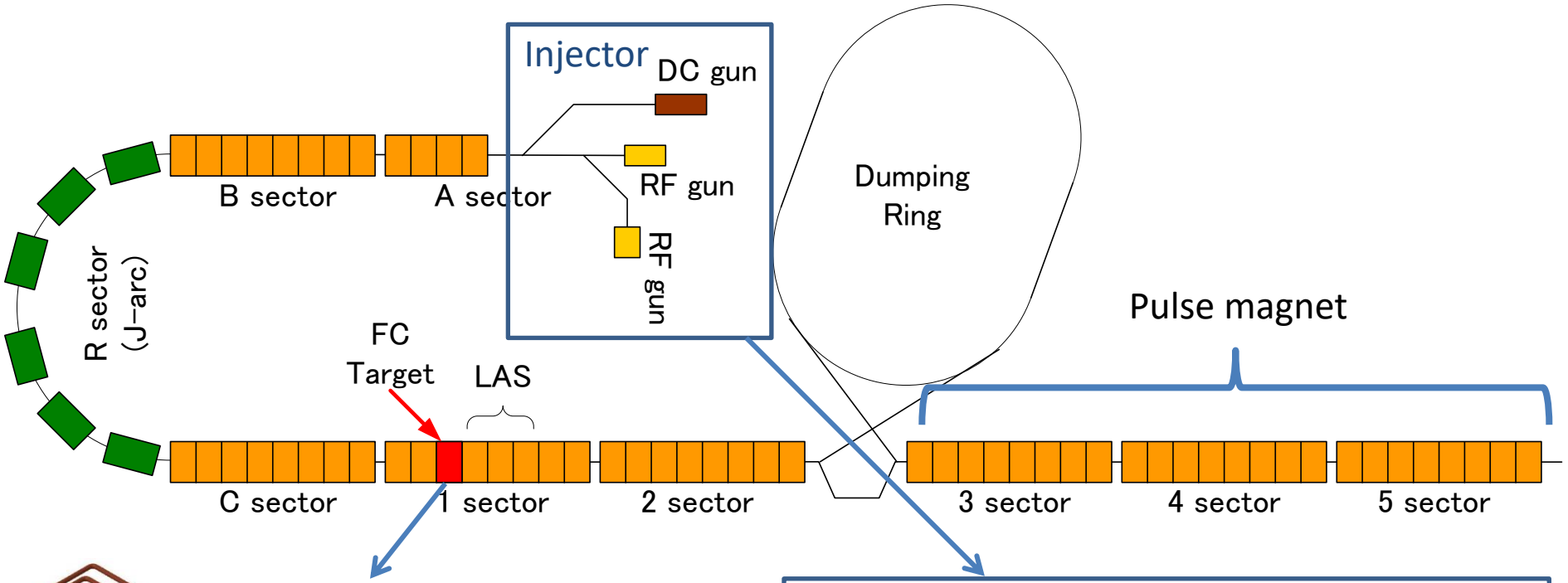
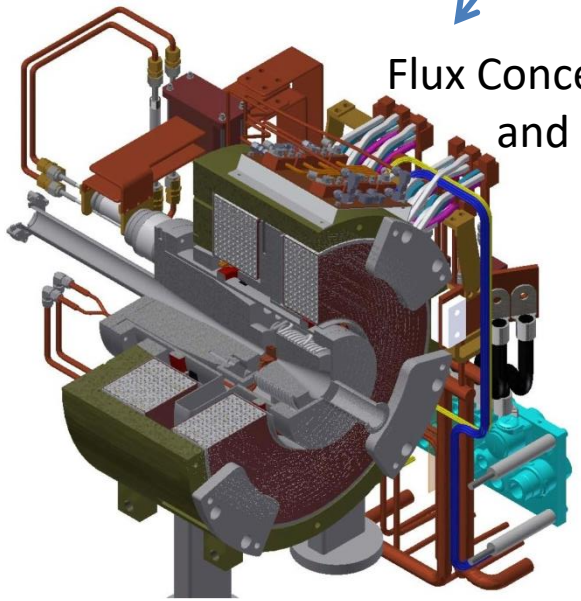
Injector Linac Status

Takuya Natsui

Injector Linac





Flux Concentrator (FC)
and Positron Target

Thermionic DC Gun

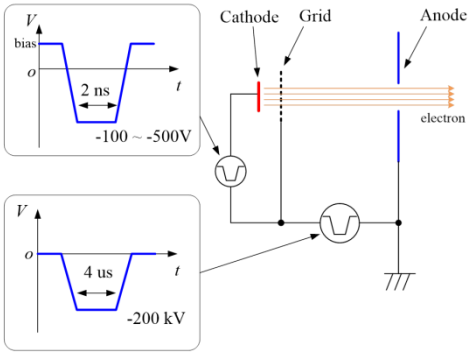
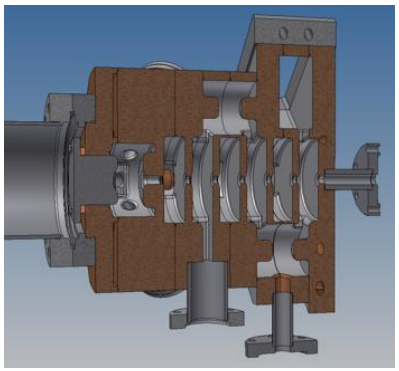
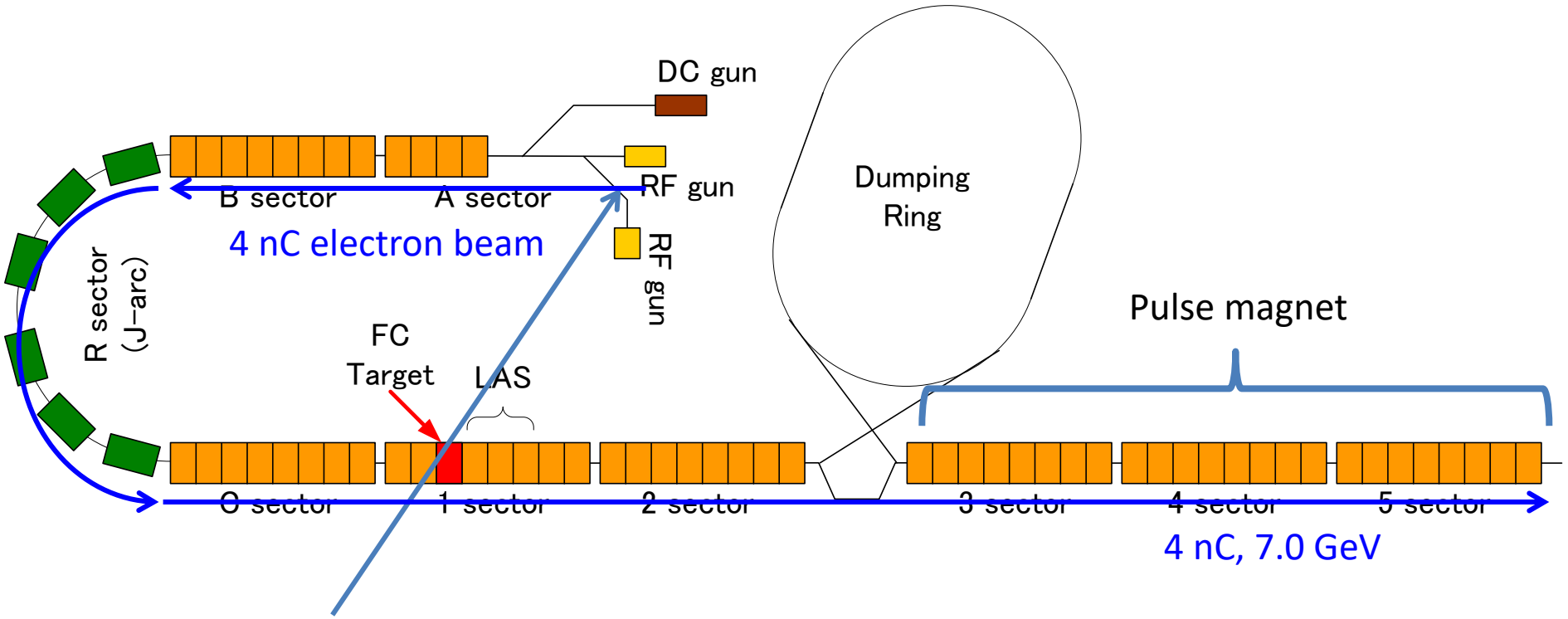
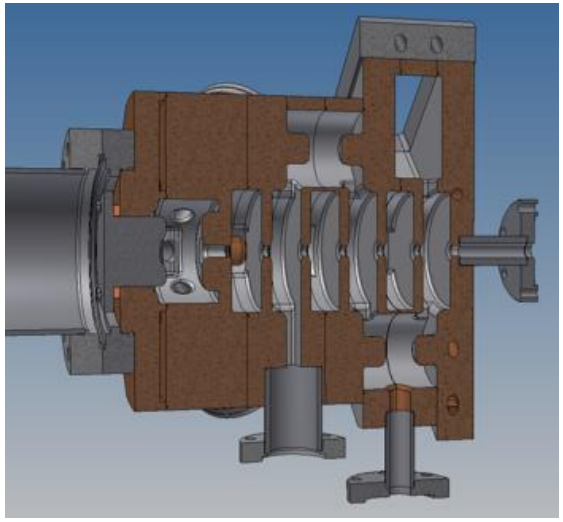


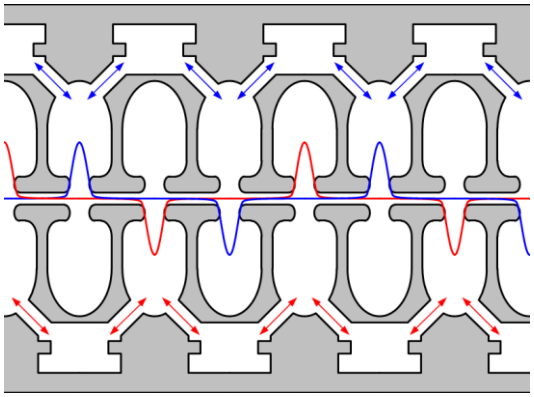
Photo cathode
RF gun



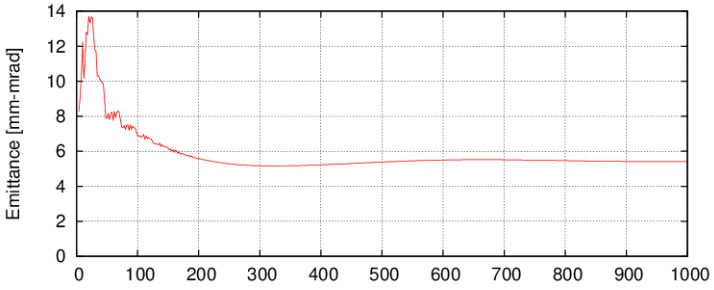
Electron beam





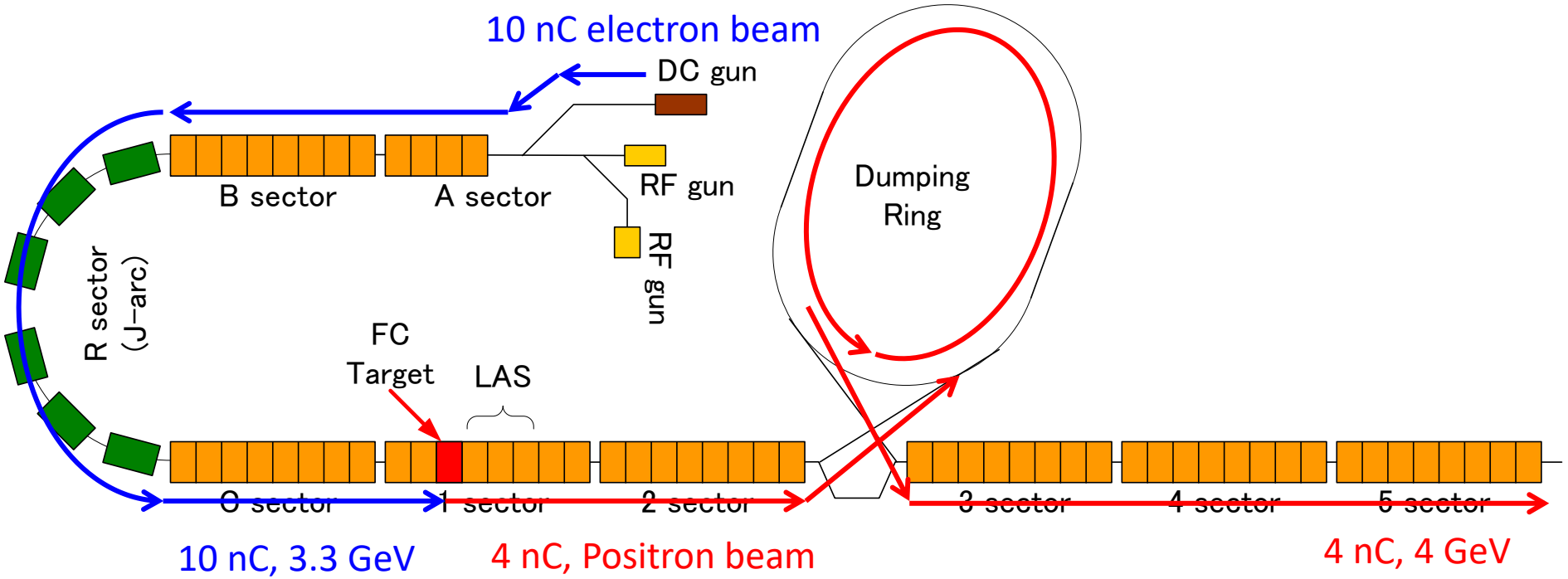


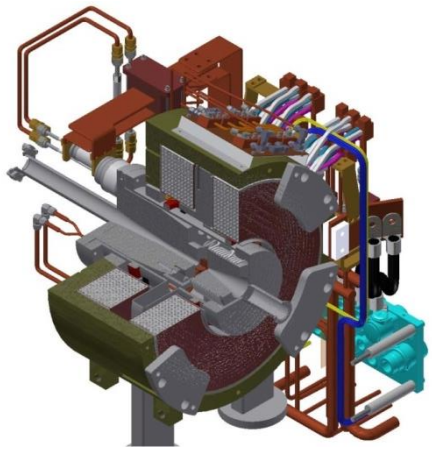
Quasi-traveling wave
side coupled cavities

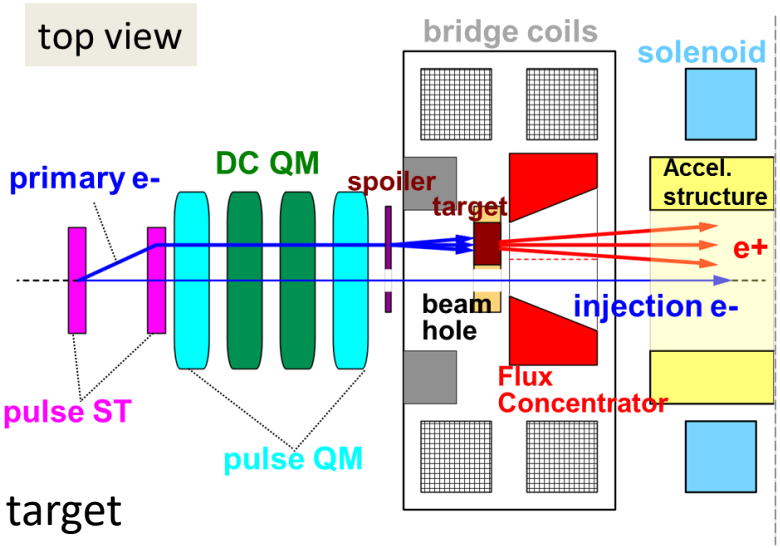


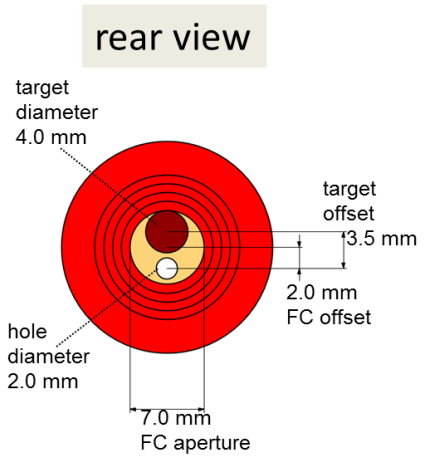
Emittance is 6 mm-mrad
in simulation

Positron beam





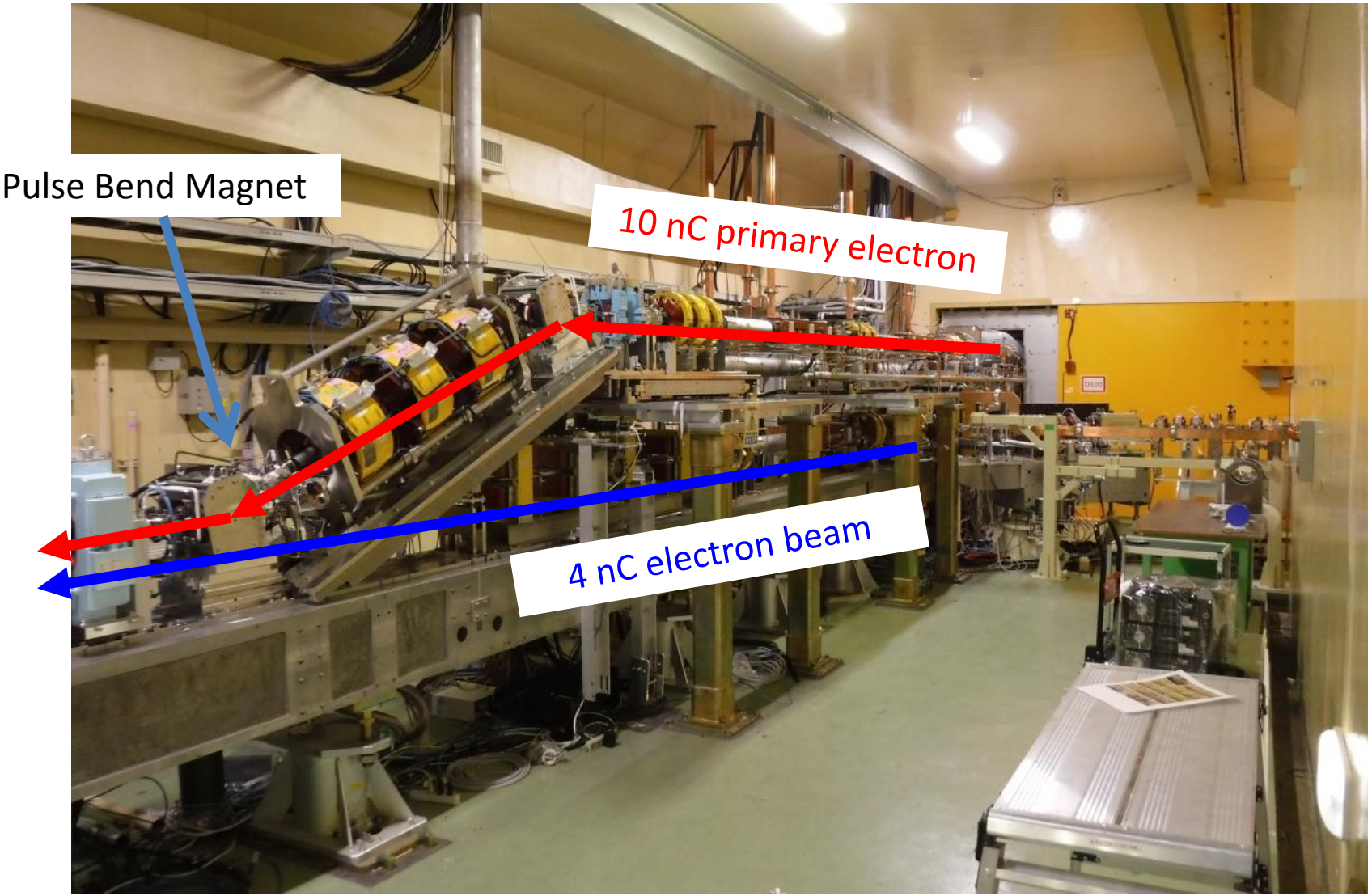




Flux Concentrator(FC), Positron target

Injector line

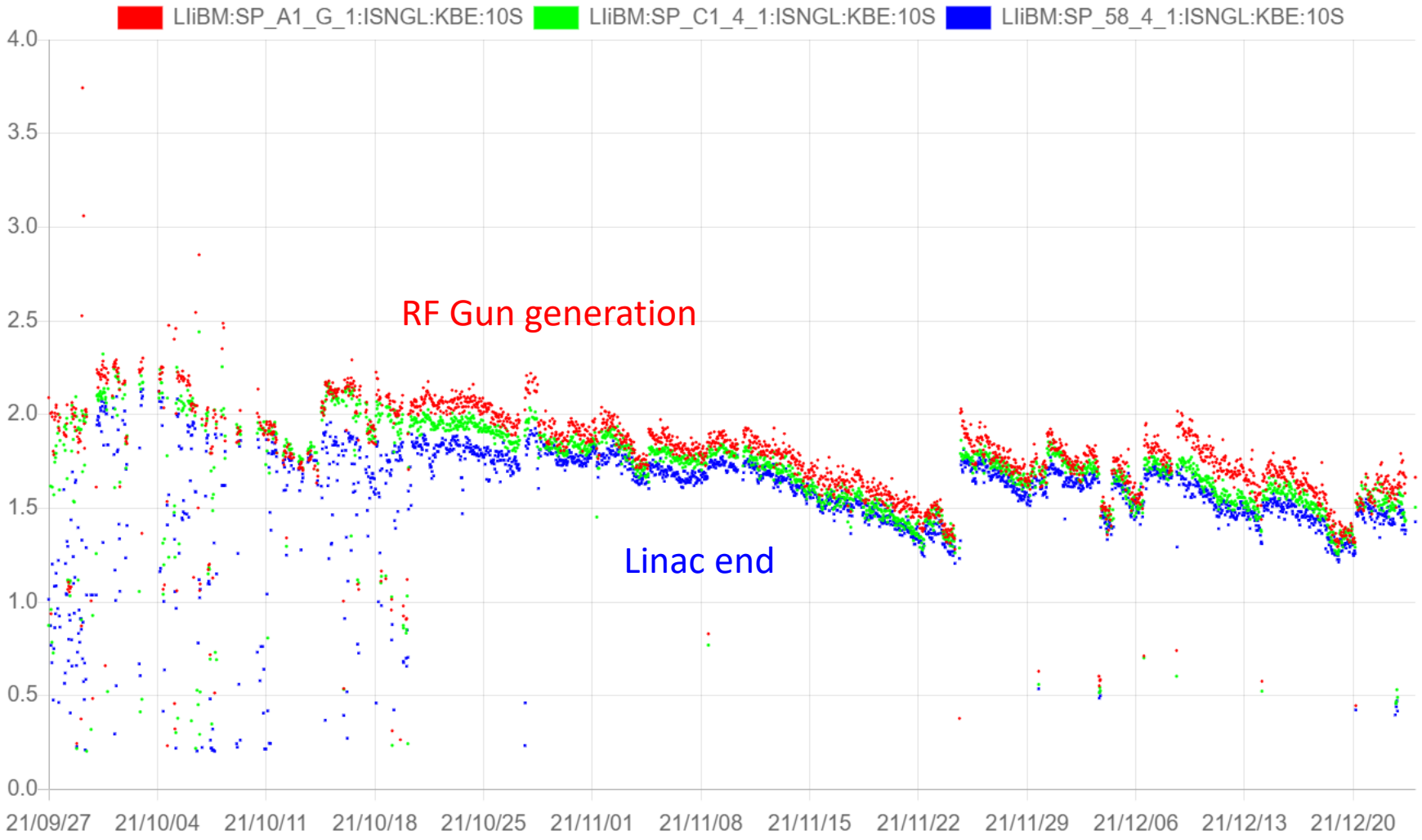
We have two lines in injector sector for positron and electron beam.



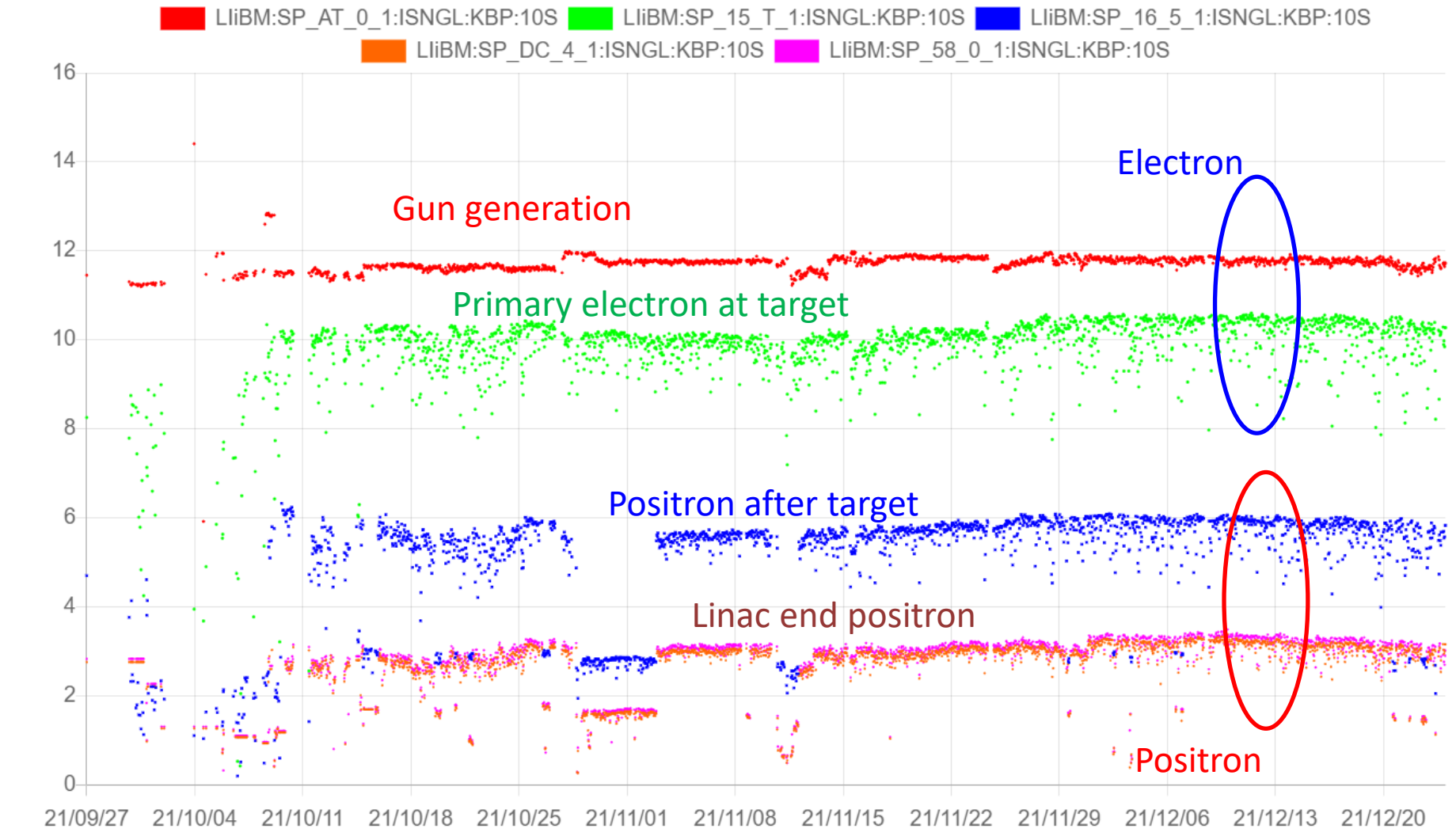
Beam status

	2021c		Final goal	
Beam	e+	e-	e+	e-
Energy	4.0 GeV	7.0 GeV	4.0 GeV	7.0 GeV
Bunch charge 1^{st} , 2^{nd} [nC]	3.0 , 2.5	2.0 , -	4.0, 4.0	4.0, 4.0
Normalized emmittance [mm-mrad]	120, 5 (Hor. , Ver.)	50-20, 50-20 (Hor. , Ver.)	100, 15 (Hor. , Ver.)	40, 20 (Hor. , Ver.)
Simultaneous top-up injection	4+1 rings (LER, HER, DR, PF, PF-AR)		4+1 rings (LER, HER, DR, PF, PF-AR)	

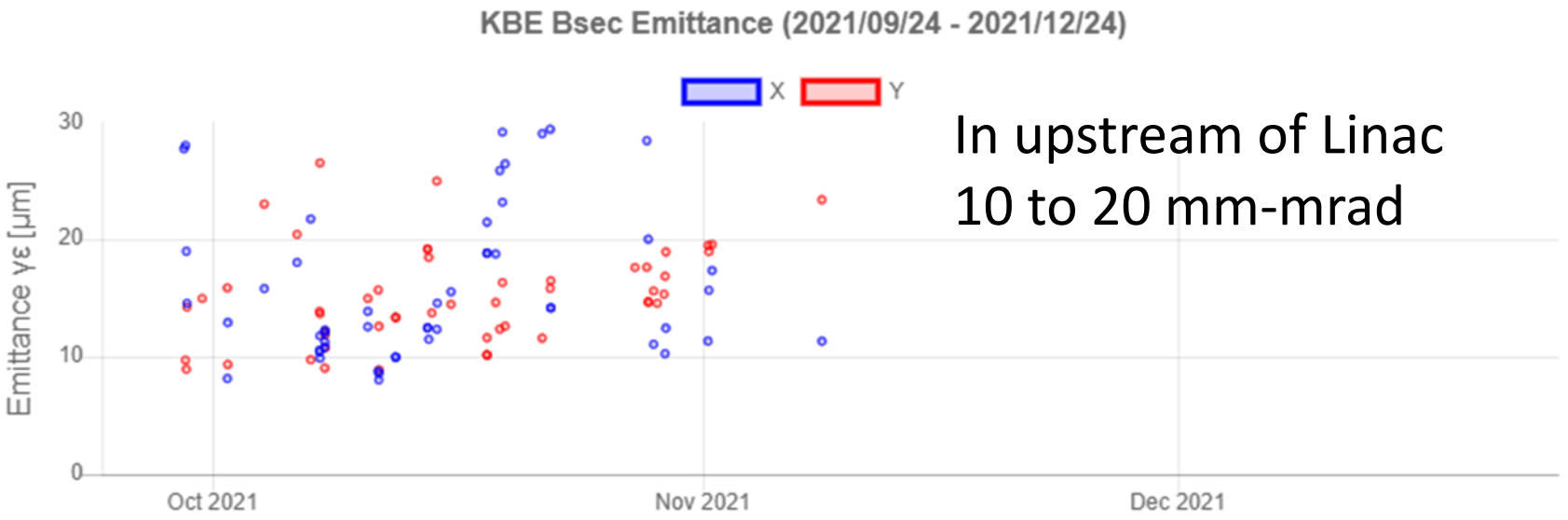
Electron beam charge 2021c



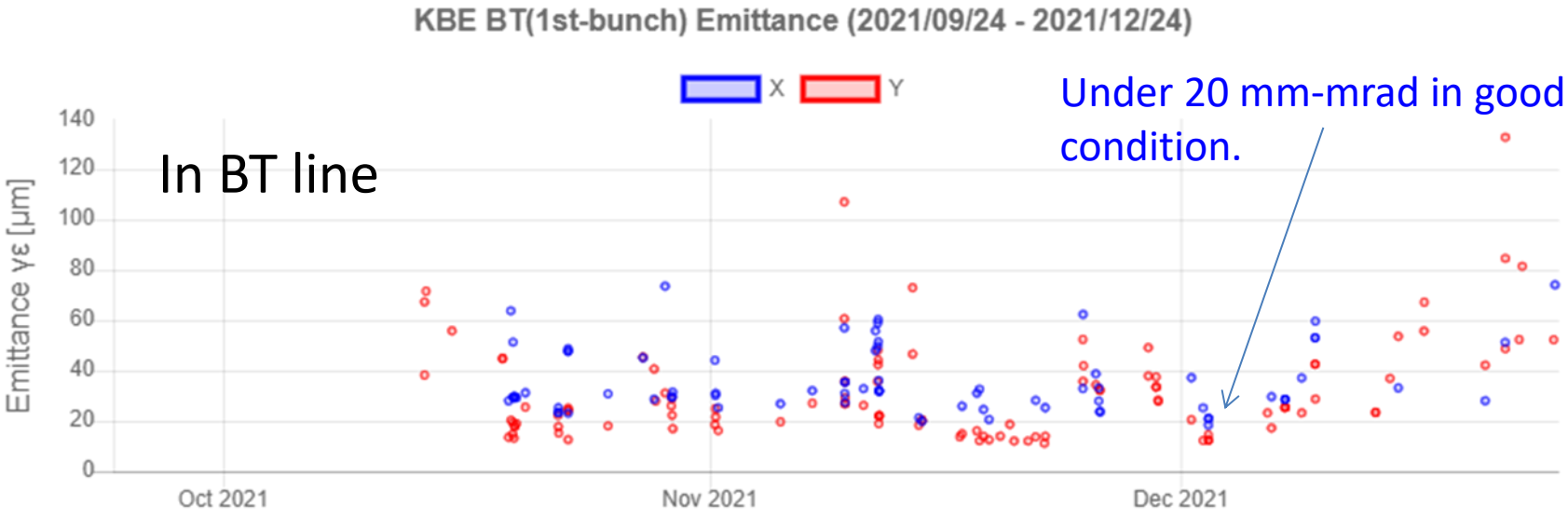
Positron beam charge 2021c



Electron beam emittance 2021c



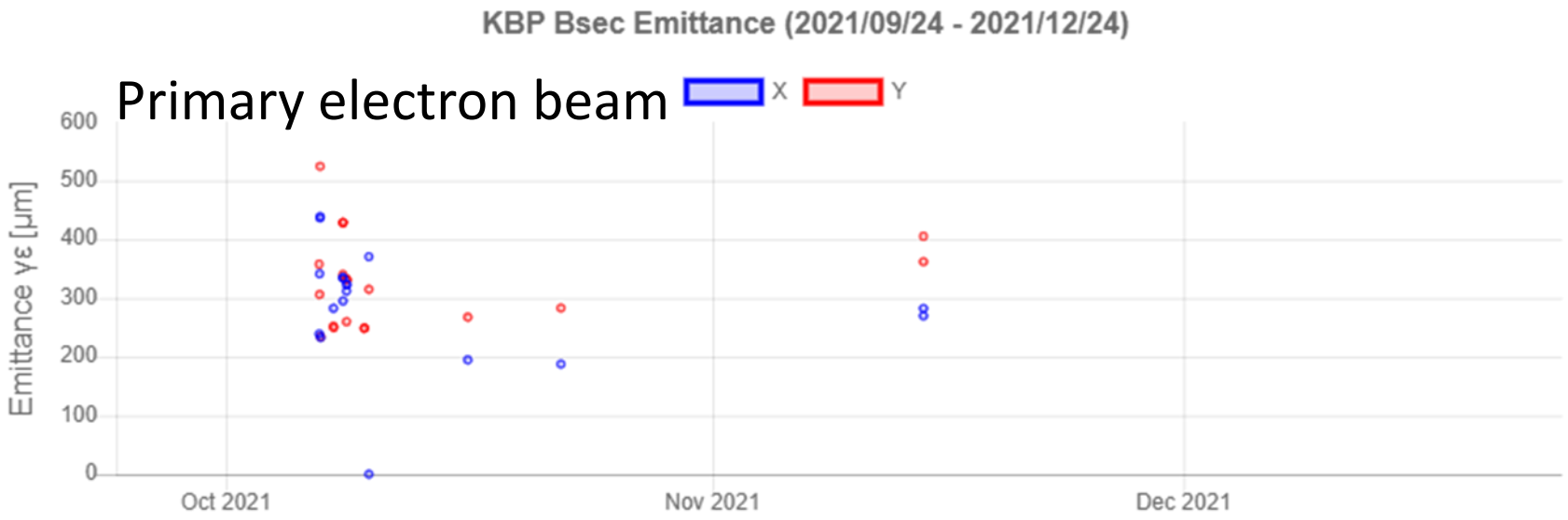
In upstream of Linac
10 to 20 mm-mrad

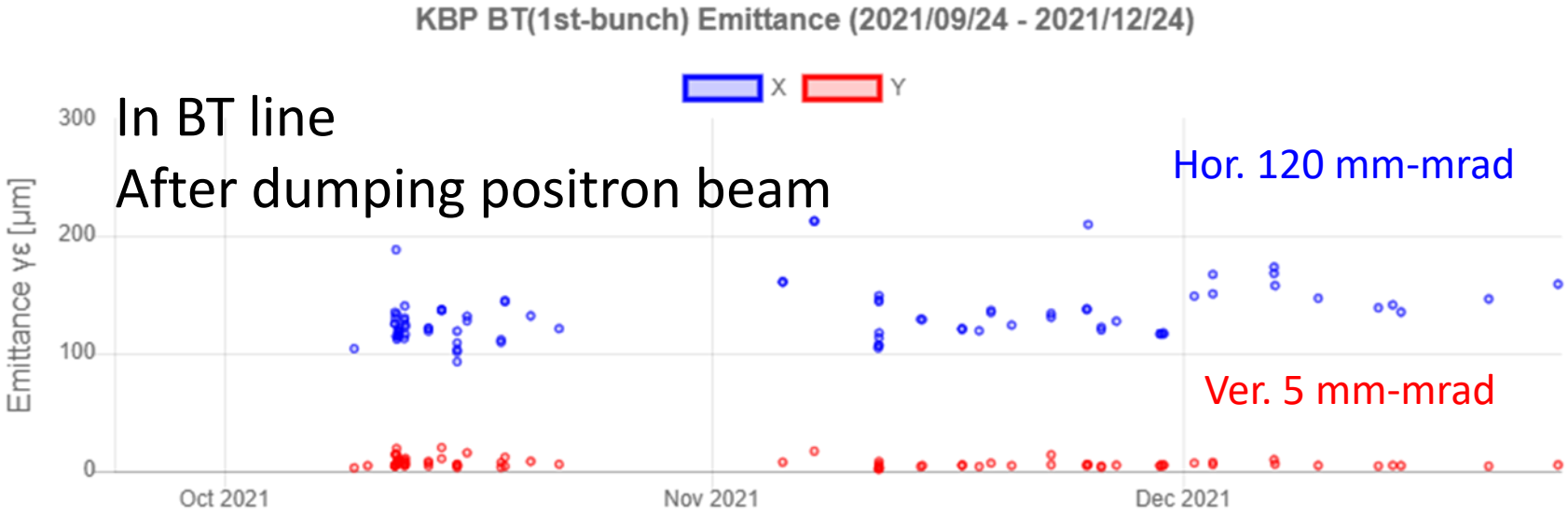


In BT line

Under 20 mm-mrad in good condition.

Positron beam emittance 2021c

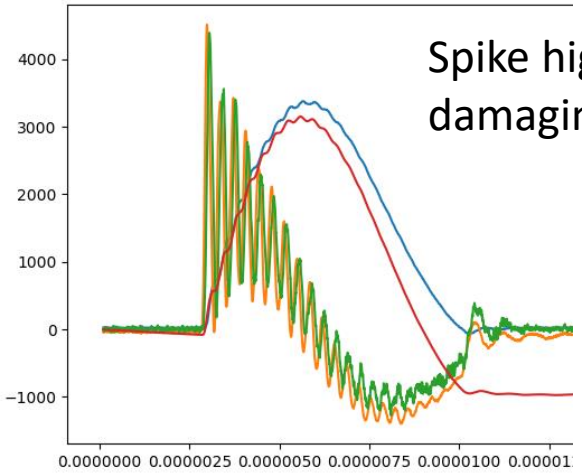




FC modulator improvement

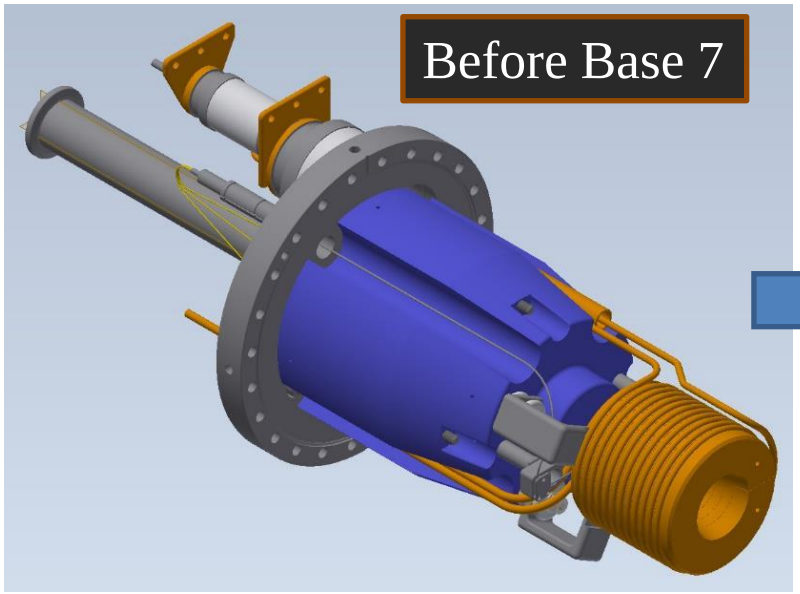
- In the past, FC was damaged by breakdown, but the damage was avoided with improved FC.
- However, the spike voltage that could induce breakdown still remained.
- Spike voltage sometimes caused malfunction of control equipment.
- In last summer, we modified the FC modulator and succeeded in significantly reducing the spike voltage.

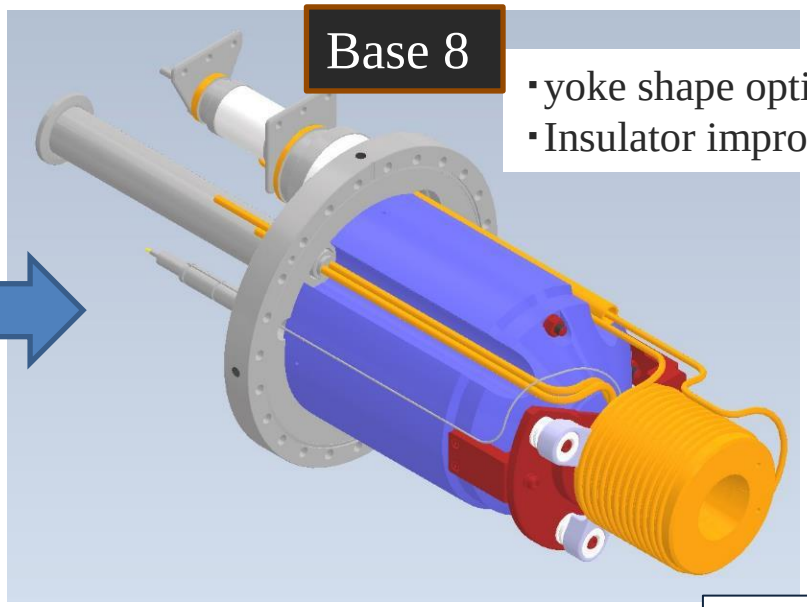
FC head improvement (2020c)



Spike high voltage had been damaging to FC head

New FC is very robust.
No break down.

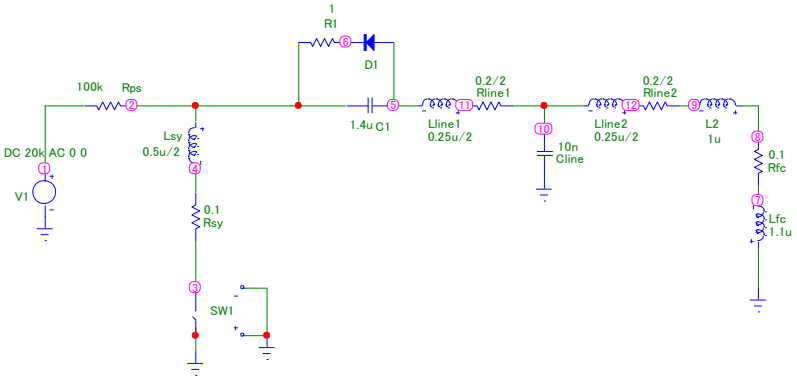


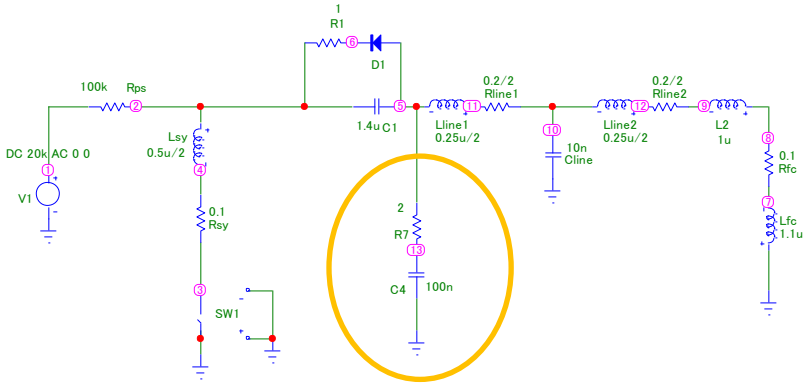


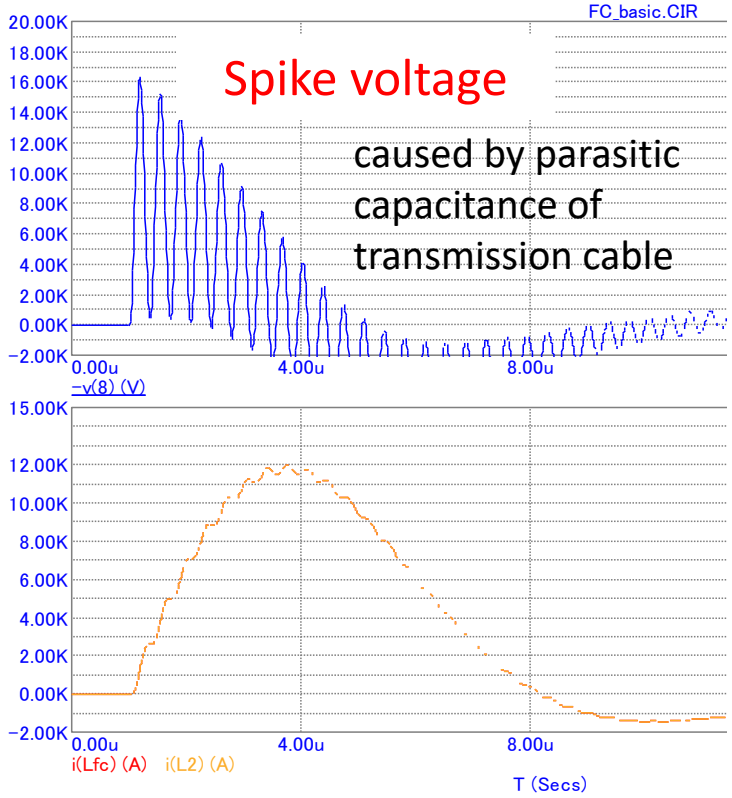
Y. Enomoto

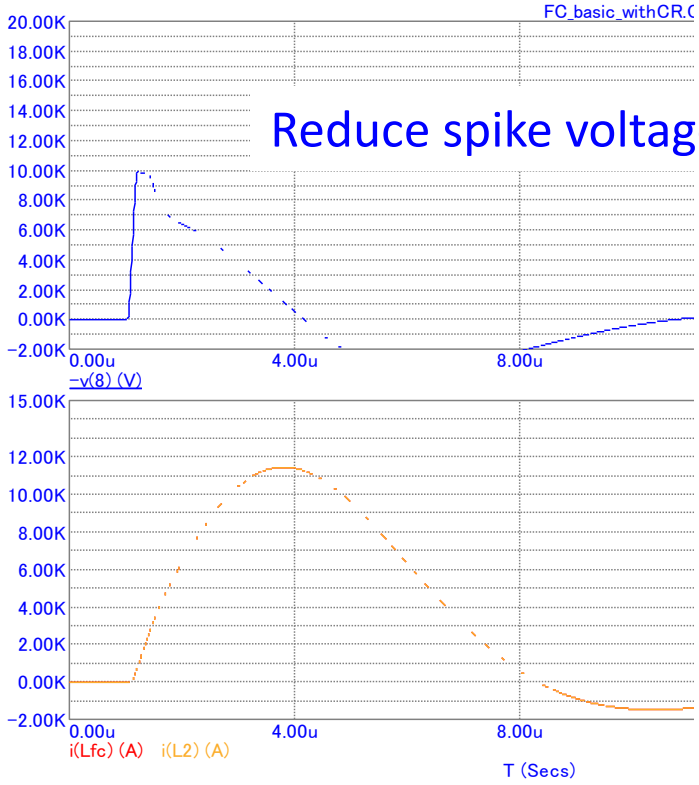
Circuit simulation of FC modulator for reduce spike voltage

We investigate a source of spike voltage and reduction method





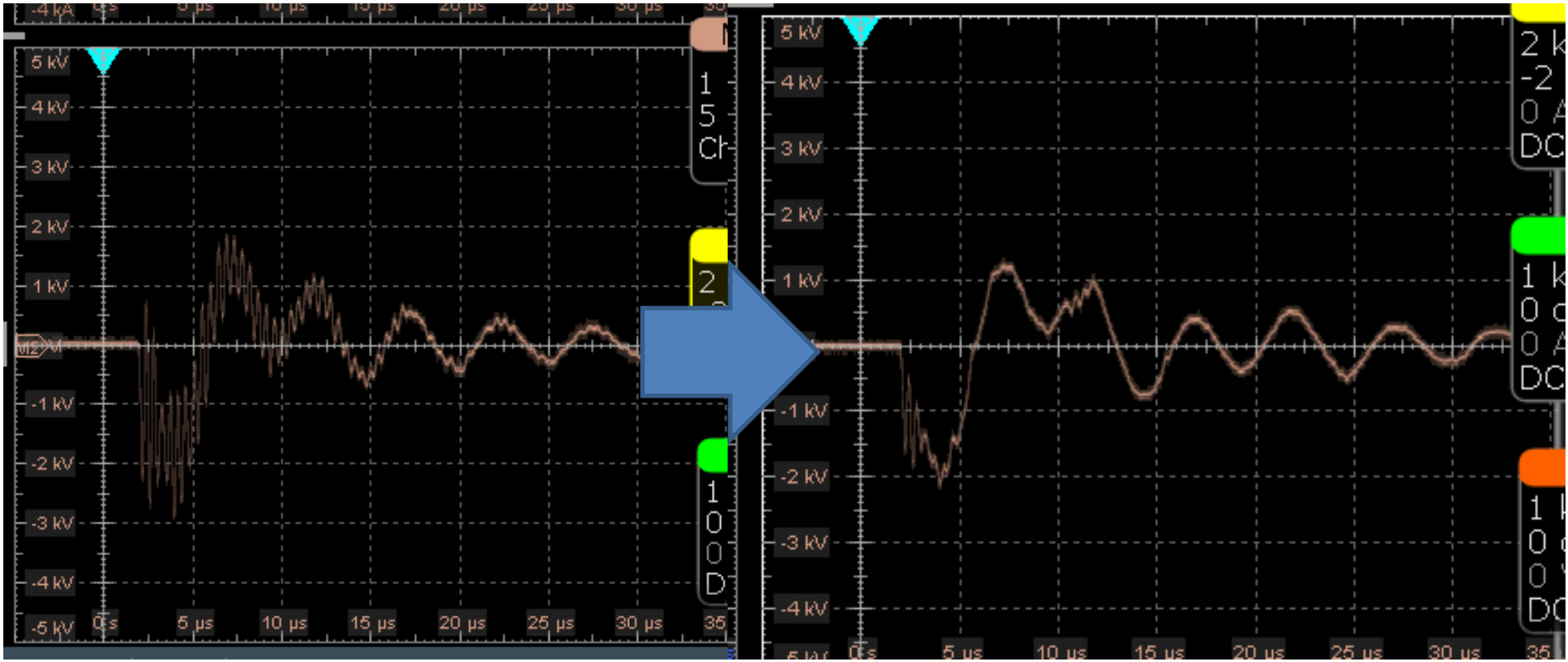




Set RC circuit to the FC modulator

RC circuit

Result of modified FC modulator



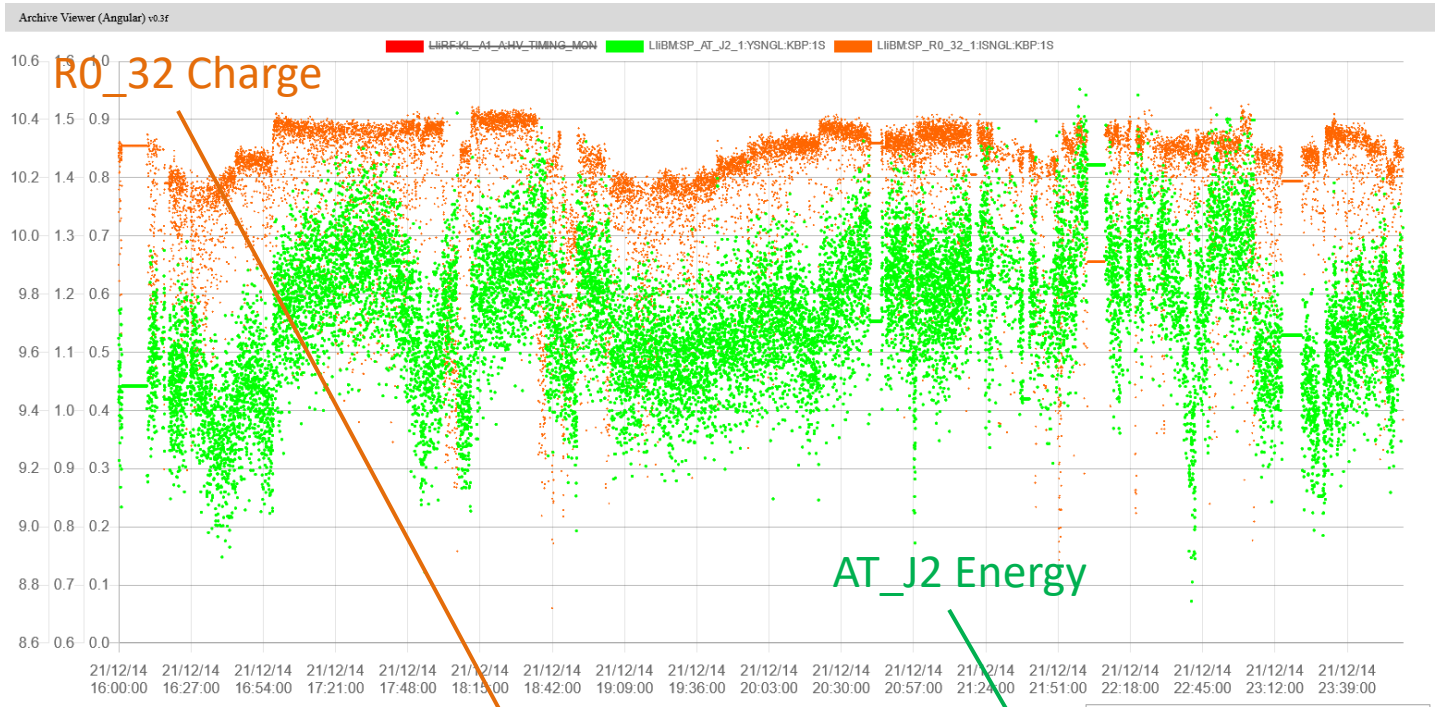
Measured reduction of spike voltage was almost same of simulation result.

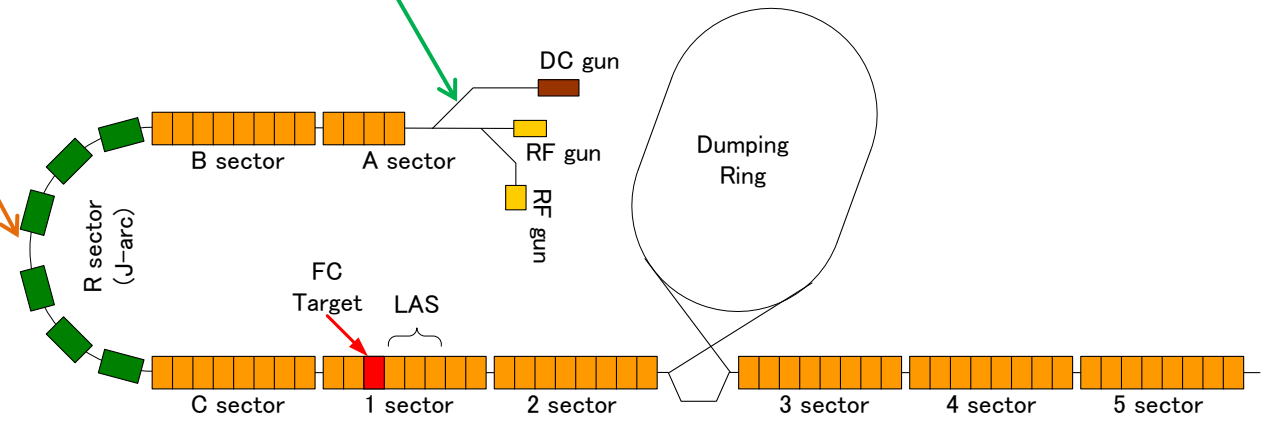
We have no trouble of FC noise in 2021c.

Issue of unstable positron primary beam

- Positron primary beam was often unstable beam charge at target.
- It caused by energy unstable at injector line.
- Source of energy jitter is HV pulse shape and HV timing jitter.
- We adjust positron primary beam to stable operation.

Energy jitter of AT line (Thermionic gun injector line) cussed beam loss at J-arc



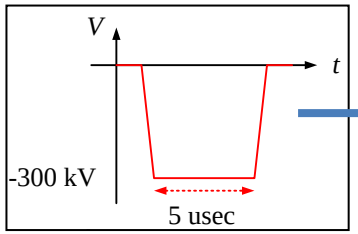


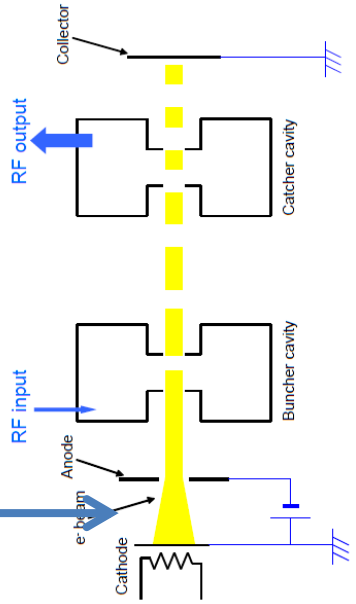
Thermionic gun modulator had been removed. Currently, one modulator feed HV pulse to two devices which is klystron and gun.

We use klystron modulator with parallel connection.
It is abnormal usage.

Modulator feed pulse HV.

Flat pulse is necessary.

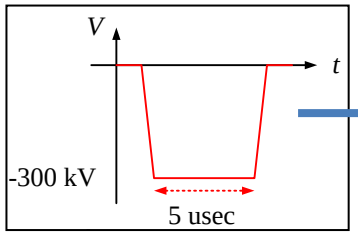


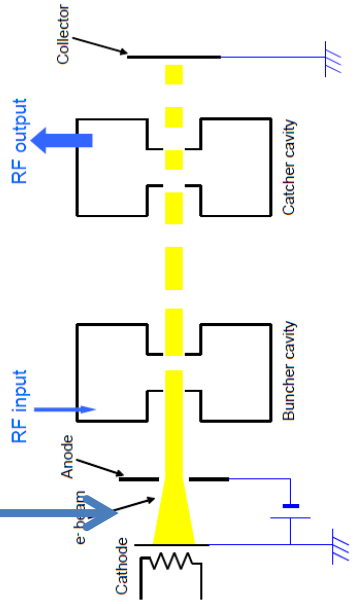


Normal usage

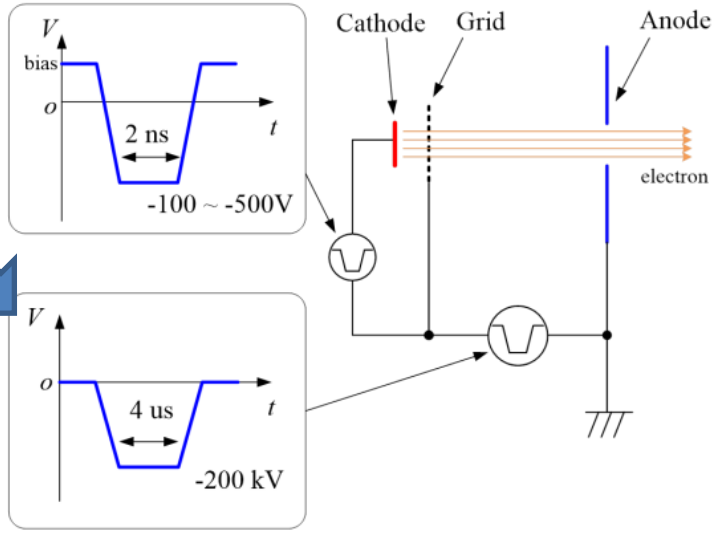
Modulator feed pulse HV.

Flat pulse is necessary.





Parallel connection

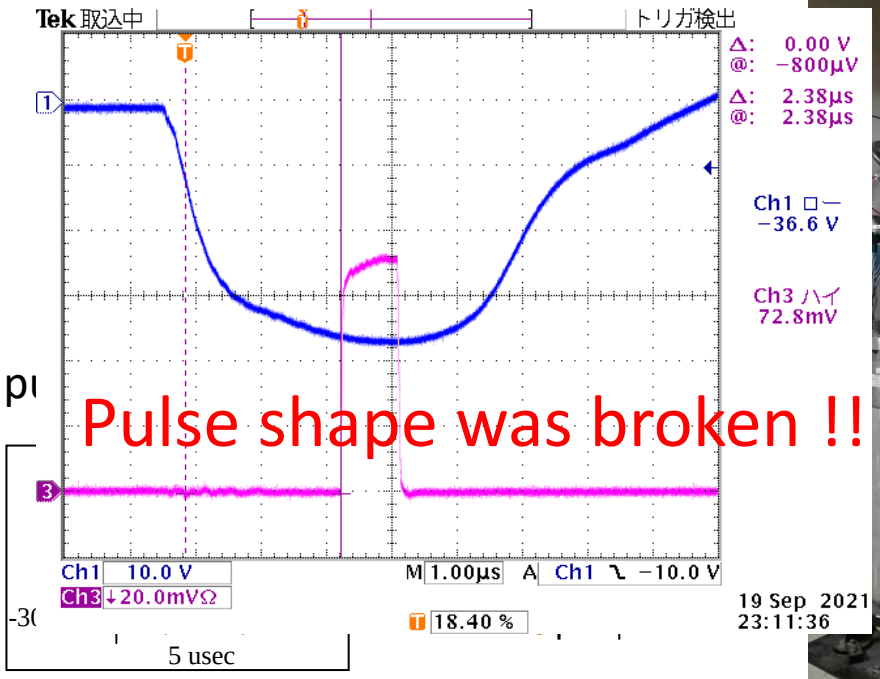


At injector, gun was connected.

Modulator feed pulse HV.

Modulator pulse timing jitter is 10 ns

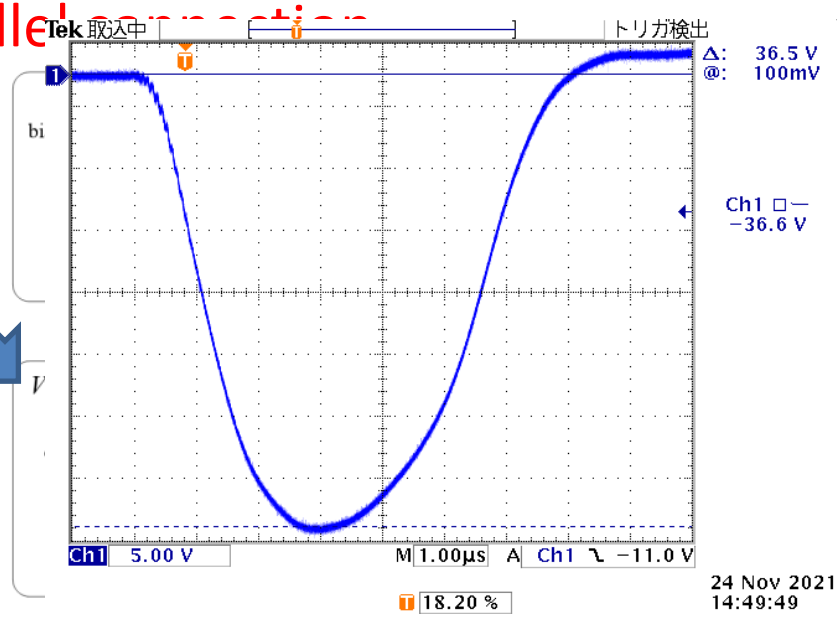
Sensitive to timing jitter



Flat pu

Pulse shape was broken !!

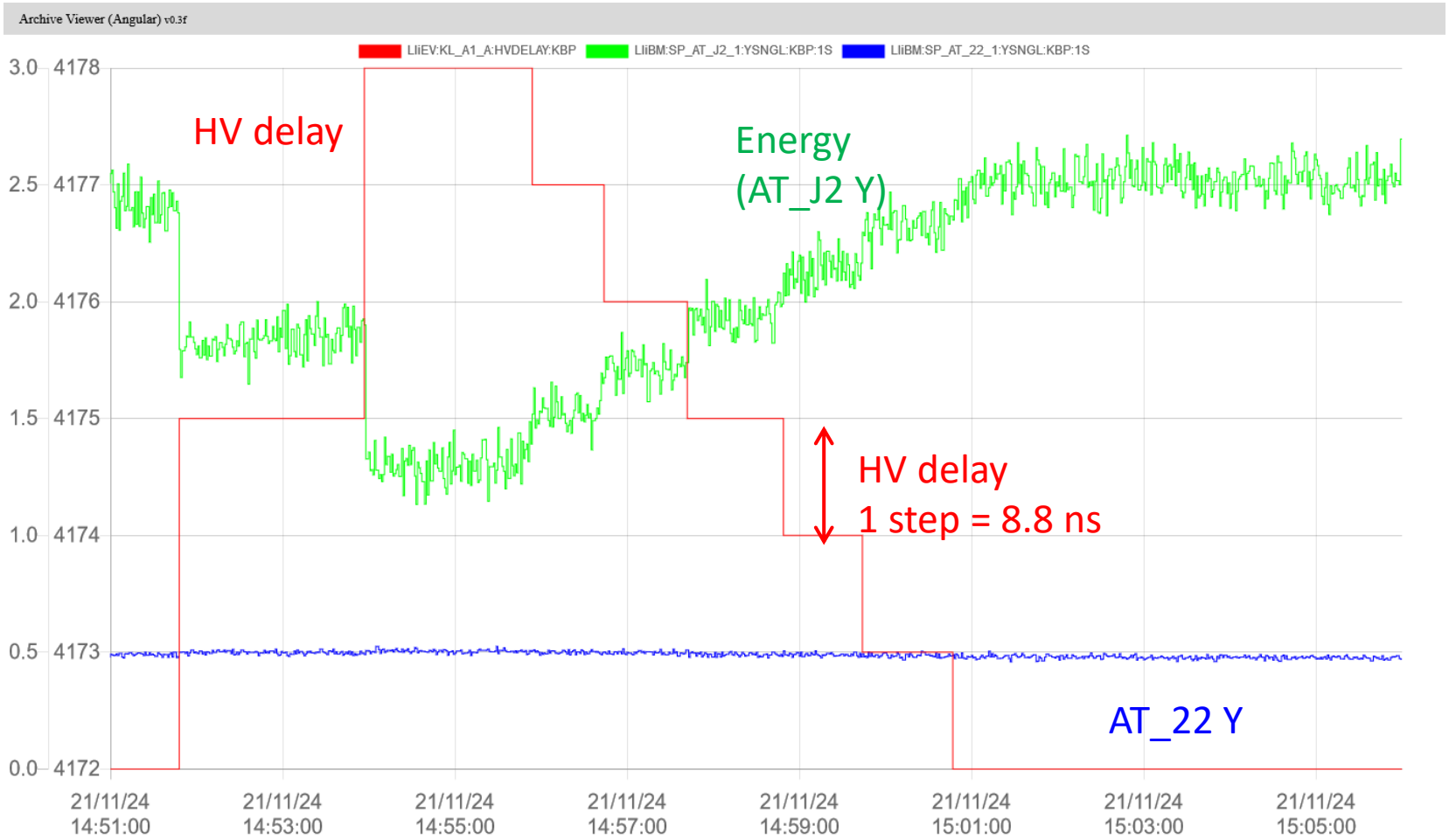
Parallel connection



At injector, gun was connected.

Operation delay timing is sensitive point for beam energy.

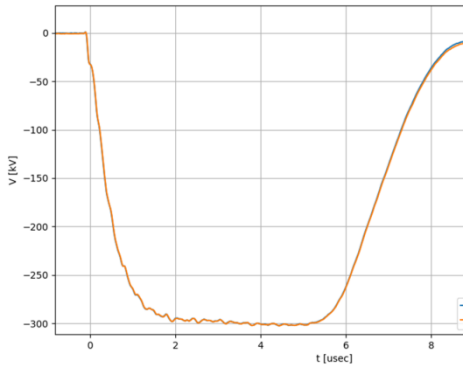
2022/01/17 study



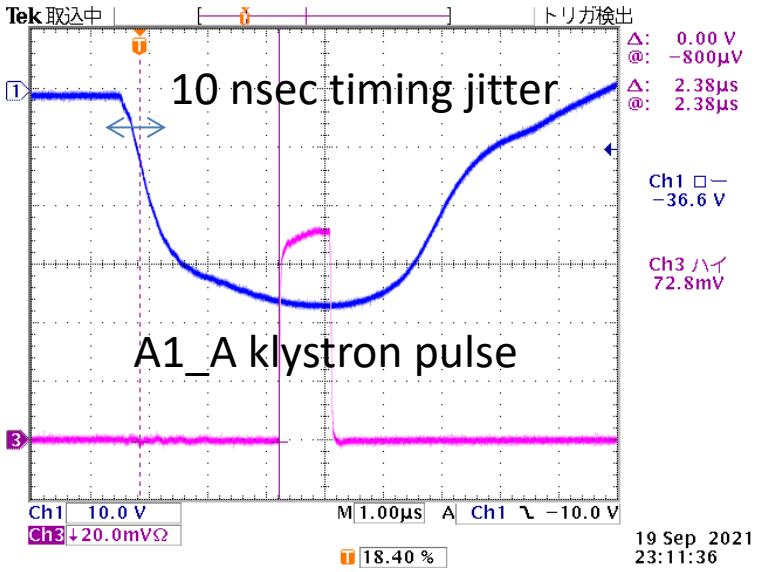
It was also experimentally confirmed that the timing of the voltage pulse greatly affects the beam energy

Source of beam instability

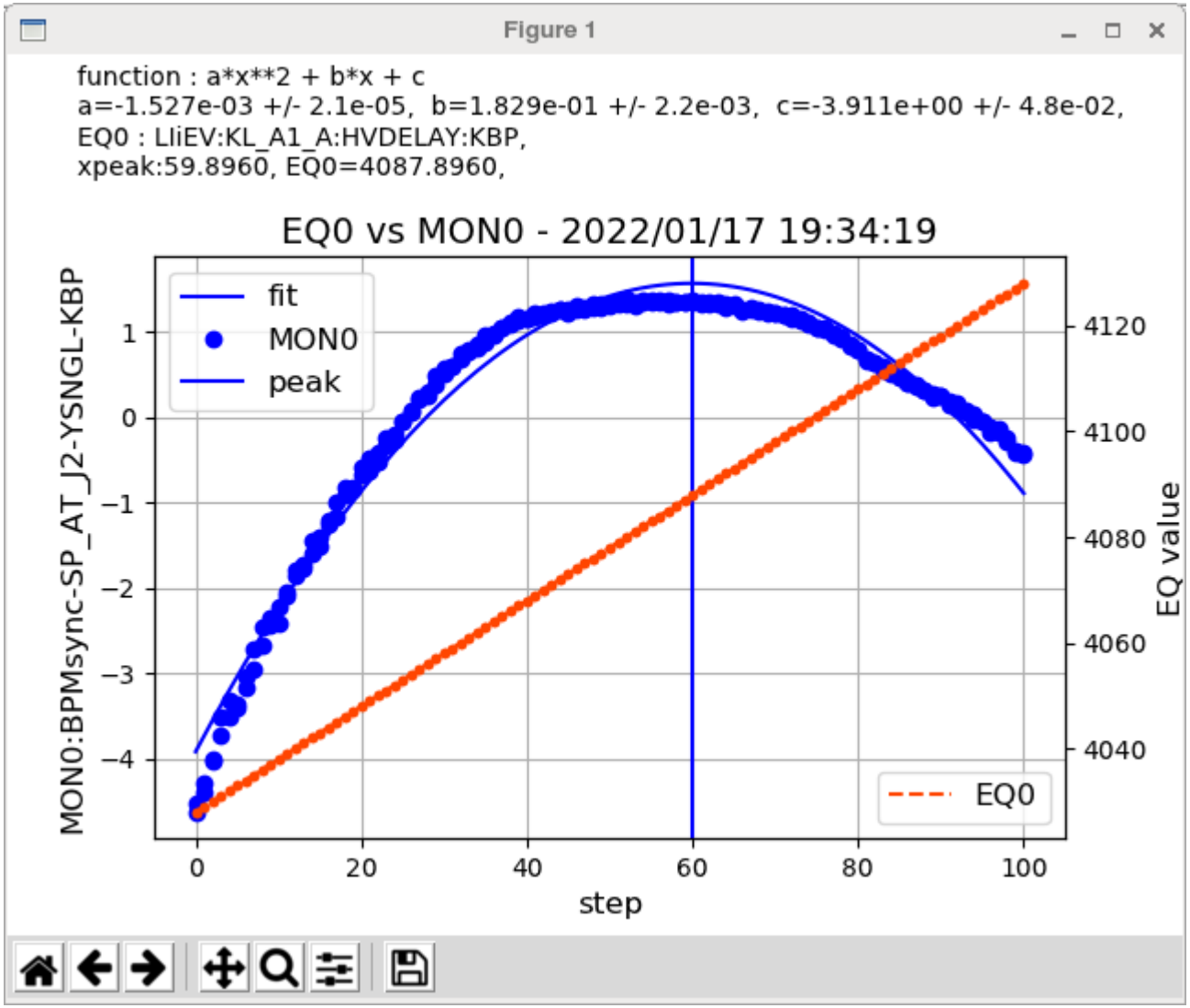
- Modulator has 10 nsec timing jitter
- Normally, flat pulse is no problem.
- Exceptionally, A1_A klystron is greatly affected due to the broken pulse shape.



Normal pulse



We found a delay timing that reduces the effect on beam energy.



We will adjust a positron primary beam to stable injection for 2022 SuperKEKB

Conclusion 2021c

- Beam charge is still not achieved to final goal. But it is enough charge in 2021c.
- Positron charge is almost achieved. We will improve transmission ratio.
- We can increase electron beam with laser power margin and 2nd bunch operation.
- Emittance is sometimes achieved final goal value. But good condition is breaking easily. We must make an effort to maintain stable conditions.
- We are making various improvements every day to stabilize the beam. Hardware maintenance in shutdown term and beam study in operation term.