

# HIGH POWER INPUT COUPLERS FOR CHINA ADS

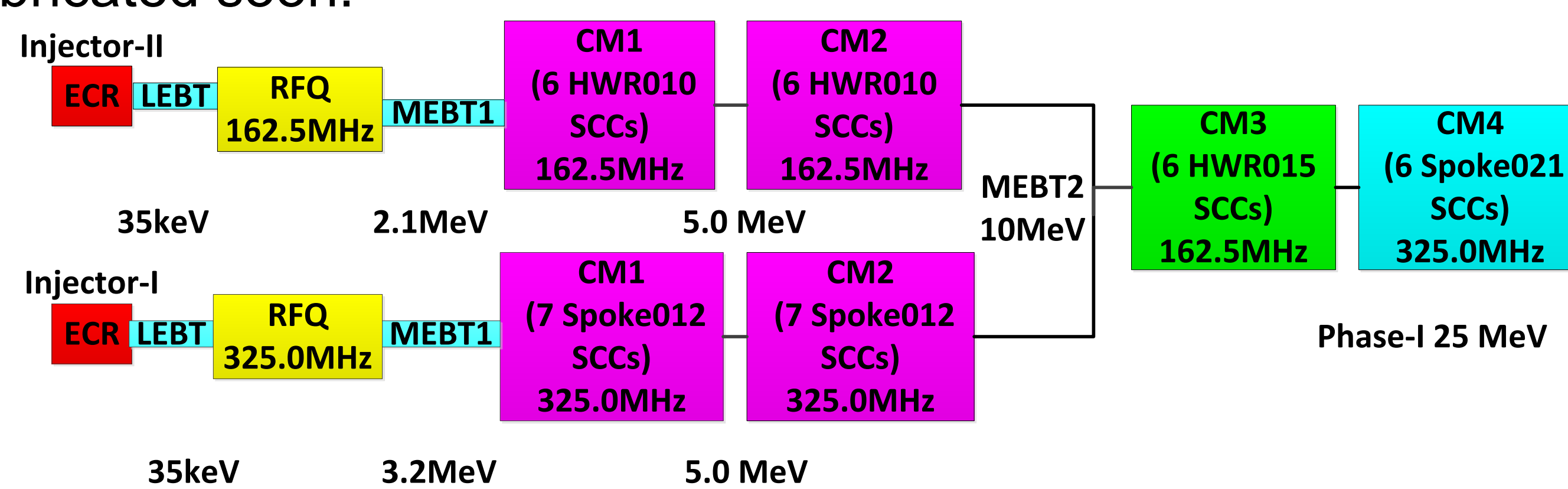
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## Abstract

High power input couplers are key components of the superconducting system for China Accelerator Driven sub-critical System (C-ADS) project. For the first phase, C-ADS includes four types of superconducting cavities (SCCs) of two frequencies, 162.5 MHz HWR SCC and 325 MHz Spoke SCC up to the energy of 25 MeV. All input couplers for the SCCs are developed in IHEP. This paper will describe the development status of the high power input couplers for C-ADS.

## 1. INTRODUCTION

For Phase-I of C-ADS, four types of superconducting cavities (SCCs) of two frequencies are adopted. All input couplers for the SCCs are developed in IHEP. Up to now, all injector couplers have been assembled with both the Test Cryomodules (TCM) and the first formal cryomodules (CM1); joined the cavity RF processing and beam commissioning. In the meanwhile, the design of the input couplers for the main linac has been completed and to be fabricated soon.



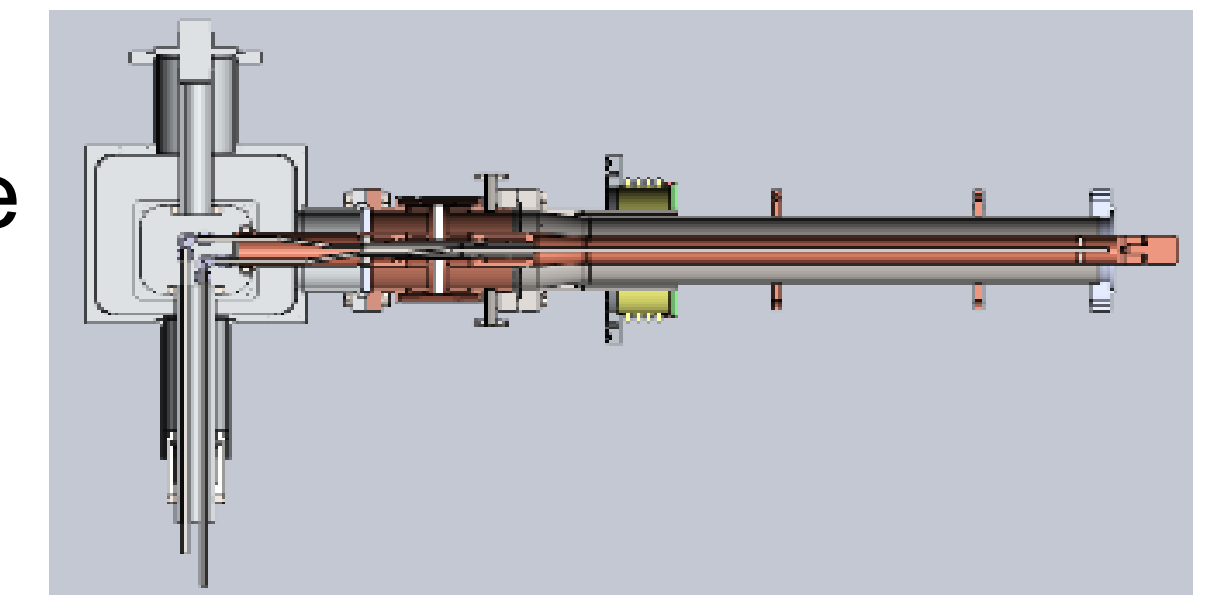
The schematic of C-ADS (Phase-I).

## 2. DESIGN OF THE COUPLERS

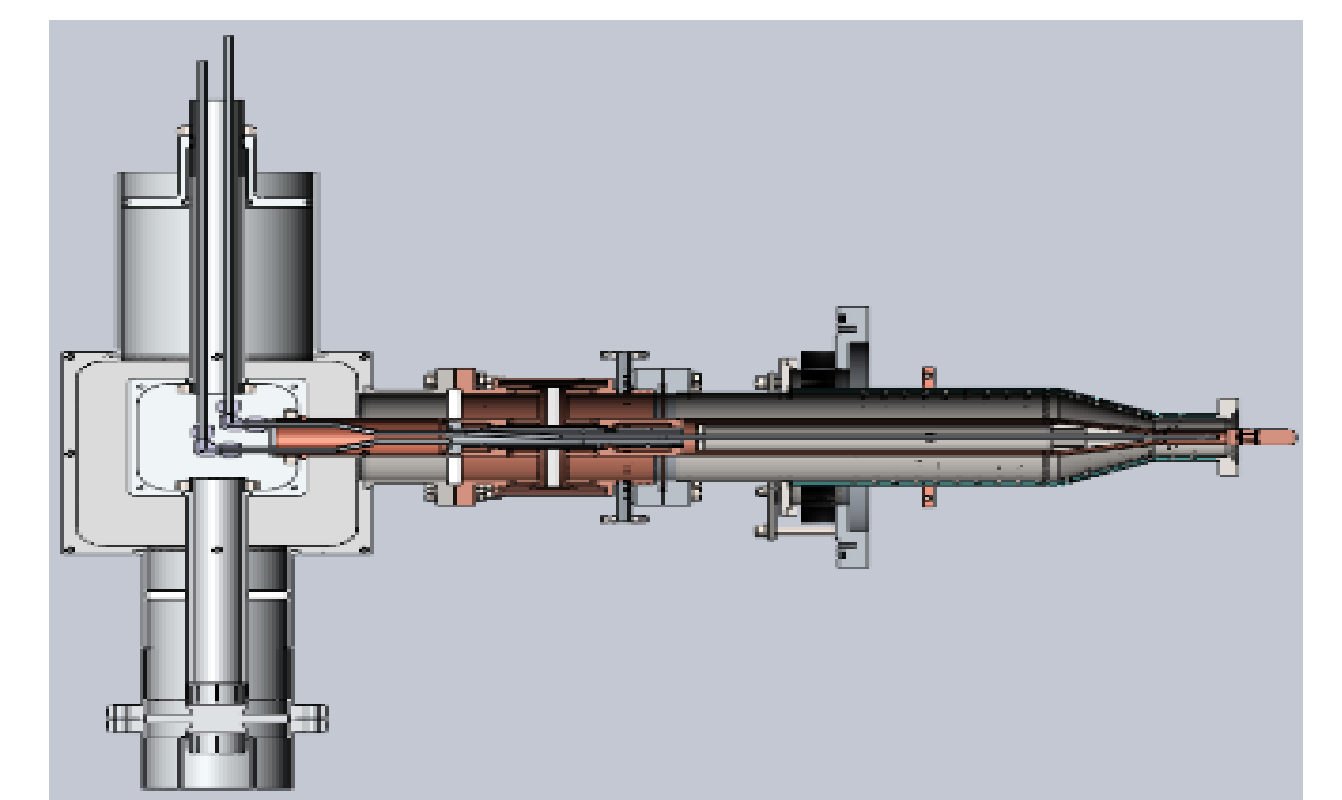
Thoroughly and carefully simulations were done to determine the RF dimensions, mechanical structures and cooling.

The main parameters of the couplers for C-ADS SCC (Phase-I)

Parameters	Spoke-012	HWR-010	Spoke-021	HWR-015
Frequency (MHz)	325	162.5	325	162.5
RF power (kW)	10	20	25	25
Qext	7E5	7E5	8E5	6.7E5
Dynamic losses to 2K (W)	0.24	/	/	/
Dynamic losses to 4K (W)	2.20	0.18	3.10	1.85
Dynamic losses to 80K (W)	12.1	14.2	12.3	10.6



Input coupler of Spoke-012 cavity for C-ADS Injector-I



Input coupler of HWR-010 cavity for C-ADS Injector-II

## 3. MANUFACTURE OF THE COUPLERS

Eleven Spoke-012 couplers (two prototypes and nine formals) and ten HWR-010 couplers (two prototypes and eight formals) have been fabricated since 2012; And seven more Spoke-012 couplers and twelve more HWR-010 couplers are under fabrication now.

After fine adjustment of the plating process and the mechanical design, durably plated tubes were finally achieved. Through exploration, the window brazing procedure was optimized to reduce the number of the ceramic thermal cycling.

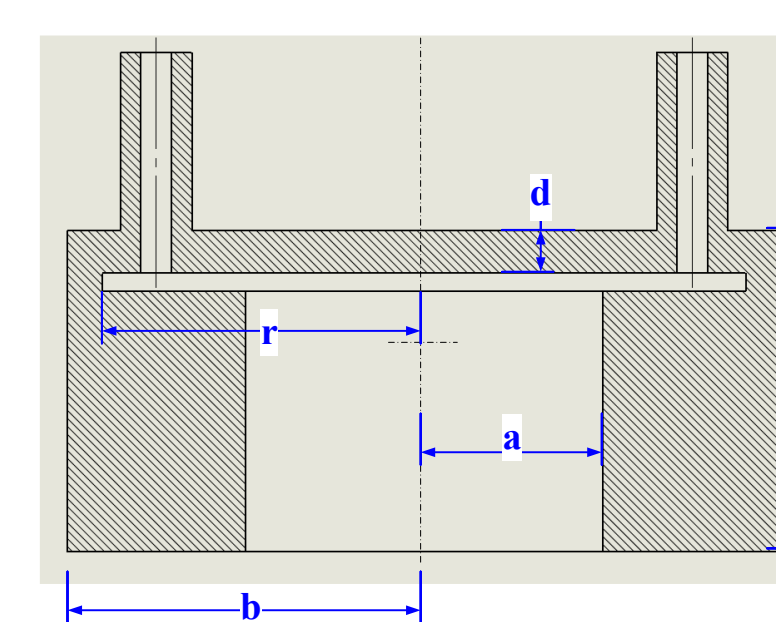


The fabricated coupler components.

## 4. HIGH POWER CONDITIONING ON THE TEST STAND

Special test benches were designed to satisfy the requirements of low working frequencies. Both traveling wave (TW) and standing wave (SW) modes conditioning are processed for each coupler, initially with pulsed, TW mode. For SW mode conditioning, a short circuit connected with the downstream coupler is moved, with step of  $\lambda/8$  over a whole  $\lambda/2$  length, to assure that all phases seen by the couplers.

Seven formals for 325 MHz Spoke-012 SCC for Injector-I and Six formals for 162.5MHz HWR-010 SCC for Injector-II have been high power tested up to the nominal power levels in both TW (Spoke-012: 10 kW; HWR-010: 20 kW) and SW modes (Spoke-012: 5 kW; HWR-010: 8 kW). Generally it took 10 to 15 hours for TW conditioning. For SW mode, the conditioning of the first position took 2 to 5 hours; and less than 1 hour for the rest of positions.



The conceptual design of the test benches.



The high power test system for HWR couplers



The high power test system for Spoke couplers

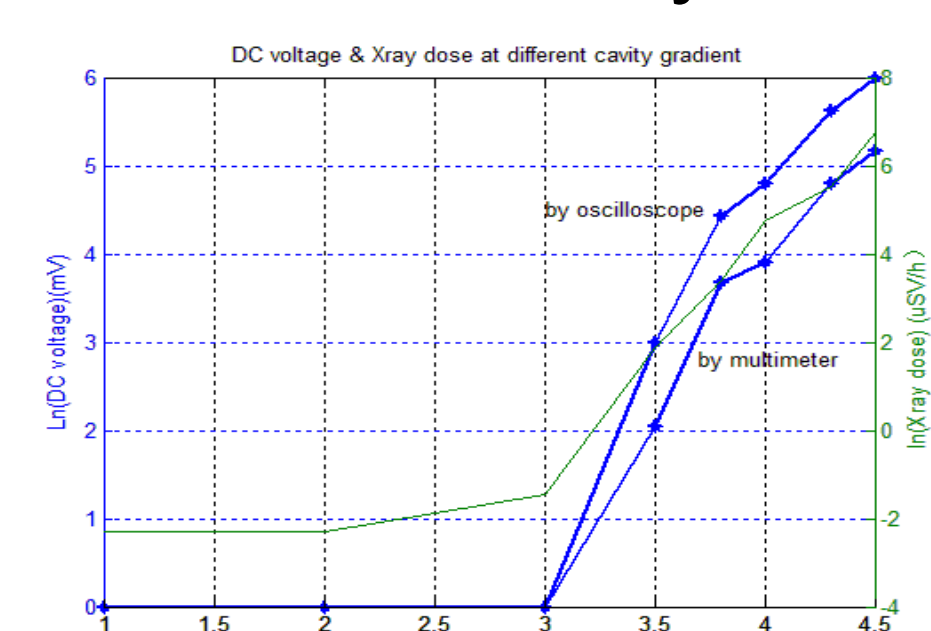
## 5. RF PROCESSINGS IN THE CRYOMODULE

### Couplers of 325 MHz Spoke-012 SCC for Injector-II

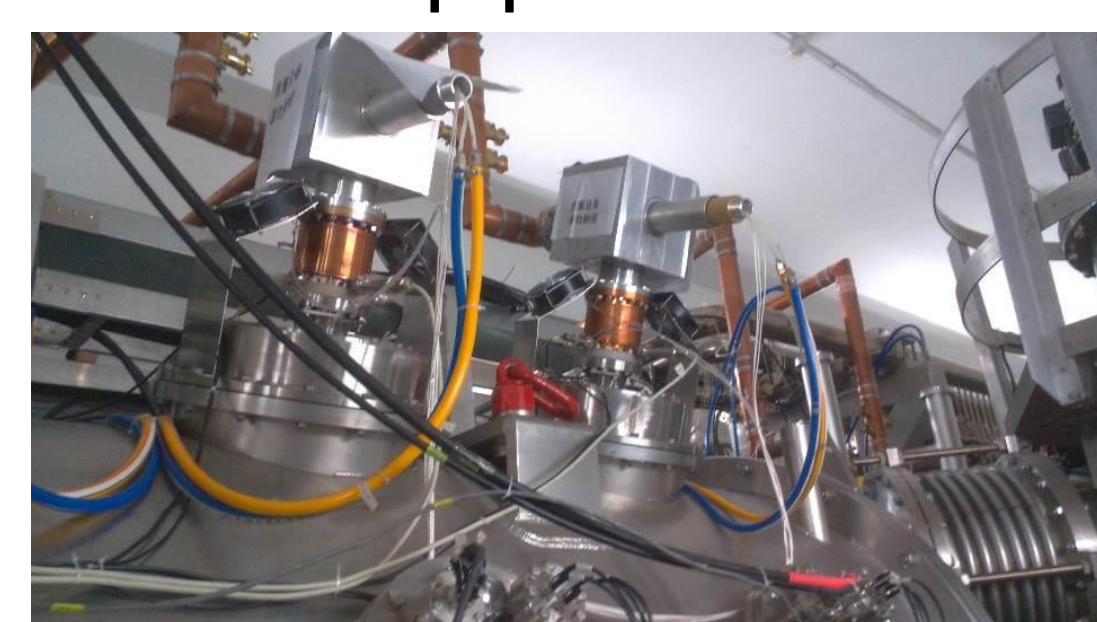
Unexpected fatal window crack were encountered during the in-cryomodule processing of Spoke-012 couplers. Finally, we found the crack reason based on a series of experiments. A lesson learned from the in-cryomodule RF processing is that FE may resulted in fatal ceramic crack, especially for the low beta SCC with coupler located in the cavity wall instead of beam pipe.



The vacuum side of the cracked ceramic turns on a uniform yellow color.



Expected DC voltage was detected from the pick-up port as the X-ray dose arising.



7 formals are under the cavity RF processing and beam commissioning now. No ceramic cracked after improvement.

### Couplers of 162.5 MHz HWR-010 SCC for Injector-II

Six formals were processed without and with beam successively in the middle of 2015. 10 mA proton has been accelerated from 2.1 MeV to 5 MeV now.



The in-situ couplers of 162.5 MHz HWR-010 SCC for Injector-II.