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RF Sources

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PIP-II Machine Advisory Committee Meeting

15-17 March 2016

High Level Amps Requirements

	Frequency [MHz]	Number of RF cavities	Number of RF amplifiers per cavity	RF amplifier power [kW]
RFQ	162.5	1	2	75
MEBT Bunching cavities	162.5	3	1	3
First HWR cavity	162.5	1	1	3
Other HWR cavities	162.5	7	1	7
SSR1	325	16	1	7
SSR2	325	35	1	20
LB650	650	33	1	40
HB650	650	24	1	70

Amplifiers are CW and pulse capable

High Level Amps Requirements

Amplifiers for PXIE will operate at CW or pulsed
Total of 21 amplifiers 541 kWatts AC power

Amplifiers for PIP-II will operate pulsed initially, CW eventually
Total AC power for RF amps at PIP-II 1732 kW pulse mode

Cooling water set at 83 degrees F to satisfy RFQ circulator needs

The circulators for the RFQ are large and will be located in the amplifier gallery. The rest of PXIE circulators will be in the cave.

Location of circulators for PIP-II to be determined.

RFQ High Level Amps

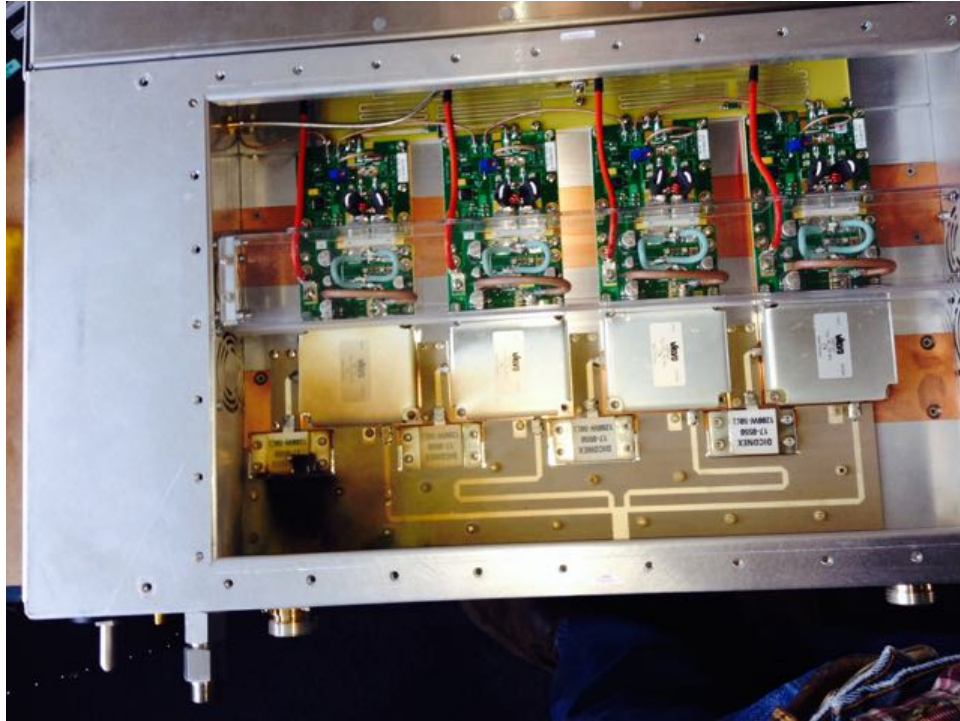
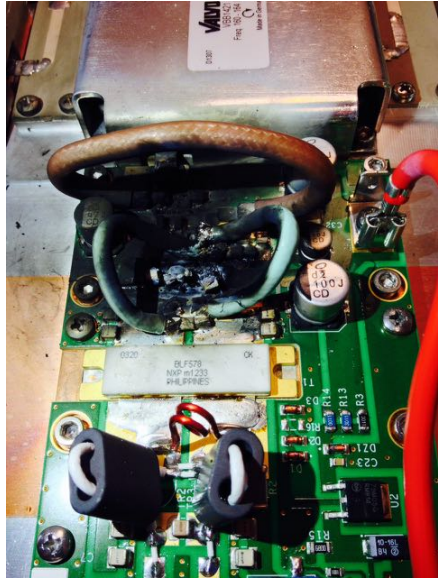


Two Sigmaphi 75 kW CW
162.5 MHz amplifiers



Two Ferrite 75 kW CW
circulators

RFQ High Level Amps Failure Modes CW Operation

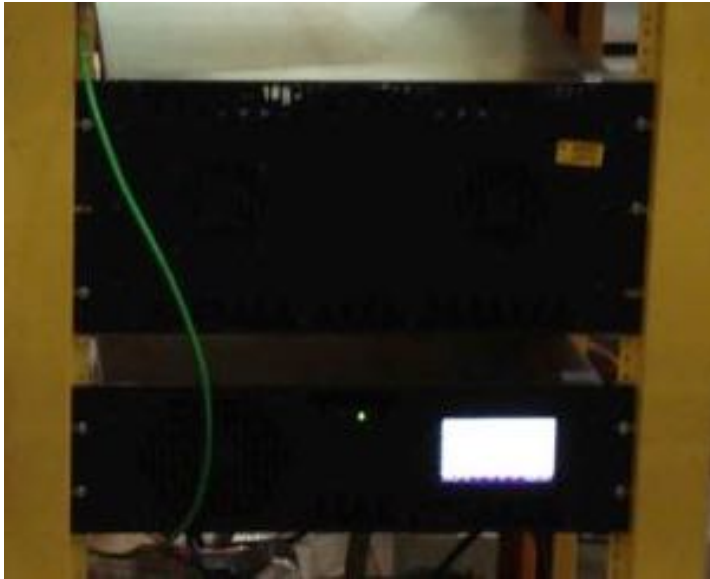


- Individual RF amplifier failures
- Circulator failures
- Distribution card failure

RFQ High Level Amps

- Original Purchase Order with Sigmaphi includes some spare parts
- Not adequate spares to account for the infant mortality
- A full set of spare modules and amplifier pallets on order @ \$42K
- Delivery is expected May 2016
- Temporary solution is to run in pulsed mode not exceeding 10% duty cycle
- Extended 6 week 24/7 pulsed 10% operation performed late 2015
- No failures occurred in the six week trial
- Amps hooked up to RFQ, January 2016
- Conditioning of RFQ has been successful to 120 kW at 5% duty cycle, February 2016
- Running in CW mode will be deferred until beam established reliably in pulsed mode (and all spares have been tested, June 2016?).

MEBT High Level Amps



COMARK Communications Price Proposal
P#1998 in Response to 250245-RFC
For
Five (5) 162.5MHz, 3kW CW RF Amplifiers

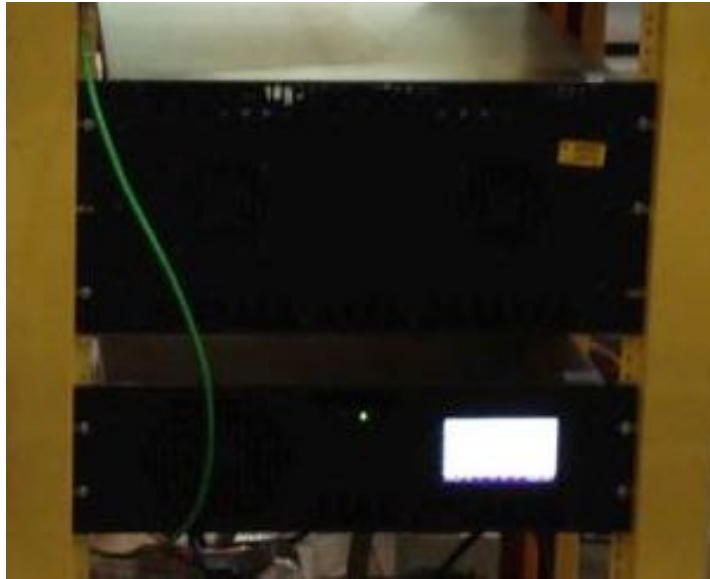
Comark 162.5 MHz
3 kW CW



Fourth round of testing resulting in failure modes.

- Circulator failure
- Control interface failure
- Control interface freezes due to RF interference
- Interlocks not failsafe

MEBT High Level Amps



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For
Five (5) 162.5MHz, 3kW CW RF Amplifiers

Comark 162.5 MHz
3 kW CW



- Of the five units ordered, 4 at back at the factory for repair
- Delivery of working units very close to critical path
- Retaining one amplifier that delivers RF power, but will require custom interlocks to allow safe operation.
- Delivery of final units TBD depending on repairs.

Indian Collaboration High Level Amps



BARC 3 kW CW 325 MHz Prototype

- Amplifier failed on initial turn on
- Visit from BARC engineer makes repairs
- Amplifier successfully tested December 2015
- Basis for 7 kW CW unit drives SSR1 cavities
- The FRS has been approved
- TRS is in review process
- Discussions on delivery schedule

Indian Collaboration High Level Amps

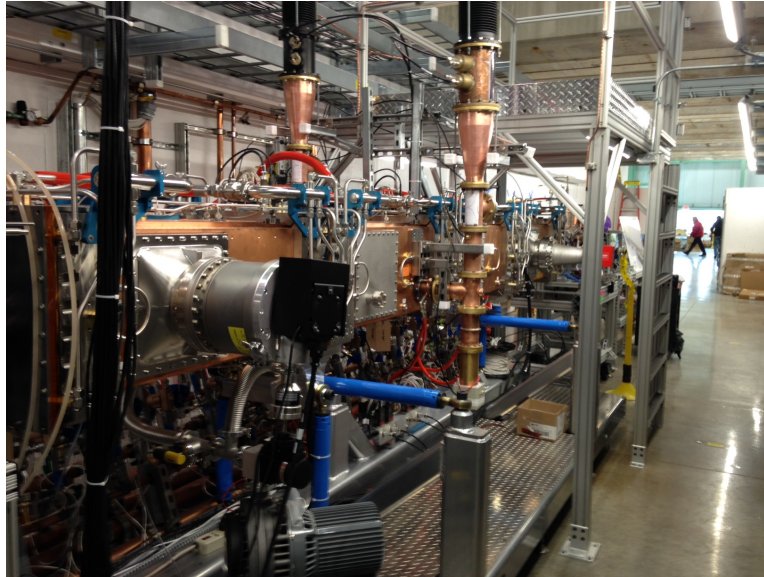


30 kW prototype under test

RRCAT 40 kW CW 650 MHz

- RRCAT has constructed a 30 kW prototype
- Delivery of prototype delayed until 2017 due to limited resources at FNAL
- The FRS has been approved
- TRS has yet to be written
- Discussions on delivery schedule

Current Status



- RFQ conditioned to 120 kW @ 5% duty cycle
- LLRF calibrations have been performed
- Resonance Control has begun
- MEBT to be installed soon followed by RF system integration
- Procurement of HWR amps delayed due to lack of funds
- Amplifiers from Indian institutions delivery start 2nd Q 2018
- By start of PIP-II construction, all Amplifier woes will be in the past!
Experience and spares inventory should provide good availability