Deep Virtual $\pi\pi$ Production Simulation Pseudo-Code

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1. Event Generation

   (a) Generate beam particle four-vectors k^μ =`k4Beam`, P^μ`P4Beam`.
   Construct light-cone 4-vectors n_e^μ, $\widetilde{n}_e^\mu$.

$$n^\mu = \alpha\left[k^\mu - \frac{m_e^2/(k\cdot P)}{1+\sqrt{1-\delta_e}}\,P^\mu\right], \quad \delta_e = \frac{m_e^2 M_p^2}{(k\cdot P)^2} \quad \widetilde{n}^\mu = \widetilde{\alpha}\,[-k^\mu + ()P^\mu] \tag{1}$$

   Construct lab based transverse unit vectors $X_{\rm Det}^\mu$, $Y_{\rm Det}^\mu$:

$$X\cdot X = -1 = Y\cdot Y, \qquad X\cdot n = 0, \qquad \text{etc.} \qquad \epsilon_{\mu\nu\rho\sigma} n_e^\mu X_{\rm Det}^\nu Y_{\rm Det}^\rho \widetilde{n}_e^\sigma = 1 \tag{2}$$

   (b) Generate Invariants: Q^2, x_B, Φ_e;

   (c) Construct four-vectors: `k4Scat`, `q4Virt` and basis unit vectors

$$n_q^\mu, \qquad \widetilde{n}_q^\mu \qquad X_q^\mu \qquad Y_q^\mu$$

   with constraint $Y_q\cdot k' = 0$.

   (d) Generate Two-Pion mass-squared $M_{\pi\pi}^2$;
   Generate invariant momentum transfer squared t_p.
   Generate Invariant azimuthal angle $\Phi_{\pi\pi}$ (value is from 0 to 2π, meaning to be defined below);
   Construct all remaining final state four vectors;
   Generate two-pion rest-frame variables $\cos\theta_+$ and ϕ_+.

   (e) Compute invariant flux and phase space factors.

2. Construct amplitude for $e+p\to e+\pi^+ + N^*$ with a virtual π^- exchange coupled to $\pi^- p\to\pi^- p$ amplitudes of SAID.
   Four-vector `p4Virt = q4Virt−p4piPlus`.
   Define final state $\pi^- p$ Center-of-Mass frame and determine pion scattering angle.
   Sum over SAID πN amplitudes up to $F_{17}(1700)$.
   Use helicity basis for nucleon spin.

3. Construct amplitude for $e+p\to e+\pi^- + N^*$ with a virtual π^+ exchange coupled to $\pi^+ p\to\pi^+ p$ amplitudes of SAID.

4. Construct Schilling and Wolf style amplitude for diffractive production in (I,J) = (0,0) and (1,1) channels