The Impact of Machine Protection on Accelerator Reliability and Beam Availability

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www.europeanspallationsource.se
Accelerator Reliability Workshop, 2015
• Reliability = $e^{-\lambda t}$

• Availability = MTBF / (MTBF+MDT)
Damage

\[ \mu s \]

- Proton Beam Monitoring Systems
- Local Protection and Beam Permit Systems Accelerator Segment
- Local Protection and Beam Permit Systems Target Segment
- Local Protection and Beam Permit Systems Neutron Science Segment

Beam Interlock System

Beam Switch-Off Actuation Systems

Proton Beam State

Christian Hilbes, 2015
Synchrotrons:
Reliability $\propto$ Availability

Linacs:
Reliability $\propto$ Availability
<table>
<thead>
<tr>
<th>System</th>
<th>prediction 2005</th>
<th>observation 2010</th>
<th>observation 2011</th>
<th>observation 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBDS</td>
<td>$6.8 \pm 3.6$</td>
<td>9</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>BIS</td>
<td>$0.5 \pm 0.5$</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>BLM</td>
<td>$17.0 \pm 4.0$</td>
<td>0</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>PIC</td>
<td>$1.5 \pm 1.2$</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>QPS</td>
<td>$15.8 \pm 3.9$</td>
<td>24</td>
<td>48</td>
<td>56</td>
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<td>SIS</td>
<td>not studied</td>
<td>4</td>
<td>2</td>
<td>4</td>
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</table>
Signal

Computer Control System

MPS Action
E-logbook

Post-mortem
Energy Power Problems
PLEASE TELL ME THEY'RE NOT MAKING BROTH
REDUNDANCY
Just in case you're totally oblivious.
Conclusions

- Removing beam
- Relation between reliability and availability
  - Storage Rings
  - Linacs
- Rigorous analyses help
- Unexpected faults
  - UFOs at LHC
  - Integrated losses at SNS
- Redundancy

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“Simplicity is the ultimate sophistication.” — Leonardo da Vinci
Thank you!

ESS, April 10
References

Papers etc.

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Water on road: https://f-media-cache.ak0.pinimg.com/736x/68/23/b9/6823b902d6b499ddec2c0b7fcdc582c8.jpg
Logbook: https://lns6.gapght.com/9dxKiAMxM03CeXyLH19zW6AsPMR3JN4mBMS1zETDqPqMK7xgaZKh8qQKVYv4w300.png
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