RF bypasses in the PS

J. Bento, H. Damerau

- Isolated vacuum flanges (~ 200) to avoid ground loops and the associated field perturbation (~2.3 T/s)
- **New problem:** Each of the isolated flanges + ground loop forms a resonator (\(f_{\text{res}} \approx 1.5\) MHz, \(Q \approx 1\))

→ **Solution:** RF bypass to reduce impedance and resonance frequency of parasitic resonator
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![Graphs showing impedance and frequency response before and after RF bypass](image.png)
RF bypasses: damped coupling capacitors

Schematics:

- Inventory:
  - ~ 150 normal bypasses installed
  - ~ 45 short circuits on isolated SS
  - ~ 5 old pince-type bypasses
- Installed on the outside of the flanges
- Checked during each (E)YETS by J. Bento (BE-RF-FB)
Beam measurements (2009)

Bypass behaves like wall current monitor with ~1 Ω resistance
Beam measurements (2009)

- RF voltage of more than 100 V during TOF ejection
- **BUT:** Bunches only ~ 20 ns long! Moderate average power

Average power over one turn:

\[ P = N_b \cdot \frac{R}{T_{rev}} \frac{N^2 e^2}{2\sqrt{\pi} \sigma_T} \]

(Short Gaussian bunch approximation)

- Average power < 10 W, even for a super-cycle full of TOF (AD similar)
- More power on CNGS: ~ 10 W (less peak voltage more bunches)
- Less for other beams
### Summary

#### Estimated maximum power per turn (at extraction)

<table>
<thead>
<tr>
<th></th>
<th>$N_b$</th>
<th>$N_{\text{ppb}}$</th>
<th>$4\sigma$ [ns]</th>
<th>$P_{\text{max}}$ [W]</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHC25ns (operational)</td>
<td>72</td>
<td>$1.3 \cdot 10^{11}$</td>
<td>4</td>
<td>4</td>
<td>Low average power</td>
</tr>
<tr>
<td>LHC25ns (LIU)</td>
<td>72</td>
<td>$2.6 \cdot 10^{11}$</td>
<td>4</td>
<td>17</td>
<td>Average power &lt; 10 W</td>
</tr>
<tr>
<td>AD</td>
<td>4</td>
<td>$3.8 \cdot 10^{12}$</td>
<td>30</td>
<td>26</td>
<td>Average power &lt; 10 W</td>
</tr>
<tr>
<td>TOF (operational)</td>
<td>1</td>
<td>$8 \cdot 10^{12}$</td>
<td>20</td>
<td>44</td>
<td>Average power &lt; 10 W</td>
</tr>
<tr>
<td>Worst case with 2 GeV</td>
<td>4</td>
<td>$1.3 \cdot 10^{13}$</td>
<td>20</td>
<td>~400</td>
<td>Average power ~ 60 W</td>
</tr>
</tbody>
</table>

→ RF bypasses checked every (E)YETS, **no resistor failure since 2009**
  - SS48 vacuum leak most probably due to bad contact of ‘pince’ type RF bypass
→ Additional **series of spares in production, integrated design**
→ Present RF bypasses expected to be **compatible with LHC-type beams after LIU upgrades**
→ Possibly **new bypasses for higher-intensity fixed-target beams**