

Status of the Metrology Light Source

ESLS XXIV - Lund, Sweden

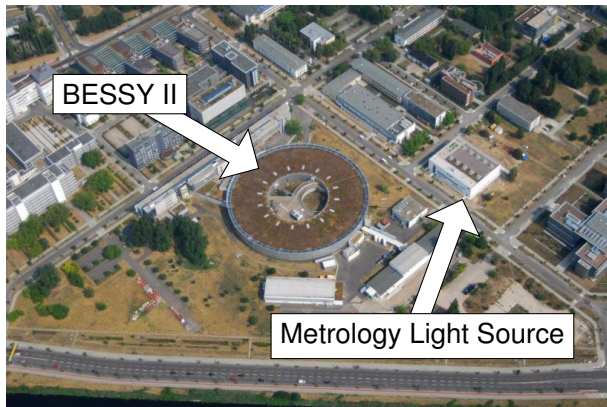
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The Metrology Light Source (MLS)



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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The Metrology Light Source

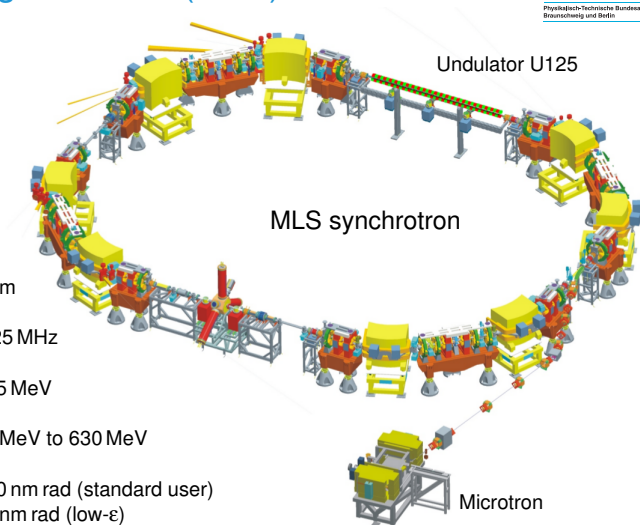
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Circumference	48 m
Rev. Frequency	6.25 MHz
Injection Energy	105 MeV
Operation Energy	50 MeV to 630 MeV
Emittance	100 nm rad (standard user) 25 nm rad (low- ϵ)
Typical lifetimes for diff. operation modes at 150 mA	6 h (standard user) 2 h (low- ϵ) 10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

Operation modes



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

MLS Operation Master Control Panel

Settings

Mode: Injection Energy Ramp **Optic Ramp**

Machine Conn: **Standard User**

Target Optic to ramp to: 10 3/4 MeV

Run Orbit-Correction after O-Ramp: **Low/Alpha User**

Run RF-Freq.-Ctrl. after O-Ramp: **Low emittance**

Noise Generator Mode: **Low/Alpha Hybrid**

Feed Forward High Lifetime Islands

Ramp to specified Optic!

curr. table: Aps1/OC/Optic-Ramp/StandardUser629MeV [Up] [E]

Commands: **Active!** [Deactivate]

Readbacks and Status

act. Current: 134.901 mA

act. Lifetime: 5,644 h

act. Energy: 629.0 MeV

current Optic: 10%cplg

active Ramp: None

Optic Table Set: Standard User

Injection/Trigger: off

Injection: disabled

U125 gap&state: 34,498 mm

TuneFF-TblSet: Standard User

Waiting for min. current (-1mA)

History

13:14:49 Ramping finished

13:14:49 Finished eRamp

13:14:50 checking existence of Optic Ramp tables

13:14:50 switching Optic tables to 'Standard User'

13:14:50 next optic is "Standard User"

13:14:50 ramp Optic to Start Optic (100%cplg)

13:14:50 RF external phase modulation disabled

13:14:50 preparing to ramp Optic

13:14:50 next optic is "Standard User"

13:14:50 Approach O-Ramp (100%cplg)

13:15:01 Ramp Optic

13:15:01 ramp Optic to Target Optic (10%cplg)

13:15:05 enabling Noise FFWD

13:15:05 switching on Noise Generator

13:15:06 switching OpCheck to "Standard User"

13:15:07 U125 returned and unlocked

13:15:07 Waiting for min. current (-1mA)

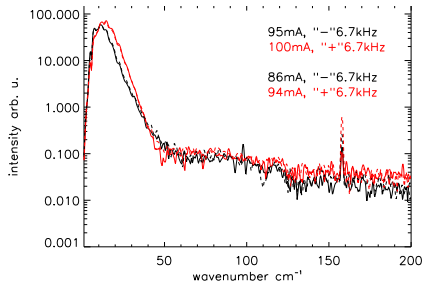
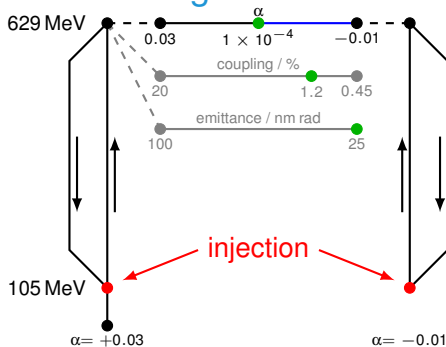
13:15:07 activating Orbit Correction

13:15:07 sequence finished

13:15:51 Microtron is off now

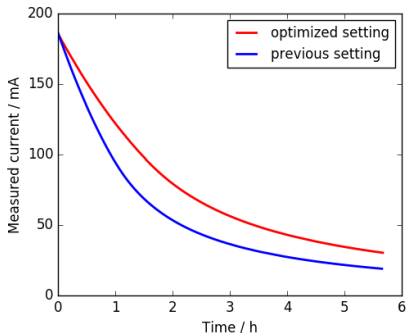
- ▶ Standard user mode
~ 55 % User Time
- ▶ Special modes
~ 45 % User Time
 - ▶ low- ϵ
 - ▶ low- α
 - ▶ neg.- α
 - ▶ low currents
(countable no. of e^-)
 - ▶ low energy
(down to 50 MeV)
 - ▶ Island buckets
 - ▶ single bunch / flexible bunch pattern

Positive / Negative α

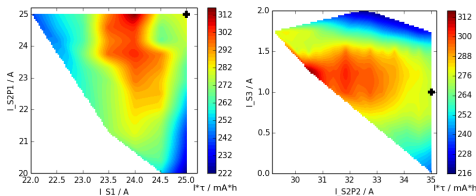


- ▶ MLS is a ramped machine, therefore new injection state developed
- ▶ now high currents at neg. low- α and at similar optics as pos. low- α available
- ▶ no major difference in spectra observed
- ▶ But: detailed investigation of performance shows a clear preference for using neg. α optics:
 - ▶ higher bursting threshold
 - ▶ enhanced stability of THz-power (non-bursting)

Lifetime in low- ϵ operation mode



- ▶ emittance $\epsilon_x = 25$ 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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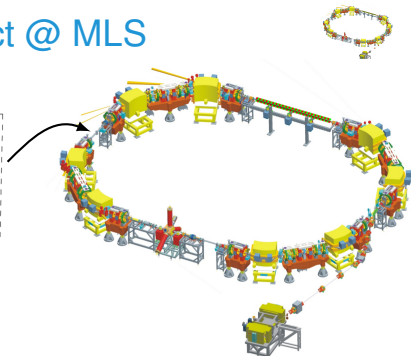
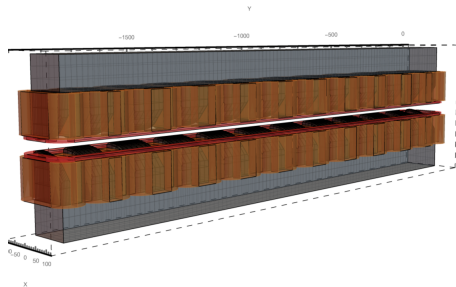
Positive / Negative α

Lifetime in low- ϵ operation mode

Status Robinson Wiggler Project

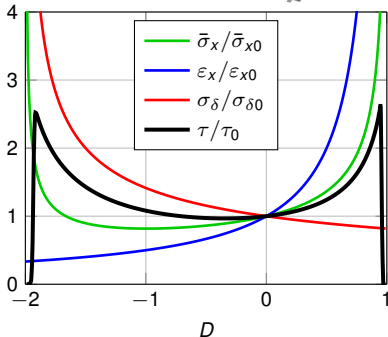
Genetic optimized User Optics

Status Robinson Wiggler Project @ MLS

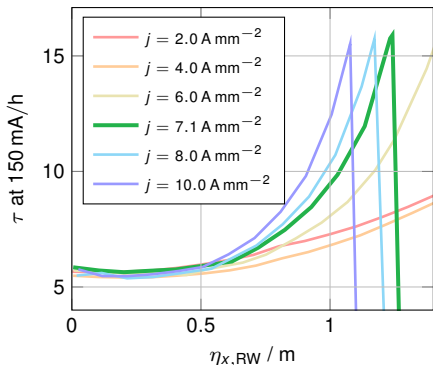
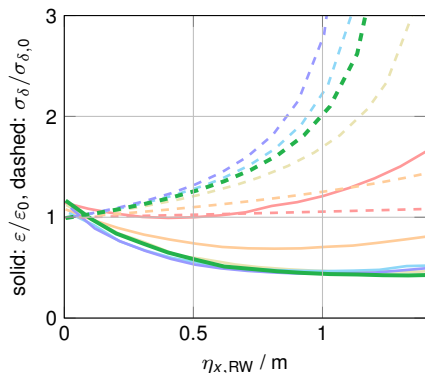


$$\tau_t \propto \sigma_x \sigma_s \quad \sigma_x = \sqrt{\epsilon_x \beta_x + \sigma_\delta^2 \eta_x^2} \quad \sigma_s \propto \sigma_\delta$$

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



Status Robinson Wiggler Project @ MLS



- ▶ possible lifetime improvement from 6 h to ~ 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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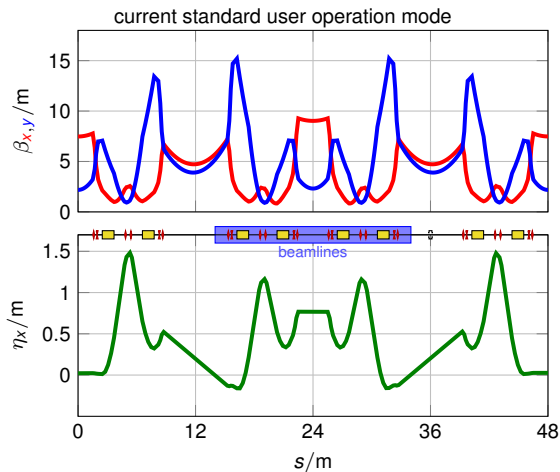
Genetic optimized User Optics



- ▶ individually powered quadrupoles at the MLS
- ⇒ 24 degrees of freedom
- ▶ scanning no longer efficient ⇒ roll the dice

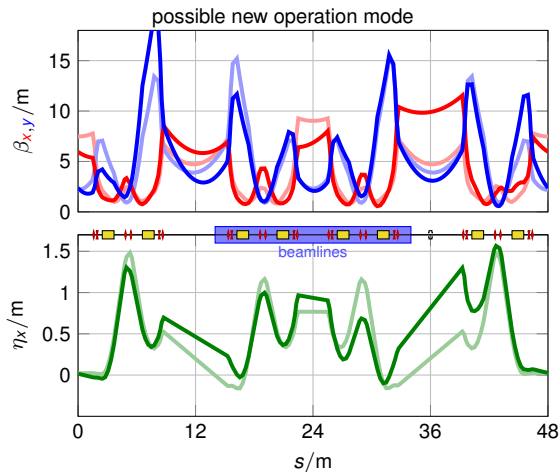
- ▶ optimize for
 1. source size and divergence at beamlines
 2. reasonable Touschek lifetime
 3. small dispersion function at the septum magnet (also lifetime related)

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



- ▶ The reduction in source size and divergence is achieved by
 - ▶ reducing the horizontal emittance from $\varepsilon_{x,SU} = 100$ nm rad to $\varepsilon_{x,NO} = 65$ 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



- ▶ 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...