QSRAD meets LIAR-DIMAD

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Outline

- The QSRAD code for calculating SR
  - what the code does
  - apertures and masks
  - approximations in the code
- Compare results of Stand-Alone calculation with the new code in Liar-Dimad
  - Number of photons and average energies
  - Energy distributions
- Summary of status and next steps
Previous SR Calculations

- QSRAD code written by Al Clark for PEP-I to design MDI and masking for TPC
  - Descendent used by Mark-II & SLD at SLC
  - BaBar at PEP-II used another descendent
  - All use same core code (perhaps also JLC)
- QSRAD does not follow individual photons
  - Calculates an “average” photon in a SR fan
  - OK; not interested in quantum fluctuations
- Follows weighted macroparticles on a grid
- Resulting code samples beam tails well, and runs fast; typically run $10^4$ to $10^6$ particles
More about QSRAD

- Optics initially only included quads
  - Now has skew quads, bends, corrector kicks, and magnet offsets in position and angle
  - Does not have higher order multipoles
- Does not have energy spread
- Considered adding additional optical elements
- But prefer to interface core code to standard optics code, and use all standard inputs
- Working on interface to Matlab-Liar-Dimad
- Thanks to Linda Hendrickson for her help!
SR Calculations

- SR calculated from $E_b$, $L$, $\theta$ (had used $B$)
- Tabulate $N_\gamma$ and critical energy of SR photons incident on areas of interest
- For each surface, compiles a histogram of $k_c$, and expands bins in SR distribution at end
- Compile a variety of information
  - which magnet did the SR come from?
  - which part of beam did SR come from?
  - Spatial and angular distributions of SR
  - ...

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Apertures and “Masks”

- The mask file defines a series of ellipses
  - these define annular regions, cylinders, cones
  - masks, apertures, and beam pipes
- Masks are opaque, and scattered SR is not followed in this code
- In results here, use:
  - 1 cm steps from 10 cm to 1 cm radius
  - 1 mm steps from 1 cm to 0.1 cm radius
  - all at S = 0 (IP)
SR Transmitted by Aperture

- Critical energy and number of photons calculated from $E_b$, $L$, $\theta$.
- Fraction of photons transmitted calculated from lengths of line segments $AB$ and $CB$.
- No. photons transmitted = $(CB/AB) \times N_\gamma$
Approximations

- In effect, use an average magnetic field for each particle traversing each magnet
- Ignore SR out of the bend plane
  - negligible effect if angular spread in beam is larger than $1/\gamma \sim 2 \mu \text{rad}$ at 250 GeV
  - out of plane radiation can be added
- Energy distributions are not a pure single-energy SR distribution
  - compile the actual energy distribution
  - also quote a critical energy based on fraction of SR < 10 keV
EFFH_250 Lattice

- Calculations done with EFFH_250 lattice
  - Pantaleo FF with $L^* = 4.3\ m$
  - no sextupoles or octupoles used in Stand-Alone calculation
  - turned off sextupoles and octupoles in DIMAD (at least attempted to)
- For testing, place mask planes at IP,
  - 1 mm rings out to 1 cm radius
  - then 1 cm rings
### IP Parameters

- Parameters resulting from Dimad runs, and input to Stand-Alone run

<table>
<thead>
<tr>
<th></th>
<th>Stand-Alone</th>
<th>Sext &amp; OCT OFF</th>
<th>Sext &amp; OCT ON</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IP S(x,y)</strong></td>
<td>0.0</td>
<td>0.275 (\mu)m 2.211 nm</td>
<td>0.275 (\mu)m 2.196 nm</td>
</tr>
<tr>
<td><strong>IP S'(x,y)</strong></td>
<td>22.814 (\mu)rad 18.553 (\mu)rad</td>
<td>22.813 (\mu)rad 18.560 (\mu)rad</td>
<td>22.814 (\mu)rad 18.553 (\mu)rad</td>
</tr>
<tr>
<td><strong>Espread</strong></td>
<td>0.0</td>
<td>0.6 keV</td>
<td>0.6 keV</td>
</tr>
</tbody>
</table>
Compare Results of Standalone & Dimad Versions

Number & Energy of Incident Photons

- SR at large radii is from QF3 and QD2
- SR at small radius is from QF1 and QD0
Pretty good agreement between SA and Sext-OFF
Disagreement with Sext-ON grows with energy
I might be doing something wrong in DIMAD!
Compare Results
Energy Distributions

- **Mask 22:** Sext-ON & Sext-OFF are nearly the same, but S-A is uniformly higher by about 30 %
- **Mask 23:** All three spectra are in good agreement

Test Masks: Mask #22, 0.3 > R > 0.2 cm

Test Masks: Mask #23, 0.2 > R > 0.1 cm
Conclusions

- Reasonable agreement between Stand-Alone QSRAD and the DIMAD result
- DIMAD results have sharper cutoffs of SR, Perhaps related to sampling of distribution tails; better in Stand-Alone
- Need to understand DIMAD sampling
- Did not expect more SR when Sext & Oct turned on; need to understand this
To-Do List

- Get help with DIMAD!
- Study discrepancies and surprises
- Move to current lattice, and compare with Takshi
- Send output to Matlab
- Clean up code
- Draw the pictures everyone likes to see