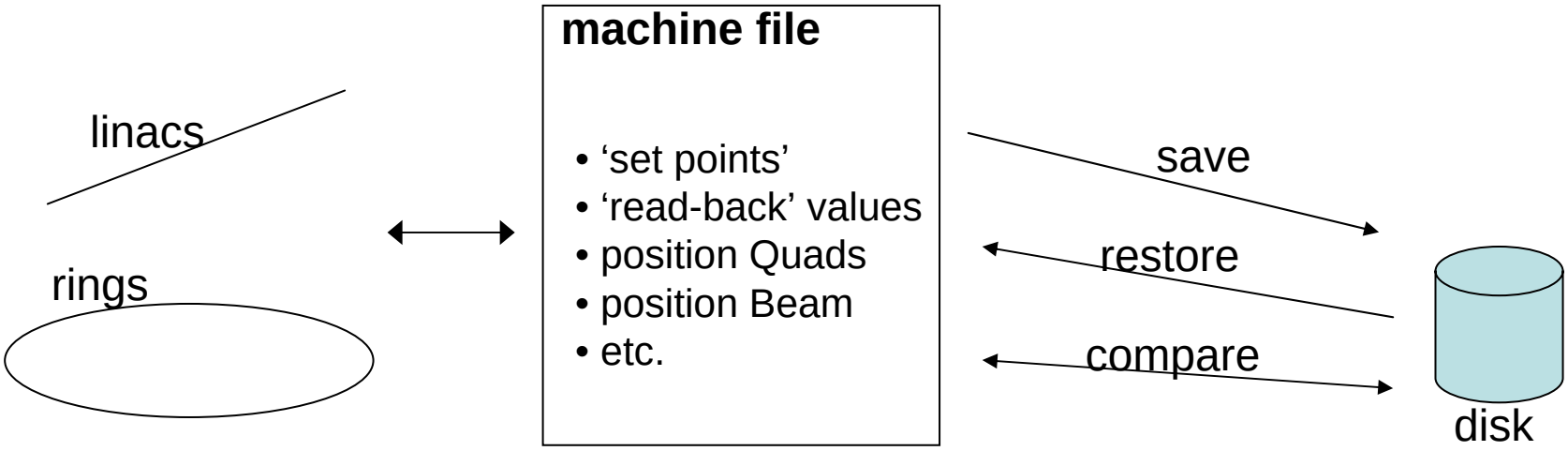
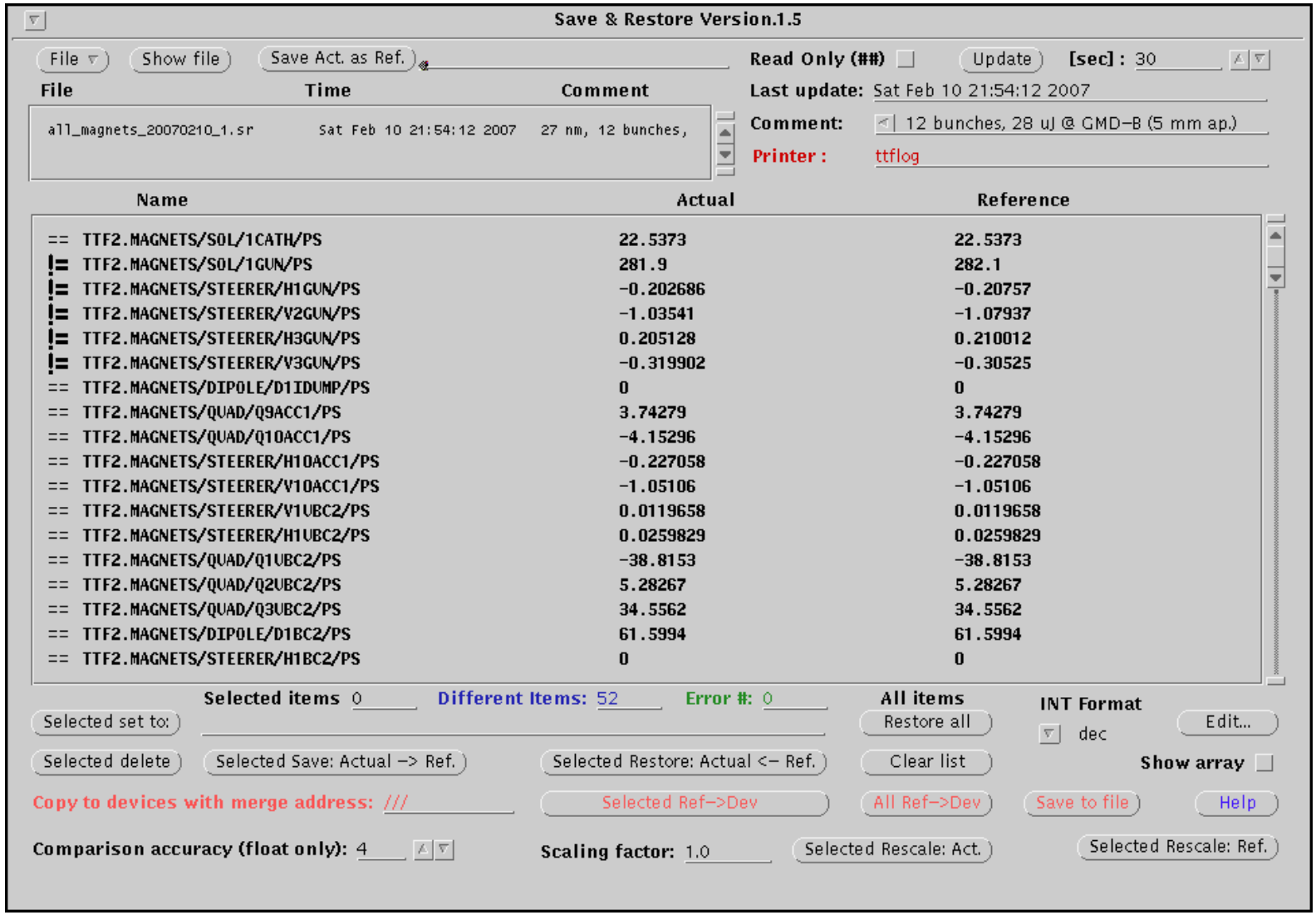
A more reproducible FLASH operation with the new machine file system

Jürgen Maass (MCS) and Pedro Castro (MPY)

Definition: "Machine file system"



There is an existing solution to read and save parameters:
Save & Restore program



Index:

- overview of the project
- four cases where the new file system can help you
- other features
- summary and outlook

Scope of this presentation:

- present the advantages of the new system
- present some new concepts
- open a long-term forum for discussion, exchange of ideas between users (operators), coordinators and programmers

out of scope:

- how to get a reproducible machine
- to demonstrate that the machine is more reproducible with this program
- which programming language, which file format, which server, etc

OVERVIEW OF THE PROJECT "FILE SYSTEM"

Goal: PETRA III

http://adweb.desy.de/mst/PETRA_III_Kontrollsystem/Projektplanung/Wbs/Betriebsautomatisierung.htm

Betriebsautomatisierung (Zustände, Abläufe, Freigaben)

Stand: 06.06.2007

Autor: R. Bacher

- **Verantwortliche Person**: J. Maass

Goal extension: also for FLASH

Collaboration:

MCS 1 : J. Maass, S. Herb
+
MCS 4 : K. Rehlich, R. Kammering, O. Hensler, E. Sombrowski, F. Teger
+
MPY : P. Castro

Goal extension: also for FLASH

Test alpha- or beta-versions in FLASH:

- early feedback from operators → easier to re-program
- FLASH operation can profit now

But:

- programs are not finished (only 10% done)
- programs have not all features
- programs can be full of bugs (please, report them to us)

Advantages of a common software for all machines:

- extensive tests by FLASH → less bugs for PETRA III
- operators needs to learn how to use ONE program
- only ONE program to maintain

But:

- control systems are different
- machines are really different (have different requirements)

- *PETRA Prozeduren:*
  - ***Transportwegoptimierung und Injektion***:
    - kritisch ist die vertikale Ebene
  - ***Rampen:***
    - keine große Rampzyklen mit Strahl mehr,
    - Zyklen in Gruppen oder alle Magnete zusammen, gegenseitige Beeinflussung beachten
  - ***Beulen:***
    - aller Art,
    - zur Feinabstimmung mit Strahl
  - ***Korrektur der Orbitstörungen beim Undulator Fahren***:
    - möglicherweise über statische Tabellen die im Undulator integrierten Korrekturspulen nachfahren (Feedforward),
    - Tune nachziehen,
    - Zusammenhang Beschleuniger (Orbit) und Beamlines (Photonenstrahllage) beachten
  - ***langsames Orbitfeedback:***
    - < 0.1 Hz,
    - möglicherweise müssen die Korrekturtabellen vom Kontrollsystem dynamisch angepasst werden
  - ***Füllmuster:***
    - verschiedene Muster,
    - Bunchzahl variiert zwischen 40 / 960 auf Wochen- bzw. Monatsbasis,
    - möglicherweise auch andere Füllmuster gewünscht ("Hybridmodus")
  - ***Top-Up Betrieb:***
    - Schnittstelle und Regelloop zu /mit MSK
  - ***Übergeordnete Funktionen des Autopilots:***
    - routinemäßiger Strahlbetrieb,
    - Optimierung nach Wartungstagen und/oder Kurzreparaturen,
    - Aufsetzen des Beschleunigers und Einbinden von Matlab Prozeduren (z.B. Messung der Chromatizität) → MPY
  - ***Optik:***
    - Optik → Maschine (Stromliste),
    - Maschine (Stromliste) → Optik
  - ***Referenzorbits:***
    - in Abhängigkeit vom Füllmuster
  - ***Alarme:***
    - umfangreiches und konsistentes Alarmsystem,
    - ? Erzeugung von Voralarme, damit rechtzeitig reagiert werden kann,
    - Fehler bei den Vorbeschleunigern müssen innerhalb weniger Minuten behoben sein,
    - Operatorerfahrungen mit Alarmsystemen bei HERA, PETRA, DORIS und den Vorbeschleunigern dokumentieren und einfließen lassen
  - ***Freigaben:***
    - ? ? Permit System

Four cases where the new file system can help you

Case 1) which file should I use?

1) list of files:

…
all_magnets_20070312_4.sr
all_magnets_20070313_1.sr
all_magnets_20070314_1.sr
all_magnets_20070314_2.sr
all_magnets_20070314_3.sr
all_magnets_20070314_5.sr
all_magnets_20070315_1.sr
all_magnets_20070315_2.sr
all_magnets_20070315_3.sr
all_magnets_20070315_4.sr
all_magnets_20070315_5.sr
all_magnets_20070315_6.sr
all_magnets_20070315_7.sr
all_magnets_20070315_8.sr
all_magnets_20070326.sr

which one is good?

for bypass or for SASE?

which wavelength? how much SASE?

taken with beam?

---

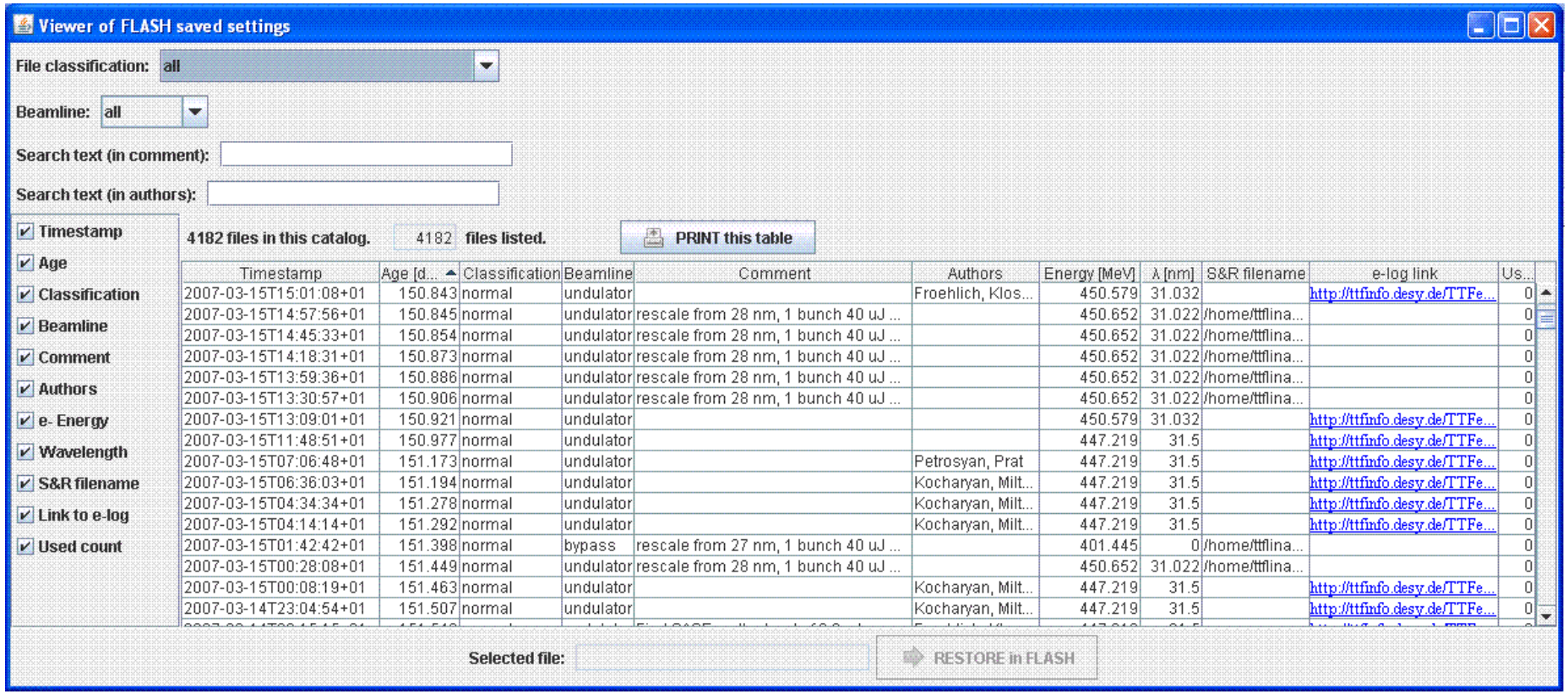
total: 4000 + 1500 files saved in FLASH

/home/ttflinac/save_restore/Magnets/
- Cycling/
- References/ --> magnets_*_reference.sr (6 files)
- autosaved/ ------> all_Magnets_2007* (507 files)
  - 2006/ ------> all_Magnets_2006* (860 files)
  - old_data/ ------> saved_2006* (254 files)
- machine-setup/ ------> setup_* (2004) (10 files)
- old/ --> "040505_100MeV_Transm2End.sr" (7 files)
- run01-04/ ------> all_magnets_04* (35 files)
  - ------> inj_magnets_04* (35 files)
- run02-04/ ------> all_magnets_2004* (210 files)
  - ------> all_magnets_2002* (1 file)
  - Injector/ ----> injector_magnets_* (13 files)
- run01-05/ ------> all_magnets_2005* (640 files)
- run02-05/ ------> all_magnets_2005* (175 files)
- run03-05/ ------> all_magnets_2005* (57 files)
  - ---> magnets_*_reference.sr (6 files)
- run01-06/ ------> all_magnets_2006* (327 files)
  - ------> all_magnets_2005* (2 files)
- run02-06/ ------> all_magnets_2006* (583 files)
  - ---> magnets_*_reference.sr (6 files)
- run03-06/ ------> all_magnets_2006* (124 files)
- run01-07/ ------> all_magnets_2007* (145 files)

/home/ttflinac/save_restore/Micromovers/
- autosaved/ --> uMovers_2006* (863 files)
  - --> uMovers_2007* (505 files)
- run-Sep-2005-May-2006/ --> all_magnets_20051206_1.sr (1 file)
  - --> all_uMOVERs_2005* (22 files)
  - --> all_uMOVERs_2006* (80 files)
  - Old_direction/ --> all_uMOVERs_2005* (25 files)
  - old_files/ --> motor_mmpos_SP_2005* (7 files)
- MultiKnob/
- Optics/
- Orbit/
- RESCALINGTEST/ --> all_magnets_2006* (2 files)
- References/
  - reference_for_WL/ --> all_magnets_2006* (14 files)
    - --> all_uMOVERs_2006* (13 files)

1) list of files: THE SOLUTION

File browser / Catalog viewer



Timestamp	Age [d...	Classification	Beamline	Comment	Authors	Energy [MeV]	λ [nm]	S&R filename	e-log link	Us...
2007-03-15T15:01:08+01	150.843	normal	undulator		Froehlich, Klos...	450.579	31.032		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T14:57:56+01	150.845	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T14:45:33+01	150.854	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T14:18:31+01	150.873	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T13:59:36+01	150.886	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T13:30:57+01	150.906	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T13:09:01+01	150.921	normal	undulator			450.579	31.032		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T11:48:51+01	150.977	normal	undulator			447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T07:06:48+01	151.173	normal	undulator		Petrosyan, Prat	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T06:36:03+01	151.194	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T04:34:34+01	151.278	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T04:14:14+01	151.292	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T01:42:42+01	151.398	normal	bypass	rescale from 27 nm, 1 bunch 40 uJ ...		401.445	0	/home/ttflina...		0
2007-03-15T00:28:08+01	151.449	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T00:08:19+01	151.463	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-14T23:04:54+01	151.507	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0

Case 2) I need SASE at 24.5 nm,
which file should I use?

2) you need SASE at (for example) 24.5 nm

phone the run-coordinator

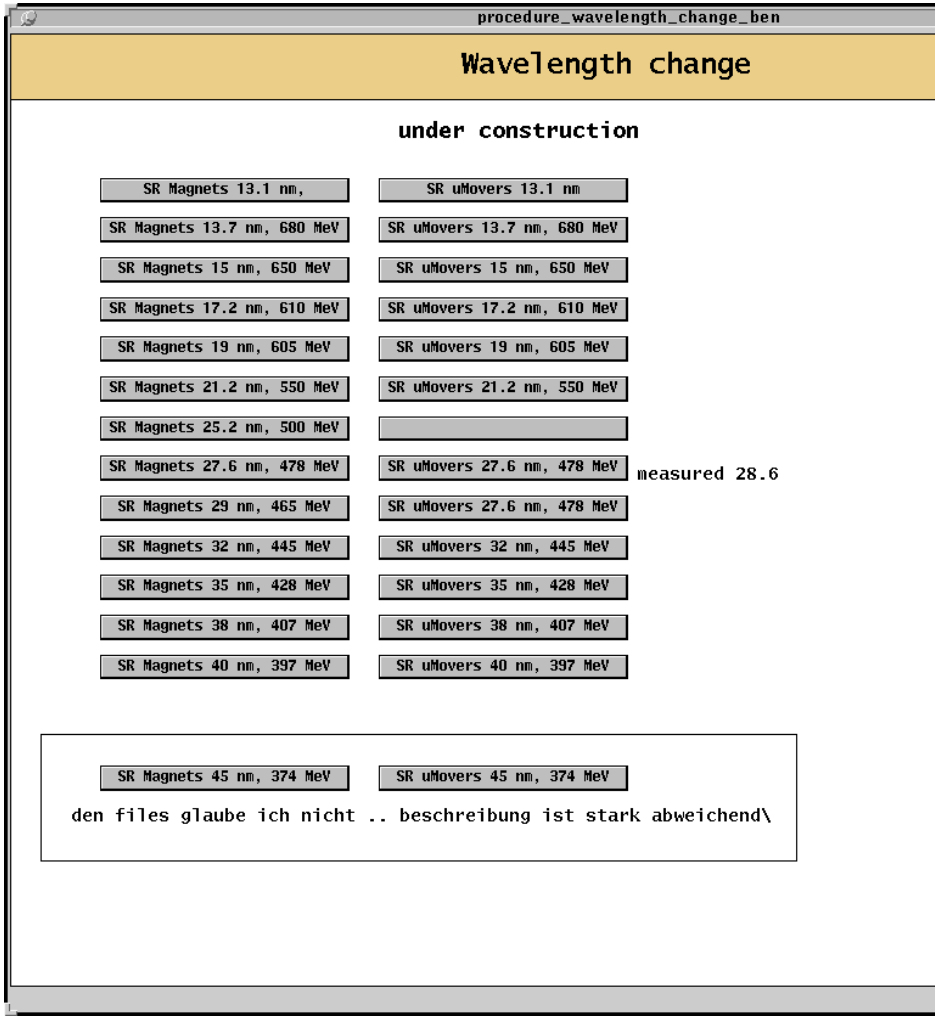
ask E. Schneidmiller

look in ddd panel (B. Polzin)

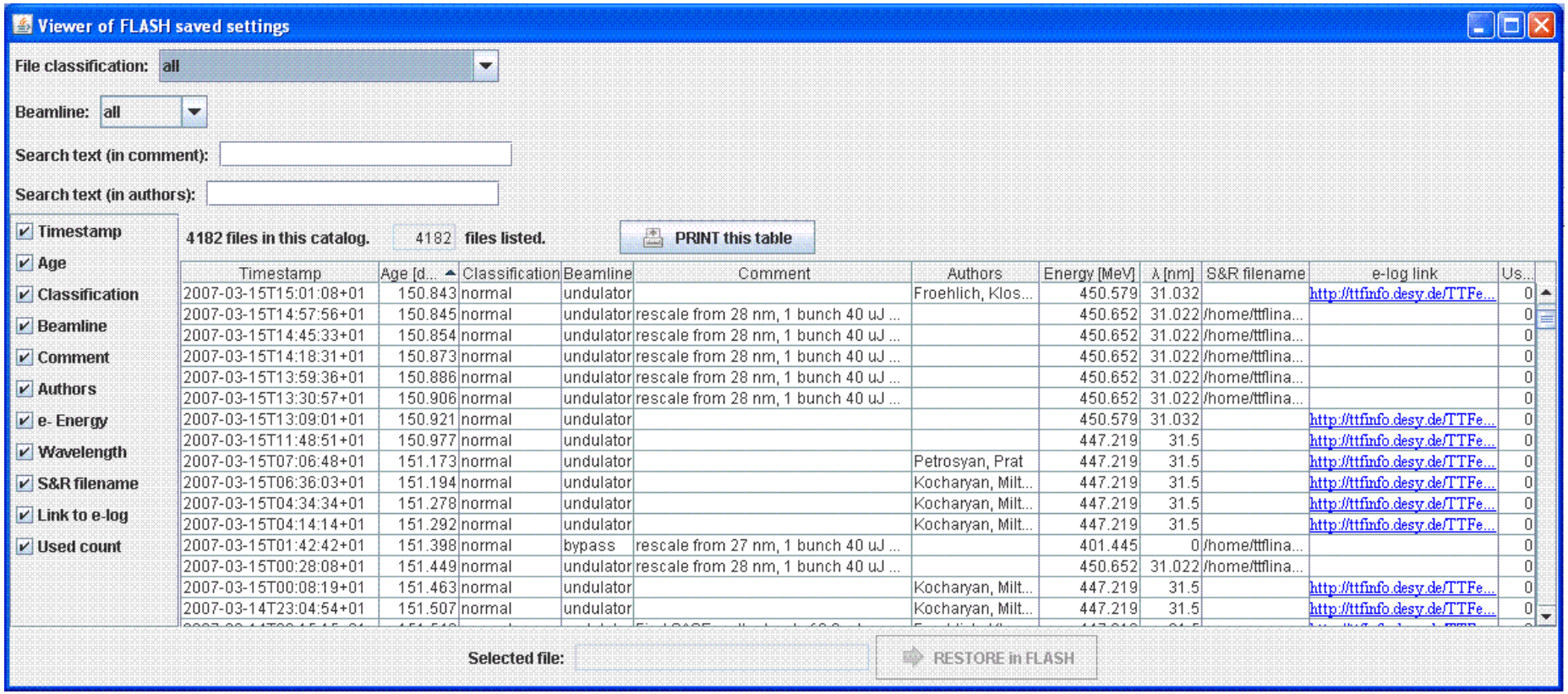
or

search in e-logbook

(good luck!)



2) you need SASE at (for example) 24.5 nm: THE SOLUTION



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2007-03-15T11:48:51+01	150.977	normal	undulator			447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T07:06:48+01	151.173	normal	undulator		Petrosyan, Prat	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T06:36:03+01	151.194	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T04:34:34+01	151.278	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T04:14:14+01	151.292	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-15T01:42:42+01	151.398	normal	bypass	rescale from 27 nm, 1 bunch 40 uJ ...		401.445	0	/home/ttflina...		0
2007-03-15T00:28:08+01	151.449	normal	undulator	rescale from 28 nm, 1 bunch 40 uJ ...		450.652	31.022	/home/ttflina...		0
2007-03-15T00:08:19+01	151.463	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0
2007-03-14T23:04:54+01	151.507	normal	undulator		Kocharyan, Milt...	447.219	31.5		http://ttfinfo.desy.de/TTFe...	0

+

select a wavelength (range) (to be implemented)

+

sort by SASE level or by date

Case 3) How close is the machine to the status described in a given logbook entry?

08.03.2007 22:51 ttflinac — **Main linac parameters**

Laser

```
Number of bunches ..... 15
Bunch frequency ....... 100 kHz
Macropulse rep'rate .... 5 Hz
Flashlamp current ..... 2
Flashlamp start time ... 2.16 ms
Attenuator SP ......... 5488
Iris diameter ......... 1.95 mm
Piezo Voltage ......... 4.944 V
```

Gun

```
Feedforward/Feedback ... on/on
Pfwd SP ................ 3.25
Phase SP ............... -112.68 deg
Pfwd (peak) ............ 3.509 MW
Prefl (peak) ........... 1.711 MW
Pfwd (sample point 700)  3.6264 MW
Prefl (sample point 700) 0.053319 MW
Flat top ............... 200 us
Water temperature SP ... 60.31 deg C
Main solenoid .......... 294.6953 A
Bucking coil ........... 26.0018 A
Gun dipole ............. 0 A
Charge 3GUN(Tl) ........ 0.91614 nC
```

ACC1

```
Feedforward/Feedback ... on/on
Pfwd SP ................ 15.21
Phase SP ............... 176.9183
Pfwd C1.ACC1 ........... 54.1813 kW
Pfwd C5.ACC1 ........... 251.9692 kW
Flat top ............... 100 us
Beam loading comp. (BLC) off
BLC current/duration ... 0.8 mA/70 us
Dipole BC2 ............. 61.5994 A
Pyro 9DBC2 ............. -0.060908 V
Radiator 9DBC2 ......... open
```

ACC2/3

```
DSP trigger rate ....... 5 Hz
Feedforward/Feedback ... on/on
Pfwd SP ................ 21.9
Phase SP ............... 88.7419
Pfwd C5.ACC2 ........... 0.1567 kW
Pfwd C1.ACC3 ........... 0.09197 kW
Flat top ............... 188 us
Beam loading comp. (BLC) off
BLC current/duration ... 0.8 mA/600 us
Dipole BC3 ............. 40.694 A
Pyro 14BC3 ............. -0.097174 V
Pyro 4DBC3 ............. -0.065883 V
Radiator 4DBC3 ......... open
```

ACC4/5

```
DSP trigger rate ....... 5 Hz
Feedforward/Feedback ... on/on
Pfwd SP ................ 18.06
Phase SP ............... 178.7218
```

Collimator

```
Dipole D1ECOL .......... 122.4912 A
Energy dogleg .......... 691.8683 MeV
```

3) with a logbook entry, how to compare values?

08.03.2007 22:51 ttflinac — **Main linac parameters**

Laser
Number of bunches 15
Bunch frequency ..... 100 kHz
Macropulse rep'rate .... 5 Hz
Flashlamp current 2
Flashlamp start time ... 2.16 ms
Attenuator SP 5488
Iris diameter ..... 1.95 mm
Piezo Voltage ..... 4.944 V

Gun
Feedforward/Feedback ... on/on
Pfwd SP 3.25
Phase SP ..... -112.68 deg
Pfwd (peak) ..... 3.509 MW
Prefl (peak) ..... 1.711 MW
Pfwd (sample point 700) 3.6264 MW
Prefl (sample point 700) 0.053319 MW
Flat top ..... 200 us
Water temperature SP ... 60.31 deg C
Main solenoid ..... 294.6953 A
Bucking coil ..... 26.0018 A
Gun dipole ..... 0 A
Charge 3GUN(T1) ..... 0.91614 nC

ACC1
Feedforward/Feedback ... on/on
Pfwd SP 15.21
Phase SP 176.9183
Pfwd C1.ACC1 ..... 54.1813 kW
Pfwd C5.ACC1 ..... 251.9692 kW
Flat top ..... 100 us
Beam loading comp. (BLC) off
BLC current/duration ... 0.8 mA/70 us
Dipole BC2 ..... 61.5994 A
Pyro 9DBC2 ..... -0.060908 V
Radiator 9DBC2 ..... open

ACC2/3
DSP trigger rate ..... 5 Hz
Feedforward/Feedback ... on/on
Pfwd SP 21.9
Phase SP 88.7419
Pfwd C5.ACC2 ..... 0.1567 kW
Pfwd C1.ACC3 ..... 0.09197 kW
Flat top ..... 188 us
Beam loading comp. (BLC) off
BLC current/duration ... 0.8 mA/600 us
Dipole BC3 ..... 40.694 A
Pyro 14BC3 ..... -0.097174 V
Pyro 4DBC3 ..... -0.065883 V
Radiator 4DBC3 ..... open

ACC4/5
DSP trigger rate ..... 5 Hz
Feedforward/Feedback ... on/on
Pfwd SP 18.06
Phase SP 178.7218
Pfwd C1.ACC4 ..... 0.05278 kW
Pfwd C2.ACC5 ..... 0.000939 kW
Flat top ..... 185 us
Beam loading comp. (BLC) off
BLC current/duration ... 0.8 mA/660 us

Collimator
Dipole D1ECOL ..... 122.4912 A
Energy dogleg ..... 691.8683 MeV

Bypass
Dipole D1BYP ..... 0 A
Energy bypass ..... 2.6006 MeV

Dump
Dipole D1DUMP ..... 133.5912 A
Dipole D6DUMP ..... 147.0176 A
Radiation level (wall) . 163 counts/ms

Feedbacks
Charge feedback ..... off
Charge feedback SP ..... 0.2 nC
PTO feedback ..... on

Magnets saved to:
/home/ttflinac/save_restore/Magnets/autosaved/all_Magnets_20070308T225118.sr
uMovers saved to:
/home/ttflinac/save_restore/Micromovers/autosaved/uMovers_20070308T225122.sr
Orbit reference saved in
/home/ttflinac/bin/matlab/orbit_stability/2007-03-08T225123-orbit-stability

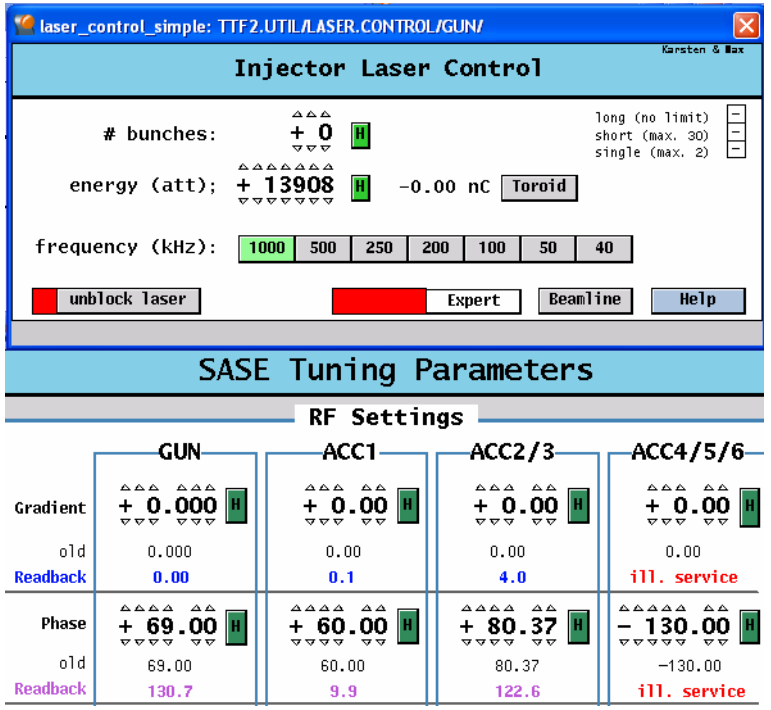
open magnet currents (with SR)

open magnet positions (with SR)

open ref. orbit (with orbit display)

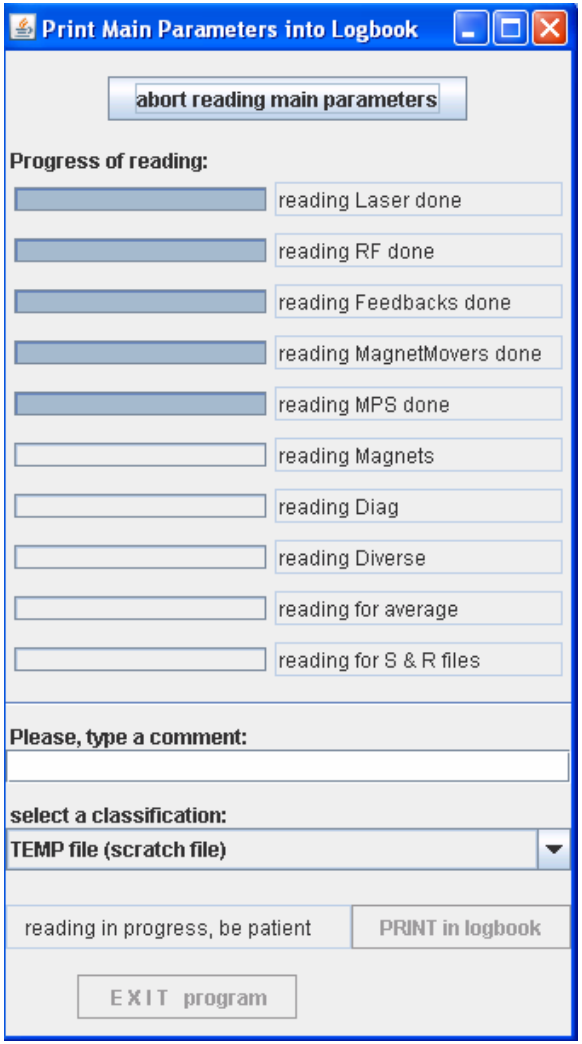
and

compare 'visually' with ddd panels

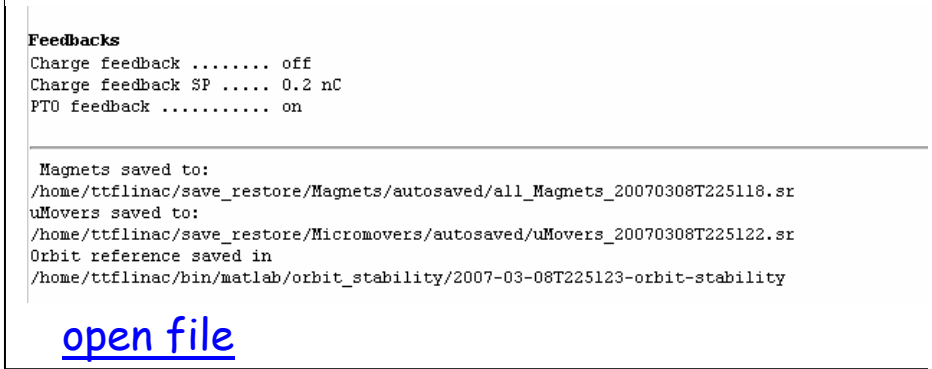


3) with a logbook entry, SOLUTION to compare values

the new program to print into logbook:



saves all parameters into file
and prints



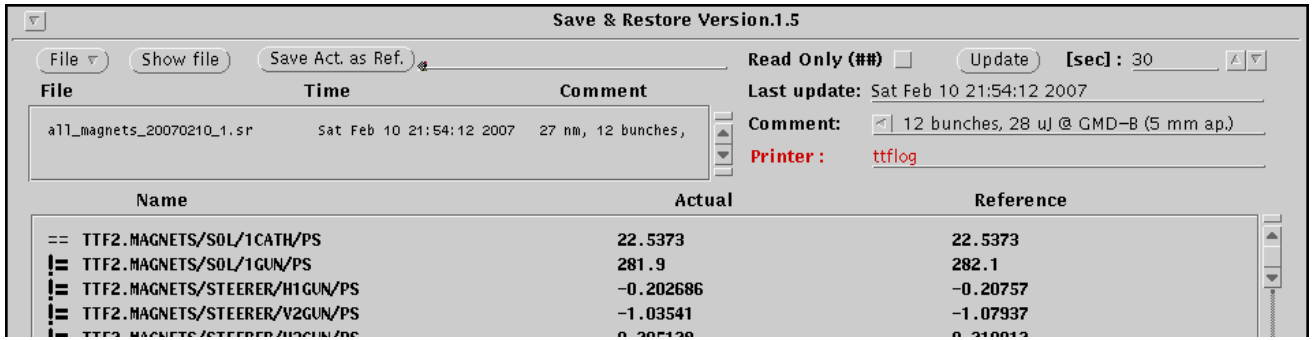
button to start program
to view and compare values (to be implemented)

3) with a logbook entry, SOLUTION to compare values

the new program to compare values (not yet available)

- compare file values and present values

(in a similar way as SR:)



new features:

- compare values between two files
- compare values with 'individual tolerances'

example: steerer V6DBC2: 1 bit = 0.1 mA

dipole D6DUMP: 1 bit = 6.4 mA

- sort parameters by device, property, z position, diff., etc.

Case 4) how to restore magnet currents?

4) restore magnet currents

Manual procedure (example for FEL beamline):

1) stop beam and dark current
2) switch on D1IDUMP, D1BYP, D14SEED
3) set D1BYP to 60 A
4) restore currents (except D1BYP)
5) cycle magnets (except D1BYP)
6) cycle D1BYP to zero field

THE SOLUTION

use of sequencer (to be implemented):

sequences are written and tested by experts

operator starts the sequencer by selecting a file and the corresponding sequence

Other features

File classification

temp file: for temporary data or scratch data or data was edited/changed
(beam is off or some systems are off)

normal file: there is beam (good transmission)

reference file: official file for routine operation
(a coordinator recommends the use of this file)

special file: special settings for machine studies, tests, etc.

optics file: values calculated from optics programs

Useful data missing in the files?

cycling status → magnetic field reproducibility

toroid values → bunch charge transmission

photomultipliers → beam losses

… and more

THE SOLUTION:

the parameter list can be extended by system experts

the parameter are grouped:

Magnets, MagnetMovers, RF, Laser, Feedbacks, Diagnostics

each group has a 'template file'

template file contains a list of parameters to save

Summary and outlook

- a new file system is being developed in a MCS-MPY collaboration

- it is 'universal' : same for all machines (rings and linacs)

- FLASH can already now profit from it (partially)

- feedback (bug reports, ideas) from users is very welcome

Main features:

- easy to search for files

- compare file-to-present status or file-to-file

- run procedures (with the sequencer)

- run in Unix, Linux, Windows, … (at the moment only in Sun)

Thank you for your attention

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