Fixed Target Experiments at

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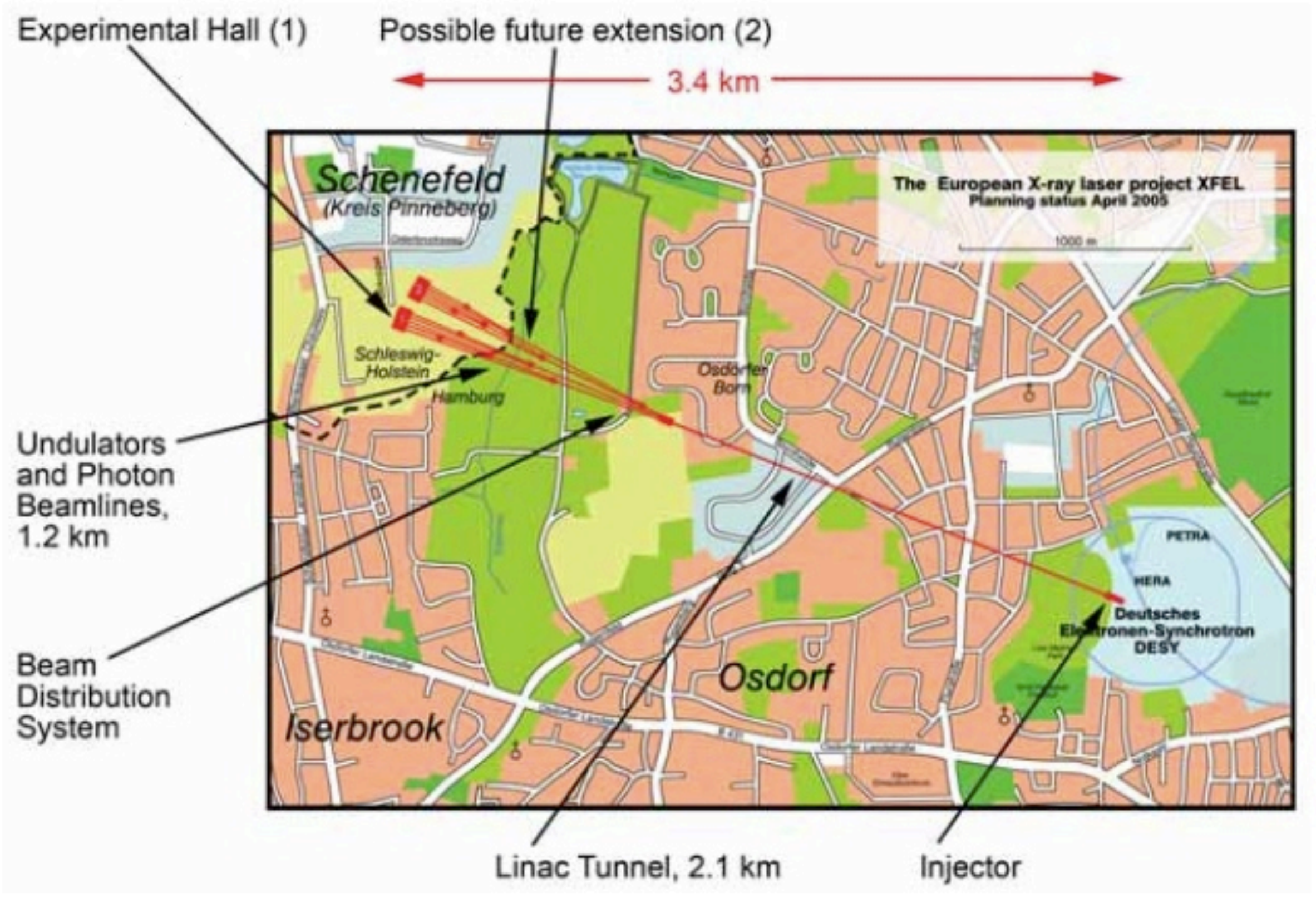
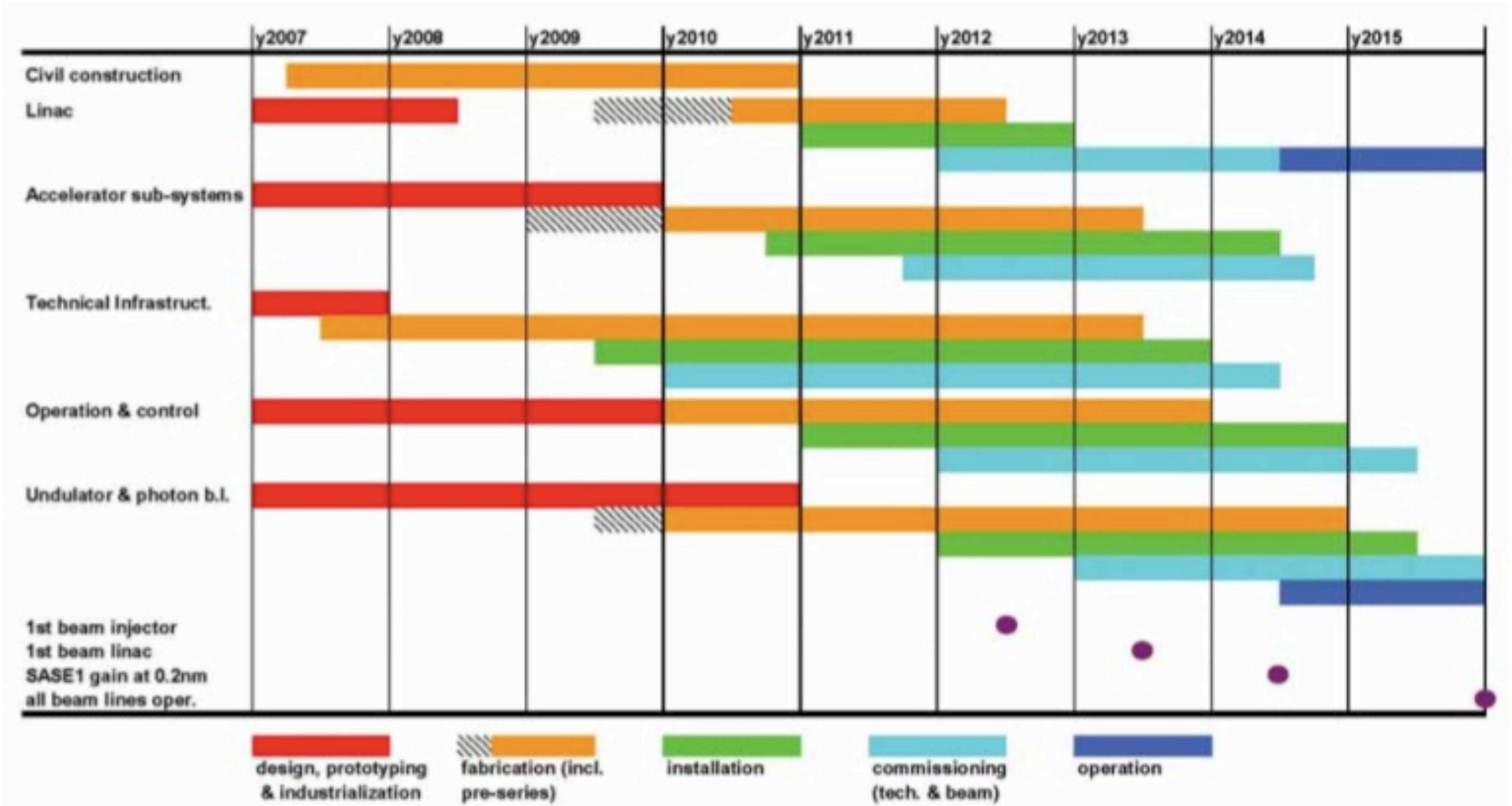
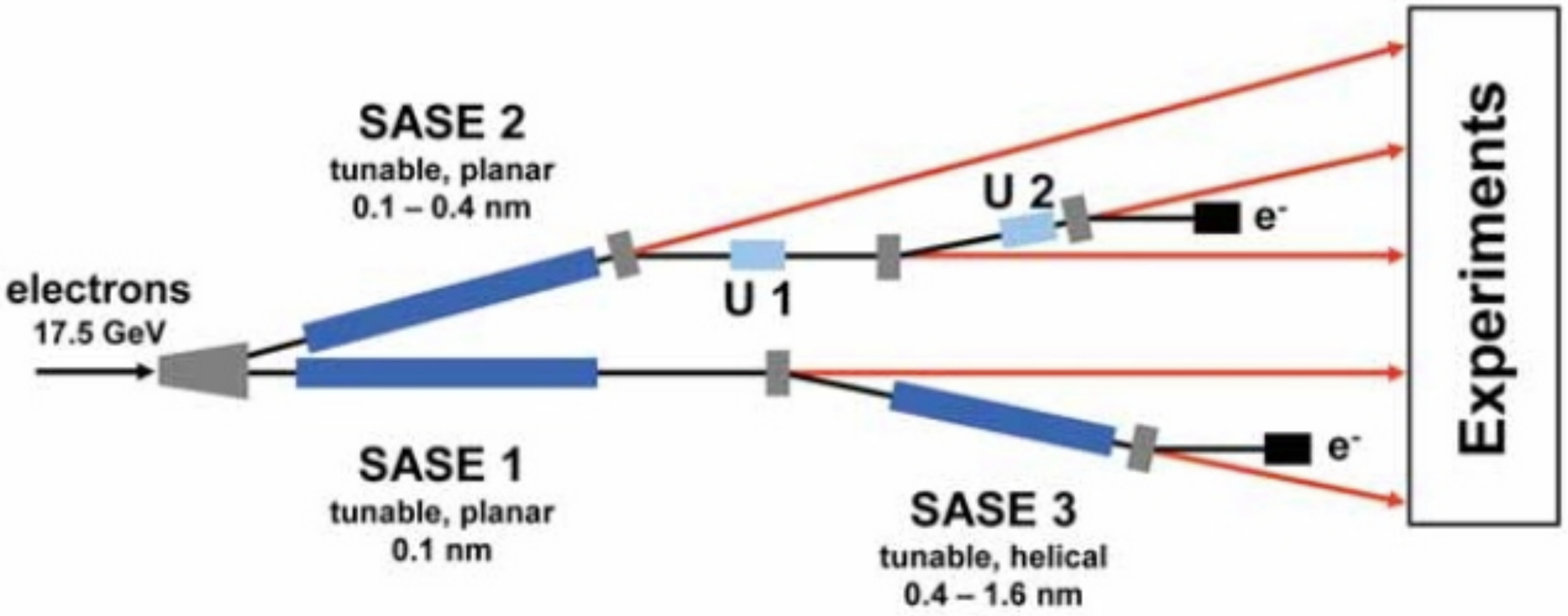
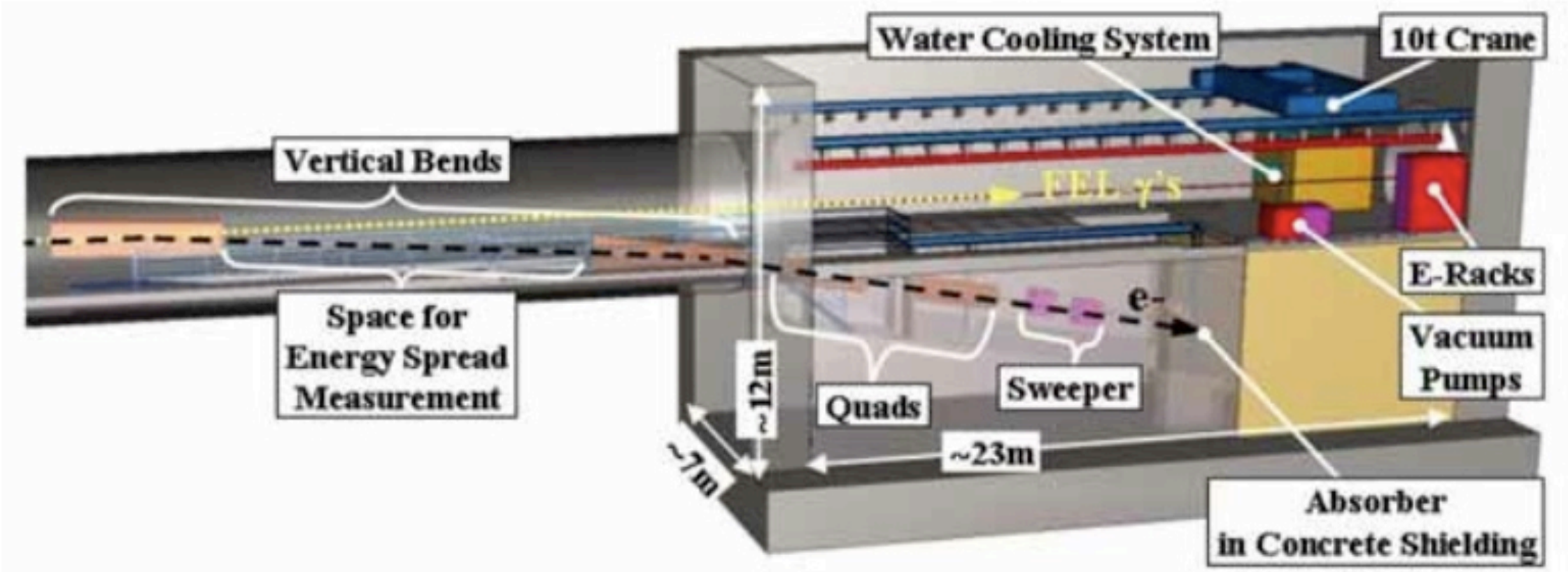
Technical design report http://xfel.desy.de/tdr/tdr/


Experimental Hall (1)
Possible future extension (2)
3.4 km
Undulators and Photon Beamlines, 1.2 km
Beam Distribution System
Linac Tunnel, 2.1 km
Injector
Schenefeld
(Kreis Pinneberg)
Schleswig-Holstein
Hamburg
Osdorfer Born
Osdorf
Iserbrook
The European X-ray laser project XFEL
Planning status April 2005
1000 m
PETRA
HERA
Deutsches Elektronen-Synchrotron DESY


y2007
y2008
y2009
y2010
y2011
y2012
y2013
y2014
y2015
Civil construction
Linac
Accelerator sub-systems
Technical Infrastruct.
Operation & control
Undulator & photon b.l.
1st beam injector
1st beam linac
SASE1 gain at 0.2nm
all beam lines oper.
design, prototyping & industrialization
fabrication (incl. pre-series)
installation
commissioning (tech. & beam)
operation


SASE 2
tunable, planar
0.1 – 0.4 nm
U 2
e⁻
electrons
17.5 GeV
U 1
Experiments
SASE 1
tunable, planar
0.1 nm
e⁻
SASE 3
tunable, helical
0.4 – 1.6 nm

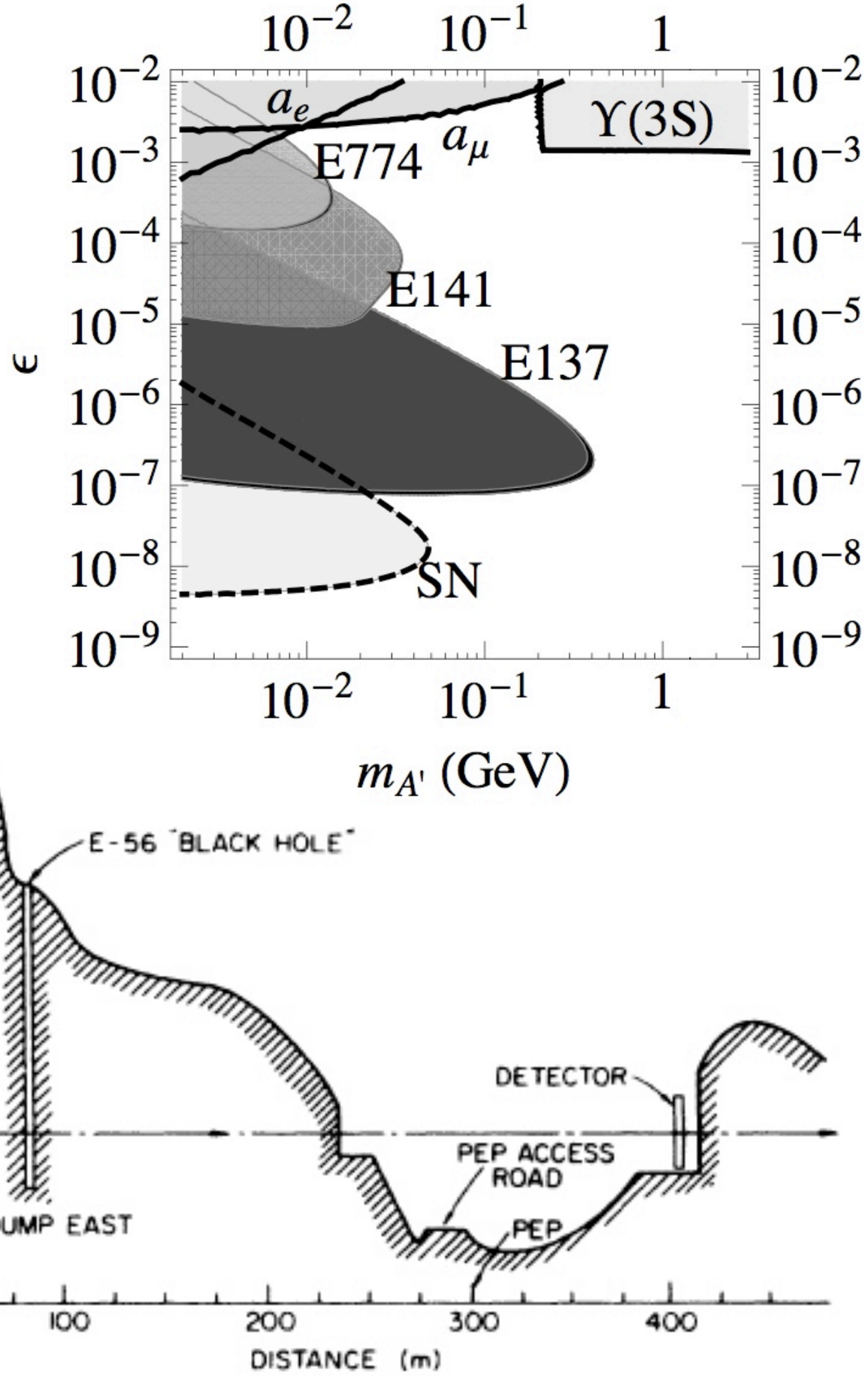


E_0, electron energy	max. 25	GeV
N_t, number of electrons per bunch train	max. $2.5 \cdot 10^{13}$ ⇔	4μC
I_{ave}, average beam current	max. 40	μA
W_t, energy carried in one bunch train	max. 100	kJ
P_{ave}, average beam power	max. 300	kW

Pulsed operation

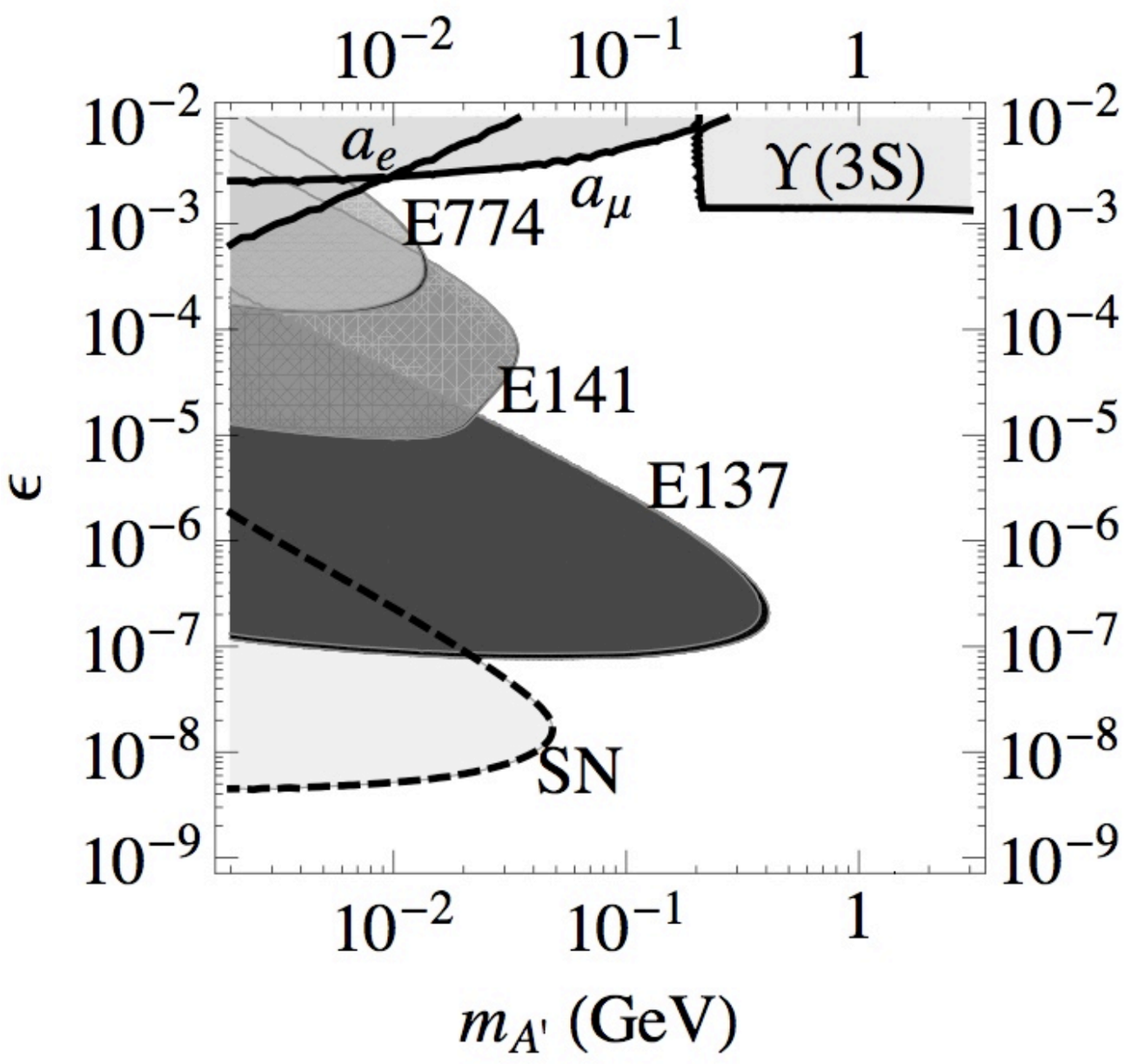
Energy for 0.1nm wavelength *(maximum design energy)*	17.5 GeV *(20 GeV)*
Number of installed accelerator modules	116
Number of cavities	928
Acc. gradient (104 active modules) at 20 GeV	23.6 MV/m
Number of installed RF stations	29
Klystron peak power (26 active stations)	5.2 MW
Loaded quality factor Q_{ext}	4.6×10^6
RF pulse length	1.4 ms
Beam pulse length	0.65ms
Repetition rate	10 Hz
Maximum average beam power	600 kW
Unloaded cavity quality factor Q_0	10^{10}
2K cryogenic load (including transfer line losses)	1.7 kW
Maximum number of bunches per pulse *(at 20 GeV)*	3,250 *(3,000)*[1]
Minimum bunch spacing	200 ns
Bunch charge	1 nC
Bunch peak current	5 kA
Emittance (slice) at undulator	1.4 mm*mrad
Energy spread (slice) at undulator	1 MeV

$3 \times 10^{-5} C/s$ $6 \times 10^9 e's/bunch$ $0.6 MW$



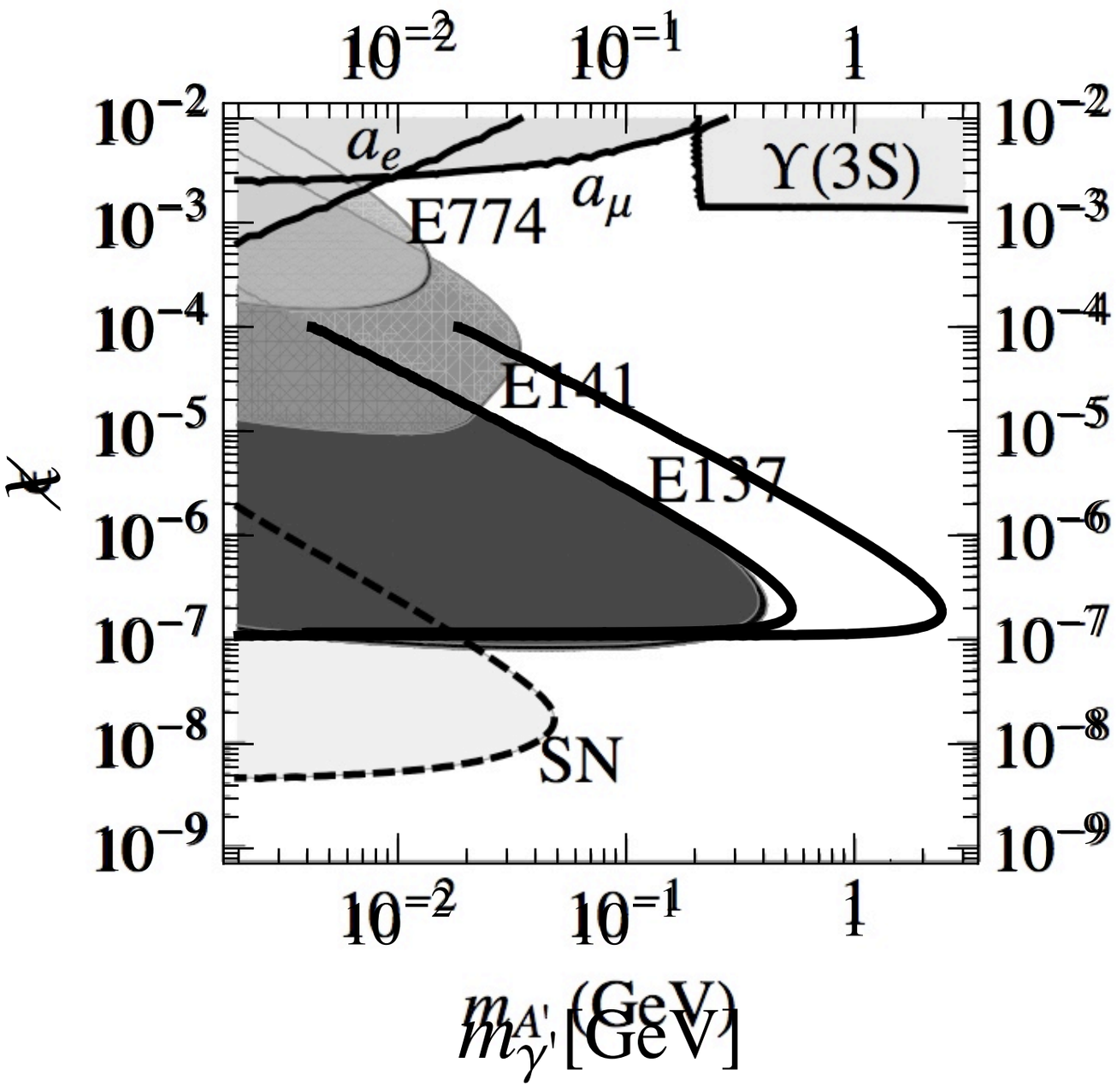
E137

- 30 C
- E0=20 GeV
- 200m hill
- 200m decay length
- 10 Events



XFEL(?)

- 30(x20) C
- E0=17.5 GeV
- 10m target
- 20m decay length
- 10 Events



XFEL(?)

- 30(x20) C
- E0=17.5 GeV
- 10m target
- 20m decay length
- 10 Events

CW operation (?)

Beam energy	7 GeV
Accelerating gradient	7.5 MV/m
Number of CW RF stations	116
RF power per accelerator module	≈20 kW
Beam current	0.18 mA
Loaded quality factor Q_{ext}	2×10^7
Bunch frequency	180 kHz
Unloaded quality factor Q_0	$2 \cdot 10^{10}$
2 K cryogenic load	≈3.5 kW

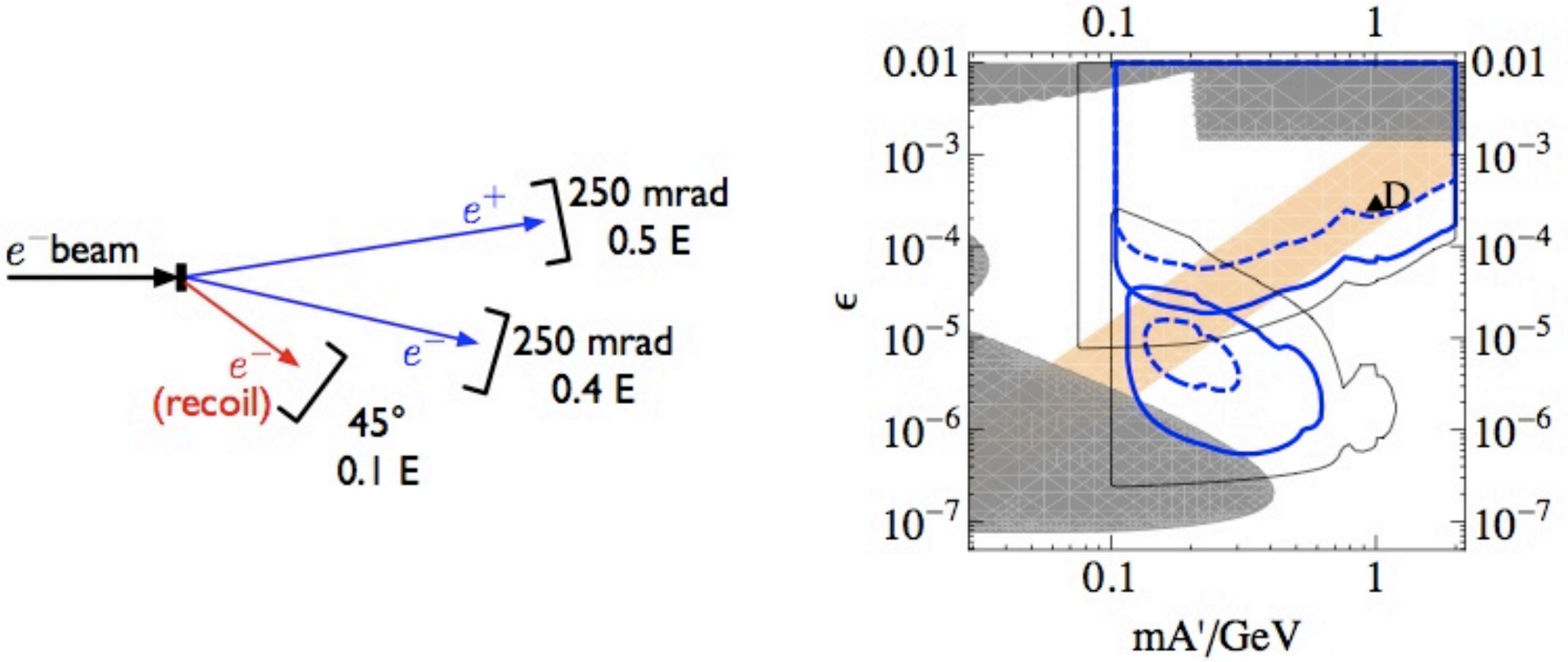


FIG. 7: **Left:** Schematic diagram of an experimental scenario for benchmark point D ($\epsilon \sim 3\times10^{-4}$, $m_{A'} \sim 1$ GeV). An electron beam with an energy of ~ 6 GeV and a current of about 100 μA – 200 μA is incident upon a 0.1 radiation length aluminum target. A wide-angle high-resolution spectrometer allows triggering on events in which one electron and one positron carry most of the beam energy. The signal is distinguished from background events with the help of various kinematic selection cuts (relatively symmetric l^+l^- final state and possible recoil electron tagging) and a "bump hunt" — see text and appendix C for further details. **Right:** Various estimates of the possible reaches of a wide-angle spectrometer, with (bottom) and without (top) tagging vertices displaced by > 1 cm to reject background. In each case, the outer thin black line represents a significant total rate, with no geometric acceptance requirements ($S/\sqrt{B} > 5$ in the no-vertex (top) region, 10 or more events in the vertex (bottom) region). The thick blue curve shows the reach when decays are required to land more than 200 mrad away from the beam line, and the inner dotted curves assume an additional 1% signal efficiency from acceptance. In these two cases, each curve represents the total reach obtained by running at several beam energies. *Gray contours and Orange Stripe:* exclusions from past experiments (E137, E141, E774, electron and muon anomalous magnetic moments, and $\Upsilon(3S)$ resonance searches) and the region that explains DAMA/LIBRA in a simple model — see Figure 1 for more details.