



Electron Gun/Collector + individual systems tests and summary on resources for the Electron Beam Test Stand

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HL-LHC Hollow Electron Lens (production) kick-off meeting – 13 April 2021

Scandia-doped W cathode electron gun

Cathode ID 8.05 – OD16.1 mm, 5 A at 10 kV extraction voltage

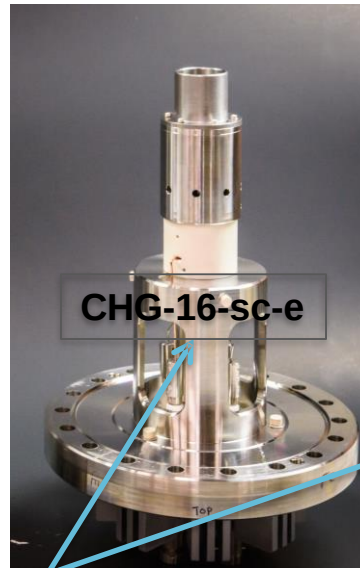
- HEL e-gun prototype CHG-16-sc
- Successfully tested (5A x 10kV)
- Body too big to fit gun solenoid

- HEL e-gun prototype CHG-16-sc-e
- Failed test at test stand (leakage current through ceramic insulator).
- Measurements indicate causes as low resistivity of ceramics and too a high T when filament hot

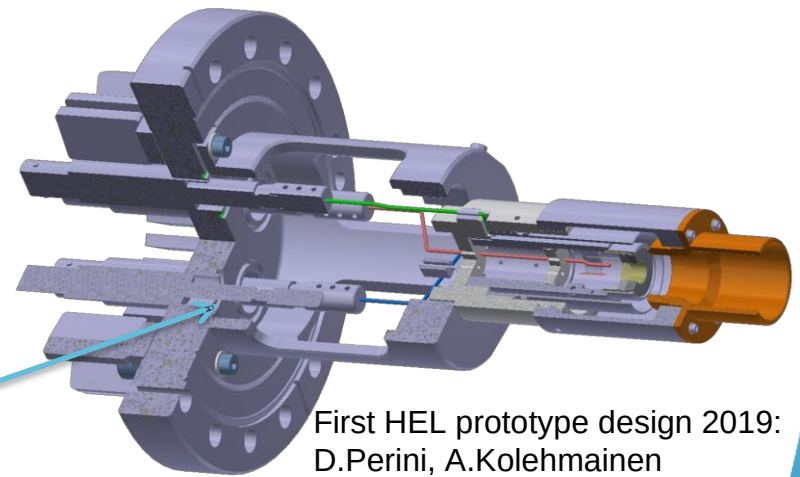


courtesy of G.Stancari

Successfully tested at FNAL
Now delivered to CERN



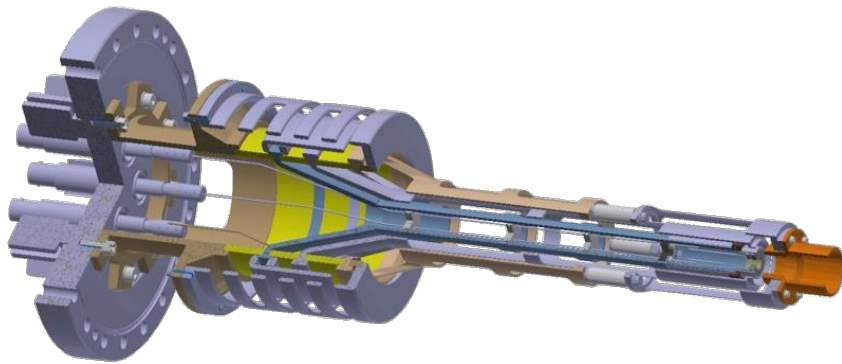
Tested both at FNAL and CERN
Problems with leakage current



First HEL prototype design 2019:
D.Perini, A.Kolehmainen
CERN

Scandia-doped W cathode electron gun

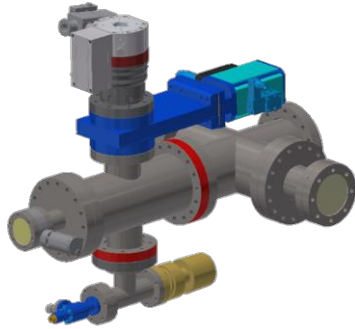
👉 HEL e-gun prototype CHG-16-sc-e BIS







- 👉 Issued from trying to better dissipate heat of ceramics.
- 👉 Use Alumina and pre-treatment
- 👉 Complete design including back pumping
Produced, being assembled, ready end April – beg. May 2021.
- 👉 Will be first tested at gun-test-facility for electrical and T performance, then characterised in electron beam test stand




👉 Plan to exchange ceramics in HEL e-gun prototype CHG-16-sc-e and adapt design to HEL (include back pumping) to have a simpler and sturdier design. Tests foreseen in second half 2022.







E-lens test stand





Dedicated E-GUN test stand

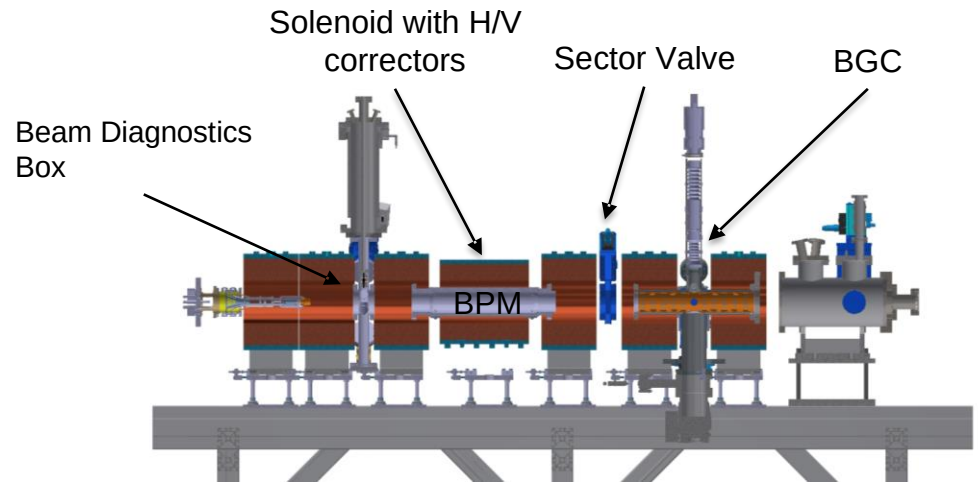
-  Outgassing of the gun (RGA and pressure gauge)
-  Gun temperature (viewport)
-  HV breakdown
-  NO measurements of electron current

-  Resistive magnets (0.4T max)
-  H/V correctors
-  Capability of testing:

-  E-gun
-  Collector
-  BPM, BGC
-  Modulator
-  HV power convertor
-  HV control and interlocks

Not tested:

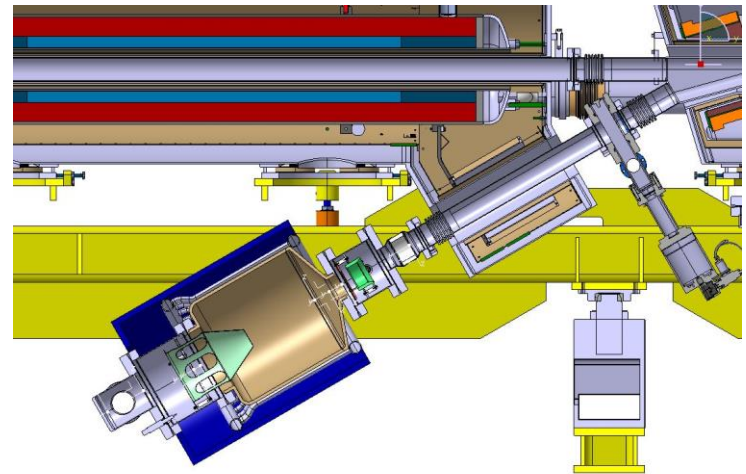
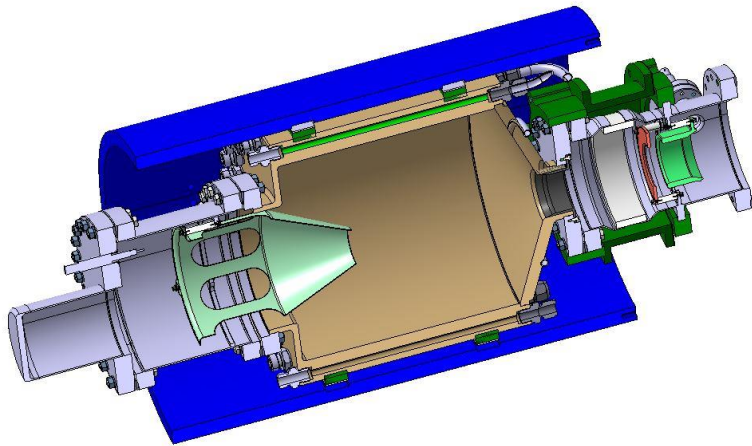
-  E-beam dynamics
-  Correction of magnet bend down-shooting



Rossi, Sadovich – 103th HL-LHC Technical Coordination Meeting, 7 May 2020

HEL Collector

- ✚ Mechanics/cooling to withstand max 5 A x 15 kV power
- ✚ Biasing to reduce outgassing and secondary electrons, recover power, improve efficiency
- ✚ Collector design completed, ready for prototyping
- ✚ To be verified with simulations, before proceeding:
 - ✚ Collector solenoid sufficient to shrink e-beam through extraction arm.
 - ✚ Collector efficiency with biasing (retarding and repelling) electrodes
 - ✚ Vacuum performance



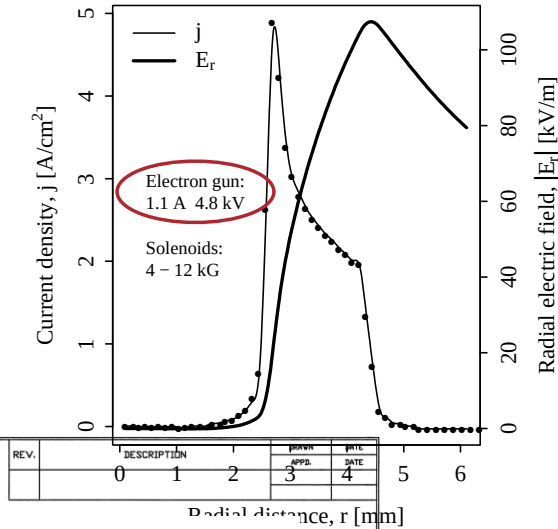
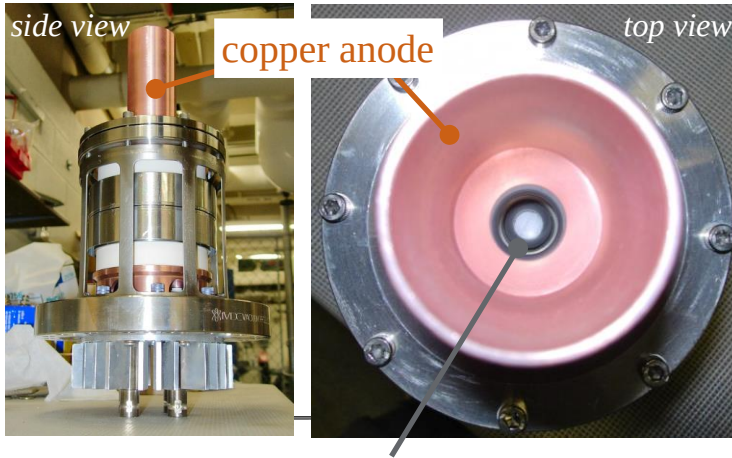
- ✚ Prototype ready ~ 9 month after launching production.
- ✚ To be tested at CERN (test stand)
- ✚ Will allow tests with full current for BGC and anode modulator

Conclusion

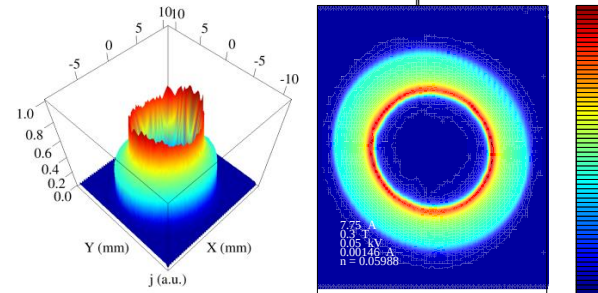
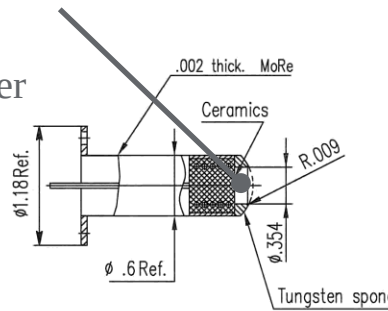
- 👉 Electron gun:
 - 👉 Extraction of 5A x 10kV from small cathode demonstrated already in 2017
 - 👉 Open point: design gun that fits into space and has sufficient insulation (temperature + material choice)
 - 👉 Programme well defined and resources available
- 👉 Collector:
 - 👉 Design to specification completed
 - 👉 Open point: verify efficiency, vacuum and collector solenoid
 - 👉 Tests to validate foreseen, and resources available
- 👉 Test stand:
 - 👉 Planning to accommodate multiple testing being worked out
 - 👉 Long term SY-BI resources have been estimated
 - 👉 External tests after 2023 (UK-CI and BINP) for validation of in-kind requires additional manpower from contributing institutes
 - 👉 UK-CI ends in 04/2025
 - 👉 Detailed description of WBS is needed to fully evaluate support resources



15-mm (0.6-in) hollow e-gun (HG06) used in Tevatron



tungsten dispenser cathode
convex surface
15-mm outer diameter
9-mm hole diameter



2009-2011

4 Giulio

G. Stancari, ColUSM 17 Mar 2017

ermilab

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	DATE
FRACTIONS	DECIMALS	ANGLES	DRAWN	G. Kuznetsov 02/28/06
±.006		± .25°	CHECKED	
1. BREAK ALL SHARP EDGES 50% MAX.			APPROVED	
2. DO NOT SCALE DRAWING			USED ON	5TELO2010200
3. DIMENSIONS BASED UPON ANSI Y14.3M-1998			MATERIAL	
4. MAX. ALL MACH. SURFACES 6:3				
FERMI NATIONAL ACCELERATOR LABORATORY				

03 September 2020

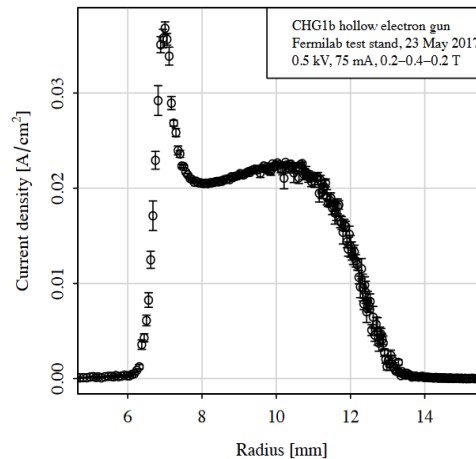
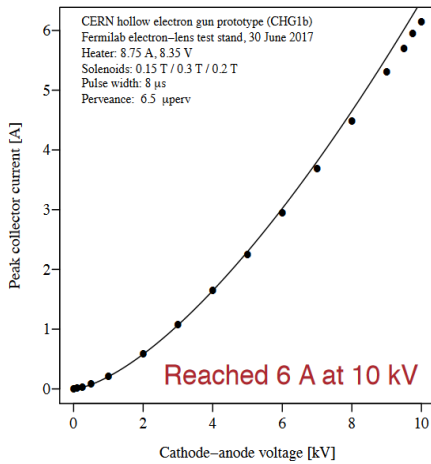




15-mm (0.6-in) hollow e-gun (HG06) used in Tevatron



Measured performance of CHG1b 25-mm e-gun



Data file: CHG1b_170523_8p75A_2-4-2kG_500V_75mA_hires.txt.gz

G. Stancari, CoIUSM 9 Mar 2018



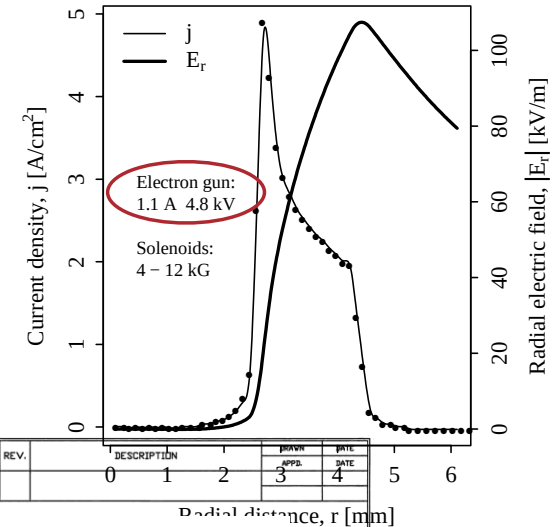
4 Giulio Stancari | Electron-gun emission and calculation of residual fields

LHC CoIUSM | 9 Mar 2018

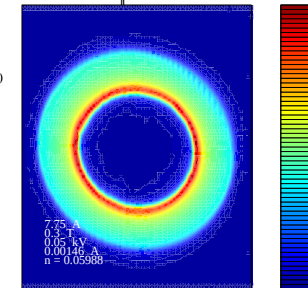
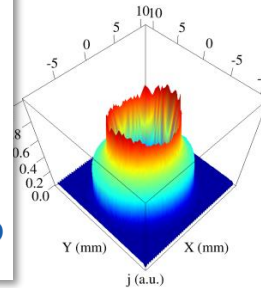
2009-2011

Tungsten sponc

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REV.	DESCRIPTION	REV.	DATE
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1		4	
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6			



G. Stancari, CoIUSM 17 Mar 2017

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UNLESS OTHERWISE SPECIFIED			ORIGINATOR	
FRACTIONS	DECIMALS	ANGLES	DRAWN	G. Kuznetsov
$\pm .006$	$\pm .25'$		CHECKED	02/28/06
1. BREAK ALL SHARP EDGES .02" MAX.			APPROVED	
2. DO NOT SCALE DRAWING			USED ON:	5TEL02010200
3. DIMENSIONS BASED UPON ANGLES TO CENTER			MATERIAL:	
4. MAX. ALL MACH. SURFACES 6.3 $\sqrt{\text{R}}$				
FERMI NATIONAL ACCELERATOR LABORATORY UNITED STATES DEPARTMENT OF ENERGY				
Cathode				

September 2020

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