sFLASH

direct HHG-seeding and beyond

FLASH accelerator Workshop, October-4, 2011

on behalf of the sFLASH group

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pported by BMBF under contract 05 ES7GU1

G GrK 1355

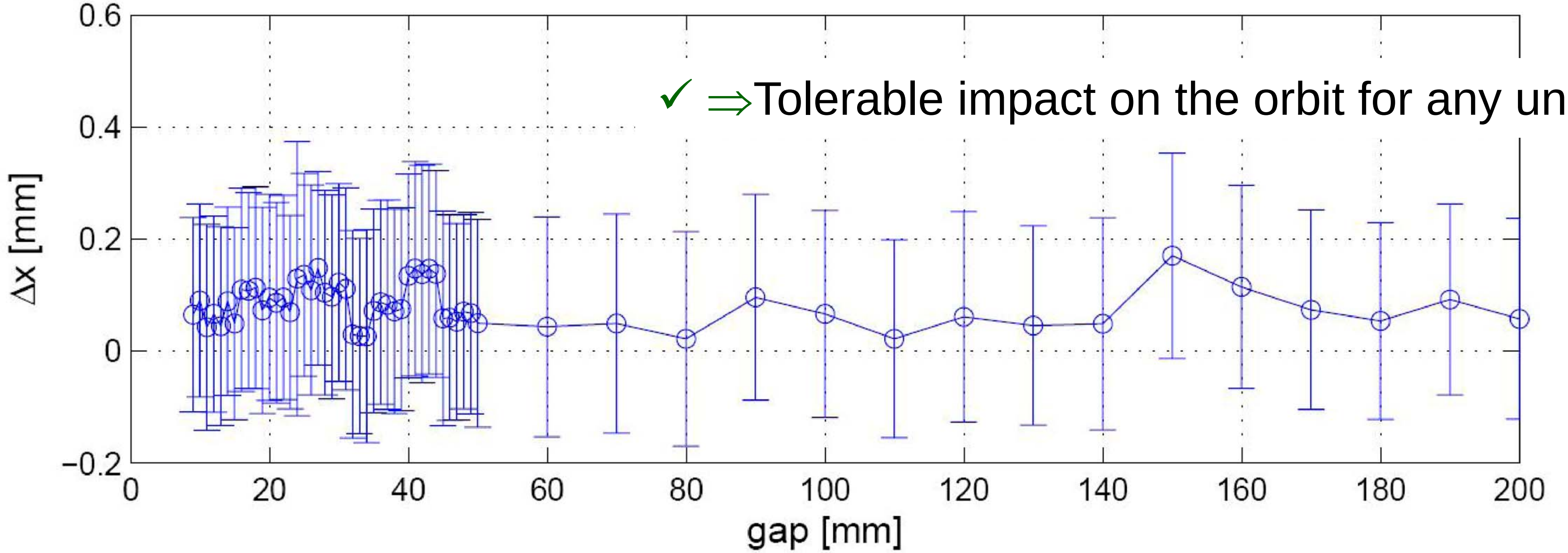
Presents status and commissioning results

Improvements during the 2011 shutdown

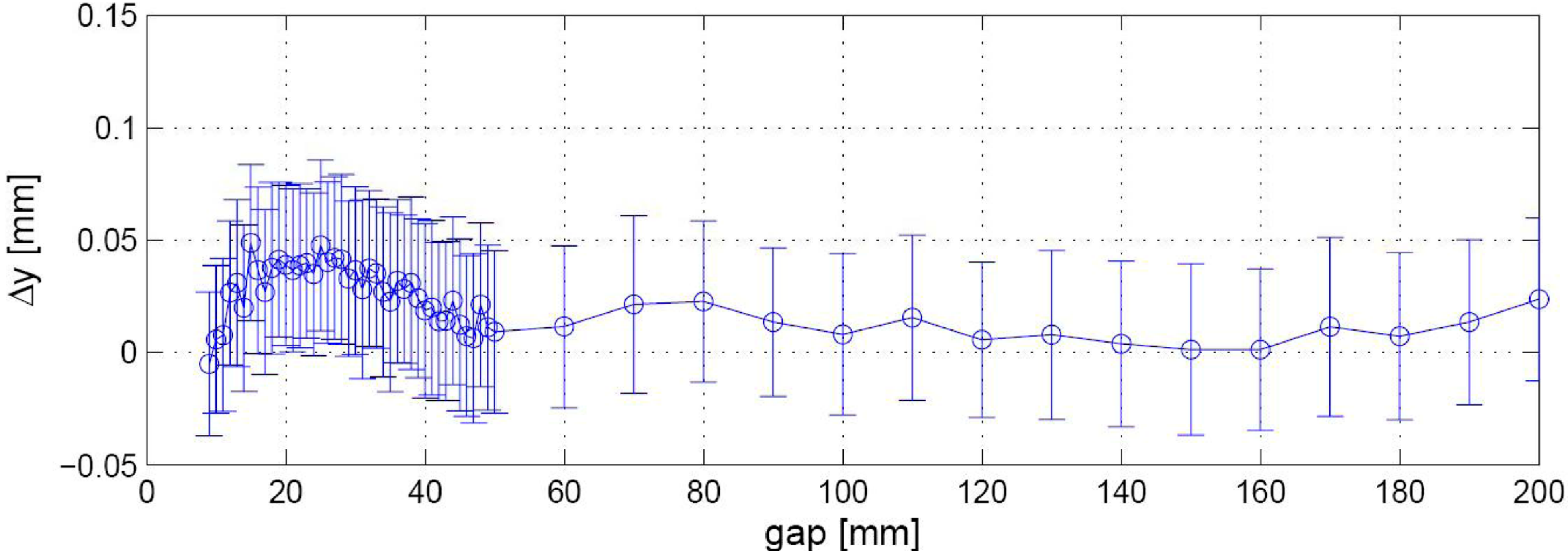
sFLASH-HGHG option

Outlook

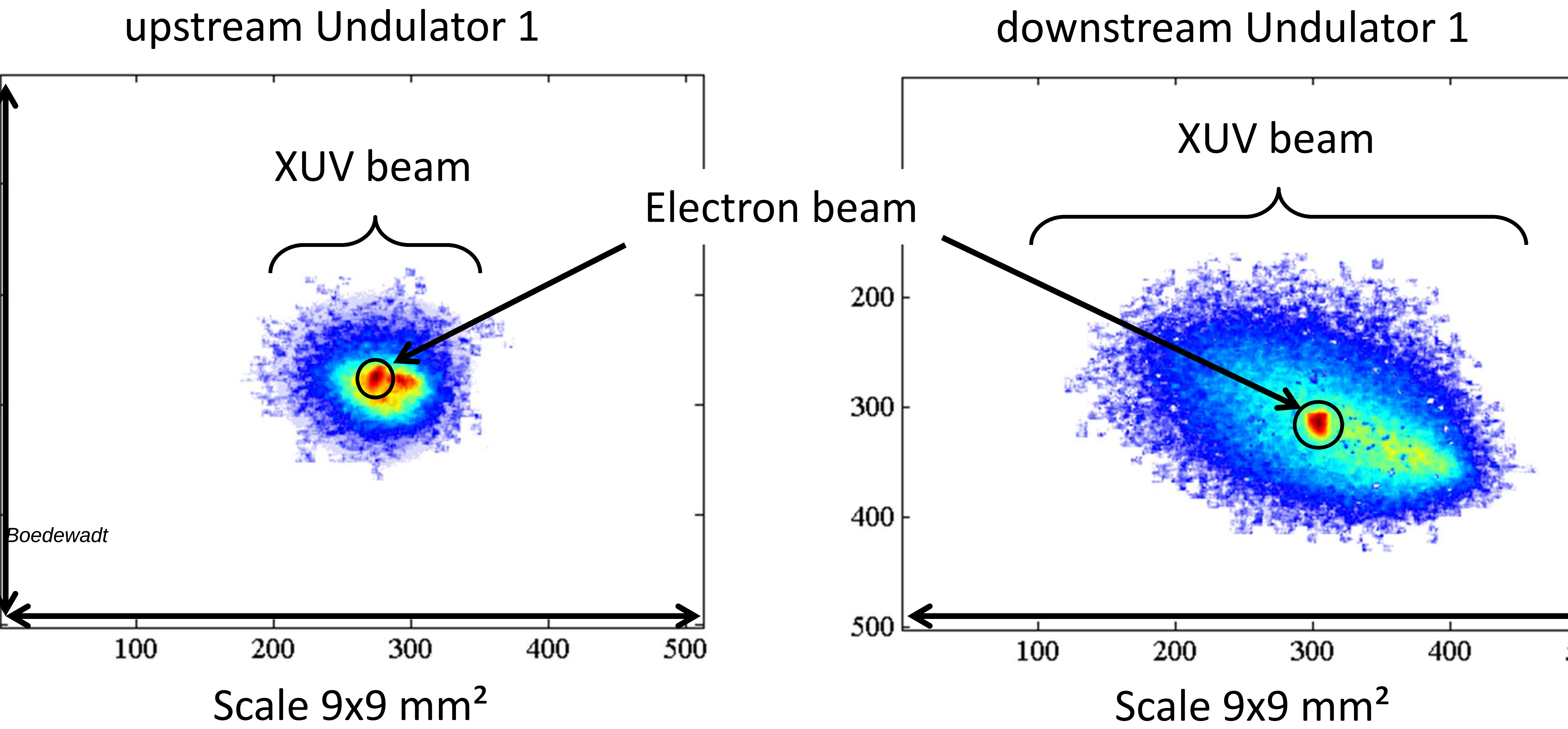
Beam position as a function of the gap of the first sFLASH-undulator



✓ ⇒Tolerable impact on the orbit for any undulator



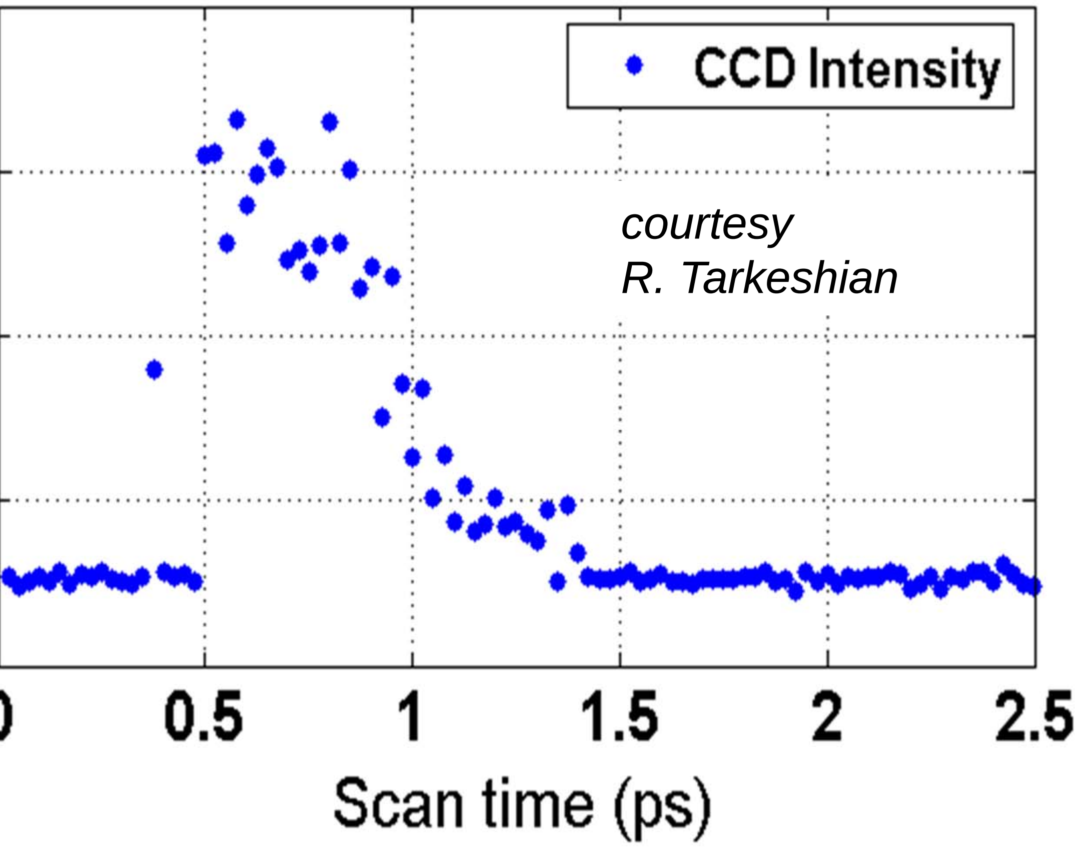
Superimposed beam profiles measured on Ce:YAG screen

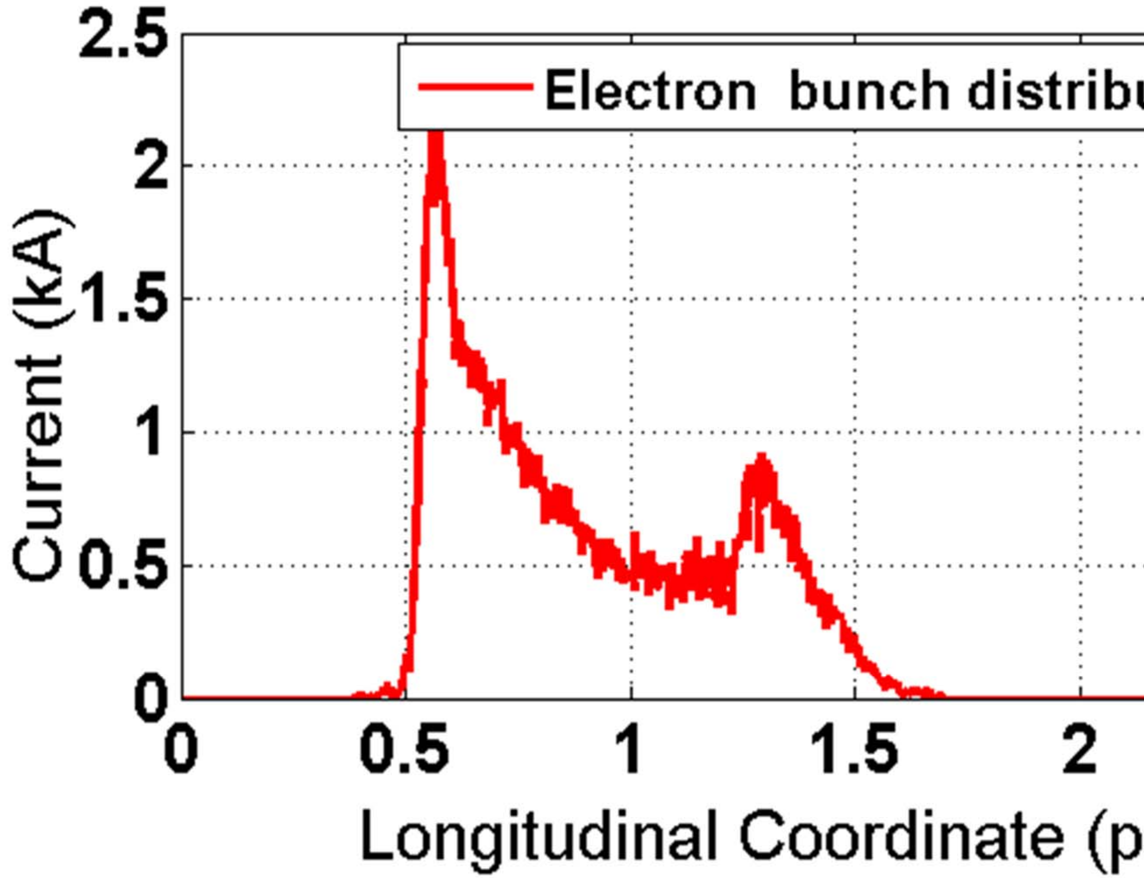


$\Delta X, \Delta Y < 50\ \mu m$

$\theta < 50\ \mu rad, \Rightarrow$

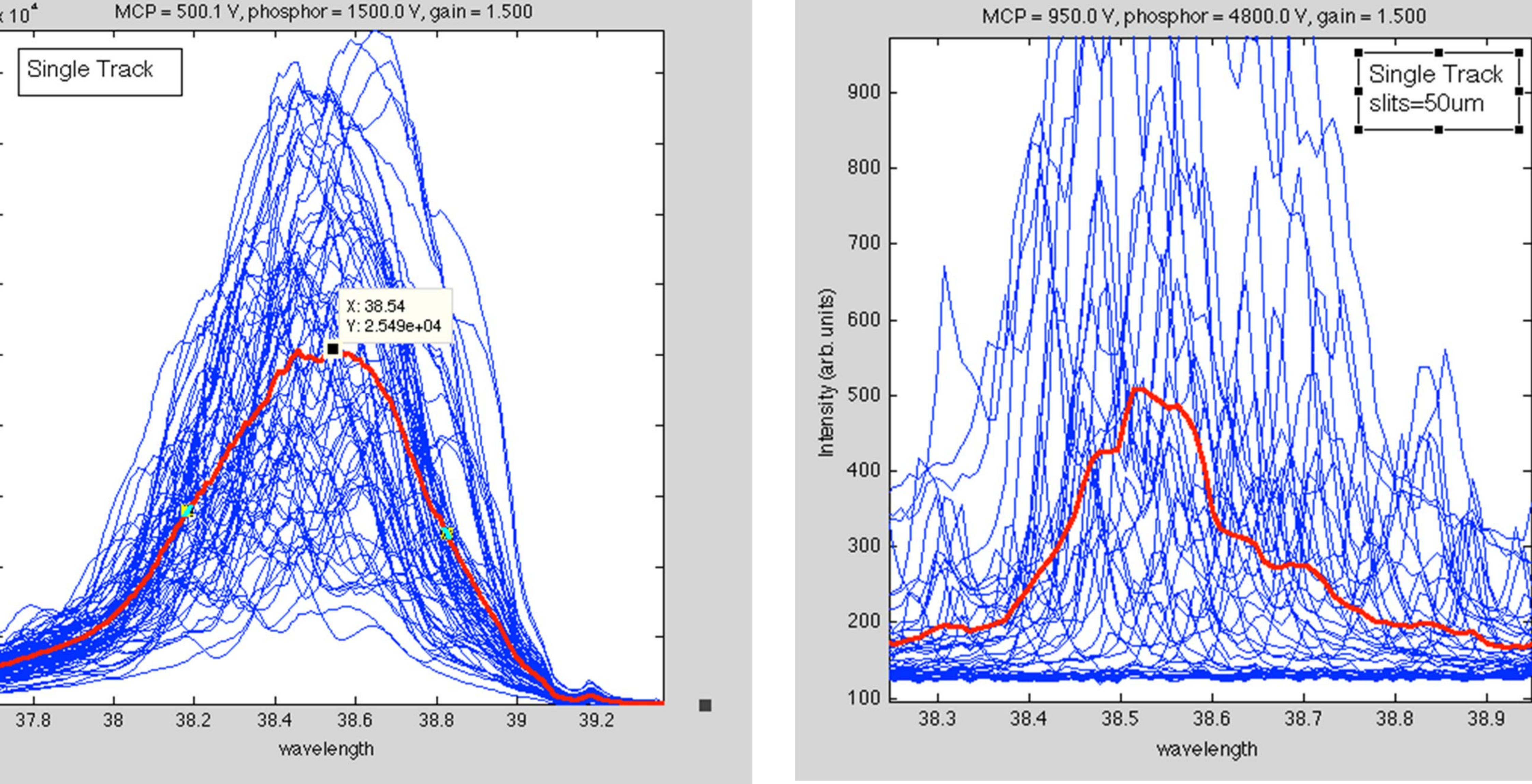
$$\Delta\lambda / \lambda = \gamma^2 \theta^2 / \left(1 + k^2\right)$$





ft)-Measurement of the intensity of the emitted coherent radiation as nction of the relative delay (25 fs step) of the IR-pulse. The temporal erlap between the IR-light and the electron bunch enhances the diation intensity.

ght)-Longitudinal charge distribution measured with transverse flecting cavity. To be compared with the measurement in the left.

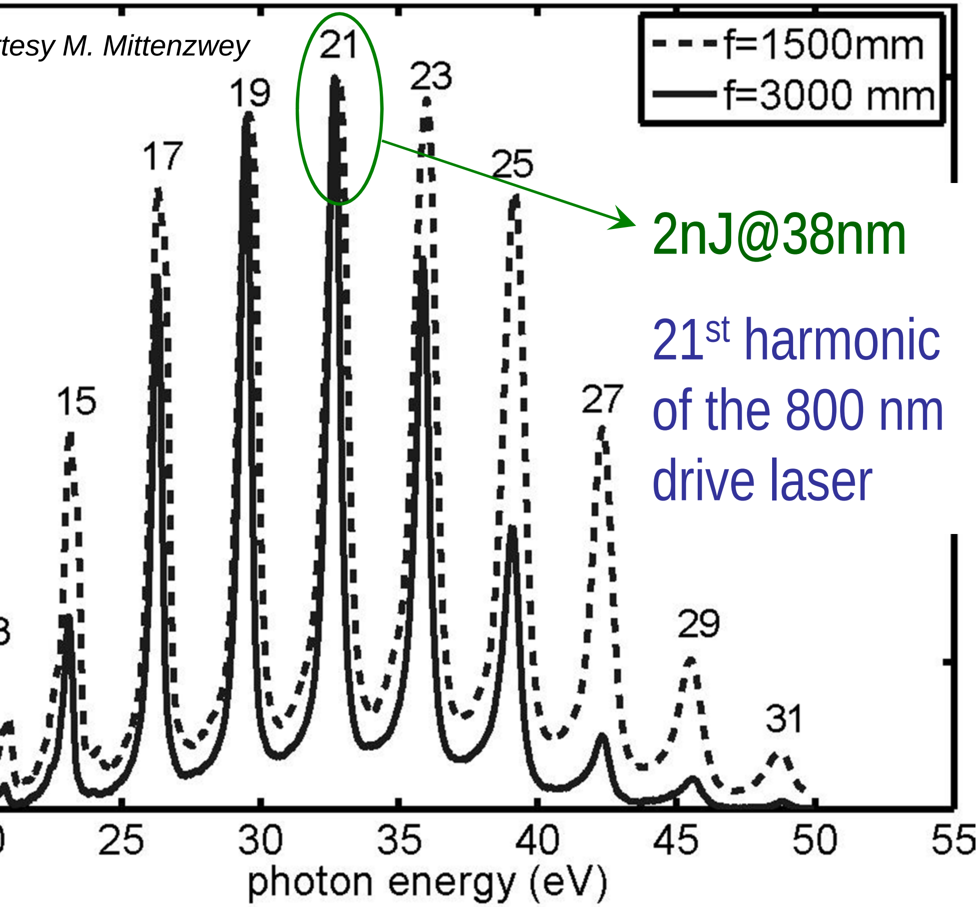


(left) Single-shot spectra of the SASE-radiation.

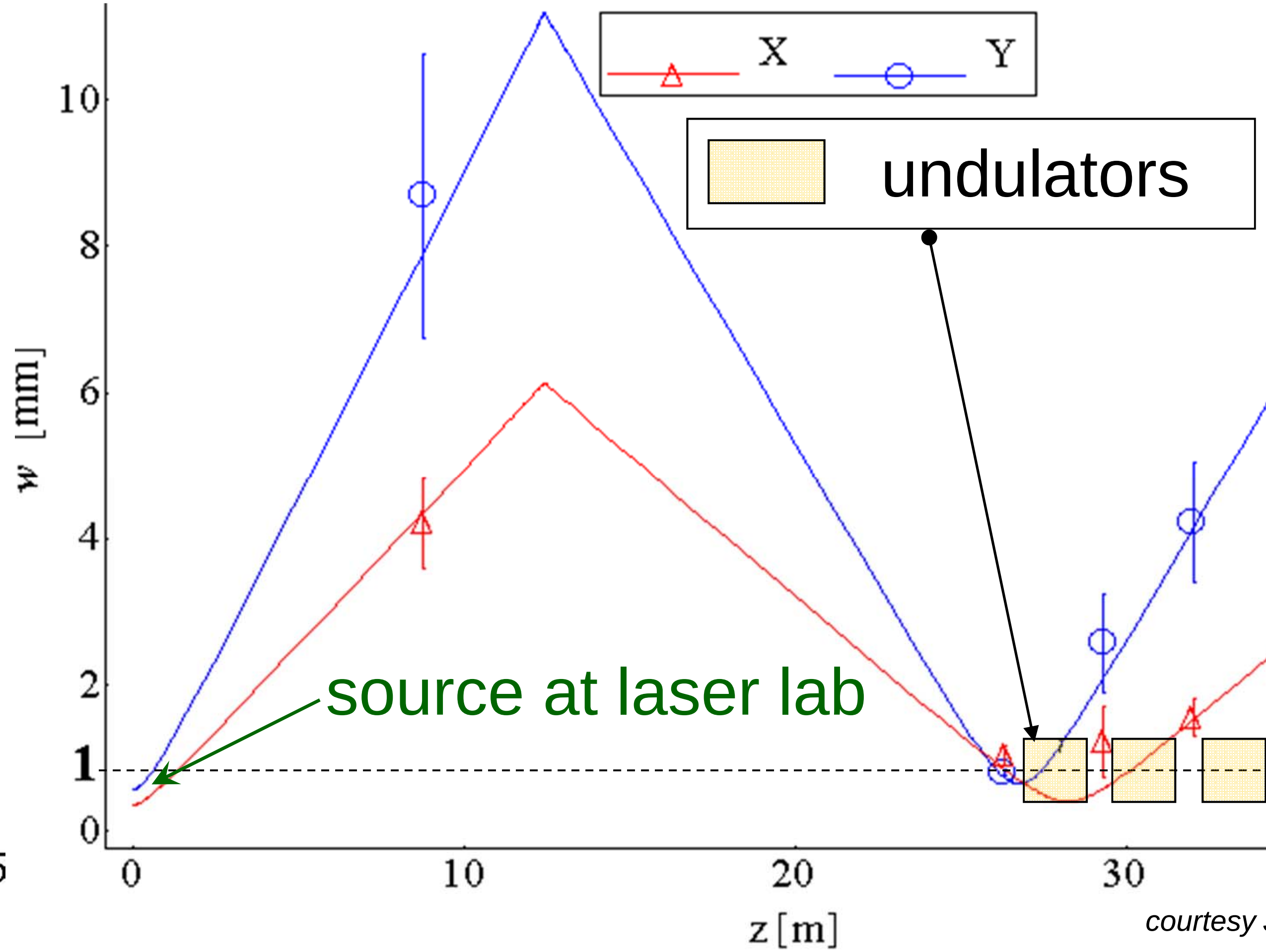
(right) Single-shot spectra of the HHG seed.

The red curve is the average over all single shots

Spectrum measured in the laser lab



Seed size along the injection beamline and un



G energy @ 38nm at the source ≈ **2 nJ**

HHG energy at the undulator ≈ **0.4 nJ** (the best case with 20% transmission

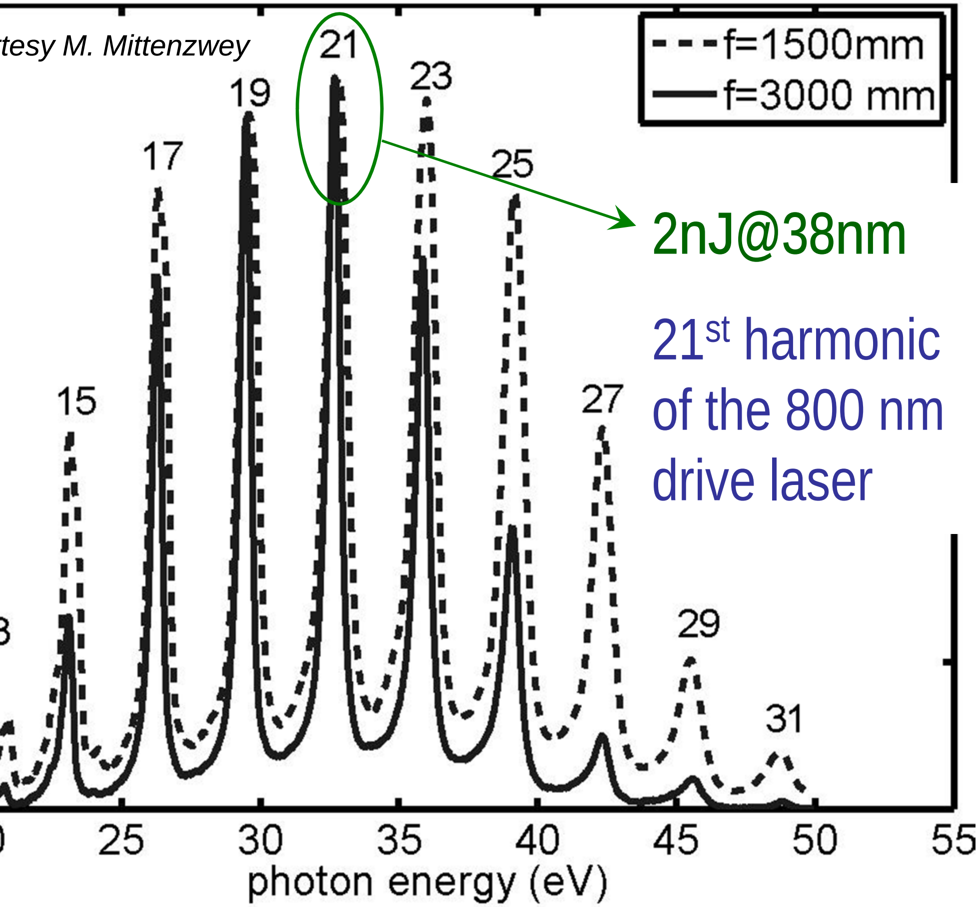
G energy coupled to electron beam ≈ **0.016 nJ** (due to $\sigma_{HHG} >> \sigma_{e^- beam}$)

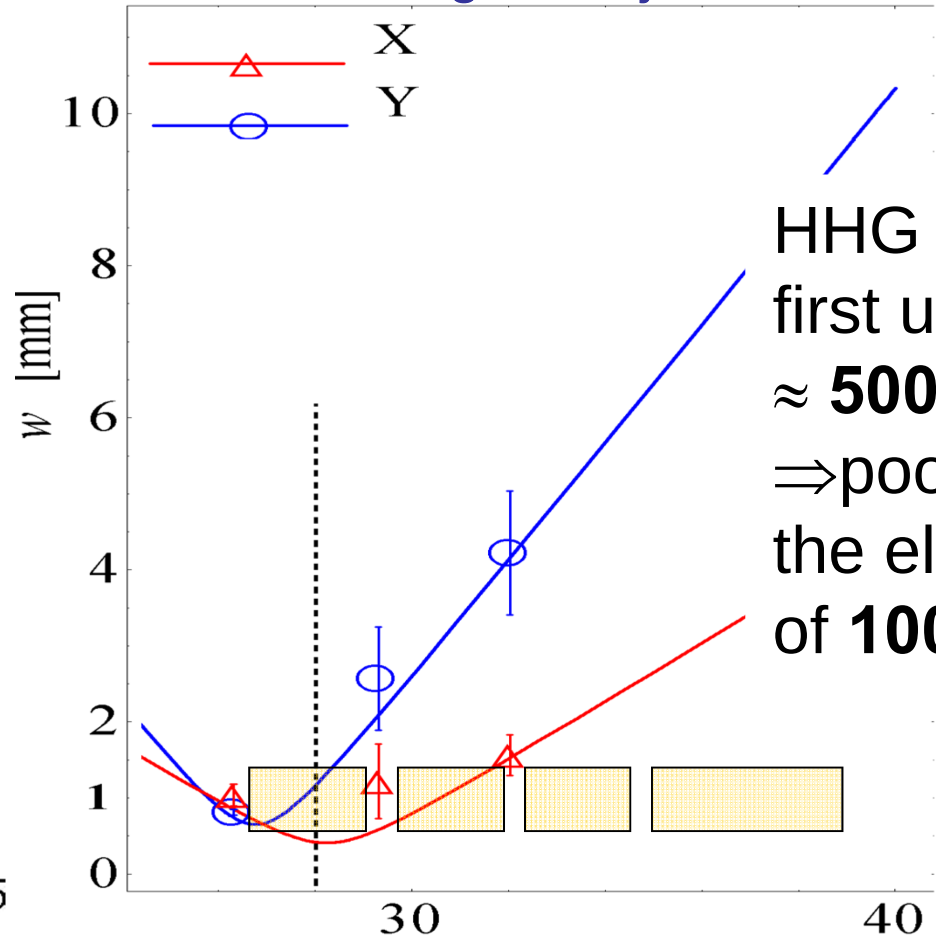
ctive seed power ≈ **800 W**. Shot noise power ~ **100 W**

oton diagnostics integrates over radiation pulse→

spectrum measured in the laser lab

Seed size along the injection beamline and und





HHG size along t
first undulator
≈ **500 μm** (rms),
⇒poor coupling t
the electron bear
of **100 μm** (rms).

courtesy

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oton diagnostics integrates over radiation pulse→

G generation and transport

<u>ditional HHG diagnostics in injection beamline</u>

- Double Al filter.
- XUV diode with additional appertures.
- XUV spectrometer.
- MCP near last injection mirror for online HHG-energy measurement.
- XUV PD at 10ORS

<u>aptive optics for the IR-drive laser</u>

<u>aptive optics for the HHG seed laser</u>

<u>v compression scheme for the IR drive laser</u>

ctron diagnostics

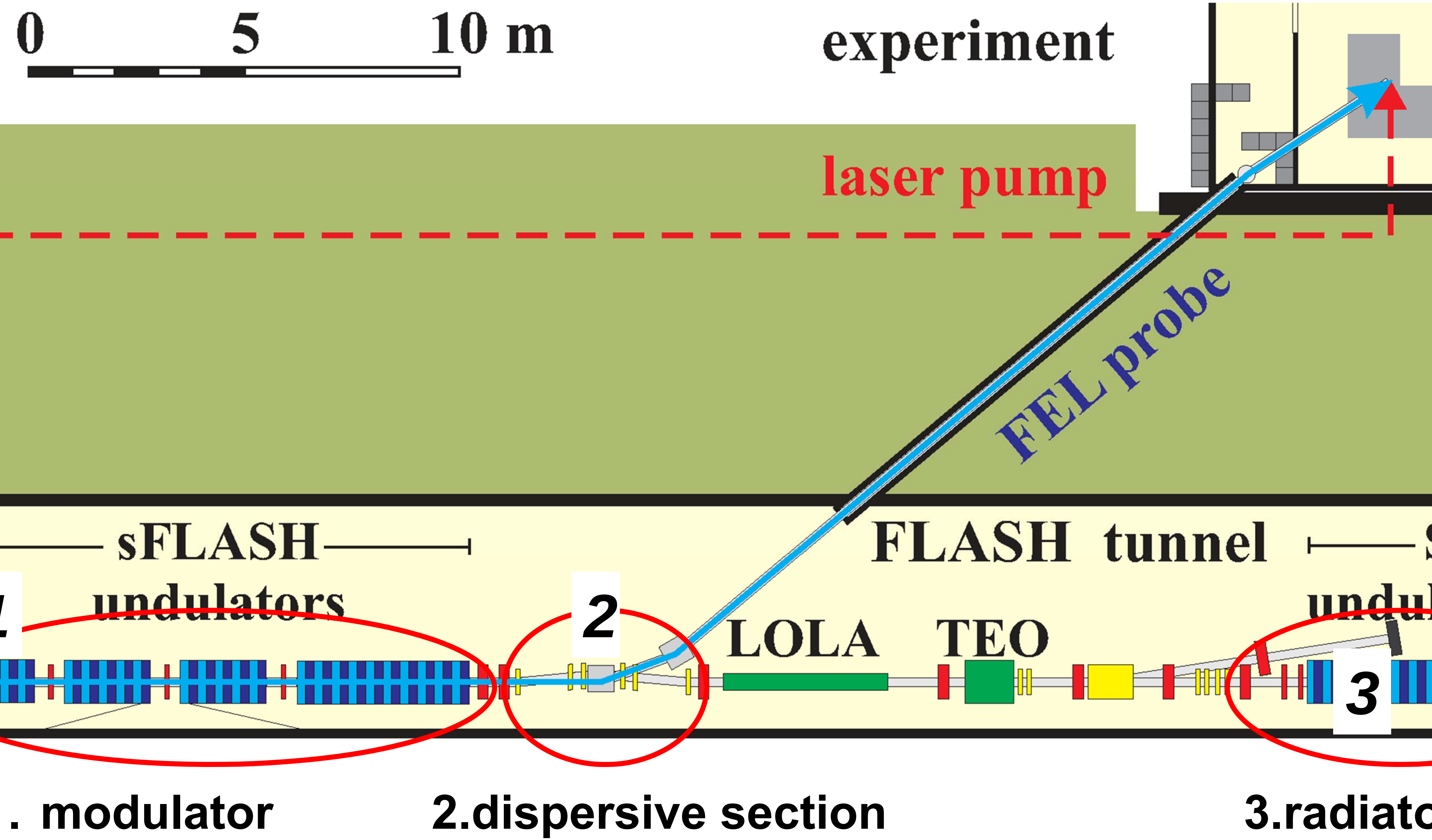
<u>ur additional WS in SFUND3 and SFUND4 (two horizontal, two vertical)</u>

<u>eak-camera exchange</u>

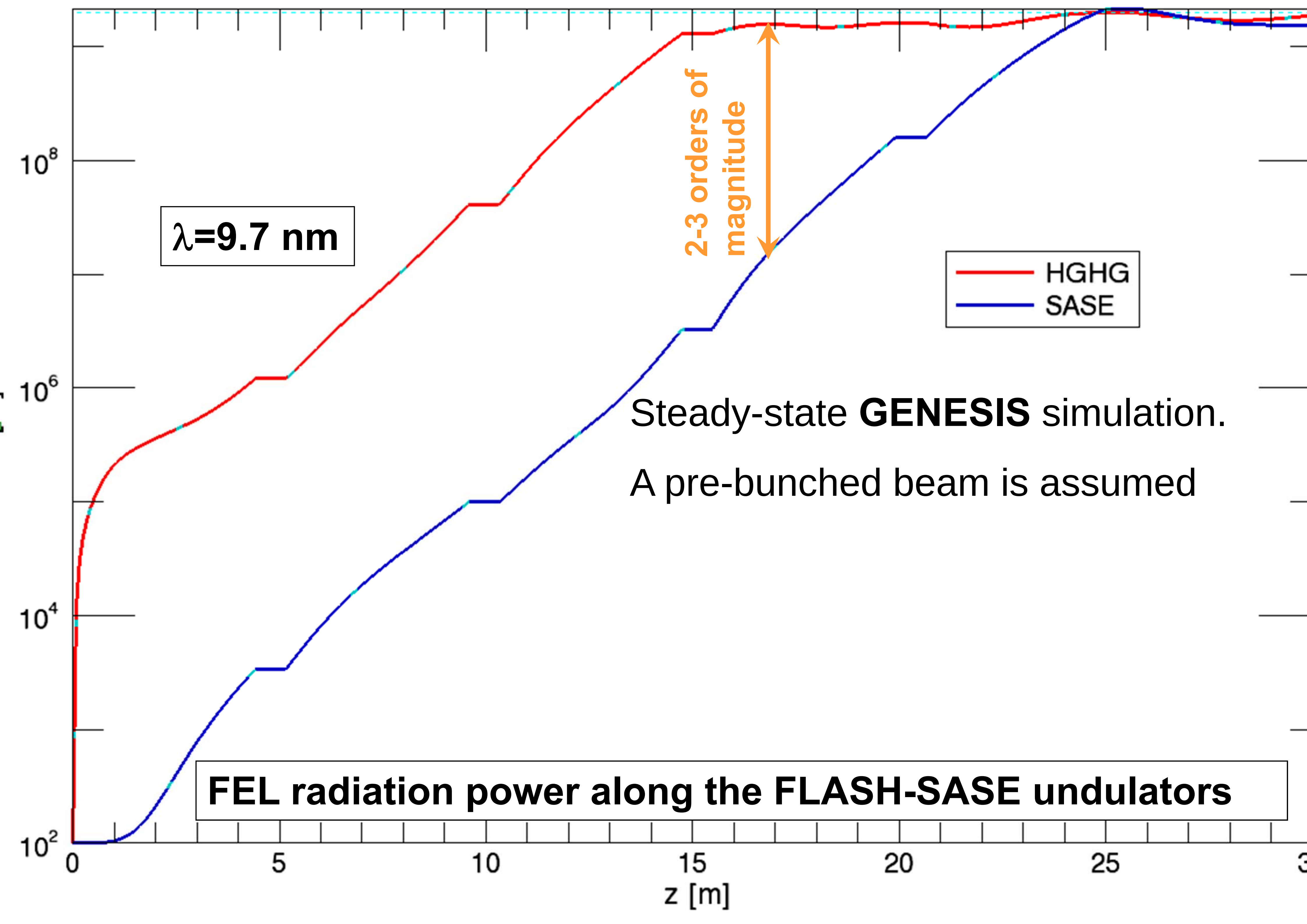
m seeding option

<u>change the existing '13 nm' with '60 nm' coatings.</u>

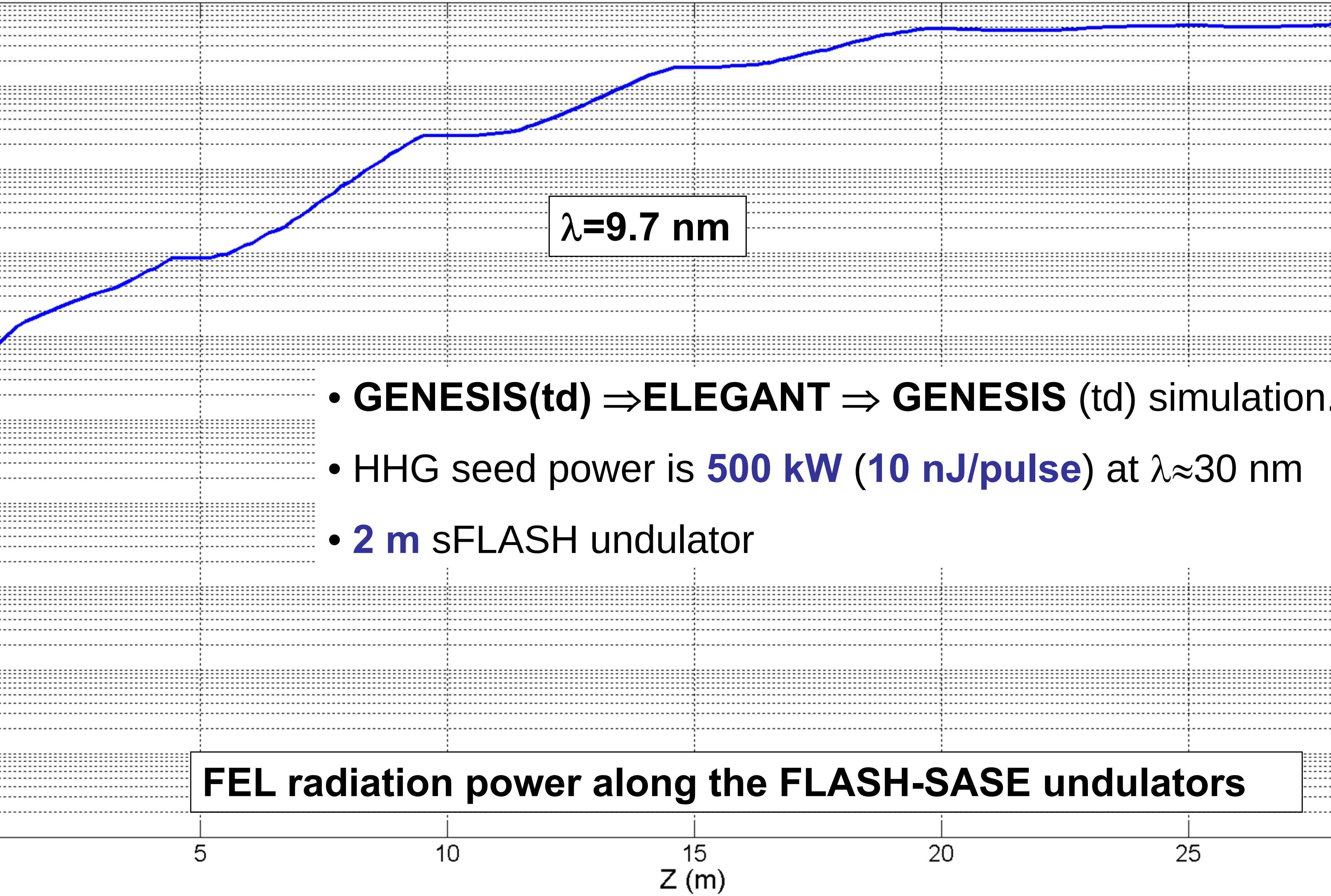
<u>ring the shutdown install an additional valve for '60 nm' spectrometer.</u>



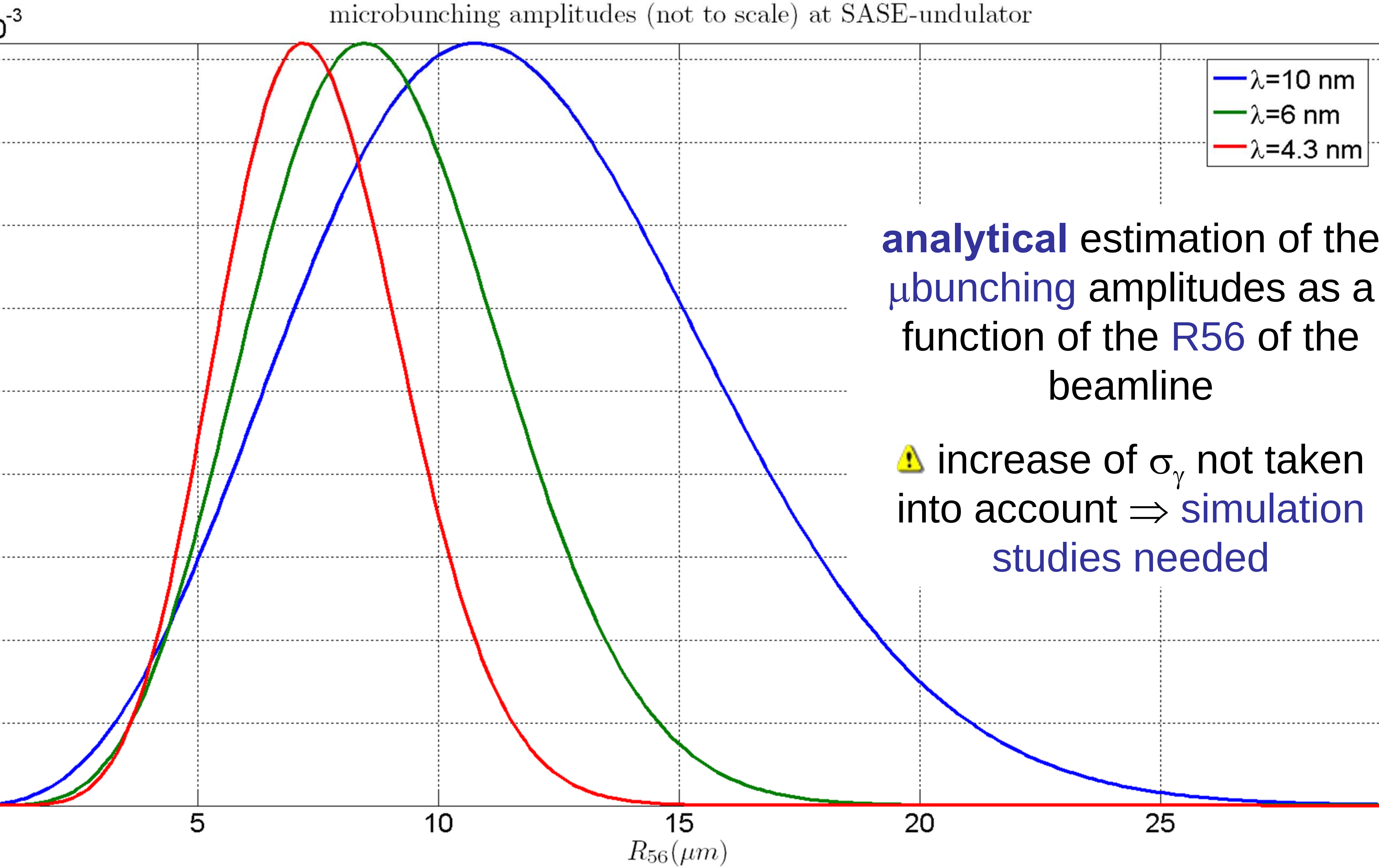
0
5
10 m
experiment
laser pump
FEL probe
sFLASH
undulators
FLASH tunnel
2
LOLA
TEO
3
. modulator
2.dispersive section
3.radiato



λ=9.7 nm
2-3 orders of magnitude
HGHG
SASE
Steady-state GENESIS simulation.
A pre-bunched beam is assumed
FEL radiation power along the FLASH-SASE undulators
10^8
10^6
10^4
10^2
0
5
10
15
20
25
z [m]

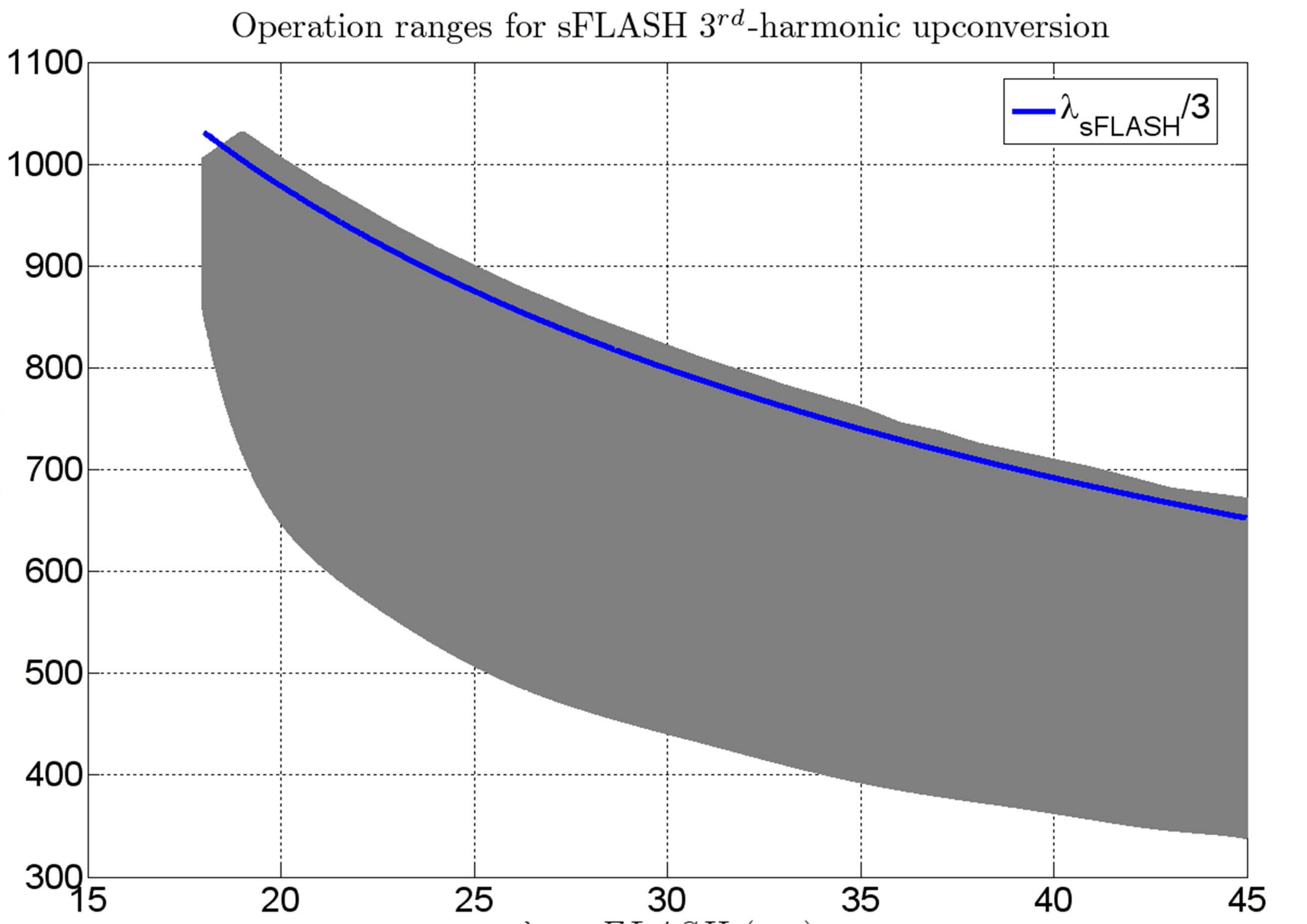


- **GENESIS(td) ⇒ELEGANT ⇒ GENESIS** (td) simulation.
- HHG seed power is **500 kW** (**10 nJ/pulse**) at λ≈30 nm
- **2 m** sFLASH undulator



analytical estimation of the μbunching amplitudes as a function of the R56 of the beamline

⚠ increase of σ_γ not taken into account ⇒ simulation studies needed


Operation ranges for sFLASH 3^{rd}-harmonic upconversion
$\lambda_{sFLASH}/3$
1100
1000
900
800
700
600
500
400
300
15
20
25
30
35
40
45

- More powerful HHG source $\Rightarrow$ needed pulse energy > 10 nJ $\Rightarrow$ > 500 kW seed power for 3rd harmonic.
- Studies to find optimized operation parameters:

– Minimum required laser power

– Length of modulator radiator

– Strength of the dispersive section (R56)

– Electron beam properties (S2E)

– Tolerances

– Diagnostics

- Implement a theoretical model of the HHG generation into simulations. Needs a benchmark against experimental data.