

Project X
Project X



RF Power Sources
for
Project X

Ralph J. Pasquinelli
Fermilab

Collaboration Meeting @ SNS April 12-14, 2011



Frequencies and Powers

- *Four Frequencies, 162.5, 325, 650, 1300 MHz*
- *RFQ 162.5 MHz, 200 KW CW (preliminary)*
- *Spoke resonators 325 MHz, 1-7 KW CW*
- *Elipitical Cavities 650 MHz, 30 KW CW*
- *ILC Type Cavities 1300 MHz, 100KW long pulse*



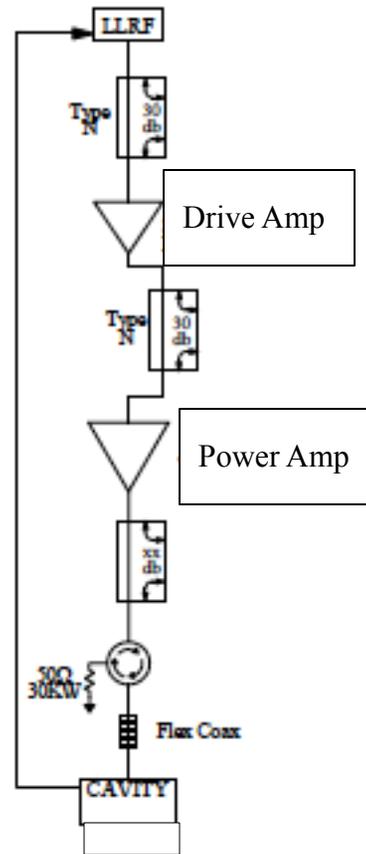
Number of Cavities

- *1 RFQ 162.5 MHz*
- *26 SSR0 $\beta=0.117$ 325 MHz*
- *18 SSR1 $\beta=0.220$ 325 MHz*
- *44 SSR2 $\beta=0.400$ 325 MHz*
- *42 Elliptical $\beta=0.610$ 650 MHz*
- *160 Elliptical $\beta=0.900$ 650 MHz*
- *115-192 Elliptical $\beta=1.000$ 1300 MHz*



Typical Performance Specs

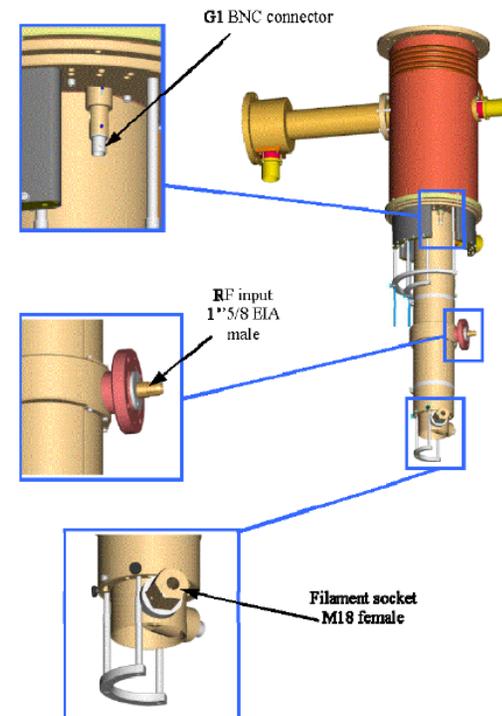
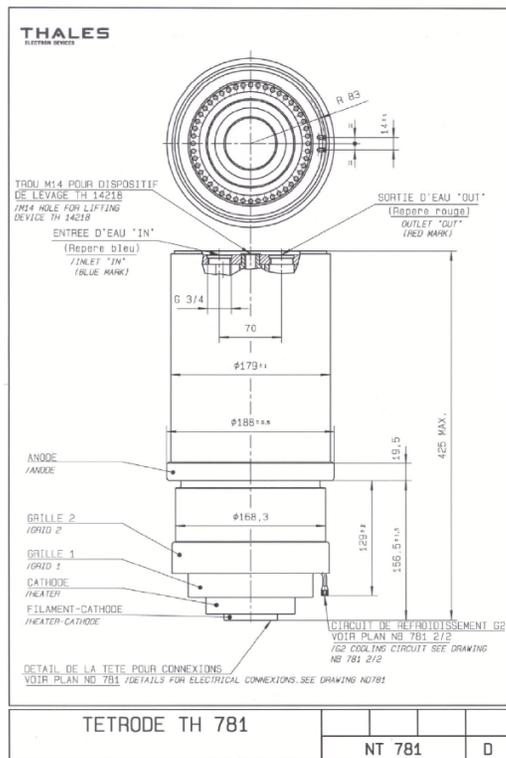
- *60% efficiency at saturated power*
- *50% efficiency at -1 dB power minimum*
- *Water cooled*
- *Bandwidth 1 MHz minimum*
- *LLRF drive of 0 dBm for P_{sat} output*
- *50 ohms input/output impedance*
- *Output protected against opens and shorts*



*Nominal Block Diagram
One RF Source per Cavity
in CW Linac*



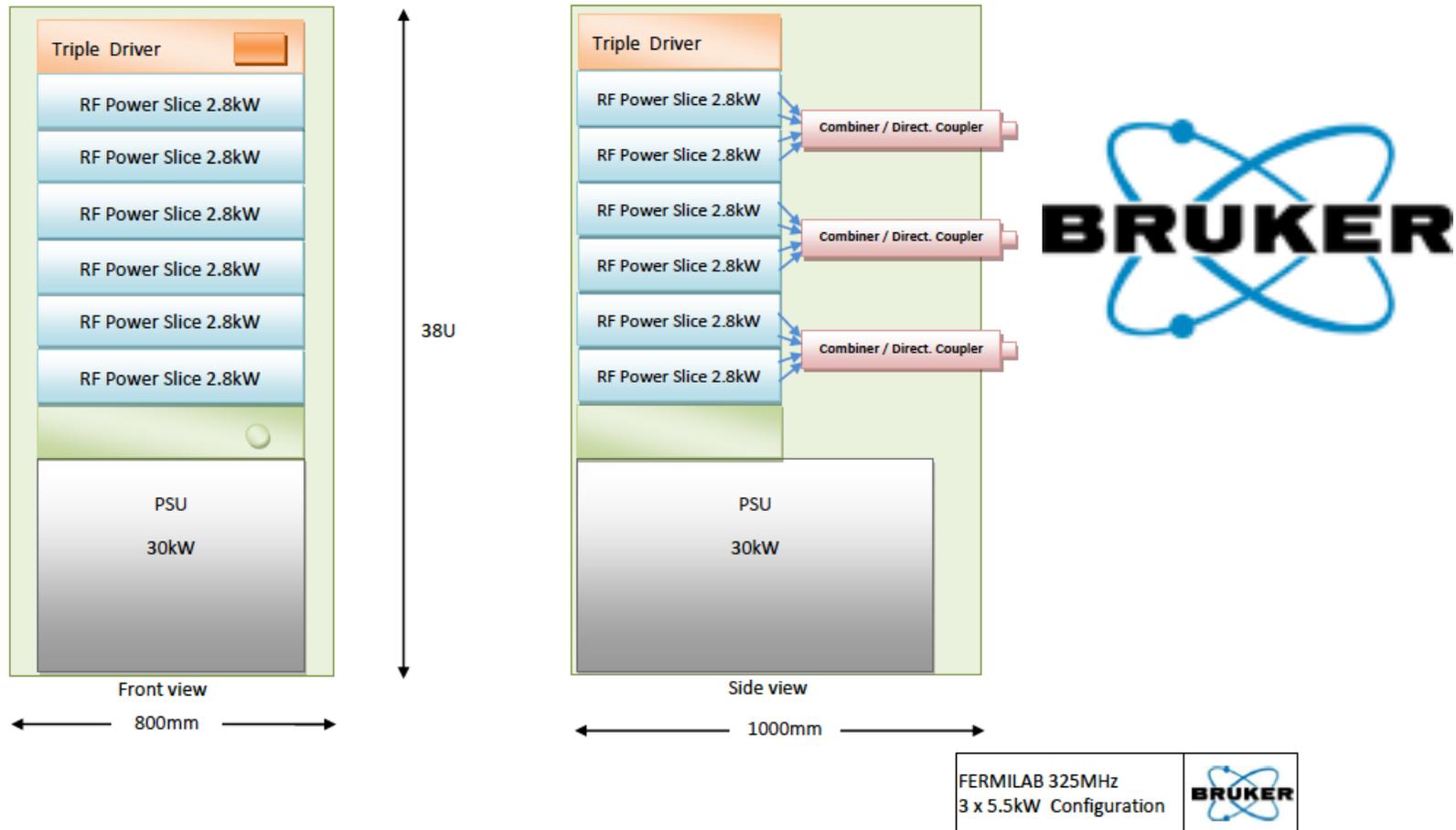
RF Power for 162.5 MHz RFQ



*Thales 781 Tetrode and Cavity
200 Kwatts CW*



Commercial Solid State Development

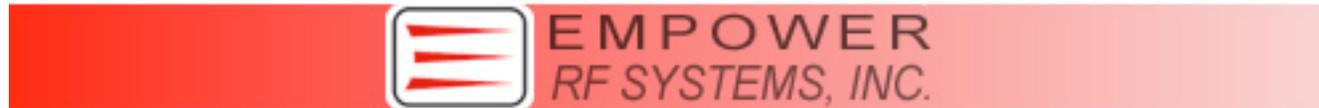


Project X
Project X

RF Sources for Project X



Commercial Solid State Development *Other Possible Vendors*





RF Sources for Project X



Commercial Solid State Development

Ultra High Efficiency Solid-State Power Amplifiers



GREEN MOUNTAIN RADIO RESEARCH COMPANY

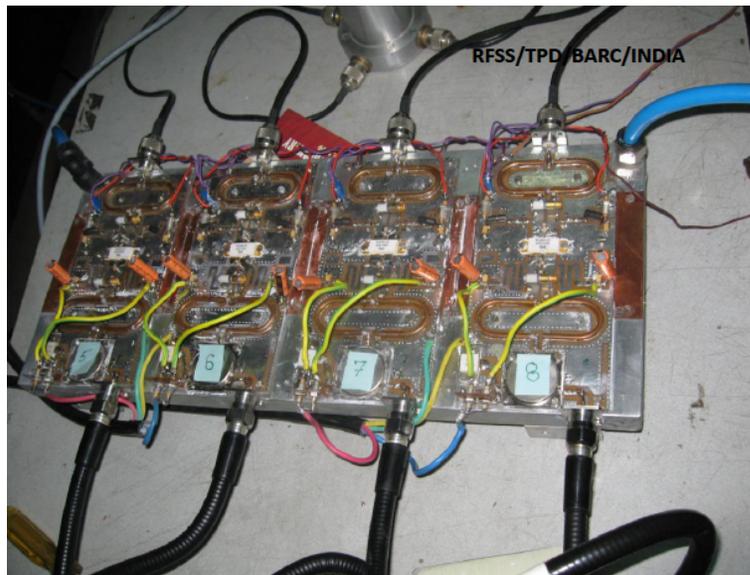
77 Vermont Avenue, Fort Ethan Allen, Colchester, Vermont 05446 U.S.A.

Phone/Fax: +1 (802) 655-9670 | Email: f.raab@ieee.org

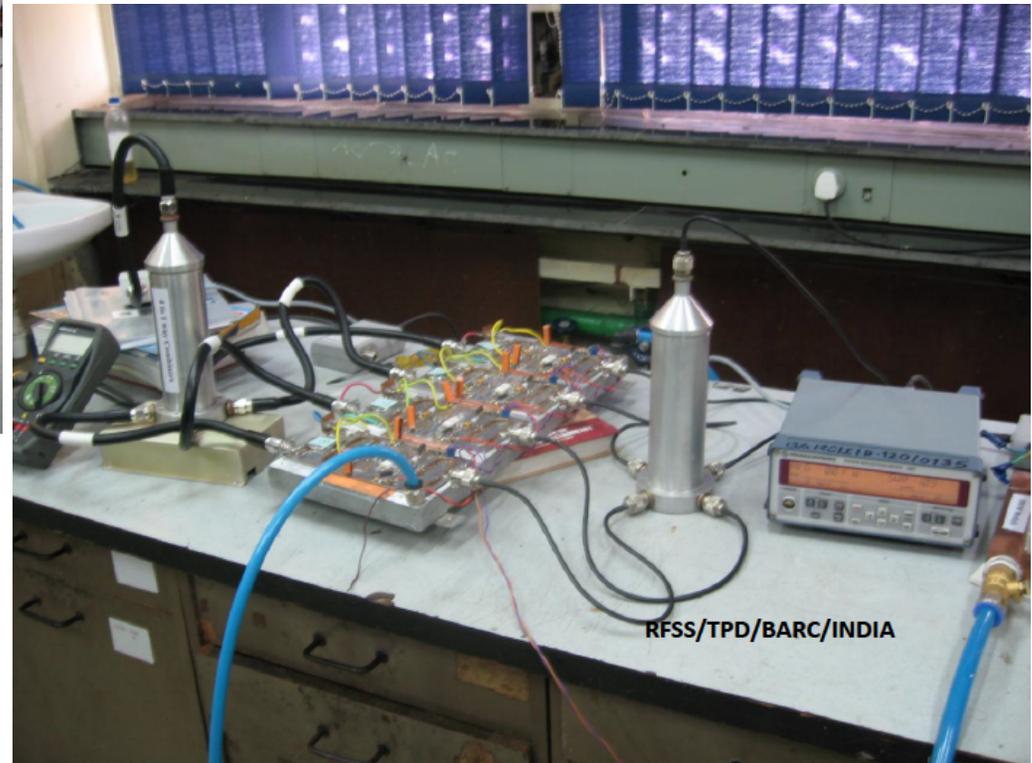
Application for SBIR Funding Pending



Solid State Development at BARC, Mumbai, India



*1 KW @ 350 MHz Prototype
Units to 7 KW Proposed*





Solid State Development at RRCAT, Indore, India



1 kW Solid State RF Amplifier for Booster

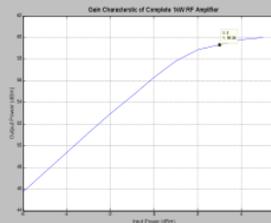


Tetrode Tube based Amplifier has been replaced by indigenously designed and developed 1kW Solid State RF Amplifier. This has resulted in improved performance .

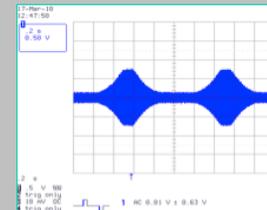


1kW RF Amplifier

Frequency	31.6 MHz	Output Power	1 kW
Operation Mode	CW	Gain	55 dB
Harmonics	-45 dBc	Efficiency	48 %



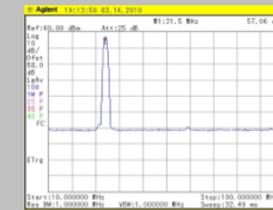
Gain characteristics of 1kW RF amplifiers



RF Cavity Gap Voltage



250Watt RF Amplifier Module



Spectral purity



Solid State Development at RRCAT, Indore, India



8 kW ,505.8 MHz Amplifier



Front View of 8 kW SSPA



Rear View of 8 kW SSPA

InPAC - 2011, IUAC, New Delhi Feb 15-18, 2011



Comark E2V IOTs Transmitters at Meson Test Facility

Two 30 KW CW Turn Key Systems
A Third System in Storage for NML





Commercial IOTs



VKP-9070 IOT Amplifier

CPI/Microwave Power Products (MPP) offers IOT's for particle accelerator applications. Integral Cavity Inductive Output Tubes (IC IOT) have been created by utilizing the fundamental electrical design of our external cavity IOT used in terrestrial UHF television broadcasting and incorporating conventional klystron cavity and coupling technology. The VKP-9070A is an IC IOT that provides 80 kW CW from 650 to 805 MHz. CPI also offers IC IOT's that provide 90 kW CW at 500 MHz and 30 kW CW or 90kW pulsed at 1300 MHz.

FEATURES

- Coaxial Output Window with Alumina Ceramic
- Water-cooled collector, cavity, and coupling loop
- Air cooled input circuit and electron gun
- Compact size with "collector (water) down"
- Requires VYW-9070A (Magnet, I/P circuit, & Stand)



VKP-9070A with VYW-9070A



Commercial IOTs

IOTD2100
IOT Amplifier for
UHF Television Service

*E2V
D2100
30 KW CW*





Commercial IOTs

Electron Devices



TECHNICAL BULLETIN

**USING THE L-3 IOTD-130D
AS A REPLACEMENT FOR THE E2V D2130**

This IOT was designed as a direct replacement for the e2v D2130 tube to be used in an existing e2v trolley.

- The primary difference between the D2130 and the L-3 IOTD130D is the location of the upper cooling pipe connections. The L-3 IOTD130D utilizes the standard drift tube cooling method with an isolated body/collector as opposed to the D2130 anode cooling and non isolated body/collector.

30 KW CW



Proposal for long pulse (26msec) 1300 MHz Klystrons

		500 kW pk 30 kW ave	1 MW pk 60 kW	2 MW pk 120 kW
Output Power (kW)		554	1163	2336
Beam Voltage (kV)		70	90	120
Beam Current (A)		12	20	30
Beam Power (kW)		840	1800	3600
Perveance (uP)		0.65	0.74	0.72
Efficiency at Saturation		66%	65%	65%
Output power at 2 dB back-off		349	734	1474
Efficiency at 2 dB back-off		42%	41%	41%
Production quantity		75 - 125	38 - 62	19 - 31

Similar Proposal from Thales Pending



Proposed Next Steps

- *Prototype 1 KW solid-state amplifier modules*
- *Test Stands @ Meson and NML*
- *Evaluation of Solid-State/IOT/Klystron options*
- *Optimizing based on cost and performance*