KEK test area plans

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Two X-band high power stations in KEK

Nextef (100MW)

- Modulator and twin klystrons
- Test area in Shield-A

KT-1 (50MW)

- Klystron Test,
- Small experiments (in Lead shield box)
What to be pursued by KEK X-band

- **Practical structure evaluation and develop high power system**
  - Aiming at CLIC design
  - Minimum required power and pulse width are ~ 75MW and ~ 240ns.
  - Nextef is our only choice to conduct this work. These parameters are just we are operating. Introducing power compression system is needed beyond these.

- **Basic research on high gradient**
  - Study with: Single-cell, Narrow waveguide, C10, CD10, ...
  - Required the power as low as10MW to very high >>100MW with pulse width ~500ns.
  - KT-1 is suitable for these works. We may use Shield-B with Nextef klystrons.

- **Development of components and devices**
  - load, directional coupler, ..., Klystron, ...
Pulse Compressor (circular TE11 / TE21) proposed by M. Yoshida.

22m - One Channel

TE₁₁ Mode
Converter

Upgrade using higher mode

TE₁₁-TE₁₂
Reflector

2009 version

1500ns → 300ns
Gain = 3.3 @ 3dB

Final version

750ns → 150ns
Gain = 3.6 @ 3dB

25 MW × 2 Klystons
× gain=3
→ 150MW
Gycom High-Q Cavity PC

Our colleague, Sergey Kuzikov from GYCOM, Nizny-Novgorod, Russia have proposed extremely interesting design of the cavity pulse compressor. The main features:

# Big cavity volume with mixed-modes oscillation will provide enough Q-factor (~2*10^5).
# The nature of the mixed-modes field pattern allows for the damping of the spurious modes, as well as for installation of the sufficient pumping of the cavity volume.
# The clever idea - to use the iris position as a frequency tuner will keep the quality of the modes mixing unperturbed during tuning procedures.
# The overall design looks very simple and inexpensive.
# He confirmed that they are interested in building the device for us.

\[
Q_{ohm} = \frac{2kl}{2P_u + 2P_{con} + P_{iris} + P_{plunger}} = \frac{365}{2 \cdot 4.2 \cdot 10^{-5} + 2 \cdot 1.5 \cdot 10^{-4} + 1.5 \cdot 10^{-4} + 3 \cdot 10^{-4}} = 4.4 \cdot 10^5
\]

\[
Q_{diff} = \frac{365}{1 \cdot 10^{-3}} = 3.7 \cdot 10^5
\]

\[
Q_0 = \frac{Q_{ohm} \cdot Q_{diff}}{Q_{ohm} + Q_{diff}} = 2 \cdot 10^5
\]
12 GHz, cavity-based pulse compressor (SLED or BOC); compression: 1500 ns → 300 ns

Discussion:
The cavity with Q-factor above 80,000 will be sufficient to provide 100 MW flat pulses from 50 MW klystron.

- The SLED cavities (cylindrical $H_{\text{Q,NM}}$) are at their performance limit; the $Q > 100,000$ is very challenging.
- Another challenge is a rather small coupling factor (~3) and as a consequence - the small diameter coupling holes in 100 MW device. Still possible?
- The BOC cavity (moderate version) can easily provide 150,000 (180,000 was demonstrated in high power BOC version in KEK). + Distrib coupling (many (~40-100) holes)
Proposal
Pulse compression systems

Construct Yoshida PC of “final version” (double-mode version). The compressed power goes to Shield-A for the structure test.

Test of High-Q Cavity PC at Nextef. The (maximum) power of 50MW with 1.5us will be available for the test.

High-Q Cavity PC may be installed at KT-1.
# Pulse compressors

<table>
<thead>
<tr>
<th>Source RF</th>
<th>Compressed (Gain=3)</th>
<th>Source RF</th>
<th>Compressed (Gain=2.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500ns</td>
<td>300ns</td>
<td>1500ns</td>
<td>300ns</td>
</tr>
<tr>
<td>25MW X 2</td>
<td>150MW</td>
<td>25MW</td>
<td>60MW</td>
</tr>
</tbody>
</table>

- Nextef: Yoshida Delay Line PC with Double Modes
- KT-1: Gycom High-Q cavity PC
Comment: Practical operation limit of PPM Klystron

Plots of Pulse Shortening Events on Power / Width plane.

- **PPM4 (2003)**
- **PPM4G2A (2006)**

- Practical operation limit of PPM Klystron is 25MW, 1.5us.
TE11/TE21 PC Configuration

- 3dB Hybrid
- Shield-B
- Shield-A
- PC coupler = 3dB Hybrid
- Nextef Klystrons: 25 MW x 2; 1.5us
- Mode Launcher:
  - Rect TE01 -> Circ TE11L
  - Circ TE11R -> Rect TE01
- Taper
- Circular Delay Line: 22 m Long
- Reflector: TE11 <-> TE21

Note: The Delay Line is also used as a transmission line of C-band RF.
Reconfiguration of transmission lines

Current configuration → Proposed configuration
Nextef Area as of July 3.

Nextef Klystrons and Modulator

Shield-A
(T18 Disk-> T18 Quad )

Shield-B

Phi-80 Circular waveguide
Nextef Planning
revised on July 1, 2009.

2009
1 2 3 4 5 6 7 8 9 10 11 12

2010
1 2 3 4 5 6 7

T18_VG2.4_Disk #2
TD18_VG2.4_Quad
TD18_VG2.4_Disk
T18_VG2.4_Disk #4

C-band line from KT-2
RF transmission test, SKIP test, structure (CKM-004) test
NWG Cu-005
Component tests

KT-1
C-band Structure Test

Gycom Pulse Compressor test
X-band transmission line construction

A
B
Nextef Configuration

KT-1
X-band

KT-2
C-band
Conclusion

Nextef

Sheild-A:

• We continue X-band structure tests.
• Delay Line Pulse Compression system will be installed in FY 2009. 150MW 300ns pulse is expected.
• DLPC starts operation in early summer 2010 after a 2m-long C-band structure test. (The test starts in April 2010. Note the test occupies the delay line.)

Sheild-B:
• X-band power line will be established from Nextef klystrons.

KT-1
• Continues tests of RF loads as well as klystron test.
• Install Gycom Cavity PC after its test(proposal).
Nextef planning (longer period)

- Establish system with KX03
- T18_VG2.4_Disk #2
- TD18_VG2.4_Quad
- TD18_VG2.4_Disk
- C-band structure test
- T18_VG2.4_Disk #3
- TD24_VG_Disk_Practical
- TD24_VG_Disk_Practical for long run
- Pulse compression
- Installation and commissioning
- KT-1
- Nextef

To be determined reflecting the status