Gun conditioning at PITZ.

PITZ gun
Conditioning procedure
Momentum and gradient of the Gun
History of the Gun 4.4 operation at PITZ
Interlock statistics
Dark current measurements
Cathodes
Summary

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The PITZ RF Photo Gun

The RF photo gun operates with a standing wave regime in the π-mode with resonant frequency of 1.3 GHz

The gun consists of:
- normal-conducting cavity (1.6 copper cells)
- exchangeable molybdenum cathode with CuBe contact spring
- pair of solenoids

Main parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Accelerating gradient at the cathode, MV/m</td>
<td>60</td>
</tr>
<tr>
<td>Beam energy after gun, MeV</td>
<td>~6.5</td>
</tr>
<tr>
<td>Full RF power, MW</td>
<td>6.5</td>
</tr>
<tr>
<td>Number of bunches</td>
<td>1..600</td>
</tr>
<tr>
<td>RF pulse, µs</td>
<td>≤650</td>
</tr>
<tr>
<td>Repetition rate, Hz</td>
<td>10</td>
</tr>
</tbody>
</table>
Conditioning steps:
1. Rep. Rate. 5 Hz, RF pulse length 10 µs, RF power from 0 to Max
2. Rep. Rate. 5 Hz, RF pulse length 20 µs, RF power from 0 to Max
3. Rep. Rate. 5 Hz, RF pulse length 50 µs, RF power from 0 to Max
4. Rep. Rate. 5 Hz, RF pulse length 100 µs, RF power from 0 to Max
5. A) Rep. Rate. 10 Hz, RF pulse length 10 µs, RF power from 0 to Max
   B) Rep. Rate. 10 Hz, RF pulse length 50 µs, RF power from 0 to Max
6. Rep. Rate. 10 Hz, RF pulse length 100 µs, RF power from 0 to Max
7. Rep. Rate. 10 Hz, RF pulse length 200 µs, RF power from 0 to Max
8. Rep. Rate. 10 Hz, RF pulse length 400 µs, RF power from 0 to Max
9. Rep. Rate. 10 Hz, RF pulse length 650 µs, RF power from 0 to Max

Ramp-up procedure:
• RF power increase by steps of max 0.2 MW every 15 min. for new RF pulse length
• vacuum pressure < 10⁻⁷ mbar (Thales requirement).
• In case of significant vacuum or other trips:
  • re-ramp RF power from 0 with short pulses (10µs)
  • restart with step 1 or step 5 respectively
  • increase the pulse length in reasonable steps
• Initially, the rf gun solenoid is off (than sweep).
• Only FF, no FB.
Momentum and gradient of the Gun 4.4

**Field profile fit**

\[ P_{\text{gun}}[\text{MW}] = 0.0018 \times (E_{\text{cat}}h[\frac{MV}{m}])^2 \]

60 \( \frac{MV}{m} \) → 6.5 MW

**Conditioning Goal:**
10Hz x 650us x 6.5MW
with solenoid

**Conditioning Milestone:**
24h unperturbed run at Goal + I_{main}=390A

**Power in the gun, MW (5MW coupler)**

<table>
<thead>
<tr>
<th>Power (MW)</th>
<th>Beam momentum, MeV/c</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.46</td>
<td>3.390</td>
</tr>
<tr>
<td>3.00</td>
<td>4.704</td>
</tr>
<tr>
<td>4.53</td>
<td>5.678</td>
</tr>
<tr>
<td>6.47</td>
<td>6.657</td>
</tr>
</tbody>
</table>

**Beam momentum, MeV/c**
Gun 4.4 run history from 08.10.2013 until 23.03.2014

- Repetition rate was changed from 5Hz to 10Hz
- End of the conditioning and beginning of gun tests
Guns 4.3 and 4.4 conditioning history

Power in the gun

- RF pulse length
- Main solenoid current

Gun 4.3

1st time reached maximum peak power
1st time reached maximum pulse length
1st time started operation with solenoid

Gun 4.4
Gun 4.4 interlock statistics

Statistics for all run time

Statistics for different run periods

- Conditioning at 5 Hz
- Conditioning at 10 Hz before solenoid was switched on
- Conditioning at 10 Hz after solenoid was switched on
- Operation at 10 Hz with solenoid
Dark current measurements

Dark current at LOW.FC1 (Pgun=6.5MW, 200us) @ 0A

- p-2-p
- amplitude

Max dark current, nA

Power in the gun, MW

Gun 4.3

Graphs showing dark current measurements

Dark current at LOW.FC1 (Pgun=6.5MW, 200us) @ Maximum

- p-2-p
- amplitude

Maximum dark current vs. power in gun (200us)

Gun 4.4

Graphs showing dark current measurements

Power in gun (MW)
Cathodes

126.2 Cs$_2$Te

636.1 Mo

633.1 Mo

638.1 Mo

640.1 Cs$_2$Te

Photoelectron and DC beams at High1.Scr1
No booster
LT = 6%
I main = 326A
Summary

- Gun 4.4 was conditioned and could be operated
- Gun 4.4 showed good progress in the conditioning process
- Dark current values are the same as for the gun 4.3
- Cathode damages were observed during operation of the gun
Thank you for your attention.
Mo cathodes observation

- Extracted cathode (636.1) was in upright (azimuthally) position
- There are a lot of marks on the side surfaces
- No damages/spots observed at the front surface
Examples of the Gun IL events
1st event - normal run

2nd event - spike on the refl. power in both waveguides at the middle of the pulse + PMT and e-detector activity

3rd event - normal run

4th event - shortening of the pulse and lls

5th event - preamplifier off