# Overview on beam-beam simulation GUINEA-PIG(++) improvements

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Cécile Rimbault, LAL Orsay


# Overview on beam-beam simulation GUINEA-PIG(++) improvements

- **NEW:** Depolarization of beam particles.

Summary of bbsim task up to now

- Incoherent Pair Study and GP benchmarking
- Implementation of beam-beam space charge effect on Bhabha scattering and consequences on luminosity measurement
- C++ version of GP, with regular upgrades and distribution.

# Implementation of Depolarization in GP++

P. Bambade, F. Blampuy (summer intern), G. Le Meur, C. Rimbault

# Depolarization

• Spin Precession induced by the collective EM field of the oncoming beam, described by T-BMT equation (dominant effect at ILC):

$$\frac{d\vec{S}}{dt} = \frac{-e}{m\gamma}\left[(1+\gamma a)\vec{B}_T + (1+a)\vec{B}_L - (a+\frac{1}{1+\gamma})\gamma\vec{\beta}\times\frac{\vec{E}}{c}\right]\times\vec{S}$$

*Where a=0.0011596 is the coeff of anomalous magnetic moment of electron*

Precession angle = γa x deflection angle ➔ 567xdeflection angle for ILC nominal

• Spin-Flip effect during synchrotron radiation: Sokolov-Ternov effect, tends to depolarize spins in linear collider. Probability for the spin to flip (s➔-s) at the moment of photon emission, proportional to the photon energy.

• At very hight energy ST effect becomes more important

# Depolarization beam-beam codes

• In beam-beam simulation, particles are replaced by macro-particles ➔ statistical representation.

• In GP++, access to the state of the interacting particles in the luminosity file.

• In Cain, luminosity file contains only luminosity values as function of bin energy for all the polarization couples

• At a first implementation, Yokoya's formulae are used for ST process in GP++.

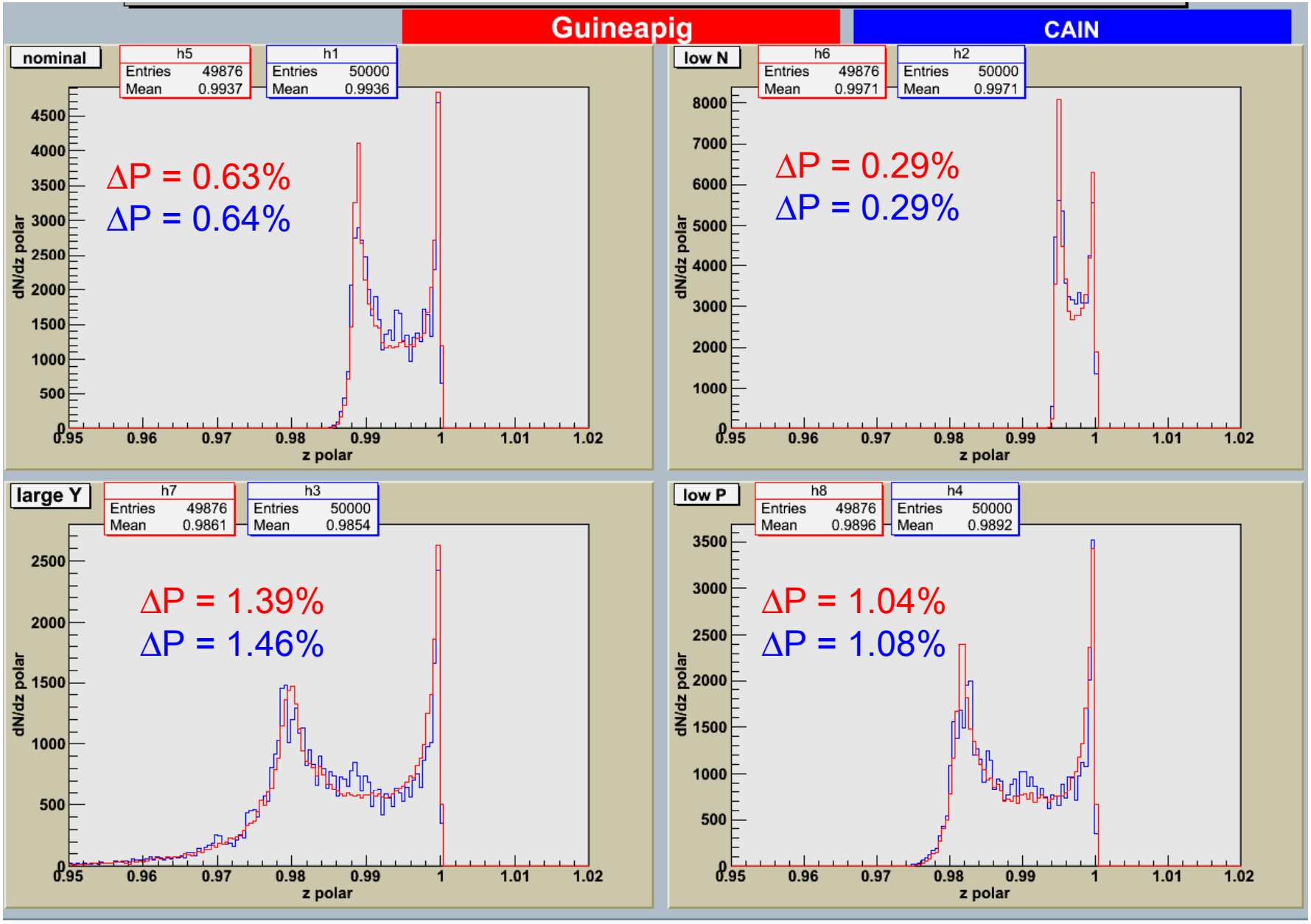
• Depolarization comparison between GP++ and CAIN can be direct for beam, not for luminosity.

• For the moment: only beam particles have a spin treatment in GP++, CAIN as a more complete one (photons, pairs...)

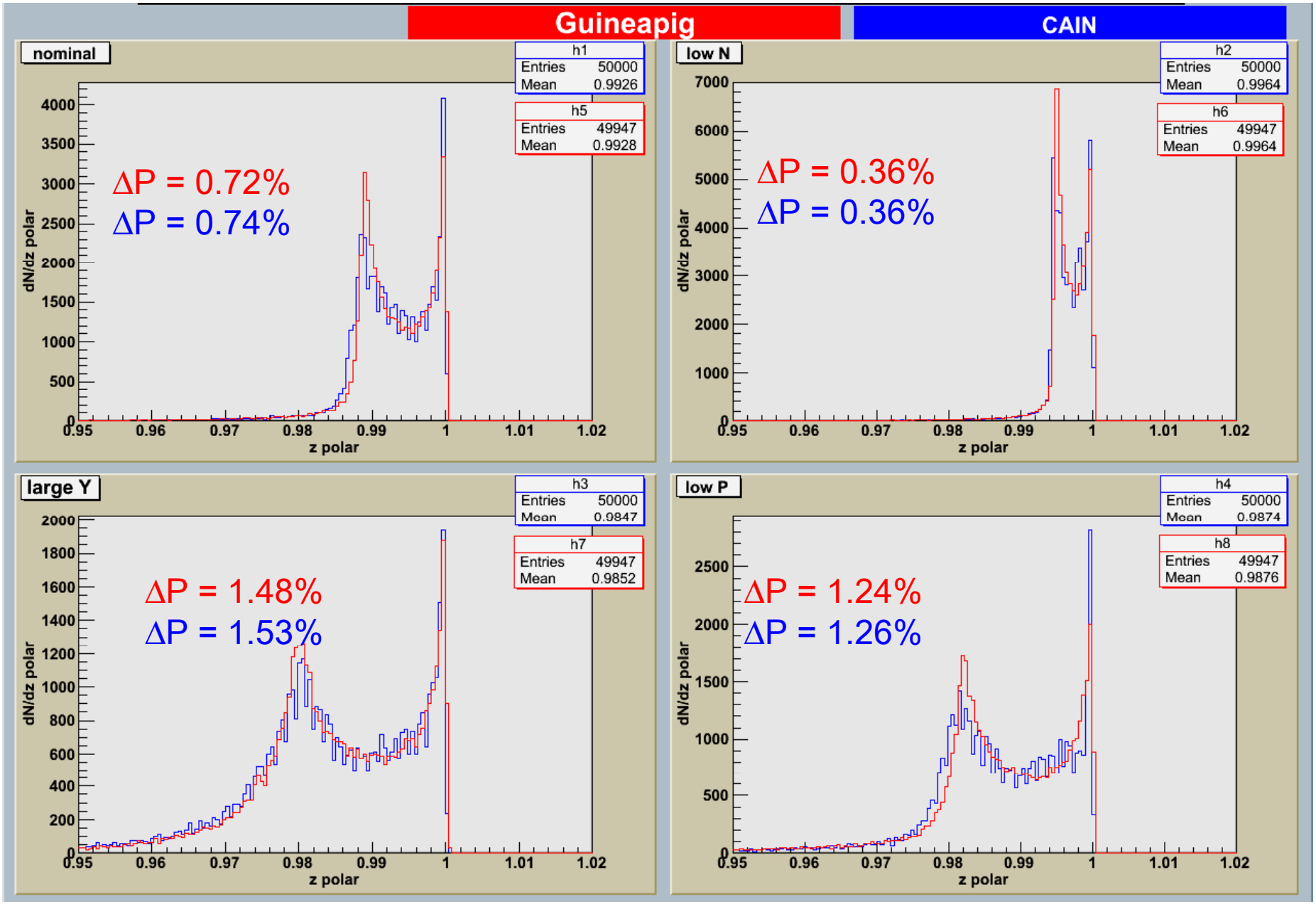
GP++ works with 100% initial polarized beam

• Comparisons are show for the 4 ILC beam parameter sets at 500GeV cms

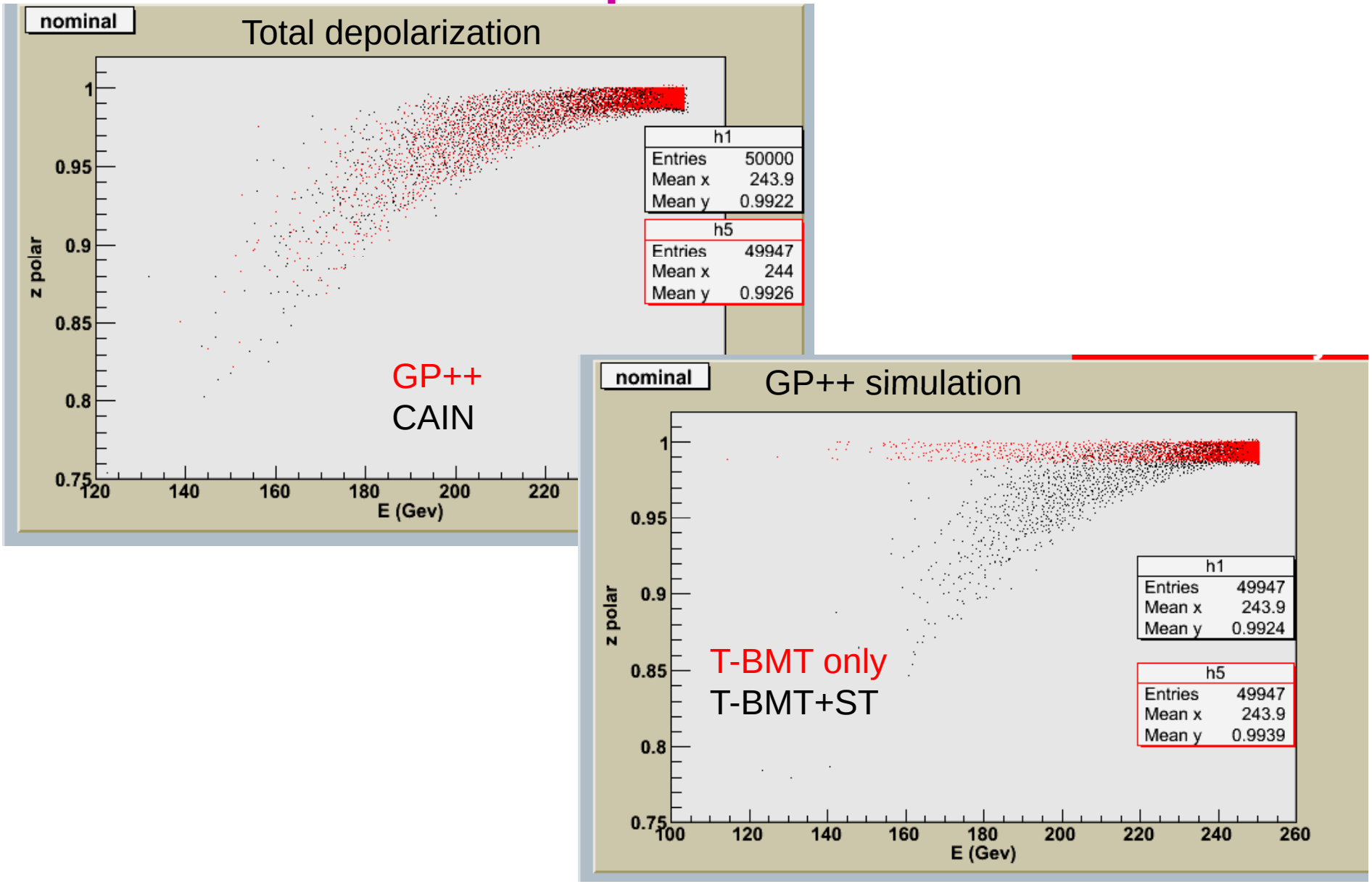
# Comparison of CAIN & GP++ T-BMT for $e^-$ after beam-beam interaction: $\Delta P = 1 - \langle P \rangle$



# Comparison of CAIN & GP++ total depolarization for $e^-$ after beam-beam interaction: $\Delta P = 1 - \langle P \rangle$



# Look on energy depolarization energy dependence



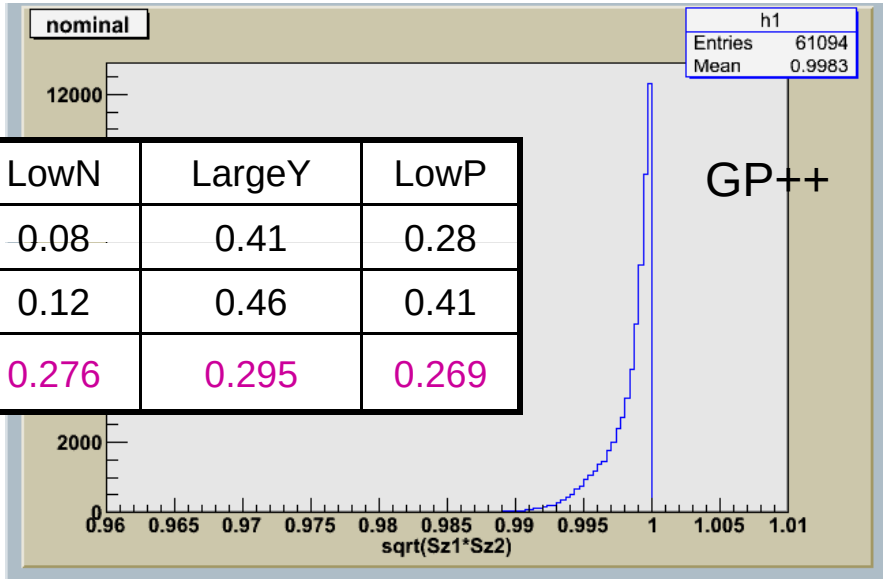
# Luminosity weighted depolarization

• From Yokoya & Chen paper, $\Delta P_{lw} \sim 0.273 \Delta P$ for T-BMT process

• With GP++, access to individual polarization state of the luminosity contributing particles, at the interaction event.
We calculate $\Delta P_{lw} = 1 - \mathrm{sqrt}(\langle Sz1*Sz2 \rangle)$, Sz beeing the statistical population polarized +1 per macro-particles

• For CAIN, it remains some "ontological" questioning on its calculation (need discussion with concerned theorists ).
➔ comparison with I.R. Bailey, A.F. Hartin, G.A. Moortgat-Pick *et al.* EPAC08 paper

| Lumi Depolarization in GP++[CAIN] | Nominal | LowN | LargeY | LowP |
|---|---|---|---|---|
| T-BMT only | 0.17 [0.17] | 0.08 | 0.41 | 0.28 |
| T-BMT+spin-flip | 0.22 [0.22] | 0.12 | 0.46 | 0.41 |
| $\Delta P_{lw}/\Delta P$ for T-BMT | 0.270 | 0.276 | 0.295 | 0.269 |



# Depolarization in GP++: summary & future

• Comparisons and tests: 3 months intership of F. Blampuy (more comparisons and test have been done: for 1 TeV, offset dependence (none), computing parameter sensibility...)

• Comparisons with CAIN, the first reference, is a good test of GP++ implementation: Good agreements

• Soon should be implemented partial polarization in GP++

• Theorical initial calculations should be verified (I am not saying they are false!)

• Photon depolarization will come later.

• Discussion are needed with theorists

• More studies are needed for CLIC energy

*We thanks I. Bailey, A. Hartin, K. Mönig, G. Moortgaat-Pick, D. Schulte for help and useful discussions*

# Overview on previous bbsim GP(++) improvements - 1

- Incoherent Pair Background Study in GP, CAIN, BDS and GP benchmarking
  - EUROTeV-Report-2005-016 **PRSTAB 9, 034402 (2006)**
- Implementation of beam-beam space charge effect on Bhabha scattering and consequences on luminosity measurement: large impact on physics!
  - Collaboration with Forward CALorimetry Group
  - Participation to Status Report Desy PRC R&D 02/01
  - EUROTeV-Report-2007-017 **JINST 2 P09001**

**C. Rimbault, P. Bambade, K. Mönig, D. Schulte**

# Overview on previous bbsim GP(++) improvements – 2

**G. Le Meur, F. Touze, C. Rimbault, O. Dadoun**

- GP++ use **CMT environment** ➔ easy compilation
- GP++ versioning, updating and releasing achieved with **SVN**
- GP++ is distributed on the web software development tool **TRAC**:
  **https://trac.lal.in2p3.fr/GuineaPig**
- GP++ code can be run both on 32-bit and **64-bit** computers.
- New keyword **rndm_seed** allows to choose the random generation seed.
- 1st Physics simulation improvement: easy interface to apply beam-beam effects on Bhabha event input files + associated photons. See documentation

  **http://flc.web.lal.in2p3.fr/mdi/BBSIM/bbsim.html**
- Automatic GRID sizing option
- All results are now in the main output file, with units!
- NEW: Beam particles depolarization effect, polarization state in beam files, lumi file, and dump files.

**Of course, the more YOU use it, the more YOU test it, the more GP++ can be improved**