Status of the

Metrology Light Source

ESLS XXIV - Lund, Sweden

Tobias Tydecks et al.

Helmholtz-Zentrum Berlin (HZB)

tobias.tydecks@helmholtz-berlin.de

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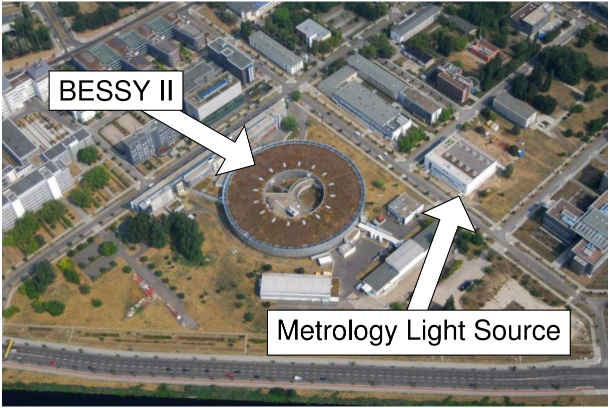
The Metrology Light Source (MLS)



Outline

Status MLS

- The Metrology Light Source
- Positive / Negative α
- Lifetime in low-ε operation mode

Status Robinson Wiggler Project

Genetic optimized User Optics

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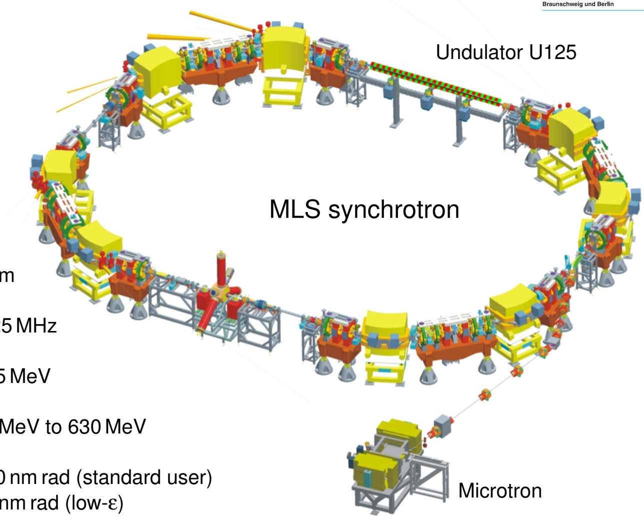
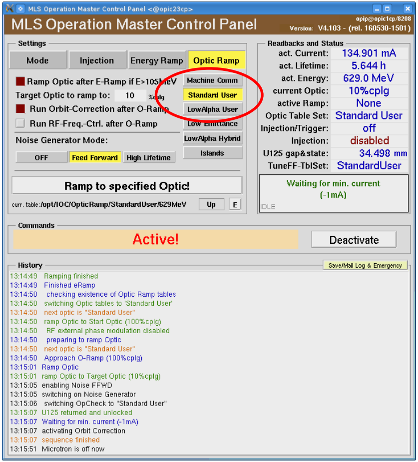


Circumference	48 m
Rev. Frequency	6.25 MHz
Injection Energy	105 MeV
Operation Energy	50 MeV to 630 MeV
Emittance	100 nm rad (standard user) 25 nm rad (low-ε)
Typical lifetimes for diff. operation modes at 150 mA	6 h (standard user) 2 h (low-ε) 10 h (low-α)

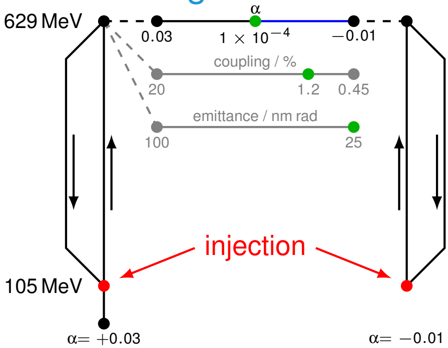
Operation modes

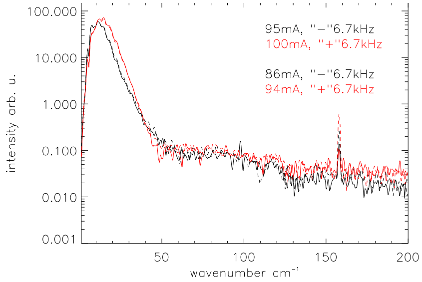
- Operation completely **automated**
- selection of desired user mode by **pushing one button**
- energy ramp and state transitions **current conserving**



- Standard user mode
  $\sim$ 55 % User Time
- Special modes
  $\sim$ 45 % User Time
  - low-ε
  - low-α
  - neg.-α
  - low currents (countable no. of e^-)
  - low energy (down to 50 MeV)
  - Island buckets
  - single bunch / flexible bunch pattern

Positive / Negative α

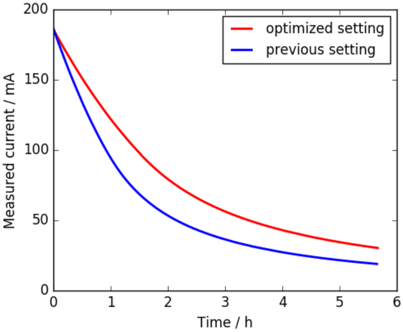


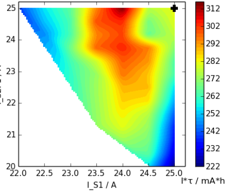


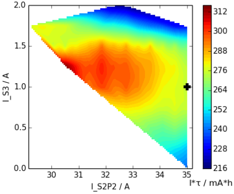
- MLS is a ramped machine, therefore new injection state developed
- now high currents at neg. low-α and at similar optics as pos. low-α available
- no major difference in spectra observed

- But: detailed investigation of performance shows a clear preference for using neg. α optics:
  - higher bursting threshold
  - enhanced stability of THz-power (non-bursting)

Lifetime in low-ε operation mode







- emittance $\varepsilon_x = 25\,\text{nm rad}$
- improvement of lifetime in low-ε mode by 30 % achieved by in situ sextupole scan
- longer user runs (1.5 h $\rightarrow$ 2.0 h) & improved temporal stability
- further improvement with in situ particle swarm algorithm $\rightarrow$ **see talk by Ji Li tomorrow Wed 12:15 - 12:35**

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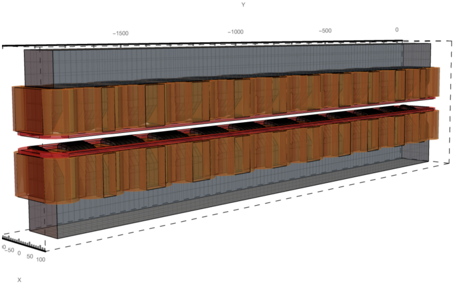
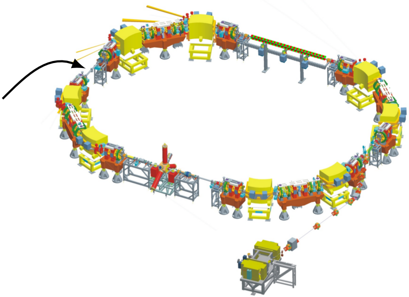
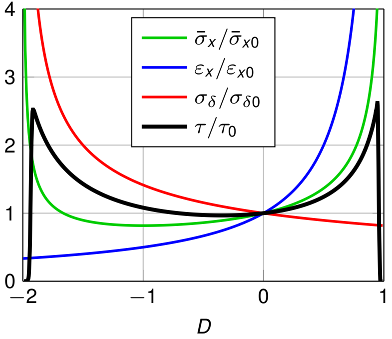




$$\tau_t \propto \sigma_x \sigma_s \qquad \sigma_x = \sqrt{\varepsilon_x \beta_x + \sigma_\delta^2 \eta_x^2} \qquad \sigma_s \propto \sigma_\delta$$

- transfer damping between hor. and long. plane
- keep $\bar{\sigma}_x = \text{const.}$
- increase σ_s
- improve lifetime by more than 100 %



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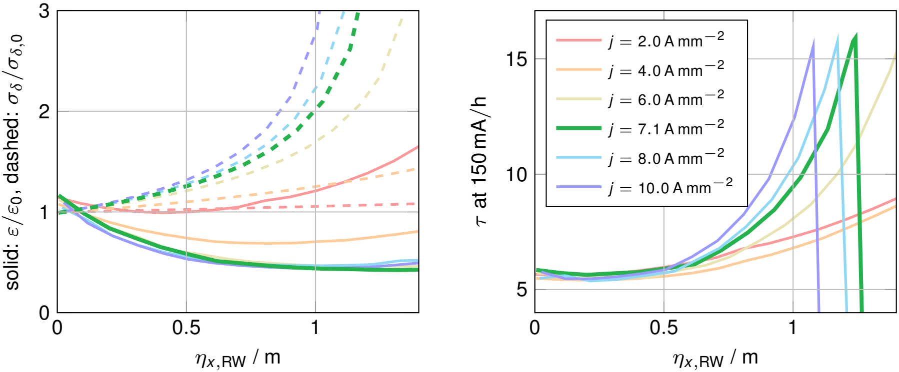

- possible lifetime improvement from 6 h to $\sim$ 15 h @ 150 mA
- increase of integrated photon flux for 6 h user run: 30 %
- increased temporal stability
- project funded, technical specifications in their final stages

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Genetic optimized User Optics

Genetic algorithm for optimization

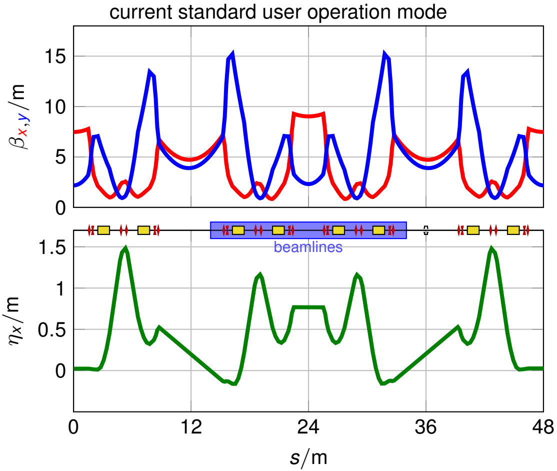
- individually powered quadrupoles at the MLS

$\Rightarrow$ 24 degrees of freedom

- scanning no longer efficient $\Rightarrow$ roll the dice

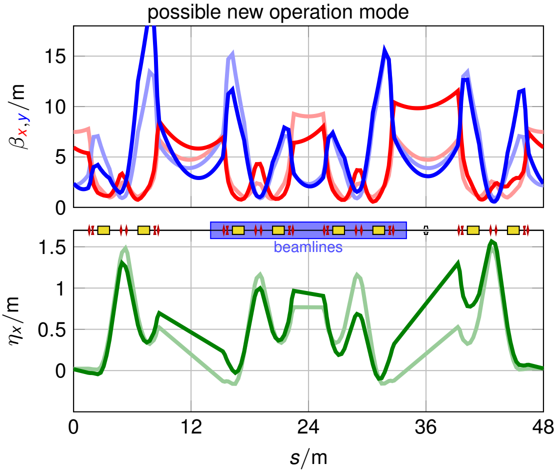
- optimize for
  1. source size and divergence at beamlines
  2. reasonable Touschek lifetime
  3. small dispersion function at the septum magnet (also lifetime related)

Optical functions - SU vs. New Optics



- quadrupoles no longer grouped into equally powered “families”
- breaking of symmetry allows optimization of source size at beamlines

Genetic optimized optics



- quadrupoles no longer grouped into equally powered “families”
- breaking of symmetry allows optimization of source size at beamlines

Genetic optimized optics

- The reduction in source size and divergence is achieved by
  - reducing the horizontal emittance from $\varepsilon_{x,\mathrm{SU}} = 100\,\mathrm{nm\,rad}$ to $\varepsilon_{x,\mathrm{NO}} = 65\,\mathrm{nm\,rad}$,
  - reducing the value of the horizontal β-function at the beamlines,
  - reducing the value of the horizontal dispersion at the beamlines,
  - reducing the gradients of the optical functions at the beamlines.
- reasonable Touschek lifetime is achieved by enlarging the optical function where no beamline is located while keeping dispersion at the septum small

Genetic optimized optics

Beamline	$\Delta\sigma_x/\%$	$\sigma'_x/\%$	$\sigma_y/\%$	$\sigma'_y/\%$
IDB	-7	-27	-28	-8
QPD01	-39	4	-29	-29
QNIM	-41	-6	-29	-29
EUV	-24	-20	-13	-24
VUV	-32	14	-14	-2
THz	-35	-1	-16	-37
IR	-41	-5	-16	-29
QPD00	-34	2	-17	-29

- optics ramp table set up
- further tests after shut down

Summary

- MLS is running well and users are happy
- continuing development of existing and new operation modes
- ongoing projects:
  - Robinson Wiggler for improving the lifetime and further enhancing the flexibility of the MLS
  - development of new optics optimized for user community by breaking symmetry

Thank you for your attention...