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#### **Injector Linac Overview**

#### Kazuro Furukawa for Injector Linac, SuperKEKB

Injector Linac Status

K.Furukawa, ARC2018, Mar.2018 1

**Injector Linac Mission** 



#### **Mission of Electron/positron Injector in SuperKEKB**

- For 40-times higher luminosity in SuperKEKB collider
- Low emittance & low energy spread injection beams with 4 times higher beam current
  - × New high-current photo-cathode RF gun
  - New positron capture section
  - Positron damping ring injection/extraction
  - Optimized beam optics and correction
  - Precise beam orbit control with long-baseline alignment
  - **Simultaneous top-up injection to DR/HER/LER/PF/PFAR**
- Balanced injection for the both photon science and elementary particle physics experiments





The single injector would behave as multiple injectors to multiple storage rings by the concept of virtual accelerator





#### **Required injector beam parameters**

Stage	KEKB	(final)	Phas	se-l	Phas	se-ll	SuperKEKB (final)	
Beam	e+	e–	e+	e–	e+	e–	e+	e–
Energy	3.5 GeV	8.0 GeV	4.0 GeV	7.0 GeV	4.0 GeV	7.0 GeV	4.0 GeV	7.0 GeV
Stored current	1.6 A	1.1 A	1 A	1 A	1.8 A	1.3 A	3.6 A	2.6 A
Life time (min.)	150	200	100	100	-	—	6	6
Bunch charge (nC)	primary e- 10 → 1	1	primary e- 8 $\rightarrow 0.4$	1	0.5	1	primary e- 10 → <mark>4</mark>	<u>4</u>
Norm. Emittance (γβε) (μrad)	1400	310	1000	130	200/40 (Hor./Ver.)	150	<u>100/15</u> (Hor./Ver.)	<u>40/20</u> (Hor./Ver.)
Energy spread	0.125%	0.125%	0.5%	0.5%	0.16%	0.1%	<u>0.16%</u>	<u>0.07%</u>
Bunch / Pulse	2	2	2	2	2	2	2	2
Repetition rate	50 Hz		25 Hz		25 Hz		50 Hz	
Simultaneous top- up injection (PPM)	3 rings (LER, HER, PF)		No top-up		Eventually		<u>4+1 rings</u> (LER, HER, DR, PF, PF-AR)	



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#### **Injector-related Subjects to Discuss**

- Injector Overview
- RF Gun Mitsuhiro Yoshida
  - Performance improvement in Phase-1, 2 and development for Phase-3
- Accelerating Structure Hiroyasu Ego
  - Accelerating structure performance and degradation recovery
- Pulsed Magnet Yoshinori Enomoto
  - Home-grown components for pulse-to-pulse controls in simultaneous injection
- Positron Generation Yoshinori Enomoto
  - Performance with damping ring and recovery from discharge issues
- Injector Commissioning Masanori Satoh
  - Injector performance in Phase 1, 2 and planning for Phase-3
- Beam Jitters Yuji Seimiya
  - Unexpected beam jitter observation after target hole
- Timing Controls Hitoshi Sugimura
  - Damping ring injection/extraction and bucket selection with main rings
- LTR & RTL commissioning Naoko lida
  - Evaluation of beam manipulation at damping ring injection/extraction



#### **Examples of Other Recent Improvements**

- Energy and bunch compressors on the beam transport of DR
- Beam lines and power supply rearrangement for DR BT
- Thermionic gun and bunchers
- Beam position monitors
- Wire scanners and streak cameras
- LLRF system to co-op with event timing controls
- LLRF monitors
- Independent RF amplifiers
- Alignment
- Direct beam transport to PF-AR
- Safety system and radiation control licenses
- Rejuvenation of old components
- Operation software
- Operation manuals



# **DR LTR / RTL Waveguides**

- Accelerating structures for energy / bunch compressors on DR LTR / RTL beam lines
- 45-m waveguides from linac gallery
- Fabrication errors of ~150 µm were found (while schematics from KEK and from maker were correct)





### **DR LTR / RTL Waveguides**





- Components with red circles had to be replaced (Sep - Nov.2017)
- Successfully commissioned (Dec.2017)



#### **Energy Compressor on LTR**

**Other Improvements** 



#### Klystron Modulator Installation and Temporary Gun Removal



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# **SuperKEKB Domestic Review**

#### The third domestic review meeting

- On September 8th, 2017
- Reviewers of Atsushi Enomoto, Katsunobu Oide (chair), Kotaro Satoh, Fujio Naito, Tatsuo Nakada, Junji Haba, Kentaro Harada, Yosuke Honda, Shinichiro Michizono
- <http://accphys.kek.jp/indico/conferenceDisplay.py?confld=122>
- Positron source
- Photo cathode RF gun
- Accelerating structure
- Pulsed magnets

**&QCS** 

Luminosity tuning

DR timing system

- Electron cloud instability in Phase 1 operation
- Beam background, MDI

#### **¤** Two of them received recommendations



### **Positron source**

#### Recommendation

- Avoid a fatal destruction by securing the discharge interlock activation within a pulse.
  - >=> The interlock system was re-examined, and it is believed that it did work within a pulse. (However, the pulse-to-pulse recording system was not working at the time. It should be made robust.)

#### Consideration

# FC may provide 20% increase from 6 kA to 12 kA ¤ Balanced man-power distribution should be necessary



# RF gun

#### Recommendations

- New technologies seem to be introduced too often. Further discussions on available facilities are necessary.
  - ==> Weekly meetings are held at the linac open space, in which members from other groups participate. Dr. Yosuke Honda, one of the reviewers, further contributes to the laser discussion weekly.

Considering whole operation would stop on the gun failure, an existent technology should be employed
X=> As was recommended in past review meetings,

existent technologies were applied for Phase-2. However, we are still open to Phase-3 options.





#### Summary

 Injector is ready for Phase-2 commissioning incorporating recommendations in the past reviews.

The facility is believed to be ready for the first year in Phase-3 while it may face challenges to achieve the final beam qualities.



## Thank you











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## **Injector Linac Overview**

#### Injector linac configuration



#### Major upgrade items

- **¤ Photo-cathode RF-gun for low-emittance e-**
- **¤** Flux concentrator, LAS structure, solenoids, quads for e+
- **¤** Pulsed magnets for adequate beam optics for each beam
- **¤ High-precision beam position monitor**
- **¤ High-precision beamline alignment for low emittance**

# **Structure of Waveguide Flange**



KĖKB