US Module Production Status

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for the
US CMS Silicon Tracker Group

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Covered in this talk

- US Group Evolution past year and upcoming year
- Status of all production equipment and manpower
- Making US production lines fully robust
  - Steps we have taken
  - What we still need from CMS at large
- Planning for upgrading production capacity further
Preparing for the mad rush

- Eventually we will get good parts in large quantities
  - Deliveries will not be smooth
  - Meeting the schedule will require
    - Higher than expected peak production rates
    - Extremely robust and stable production lines
    - Well trained personnel
- **Current proven capacity in US is 15 modules/day/site**
  - Further capacity expansions are possible
    - No further fabrication equipment needed and no expansion in test equipment required
    - Achieve by extending work day (split shifts) and/or adding support personnel to major production tasks
- Rates under study:
  - FNAL: 18/day sustainable and 21/d peak
  - UCSB: 21/d sustainable and 24-27/d peak
US CMS Tracker Group

- **Brown University**
  - R. Hooper, G. Landsberg, C. Nguyen, H. Nguyen
- **University of California, Riverside (UCR)**
  - P. Gartung, G. Hanson, G.Y. Jeng, G. Pasztor
- **University of California, Santa Barbara (UCSB)**
- **University of Illinois, Chicago (UIC)**
  - E. Chabalina, C. Gerber, L. Nigra, T. Ten
- **Fermilab (FNAL)**
  - M. Demarteau, A. Ronzhin, K. Sogut, L. Spiegel, S. Tkaczyk + technicians
- **University of Kansas (KU)**
  - P. Baringer, A. Bean, L. Christofek, D. Coppage
- **Mexican Consortium:**
  - Cinvestav: H. Castilla, R. Perez, A. Sanchez
  - Puebla: E. Medel, H. Salazar
  - San Luis Potosi: A. Morelos
- **University of Rochester (UR)**

19 joined group this past year (includes 3 UCSB technicians)

We are in the process of adding a few more post-docs & students

9 left or soon to leave the group (includes KSU and 2 UCSB technicians)

Manpower no longer a critical concern
### Assembly Plates

<table>
<thead>
<tr>
<th>UCSB Plates</th>
<th># Fabricated (parts made)</th>
<th># Commissioned (ready to be used)</th>
<th>plates used in module production so far</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOB R-phi</td>
<td>7</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>TOB Stereo</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>TEC R5 R-phi</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TEC R5 Stereo</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TEC R6</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>TEC R7*</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
<td><strong>19</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

- **FNAL TOB assembly plates (all used in production already)**
  - 5 r-phi
  - 3 stereo

**Total of 29 plates in the US**
<table>
<thead>
<tr>
<th>Task</th>
<th>Capacity</th>
<th>Manpower issues</th>
<th>Software Issues?</th>
<th>Hardware Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid Bonding &amp; Thermal Cycle</td>
<td>84/d</td>
<td>Mexico has only one experienced tech.</td>
<td>Recently resolved</td>
<td>No</td>
</tr>
<tr>
<td>Module Assembly</td>
<td>&gt;30/d</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Module Bonding</td>
<td>&gt;30/d</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ARC Testing</td>
<td>&gt;30/d</td>
<td>None</td>
<td>Finalizing</td>
<td>DEPP</td>
</tr>
<tr>
<td>LT Testing</td>
<td>200/wk</td>
<td>UCR Repair center</td>
<td>Finalizing</td>
<td>Yes</td>
</tr>
<tr>
<td>ARC LED</td>
<td>&gt;30/d</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Module Reinforcing</td>
<td>&gt;30/d</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Rod Assembly</td>
<td>&gt;4/d</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Single rod test</td>
<td>&gt;4/d</td>
<td>2 people to be added</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Multi-rod burn-in</td>
<td>32/wk</td>
<td>None</td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>
Hybrid Thermal Cycler/ARCS Status

From Tony’s talk in the testing meeting

- Recently upgraded to Bruno’s current code
  - PLL forcing
  - Drifting pedestal check
  - Added xml file auto-upload
- UCSB, FNAL and Mexico City thermal cycler are commissioned
  - Still have a few minor “features”
    - Single channel shorts, etc.

We have all ARCS equipment+spares we need
DAQ Equipment Status

- 2 fully equipped Vienna boxes
  - 1 slot in UCSB non-functional
- 2 single-rod stands
  - Missing TPO to use MUX
  - FNAL missing rod FEC
    - Can’t run 1-rod stand and rod thermal cycler
- 2 multi-rod thermal cyclers
  - Both MUXs have been used to test 5 rods simultaneously
  - Have enough equipment to fully commission system
    - Only 2 MUX cards + DAQ spares missing

- To instrument UCR Repair Center & have all critical spare components required in the US we need:
  - 2 TSC – in production?
  - 5 TPO – in production?
  - 5 rod FEC
    - Picking these up Friday
  - 1 eMUX crate – 1 week away?
  - 5 eMUX boards – “ “
  - 4 oMUX boards – “ “
  - 7 CCU
    - Pick up Friday
  - 10 VUTRI - ?
  - 10 PAACB – half are built, half being assembled now
  - 19 hybrid-to-utri adaptors - ?

From Tony’s talk in the testing meeting
DAQ Equipment Status II

• With current TPOs:
  • Cannot run single rod stands
  • With 1 failure we lose either:
    • 70% capacity of a Vienna box
    • 1 rod system
  • Cannot run more than 16 APVs in UCR stand

• Without additional MUX, CCU, VUTRI, PAACB, hybrid-to-utri adapter boards
  • Can’t run UCR LT which is crucial to ops of US Repair center

• With current TSC complement:
  • With 1 failure we lose either:
    • 1 Vienna box
    • 1 single rod stand, or
    • 1 rod thermal cycler

• Without additional hybrid-to-utri adaptors:
  • We cannot load Vienna box fast enough to run two cycles at either UCSB or FNAL.
  • Would have to go to sample cold testing during production

Component shortages and failures have potential to severely limit production testing capacity which can no longer afford
Backup Equipment

- Spare sensor and hybrid tools being produced at UCSB for UCSB, FNAL and Brussels.
- Upgraded OGP computer OS and OGP software
  - Automated routine occasionally missed fiducial marks. The new software fixes this problem.
- Setting up back-up gantry computers with spare U600 controllers and expansion cards already installed.
- Purchased backup components for every piece of production equipment or tooling that, if it were to fail, would cause a significant reduction in production.
UCSB TEC Production

• Miscellaneous info
  • 10 more shipping boxes (20 modules each) being made now
  • R7 plates ready for module production by end of August
  • Design for R7 module carrier and wirebond fixture is complete, started making 100 carriers: all complete within the next 2 weeks
  • All wirebond fixtures and 100 module carriers for R5 and R6 complete.

• General capacity issues
  • Could saturate our production capacity with TEC production
    • Actual rate will depend on need and availability of parts as well as TOB production parts availability and schedule
    • Another step higher in production capacity (by extending work day via overlapped shifts):
      • Bonding and Testing capacity adequate
      • LT testing capacity limit is ~100 per week but could eventually be mostly TEC if necessary (TOB burn-in shifted to rods) or sampled
• **DB stability**
  - For our production rates, we must automate all DB queries.
    - Need to standardize and maintain stable all data structures
  - We rely on data to be accurate and complete from all preceding processing of components and structures.

• **Old or un-installable components**
  - Prefer to remove them physically from our production sites and to have them properly marked in DB
Summary

• No longer have a manpower shortage
• Have studied all possible threats to production stability
  • Purchased or manufactured spares
  • Some test equipment still needed
• Studying further increases in capacity
• Systems status
  • All stages of production have been exercised and are or are near to being finalized except rod testing
  • Multi-rod stands still have substantial work ahead
    • Testing protocols are very preliminary
    • Software has made huge progress but is very fresh and evolving
    • Full coordination of multi-rod daq and chiller systems still to be commissioned