

Development of fundamental power couplers for several years at CETD

TTC Meeting 2020

4th - 7th February 2020, Geneva

Masao Irikura, H. Takahashi, H. Yasutake, K. Tetsuka

CANON ELECTRON TUBES & DEVICES CO., LTD.

5th February 2020

Outline

- **Company Overview**
- **Power Coupler Products**
- **Development of FPCs for several years**
 - **E42135 for MSU / FRIB**
 - **E42140 for HZB / bERLinPRO**
 - **E42144 for CEA-SACLAY / SARAF**
- **Proposal from CETD to Customers**
- **Summary**

Company Overview

Company profile

Company Name	Canon Electron Tubes & Devices Co., Ltd.
Founded	1915 (A part of Toshiba Corp.)
Established	October 1 st , 2003 (Renamed: Nov. 1 st , 2018)
Headquarters	1385, Shimoishigami, Otawara-shi, Tochigi 324-8550 , Japan
Business	Development, manufacture and sales of electron tubes and applied products
Main Products	Klystrons, Gyrotrons, Power Grid Tubes, X-ray Tubes, FPDs (Flat Panel Detectors), X-ray Image Intensifiers



Appearance of headquarters



Pictures of main products

Power tubes



X-ray tubes



X-ray flat panel detectors: FPD



X-ray Image Intensifiers



Power Coupler Products

Product lineup

Type	Frequency (MHz)	Input Power	CW/Pulse	Super/Normal
Power Coupler				
E42135	322	10 kW	CW	SC
E4277	324	400 kW	0.62 ms	NC
E4294	324	400 kW	0.62 ms	NC
E4262	500.1	300 kW	CW	NC
E4263	508.6	300 kW	CW	NC
E4268	508.9	800 kW	CW	NC
E42107	508.9	800 kW	CW	NC
E4274	508.9	40 kW	CW	NC
E42128	704	1.2 MW	3.6 ms	SC
E42109	1,300	20 kW	CW	SC
E42111	1,300	300 kW	CW	SC
E42100	1,300	1 MW/ 500 kW	0.4 ms/ 1.3 ms	SC
E42101	1,300	1 MW	1.5 ms	SC
E42130	1,300	1 MW	1.5 ms	SC
RF Window				
E4271/ E42110	508.6	350 kW	CW	SC
E4278	805	550 kW	1.3 ms	SC
E4279	972	350 kW	0.62 ms	SC

- CETD began to manufacture couplers in 1980s. The first coupler was the E4260 for KEK / TRISTAN and the first SCC coupler is E4270 (509 MHz - CW 150 kW).
- CETD had sold mainly to customers in Japan before 2000.
- The E4278 for SNS has been manufactured since 2000.
- CETD has about 20 types of couplers in the product lineup.



E4260/E4261



E4278

Development of FPCs for several years

The number of orders for new products from overseas have increased since 2013.

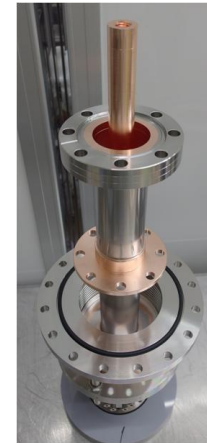
Year	Customer / Project	Type	Remarks
2013	CEA-SACLAY / ESS	E42128	704.4 MHz, prototype
2013	KEK / ILC	E42130	STF-II type, outer axis $\Phi 40$ mm
2015	IBS / RISP	E42136	prototype
2015	MSU / FRIB	E42135	220 pcs



E42128
(for ESS/704 MHz)



E42130
(for KEK/ILC)



E42136
(for IBS/RISP)



E42135
(for MSU/FRIB)

E42135 for MSU / FRIB

**CETD received the order for the FRIB couplers from MSU in 2016.
Development and mass production : Jun 2016 to Dec 2017.**

- **Assembly : Hydrogen brazing , TIG welding**
- **New Processes at CETD : Ultrasonic cleaning, baking, and RF conditioning**
⇒ **Conditioning time has been reduced at MSU.**

Frequency	322 MHz
Input power	CW 10 kW
Quantity	220 pcs

- **There were some leaks in early production due to special gaskets. By reviewing the gasket structure, the problem was solved.**
- **CETD received the Supplier Appreciation Award from MSU in 2018.**



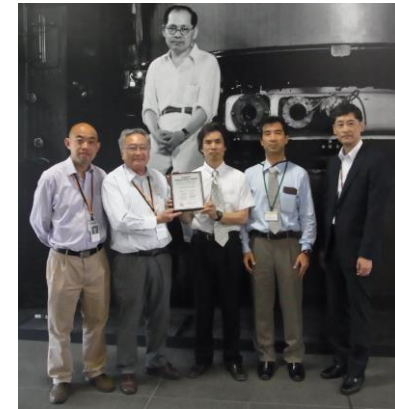
Ultrasonic cleaning
with ultrapure water



Baking



RF conditioning
(provided by MSU)



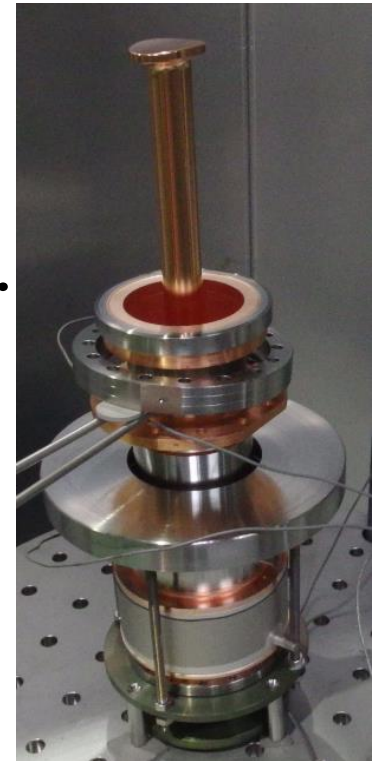
E42140 for HZB / bERLinPro

CETD has developed E42140 for the bERLinPro project of HZB.

- **Assembly : Vacuum brazing,
Hydrogen brazing,
TIG welding**
- **Other process : Outgassing measurement,
RGA.**

Frequency	1.3 GHz
Input power	CW 120 kW
Quantity	8 pcs

- **Inner conductor tip is elliptical. It was difficult to adjust the position of the outer conductor parts.**
- **Some measurement points were hard to be measured.**
- **Required specifications of the inner conductor**
 - Rz1.6 --- Realized by machining
 - Electrolytic polishing --- Optimal conditions were found in some sample experiments.
- **All delivered by Apr 2019**



E42140

E42144 for CEA-SACLAY / SARAF

CETD received the order for the SARAF-Phase-II LINAC couplers.

29 pcs in production from Jun 2019

- **Assembly : Vacuum brazing, TIG welding**
- **Other process : Outgassing measurement and RGA (2 pcs per batch).**

- **It took a little time to finish sample works.**
- **Web meetings were held regularly every other week. Development was proceeded as planned.**
- **Prototypes (4 pcs) delivered in 2018**
- **20 pcs shipped by Jan 2020.**
- **Complete delivery by May 2020**

Frequency	176 MHz
Input power	CW 11.4 kW
Quantity	4 pcs+ 19 pcs+10 pcs



E42144

Proposal from CETD to Customers

We want to meet customer's requests as much as possible.

1. Requests for new model order

(We would like ...)

- to have enough time of elemental technology development.**
- (or) to omit or simplify the sample work by referring to the results in other projects.**
- to request additional costs, when specifications are added or changed.**

2. Suggestions for cost reduction

- Specified geometric tolerances can be manufactured.**
- Addition of adjustment mechanism or robust design instead of specifying tight tolerances.**
- Reducing inspection items in mass production**
- Supplied materials (or parts) from customers [SUS316LN etc.]**
- Choosing hydrogen brazing (that has short cycle time and is low cost)**

Proposal from CETD to Customers

3. Other suggestions

- **By providing equipment and technical support, CETD will be able to carry out some of the manufacturing and evaluation. (e.g. RF conditioning)**
- **On the other hand, is it possible to carry out part of the manufacturing process using the equipment at customer's facility ?**

4. Additional request

- **We want to receive orders regularly for efficient use of equipment.**

Summary

- **CETD has developed several types of FPCs for several years.**
 - **MSU / FRIB - HZB / bERLinPro - KEK / ILC etc.**
 - **CEA-SACLAY / SARAF and ESS - IBS / RISP**
- **We have established new processes.**
 - **Baking - RF conditioning - Gas analysis**
- **I introduced requests and comments from suppliers. With the active cooperation of the customers, good products can be developed at low cost.**
- **Our company name was changed. We will keep on manufacturing FPCs and developing new ones.**

Thank you for your attention!

Canon

CANON ELECTRON TUBES & DEVICES CO., LTD.