Electron Source Development for ERL/STF/ILC

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- Boundary Conditions : Aims and Resources.
- A possible way of work sharing.
- Summary.

Boundary Conditions
- Aim -

- ERL:
  - 100mA average current (1.3GHz, 77pC), CW,
  - Super-low emittance : <1 πmm.mrad,
  - Short bunch: <2ps.
- STF/ERL test machine driver:
  - 10/100 mA average current, pulsed/CW,
  - Low emittance: ~10 πmm.mrad,
  - Maybe less performance is tolerable.

Boundary Conditions -Aim-

- ILC:
  - 10mA average current, 0.9ms macro pulse repeated in 5Hz,
  - Low emittance : ~10 π mm.mrad,
  - Polarized.
- ILC positron driver:
  - 10mA average current, 0.9ms macro pulser repeated in 5Hz,
  - Ordinal emittance : ~ 100 π mm.mrad.

Boundary Conditions -Resources-

- SLAC:
  - long experience on DC NEA GaAs (Strained or strained super-lattice) gun,
  - High ability on the designing RF cavity,
  - SCLS : Cu cavity with Cu cathode.
- BNL/AES:
  - High ability on the designing RF cavity,
  - Long operation experiences on metal-cathode RF gun,
  - Developing SRF gun with Diamond/NEA GaAs cathode.

Boundary Conditions
-Resources-

- FNAL:
  - Experience on RF gun development for A0/A1 injector (side coupled L-band Cu cavity), but they have not been working well.
  - They strongly promote ILC project and are recruiting many researchers.
  - DOE/FNAL concentrate the human and financial resources into FNAL as a candidate of ILC central laboratory.

Boundary Conditions
-Resources-

- KEK:
  - Experience on RF Gun with CsTe cathode,
  - High ability on the machining,
  - No ability for laser R&D,
  - No resource allocation at this moment.
- Nagoya :
  - Long experience on cathode development: GaAs, CsTe,
  - Long experience on DC photo-cathode gun operation,
  - Concentrating R&D for SPLEEM.

Boundary Condition
- Resources -

- JAEA:
  - Experience on DC thermionic gun operation,
  - Developing DC photo-cathode gun with NEA GaAs for ERL prototype,
  - Human resorce for R&D.
- Sp8 (JASRI):
  - Experience on RF Gun development and operation,
  - High ability on the cavity surface investigation and treatment,
  - High ability on the laser development.

Boundary Conditions
-Resources-

- Sp8 (RIKEN) :
  - State-of-the-art thermionic gun with a beam chopper.
  - No human resource for R&D because the facility is in commissioning phase.
- LAAA(Laser Aided Accelerator Association):
  - High ability on the laser R&D and manipulation technology.
  - It is a virtual lab. No “real” resources.
  - “Real” resources must be prepared by “real” labs.

Shared Efforts

- Design RF Gun cavity, which has high vacuum conductance (SLAC)
- Study NEA GaAs cathode (JAEA, Nagoya, SLAC)
- Basic study on GaN cathode (SLAC)
- Yb fiber laser system R&D (KEK under consultation with LAAA)
- Nd:YAG laser system R&D (KEK under consultation with LAAA)
- Improvement on Ti:Sapphire laser system (SLAC)
- Life time test for NEA GaAs in ATF RF gun with a vacuum modification (KEK)

Shared Efforts

- Manufacture L-band RF Gun cavities for SLAC, KEK, and FNAL with the state-of-art machining technology (KEK)
- Laser manipulation technology (KEK, Sp8, LAAA)
- Develop an evaporation chamber, which is capable to use NEA GaAs, CsTe, GaN, etc. (KEK)
  - High vacuum quality ~ 1E-11 Torr
  - Cesiation and Teluriation
  - Heat cleaning
  - Oxygen leak valve
  - Replaceable cathode block

Resource Allocation -KEK case-

	2006	2007	2008
RF Gun cavity & RF Systerm	0	1	1
ATF NEA GaAs/GaN test	0.5	0.5	0
Cathode & evaporation chamber	1	2	2
Yb laser	1.5	3	3
Manpower (FTE)	3	6.5	6

- This effort must be a big contribution not only for ILC and ERL, but also general accelerator technology development.
- Resources must be prepared by KEK/JAEA as a common effort of ILC and ERL development team.

Time Table

		2006				2007				2008				2009			
		4月			10月									4月			10月
KEK/JAEA	ERL Test machine													100mA CW			
KEK	STF pahse 1					ビーム電流は未定義、エネルギー確認、加速実証											
KEK	STF pahse 2													10mA, macro pulse			
ILC-GDE	ILC-GDE				RDR									TDR			
JAEA	DC電子銃 250kV 50mA	製作				試験	試験										
JAEA/SLAC/Nagoya	700nm帯カソード(超格子)	製作			試験												
SLAC	500nm帯カソード			製作		試験	試験	試験	試験								
KEK/JAEA	DC500kV-100mA			設計		製作				試験	試験						
KEK	200kV DC			準備		試験	試験	試験	試験								
SLAC	Ti:S laser			設計		試験	試験	試験	試験	試験	試験	試験	試験	製作			
KEK/LAAA	Yb fiber laser			設計		試験	試験	試験	試験	試験	試験	試験	試験	製作			
KEK/LAAA	Nd:YAG			設計		試験	試験	試験	試験	試験	試験	試験	試験	製作			
KEK/Sp8/LAAA	Laser制御			設計		試験	試験	試験	試験	試験	試験	試験	試験	製作			
SLAC/KEK/FNAL	L-band RF Gun			設計				試験	試験	製作							
KEK/FNAL/Nagoya	Evaporation chamber			設計		試験	試験	試験	試験	製作							
KEK/SLAC	ATF NEA test			設計		試験	試験										

Work Breakdown Structure

	ERL TM	ERL	STF Phase1	STF Phase2	ILC
Laser Ti:S	-	-	-	-	DESY, SLAC
Laser Nd:YAG	KEK, LAAA	KEK, LAAA	Not assigned	KEK, LAAA	-
Laser Yb	KEK, LAAA	KEK, LAAA	-	KEK, LAAA	KEK, LAAA
Laser 制御	KEK, LAAA	KEK, LAAA	-	KEK,LAAA	KEK, LAAA, DESY, SLAC
800nm陰極	Nagoya, JAEA, SLAC	Nagoya., JAEA, SLAC	-	Nagoya/JAEA/ SLAC	Nagoya/JAEA/ SLAC
500nm陰極	SLAC	SLAC	-	SLAC	-
200nm陰極	-	-	KEK	KEK	-
RF Gun	-	-	-	SLAC, KEK, FNAL	SLAC, KEK, FNAL
DC Gun	JAEA, KEK	JAEA, KEK	KEK	KEK, Nagoya	SLAC, Nagoya

Summary

- Closely coupled common efforts among injector developments for ERL/ERL test machine, ILC, STF phase1, and phase2, are possible.
- By considering resource limitations, it is the only way, rather than possible.
- KEK and JAEA have responsibility to prepare “real” resources as the laboratory organizer.
- In addition, we have to organize applications to competitive grants to obtain financial supports.