QSRAD meets MATLAB-LIAR-DIMAD

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Outline

- The QSRAD code for calculating SR
- Interfacing QSRAD with Matlab-Liar-Dimad
- Preliminary validation -
  - Compare results with QSRAD Stand-Alone calculation
  - Compare SR with Octupoles on and off
- Summary
QSRAD

- QSRAD dates from PEP-I & TPC (Al Clark)
  - Descendents used by Mark-II & SLD at SLC, and by BaBar at PEP-II
- Tracks weighted macroparticles on a grid.
- Does not follow individual photons
  - Calculates an “average” photon in a “SR fan”
  - OK; not interested in quantum fluctuations
- Resulting code samples beam tails well, and avoids problems of low photon statistics, both important for SR backgrounds
QSRAD Limitations ...

- Optics does not have sextupoles or octupoles
- Does not have energy spread
- Does not have collective effects
- Would like to understand how SR background, i.e., collimation requirement, is affected by ground motion and other perturbations

SO ...
Interfacing with Matlab-Liar-Dimad

- Now interfacing QSRAD code to Matlab-Liar-Dimad tracking
- Core QSRAD code reorganized to use same subroutines in “stand-alone” and Matlab env.
- Essentially done, cleanup to be done
- But there are still hurdles, e.g., absence of collimation in this version of Dimad
- Linda Hendrickson crucial for the interface!
QSRAD SR Calculations

- Calculate number of photons and critical energy from $E_b, L, \theta$.
- Calculate fraction of photons transmitted from lengths of line segments AB and CB.
- No. photons incident on annulus = $(1-f) \times N_\gamma$
SR Calculations

- “Mask” file uses a series of ellipses (& slits) to define annular regions, cylinders, & cones
  ⇒ mask, aperture, & beam pipe scoring planes
- For regions of interest compile:
  - $N_\gamma$ and energy distribution of incident SR
  - Where the SR came from:
    - which magnet(s)?
    - which part of beam?
  - Spatial and angular distributions of SR
- Masks, etc. are “black”; just absorb photons
  - Distributions can be input to Geant, etc.
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 $1/\gamma \sim 2 \text{ } \mu\text{rad}$ 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
Lattice & Scoring Planes Used

- Calculations done with $L^* = 4.3$ m Pantaleo FF
  - Turned off sext and oct in DIMAD
  - Reduced energy spread in DIMAD
  - Look at SR from just 4 quads closest to IP

- For testing, place mask planes at IP,
  - 1 mm rings out to 1 cm radius
  - then 1 cm rings
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 (FD)

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Compare Results (2)
Energy Distributions

- Pretty good agreement between S-A and Sext-OFF
- See a slightly harder SR spectrum for Sext-ON
- 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.
Observations

- Reasonable agreement between Stand-Alone QSRAD and the DIMAD result
- DIMAD results have sharper spatial cutoffs of SR.
  - Perhaps related to different sampling of distribution tails; better in Stand-Alone(?)
  - Need to understand DIMAD sampling better
- Did not expect more SR with Sext & Oct on
  - Look in more detail at DIMAD calculations
Comparing DIMAD Calculations with Octupoles Off & On

- Same lattice and same mask file
- Increase emittances by factor of 100
- Look at SR from final doublet only
  - Also looked at SR from sextupoles separately
Compare Octupole Off & On

SR density at S=0 from FD (Quad, Sext, & Oct) with Sext & Oct OFF (left) and ON (right), log scale
Compare Oct. Off & On (2)

Particle density (log scale) at QD0 exit with Sext & Oct OFF (left) and ON (right)
Compare Oct. Off & On (3)

Particle density at IP, extrapolated from QD0, with Sext & Oct OFF (left) and ON (right)
Summary

- Interfaced code appears to be working OK
- Still some differences to understand
- Validation: compare with Takshi and Sasha
  - Move to current TRC lattice, L*=3.51 m
  - Need ability to simulate collimation
- Clean up code
- Improve output interface with Matlab
- The combined tools should allow studies of:
  - Variation of SR with machine perturbations
  - Extraction line energy spectrometer