ERL2011 WG3 Oct 17, 2011 T. Furuya (KEK)

# Progress of SC cavity for KEK-ERL since 2009

Oct. 17, 2011

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## **Development of SCRF**

### Last workshop in 2009: ✓ cERL was planed to obtain the basic technology for ERL



## **Development of SCRF**

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### Last workshop in 2009 : Injector cavity

> parameters

2-cell x 3	Double coupler
14.5 MV/m	170 kW x 2
5 HOM coupler	Qext = 3.3E+05

#### V. test of a prototype cavity





- Achieved 30 MV/m.
- HOM heating degraded Q0 and limited the gradient at 4MV/m.
- Need a klystron stand for the coupler power test.



#### ERL2011 WG3 **Development of SCRF** Oct 17, 2011 T. Furuya (KEK) iris of 80 mm SBP of 100 mm in 2009 : LBP of 123 mm **ML** cavity **EFB** > parameters Rsh/Q 900 ohm Coupling 3.8% 9-cell x 2 60 Ohm coupler **Ep/Eacc** 3.0 Hp/Eacc 43 Oe/MV/m 15-20 MV/m 20 kW ferrite HOM damper Qext = 2E+07Power coupler & HOM

#### V. test of a prototype cavity



17 MV/m was limited by FE.

 $\succ$ 

- Development of x-ray mapping.
- Crack of ceramic due to heating up by the excited dipole mode.
- Material search for HOM absorber.





## **Injector SC cavity**

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### **Development of injector SC cavity**

- Improved HOM couplers push up the accelerating voltage to 13 MV/m.
- Three cavities were completed and vertical tests are underway.





#### #1 cavity achieved 30 MV/m.

#### **Required Parameters**

	V <sub>acc</sub> [MV]	Q <sub>L</sub> [x10 <sup>5</sup> ]	P <sub>rf</sub> [kW]
Cavity-1	1.5	10.	10
Cavity-2	2.5	4.	25
Cavity-3	2.5	4.	25

(I<sub>beam</sub> = 10 mA, P<sub>rf</sub> /coupler)



**Completed 2cell cavities** 

## **Injector SC cavity**

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### **Development of input coupler**

- Six cw input couplers for cERL has already completed.
- > 50kW was achieved in cw conditioning.
- RF processing at the high-power test stand with a cw 300kW-klystron will be continued till December, 2011.



#### Six cw input couplers



High power test stand



#### Conditioning Results

- 1s, 0.1Hz, 100kW for 2h
- cw 30kW for 1.5h
- cw 50kW for 0.5h
- cw 100kW for 1 min

**Injector SC cavity** 

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#### **Development of injector cryomodule**

- After the cavities were covered with a He jacket, assembly of the cERL injector cryomodule is scheduled in February – March, 2012.
- The first cool-down of the cryomodule is planed in May 2012.





## 9cell structure for the main linac

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#### **Development of ML SC cavity**

- > Additional surface treatment improved the gradient to 25 MV/m.
- The cavity shape of Esp/Eacc=3 achieves the gradient of 25 MV/m.
- > However, several emitters appeared and degraded the gradient, after discharging.
- > Diagnostics using radiation monitor is under developing.
- > Two cavities for cERL were completed, and v. tests are continued till the end of this year.
- > Total assembling is scheduled in the summer of 2012.



## **9cell structure for the main linac**

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### **Development of power coupler for ML**

Structure: 20kW in cw, full-reflection double disk-ceramic of warm and cold, impedance of 60 ohm use 99.7% Al2O3 N2 gas cooling of inner conductor variable coupling of 1~4E+07

#### power test at 80K

20kW in cw for 16 hours cold window (-70°C), inner conductor (120°C)







## 9cell structure for the main linac

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#### **Development of ML cryomodule**



## **Progress of cERL**

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#### Facility of cERL (ERL Test Facility)



Cleanroom(class10) (2010)

Radiation shield (2011)

## **Progress of cERL**

#### Facility of cERL (ERL Test Facility)

tuner



## ERL search (ERL2011)

### Laboratory: KEK

Beam Energy:  $35 \text{ MV} \rightarrow 245 \text{ MV}$ Beam current:  $10 \text{ mA} \rightarrow 100 \text{ mA}$ RF frequency: 1.3 GHz cw or pulse: cw rep. rate: 1.3 GHz

#### **RF** parameters **Injector** linac

- Beam energy: 5 10 MV
- Number of cavities: 3 cavities
- Number of cells per cavity: 2 cell
- Accelerating gradient: 6.5~ 11MV/m• accelerating gradient: 15 MV/m
- Qext of power coupler: 2~5E+05
- RF power per coupler: 10~25 kW

### **Project**: cERL



#### **Main linac**

- total number of cavities:  $2 \rightarrow 8$
- number of cavities per module: 2 4
- number of cell per cavity: 9
- - Qext of power coupler: 1-4 E+07
  - RF power per cavity: 20 kW
  - 170 kW HOM load: ferrite  $1.5W \rightarrow 150W$

#### Your name: T. Furuya

## As a future project

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#### **3GeV-ERL** as the future plan

3 GeV Energy Recovery Linac (ERL) and Resonant type of XFEL (XFEL-O)



## As a future project

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## Specification of the ERL and XFEL-O

#) Linac based light source:
1) Emittance ∝ ~15pmrad ~λ/4π (Diffraction limit of soft and hard X-ray)
2) Short photon pulses~ 0.1~1 pico-second
#) A great numbers of ID-beamlines
#) Possibility to realize the XFEL-O (Full coherent light source (Space and time))

Complementarity between ERL, XFEL-O, and SASE-FEL

### Road Map of ERL

ERL2011 WG3

Oct 17, 2011

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
R&D of ERL key elements													
	Prep of Test Fa	ERL cility	cERL construc	tion	Beam test and test experiments								
					Improvements towards 3GeV class ERL								
					Construct 3GeV E			on of RL		User run			

Start the user operation of 3 GeV ERL until 2020 XFEL-O(7GeV) ewill be realized as the 2nd stage

Soon We will start to make the CDR

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## For all talker of WG3

Please submit your file.

As the custom of the ERL workshop, submit a one slide summary, please.