Injection locked CW Magnetron RF Power Source for Project X

September 11, 2013
Schematic of Vector Summation of Injection Locked Magnetrons
Ferrite’s New Line of Generators Provide the Longest Magnetron Life in the Industry.

75 kW@$1/watt
Motivation for this technique is cost savings

650 MHz

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost per Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid state 50 kW</td>
<td>$7/watt</td>
</tr>
<tr>
<td>IOT 50 kW</td>
<td>$5/watt</td>
</tr>
<tr>
<td>Magnetrons 50 kW</td>
<td>$2-$3/watt</td>
</tr>
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Project Summary  Phase II-STTR 2011
(All information provided on this page is subject to release to the public.)

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PROJECT TITLE: 60c Low-Cost Two-Stage Magnetron with Power Control For Project X

TECHNICAL ABSTRACT
Statement of the problem or situation that is being addressed - typically, one to three sentences.
State of the art high intensity proton accelerators require the development of an affordable cost, reliable RF sources with phase stability of less than 1 degree and amplitude control of +/- 15% (for identical cavities; in real situation the range can be wider). These power sources feed superconducting RF cavities for linacs capable of accelerating protons and ions up to several GeV.

General statement of how this problem is being addressed. This is the overall objective of the combined Phase I and Phase II projects.
A two-stage frequency-locked magnetron RF source will be developed to feed individual superconducting cavities. The 30-40 db gain of the system will be obtained by cascade operation of the magnetron stages controlled by slowly-varying phase generated by a Low Level RF (LLRF) system to damp electronically instabilities caused by microphonics.
Spectrum of unlocked magnetron
Magnetron power supply ripple, 60 Hz and 43 kHz
Spectrum of power supply noise
Vector Signal Analyzer real time spectrum unlocked magnetron
Harmonics with 3 watts injection drive, 1.14 kW mag out, 847 watts at output put 5 MHz span, 350 mA magnetron current
Wide spectra with 3,6,10,15,20 watts injection drive, 1.14 kW mag out, 847 watts at out put traces 1-5, 350 mA magnetron current
Harmonics with 1,3,6,10,15,20 watts injection drive, 1.14 kW mag out, 847 watts at output, 350 mA magnetron current
Trace 6 is one watt, traces 1-5 are 3-20 watts
60 Hz Harmonics with 15 watts injection drive, 1.14 kW mag out, 847 watts at out put, 350 mA magnetron current
yellow Harmonics with 25 watts injection drive, 1.14 kW mag out, blue magnetron off, TWT feed through, injection gain 15 dB
Next Steps:

Clean up power supply ripple with a filter

Characterize RF performance

Turn over to the LLRF group for vector control

Have vector modulation results by Spring of 2014