HELMHOLTZ ZENTRUM BERLIN
für Materialien und Energie

DESY

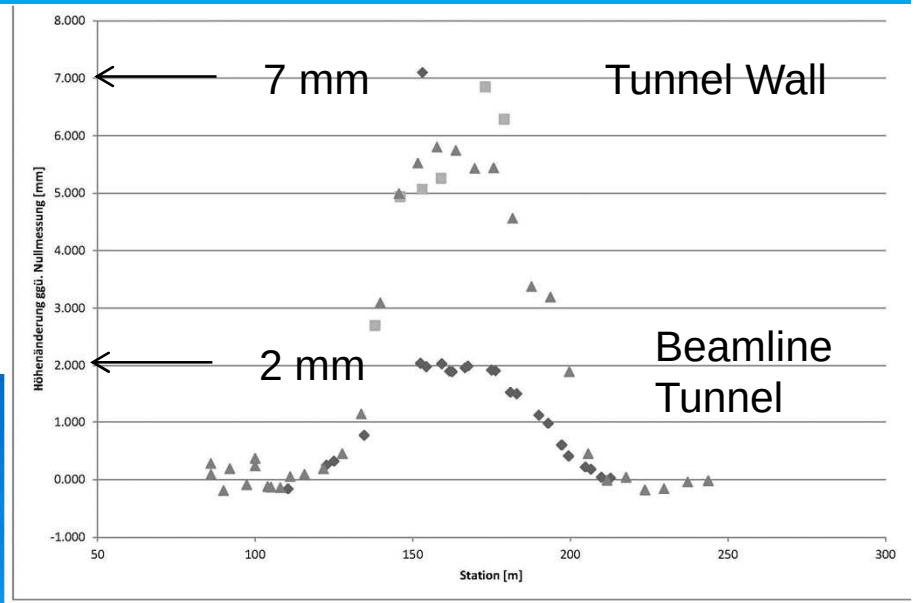
Status FLASH II Project

Bart Faatz
FLASH II
Hamburg, October 12, 2011

HELMHOLTZ ASSOCIATION

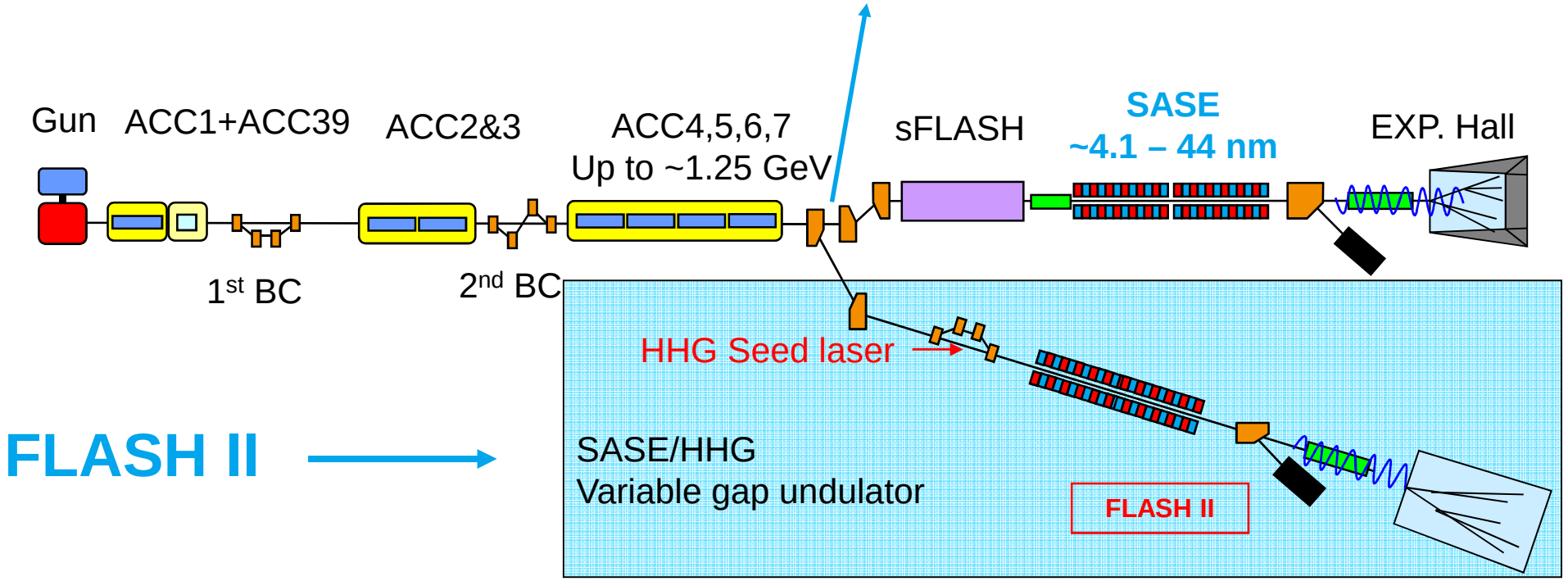
Civil Construction of FLASH II has started.

Movement
- Tunnel Wall
- Components

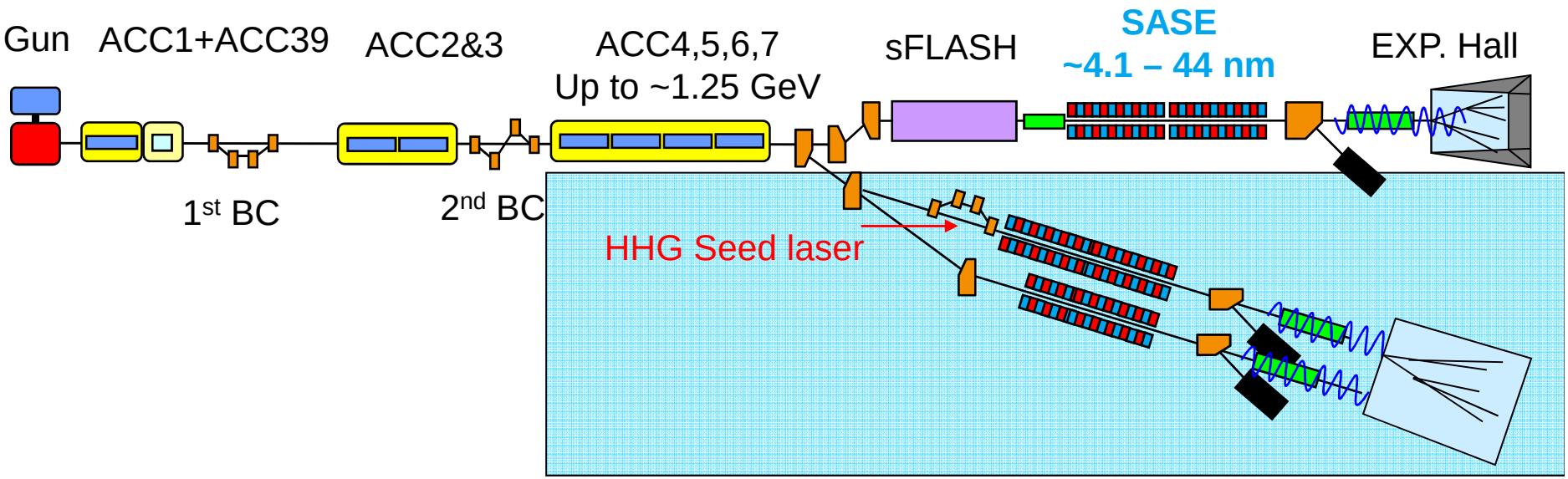


Layout after upgrade FLASH II.

- Separation FLASH and FLASH II behind last accelerator module
- Tunability of FLASH II by undulator gap change
- Extend user capacity with SASE and HHG seeding
- Use of existing infrastructure up to last accelerating module



Including FLASH3.



Long term perspective
Space in Tunnel and Hall foreseen for an additional undulator line

FLASH II: foreseen operation modes.

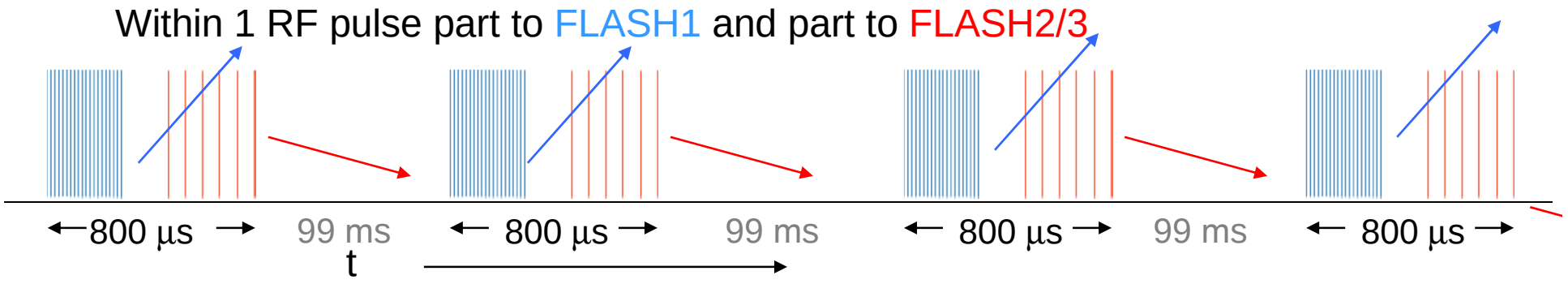
Self Amplified Spontaneous Emission (**SASE**) mode: Start from fluctuation in electron density
spiky, but at full rep.rate and short and long pulses possible.

SEEDING SCHEME PHASE 1 (with delay):
High Harmonic Generation (**HHG**) mode (see also sFLASH):
Amplify an external, frequency multiplied seed laser.
Only short pulses, but close to single mode down to ~10 nm.

Seeding: presentation by S. Reiche (next talk).
General remark: seeding has advantages, but at a price!!!!

From now on only SASE

Beamline switching (FLASH1 and 2/3).



Tests started (promising results) to offer **FLASH1 and 2 BOTH 10 Hz**

Requirements:

- Pulser/Kicker
  - Stability to avoid orbit jitter.
  - Flatness for long pulse trains.
  - Rise or Fall time of <50 µs.
  - Switch length and starting point variable.
- Laser(s)
  - Different repetition rates and charges.
  - Switching to gun in <50 µs at different start time (related to kicker).
- LLRF
  - Different beam loading FLASH1 and 2/3.
  - Small tunability of gradient or ACC45 and ACC67 for wavelength scans FLASH1.
  - Small tunability in phases of Gun, ACC1, ACC39 for variation in compression FLASH1 and 2/3.

FLASH II: Electron beam parameters.

Beam parameters	
Beam Energy	0.5 – 1.25 GeV
Normalized emittance (proj.)	1.4 – 3 mm mrad
Energy spread	0.5 MeV
Peak Current	2.5 kA
Bunches per second	<8000
Bunch Charge	0.02 – 1 nC
Undulator parameters	
Period	31.4 mm
Segments length	2.5 m
Number of segments	12
Focusing Structure	F0D0

FLASH II: Photon beam parameters.

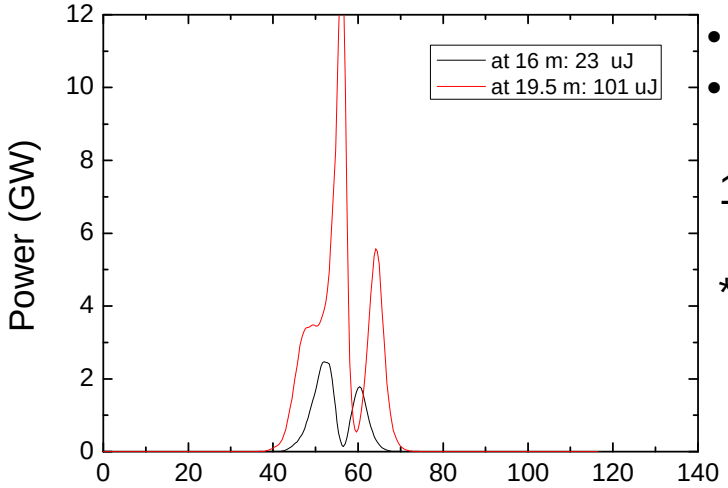
Radiation	SASE
Wavelength range SASE (nm)	4-60*
FWHM Pulse Length (fs)	10-500
Peak Power (GW)	1-5
Bandwidth (%)	0.5 – 2%
Number of pulses	<8000**
Peak Brilliance***	10^{28}-10^{31}
Pulse Energy (μJ)	1-500

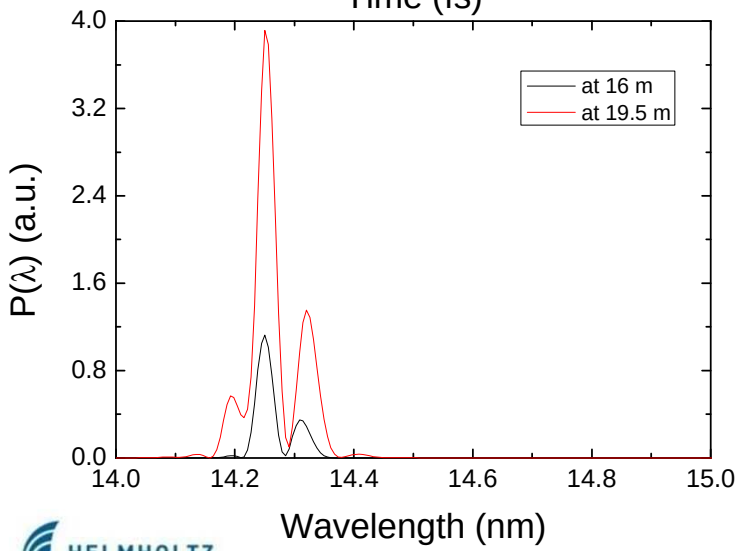
*40 (@0.7 GeV), 60 (@0.6 GeV) or 80 nm (@0.5 GeV) as maximum wavelength
Only <100 μrad rms opening angle loss free transport (probably around 60 nm)

**pulses shared between FLASH1 and FLASH2
***Photons/(s mrad^2 mm^2 0.1%)

Pulse Energy, pulse length, 10 fs rms bunch length.

Example at 1.2 GeV
4.5 nm at FLASH1



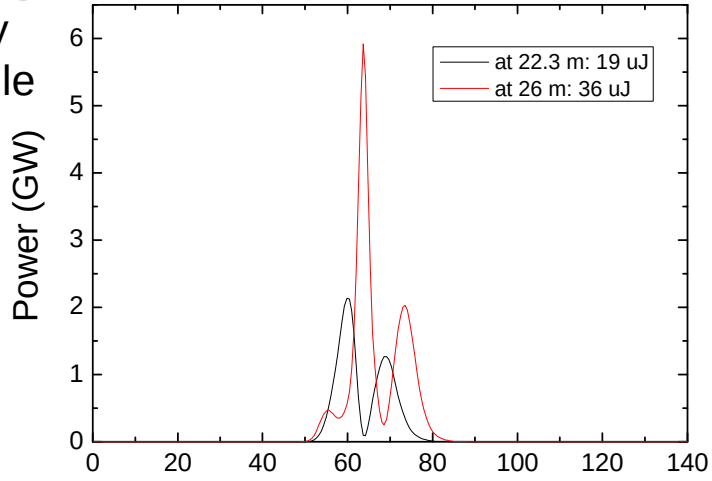


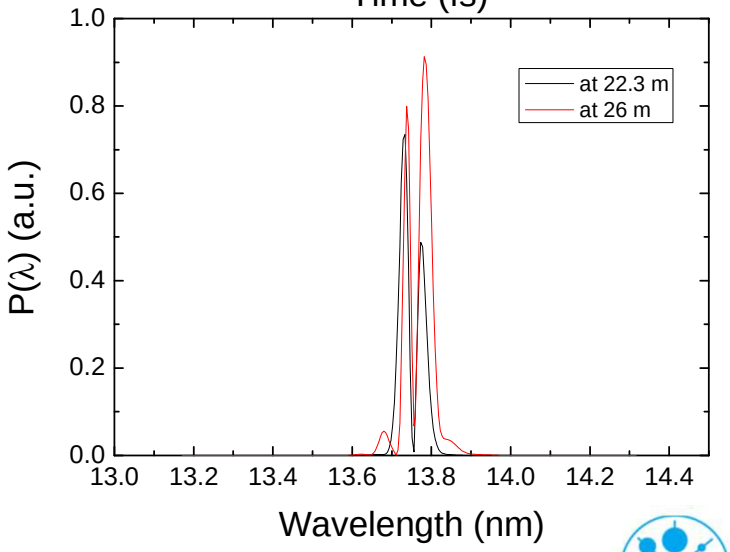
If FLASH1 changes to a different energy

- Different saturation length
- Different Pulse Energy
- Different Opening Angle

120 µrad* at 1.2 GeV
70 µrad* at 0.7 GeV
*both FWHM

Example at 0.7 GeV
13 nm at FLASH1





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Photon parameters.

In theory 1 mJ can be reached at 1 nC (also for FLASH1)

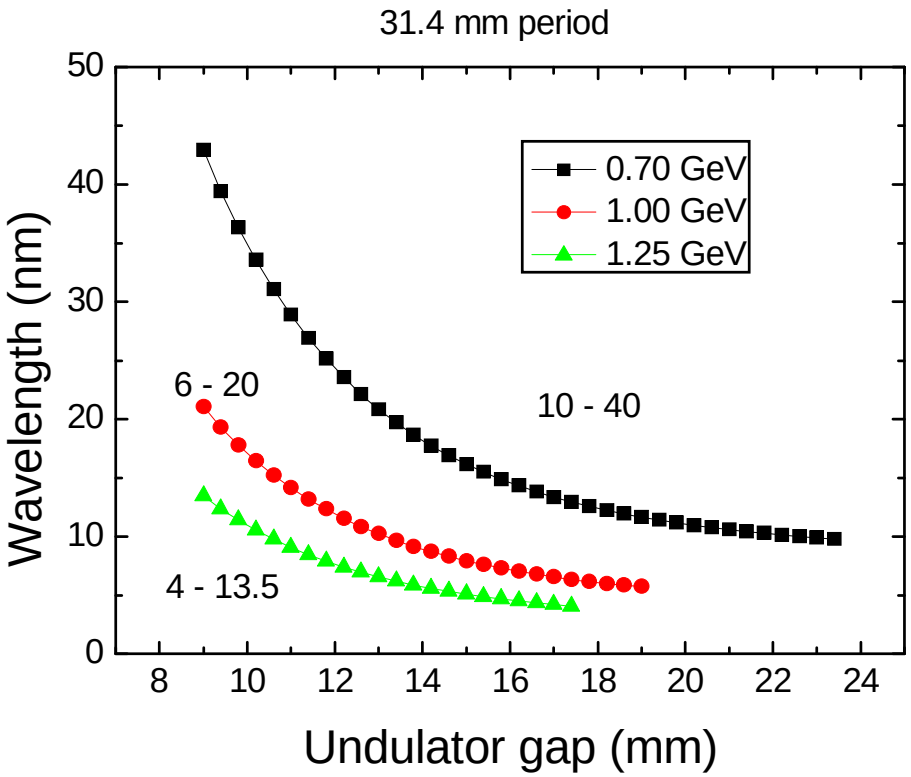
- ✓ Dispersion closed
- ✓ Ideal compression
- ✓ RF parameters controlled at top level (stability)

- Maximum reached so far is ~450 µJ (single bunch at 10 Hz)
- Improvement to get FLASH1 pulse energy up will also benefit FLASH2

At FLASH2, pulse energies will be comparable to FLASH1 (depending on undulator K)
Simultaneous operation of FLASH1 and FLASH2 will make optimal performance of both challenging.

Simulation results with more detailed SASE parameters (pulse energy, opening angle, pulse duration for different beam parameters) will appear on the WEB: http://flash2.desy.de

Wavelength range for main energies by varying the undulator gap.



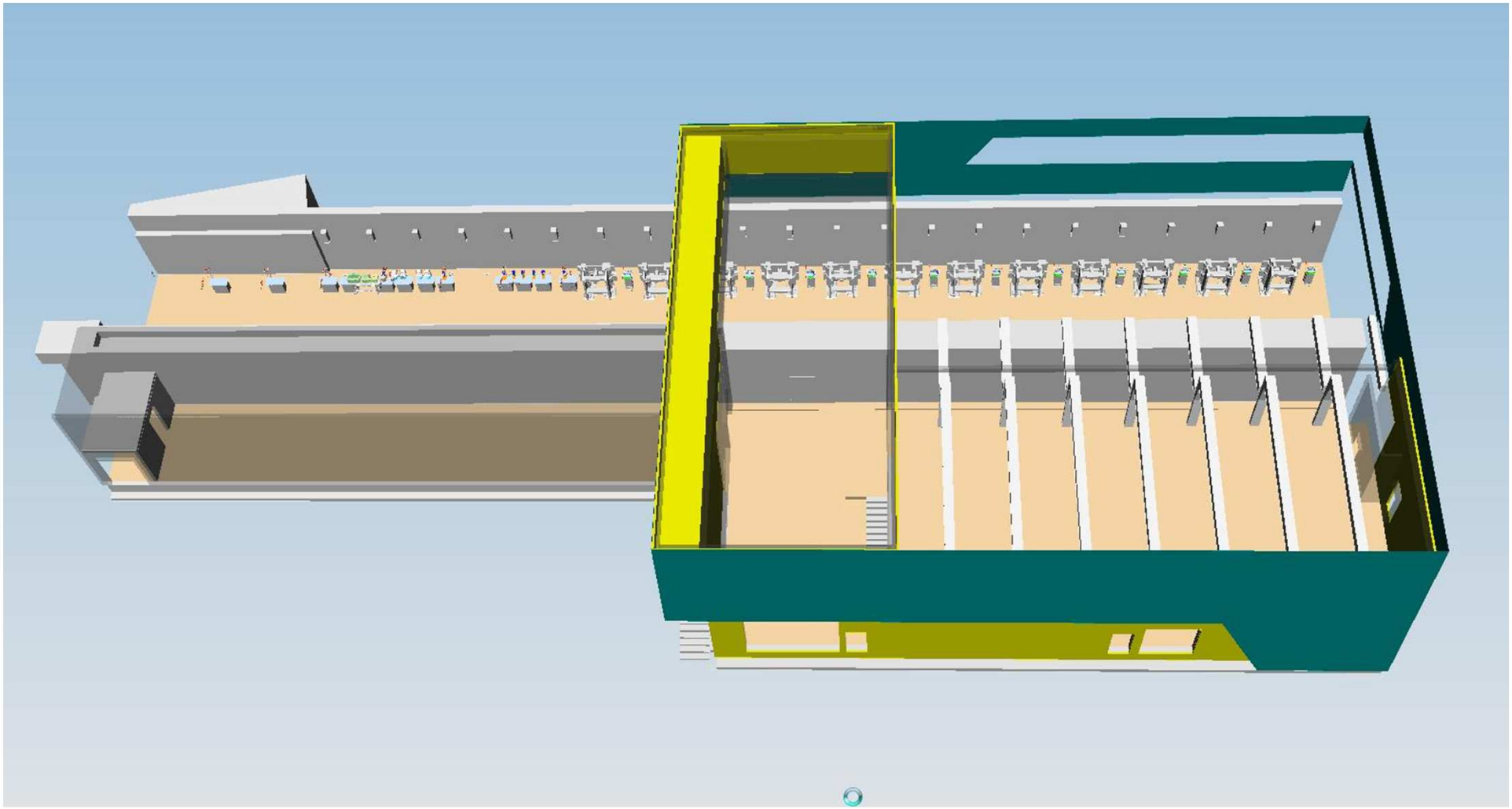
Energies mostly used at FLASH

For each energy, around 60% of all experiments can be scheduled

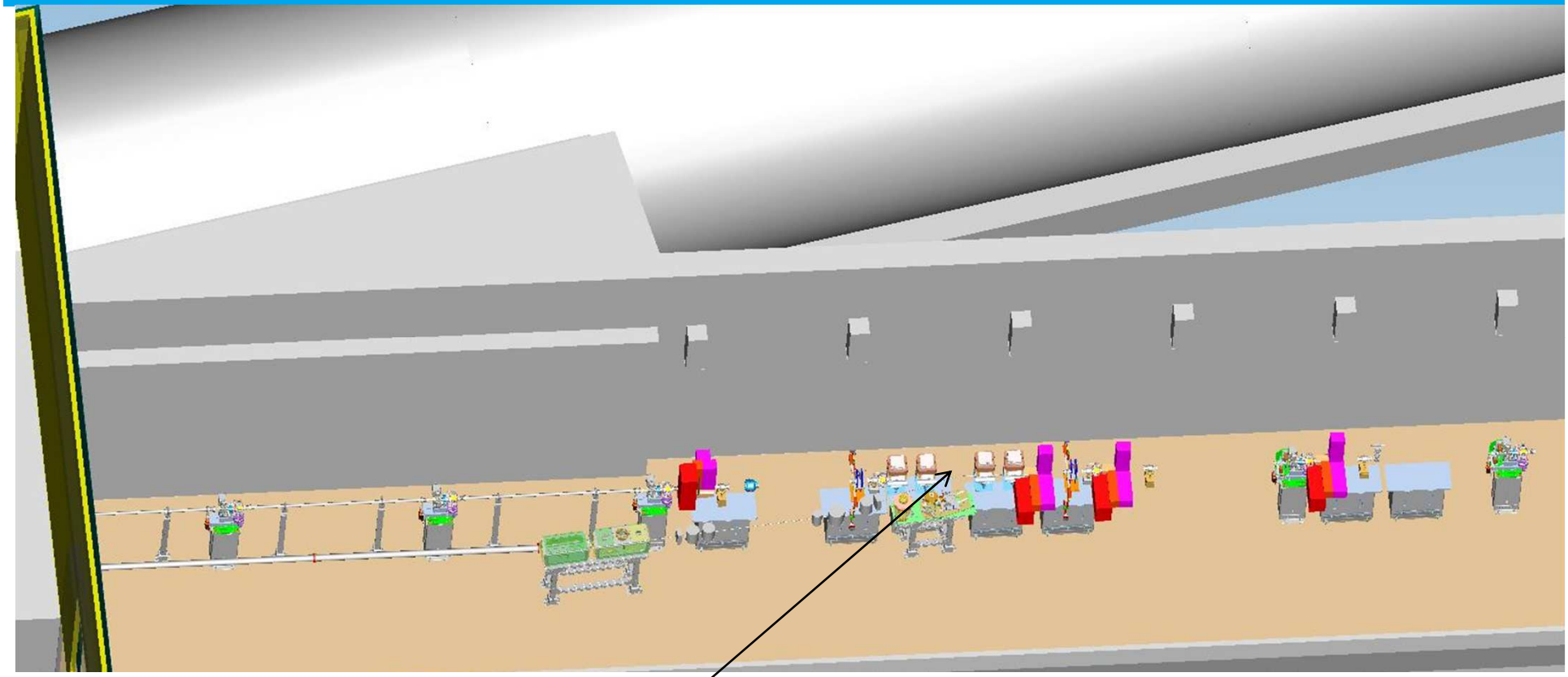
10-40 nm at 0.7 GeV with HHG seeding
>40 nm with energies below 0.7 GeV

Status of Planning: Main Tunnel Segment.

Main Tunnel with SEED and SASE Section
SEED Section only temporary beamline
SASE complete, but not all diagnostics: only linear polarization foreseen

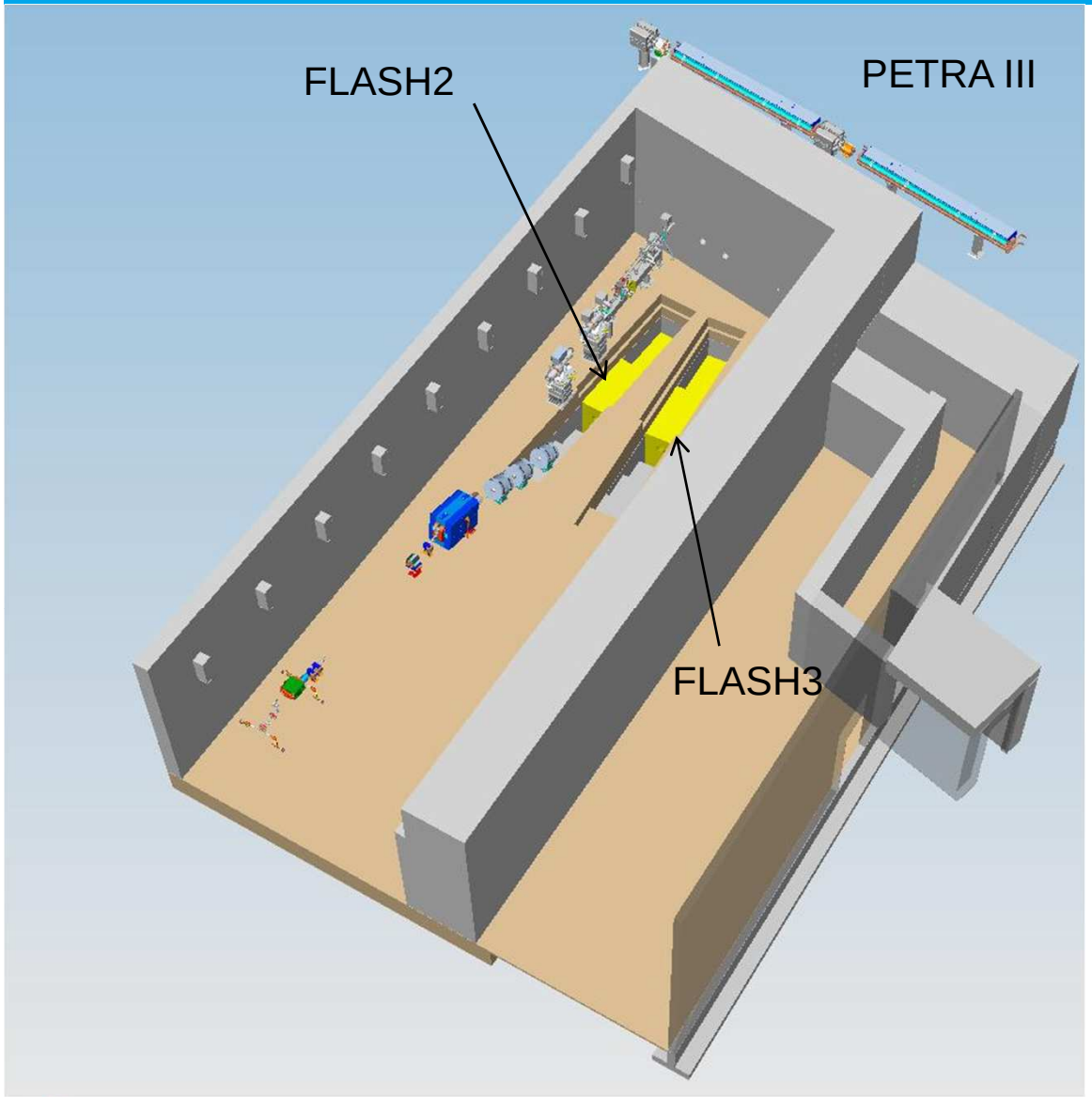


Status of Planning: HHG Seeding.



Development on seed laser, source and diagnostics on schedule
Detailed Diagnostics design at the moment not covered
Incoupling of HHG delayed

Dump Area: Space reserved for upgrades.



Installed from the start:

- Dump for FLASH3
- Extraction FLASH3
- Infrastructure FLASH3

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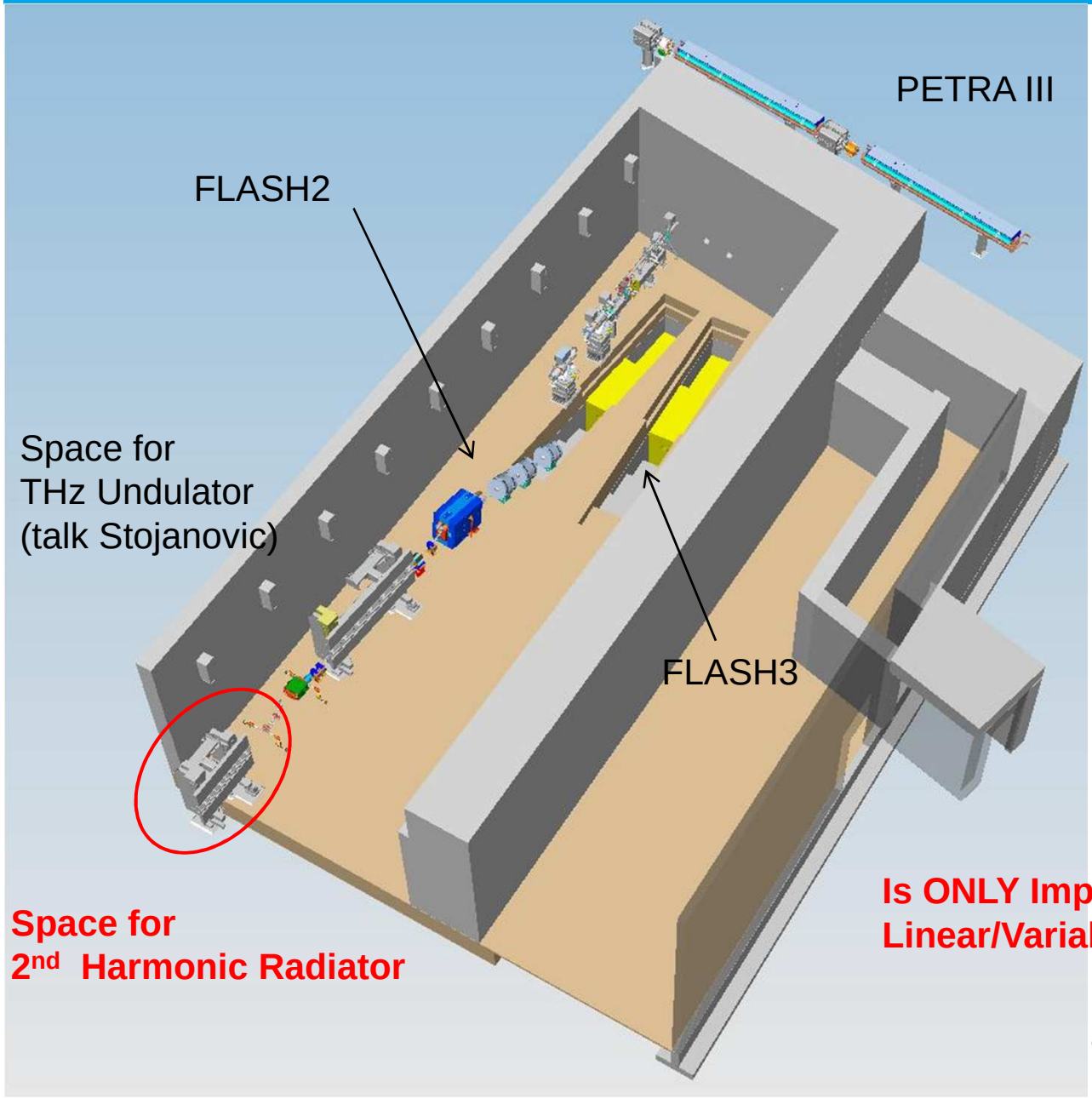
+upgrades in FLASH2

Proposed Extensions.



2nd Harmonic Radiator
Wavelength range to 2 nm
Covers complete Water Window
Pulse Energy up to ~1 uJ

Is ONLY Implemented on user demand!!!!
Linear/Variable Polarization????

Progress still as planned.

Construction:

- Phase 1, Extraction (Sept. – Dec. 2011): Shutdown FLASH needed
- Phase 2, Dump (Jan. – Feb. 2012): Shutdown PETRA needed
- Phase 3, main Tunnel and Hall (Feb. – Oct. 2012): FLASH and PETRA running
- Phase 4, Vacuum connection FLASH 1 (Jan. – March. 2013): Shutdown FLASH needed

2013 Commissioning of FLASH2 undulator line
2014 User Operation “interleaved” with studies

Timeslot needed for implementation of HHG seeding scheme at later stage….

Most of the Tunnel Design is being finalized, but most interesting for users:

- Do you want to cover the complete water window?
- What wishes do you have with respect to the beamlines/end stations (Talk by Ploenjes)?