

Development of a 2MW, CW, 170 GHz Coaxial cavity Gyrotron for ITER

**J.-P. Hogge¹, S. Alberti¹, A. Arnold^{2,3}, D. Bariou⁴, A. Beunas⁴,
T. Bonicelli⁵, R. Chavan¹, S. Cirant⁶, O. Dumbrajs⁷, O. Drumm^{2,3},
D. Fasel¹, E. Giguet⁴, T. Goodman¹, M. Henderson¹, S. Illy², J. Jin²,
G. LeCloarec⁴, C. Lievin⁴, R. Magne⁸, P.-L. Mondino⁵, B. Piosczyk²,
L. Porte¹, T.Rzesnicki², M. Santinelli⁹, A.B. Sterck¹⁰, M. Thumm^{2,3},
M.Q. Tran^{1,5}, A.G.A. Verhoeven¹⁰, I. Yovchev¹**

¹CRPP-EPFL, Switzerland, ²FZK, Germany, ³Uni. Karlsruhe, IHE, Germany, ⁴Thalès ED, France, ⁵EFDA - CSU, Garching, ⁶IFP-CNR, Milano, Italy, ⁷HUT, Espoo, Finland, ⁸CEA, Cadarache, France ⁹ENEA Frascati, Italy, ¹⁰IPP-FOM, The Netherlands.

Outline

- Design of the 170 GHz, CW, Gyrotron
 - Parameters
 - Key features & Issues
- Power supplies (MHVPS, BPS & HVSSS)
- The Coaxial Gyrotron Test stand
- Project status



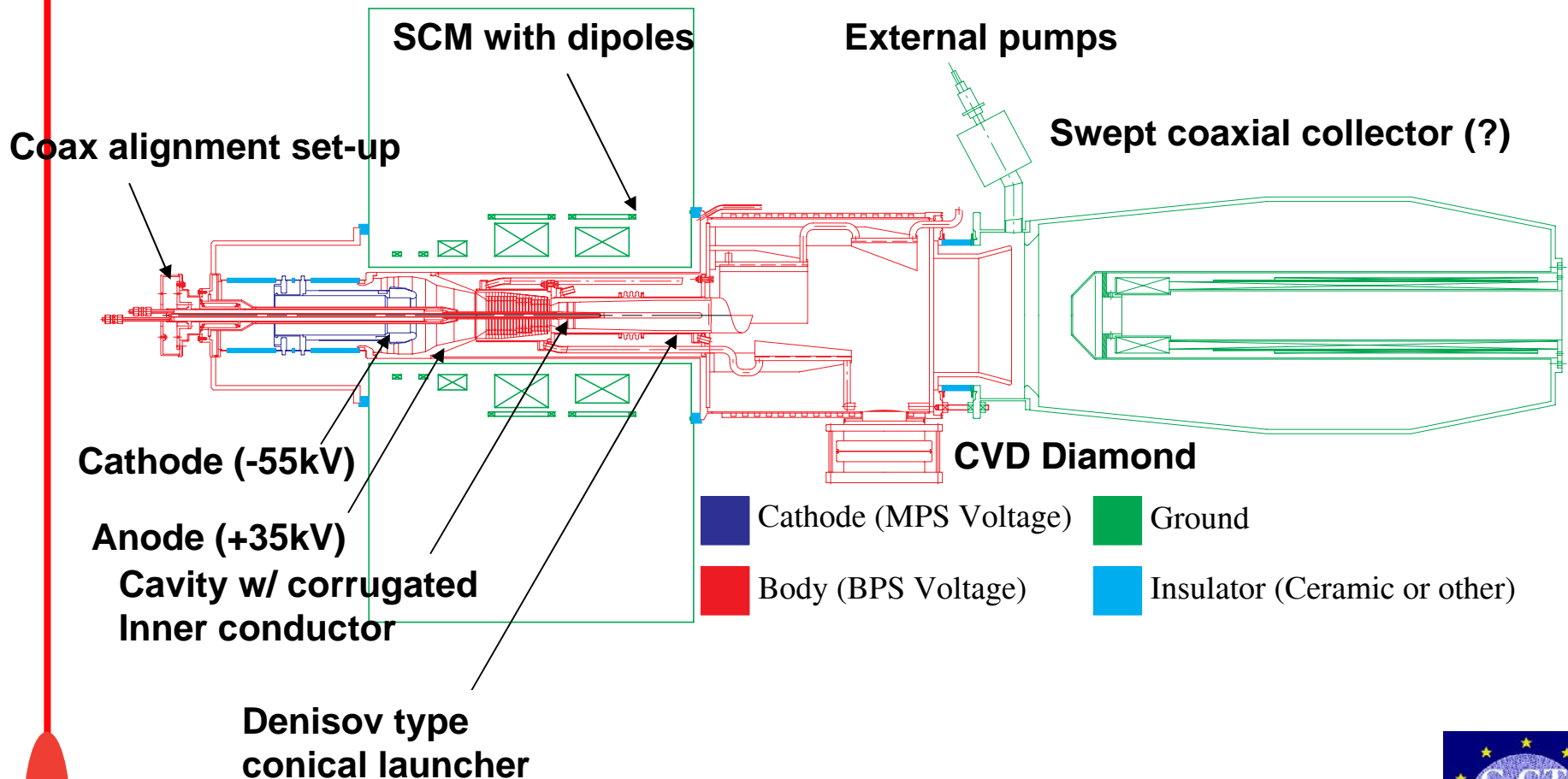
Tube design study (2003)

- HUT: Coaxial cavity + multimode simulations
- CRPP: Gun Design + SCM
- FZK: Almost everything + Short pulse experiments
- Thalès: Thermomechanical + electrical simulations



Coaxial Cavity Gyrotron, 170 GHz, 2MW, CW

Schematic of the tube & SCM



Coaxial Cavity Gyrotron, 170 GHz, 2MW, CW

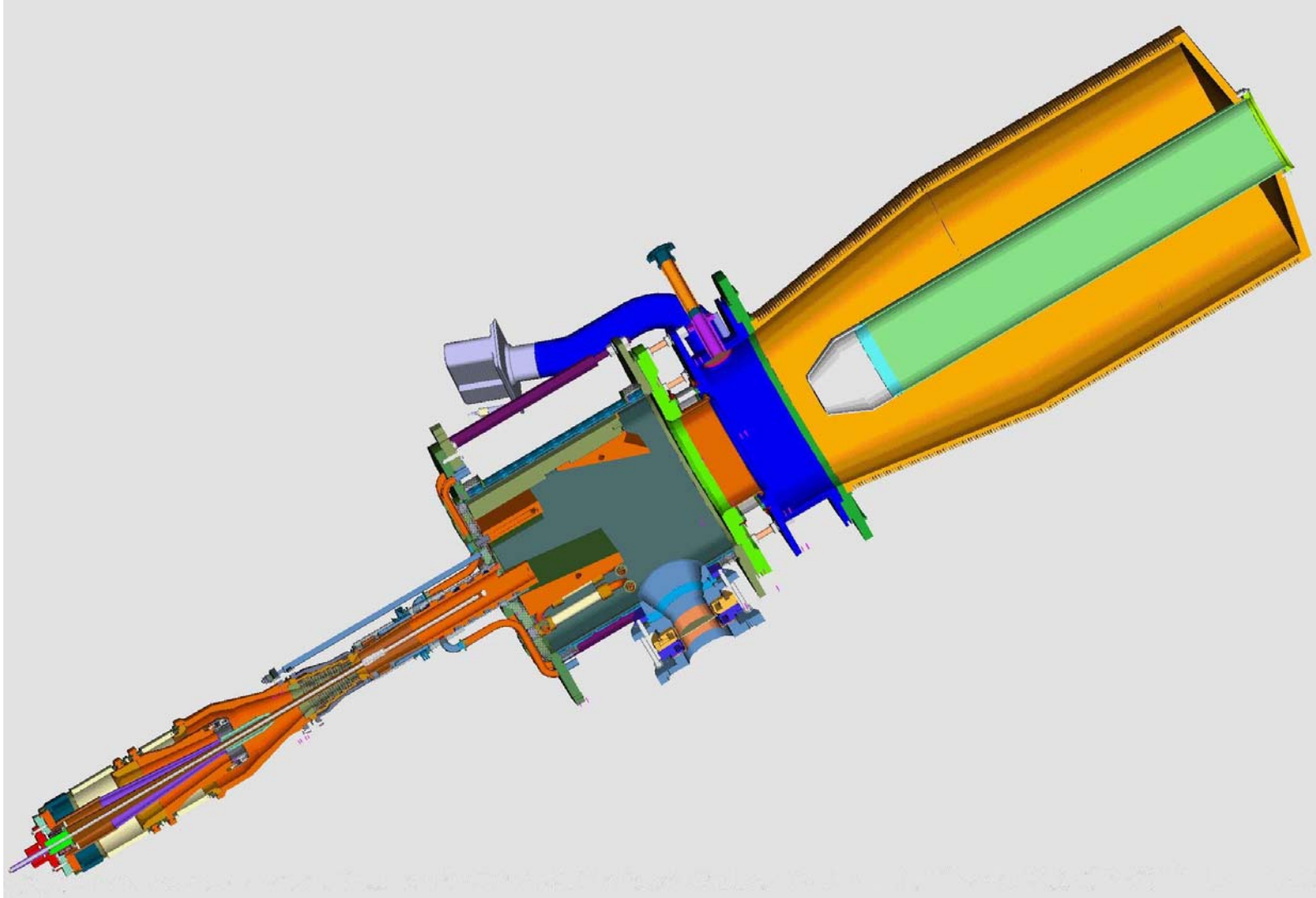
Nominal Parameters

Frequency:	170 GHz
Nominal RF Power	2 MW
Designed pulse length at nominal power	Phase 1: 1s at 2 MW Phase 2: 60s at 2 MW Phase 3: 3600s (CW) at 2 MW
Nominal acceleration voltage	90 kV
Nominal Cathode Potential	55 kV
Nominal Body Potential	35 kV
Acceleration voltage stability	$\pm 0.5\%$
Nominal Beam current	75 A

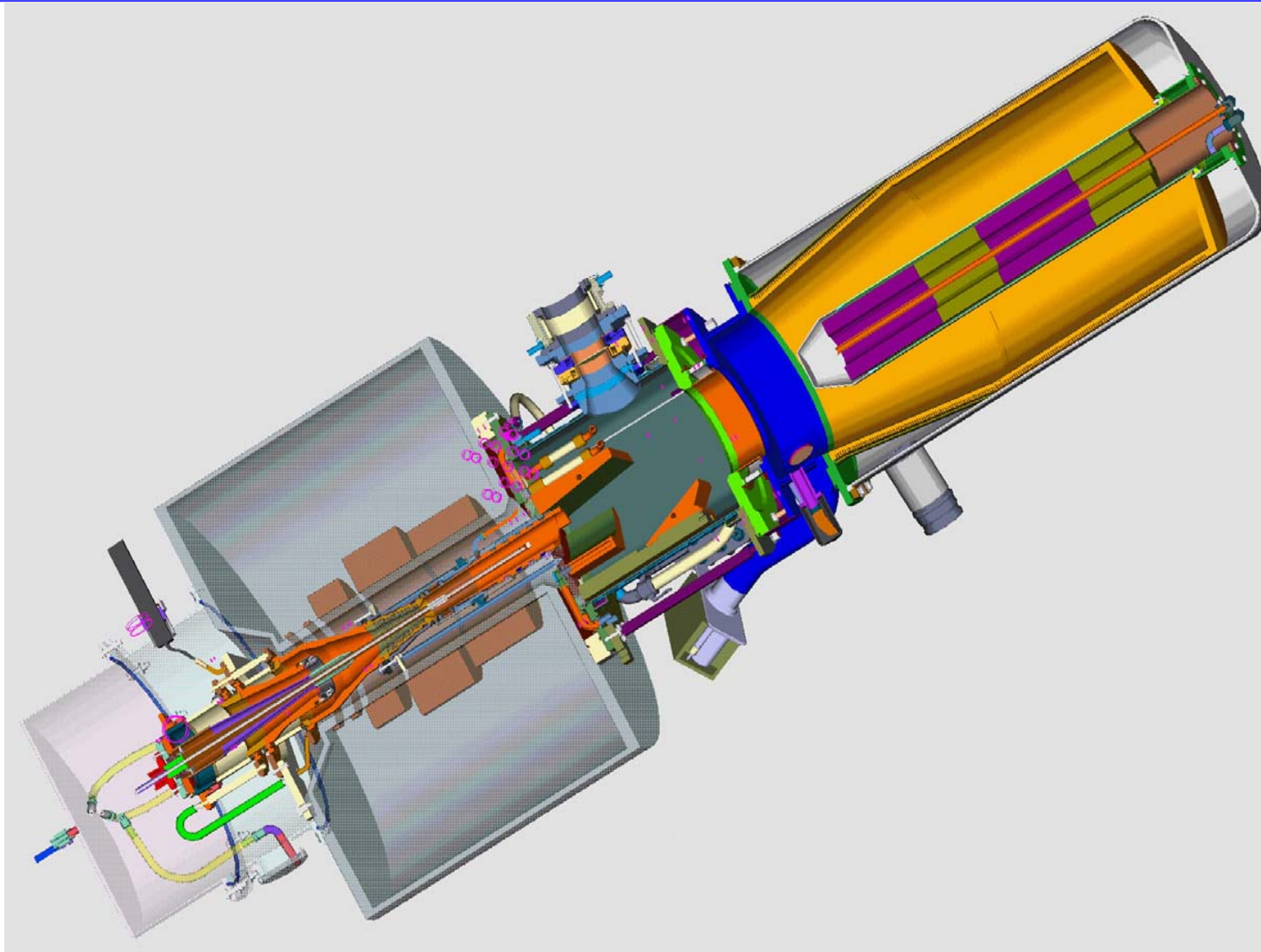
Nominal Parameters (2)

Cavity	Coaxial, TE _{34,19}
RF output efficiencyη	45% with depressed collector
Window	Diamond (CVD)
Output mode at window	TEM ₀₀ (Gaussian)
Mode purity in TEM₀₀ at window	96% \pm 1%
Output from RFCU	HE ₁₁ , 63.5 mm
Output polarization from RFCU	Variable, elliptical polarization
Output power range through variation of the body potential	0.6 MW - 2 MW
Modulation of the body voltage	0 Hz - 5 kHz sinusoidal, 25 kV p-p

Coaxial Cavity Gyrotron, 170 GHz, 2MW, CW

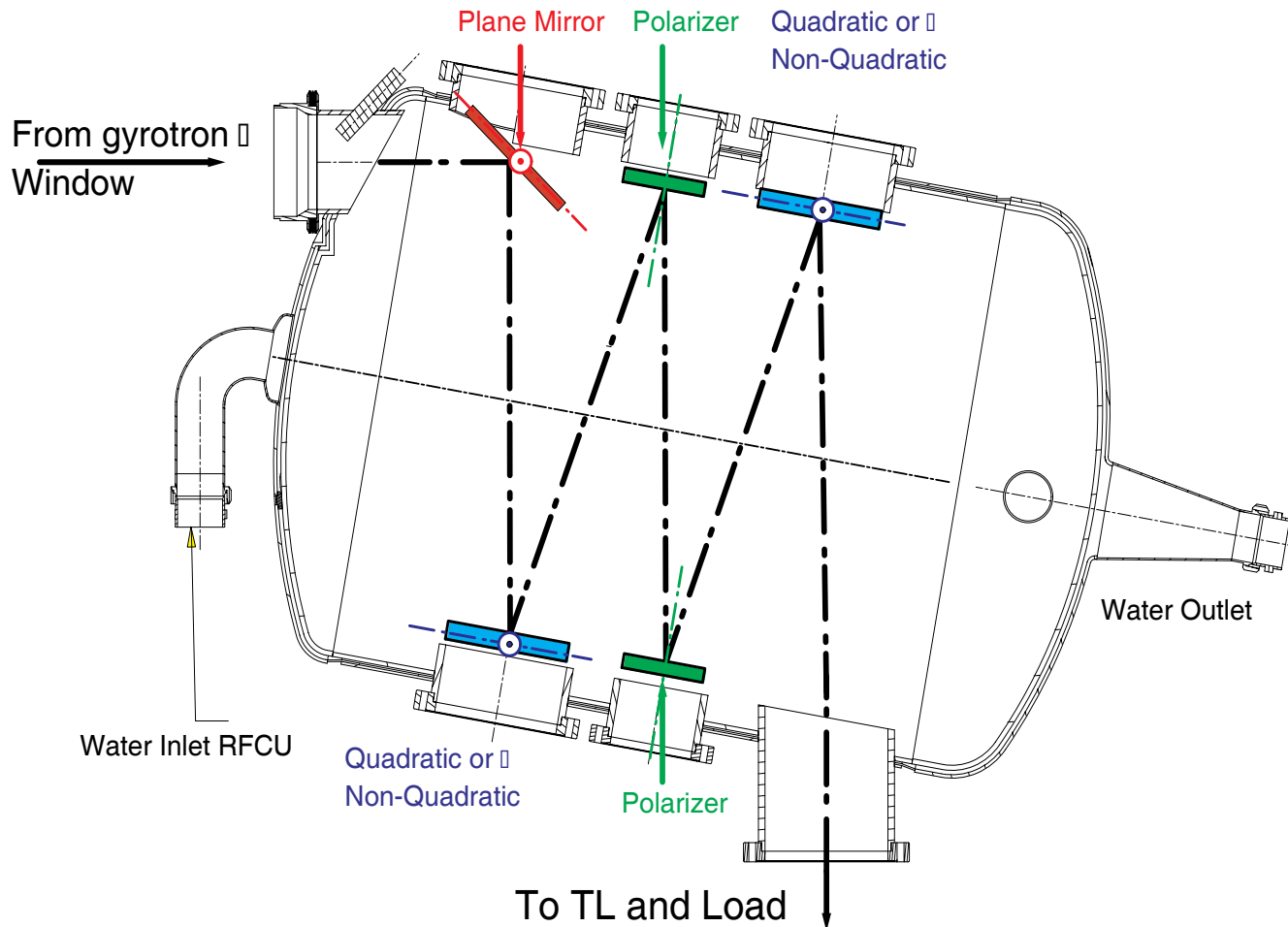


Coaxial Cavity Gyrotron, 170 GHz, 2MW, CW



Coaxial Cavity Gyrotron, 170 GHz, 2MW, CW

RF Conditioning Unit (RFCU)



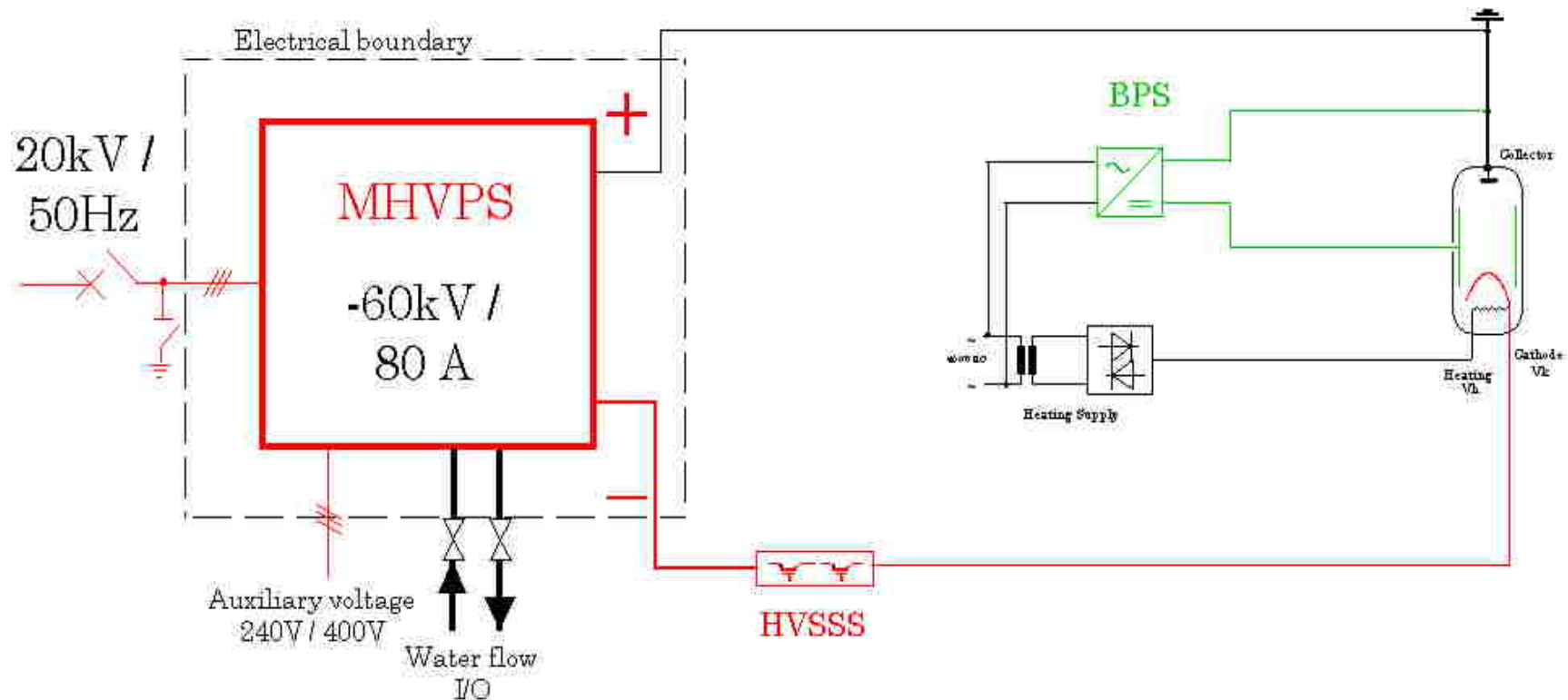
Potential issues

- Inner conductor
 - Cooling & stability
- Collector loading (2.2 - 2.8 MW)
- Stray losses handling (est. 5%)
 - Water loads
- Internal mode converter
 - TE_{34,19} not ideal



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Power supplies



MHVPS Parameters

Duty cycle	8 hours each 24 hours
Nominal output Voltage	
Output Voltage range	$-45 \text{ kVDC} < V_{\text{DC}} < -60 \text{ kVDC}$
Output Voltage accuracy: <ul style="list-style-type: none">• Static (ε_s)• Load – no Load (ε_d)• Ripple (ε_n)	$< \pm 1\%$ of V_{DC} nominal $< \pm 1\%$ of V_{DC} nominal $< \pm 2\%$ @ 600Hz, $< \pm 0,5\%$ for higher frequency
Voltage transient duration	$< 10 \text{ msec}$
Nominal output Current	80 A
Shutdown time	$< 30 \mu\text{sec} / 200\text{V}$
Measurement Accuracy: <ul style="list-style-type: none">➤ Voltage➤ Current	$< \pm 0.1\%$ of the nominal value $< \pm 1\%$ of the nominal value
Measurement bandwidth:	$\geq 500 \text{ kHz}$

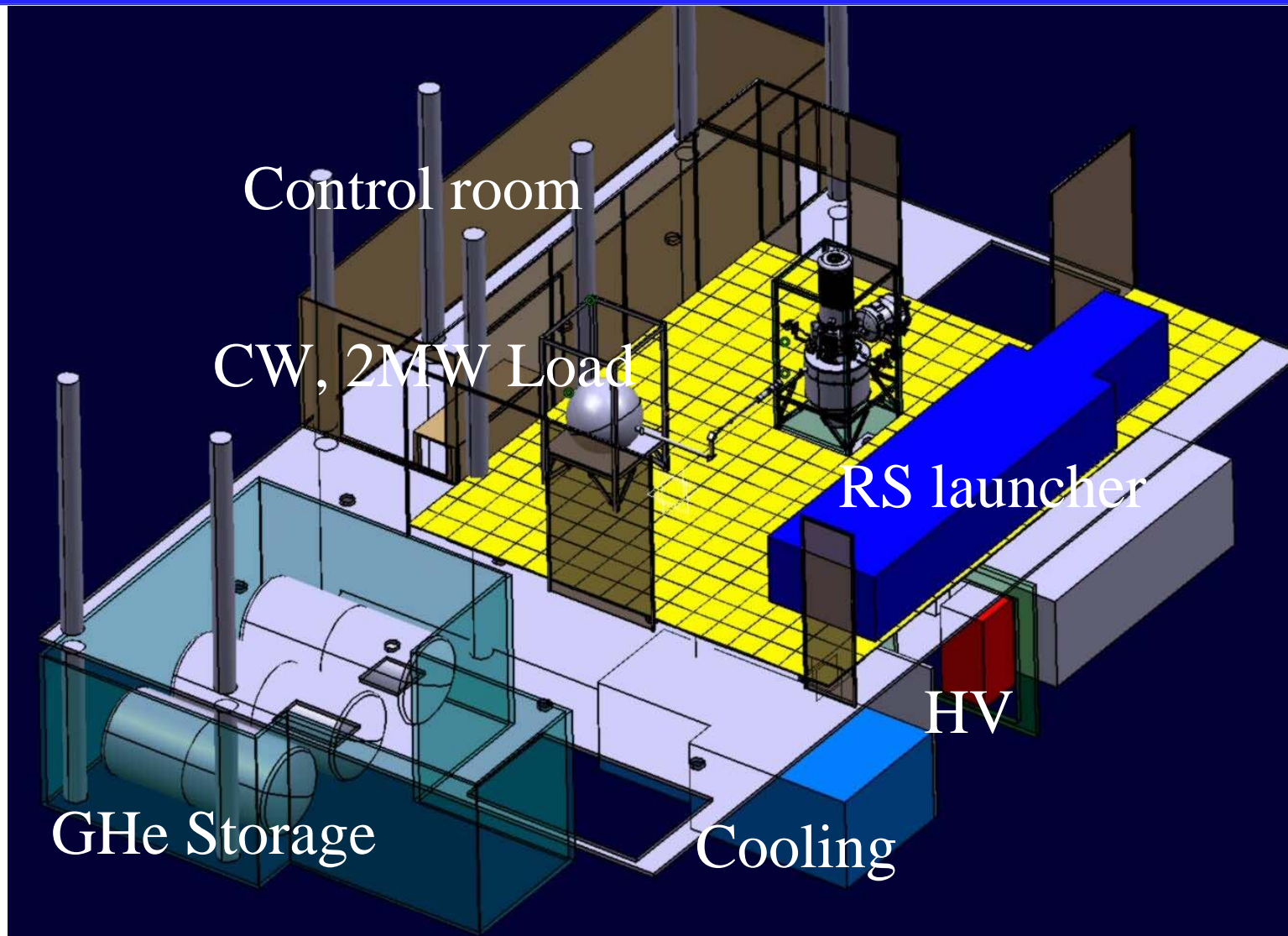
BPS Specifications

Body nominal voltage :	40 kV
Body current (static):	150 mA
Body voltage modulation: Bandwidth Depth (peak-peak)	DC to 5 kHz (sinus) 25 kV
Beam voltage Accuracy (V_{kb}):	$\pm 0.5\%$
Body peak current	< 5 A
Shut down time	< 10 μ sec
Fault energy into the gyrotron	< 10 J
Dummy load:	
R	267 k Ω
L	3 nF

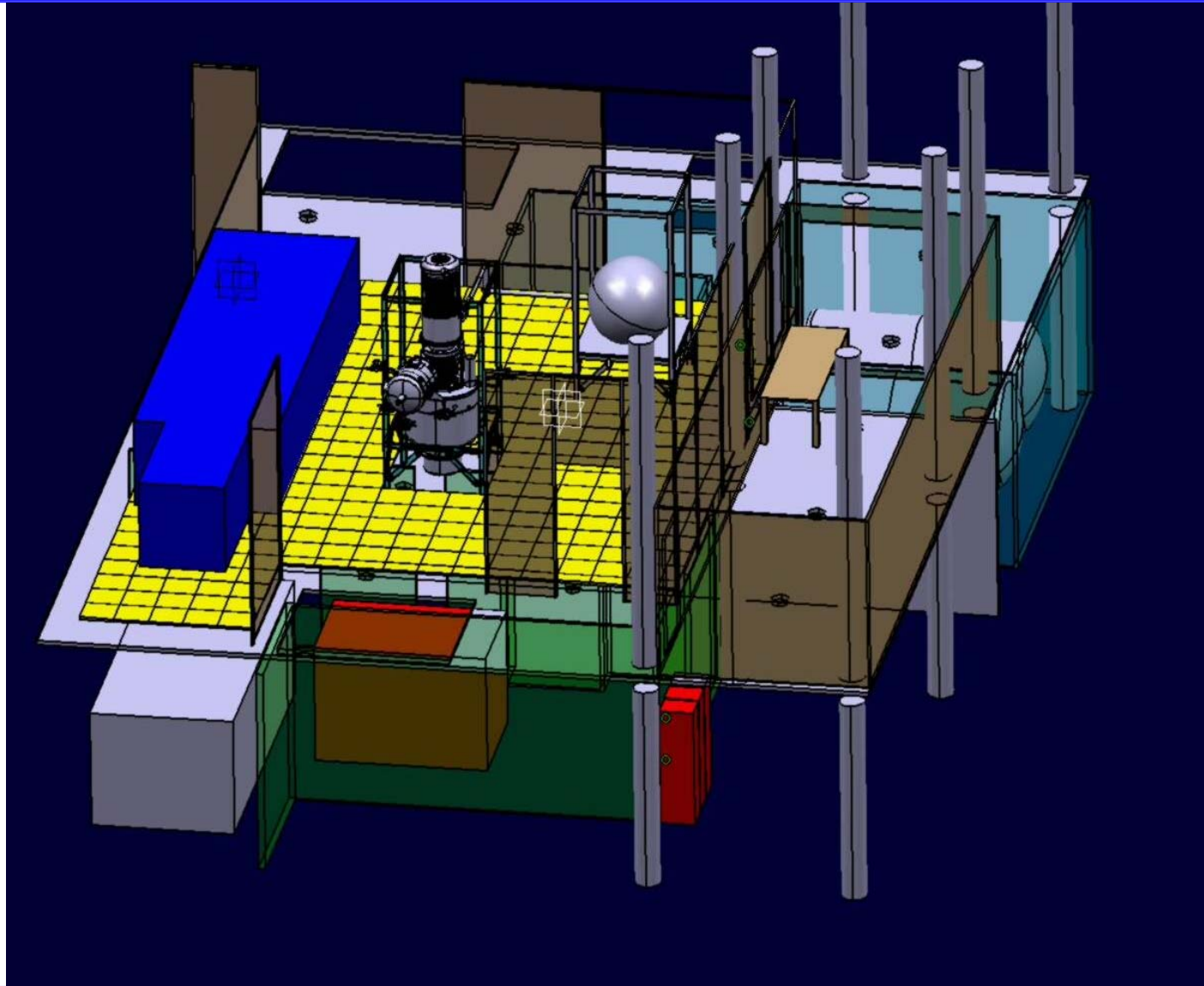
HVSSS Specifications

Technology:	
Rated Voltage (across terminals):	-60 kVDC
Rated continuous current:	
Trip current level:	
Max. peak current (fault condition)	≤ 1 kA
Min. recovery time after fault:	≤ 200 ms
Gyrotron arcing energy:	
Fast switch-off time:	
Pulse repetition frequency:	

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Status as of May 2004

- **GYROTRON**
 - Design study -> OK
 - Contract starting date: April 16th, 2004
 - Delivery scheduled Oct. 2005
- **SCM**
 - Contract estimated starting date: Oct. 2004
 - Delivery: Dec. 2005
- **POWER SUPPLIES**
 - Contract estimated starting date: Oct. 2004 (?)
 - Delivery: March 2006 (?)
- **INFRASTRUCTURE**
 - Running project

