DESY: From High Energy Physics to Synchrotron Radiation

Accelerator Operation in a changing Environment

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DESY: From High Energy Physics to Synchrotron Radiation

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HELMHOLTZ ASSOCIATION

DESY

Vocabulary

DESY: **D**eutsche **E**lektronen-**Sy**nchrotron, Hamburg, Germany

DORIS, PETRA, HERA: Storage rings at DESY

TTF, FLASH, XFEL: FELs at DESY

Content

The History of DESY

1959: Foundation of DESY

1964: 6 GeV Synchrotron, fixed target

1966: First experiments with synchrotron radiation

1974: Storage ring DORIS, e^+/e^- collider, 2 x 6 GeV
1978: Storage ring PETRA, e^+/e^- collider, 2 x 23.5 GeV

1981: 15 beamlines at DORIS, 'parasitic' use by HASYLAB
1990: DORIS becomes a dedicated light source

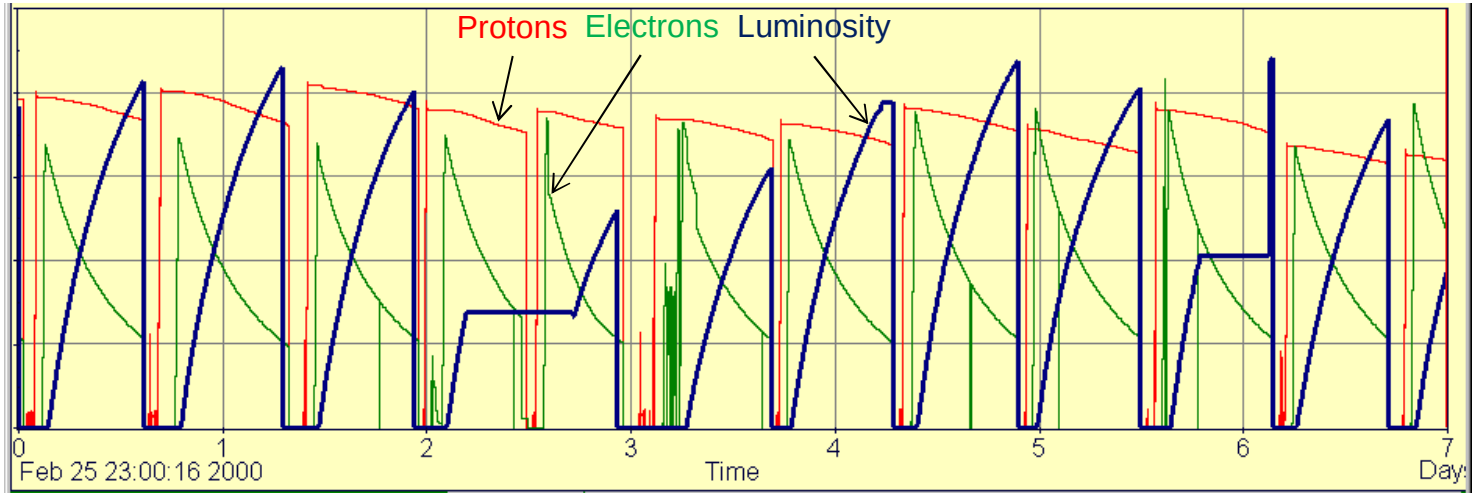
1992: Storage ring HERA, p^+/e^- collider, 920 / 27.5 GeV

1995: One beamline at PETRA, 'parasitic' use by HASYLAB
2000: VUV SASE FEL lases at 100 nm
2003: VUV SASE FEL becomes FLASH, a user facility
2007: Shutdown of HERA
2009: PETRA becomes a dedicated light source
2012: XFEL under construction

The History of DESY

Operation of a Collider Ring

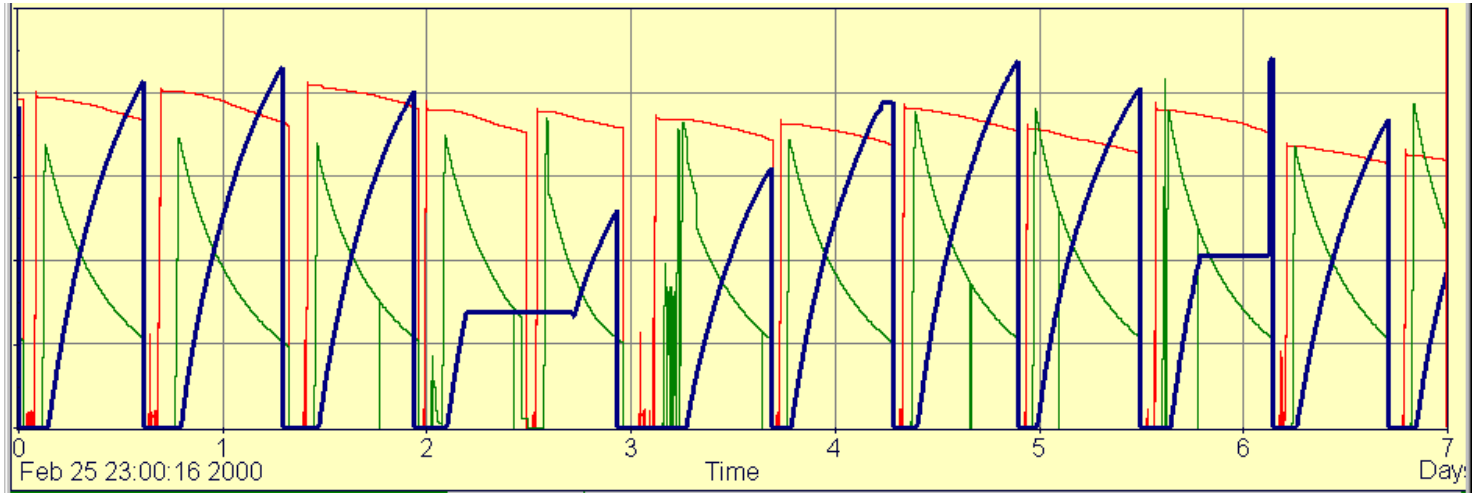
HERA Luminosity Operation:



Run Time 8 – 15 hours
Fill Time 3 – 5 hours
Lumi Efficiency ~ 75 %
Figure of Merit: Integrated Luminosity

Operation of a Collider Ring

Luminosity Operation for Operators:

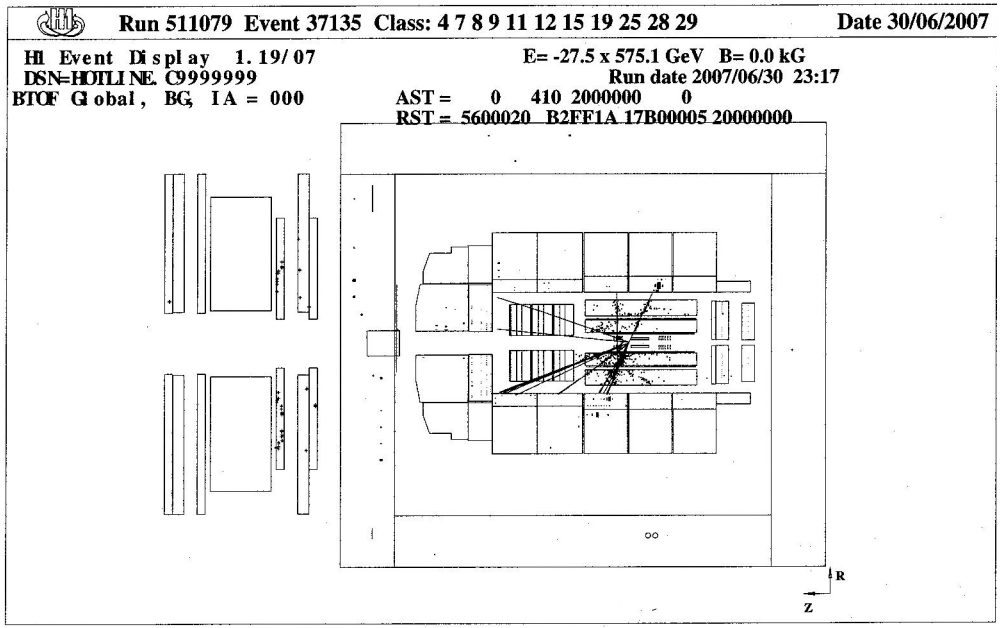


One or two fills per day

- 3 – 5 hours of hard work for ~ 3 people
- Well known procedures
- Constant training on the job
- Quick learning curve

Operation of a Collider Ring

HERA Luminosity Operation:

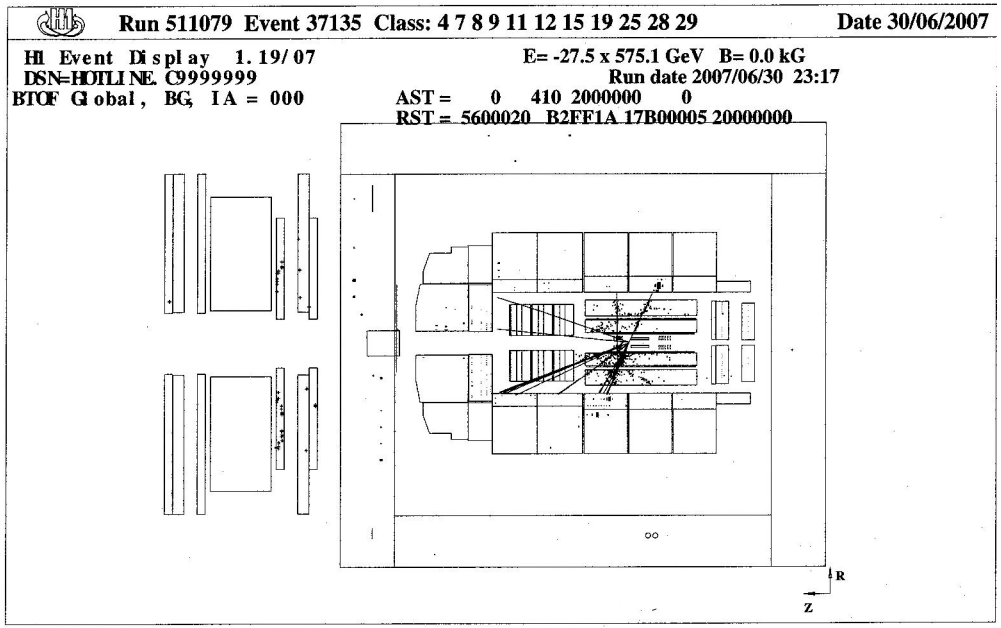


Constant struggle:
Luminosity vs. Background

- bad betatron tunes, coupling, chromaticity
- bad collimator positions
- huge beam emittance
- side bunches (particles in the next rf buckets)
- coasting beam
- bad orbit
- synchrotron radiation
- off energy particles
- many other reasons…

Operation of a Collider Ring

Luminosity Operation for Operators:



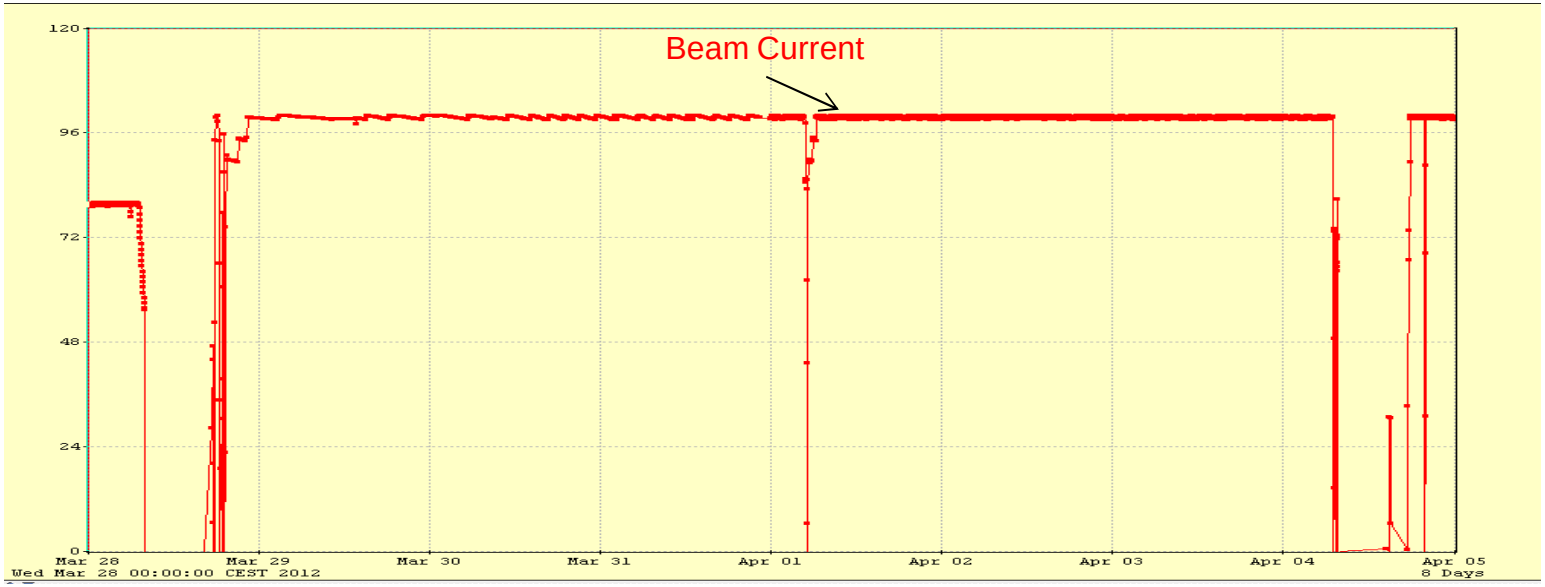
Constant attention required

- ➡ Quick learning curve
- ➡ Shifts are never boring

- bad betatron tunes, coupling, chromaticity
- bad collimator positions
- huge beam emittance
- side bunches (particles in the next rf buckets)
- coasting beam
- bad orbit
- synchrotron radiation
- off energy particles
- many other reasons…

Operation of a Ring Light Source

PETRA Operation for Operators:

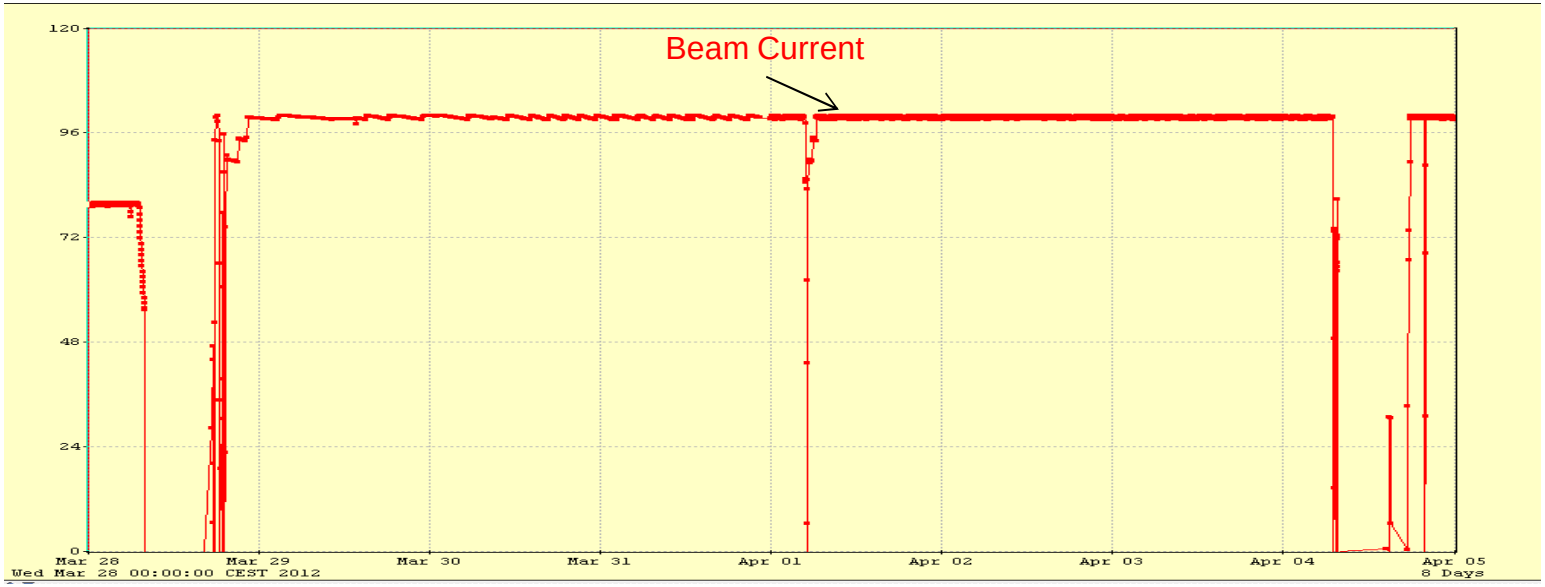


1 to 5 fills per week
TopUp operation
Figure of merit: Beam stability
Efficiency ~ 95 %

Procedures not well known
Most procedures automated
No optimization during the run
No experience with trouble
Some shifts are boring
Slow learning curve

Operation of a Ring Light Source

PETRA Operation for Operators:

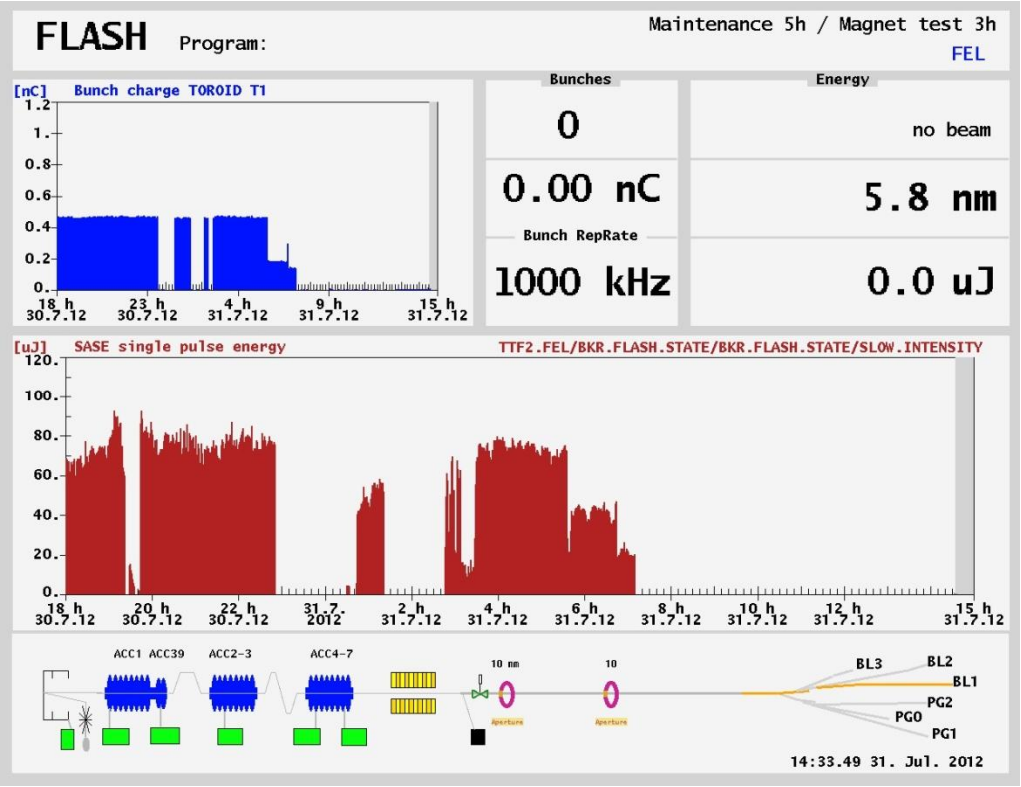


Operators are

- overqualified for long, quiet runs without any tuning
- potentially under qualified in case of a sudden beam loss

Operation of a SASE FEL

FLASH SASE Operation:



Different output from pulse to pulse

Many critical parameters

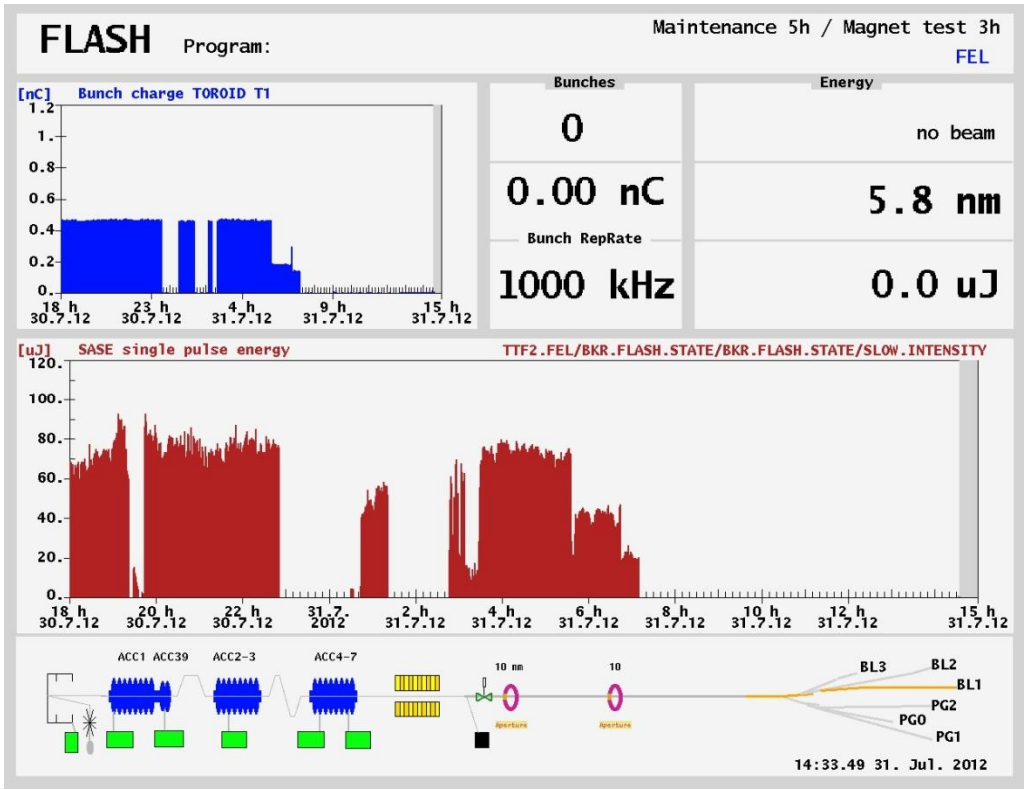
No simple recipes

Not enough automation

Critical procedures performed by experts

Operation of a SASE FEL

FLASH SASE Operation for Operators:



Procedures not always successful

Tuning without clear procedures required

Slow learning curve

Frustration tolerance required

Relations to the Users

HEP Experiments:

Experiments scheduled for ~ 10 years.

Contact persons stay in charge over years.

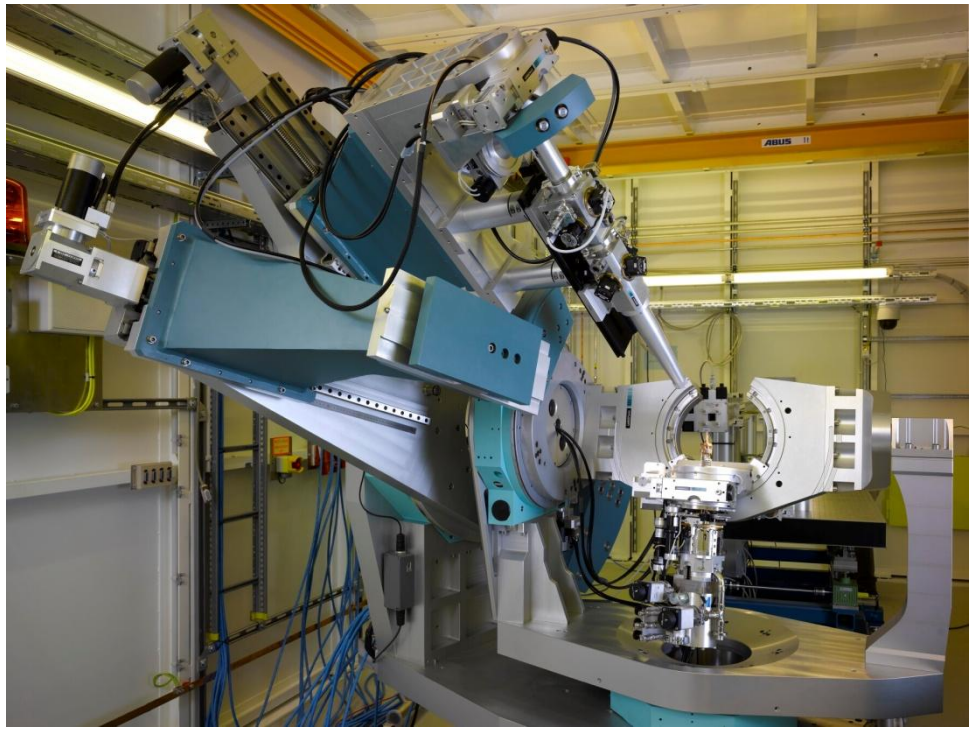
~ 4 experiments per machine.

Experimental data (Backgrounds, lumi,…) visible for operators.

Mutual trust and understanding can grow.

Relations to the Users

Synchrotron Light Experiments:



Experiments scheduled for ~ 10 days. No direct contact to the users. No user data visible.

Beamline managers stay in charge over years.

~ 40 experiments per machine.

Mutual trust and understanding grows slower.

Operator Satisfaction

Collider Rings:

A shift was good if the experiment has another X nanobarn on tape.
The operator has
- tuned the luminosity to a maximum
- tuned the background to a minimum

The operator has **contributed** to these X nanobarn.

Synchrotron Light Sources:

A shift was good if there has been no beam loss.

The operator goes home.

Changes for the Operators

Light sources were introduced over many years at DESY.

The operators learned to handle ring light sources, but preferred collider rings.

The operators hesitated to operate FLASH, our SASE FEL, because that was done by experts.

The end of HERA came not unexpected, but it came nevertheless suddenly. A lot of experience and knowledge became totally useless from one day to the other.

Now motivation is a problem, as PETRA is not a challenge and FLASH is too much of a challenge.

Changes for the Operators

What changes were introduced in the control room?

Ring Light Sorces:

- More documentation for rare events
- During quiet runs side jobs are supported

SASE FEL:

- More operator training, more theoretical background
- Better procedures and more automation
- Integration of operators in machine coordination teams

Conclusion

Operation of a Collider Ring:

- Several fills per day
- Constant tuning
- Much operating experience

- Easy to learn
- Ideal for enthusiasts
- Satisfying work

Operation of a Ring Light Source:

- Long run duration, no tuning
- Often boring
- Little operating experience

- Needs good documentation
- Needs training of rare events
- Needs a side job on quiet shifts

Operation of our SASE FEL:

- Constantly changing conditions
- Constant tuning
- Many critical parameters
- Sometimes frustrating

- Slow learning curve
- Dedicated training shifts
- Experts on call
- Few volunteers

Conclusion

For DESY in total the transition from HEP to Photon Science went rather well.

(Photon Science grew slowly over many years, HEP is still very active at LHC)

Work in the control room has changed:

From routine operation with much tuning to

- waiting for a beam loss
- tuning without guaranteed success

Some operators are missing the good old days.