Beam commissioning of the MAX IV Linac

Erik Mansten on behalf of the MAX IV linac team

Linac16

MAX IV Laboratory @ Linac16

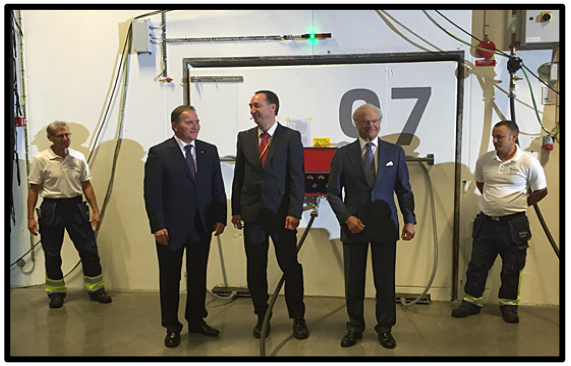
- Aleksandar Mitrovic
  - LLRF
- David Olsson
  - MOP10615, Commissioning status of the chopper system for the MAX IV injector
- Dionis Kumbaro
  - MOPLR019, High power RF commissioning
- Sara Thorin
  - TUP106013, First experimental results of T566 linearization in the MAX IV linac bunch compressors
- Erik Mansten
  - MOP106014, Relative bunch length measurements at the MAX IV linac

MAX IV

MAX IV news

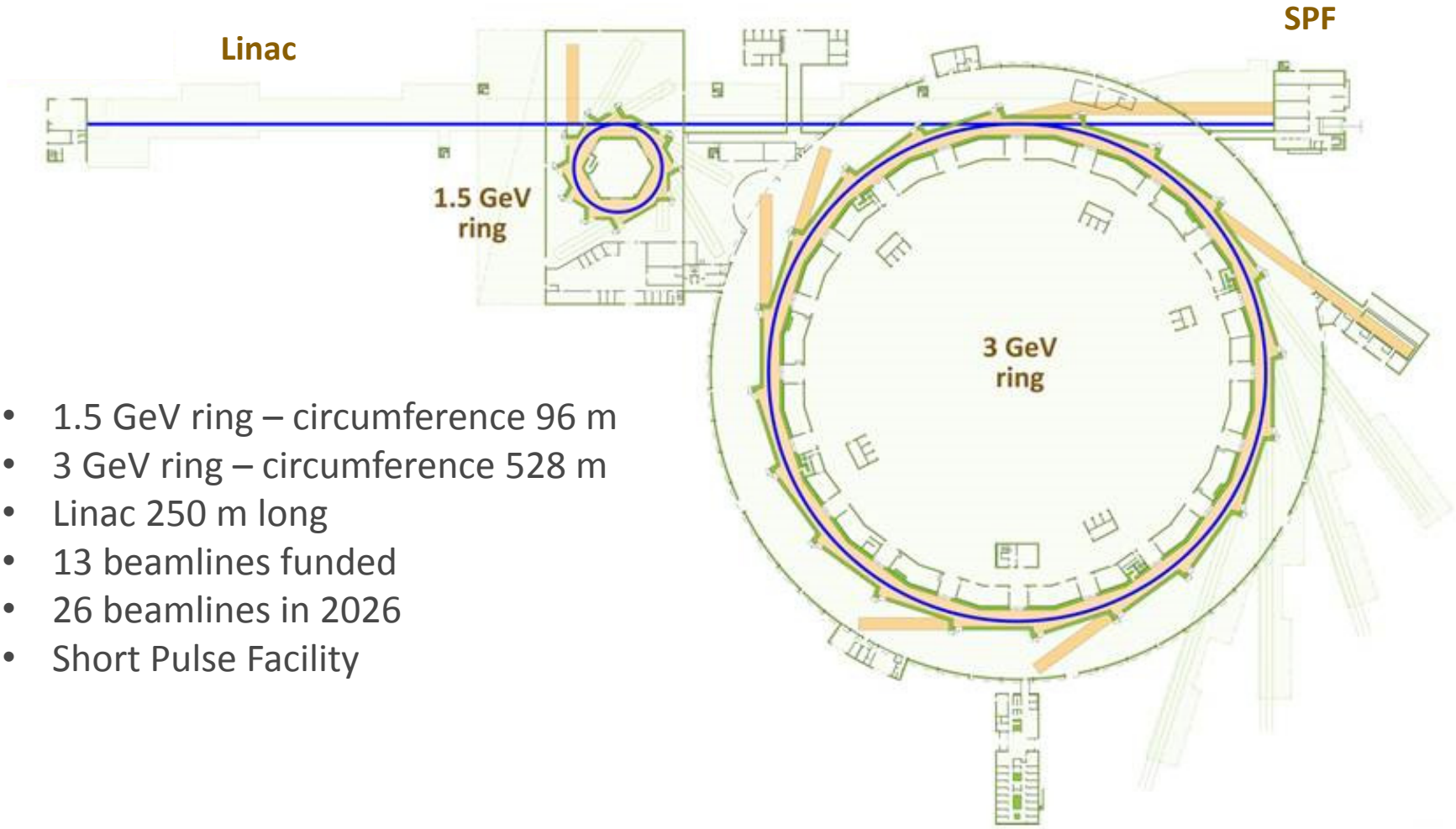
	2010	2011	2012	2013	2014	2015	2016	2017
Linac building	→	→	→	→				
Linac installation				→	→			
Linac commissioning					→	→	→	→
Linac operation						→	→	→

Spotify



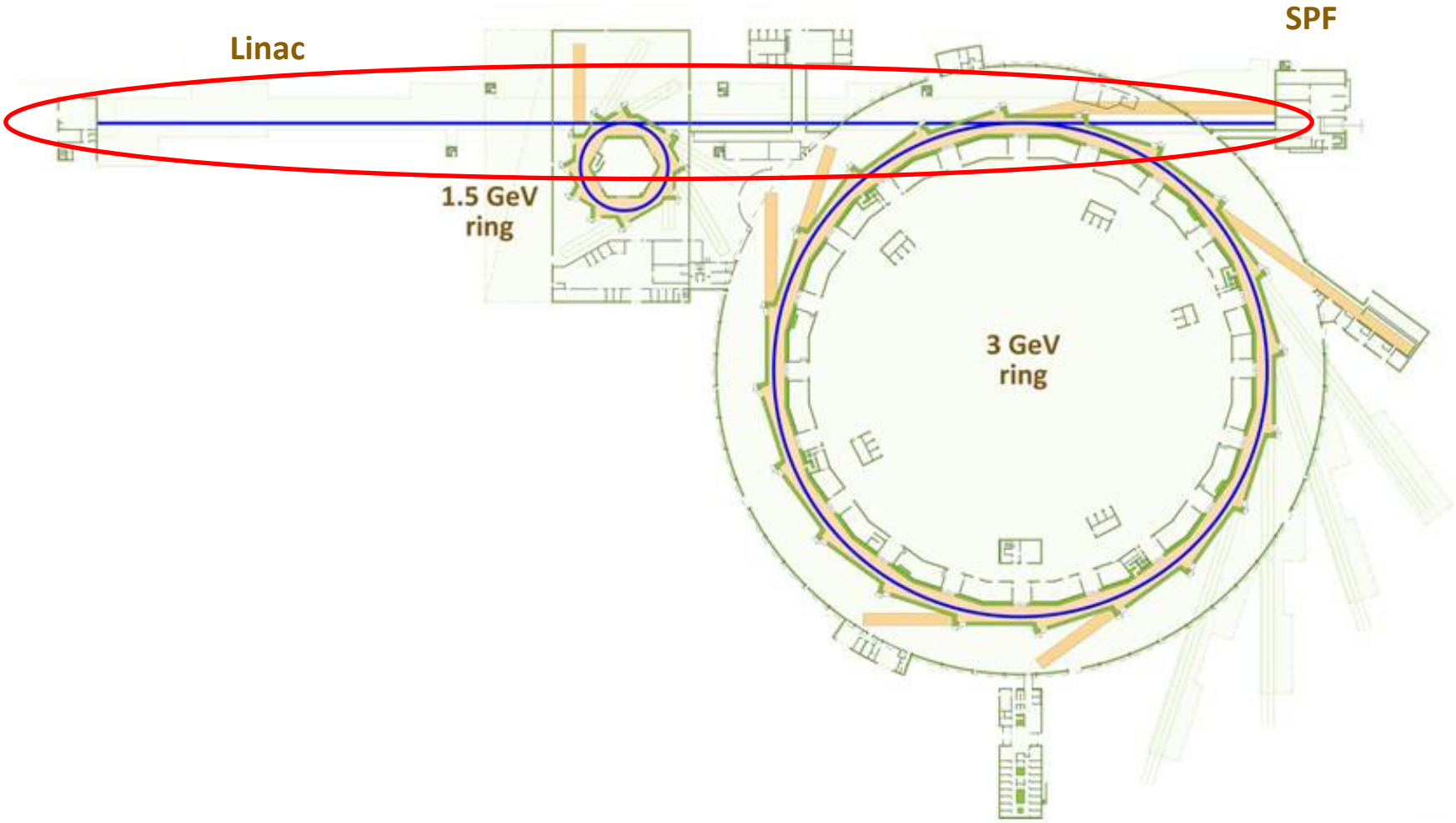
MAX IV

MAX IV



- 1.5 GeV ring – circumference 96 m
- 3 GeV ring – circumference 528 m
- Linac 250 m long
- 13 beamlines funded
- 26 beamlines in 2026
- Short Pulse Facility

MAX IV



MAX IV linac

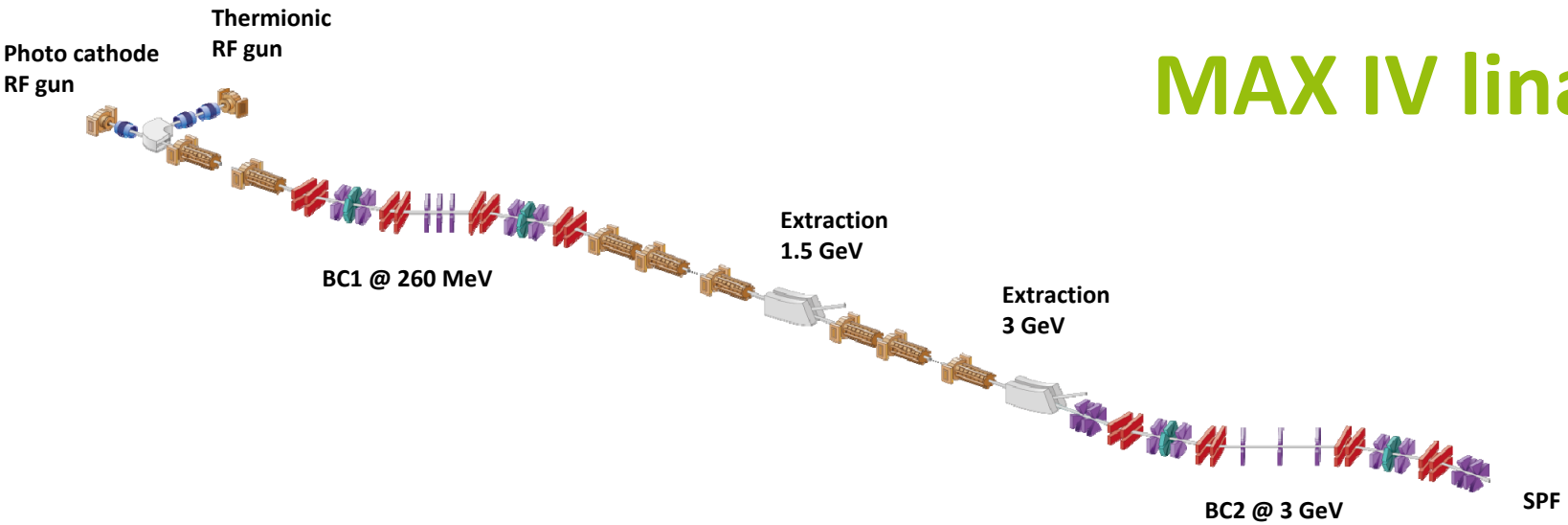
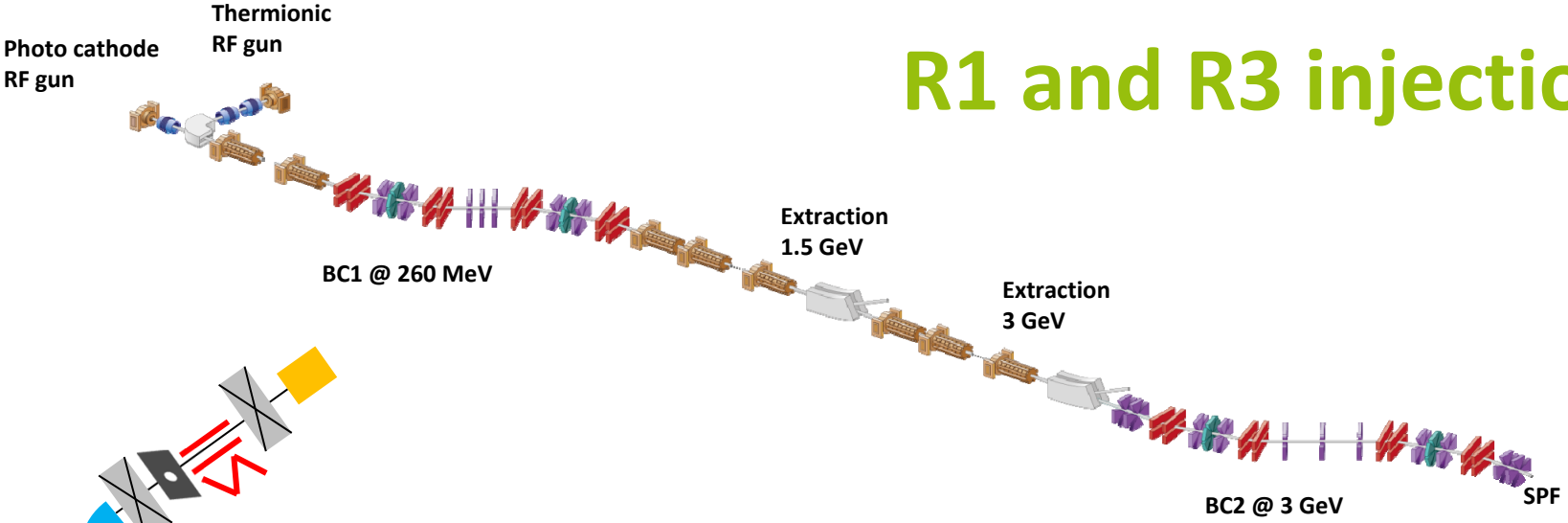
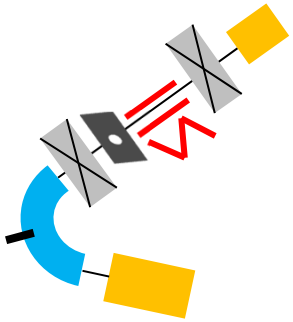


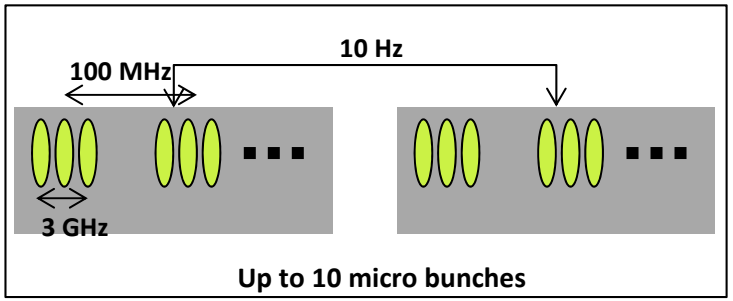
Photo cathode
RF gun
Thermionic
RF gun
BC1 @ 260 MeV
Extraction
1.5 GeV
Extraction
3 GeV
BC2 @ 3 GeV
SPF

R1 and R3 injection





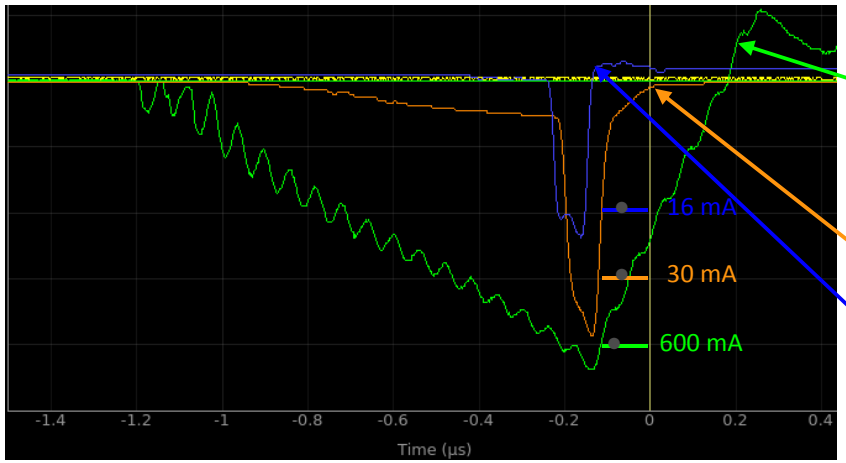
- DC chopper
- Superposition of RF fields 100 MHz, 300 MHz and 700 MHz
- 500 MHz

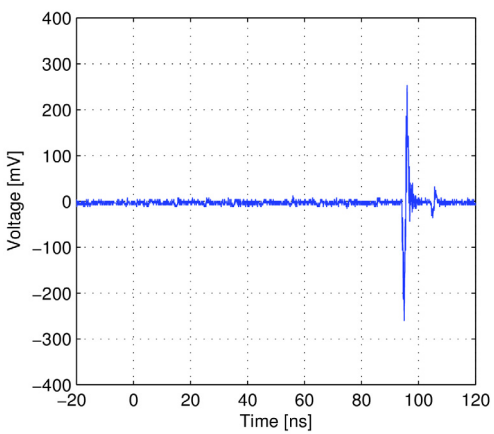


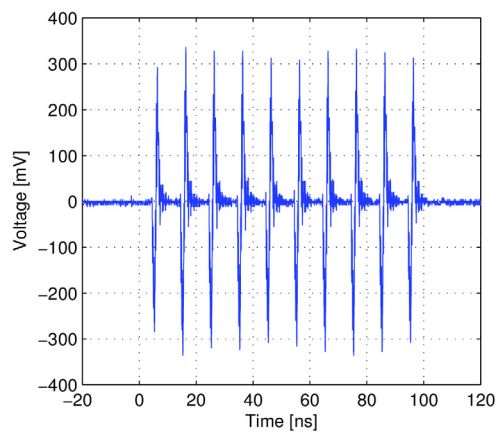
Design parameters

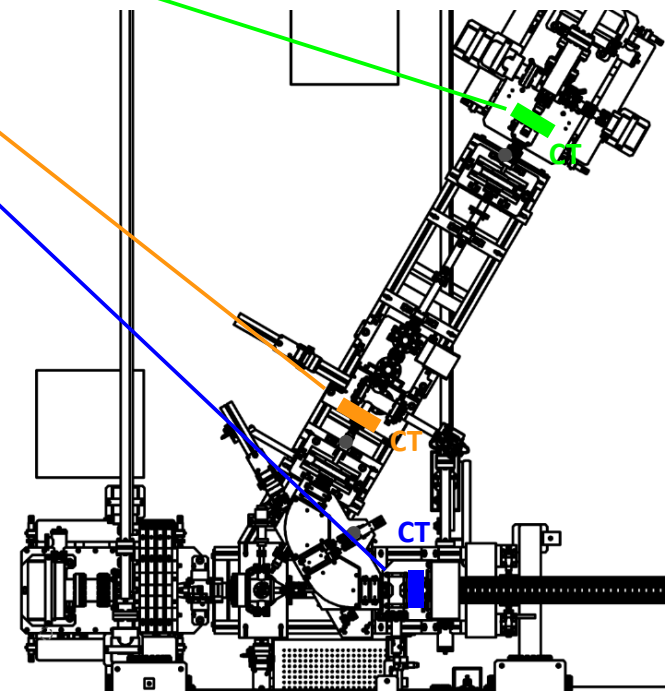
Energy	1.5 GeV/ 3GeV
Injection frequency	10Hz
Charge	0.3-1 nC/shot
Emittance	10 mm mrad
Energy spread	<0.2%

The Chopper System





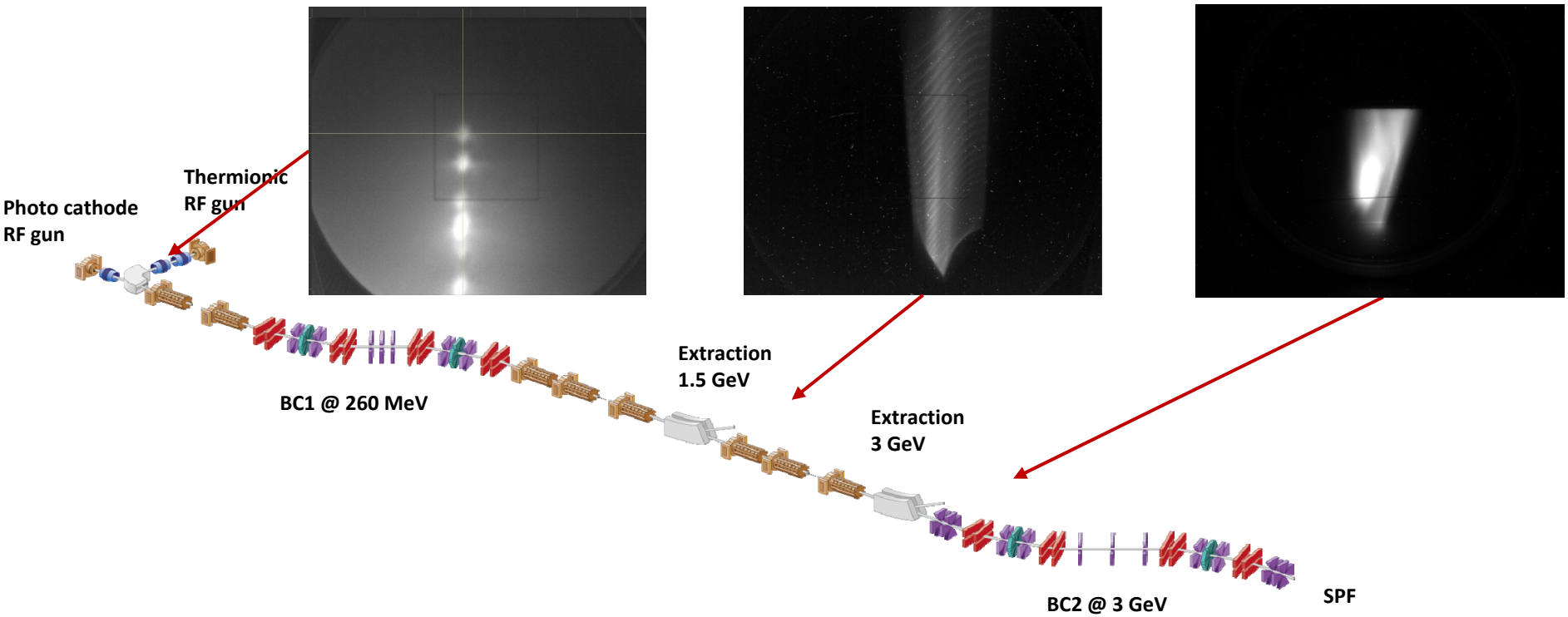




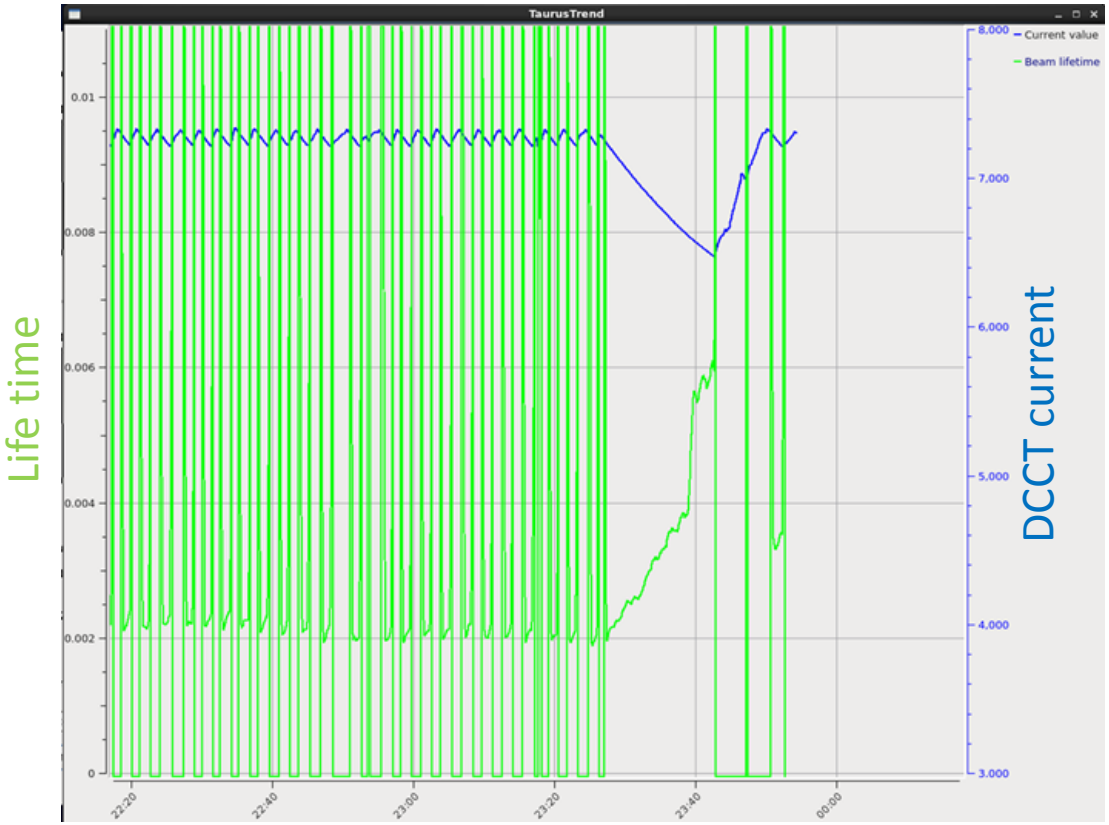
David Olsson – MOP10615

- The induced voltage at a BPM strip after two LINAC structures (W = 190 MeV). Here, one (left) and ten (right) ring buckets are filled.

R1 and R3 injection



R3 and R1 injection - status

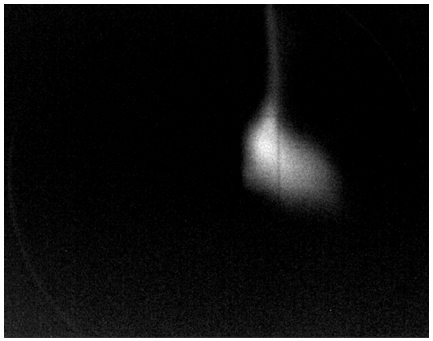


R3

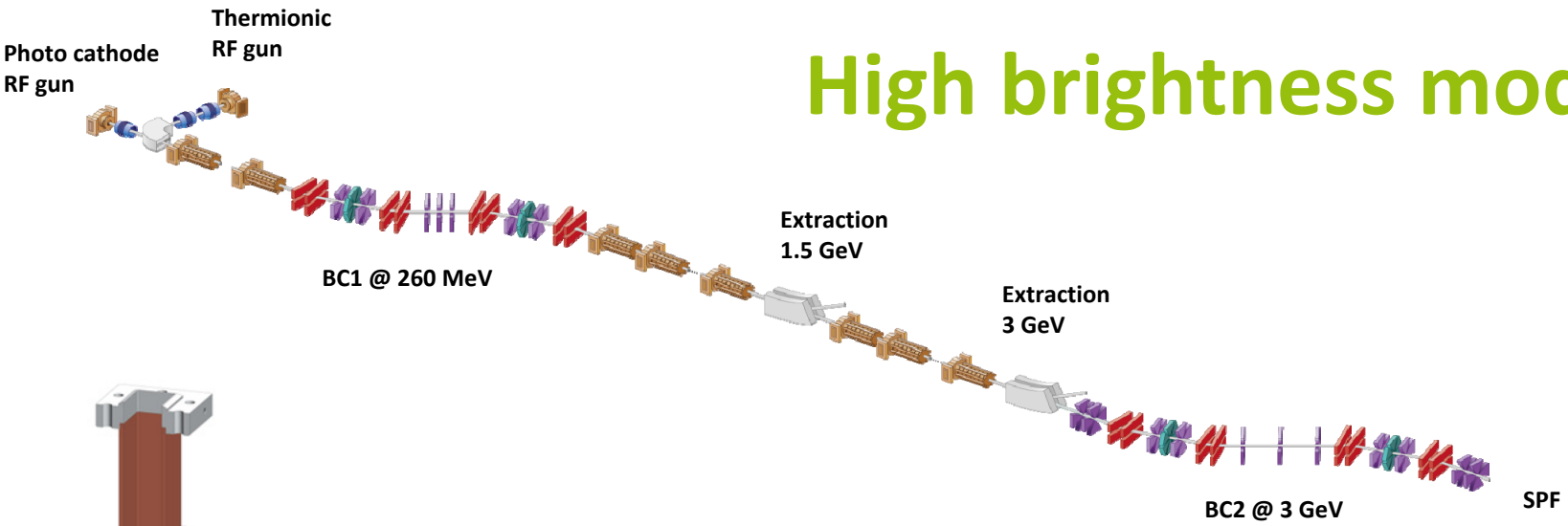
- Top-up injection
- Up to 20mA/min inj rate
- 90% inj efficiency
- First light in BL

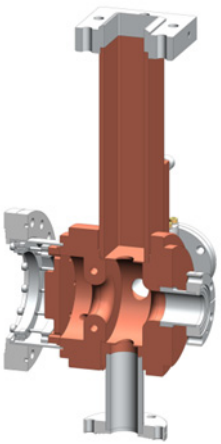
R1

- 9 turns



High brightness mode

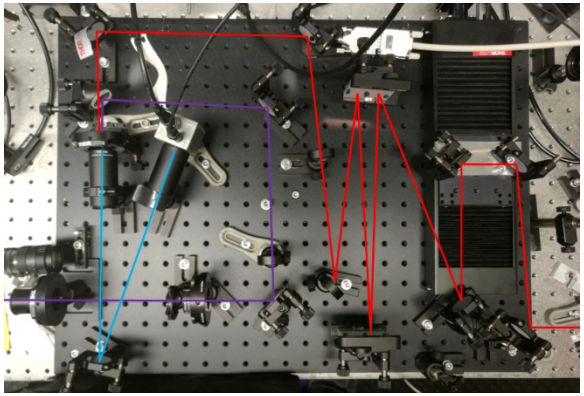


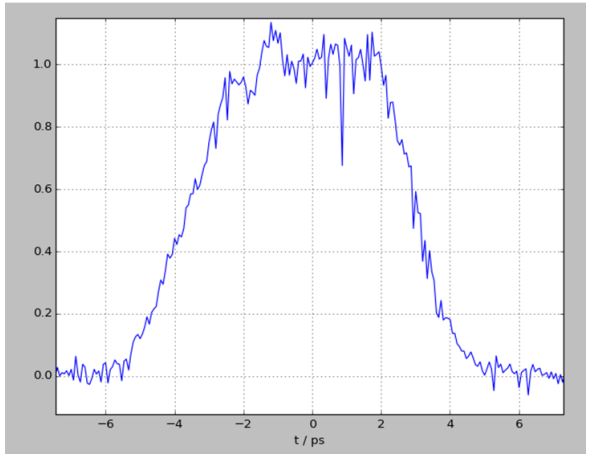


Design parameters - SPF

Energy	3GeV
Injection frequency	100 Hz
Charge	100 pC
Bunch length	100 fs
Emittance	1 mm mrad
Energy spread	<0.4%

Laser improvements for photo gun



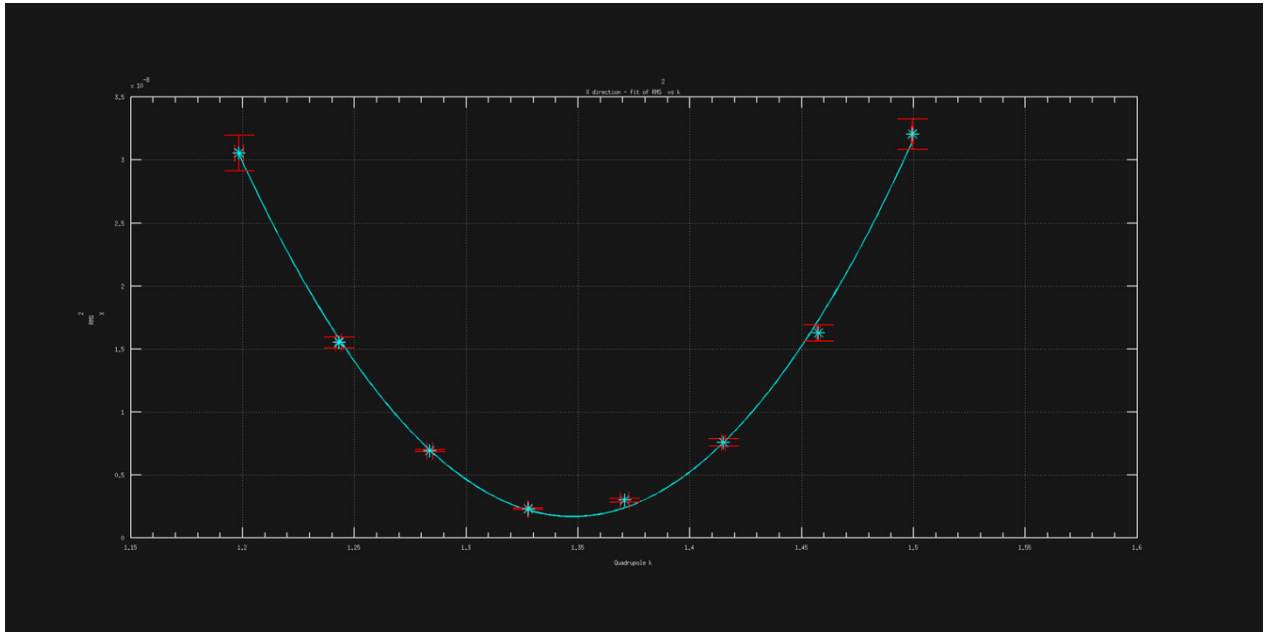


- Beam more stable due to Relay imaging through laser beam transport
- Cross correlator for 3ω pulse width measurements
- Pulse length increased from 1 ps to 6.4ps ps by pulse stacking

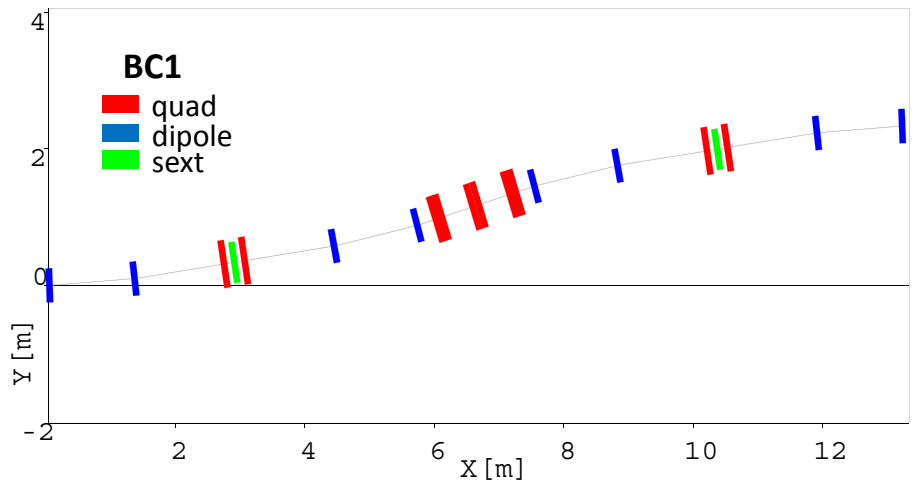
Quad scan - emittance

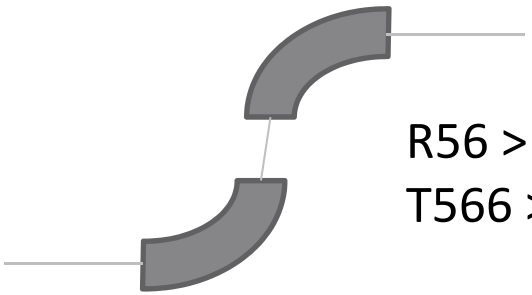
Norm emittance improved ~ **1.2 mm mrad @ 100 pC**

- Longer laser pulse
- Emittance compensation
- Good spot on cathode



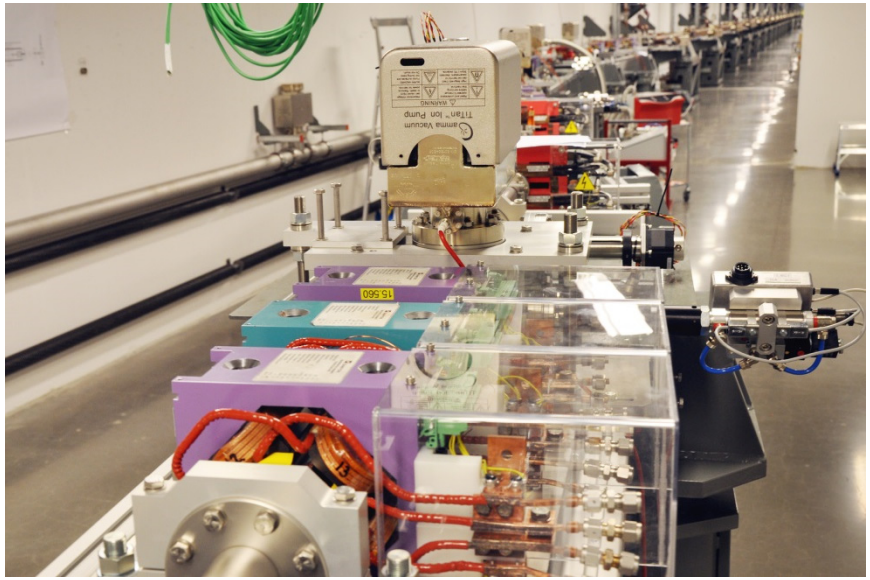
Bunch compressors – double achromats

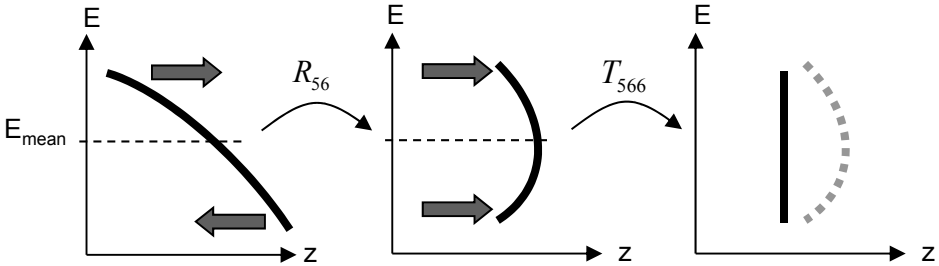




R56 > 0
T566 > 0

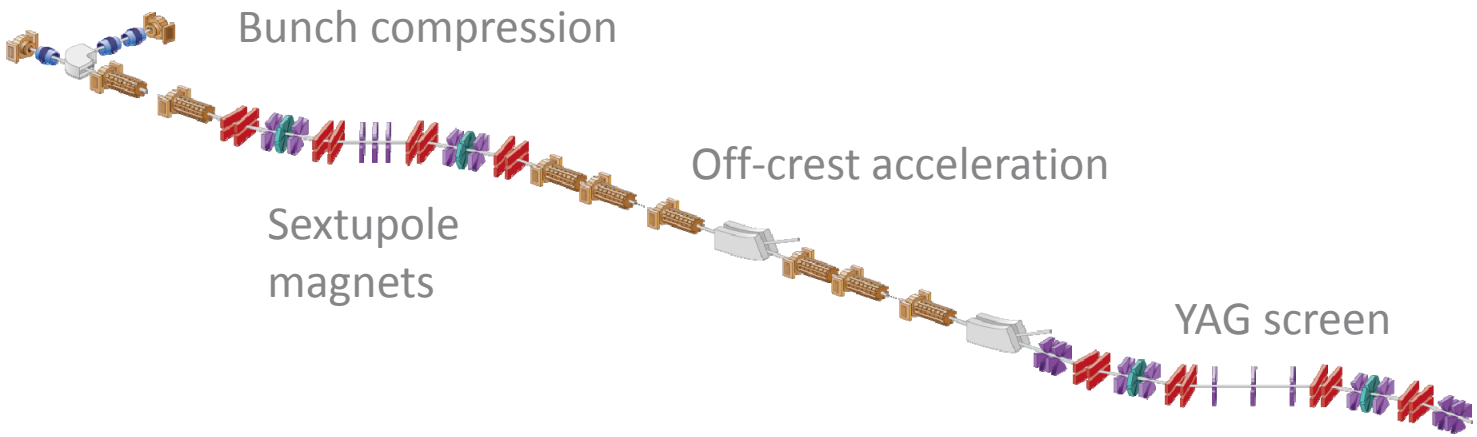
$$\Delta z = R_{56}\left(\frac{\Delta E}{E}\right) + T_{566}\left(\frac{\Delta E}{E}\right)^2$$

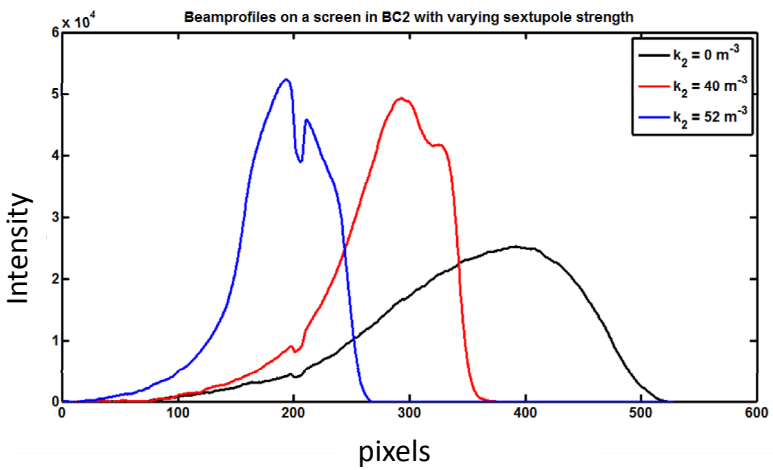


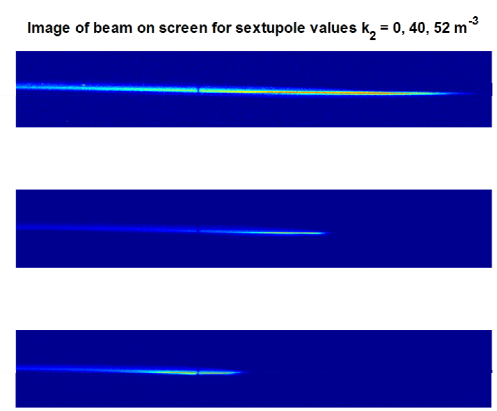


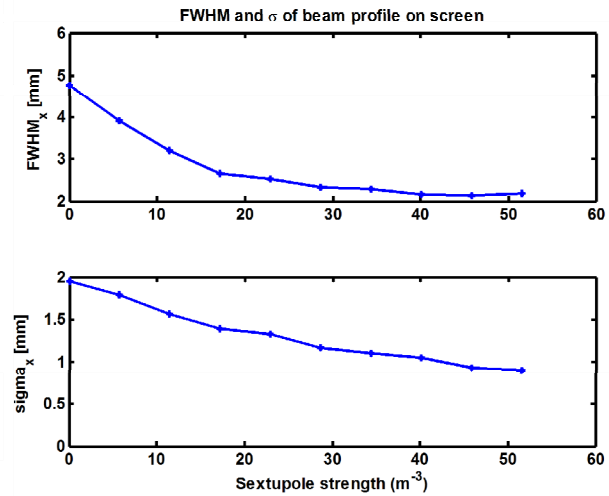
	BC1	BC2
R56	2.23 cm	2.89 mm
T566	8.05 cm	6.76µm

Bunch compressor characterisation





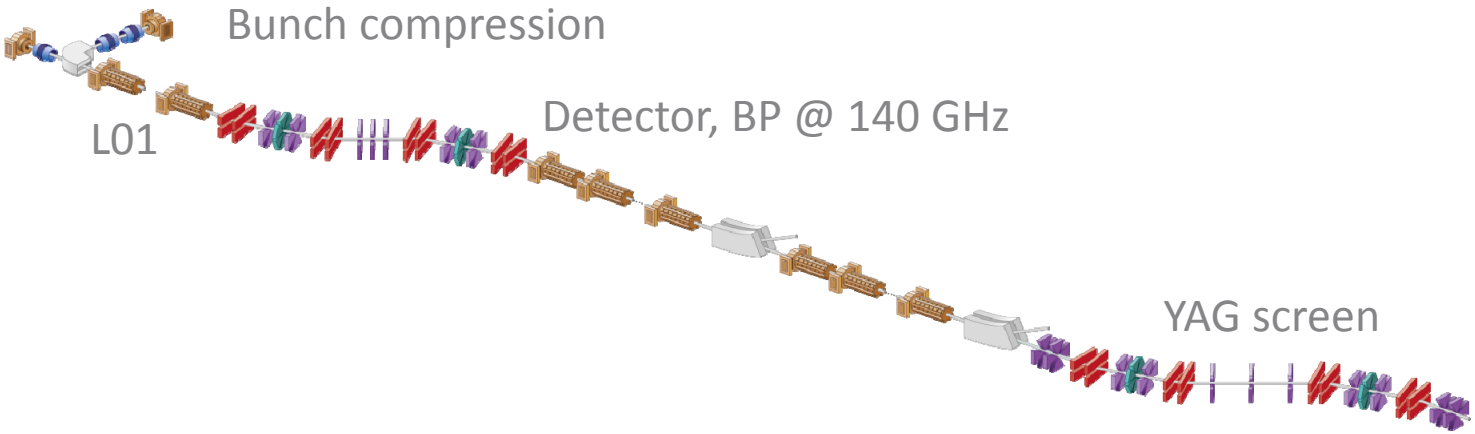


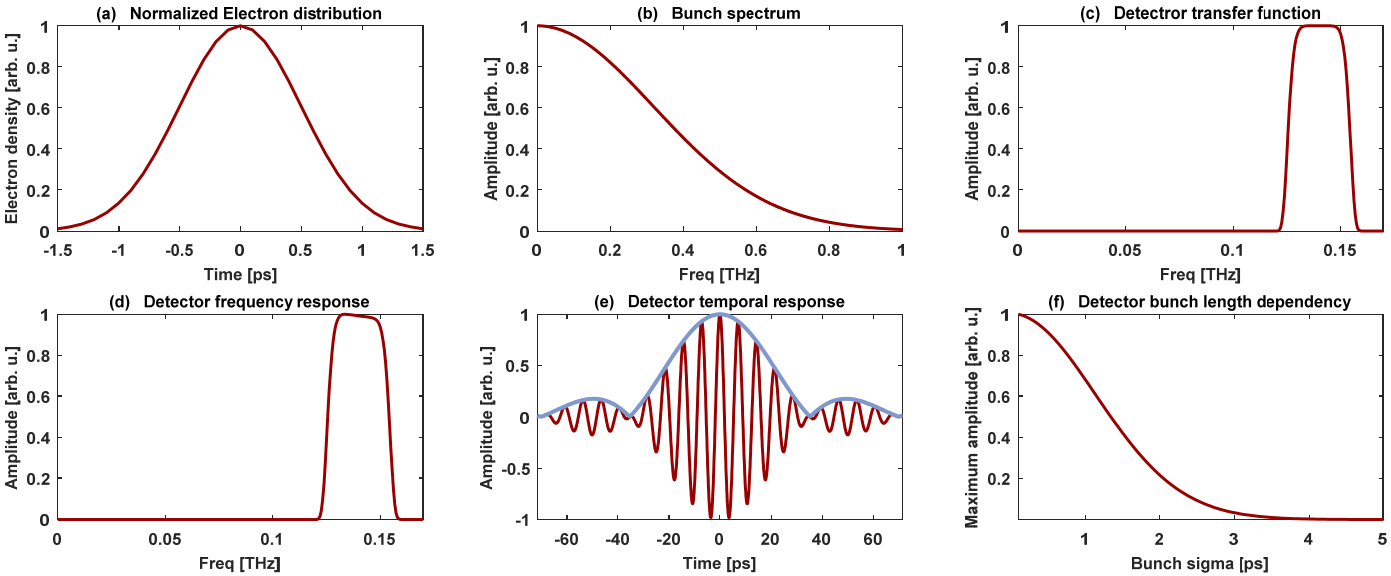


Sara Thorin - TUP106013

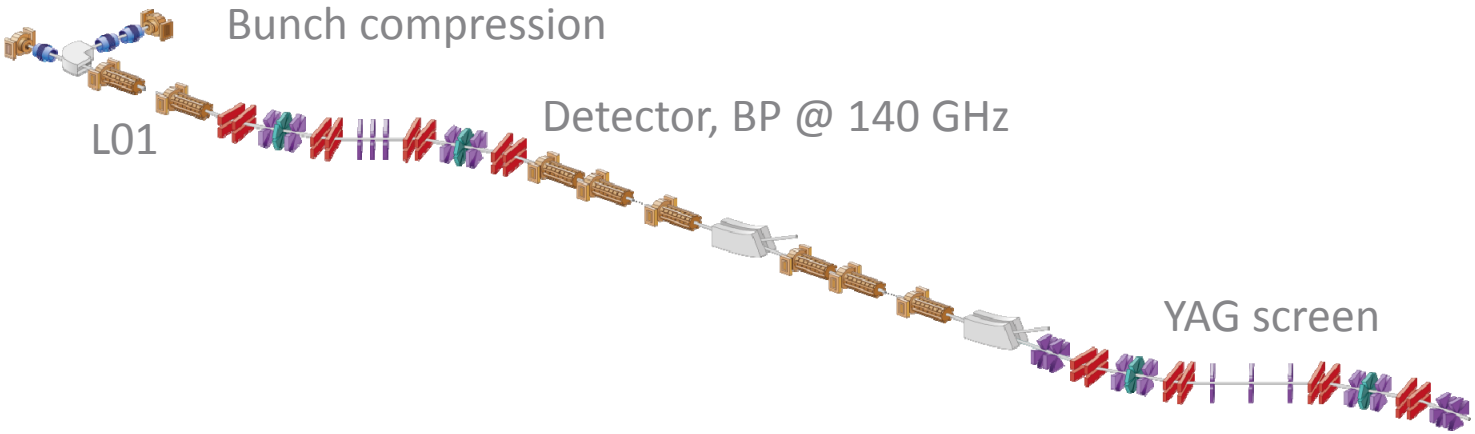
MAX IV

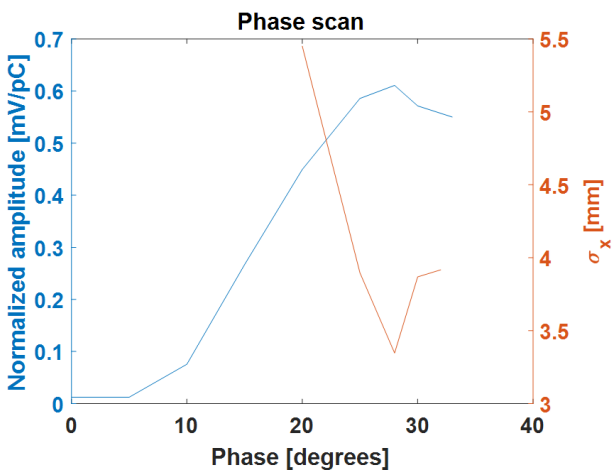
Relative bunch length measurements



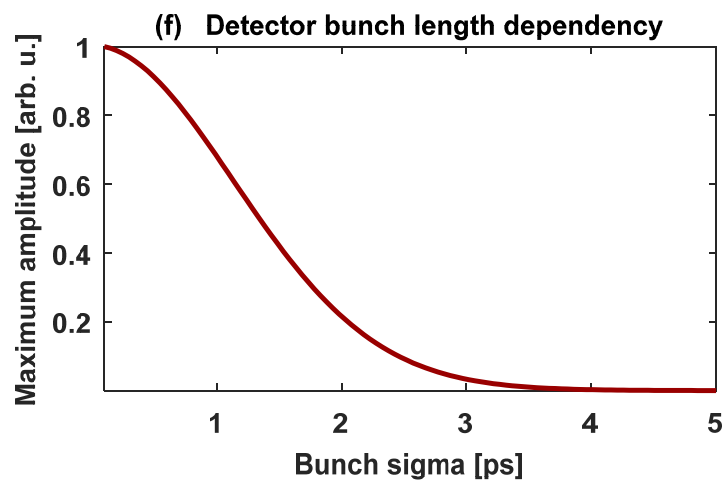


Relative bunch length measurements

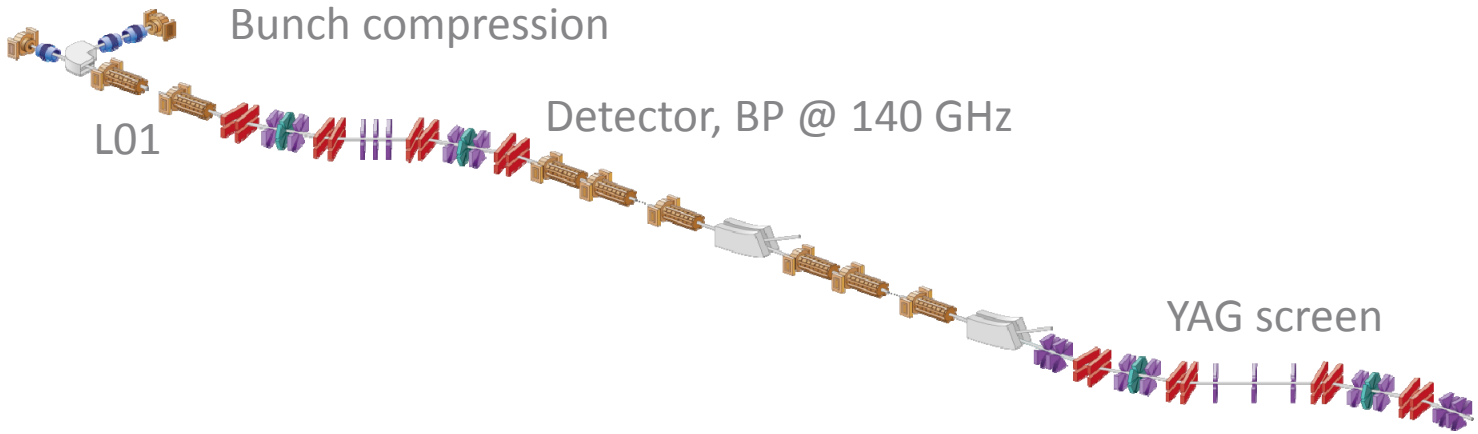


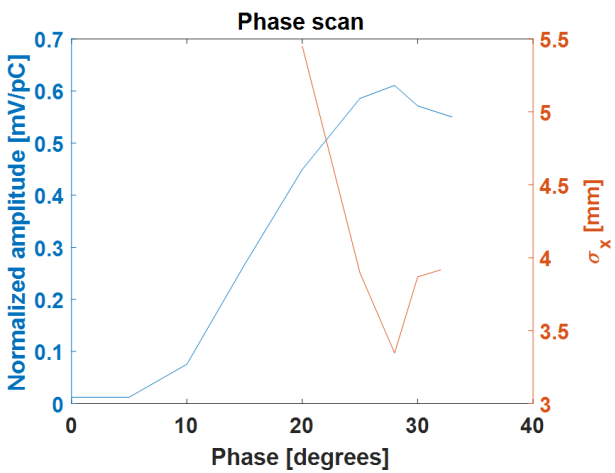


of L01

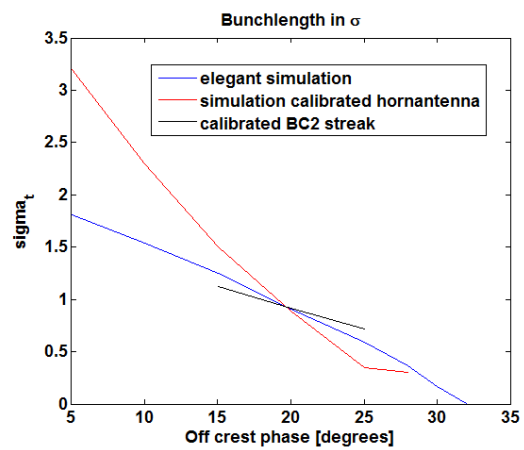


Relative bunch length measurements





of L01



Conclusion

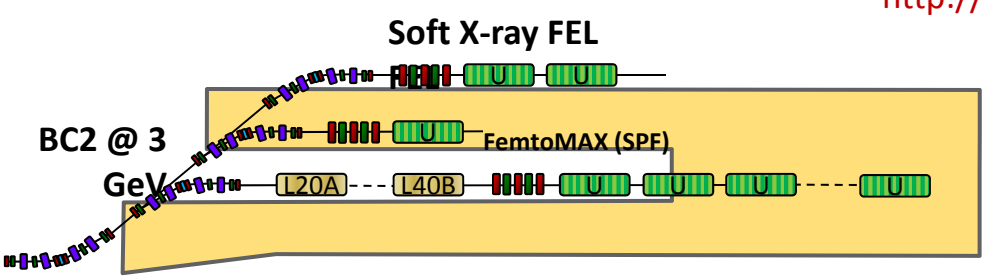
- Our own Spotify hit!
- Approved by 
- R3, 90% inj efficiency, 20mA/min inj rate
- R1, 3 turns
- Double achromat bunch compressor - linearisation proven
- Relative bunch length measurements in BC1 (0.3 ps sigma est BL)

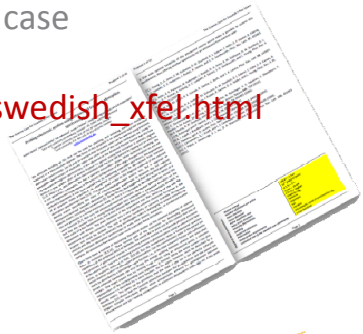
Outlook

- Emittance optimisation – higher field in RF cavity
- Relative bunch length measurements in BC2
- Absolute bunch length measurements BC2
- R1 commissioning
- FEL CDR application started

The science case for Swedish X-ray Lasers

- Collaboration between MAX IV Laboratory, the Lund Laser Centre, the Stockholm-Uppsala FEL Centre, and Uppsala University
- More than 40 proposals for science case
- http://www.llc.lu.se/sxlf
- http://frielektronlaser.se/activities/swedish_xfel.html





MAX IV