

Summary of the Working Groups

- Polarization
- $\gamma\gamma$ Technical Aspects

Conveners:

Gudrid Moortgat-Pick, Louis Rinolfi, Sabine Riemann,
Valery Telnov

International Workshop on Linear Colliders 2010, Geneva
October 25-29, 2010

Physics

Tom Rizzo: Transverse Polarization as a Different View into New Physics at CLIC

Ivan Marchesini: Combined measurement of Triple Gauge Boson couplings and polarization at the ILC

Depolarization, spin tracking, polarimetry

Ian Bailey: Depolarisation Studies

Anthony Hartin: Strong field physics in beam-beam interactions at a linear collider

Moritz Beckmann: Spin tracking studies for polarimetry at ILC

Marie Jacquet: Polarimetry with Fabry-Perot cavities

Kenneth Moffeit: Luminosity weighted polarisation

Positron polarization

Andriy Ushakov: Simulations of the polarised positron source with PPS-Sim

Sabine Riemann: Positron polarisation at RDR and SB2009

Gudrid Moortgat-Pick: Polarization issues at a Z-factory and impact of SB2009

Eugene Bulyak: Polarisation of positrons in Compton sources

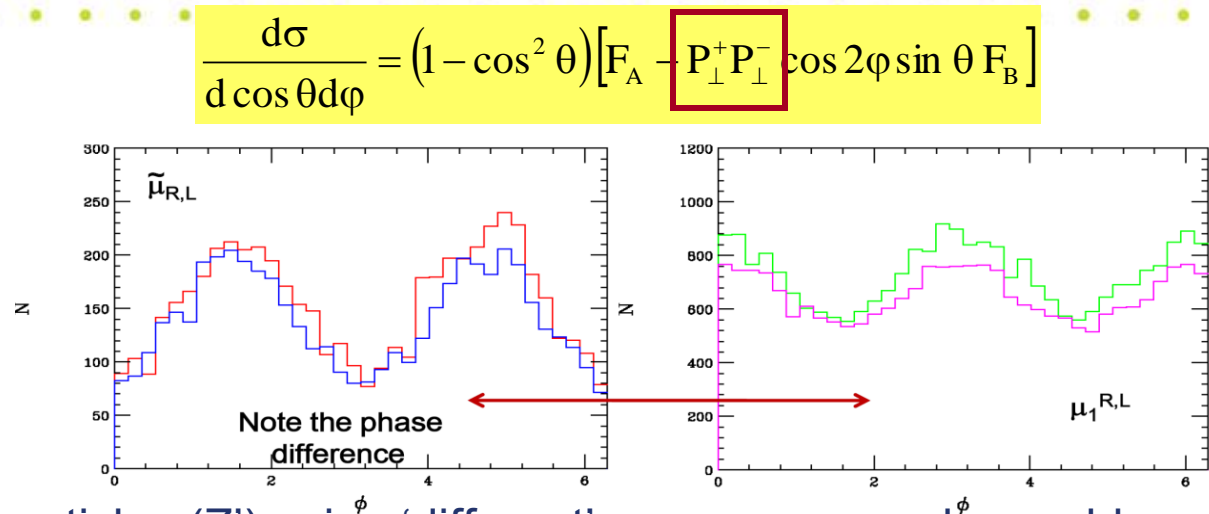


Physics with polarized beams

Physics with polarized e+ and e- beams

Tom Rizzo:

- Discriminate the spin of new particles using transverse polarization (smuon, KK in UED μ_1)

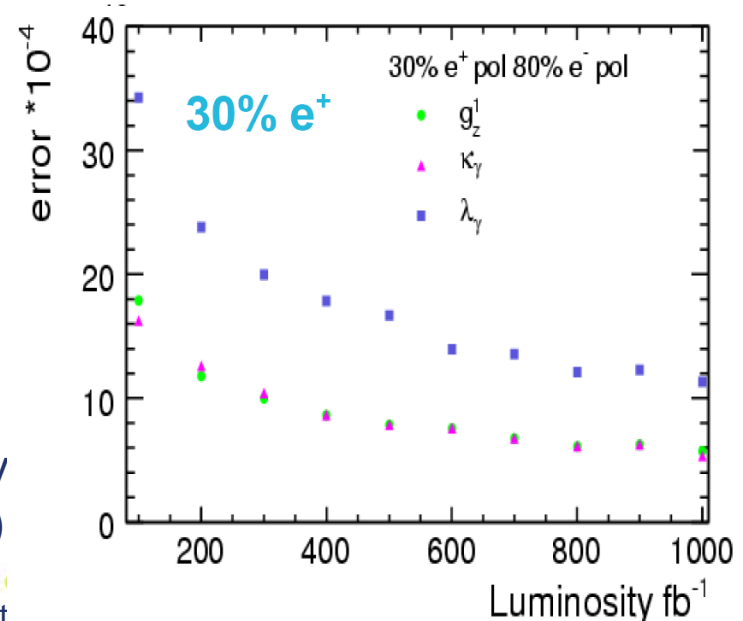


- Probe couplings of new particles (Z') using 'different' on-resonance observables based on transverse polarization

Ivan Marchesini:

- Simultaneous fit of TGCs and polarization is possible without losing sensitivity in the polarization measurement.

Absolute precision on TGCs only slightly dependent on degree of $P(e^+)$



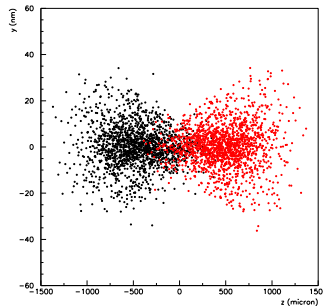


Spin tracking, depolarization, polarimetry

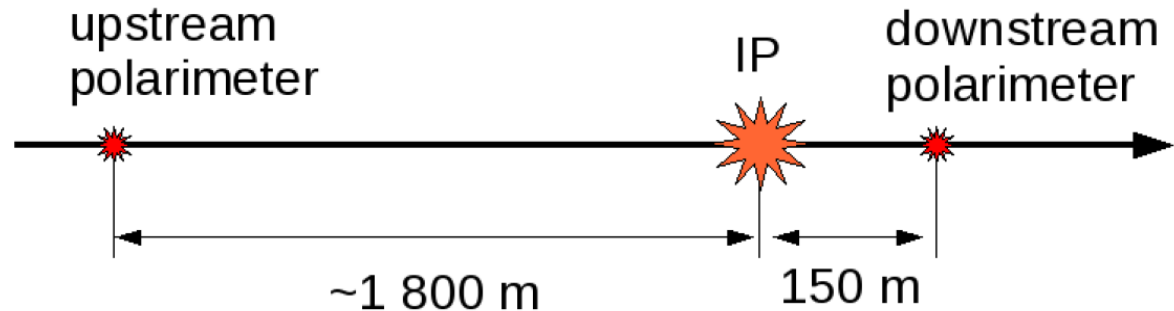
Depolarization effects

I. Bailey, T. Hartin, M. Beckmann

- Largest depolarization effects at ILC / CLIC are expected at the Interaction Points



GP++ Simulation
Rimbault



$$\Delta P_{lw} \equiv \left| \vec{P} \right|_{initial}^{e-} - \left| \vec{P} \right|_{lw}^{e-}$$

- Simulations to calculate luminosity-weighted polarisation P_{lw} at IP

- CAIN
- GP++

$$\Delta P_{lw} \sim 0.2\% \text{ (ILC)}, \sim 4\text{-}5\% \text{ (CLIC)}$$

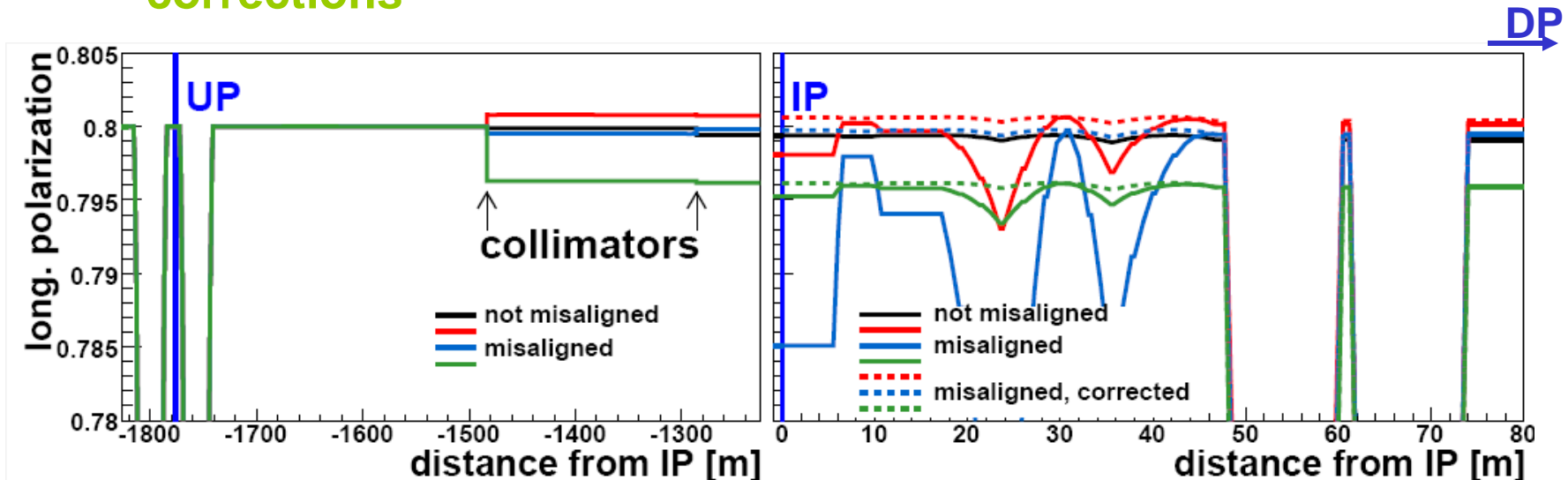
Still some discrepancies between CAIN and GP++ models → further work needed

Theoretical Models ⇔ strong field physics in beam-beam interactions; higher orders have to be included to understand the beamstrahlung process: see Tony Hartin's presentation

Spin tracking study for Polarimetry at the ILC

M. Beckmann:

- Polarization studies from upstream (UP) to downstream polarimeter (DP)
 - Particle/spin tracking using BMAD
 - study includes static misalignments, and allows feed-back corrections



To be included: crab cavities, detector magnets, collision effects, ground motion → develop calibration strategies

Polarimetry at ILC and CLIC

Precision requirement $\Delta P/P \leq 0.25\%$

K. Moffeit: **Overview upstream and downstream polarimeters**

- Spin precession at high energies
→ orbit angle tolerances for spin alignment at Compton IP and IR:
 - **<50 μrad between beam direction at polarimeters and IP for ILC**
 - **<13 μrad between beam direction at polarimeters and IP for CLIC**
- Upstream Polarimeter for CLIC possible (similar design as for ILC)
- Downstream extraction line Polarimeter for CLIC:
 - **No scheme for CLIC downstream polarimeter at highest energy and luminosity**
 - Disrupted beam

Marie Jacquet: **Fabry-Perot cavity polarimeter at HERA**

- Prospects for applications at ILC:
 - **$\Delta P_{\text{sys}} \sim 0.2\%$ possible:**
 - **Improve ADC resolution, calo uniformity, measurement of circularly laser polarization**



Positron polarization

Positron polarization and SB2009

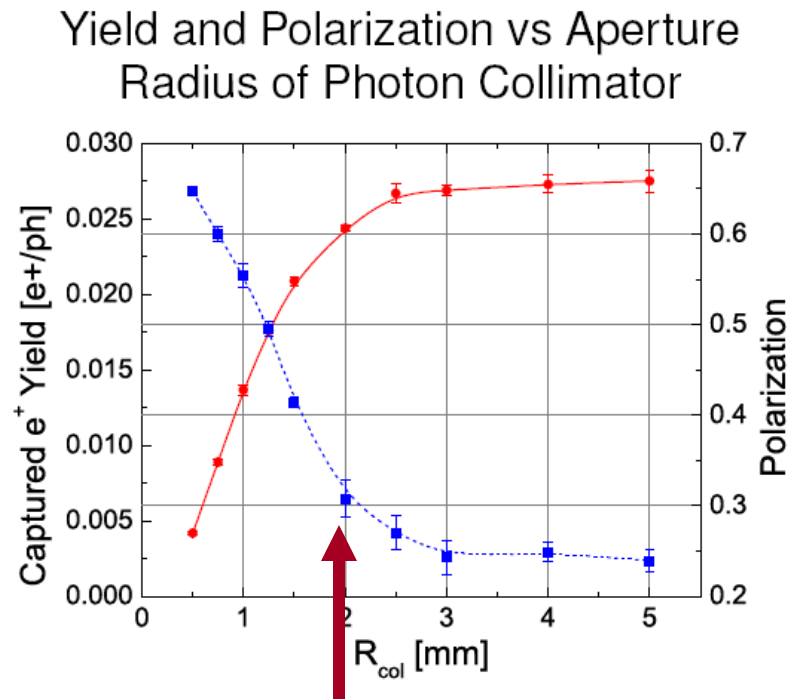
Gudi, SR, all

SB2009: $P(e^+) = 22\%$ (RDR: $P(e^+) = 34\%$)

- little gain for physics with 22% positron polarisation → better $P(e^+) > 30\%$

Proposals

1. Use photon collimator before positron production target:



Collimator with 2 mm aperture radius:

- increases polarization to $\approx 30\%$
- results in $\approx 12\%$ yield reduction

A. Ushakov

2. use energy spectrometer at positron capture section to remove low-energy positrons with 'wrong' polarization

Z Factory

Required polarization & years

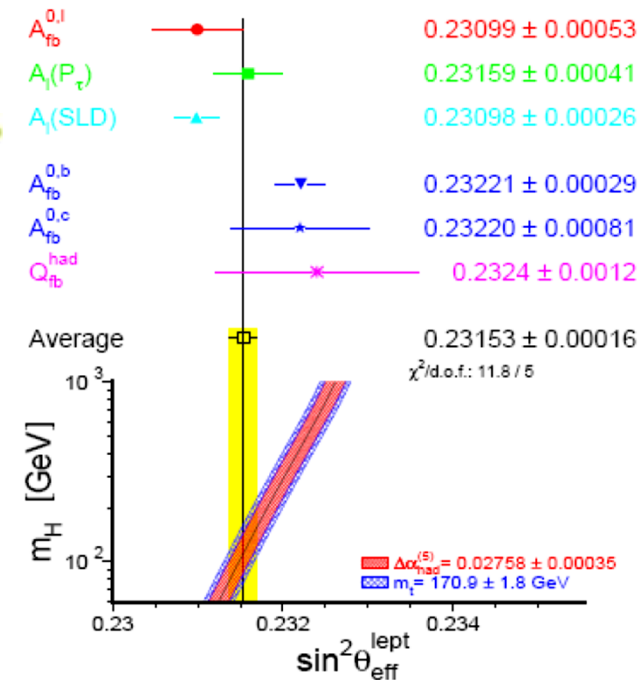
- Remember: currently $\Delta \sin^2 \theta_{\text{eff}} = 1.6 \times 10^{-4}$
- $P(e^-) = 90\%$, $\Delta P/P = 0.5-1\%$ (for e^\pm)

$P(e^+)$	#Z's	$\Delta \sin^2 \theta_{\text{eff}}$
0%	4.5×10^7	1.0×10^{-4}
	9.0×10^8	9.8×10^{-5}
22%	1.7×10^9	3.0×10^{-5}
30%	7.7×10^8	3.0×10^{-5}
50%	2.3×10^8	3.1×10^{-5}
22%	9.1×10^9	1.3×10^{-5}
30%	4.1×10^9	1.3×10^{-5}
50%	1.4×10^9	1.3×10^{-5}

No further progress

3×10^{-5} : high sensitivity to new physics!

'GigaZ': full exploitation only if $m_{\text{top}} = 0.1 \text{ GeV}$



- Polarization of both beams is mandatory !
- *GigaZ precision does need high polarization of e^\pm !*

Gudi

Overview $\gamma\gamma$ technological aspects

- *Jeff Gronberg*, Design work for the Photon Collider Laser.
- *Tohru Takahashi*, Status of an optical cavity R&D at ATF.
- *Valery Telnov*, Consideration of a photon collider without damping rings
- *Valery Telnov*, A FEL pumped solid state laser system for the photon collider at CLIC

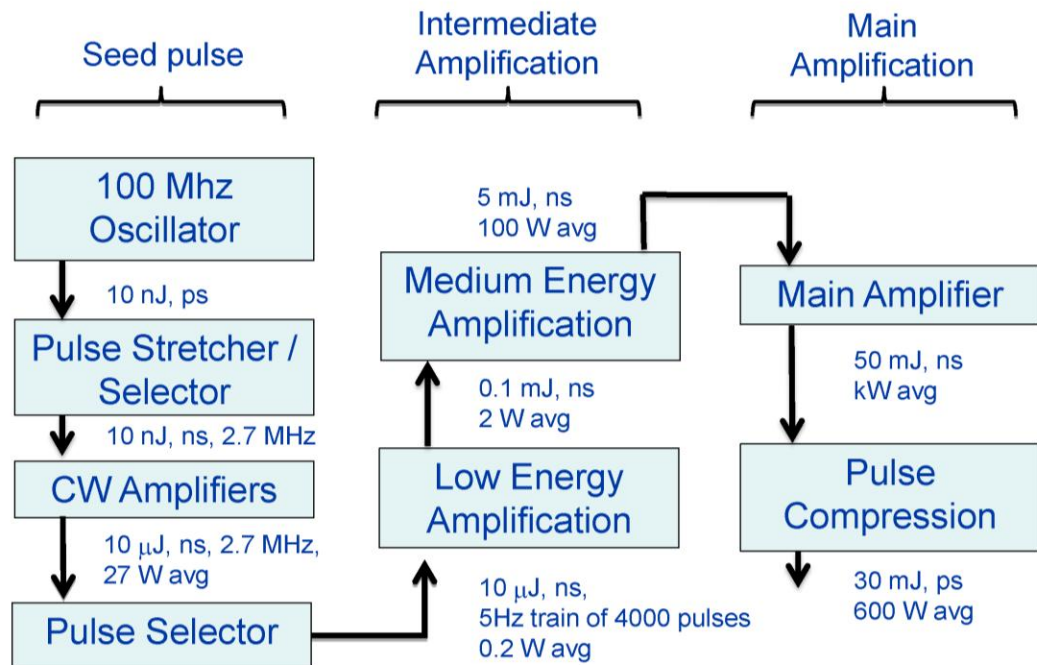
Design work for the Photon Collider Laser

Jeff Gronberg:

The stacking cavity approach for the photon collider at the ILC was considered at LLNL, including various effects which influence cavity enhancement factor ($Q \sim 300$).

Conclusion: Generating a pulse train that can maintain the gain of the cavity is possible with existing technology but maintaining phase stability is nontrivial. The study will be documented by the end of the year.

Laser system concept



Status of optical cavity R&D at ATF

Tohru Takahashi:

2 M cavity: has been tested on the ATF beam

4 M cavity: - LAL cavity installed -> prepared for collisions
- KEK-Hiroshima type being designed

Progress in understanding of 2-4 mirror ring cavity through prototype construction, calculation and experiments

Prototype cavities

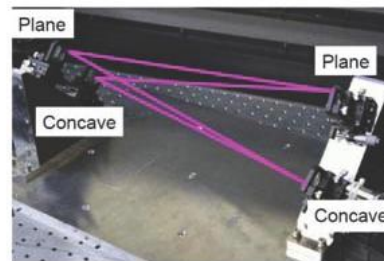
**2-mirror cavity
at KEK ATF**

moderate enhancement
moderate spot size
simple control



experiences
with
accelerator

4-mirror test bed at KEK



4-mirror cavity at LAL



high enhancement, small spot size

Consideration of a photon collider without damping rings

Valery Telnov:

The product of transverse emittances in RF guns is larger than in DRs a factor of 20 (at the ILC bunch charge $3nC$), but the longitudinal emittance is 7500 times smaller than needed for ILC.

One can generate by a photo-gun a train from many low charge micro bunches with small transverse emittances and combine them in longitudinal phase space (using the energy difference). The resulting product of transverse emittances will be an order of magnitude smaller than with DR.

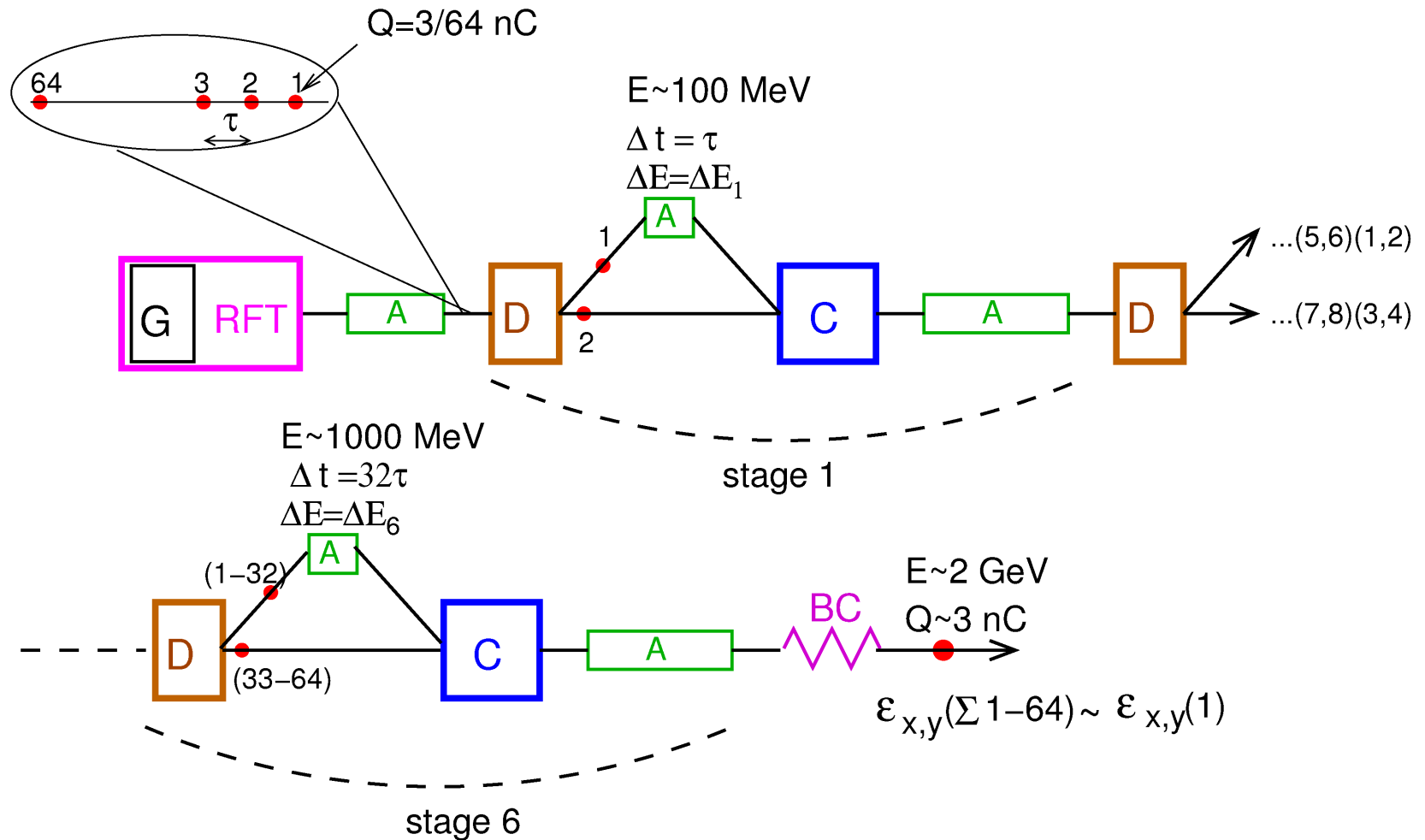
Result:

- the luminosity of the photon collider much higher than with ILC DR;
- electron DR for e^+e^- is not needed.

Problem: low emittance polarized electron RF-guns do not exist yet (there are only DC guns with very large emittances), though at the photon collider even unpolarized electrons give polarized photons.

Scheme of combining one bunch from the bunch train (for ILC)

V.Telnov



G – photogun, A – RF-cavities (accel), RFT – round to flat transformer,

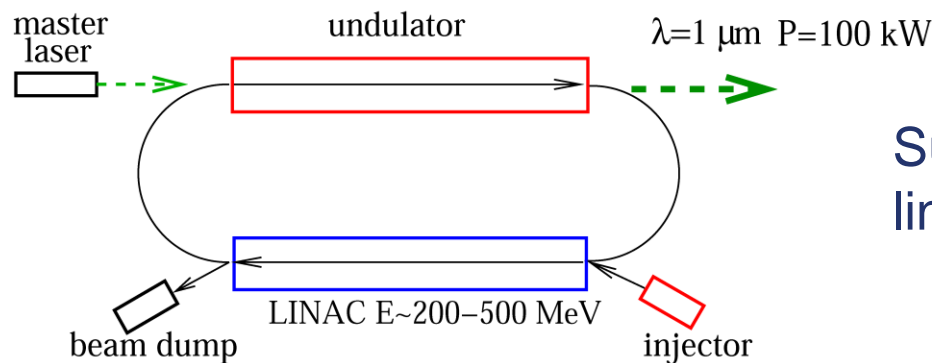
D – deflector, C – beam combiner, BC – bunch compressor

A FEL pumped solid state laser system for the photon collider at CLIC

Valery Telnov:

The photon collider based on CLIC needs a one pass laser with 5 J flash energy and CLIC pulse structure. FEL based on CLIC drive beam can not generate 5 J pulses (not enough beam energy).

Suggestion: to use FEL for pumping of a solid state laser medium with a storage time about 1 ms (5000 times longer than the CLIC train!). This energy is extracted by the train of laser pulses with the CLIC structure (177ns long).



Such pumping FEL can be based on linac with the energy recuperation

Polarization

- Positron polarization is important for physics → observables to disentangle new physics models
- Spin tracking and depolarization studies (ILC, CLIC) are ongoing
- Polarimetry at ILC → designs exist
Polarimetry at CLIC → further studies needed
to be done: polarimetry for transverse polarized beams
- SB2009: $P(e^+) = 22\%$
→ increase to $P(e^+) > 30\%$ easily achievable and needed for physics
- Polarized positron source performance simulations (ILC, CLIC) ongoing

$\gamma\gamma$ Technical Aspects

- Design work for stacking laser cavities (LLNL) done
- Experimental tests of optical cavities at KEK: 2M, 4M
- Proposal for gamma collider without DR
- Proposal to use a FEL pumped solid state laser for the $\gamma\gamma$ option at CLIC



Thank you !

Polarimetry at ILC and CLIC

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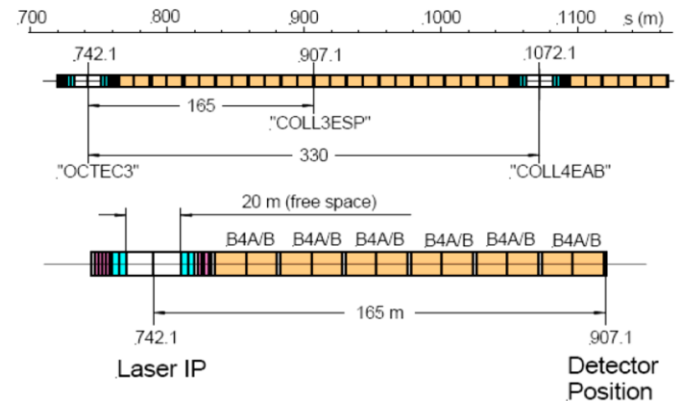
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- **Orbit through Compton IP and e+e- IP needs active feedback to maintain orbit angle within these limits**
- Upstream Polarimeter for CLIC possible (similar design as for ILC)

CLIC BDS detail:

laser IP at $s = 742\text{m}$

Compton electron detector at $s = 907\text{m}$

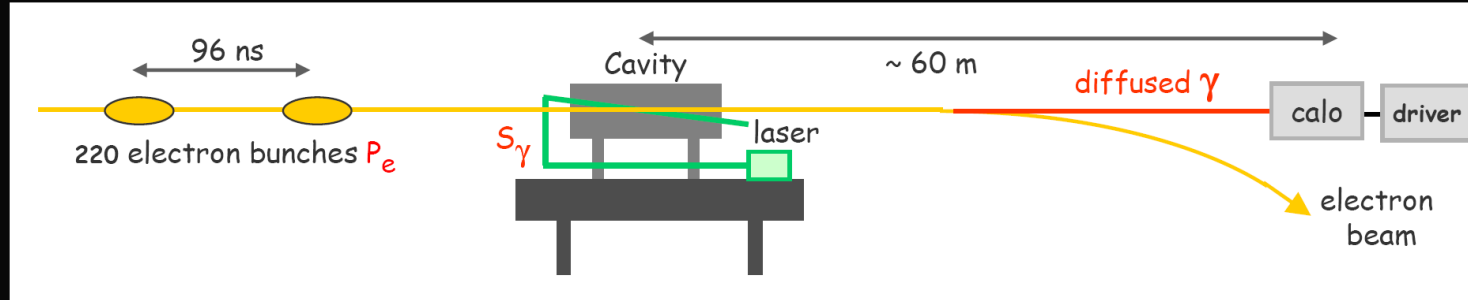


- Downstream extraction line Polarimeter for CLIC:
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Precise measurement of the longitudinal polarisation at HERA with a Fabry-Perot cavity polarimeter

Marie Jacquet

System overview



- Cavity polarimeter \rightarrow higher statistical precision
 - by increasing the power of the continuous wave laser at a few kW
 - by increasing the frequency of the e-/laser interaction at 10MHz (every e- bunch)
- Smaller systematic error $\sim 1\%$ (factor 2-3 smaller than precision quoted by the other HERA polarimeters LPOL and TPOL)

Prospects for applications at ILC:

$\Delta P_{\text{sys}} \sim 0.2\%$ possible:

- Improve ADC resolution, calo uniformity, measurement of circularly laser polarization