



RF Power Sources
for
Project X Injector Experiment
(PXIE)

Ralph J. Pasquinelli
Fermilab



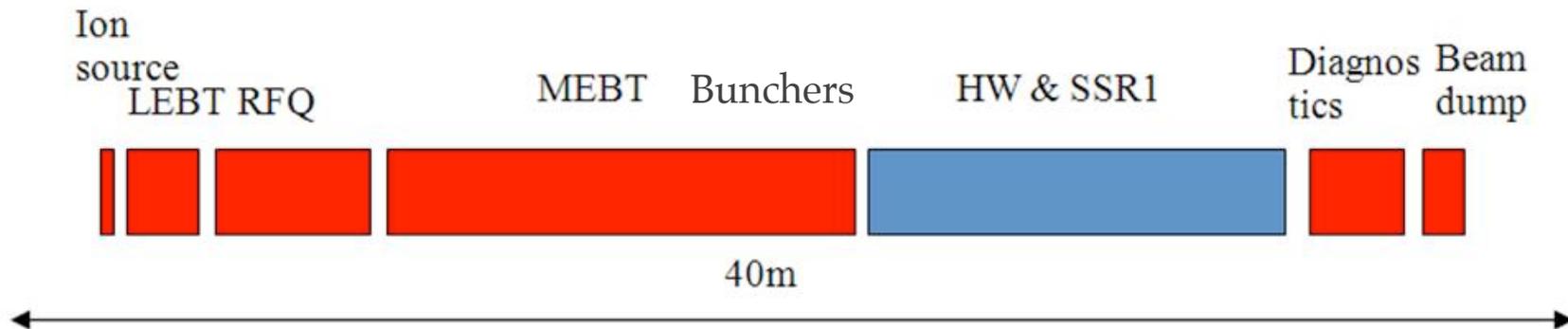
Frequencies and Powers

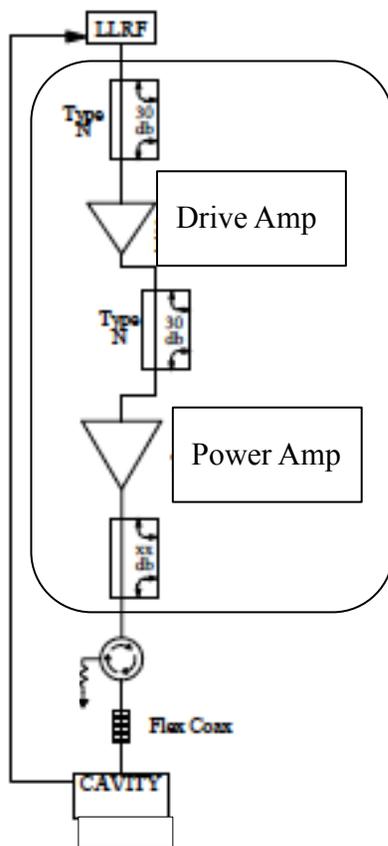
- *Two Frequencies, 162.5, 325 MHz*
- *RFQ 162.5 MHz, 150 KW CW*
- *Room Temperature Bunchers, 162.5 MHz 4 KW CW*
- *SC Half Wave Resonators 162.5 MHz, 4 KW CW*
- *SC Single Spoke Resonators 325 MHz, 4 KW CW*



Number of Cavities

- *1 RFQ 162.5 MHz*
- *3 normal conducting bunchers 162.5 MHz*
- *8 SC half wave resonators 162.5 MHz*
- *8 SC single spoke resonators 325 MHz*



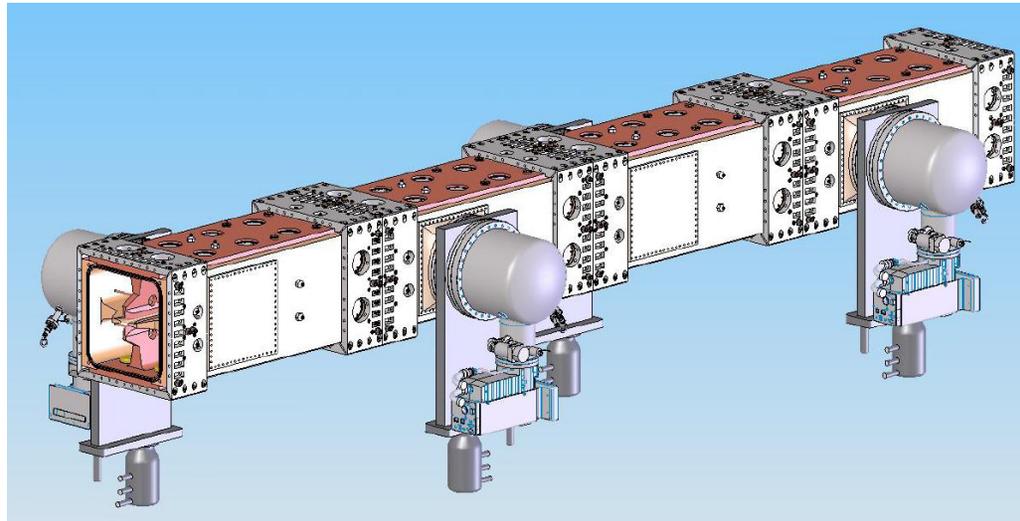


*Nominal Block Diagram
One RF Power Source per Cavity*

*The RFQ has two drive ports.
Could use two amplifiers if
It proves more economical.*



RFQ



- 162.5 MHz
- Two drive ports
- 75 kW CW into each port



Power Amplifier Requirements

- *50% efficiency at saturated power*
- *40% efficiency at -1 dB power*
- *Water cooled*
- *Bandwidth 1 to 5 MHz*
- *Sufficient gain for Saturated output with 0 dBm drive*
- *50 ohms input/output impedance*
- *Output protected to 3:1 VSWR, external circulators will be used*
- *Two drive ports on the RFQ, either two amplifiers or power splitting of one larger amplifier*
- *One amp per cavity for Buchhers, HWR, and SSR1*

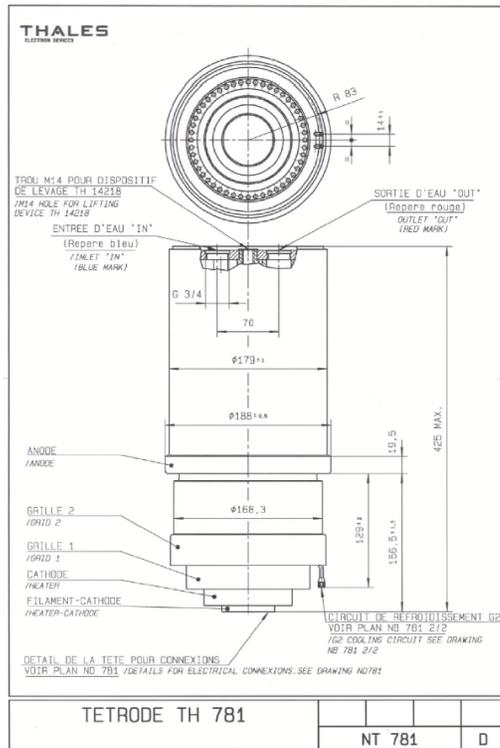


AC Power Consumption Estimate

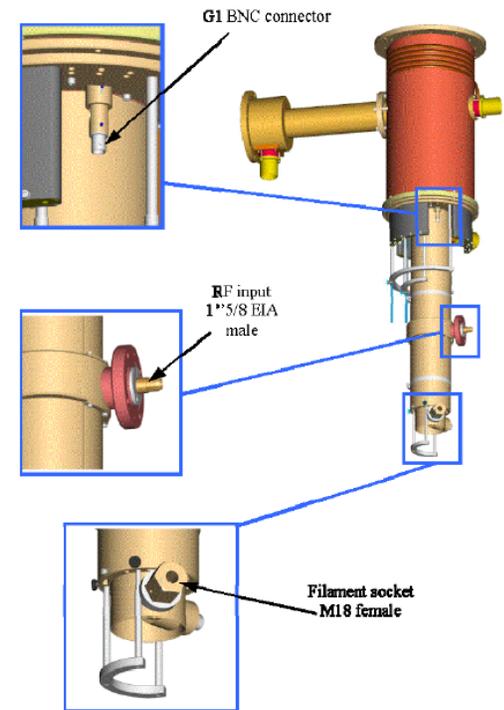
- *40% AC to RF efficiency at -1 dB power*
- *Total RF power RFQ plus 19 cavities=226 KW*
- *AC to RF power at 40%=565 KW*
- *Ancillary power for LLRF, interlocks, etc.=45 KW*
- *Total AC power= 610 KW*



In House Development of RF Power for 162.5 MHz RFQ



THALES



Thales 781 Tetrode and Cavity
200 Kwatts CW

Project X
Project X

RF Sources for PXIE



Anode Supply
10kV, 30 amps

TDK-Lambda
A.L.E. Systems



Many in use with
TH781 Tetrode.



200 KW CW RF Power for 162.5 MHz RFQ

Turn Key system estimate \$2.75 million, 18 months ARO



THOMSON

*Utilizes Thales 781 Tetrode and Cavity
200 Kwatts CW*

Project X *RF Sources for PXIE*



*LBL dual 60 KW amps...\$1million (2010)
Thales TH 571B tetrodes @ 186 MHz*



*Soleil 190 KW 352 MHz Solid-state Power amp:
50 KW per tower
330 Watts per module*

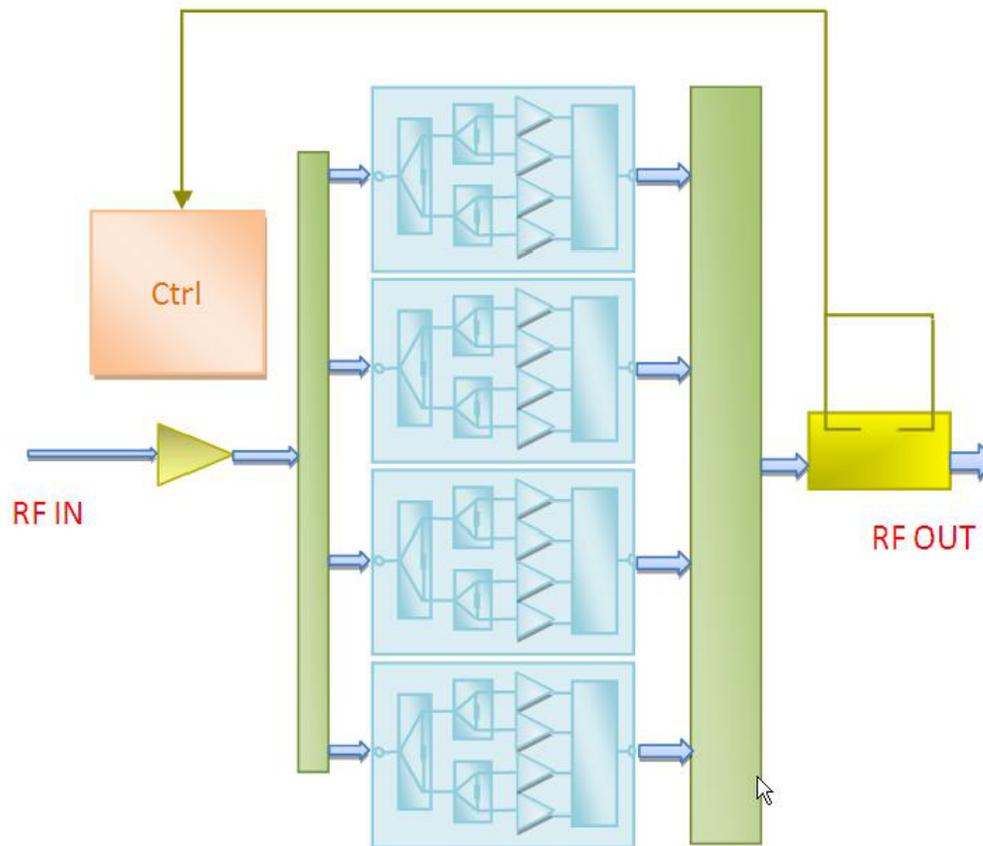


Choice of RFQ Amplifier Technology

<i>Amplifier type</i>	<i>Pros</i>	<i>Cons</i>
<i>In house Tetrode</i>	<i>Interface & Service existing tube&cavity</i>	<i>High FNAL resources</i>
<i>Vendor Tetrode</i>	<i>Turn Key system Low FNAL resources</i>	<i>May not be able to Stage funding</i>
<i>Vendor Solid-state</i>	<i>High reliability, No High Voltage Fewer consumables Low FNAL resources</i>	<i>Potential high initial cost</i>



Commercial Solid State Development



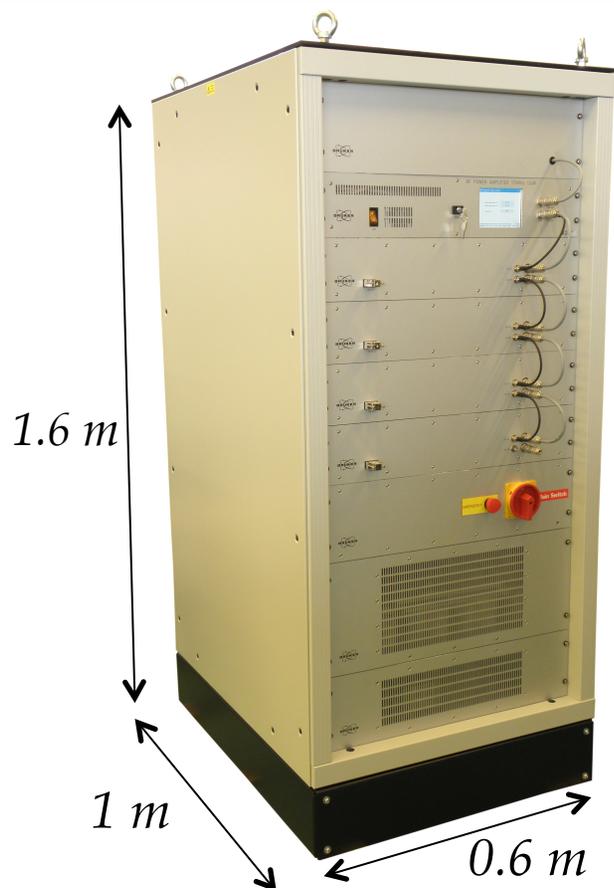
Project X
Project X

RF Sources for PXIE



10 KW CW 325 MHz in a Rack

Combines 4-2.5 KW Module, New Version combines 2-5KW Modules



PXIE review March 6,7, 2012

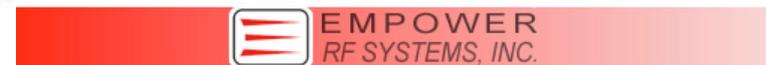
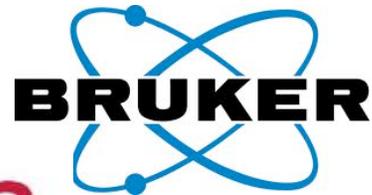
R. J. Pasquinelli

Project X
Project X

RF Sources for PXIE



Advanced Test Solutions for EMC





Summary

- *A full PXIE RF system cost estimate has been created*
- *A cost estimate for in house development of a tetrode RFQ driver has been completed and being evaluated against commercial alternatives*
- *Develop formal amplifier specifications for vendor bidding*
- *Lead time 18 months to 2 years regardless of technology for RFQ amp*
- *Lead time 9-12 months for solid-state commercial amplifiers*
- *Minimize amplifier types to reduce spares count*
- *All PXIE RF hardware can be reused for Project X*
- *Procurment of RFQ amplifier in FY2012*