Photoelectron beam asymmetry studies at PITZ: Motivation and simulations.

The photoelectron gun designed to be rotationally symmetric but the observed beam has azimuthal asymmetry:

### Parameter Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. accelerating gradient at the cathode, MV/m</td>
<td>60</td>
</tr>
<tr>
<td>Frequency, MHz</td>
<td>1300</td>
</tr>
<tr>
<td>Unloaded quality factor</td>
<td>~20000</td>
</tr>
<tr>
<td>Beam momentum after gun, MeV/c</td>
<td>7</td>
</tr>
<tr>
<td>RF peak power, MW</td>
<td>6.5</td>
</tr>
<tr>
<td>RF pulse duration, µs</td>
<td>≤650</td>
</tr>
<tr>
<td>Repetition rate, Hz</td>
<td>10</td>
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</tbody>
</table>

Also there was found that the simulated optimum machine parameters do not coincide with experimental data:

Possible origins of e-beam asymmetry:
- Vacuum mirror (checked: not a reason)
- One side RF feed
- Solenoid imperfections

Check by simulations:
- Particle tracking simulations:
  - RF field simulations: There is an RF field asymmetry and has an influence on the beam
**Gun quadrupoles**

**Experiment with two main solenoid polarities**
(Larmor angle experiment)

 Beam at the screen for normal polarity of the main solenoid

 Beam at the screen for opposite polarity of the main solenoid

The most probable place of the beam asymmetry origin

α – beam Larmor angle without beam distortion
β – Larmor angle of the distorted beam

**Gun quad design**

1\(^{\text{st}}\) iteration of the quad design (4 coils)

2\(^{\text{nd}}\) design of the quad (8 coils)

**Parameters of the 2\(^{\text{nd}}\) quad design:**
- Combination of a normal and a skew quads:
  - Gun.Q1 is the normal quad
  - Gun.Q2 is the skew quad
- Aluminum frame
- 0.56 mm copper cable
- 140 windings per coil
- 2 thermal switchers (80 degC max)
- Non-magnetic screws
- Fixed by radiation-hard cable tie
- \(Q_{\text{grad}} = 0.0117 \ \text{T/m @ 1A}\)

**Beam shape simulations by a rotational quadrupole**

1. the kick optics can be modeled as a rotated quadrupole
2. a rotated quadrupole near the coupler is effective at compensating for the kick, cancelling both the coupler emittance and the astigmatic focusing.

I \(\text{main} = -361\) A

I \(\text{main} = +361\) A

**Experiments with the gun quads**

Experiments with the gun quads:

- Sol.pol. = Positive
- Sol.pol. = Negative

Sim. with Gun Quads: Gun Q1 = -0.6A Gun.Q2 = -0.5A

"rounder" and smaller emittance!

"rounder" beam

Igor Isaev | Photoelectron beam asymmetry studies at PITZ | ST3 workshop