Title: High Intensity Positron Sources for Circular Colliders (SuperKEKB, FCC-ee)

Y. Enomoto - KEK (yoshinori.enomoto@kek.jp)

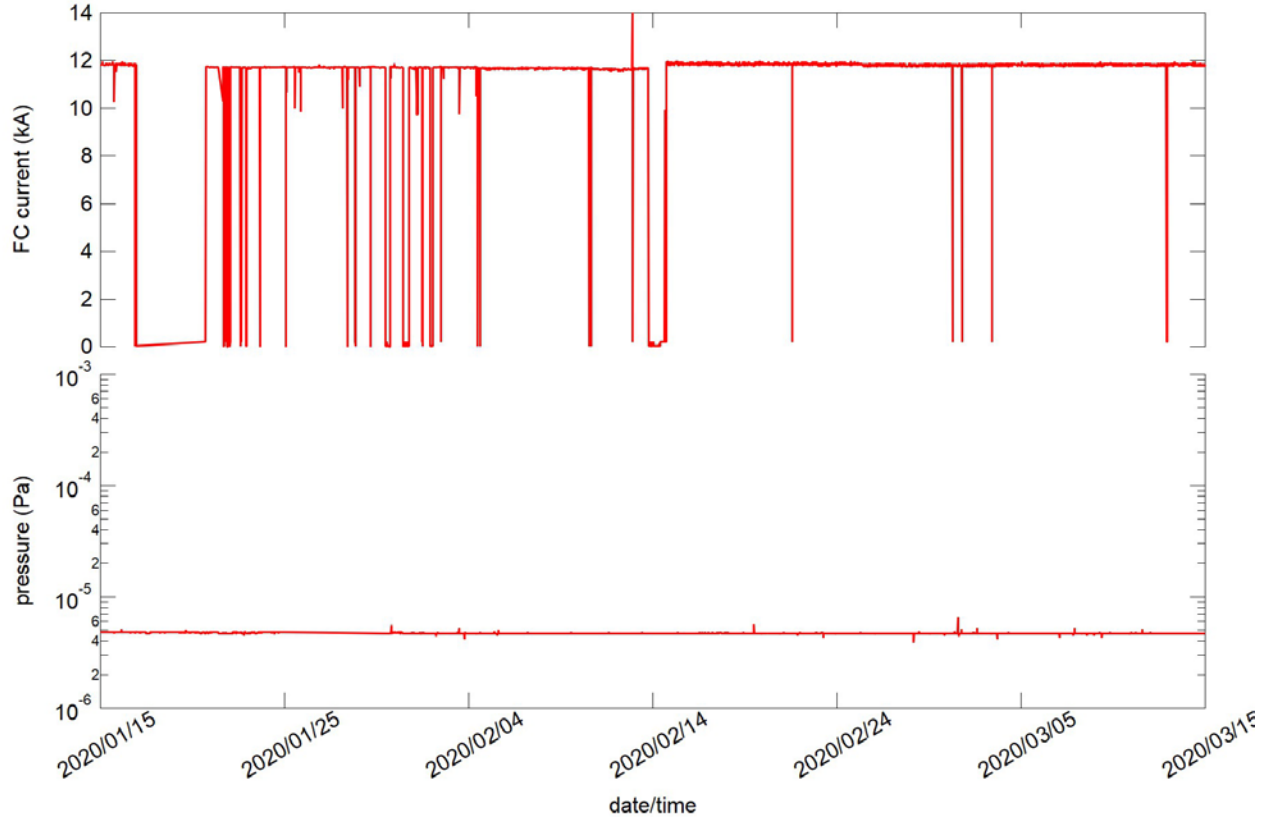
I. Chaikovska - IJCLab/IN2P3/CNRS (iryna.chaikovska@ijclab.in2p3.fr)

Recap

- The **common R&D studies** on high intensity positron sources are ongoing between **KEK** and **IJCLab** since some years
- In the scope of collaboration **both conventional and hybrid schemes** for positron production are **under investigation**.
- **Conventional scheme** is currently employed at **SuperKEKB** (highest intensity positron source currently in operation).
- To ensure high reliability of the positron source, **conventional and hybrid targets** are under study for the **FCC-ee**.
- **Collaboration is essential between French and Japanese teams in this domain.**

SuperKEKB status

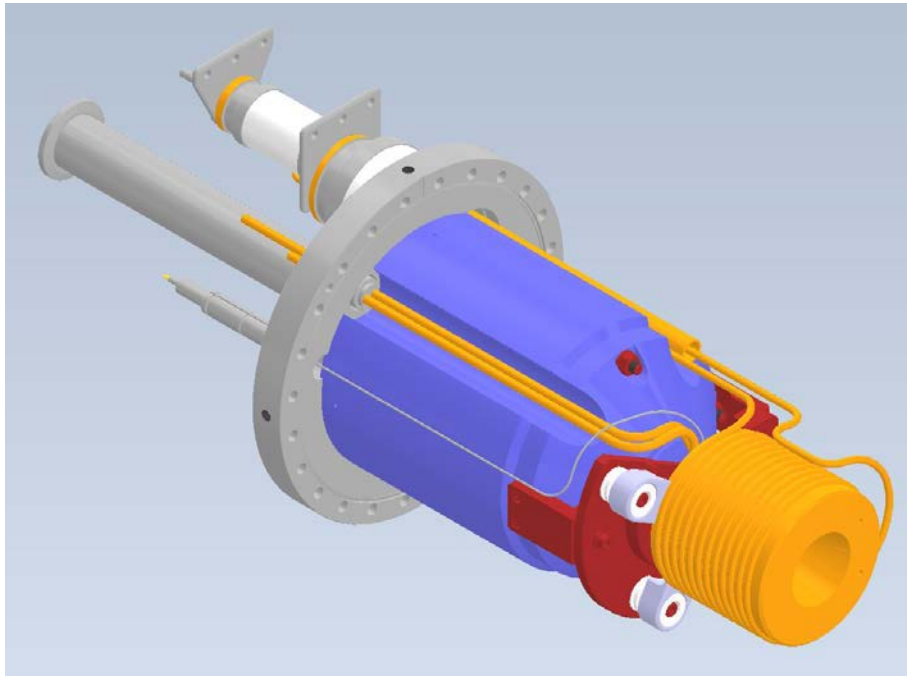
- The positron source has been in stable operation
  - Support long-term physics run
- New FC made of novel cu-alloy have been in full power and long term test at dedicated test bench
  - Present results are very optimistic

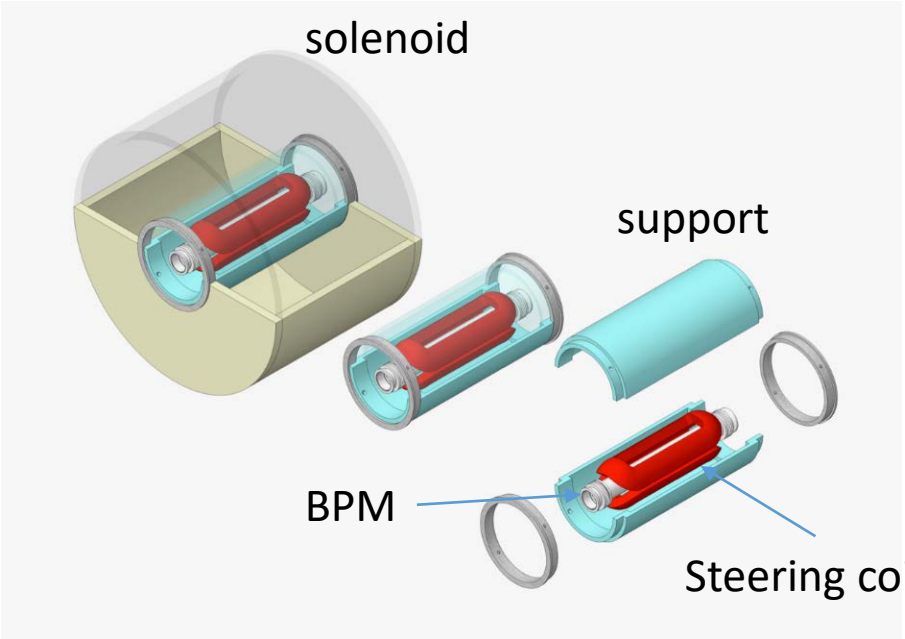


During 2months test, there are several current drop due to maintenance. However no degradation of vacuum stem from discharge was observed.

SuperKEKB upgrade

- In summer 2020, major upgrade is planned
  - New FC will be installed
    - Made of novel material
    - Optimization of yoke shape
  - BPMs and Steering coils in the capture solenoid section
    - Better beam tuning is essential for this region
  - After the upgrade, full power operation of the FC at 12 kA will start



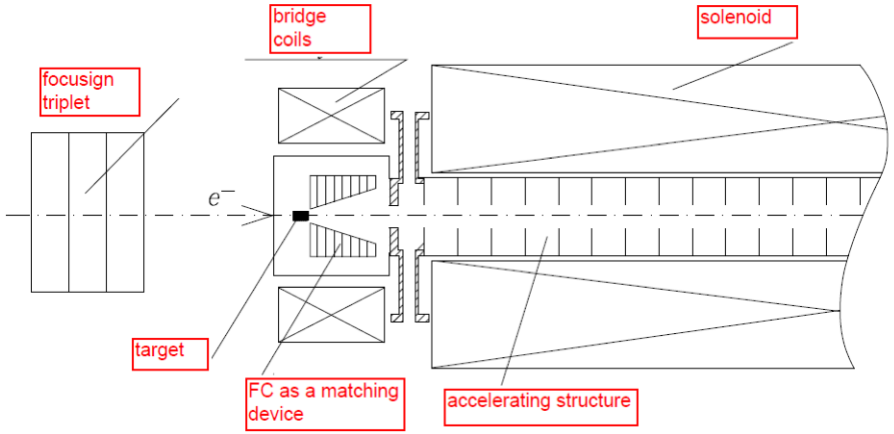


K. Yokoyama, K. Kakihara, F. Miyahara, T. Suwada

FCC-ee positron source status

The complete filling for Z running (most demanding) => Requirement @ DR:
~2.1 × 10^{10} e^+/bunch (4.3 nC)
~0.5 e+/e- without safety factor

e+ production and capture section



Primary e^- beam for e^+ production	
Beam energy	4.46 GeV
Bunch charge	4.2 × 10^{10}
Bunch length (rms)	**1** mm
Bunch transv. size (rms)	**0.5** mm
Bunch separation	60 ns
Nb of bunches per pulse	2
Repetition rate	100-**200** Hz
Beam power	12 kW

Beam Parameter	Convention	Hybrid	Hybrid 2*
Target thickness	4.5X_0	0.4 X_0/ 3.4X_0	0.4 X_0/ 2.9X_0
e+ yield @ Target	~11 e+/e-	~7 e+/e-	~11 e+/e-
PEDD	17 J/g	3 J/g	22 J/g
Deposited power	18 % (2.1 kW)	7 % (0.8 kW)	14 % (1.7kW)

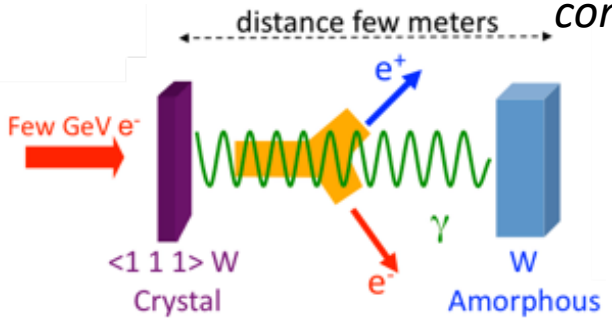
**Hybrid 2 scheme should be optimized*

Fixed target-converter **(like @ SuperKEKB)**

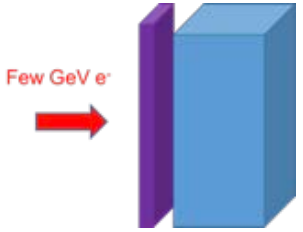
Capture: FC as the AMD + 2 GHz L-band (Hybrid scheme) or 2,856 GHz large aperture S-band structures (conventional).

Current studies: both schemes can provide *the comparable e+ yield (> 1 N_{e+}/N_{e-})* accepted by the DR

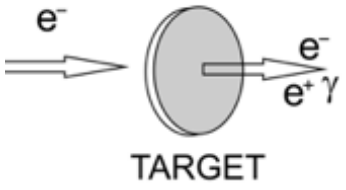
Beam Parameter	Convention	Hybrid	Hybrid 2
B_{max} = 5 T, B_{DC} = 0.5 T			
Mean Energy	190 MeV	197 MeV	235 MeV
Accepted yield	1.1 N_{e+}/N_{e-}	0.7 N_{e+}/N_{e-}	~1.4 N_{e+}/N_{e-}
Emittance hor./vert.	17 μm (1σ)	14 μm (2σ)	10 μm (3σ)
B_{max} = 7 T, B_{DC} = 0.7 T			
Mean Energy	190 MeV	198 MeV	226 MeV
Accepted yield	1.3 N_{e+}/N_{e-}	~0.9 N_{e+}/N_{e-}	~2 N_{e+}/N_{e-}
Emittance hor./vert.	21μm (1σ)	16 μm (2σ)	11 μm (3σ)



Hybrid scheme



Hybrid scheme 2



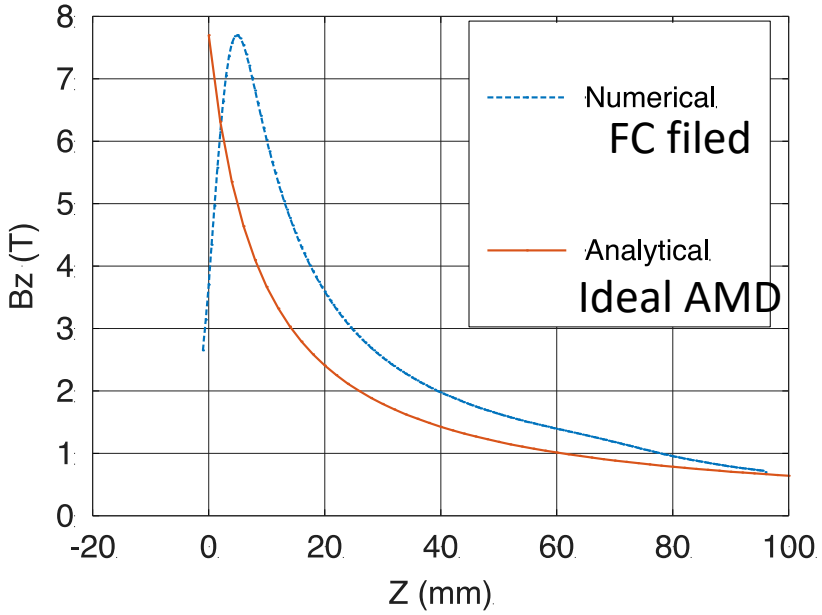
Conventional scheme

The realistic simulations up to the DR are needed + safety factor

FCC-ee positron source: planned studies

- The Adiabatic Matching Device (AMD) may use a pulsed Flux Concentrator or SC solenoid magnet

For FC option: B_{TARGET} = 3T while B_{max} ~ 8T



- Continuation of the production/capture simulations for the e+ source.
- We will concentrate on the AMD based capture system studies, in particular a capture scheme using a fringe field of the superconducting solenoid as the AMD
- A bypass line for the positron source within the FCC-ee injector complex is under consideration. Two bypass proposals based on a dogleg and a chicane are under study.

Peak of the magnetic field is at 5 mm from the target =>
40 % drop in capture efficiency

☞ **SC solenoid** => Advantages: higher field value on the target, DC operation. Promising results of the first tests at KEK (2011).