Outline of Simulation Strategy

- Goals & priorities
- Turtle-level studies
- GEANT-level simulation
- Confronting simulations with data

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Background simulations: why?

- **2 themes...**
  - validate IR upgrade design (overarching priority)
    - make sure that what we install in ’05 does not suffer from built-in flaws...
    - ...at least for those processes we can calculate (SR, beam-gas)
  - understand / improve backgrounds in present machine

- **...that are intimately intertwined**
  - validation requires credibility
    - update “old” simulations to incorporate what we learnt
    - simulations of present machine/detector configuration better get the ‘right’ answer (when confronted with measurements)...
    - ...if we want to believe predictions for the upgraded IR
  - improve those backgrounds we canNOT calculate
    - both for today’s and for tomorrow’s sake!

- **Essential that the SVT community be (even more) deeply involved in this effort!**
Architecture of background simulations (1)

- **Synchrotron Radiation**
  - MAGBENDS / QSRAD: stand-alone programs
  - SR background calculations: an intrinsic component of IR re-design
  - shouldn’t these be interfaced to GEANT?

- **Beam-gas**
  - step 1: LP-TURTLE transports particles around 1 ring turn
    - full model of ring optics (treated as transport line)
    - start with ‘nominal’ beam at IP
    - beam-gas scattering randomly around ring (bremsstrahlung or Coulomb scattering) \( \rightarrow \) transport ‘secondaries’ (\( \varepsilon' \), \( \gamma \))
    - simplified model of IR apertures (simple geometry, no showering!)
    - those particles lost ‘near’ the IP are
      - saved @ scoring plane
      - input to step 2
  - step 2: full GEANT simulation of detector + near-IR (+- 8.5 m)
    - see Mario Bondioli’s talk
Lost-particle backgrounds

- Coulomb scattering in Arcs (y-plane)
- e⁻ Bremsstrahlung in last 26 m (x-plane)

Normalized to:
- uniform pressure profile of 1 nT
- 1 A beam current
The “Background Zones” reflect the combined effect of:

- beam-line geometry (e.g. bends)
- optics at the source and at the detector
- aperture restrictions, both distant (good!) & close-by (bad!)

**Zone 1**

*Bremsstrahlung in field-free region*

**Zone 2**

**Bremsstrahlung**

**Zone 3**

*Bremsstrahlung in Arcs*

**Zone 4**

*Coulomb scattering in Arcs*
Benchmarking of simulations: comparing “predicted” and measured background levels

- **Radiation patterns**
  - for a given sensor type: independent of absolute calibration
  - among different sensors: compare fractional derivatives

- **Absolute background levels**
  - sensor calibration!
  - absolute pressure profile!

- **Global consistency/sanity checks**
  - operational experience in MCC
Pressure-bump experiment: NEG heating in BaBar straight

- Create localized P-bumps
  - NEG heating
  - DIPS on/off
- Measure response of background monitors
- Compare relative measured & simulated monitor response to validate Monte Carlo

Abort diode signal (mR/s)

Heated NEG at -60 m

Different regions

- diff. patterns
- diff. abs. levels

Heated NEG at -8 m
Understanding the absolute level of HER backgrounds (Sep 99)

Compare measured & predicted dose rates in HER:

- Monte Carlo lost-particle simulation (Turtle + BBSIM) validated by p-bump experiments
- Computed pressure profile in detector straight section (N₂-equivalent, not vac.-gauge units!)
- Average ring pressure (from lifetime) for arcs & distant straights

<table>
<thead>
<tr>
<th>HER pressure model</th>
<th>Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td>Range (m)</td>
<td></td>
<td>4 to 26</td>
<td>26 to 42</td>
<td>42 to 66</td>
<td>66-2200</td>
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<td>P_base (nT)</td>
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<td>0.5</td>
<td>0.5</td>
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<td>P_dyn (nT)</td>
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<td>2.8</td>
<td>1.2</td>
<td>6.8</td>
<td>3.4</td>
</tr>
</tbody>
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BW diode: measured vs. predicted background

Abort diodes: msv/predicted HER background ratio (400 mA)
Architecture of background simulations (2)

- **Beam-beam**
  - full simulation of beam-beam tails impractical
  - focus on collimation studies
    - optimize collimator placement/relocation (SM)
    - understand main characteristics of collimator secondaries (HB)
    - provide guidance for machine experiments
  - use Turtle machinery

- **Strategy considerations**
  - improve/update description of magnetic fields & apertures (TF, GC)
  - many fundamental features easier to understand at Turtle level
    - first round of IR-upgrade design validation will be done this way (RB)
  - GEANT-level simulation essential (MB, GB, GC)
    - to benchmark computations against data
    - to make sure there are no “alligators” hiding in new design
  - absolute background predictions always suspect
    - even when benchmarked against experiments. However...
    - ...ratios (new design / present machine) much more reliable.