FLASH II

FLASH II: a second undulator line and future test bed for FEL development

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Outline

- Proposal
- Background
- Parameters
- Layout
- Chalenges
- Timeline
- Cost estimate
- Personnel requirements
- Future extensions

Proposal

FLASH II

A combined proposal of BESSY and DESY

Present coordinators:

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Other institutes have expressed interest in collaboration

Main goals:

Extend user beam time

Further development of FEL technology (until 2013 HHG and HGHG)

Background

- User time overbooked: additional user stations needed
- Minimize interference between needed development and user operation
- Tuning time of the machine reduced by use of
  - 3rd harmonic
  - variable gap undulator → independent wavelength
- Offer improved spectral and spatial stability by seeding schemes
  - → Full transverse and longitudinal coherence

- Make use of available developments for FLASH, XFEL and PETRA III
- Make use of the combined expertise at BESSY and DESY for simulations and hardware development

Parameters: variable gap undulators

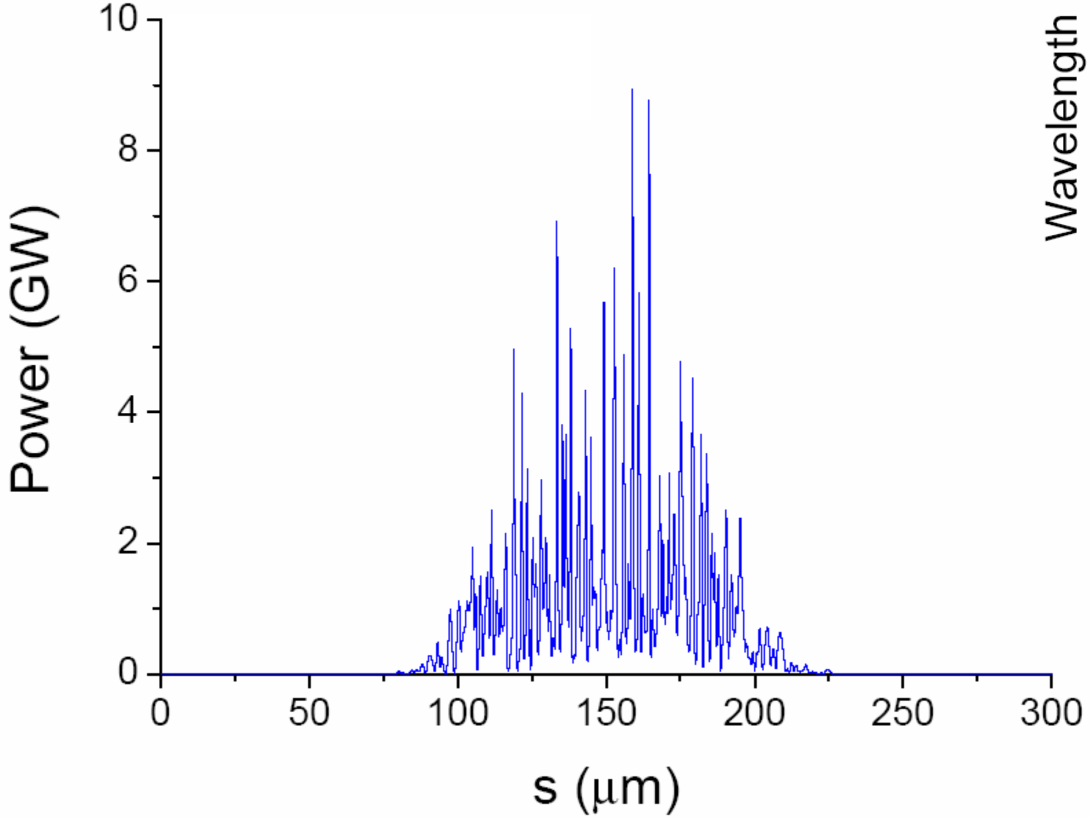
	ps pulses	fs pulses (including HHG/HGHG)
Energy range	0.45 – 1.2 GeV	0.45 – 1.2 GeV
Peak current	~ 2.5 kA	1 - 2.5 kA
Emittance	~1.5 mm mrad	1.5 – 3 mm mrad
Energy spread	0.2 MeV	0.2 MeV
Wavelength range	<5 - 60 nm	<5 - 60 nm
Pulse Energy	50-500 μJ	<50 μJ

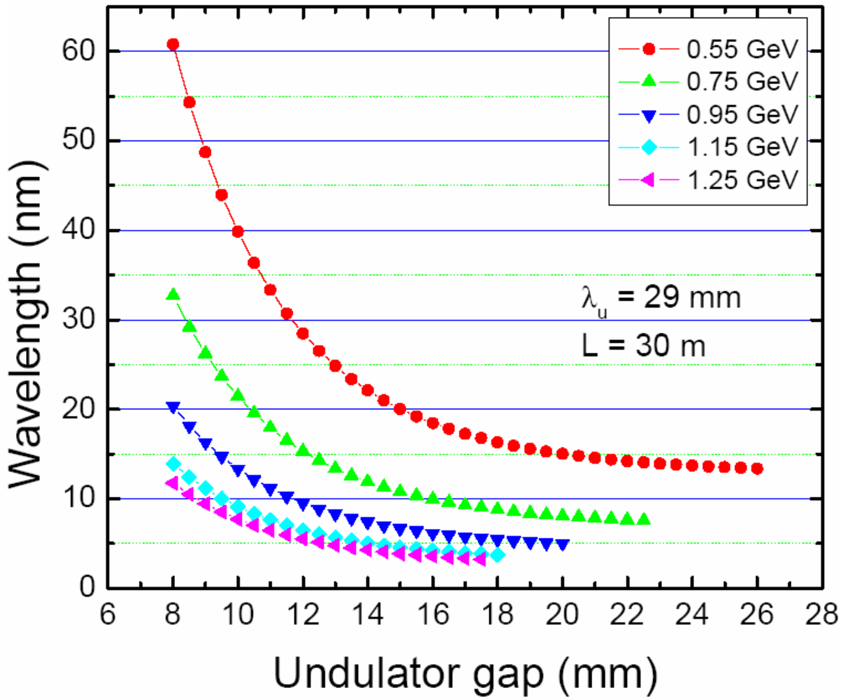
SASE at 1 MHz over full wavelength range
HHG at 10 Hz to 100 kHz down to 30 nm, possibly 13 nm (tests at sFLASH)
HGHG at 10 Hz down to 8, probably 4 nm at reduced power
Combined HHG/HGHG

Bandwidth about 1% for SASE, close to Fourier limited for HHG and HGHG

SASE simulation results

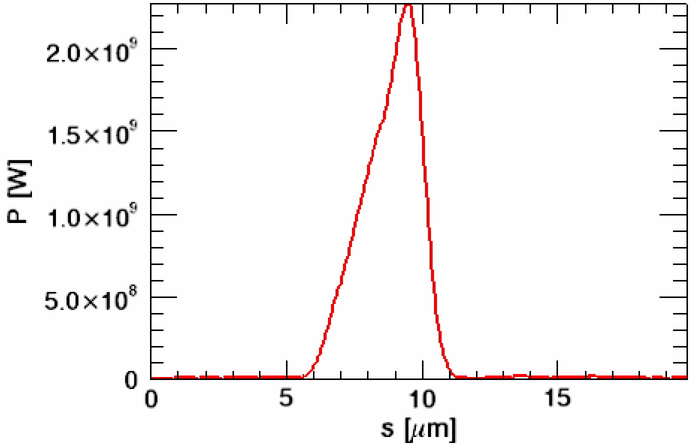
Using gap tunability

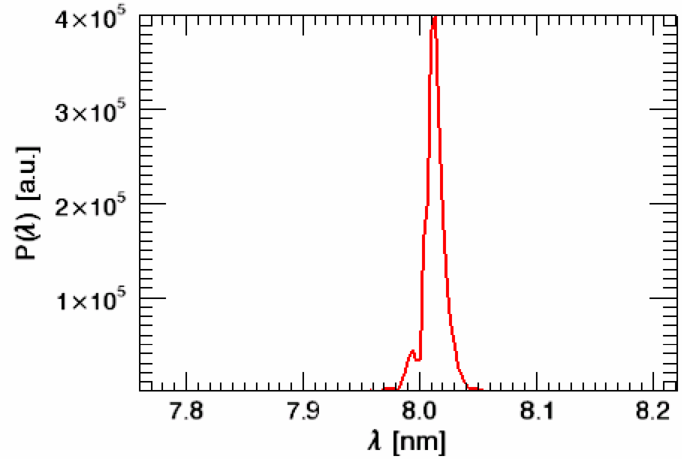




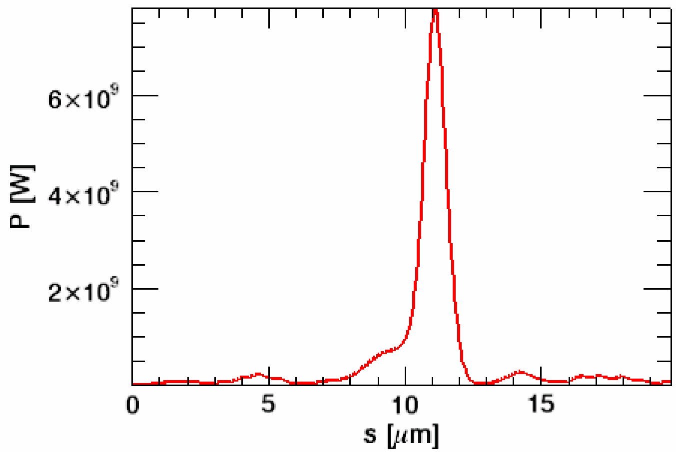
HGHG simulation results

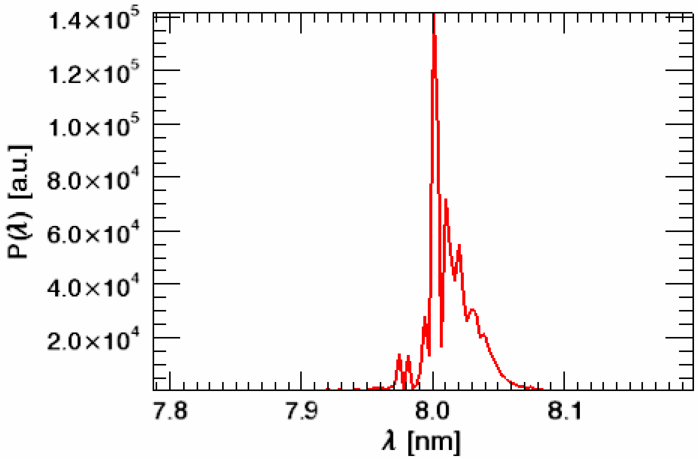
200MW-seed peak power, at z=8m





200MW-seed peak power, at z=13.8m





Courtesy A. Meseck, BESSY

HGHG tunability

$\frac{\lambda}{6}=$	$\frac{\lambda}{8}=$	$\frac{\lambda}{9}=$	$\frac{\lambda}{10}=$	$\frac{\lambda}{12}=$	$\frac{\lambda}{15}=$	$\frac{\lambda}{20}=$	$\frac{\lambda}{25}=$
32.5	24.375	21.667	19.5	16.25	13	9.75	7.8
32.667	24.5	21.778	19.6	16.333	13.067	9.8	7.84
32.833	24.625	21.889	19.7	16.417	13.133	9.85	7.88
33	24.75	22	19.8	16.5	13.2	9.9	7.92
33.167	24.875	22.111	19.9	16.583	13.267	9.95	7.96
33.333	25	22.222	20	16.667	13.333	10	8
33.5	25.125	22.333	20.1	16.75	13.4	10.05	8.04
33.667	25.25	22.444	20.2	16.833	13.467	10.1	8.08
33.833	25.375	22.556	20.3	16.917	13.533	10.15	8.12
34	25.5	22.667	20.4	17	13.6	10.2	8.16
34.167	25.625	22.778	20.5	17.083	13.667	10.25	8.2

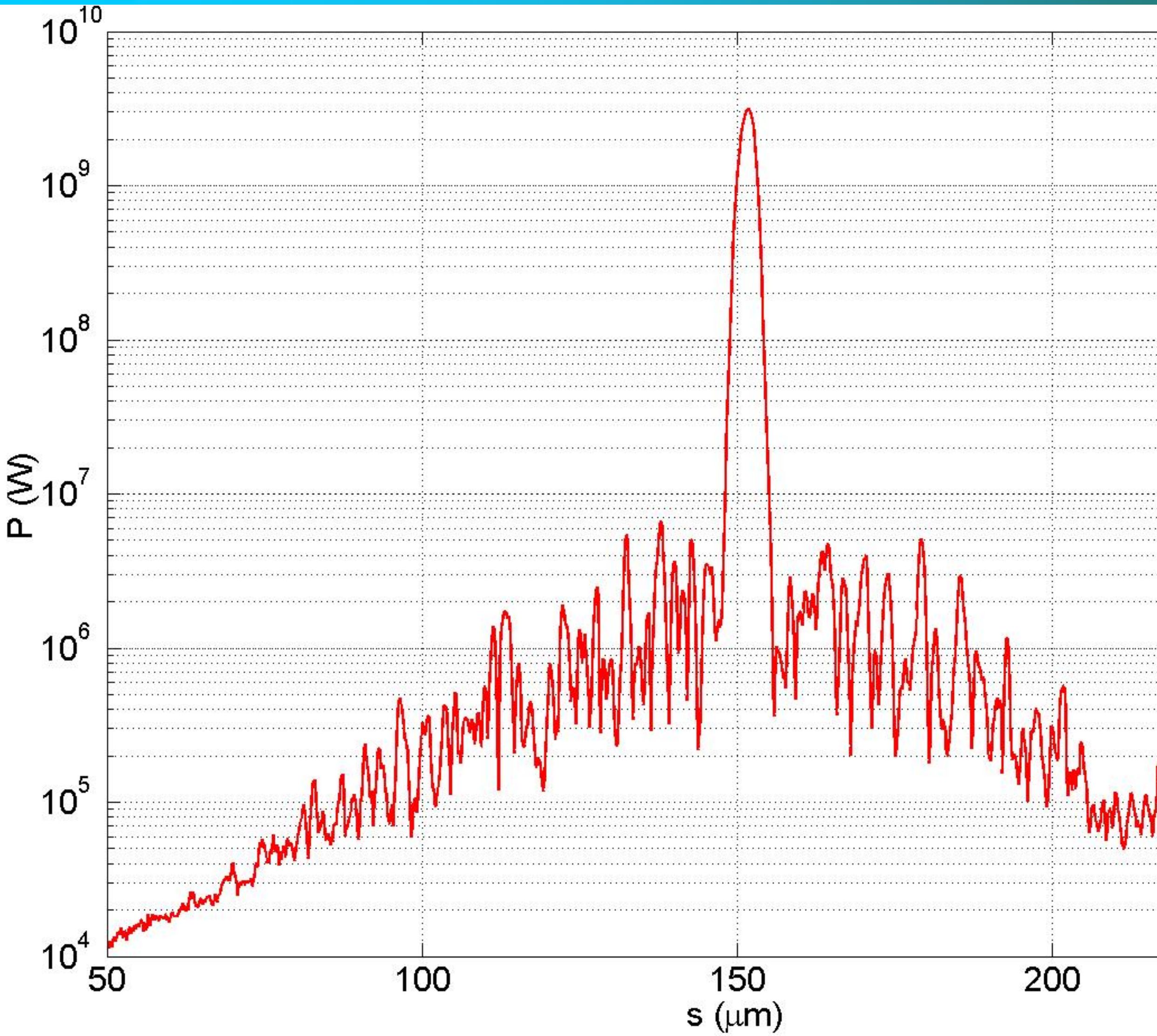
4.Harm TISA

$\frac{\lambda}{6}=$	$\frac{\lambda}{8}=$	$\frac{\lambda}{9}=$	$\frac{\lambda}{10}=$	$\frac{\lambda}{12}=$	$\frac{\lambda}{15}=$	$\frac{\lambda}{20}=$	$\frac{\lambda}{25}=$
38.889	29.167	25.926	23.333	19.444	15.556	11.667	9.333
39.722	29.792	26.481	23.833	19.861	15.889	11.917	9.533
40.556	30.417	27.037	24.333	20.278	16.222	12.167	9.733
41.389	31.042	27.593	24.833	20.694	16.556	12.417	9.933
42.222	31.667	28.148	25.333	21.111	16.889	12.667	10.133
43.056	32.292	28.704	25.833	21.528	17.222	12.917	10.333
43.889	32.917	29.259	26.333	21.944	17.556	13.167	10.533
44.722	33.542	29.815	26.833	22.361	17.889	13.417	10.733
45.556	34.167	30.37	27.333	22.778	18.222	13.667	10.933
46.389	34.792	30.926	27.833	23.194	18.556	13.917	11.133
47.222	35.417	31.481	28.333	23.611	18.889	14.167	11.333

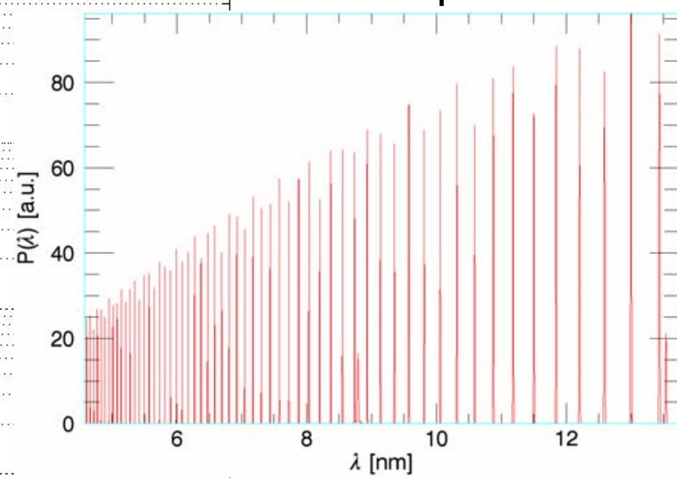
3.Harm TISA

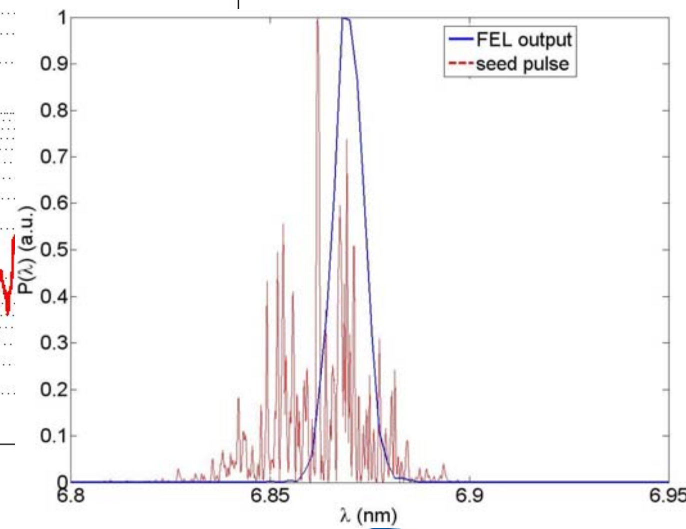
Courtesy A. Meseck, BESSY

HHG simulation results



HHG input

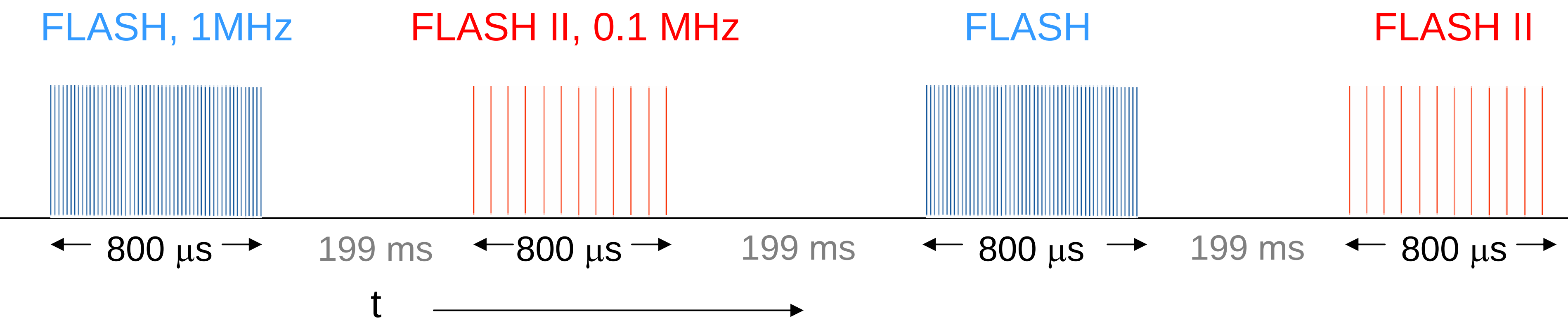




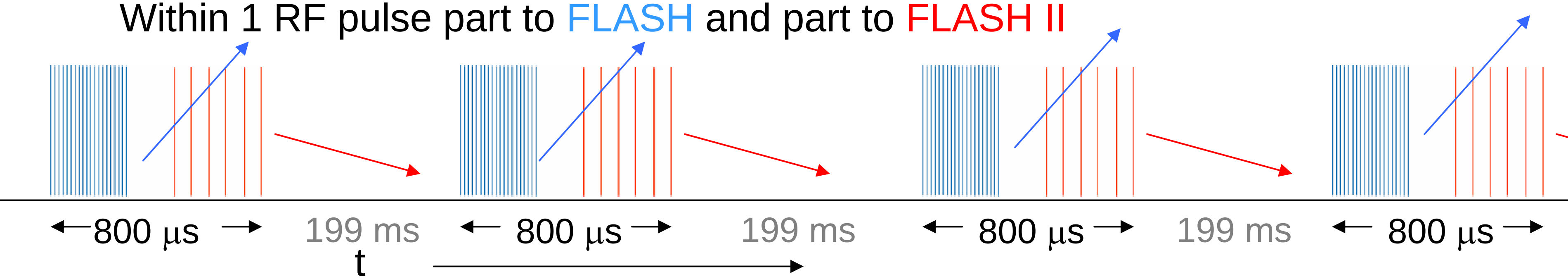
Courtesy V. Miltchev, Uni. Hamburg

Beamline switching

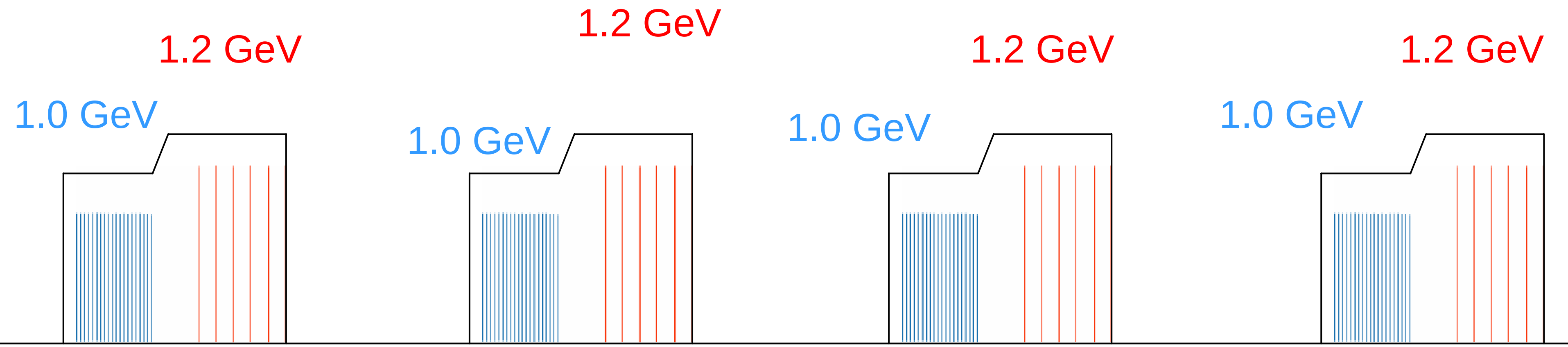
From pulse to pulse to FLASH or FLASH II



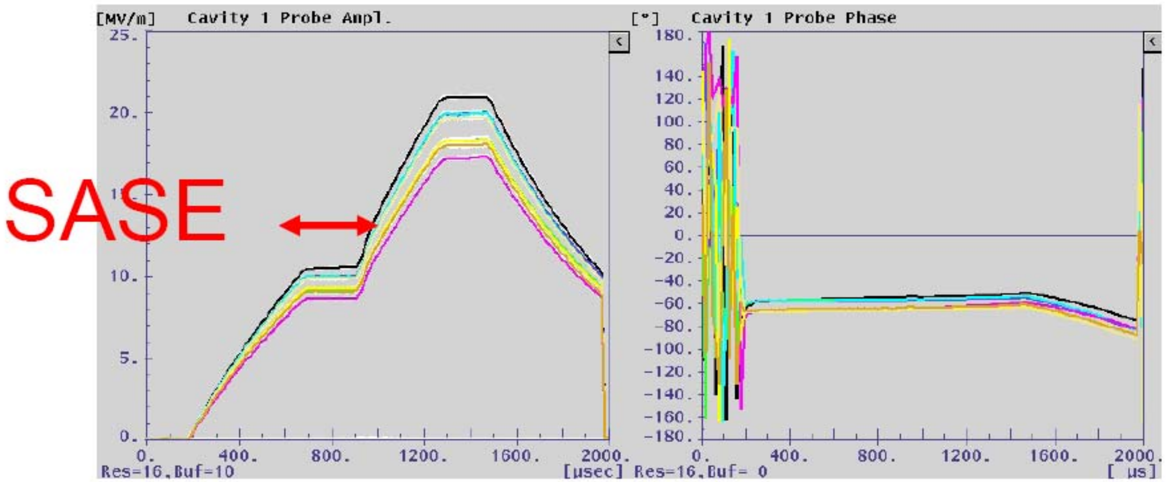
Within 1 RF pulse part to FLASH and part to FLASH II



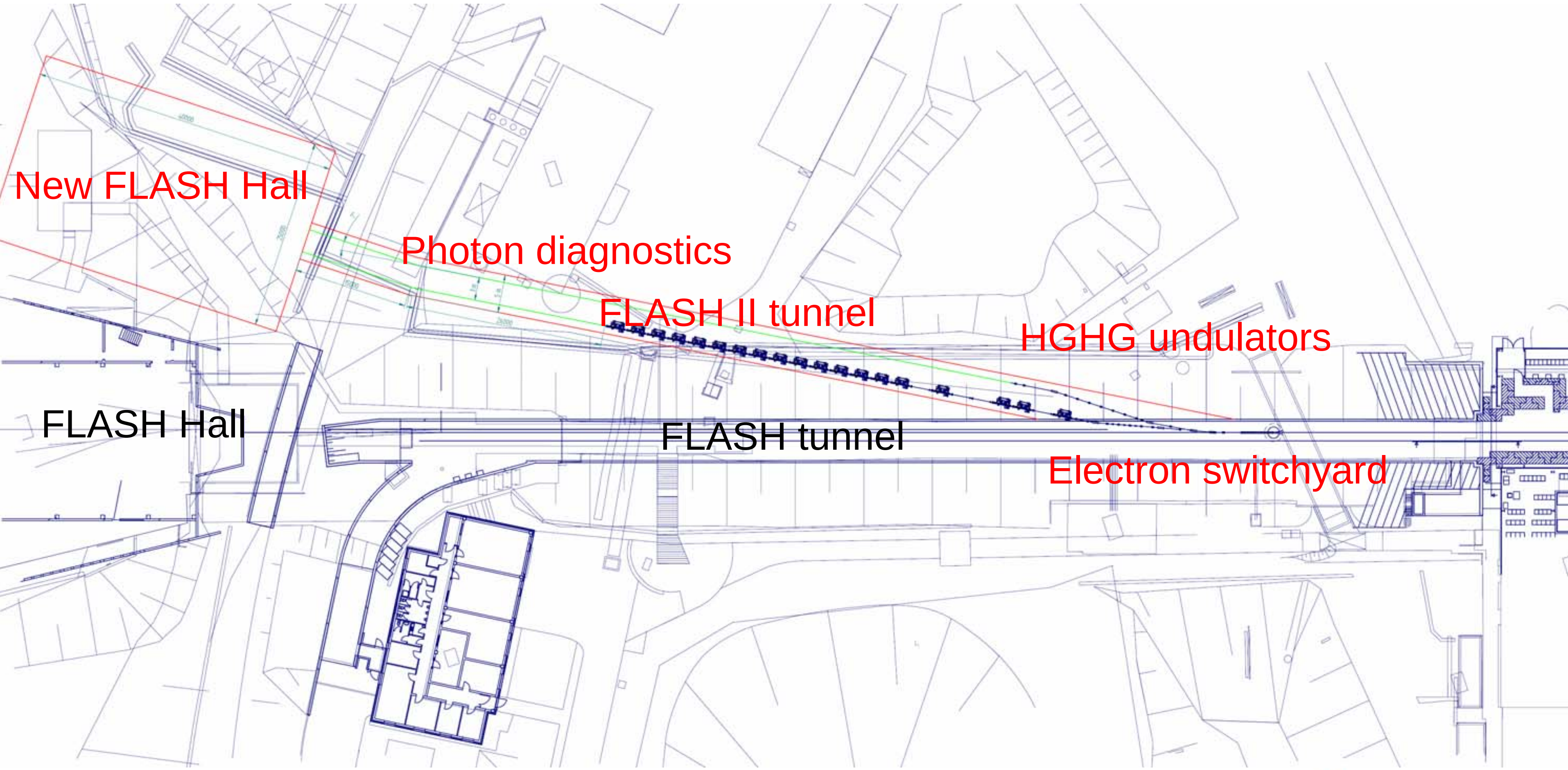
Switching with different gradients: EXOTIC



Machine running at 5 or 10 Hz, both users have 5 or 10 Hz



Layout

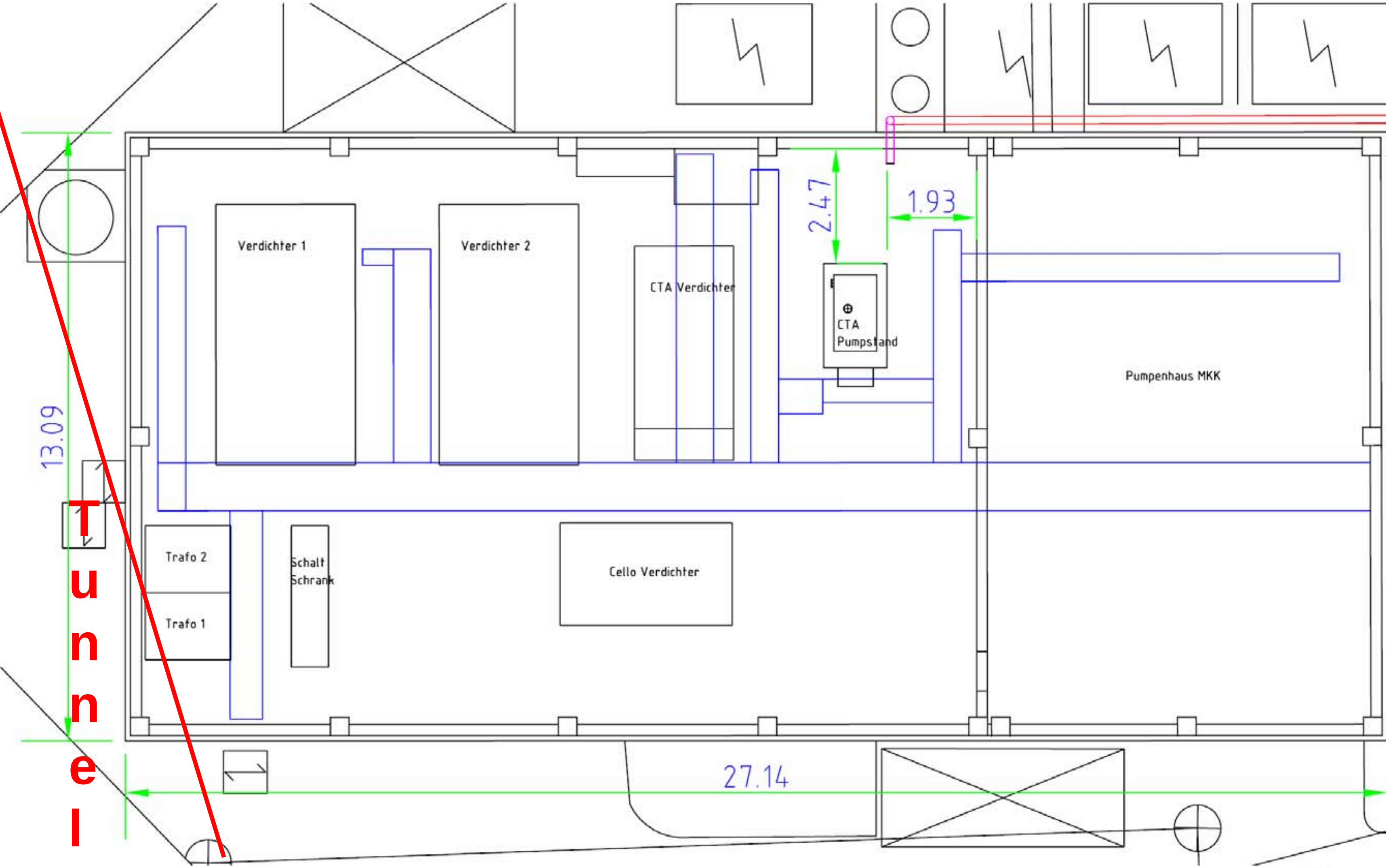

New FLASH Hall
Photon diagnostics
FLASH II tunnel
HGHG undulators
FLASH Hall
FLASH tunnel
Electron switchyard

Layout detail

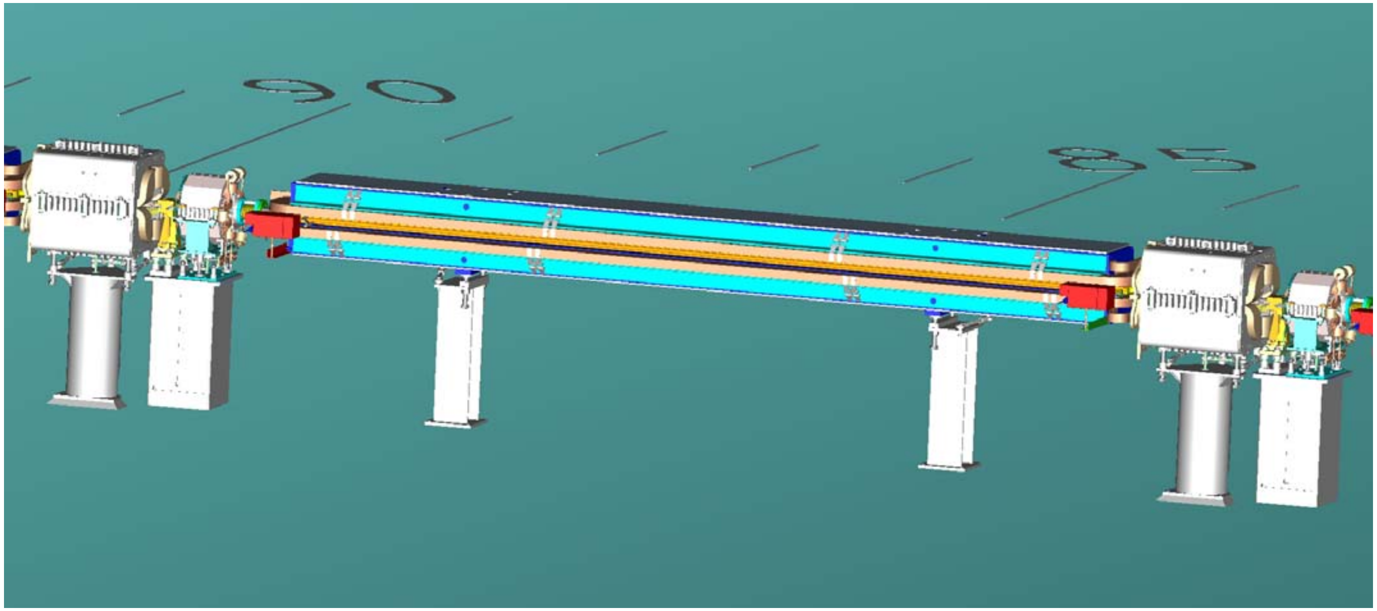
Cables/pipes along FLASH, crossing 47A, (new) cables at position experimental hall, He pipes etc. from 47A towards tunnel (FLASH backup)

New PETRA cables may determine length PETRA shutdown

Crossing 47A



Crossing PETRA



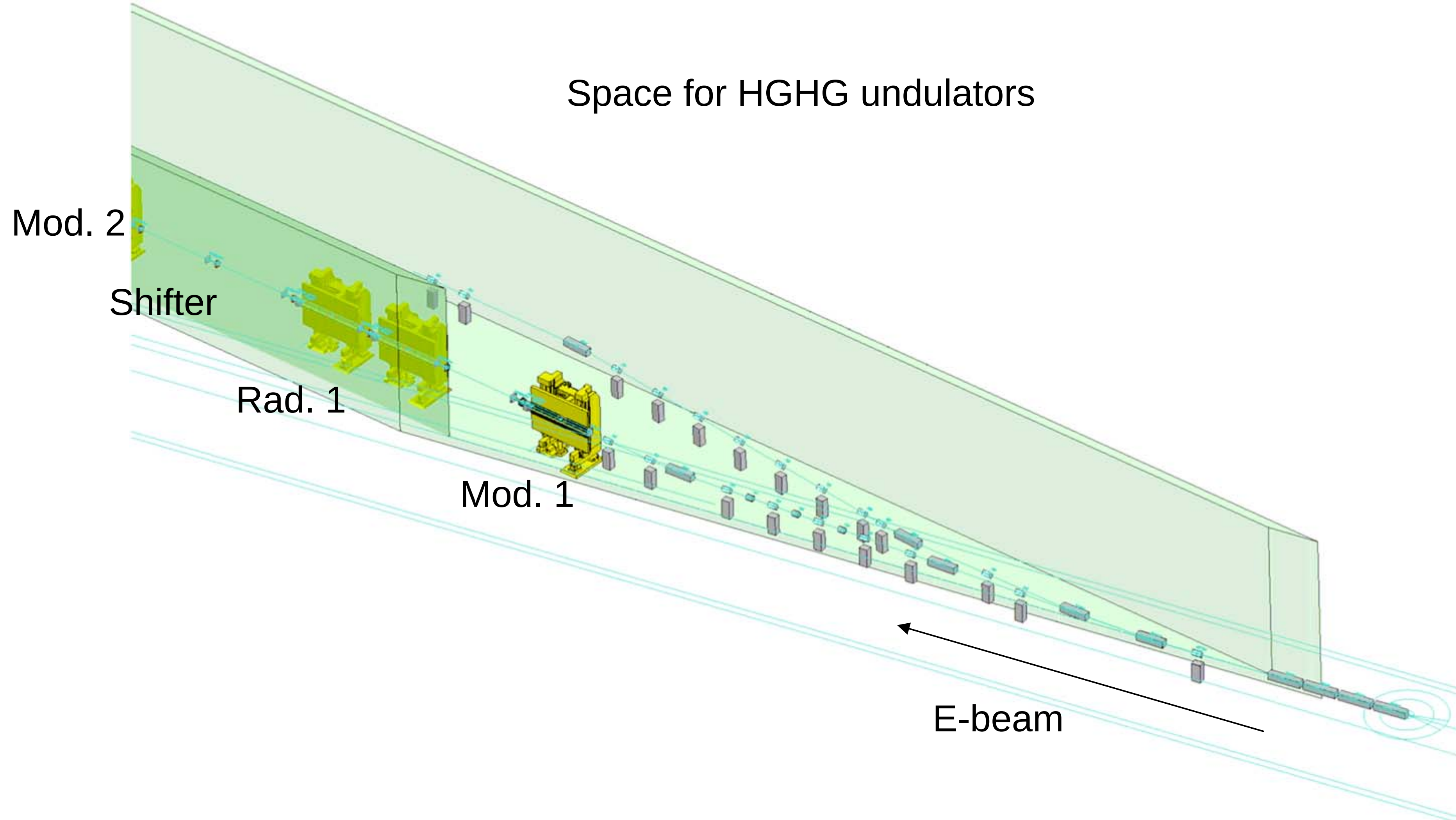
Beamlines

XUV
VUV
THz

Exact angle FLASH II compared to FLASH is determined by PETRA supports

Final angle determines the conflict with bldg. 47 A

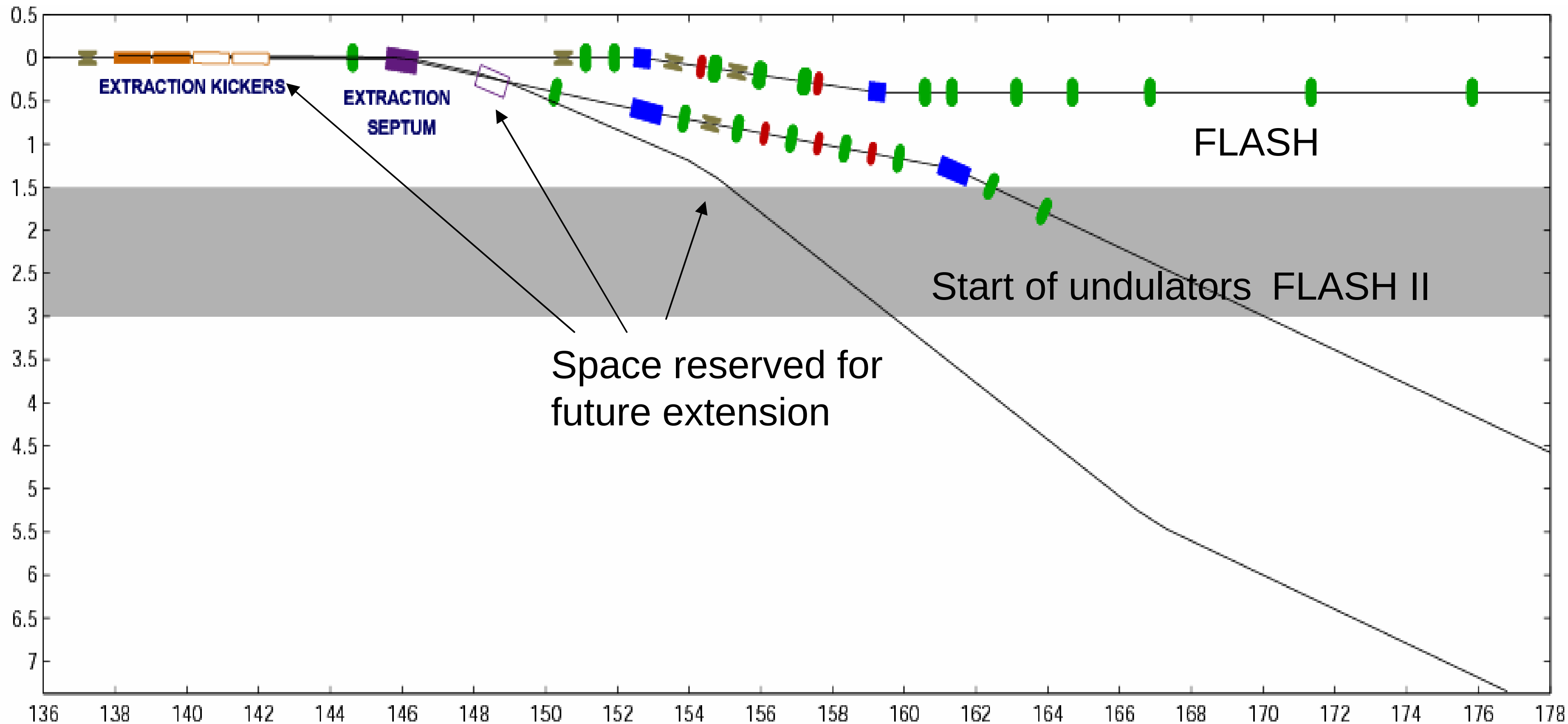
Layout for e-beam separation



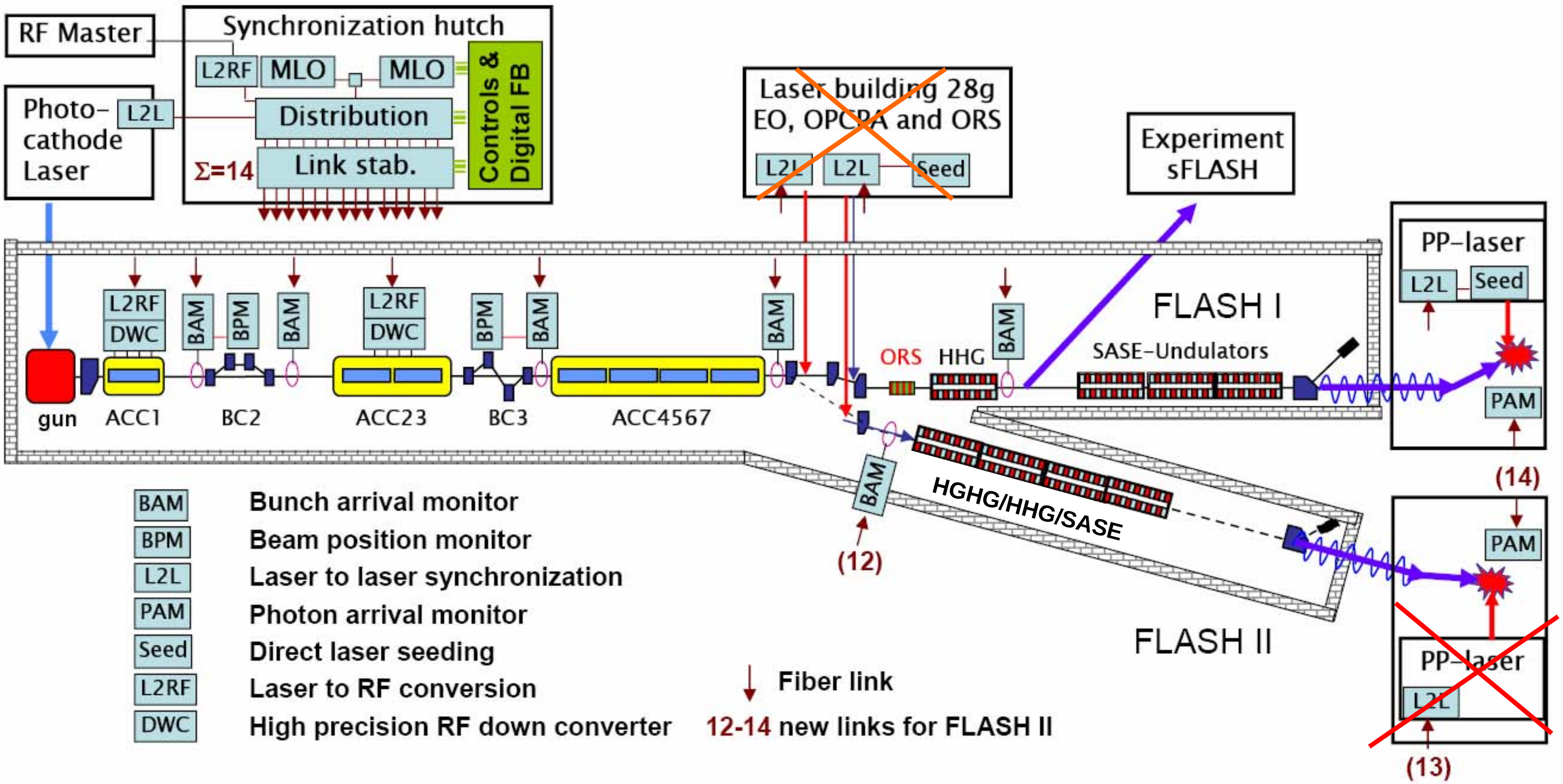
Layout: separation

E-beam

Optics simulations



Synchronization



Courtesy H. Schlarb, DESY

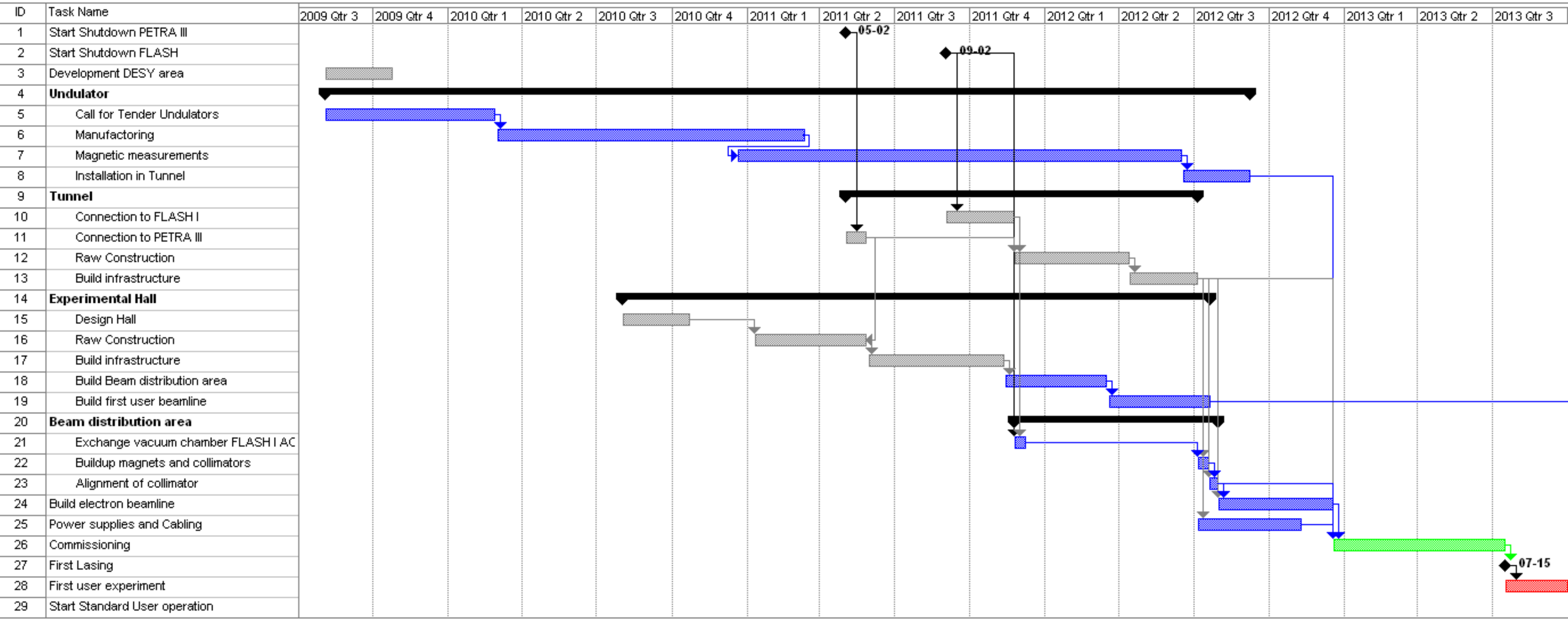
Challenges

Control of the electron beam parameters for seeding schemes
Fast tunability of the seeding wavelength
Switching between both undulator lines → independent of FLASH I
Switching between pulse trains/Switching within a pulse train (XFEL)
Correction of beam orbit, undulator gap, adjustment of optics and diagnostics

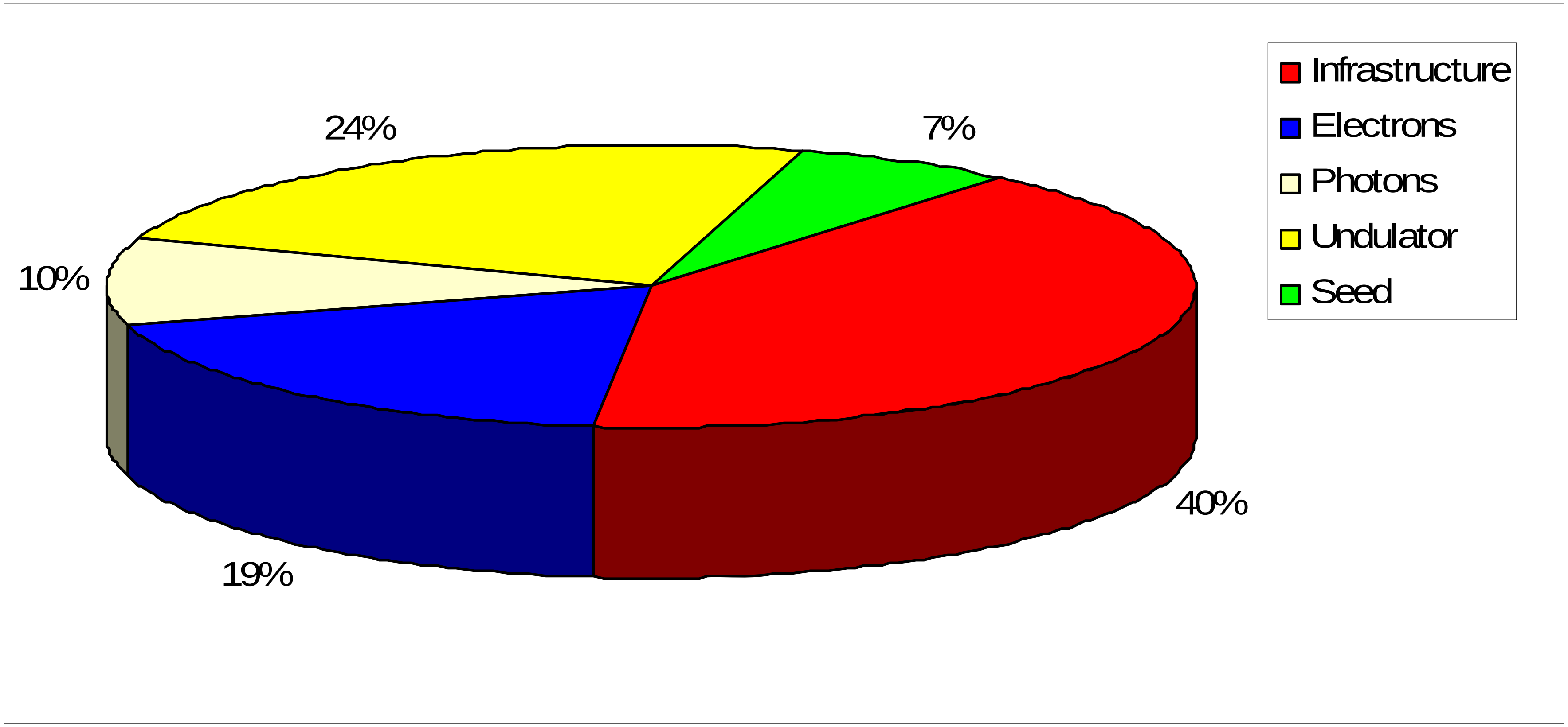
Keeping within budget
Keeping within time/personnel constrains

Timeline

Starting point determined by “call for tender” undulators
Critical points are connection with PETRA and FLASH



Rough Cost estimate FLASH II base design



Total cost of about 30 M€

'Detailed' Cost estimate

Not yet available

Personnel needs

Not yet available

Future extensions

NOT included in present planning but space is foreseen:

Upgrade of HHG laser to 1 MHz
Upgrade of undulator to variable polarization at full power*
Pump-probe of seeded FEL with THz source (FIR undulator)
Pump-probe of seeded FEL with optical laser
Pump-probe of SASE FEL synchronized, femtosecond UV radiation
Additional user stations

Dream for the future:
Full seeding at 1MHz over the entire wavelength range from 60 to <5 nm

*at reduced power the crossed undulator scheme is being studied

Summary

Many details are still under study
Many issues are still not fixed
→ determined by user needs and available budget
Support needed from users, DESY, BESSY, …..