Alignment Frame Progress at LLNL

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LLNL builds an alignment and metrology frame for ATF BPMs

- **Basic idea:**
  - Create a structure that is inherently stiff to impose rigid body motion on 3 BPMs
  - Measure slow motion from thermal drift with a metrology frame

- **Hexapods are chosen for the alignment frame**
  - Based on an LLNL project for Extreme Ultraviolet Lithography
End plates and a center ring allow the BPM to be held symmetrically.

BPM

BPM clamps

Center ring

End plate

BPM assembly attached to hexapod struts

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The solid metal flexure is the key to the design

- There are no joints in the assembly
  - Creates an extremely rigid structure
- Change in strut length from flexure allows limited range of adjustment in 6 degrees of freedom
Flexing allows limited adjustment of the BPM position in 6 dof

- Range of motion determined by maximum strain of the flexture
  - Hard limits prevent exceeding the limits
- LVDT provides readback of position
Hexapods are attached to an outer tube with motion adjustment.

First internal mode is at 200Hz
Assembly of the alignment frame has begun

- **Work done in 2003**
  - Designed and simulated the alignment frame
    - First vibrational mode at 200Hz
  - Procured all parts for the frame
  - Construction has begun

- **Work in 2004**
  - Finish frame assembly
  - Shaker table test
    - Confirm rigid body motion and vibrational modes
  - Install at ATF
  - Data taking
Outer tube is being characterized in the CMM machine
Assembly of struts has begun
### ASSEMBLY SCHEDULE

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Machine Assembly</td>
<td>49 days</td>
<td>Thu 10/23/03</td>
<td>Tue 1/13/04</td>
</tr>
<tr>
<td>2</td>
<td>BPM Mech. Charac.&amp; prgrming</td>
<td>7 days</td>
<td>Thu 10/23/03</td>
<td>Fri 10/31/03</td>
</tr>
<tr>
<td>3</td>
<td>Fixturing for assembly process</td>
<td>5 days</td>
<td>Thu 10/23/03</td>
<td>Wed 10/29/03</td>
</tr>
<tr>
<td>4</td>
<td>Asm &amp; test BPM struts, mtr., LVDT</td>
<td>14 days</td>
<td>Thu 10/30/03</td>
<td>Tue 11/18/03</td>
</tr>
<tr>
<td>5</td>
<td>SLAC to provide BPM strut mtr cntrl</td>
<td>0 days</td>
<td>Mon 10/27/03</td>
<td>Mon 10/27/03</td>
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<tr>
<td>6</td>
<td>SLAC to provide lateral heaters</td>
<td>0 days</td>
<td>Wed 11/19/03</td>
<td>Wed 11/19/03</td>
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<tr>
<td>7</td>
<td>Asm hexapods</td>
<td>10 days</td>
<td>Wed 11/19/03</td>
<td>Fri 12/5/03</td>
</tr>
<tr>
<td>8</td>
<td>SLAC to provide tube strut mtr cntrl</td>
<td>0 days</td>
<td>Mon 11/24/03</td>
<td>Mon 11/24/03</td>
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<tr>
<td>9</td>
<td>Assm hexapods into tube</td>
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<td>Mon 12/8/03</td>
<td>Fri 12/12/03</td>
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<td>10</td>
<td>Final align, BPM's into tube</td>
<td>5 days</td>
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<td>Fri 12/19/03</td>
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<td>11</td>
<td>Shaker Test</td>
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<td>Mon 12/29/03</td>
<td>Tue 1/6/04</td>
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<tr>
<td>12</td>
<td>Alignment check, attach bellows</td>
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<td>Wed 1/7/04</td>
<td>Tue 1/13/04</td>
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</tbody>
</table>

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The Shaker test will give us confidence in the system

- This idea depends on the BPMs being held as a rigid structure
- The Shaker test will let us know before installing at ATF if the frame will work
  - Each BPM will be instrumented with vibration sensor
  - We will confirm the rigid body motion
  - We will measure the resonant frequency of the fundamental mode and confirm the simulation
Alignment frame may be sufficient

- We expect that the BPMs will move on slow time scales due to thermal expansion
- If this is slow compared to the repetition rate of the ATF (<1nm / 10 bunches) it may be possible to correct offline

- We are designing a metrology frame to measure these motions
We reference to the outer ring instead of directly to the BPM

- There was no good place to attach a sensor reference
- Need to verify expected effect of thermal expansion
  - Since BPM is held symmetrically it should be ok
Outer support tube has access points for the sensors
Sensors with nm position resolution exist

- Optical grid with sub-nm position resolution has been purchased
- Design of carbon-fibre metrology frame to be done
- Needs detailed simulation and analysis if nm stability is to be achieved
Conclusion

• First priority – construction and delivery of alignment frame
  – Shaker test – January
  – Installation – February

• As time is available
  – Design of metrology frame
  – Procure prototypes and characterize