

PAUL SCHERRER INSTITUT



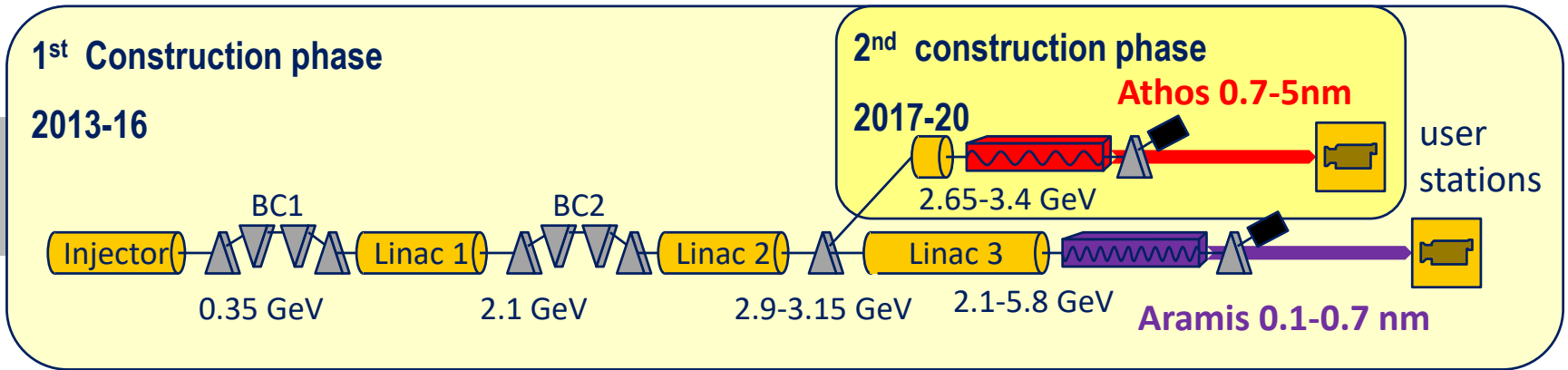
SwissFEL



Sven Reiche for SwissFEL Team :: Paul Scherrer Institut

First Lasing and commissioning status of SwissFEL

Free Electron Laser Conference, Santa Fe, 2017



Aramis

Hard X-ray FEL, $\lambda=0.1-0.7$ nm

Linear polarization, variable gap, in-vacuum Undulators

First users 2018

Athos

Soft X-ray FEL, $\lambda=0.65-5.0$ nm

Variable polarization, Apple-X undulators

First users 2021

Main parameters

Wavelength from	1 Å - 50 Å
Photon energy	0.2-12 keV
Pulse duration	1 fs - 20 fs
e^- Energy	5.8 GeV
e^- Bunch charge	10-200 pC
Repetition rate	100 Hz

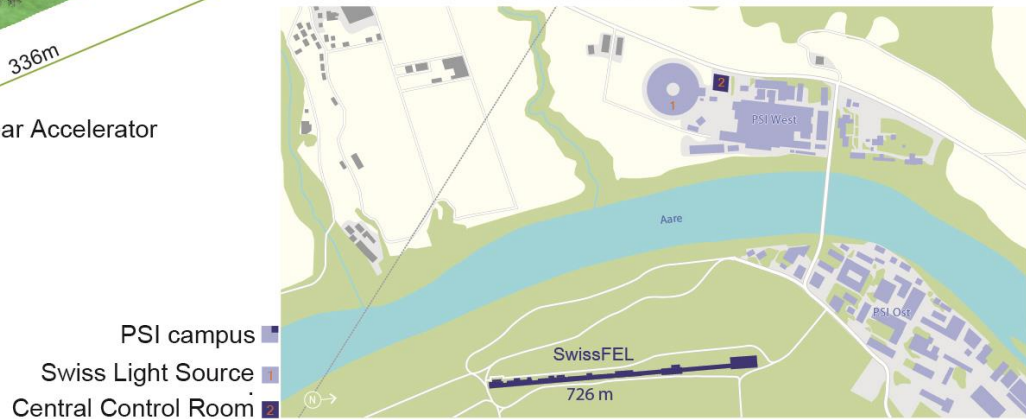
The SwissFEL Building Site

The two passages for wild game crossing.

On the first floor the RFmodulators and other supply systems are situated.



Situation of SwissFEL next to PSI campus



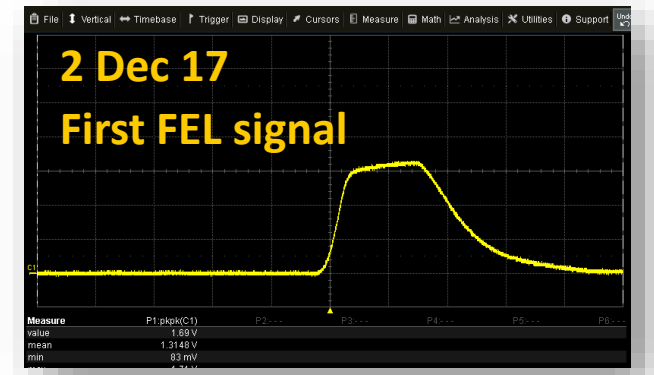
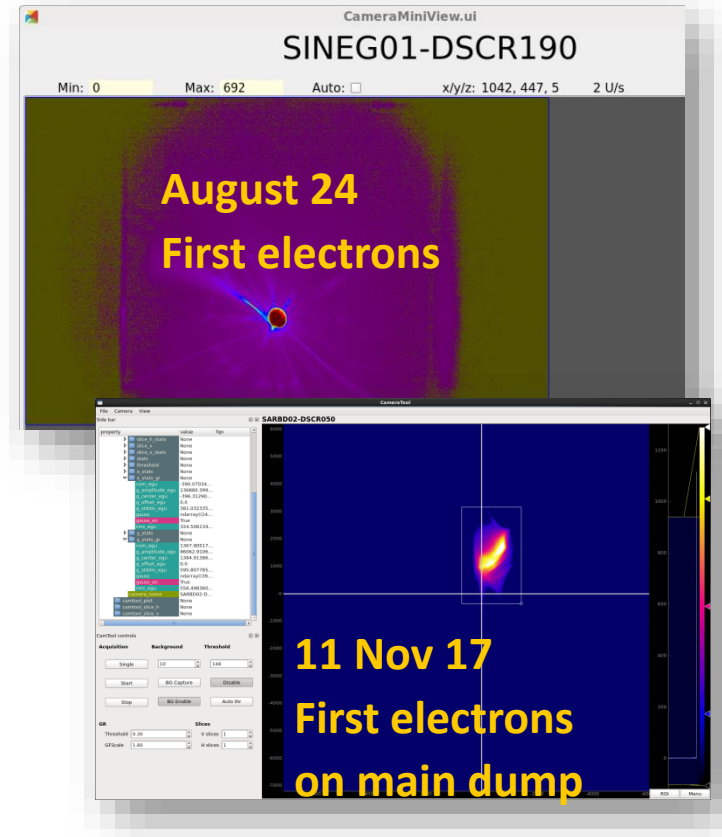
2016, October 7

Aramis Beamline complete from Photo-injector to beam

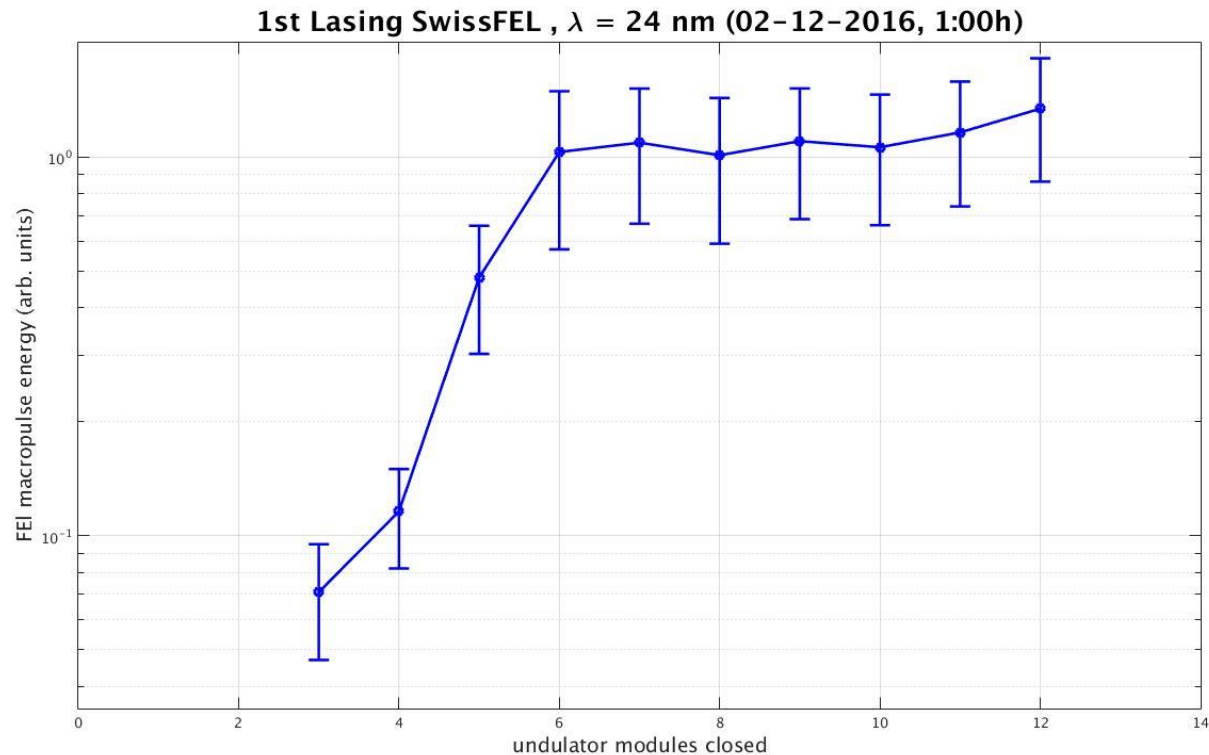


Commissioning Progress in 2016

Date	achievement
August 24	First free electrons from gun with 7.9MeV
September 7	First electrons to injector beam dump
September 8	First acceleration with one C-band module
October 7	Accelerator line to main dump completed and under vacuum
November 11	First beam transport through undulators to main dump
December 2	First lasing at 345 MeV, 24 nm
December 5	Inauguration ceremony & party



First lasing at moderate wavelength on 2.12.2016



Obtained with only 345 MeV beam energy, signal measured with Si-Diode
(half the injector RF + 1 main linac C-band RF station)

Mainly a systems test!

5.12.2016 SwissFEL, the Inauguration



On December 5th 2016, PSI held an inauguration ceremony for its new Large-scale research facility SwissFEL, with Johann N. Schneider-Ammann, President of the Swiss Confederation, in attendance.

Program 2017 & 2018

2017

Winter: Shutdown for installations

Spring: Increase beam energy up to 1 GeV

Summer: Injector Commissioning

Fall: Linac + Photonics commissioning

First pilot experiments at 2.3 keV

2018

Winter: Ramp-up beam energy to 5.8 GeV

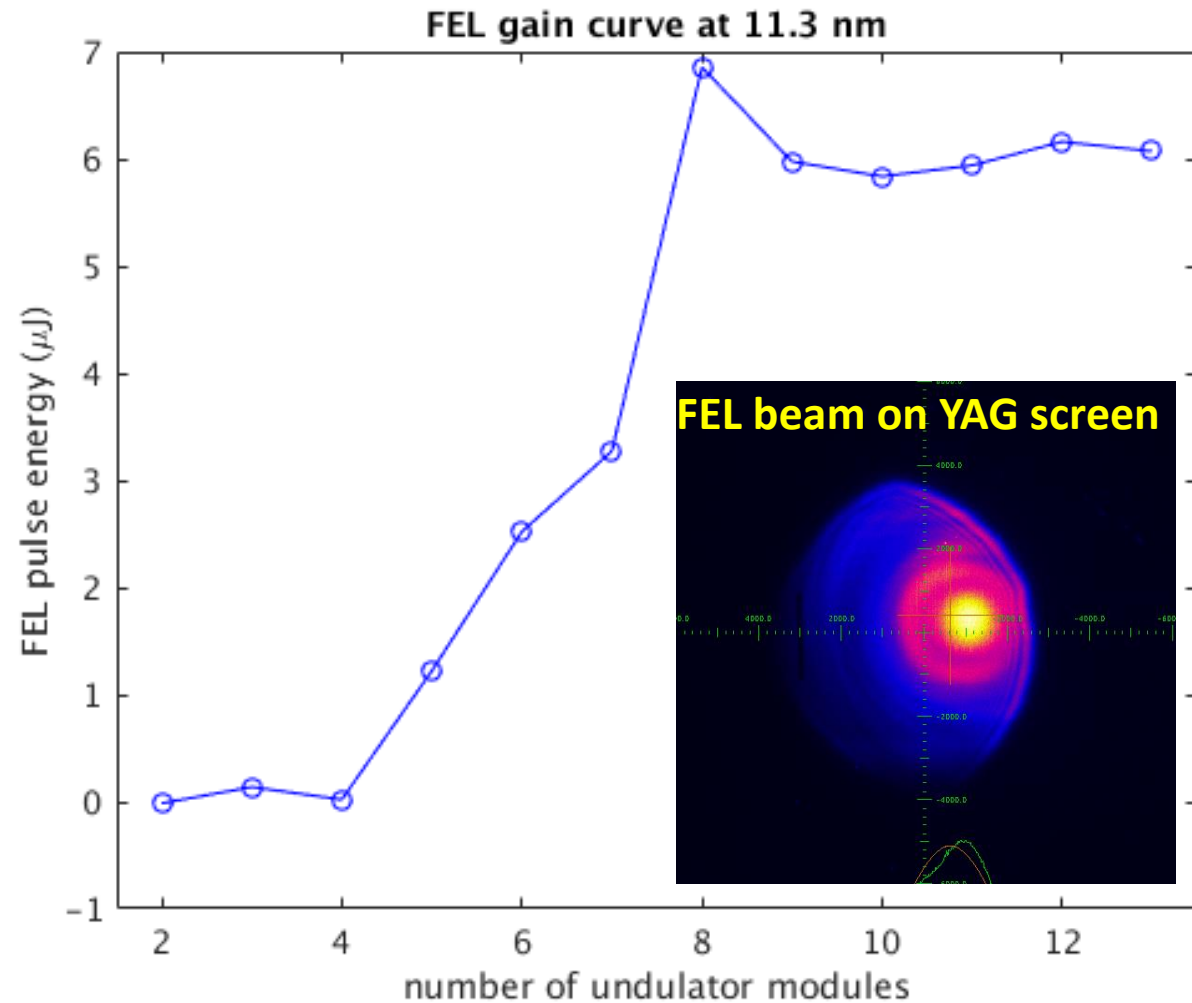
Spring: Lasing & pilot experiments at 8 keV

Summer: Lasing at 12 keV

Fall: Start of regular user operation

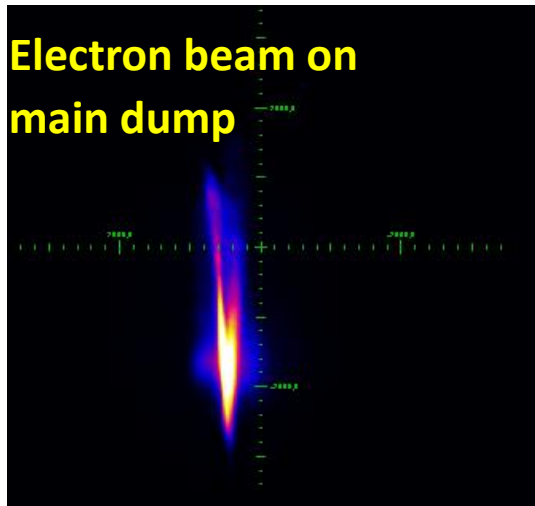
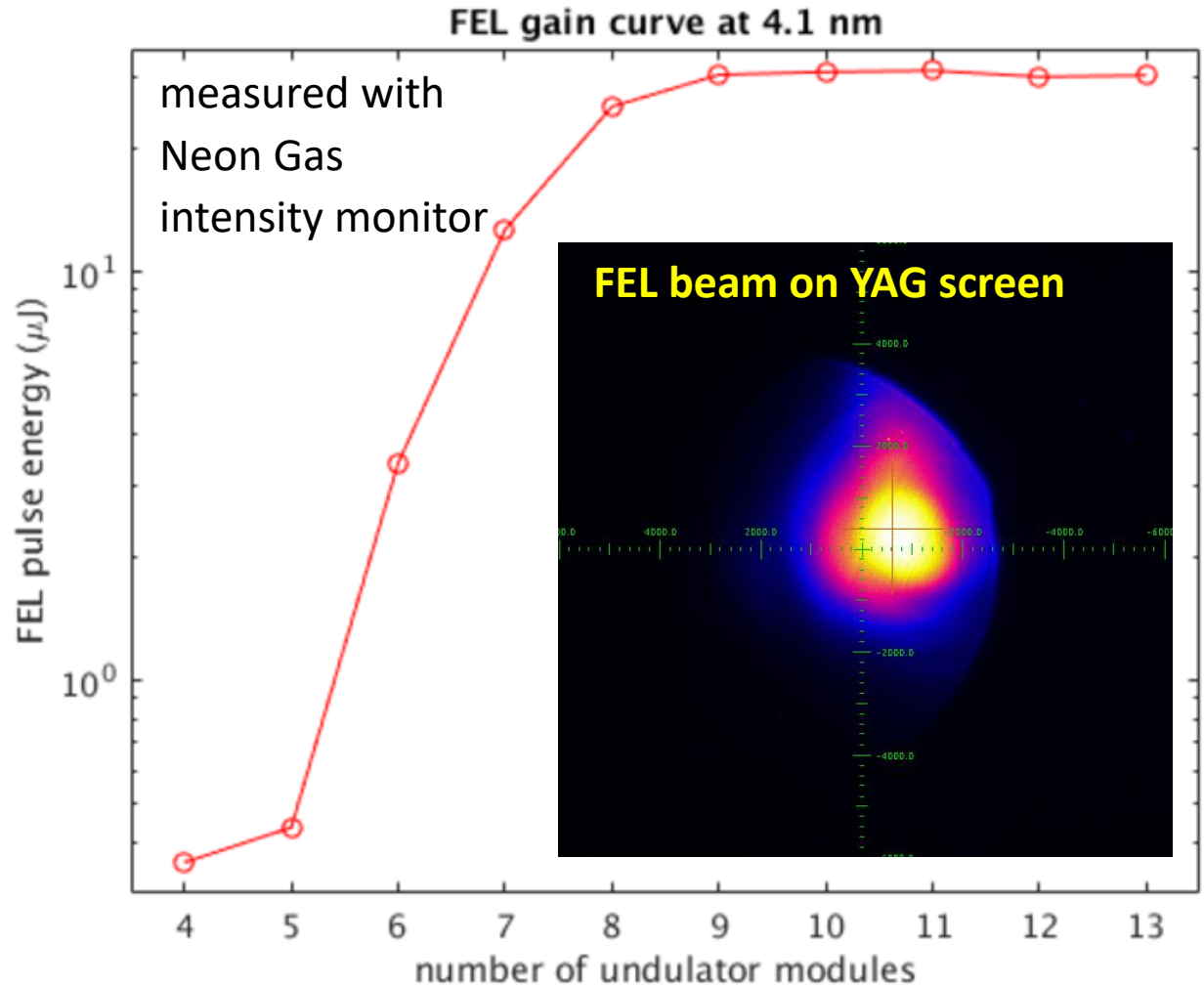
Gain curve measured with Neon Gas intensity monitor

E_{e^-}	0.545	GeV
q_B	145	pC
b.l. (rms)	≈ 0.4	ps
K	1.2	
λ_{FEL}	11.3	nm
W_{FEL} (g.m.)	≈ 7	μJ



First Lasing in nominal SwissFEL wavelength range (0.1-5.0 nm)!

E_{e^-}	0.91	GeV
q_B	145	pC
b.l. (rms)	≈ 0.4	ps
K	1.2	
λ_{FEL}	4.1	nm
W_{FEL}	≈ 30	μ J

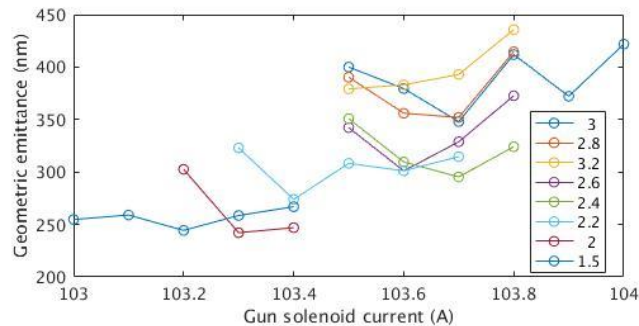
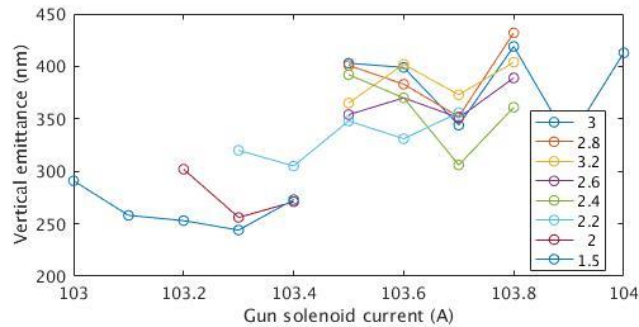
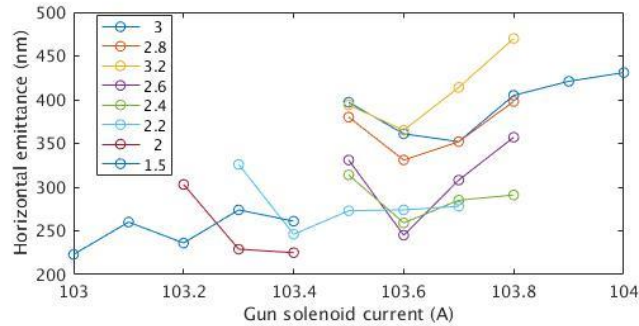


Establishing SASE at 4.1nm

- Time-consuming set-up of gun and cathode laser
 - careful transverse optics measurement and matching in injector region
 - computed optics in linac and undulators
 - set-up of single stage bunch compression in BC1 with deflecting cavity
 - steering according to BPM centers
 - so far no special alignment procedures were required in undulator region
 - measured pulse energy is consistent with theoretical expectations
- ⇒ We are positive that with the addition of more RF stations we can proceed to shorter wavelength.
- ⇒ Currently 8 out of 26 C-Band stations are being conditioned, one in operation
- ⇒ Many procedures semi-automatized
- ⇒ Emittance optimized and nominal compression achieved (see next slide)

Status of Injector Commissioning

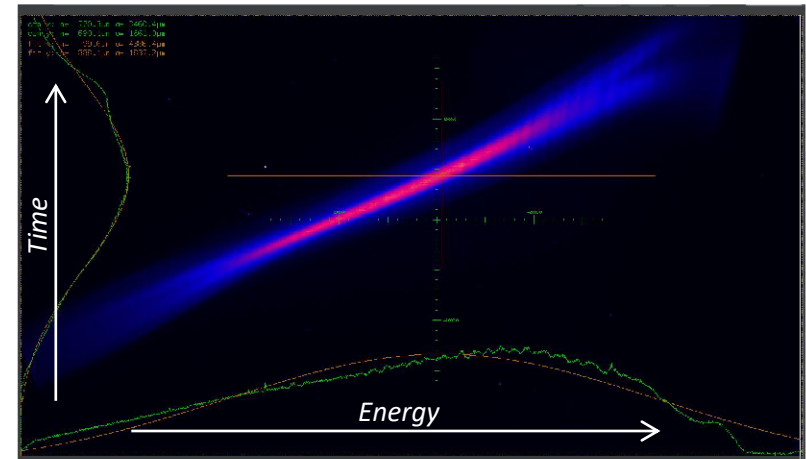
Emittance Optimization (uncompressed)



Single-Stage Compression

- BC settings precalculated and then optimized
- Compression down to 125 fs (nominal 200 fs)
- On-set of microbunch instability visible
- Coulomb explosion of head at high charges (200 pC)
- Can be mitigated with scraper in BC1

Longitudinal Phase Space Measurement

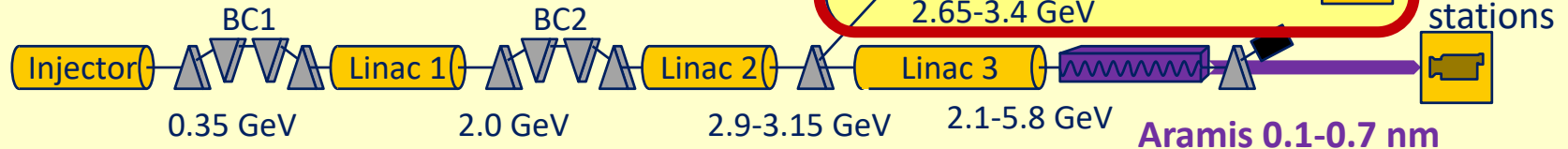


Emittance preservation after compression still to be demonstrated

Preparation for ATHOS

1st Construction phase

2013-16



ATHOS

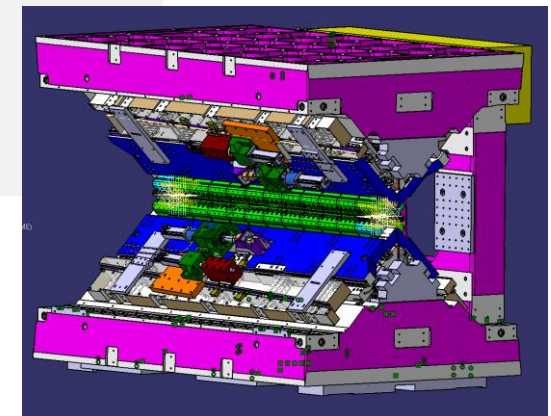
Soft X-ray FEL, $\lambda=0.65-5.0$ nm

full polarization control with U38 Apple-X Undulators

Switch Yard: already installed in phase 1

Extraction done at constant energy of 3 GeV

Apple X Undulator



For more information, see Poster MOPO38 by R. Ganter

- Lasing established at 4.1 nm without any major problems
- Injector commissioning near completion, beam energy up to 1 GeV
- Ramping up energy towards first user experiments in fall this year at 2.3 keV
- Next year: reaching 1 Angstrom (spring 2018) and start user operation (fall 2018)
- Start of Athos installation and commissioning of Athos in 2018



Thank you to the entire SwissFEL Team