

FastSim Status

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FastSim Improvements

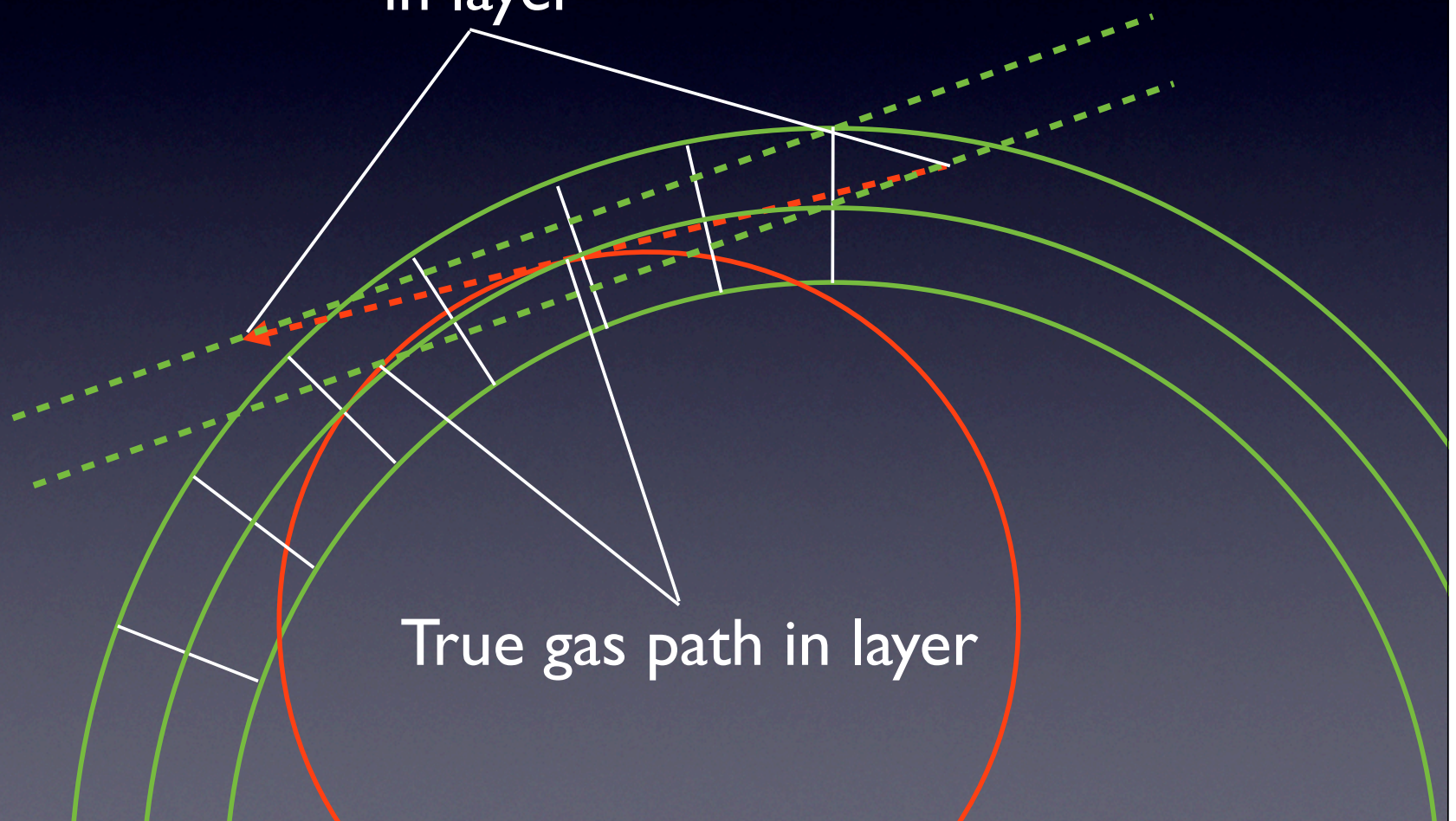
- Looper hits
- Multiple-scattering simulation and tracking
- Bremsstrahlung fix
- DCH hit merging model

Looper Problems

- FastSim models DC layers as cylinders
 - Hits generated as particle crosses fixed radius
 - Intersections computed using 1st order calculation
- Loopers pass parallel to layers at apogee
 - single hit generated when many cells traversed
 - material can be overestimated
- FastSim fixes
 - Intersections computed using 2nd order calculation
 - # Hits generated = # cells crossed
 - $N_{\text{hits}} \cong \text{pathlength}/\text{cellsize} + 1$

Top-of-arc

Linear estimate of gas path
in layer



True gas path in layer

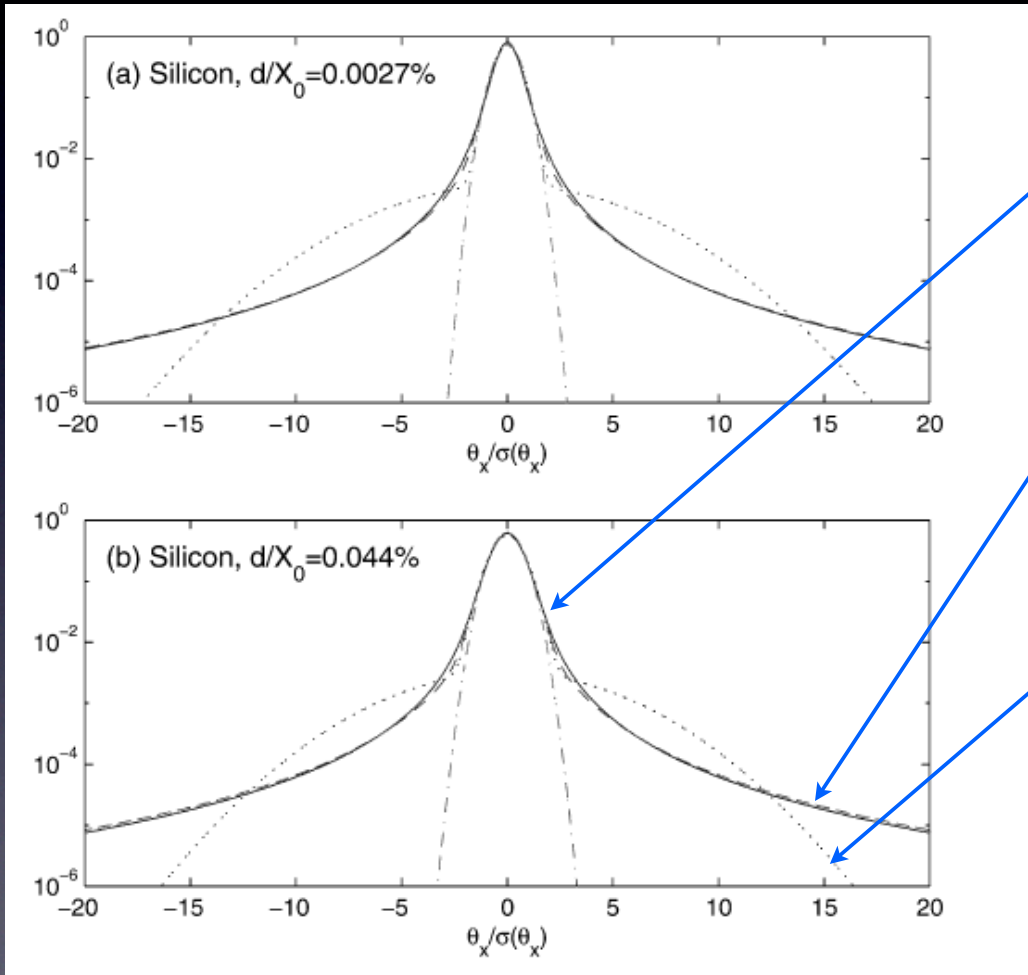
Multiple Scattering Issue

- PDG $\theta_0 = \frac{13.6 \text{ MeV}}{\beta_{cp}} z \sqrt{x/X_0} \left[1 + 0.038 \ln(x/X_0) \right]$
 - Describes Gaussian approximation to 98% core
 - Used for Crude FastSim Scattering model
 - Double Gaussian, 2% tail with $\sigma = 10X$ nominal
 - Truncated PDG RMS formula for Kalman fit σ
 - Log term fixed to $x/X_0 = 1.6\%$
 - Rough consistency between Sim and Reco

Better Scattering Model

- Computer Physics Communications 141 (2001) 230, R. Fruhwirth, M. Liendl, “Mixture models of multiple scattering: computation and simulation”
- Mixture model of Moliere scattering using:
 - Convolution of single scatters ($N_{scat} < 100$)
 - Gaussian + ArcCos(theta) tail ($x/X_0 < 0.1$)
 - Double Gaussian ($x/X_0 < 10$)
 - Parameters fit to polynomials
- Efficient MC generation code

CPC141



Convolution of single
scatters (solid)

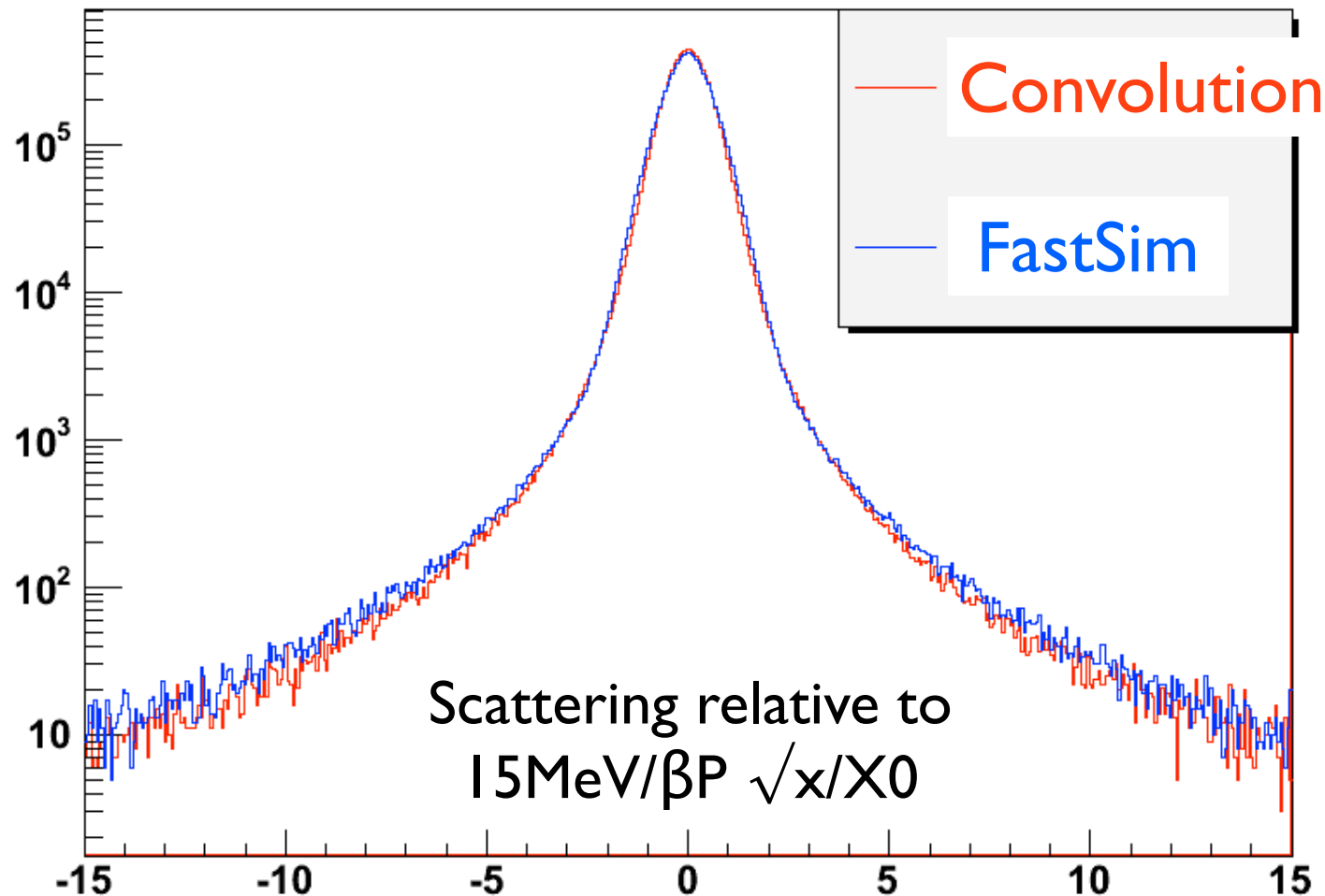
Gaussian + ArcCos
(dash)

Double Gaussian

Scattering relative to
 $15\text{MeV}/\beta P \sqrt{x/X_0}$

Implemented in FastSim

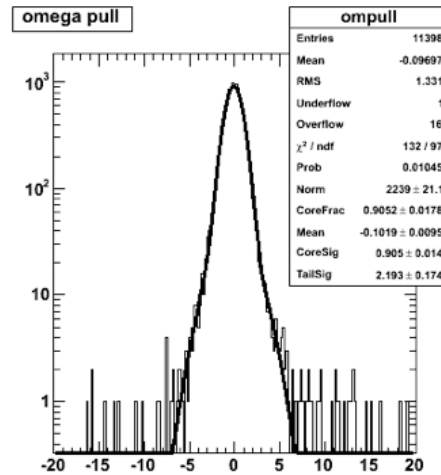
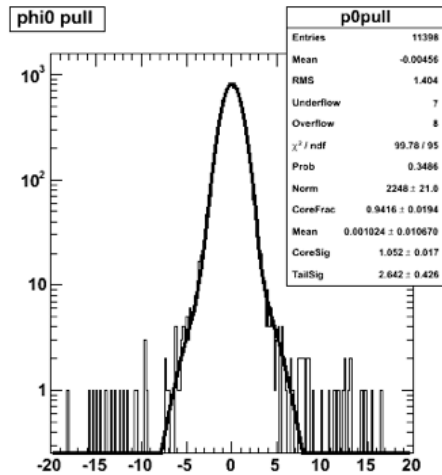
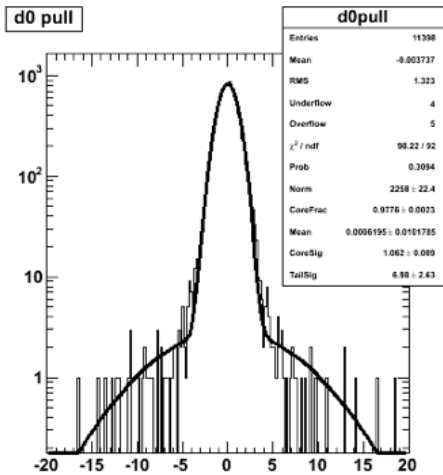
Normalized scattering angle



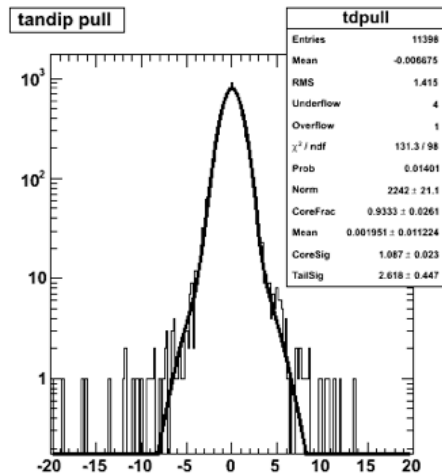
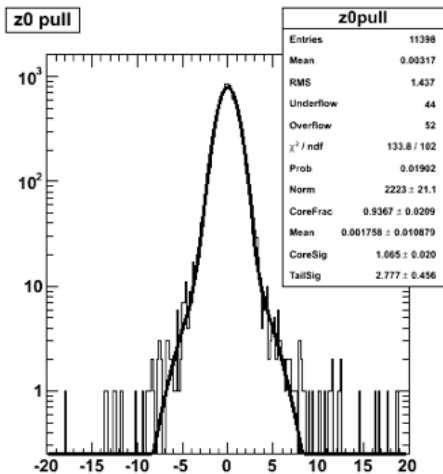
Kalman Fit Scattering

- KF requires a single σ to model scattering
 - truncated approximation to Moliere scattering
 - PDG formula not adequate after sim improvements
- NIMB 58 (1991) 6-10 (Lynch, Dahl)
 - Source of “PDG” formula and description
 - Also better approximation based on $\langle \# \text{ of scatters} \rangle$
 - accurate to 2%, $x/X_0 > 10^{-3}$
 - Tunable parameter F = tail truncation factor
- Now Implemented in Kalman filter fit
 - Caveat: Z_{eff} and A_{eff} gives wrong (linear) weighting

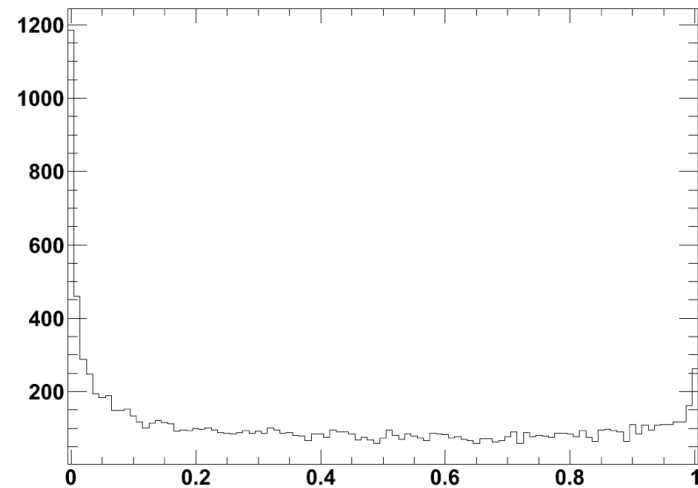
FastSim Kalman Fit



Realistic
pulls,
fit
consistency



Fit Consistency



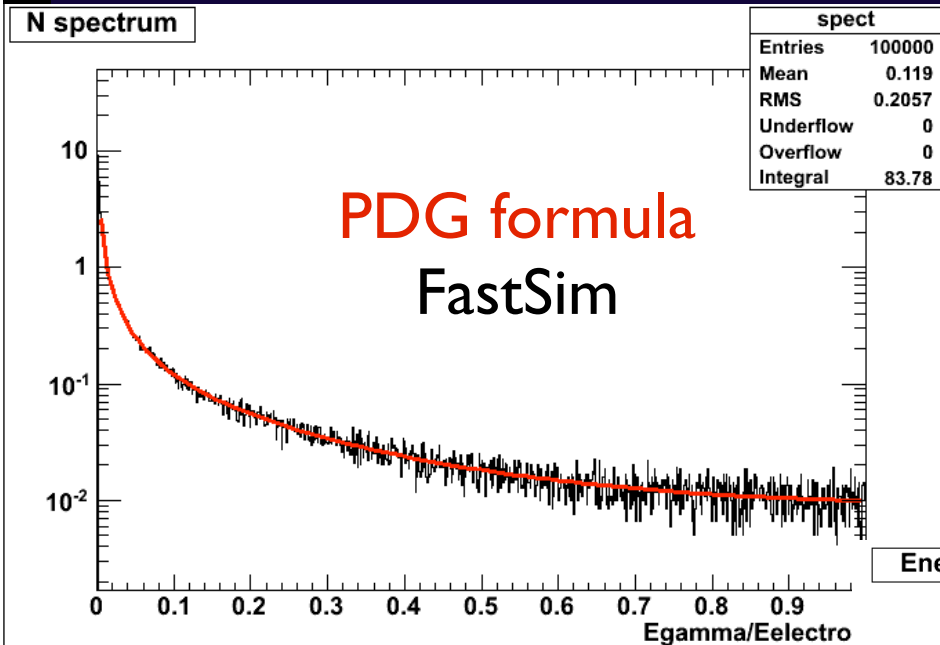
Bremsstrahlung in FastSim

- 2010 code had a serious bug
 - # of Brems photons under-estimated
 - electron energy loss under-estimated
- (New) FastSim model based on PDG formula

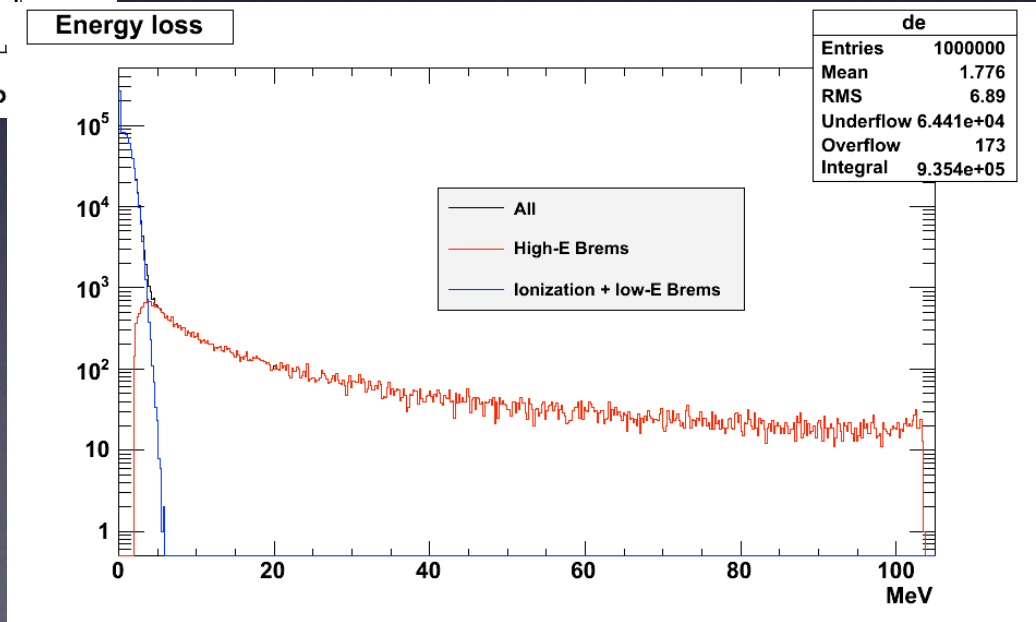
$$N_{\gamma} = \frac{d}{X_0} \left[\frac{4}{3} \ln \left(\frac{k_{\max}}{k_{\min}} \right) - \frac{4(k_{\max} - k_{\min})}{3E} + \frac{(k_{\max} - k_{\min})^2}{2E^2} \right]$$

- $k = E_{\gamma}$, $E = E_e$, $d \ll X_0$
- Brems energy lost in every e material passage
 - Only 'high-E' photons become particles
 - energy loss from integrated low-E photons modeled

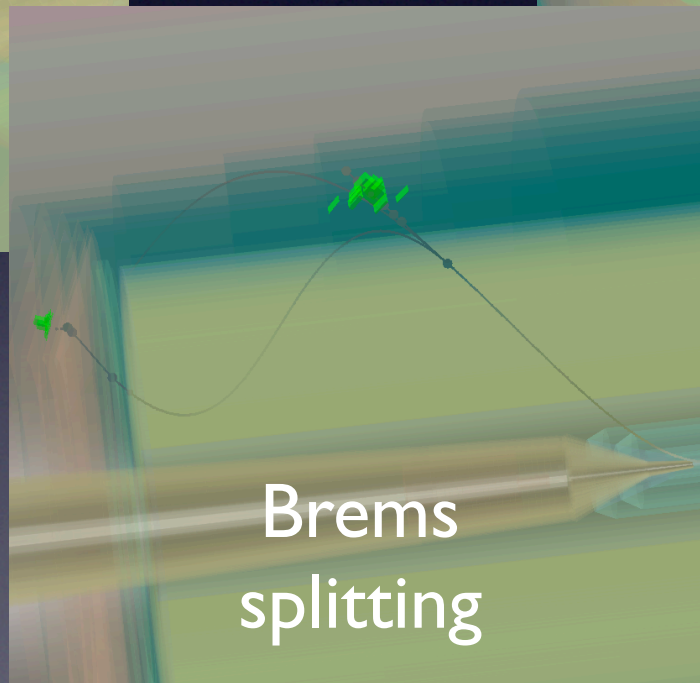
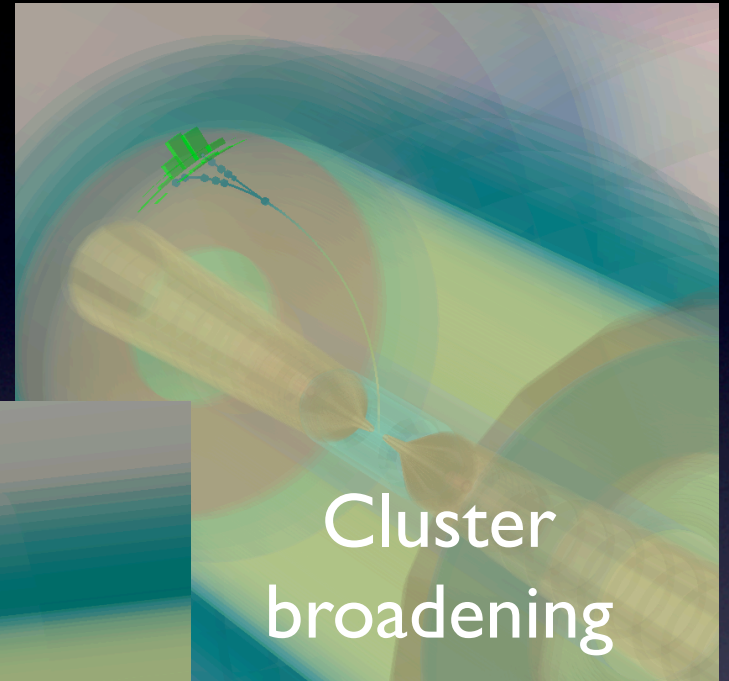
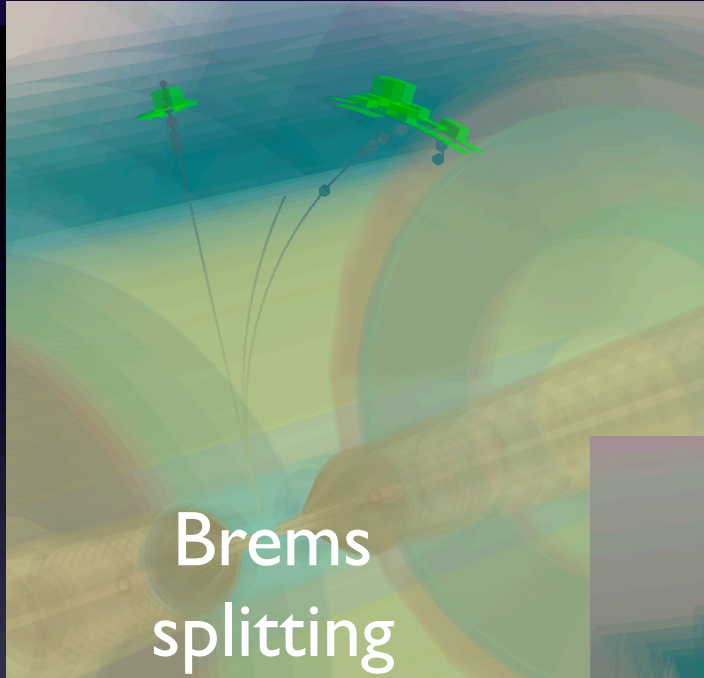
FastSim Brems Simulation



Only 'high-E' Brems are tracked as particles, but energy is always taken from the electron



Bremsstrahlung events



DCH Hit Merging

- Previous model: In-time Hits in same cell are merged
 - Position is averaged
 - merged hit assigned to higher-momentum track
- New model: Early hit wins
 - Drift time simulated using random impact parameter
 - cell size, V_{drift} set in view configuration
 - Early hit assigned to higher-momentum track if consistent ($0 < T_{\text{drift}} < R_{\text{cell}}/V_{\text{drift}}$)

FastSim ToDo

- Fix Si pattern recognition simulation
 - broken since 'looper' fix
- Si triplets
 - need 45 strips, short strips
- Cluster shape testing/tuning after Brems fix?
- Energy Straggling model needs improvement
- Public FastSim Package

Joint Issues

- Physics Tools for SuperB
 - tagging, primary vertex, ...
- Background production?
- Physics TDR needs?