POSIPOL 2009: SUMMARY

R.Chehab (IPN-Lyon)

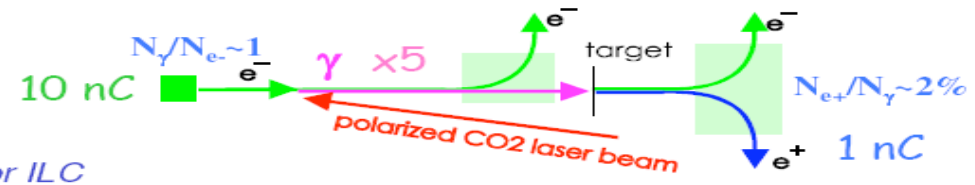
POSIPOL 2009: SUMMARY

- From june 23d to june 26th, the workshop POSIPOL 2009 was held at the IPNL (Institut de Physique Nucleaire de Lyon)
- About 30 participants were attending this meeting; they came from Europe (France, Germany, CERN), Russia, Japan, China, USA, Ukraine.
- The items covered the fields of polarized and unpolarized positron sources. Some emphasis was put on the so-called Compton Sources for which, technical developments and dedicated applications for X-rays production were presented
- An overview of the different electron-positron colliders (ILC, CLIC, SuperB) was also presented to introduce the meeting; the LHeC project was only mentionned, as the scheduled presentation was withdrawn.

POSIPOL 2009: SUMMARY

- **COMPTON SOURCES**
- **The schemes: 3 schemes were presented:**
- **(1) 4 Gev Linac & CO_2 laser [BNL]/Pogorelsky et al.**

  - The ILC and CLIC designs specify a 1 nC charge per each positron bunch.
  - The conversion efficiency of the polarized γ-photons into polarized positrons is expected to be about 2%, optimized for the 60% level of the beam's polarization. Therefore, every positron requires, as precursors, 50 γ-photons assembled in the same format (bunch length and repetition rate) as the e^-e^+ collider beams.
  - We propose to accumulate this γ-flux via Compton scattering at several consecutive IPs. In each IP, a 4.75-GeV e-beam undergoes a head-on collision with a CO_2-laser pulse that produces one γ-photon per electron.



example for ILC

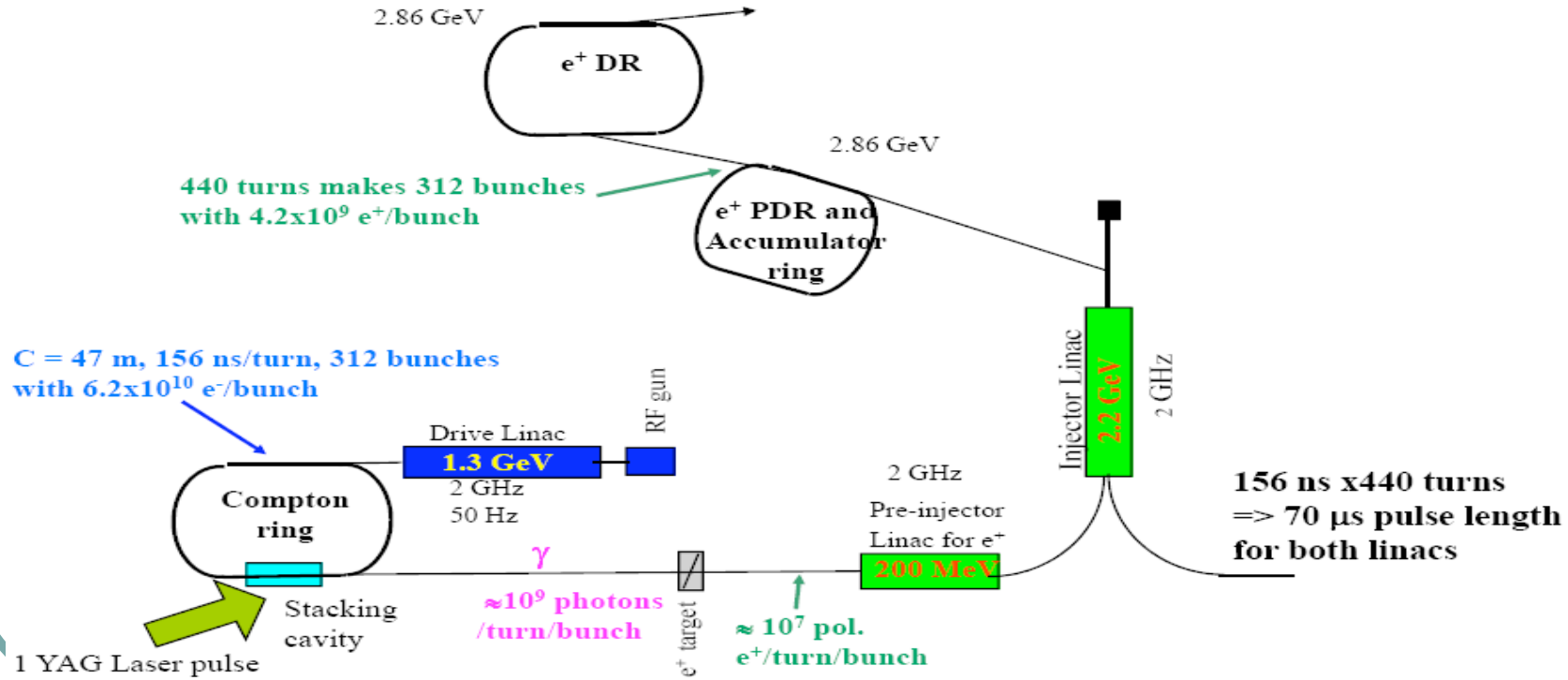
POSIPOL 2009: SUMMARY

- **COMPTON SOURCES**
- **Linac 4 GeV & CO_2 laser [BNL/Pogorelsky et al]**

e- beam energy	4.75 GeV
e- bunch charge	10 (5) nC
RMS bunch length (laser & e^- beams)	3-5 ps
γ beam peak energy	40 MeV
Number of laser IPs	5 (10)
Total $N\gamma/Ne^-$ yield (in all IPs)	5 (10)
$Ne^+/N\gamma$ capture (@60% polarized)	2%
Ne^+/Ne^- yield	0.1 (0.2)
Total e^+ yield (@60% polarized)	1nC
# of stacking	No stacking

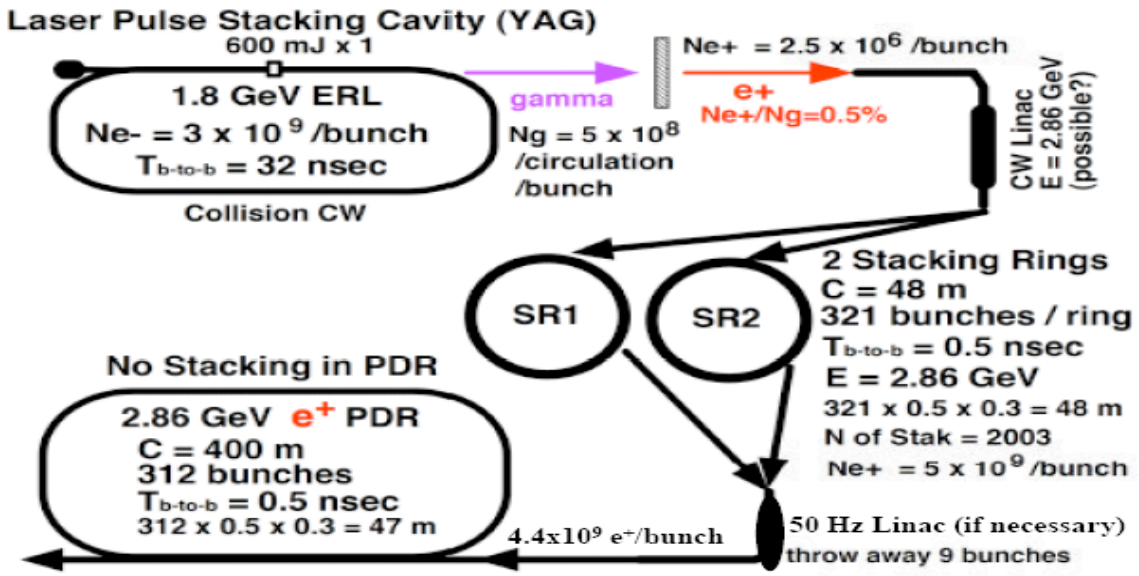
POSIPOL 2009 : SUMMARY

- **COMPTON SCHEME**
- **(2) Compton Ring & Nd:Yag laser (K.Moenig) => ex: CLIC (L.Rinolfi)**



POSIPOL 2009: SUMMARY

- **COMPTON SCHEME**
- **(3) ERL & Nd:YaG laser (AV/LAL proposition) => CLIC**



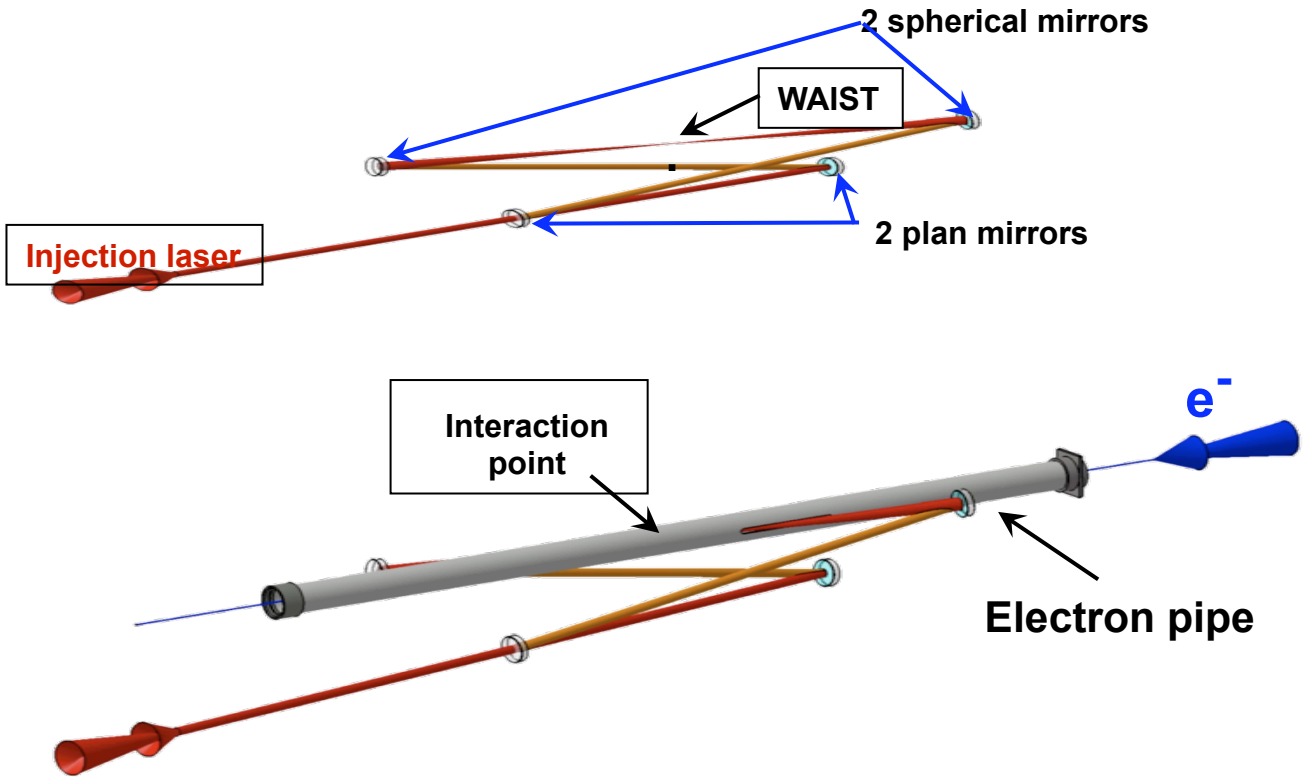
Presented by T. Omori at the 4th "ILC/CLIC e^+ studies" meeting

L. Rinolfi (CERN) and T. Omori (KEK)
ILC-CLIC e+ studies
14-May-2009

COMPTON SCHEME

Progresses on optical cavities: LAL R&D (Soskov)

Optical scheme of the nonplanar cavity

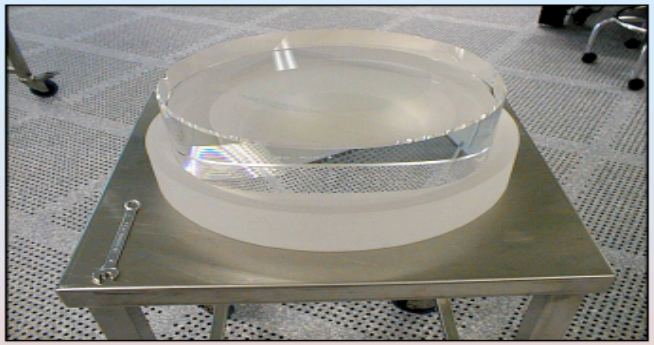


POSIPOL 2009: SUMMARY

- **COMPTON SCHEME:** **Progresses on cavities [LMA/L.Pinard]**

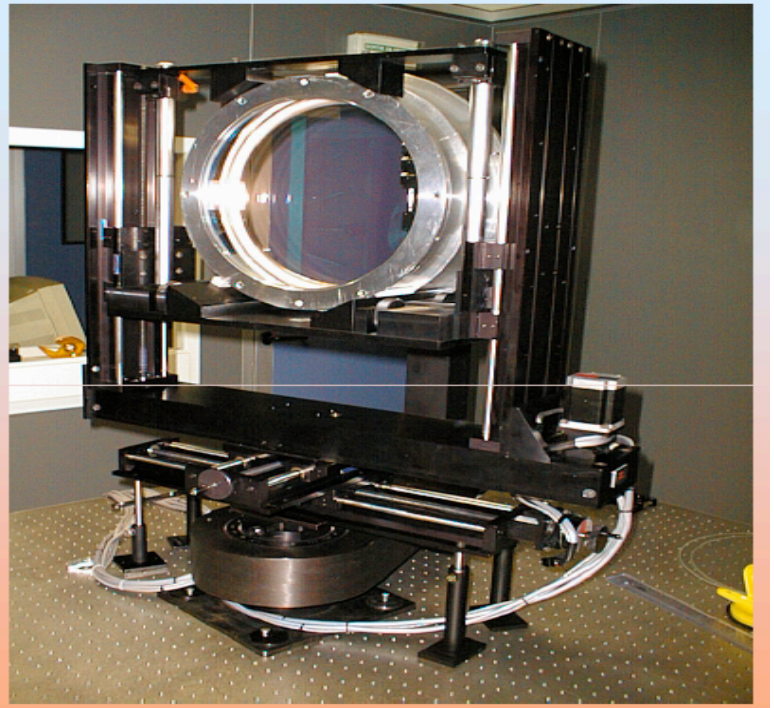
LMA

Introduction – Realizations



- Diameter = 350 mm,
- Thickness = 96 mm, Weight = 20 kg

SIDE B measurements	VIRGO specifications	LMA mesurements
average scattering	< 5 ppm	4 ppm 150x150 mm²
average transmission	10 < T < 50 ppm	42,9 +/- 0,2 ppm Ø150 mm
average absorption	< 5 ppm	0,63 +/- 0,07 ppm Ø150 mm
wavefront flatness	< 8 nm RMS Ø150 mm	3,8 nm RMS Ø150 mm



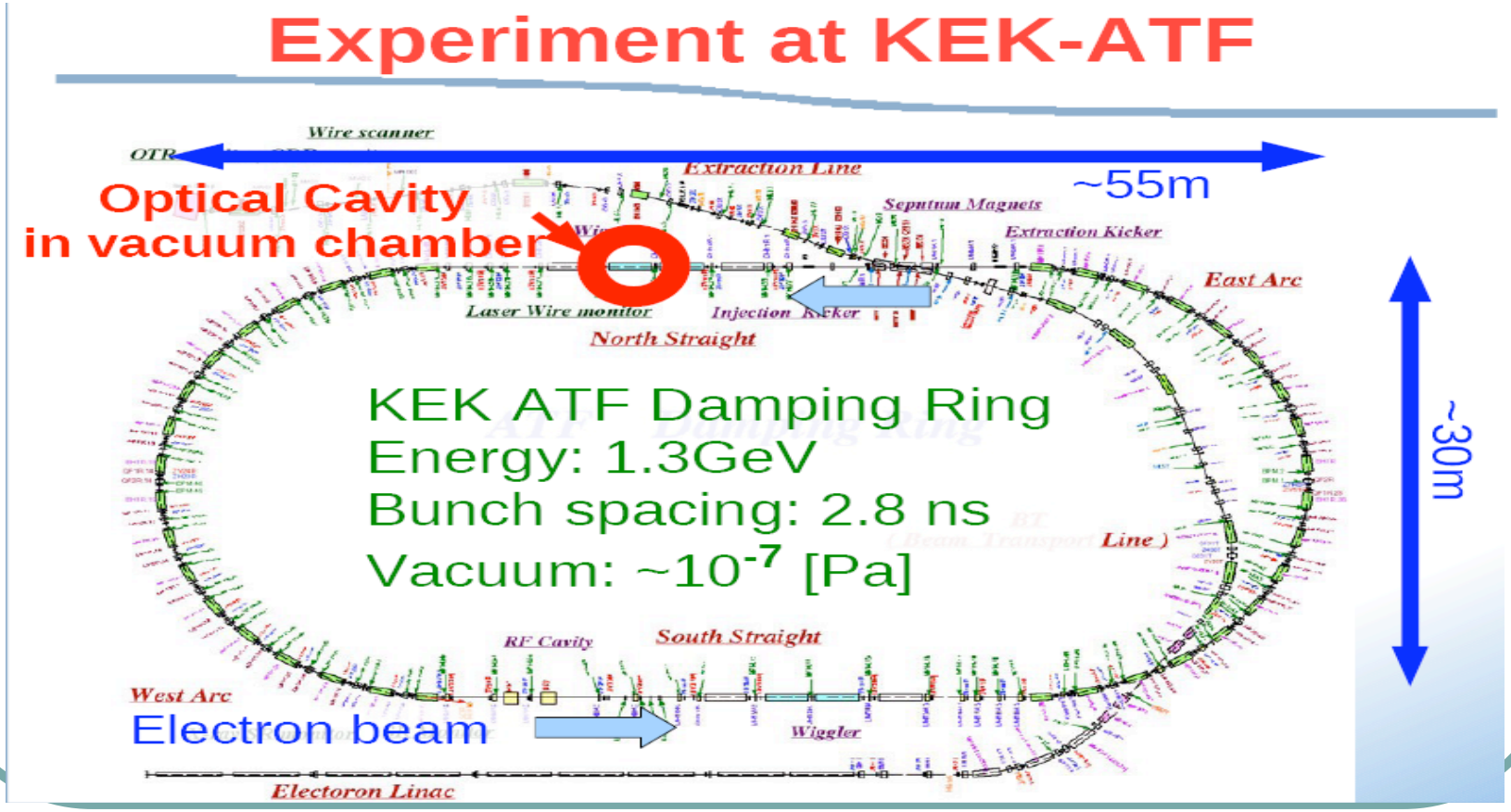
VIRGO

OL 2009
Pinard

5

POSIPOL 2009: SUMMARY

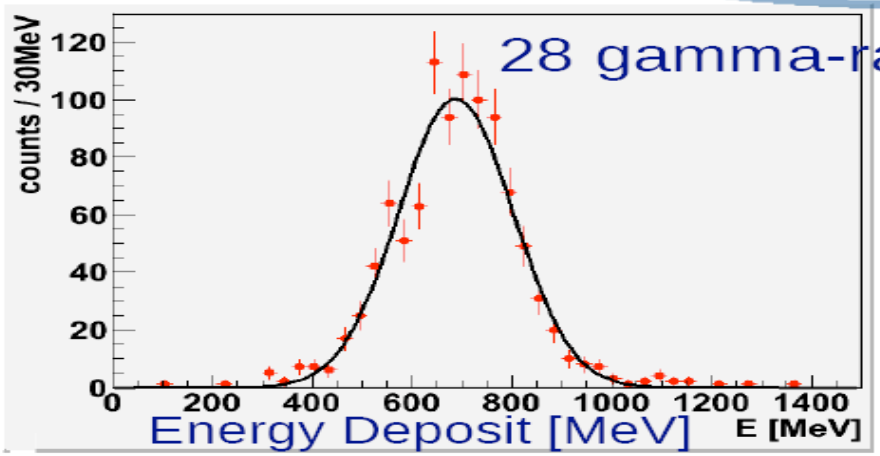
- **COMPTON SCHEME: Tests @ KEK (S.Miyoshi)**



POSIPOL 2009: SUMMARY

- **COMPTON SCHEME:** **Tests @ KEK/S.Miyoshi**

Observed Gamma-ray Spectrum



e- ring opr. mode
20 bunches / train

We observed 28.1±0.1 gamma-rays / train.
All solid angle → 60 gamma-rays / train

→ 60×2.16MHz ~ 1.2×10^8 [gamma / second]
Revolution

POSIPOL 2009: SUMMARY

- **COMPTON SCHEME: Applications to X-rays**
- **A compact light source (X domain) has been developed by LYNCEAN in California; a talk from R.Ruth described the features of these sources made of a compact electron ring associated to a laser**

POSIPOL 2009: SUMMARY

- **POLARIZED POSITRONS FROM POLARIZED BREMSSTRAHLUNG PHOTONS**
- **This idea was first proposed by A.Potylitsin; it uses a longitudinally polarized electron beam impinging on an amorphous target. The bremsstrahlung photons are circularly polarized and create longitudinally polarized e-e+ pairs. One advantage of this method is the possibility to use relatively low energy incident beams (< 100 MeV)**
- **Two projects have been presented**
- **- e+ @ JLAB (E.Voutier)**
- **- e+ @ SuperB/INFN-LNF (A.Variola)**

POSIPOL 2009: SUMMARY

- **E+ @ JLAB (E.Voutier)**

CEBAF High Intensity Positron Source

J. Dumas, C. Hyde, W.J. Kossler, T. Forest, A. Freyberger, S. Golge, J. Grames, R. Kazimi, E. Voutier

➢ The CHIPS community develops concepts and ideas for the construction of a high intensity polarized positron source at JLab for fixed target experiments to take place in the 12 GeV era.

Goals

- e^+ beam current > 100 nA in CW mode (CEBAF @ 1497 MHz)
- As large as possible e^+ beam polarization

Challenges

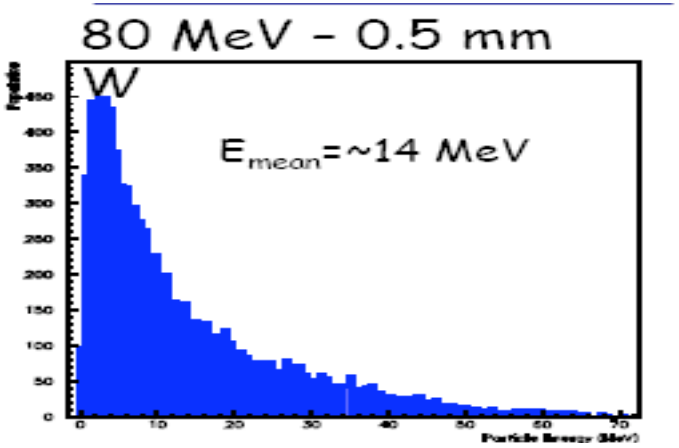
- High e^- beam intensity 1-10 mA together with high beam polarization ≥ 85%
- High power e^- target (~1 MW beam driver @ 10-100 MeV)
- Efficient e^+ capture

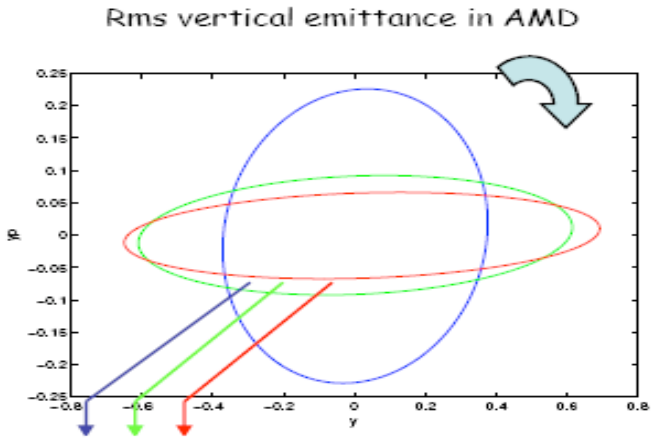
POSIPOL 2009: SUMMARY

- **e+ @ SuperB (A.Variola)**

  - For SuperB
  - @ 80-100 MeV yield => 0.2
  - Capture in L Band => 0.5
  - Total => 10% (@ ~30% polarization)
  - 15 nC (Slac gun) => ~10^{11} e^- /pulse
  - 10% => 10^{10}/pulse
  - 2 10^{11} @ 20Hz = 10^{10} !!!! IT FITS!!!
  - Preliminary considerations...needs fine tuning in capture @ 3 GHz, transport, PEDD but for the moment it works. Moreover it is possible to increase the frep (up to 100 Hz) and the number of bunches per train.

Simulations [GEANT4, PARMELA]

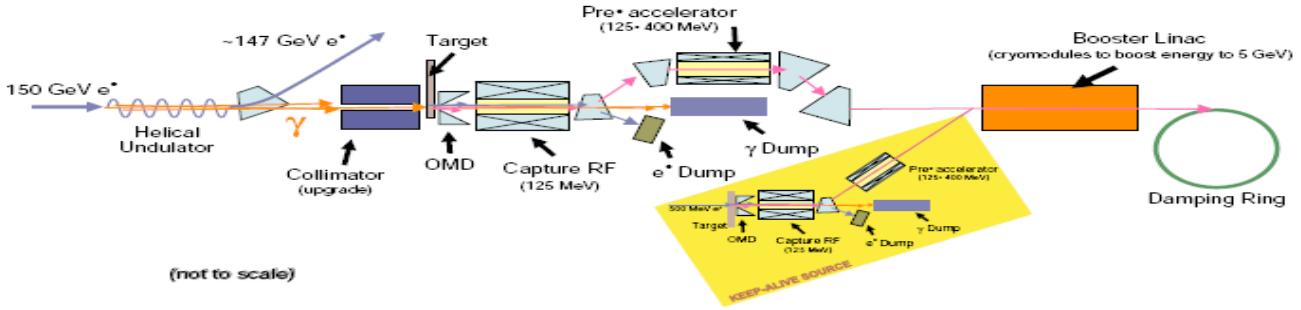




POSIPOL 2009: SUMMARY

- **POLARIZED PHOTONS FROM UNDULATOR ILC baseline**
- **A.Schaelicke**

The Baseline Source

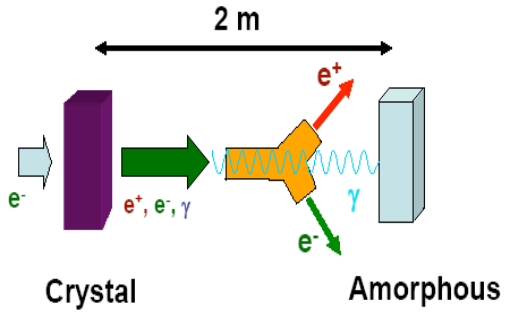


	SLC	ILC
Positrons per Bunch	3.5×10^{10}	2×10^{10}
Bunches per Macropulse	1	2625
Macropulse Rep Rate (Hz)	120	5
Positrons per second	4.2×10^{12}	2.6×10^{14}

Global Design Effort 3

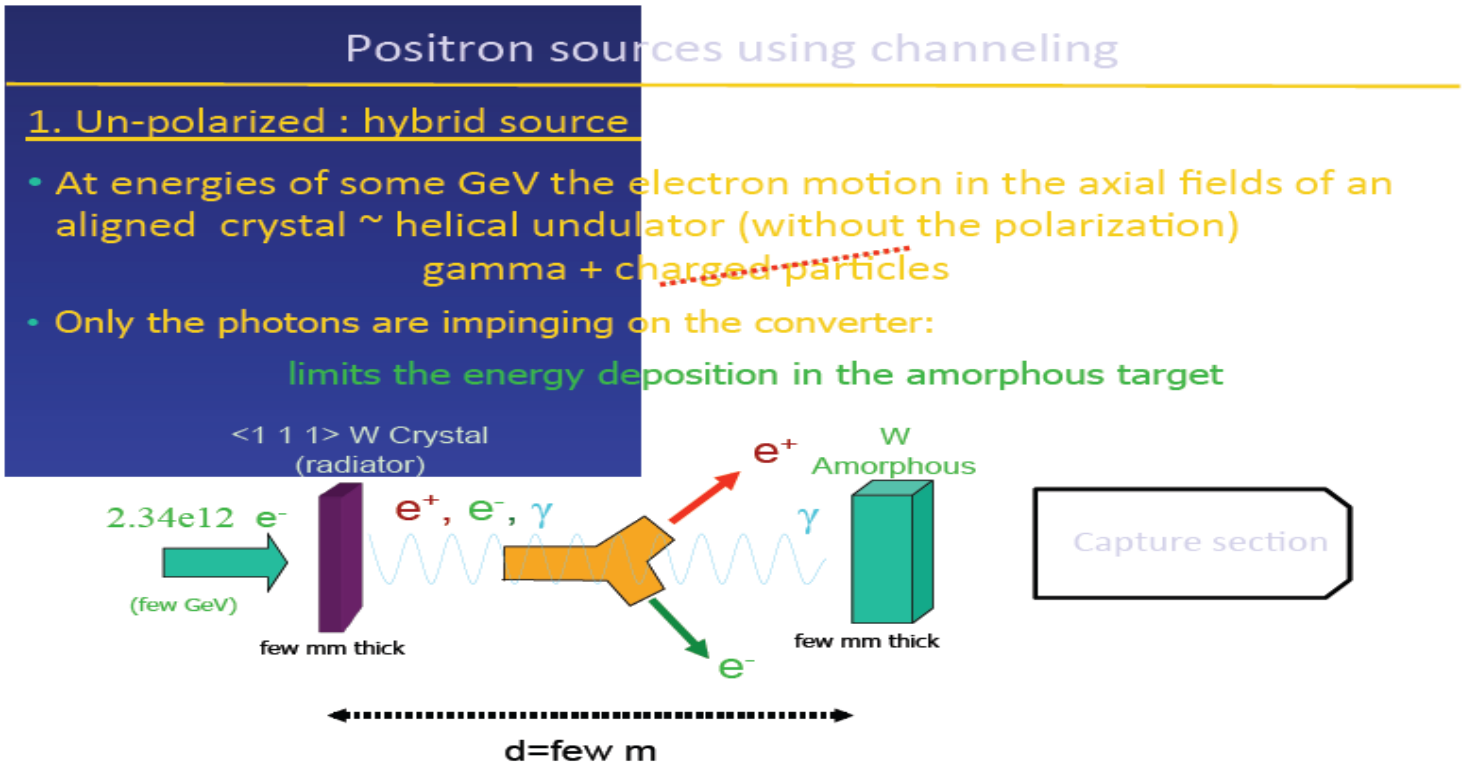
POSIPOL 2009: SUMMARY

- **HYBRID POSITRON SOURCES USING CHANNELING**
- **The hybrid source is composed of two targets: the first is a crystal-radiator providing a large number of photons due to channeling and the second is an amorphous target where these photons (and e +,e-) contribute to the shower development.**
- **Such kind of source has been tested at CERN & KEK, but without separation between the targets. Intensive simulations have been done by the LAL-IPNL-BINP group and tests are foreseen at KEK.**



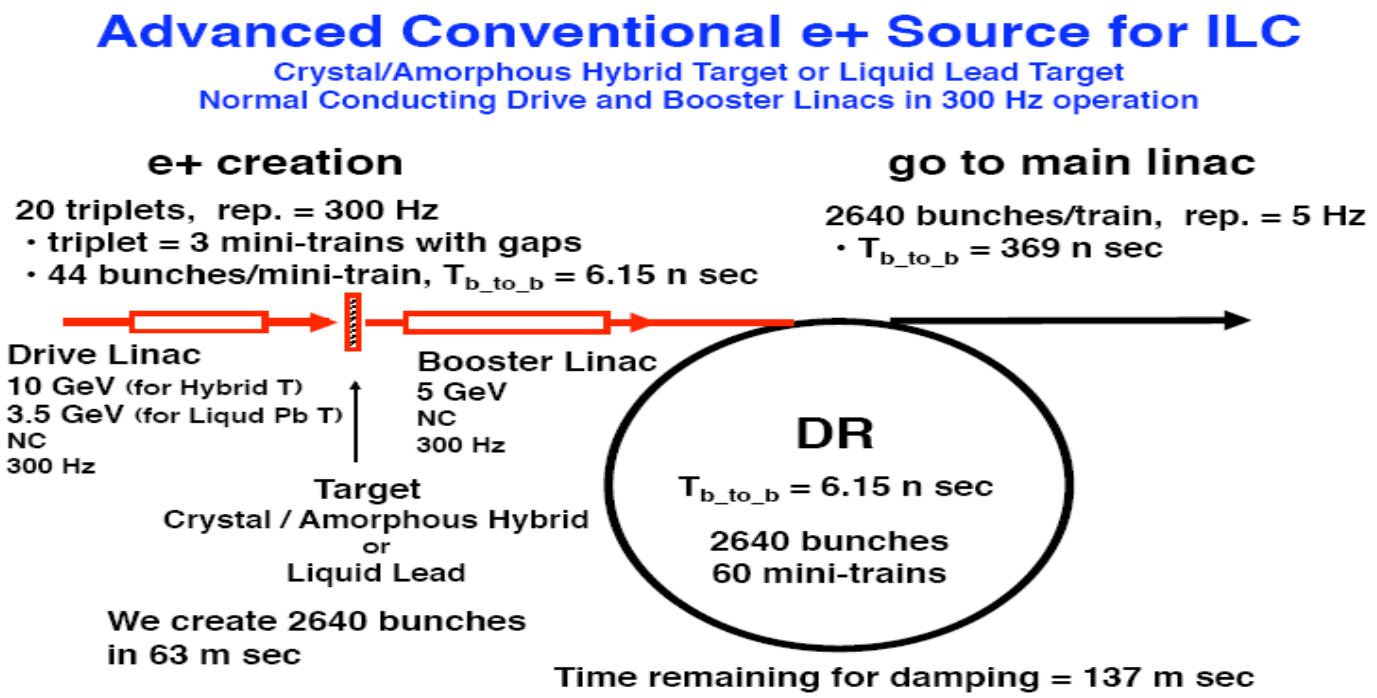
POSIPOL 2009: SUMMARY

- **HYBRID POSITRON SOURCES USING CHANNELING**
- **SIMULATIONS FOR CLIC (O.Dadoun)**



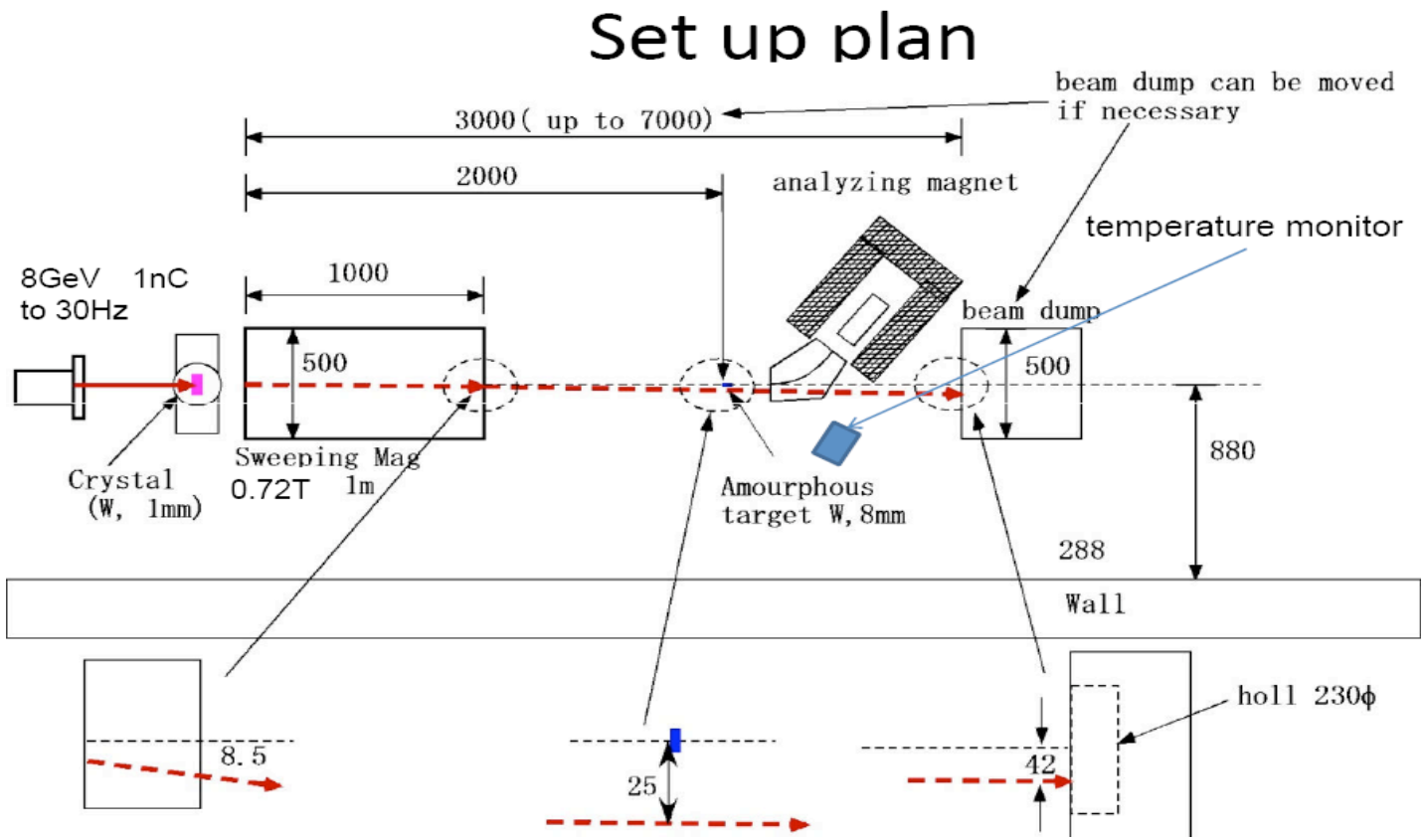
POSIPOL 2009: SUMMARY

- **HYBRID SOURCE: CAN WE USE IT FOR ILC?**
- **Needs modification of the incident beam ➔ stretched pulse (OMORI pres.)**



POSIPOL 2009: SUMMARY

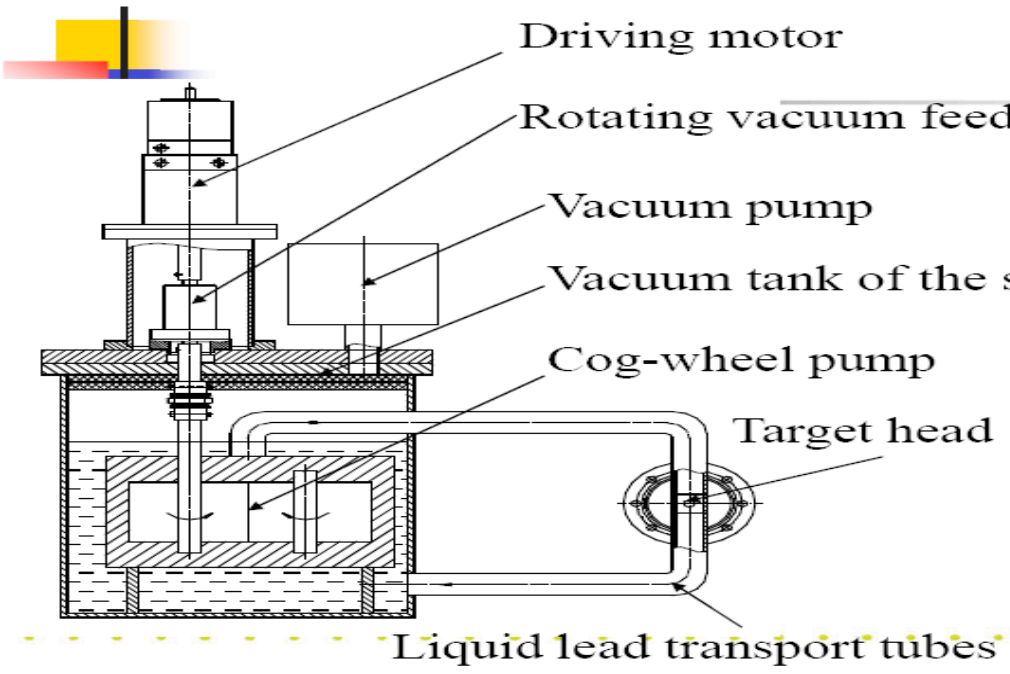
- **HYBRID SOURCE: TESTS AT KEK [T.Takahashi]**



POSIPOL 2009: SUMMARY

- **TECHNICAL DEVELOPMENTS**
- **1) Liquid targets idea of G.Silvestrov {Test foreseen at KEK/ J.Urakawa}**

System of the prototype of liquid lead positron production target.



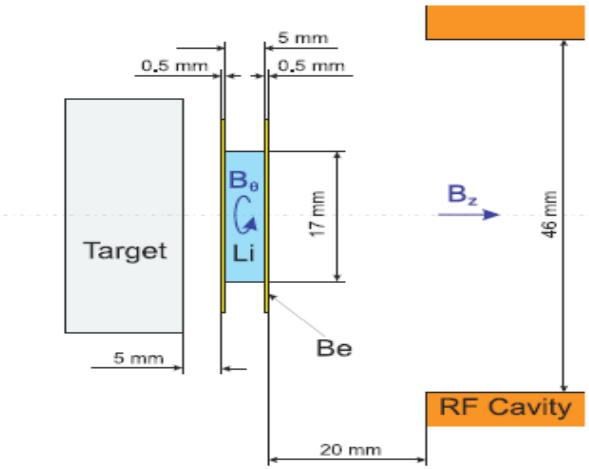
Window thickness 4mm
BN disks for windows
Diameter 12mm

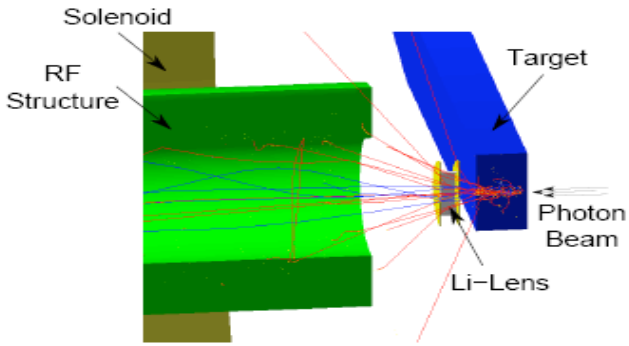
5

POSIPOL 2009: SUMMARY

- **TECHNICAL DEVELOPMENTS**
- **2) Lithium lenses ; first proposed by G.Silvestrov (A.Ushakov)**

Li-Lens Model





$$B_\theta(r) = \frac{\mu_0 I r}{2\pi a^2}$$

$$B_z = 0.5\ \mathrm{T}$$

Optimization on Li-lens radius, length, distance to target..

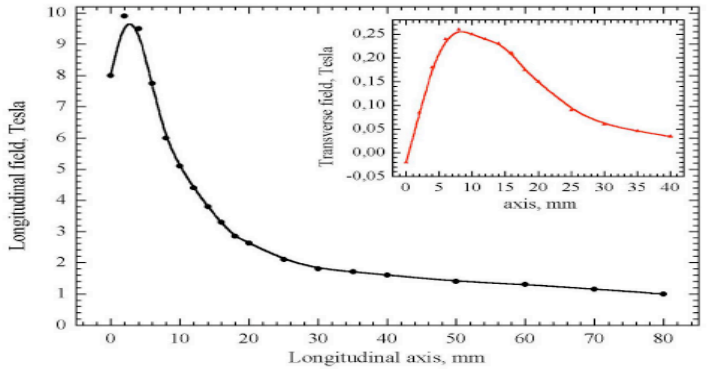
A. Ushakov (DESY) | Lithium Lens Simulations | POSIPOL, 26 June 2009 | 5 / 24

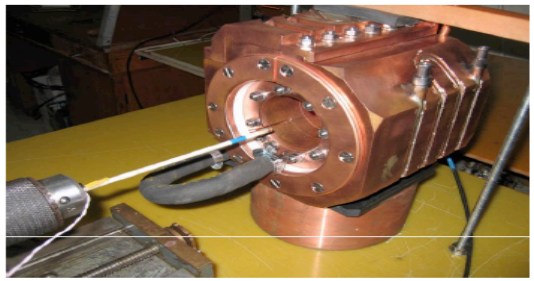
POSIPOL 2009: SUMMARY

- **TECHNICAL DEVELOPMENTS**
- **3) FLUX CONCENTRATOR (Constructed by BINP/To be installed at KEK)=> T.Kamitani**

Field distribution

16





Low-power Prototype

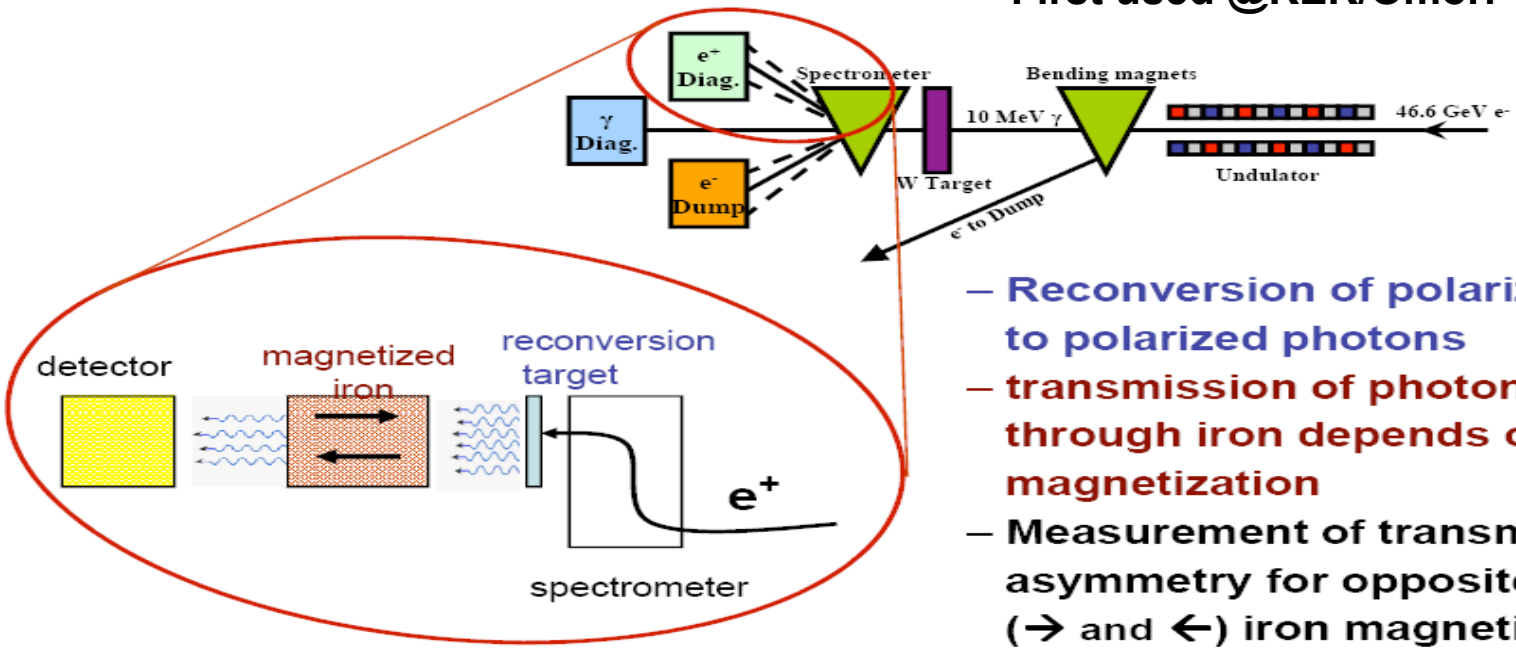
1. 10-T field can be achieved.
2. Design efforts performed with some prototypes to minimize transverse field component.
3. Field axis offsets 1 ~ 2 mm.

POSIPOL 2009: SUMMARY

- **POLARIMETRY [S.Riemann]**

ILC E166 Compton transmission polarimeter

First used @KEK/Omori



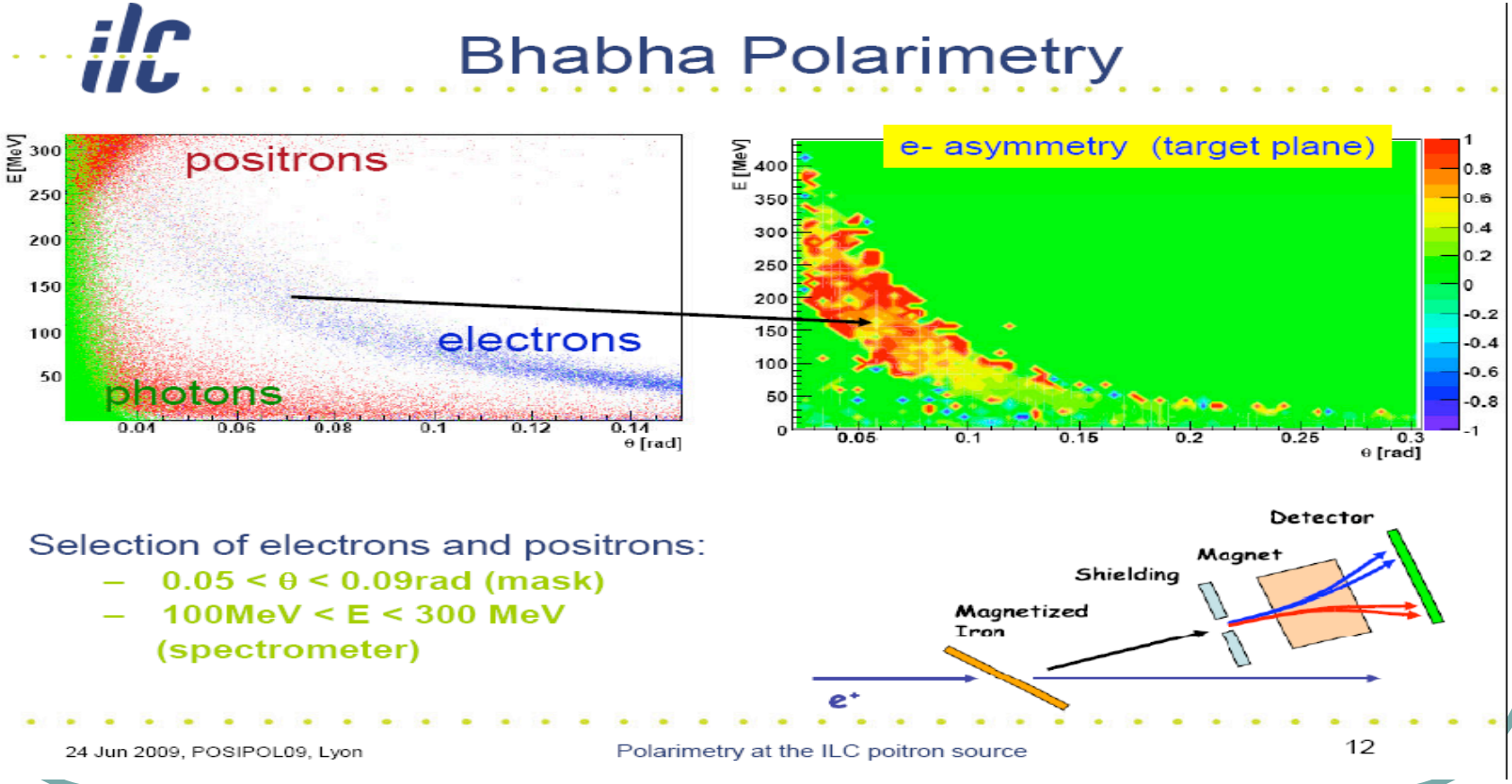
- Reconversion of polarized e+ to polarized photons
- transmission of photons through iron depends on its magnetization
- Measurement of transmission asymmetry for opposite (→ and ←) iron magnetization

Method was also used at ATF

24 Jun 2009, POSIPOL09, Lyon — Polarimetry at the ILC poitron source — 7

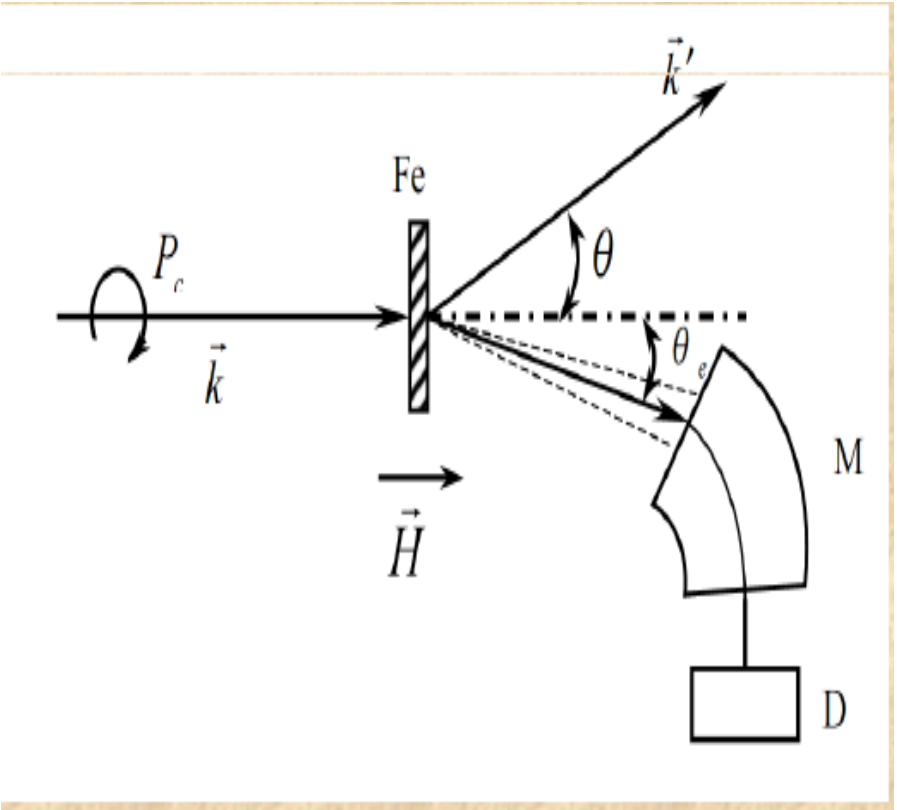
POSIPOL 2009: SUMMARY

- **POLARIMETRY (S.Riemann)**



POSIPOL 2009: SUMMARY

- **POLARIMETRY (A.Potylitsin)**
- **A.Potylitsin is proposing to**
- **use the recoil electrons from**
- **Compton scattering in the**
- **magnetized Fe foil in order to**
- **avoid noise contributions**
- **from pair processes in the**
- **Fe target. Simulations**
- **showed good results**



POSIPOL 2009: SUMMARY

- **THEORY & MODELS**
- **# THEORY**

A) Polarization of particles in electromagnetic showers developing in media (V.M. Strakhovenko)

B) Theoretical constraints in polarised reactions (X. Artru)

A) Numerical results on polarised showers were presented by V.M. Strakhovenko. They were obtained with a simulation code based on more rigorous formulae than those of Olsen and Maximon [Phys. Rev. 114, 887 (1959)] (the latter are up to now the more widely used).

The curves show a universal, rougly linear, increase of the longitudinal polarisation P_{final} of a final particle with the reduced energy $x=E_{final}/E_{initial}$. The polarisation transmission factor $P_{final}/P_{initial}$ reaches 1 at x=1.

The code describing electromagnetic shower development with an account for polarizations of all the involved particles is now practically completed.

POSIPOL 2009:SUMMARY

- **THEORY**

B) Some constraints relevant to the simulation of polarised showers were discussed by X. Artru : Parity, PT + reality of the Born amplitudes, Chirality and positivity. Following the formalism of [X. A., M. Elchikh, J-M. Richard, J. Soffer, O. Teryaev, Phys. Rep. 470 (2009)], these constrains are divided into classical and quantum ones. Quantum positivity constraints are related to entangled (non separable) states.

- **In principle, due to the non-separability of spin correlations, Monte-Carlo simulations of showers require a special method proposed by J.C. Collins and I.G. Knowles [Nucl.Phys.B304 (1988)]. However, when one is only interested in the one-particle momentum distributions and polarisations, the method actually used to implement spin is valid.**

- **A possible flaw in the method of Olsen and Maximon to include screening corrections was pointed out. It may be the reason why preliminary calculations, based on O&M formulae and presented at this conference by E. Voutier, seem to generate polarisations larger than unity at low energy. This flaw is not present in the Strakhovenko approach.**

POSIPOL 2009: Summary

- **PPS-SIM (A.Schaelicke)**
  - Idea: use Geant4 for modelling of PPS
    - start from positron production (target)
    - end after first accelerator structure
    - simplified geometry
    - aim: easy usage (also for non-G4 experts)
  - graphical user interface (GUI)
    - visualisation
    - internal analysis
  - allow for batch mode running
    - high statistics runs
    - configure via macro commands
    - post analysis

POSIPOL 2009: SUMMARY

- **PRELIMINARY CONCLUSIONS**
- **# Repeated interest for polarized positron sources for all the collider projects (ILC, CLIC, SuperB)**
- **# Merging of some R&D for the different projects: capture, heating, targetry,**
- **# Improvement in simulation tools following better theoretical understanding**
- **# Importance of experimental tests : Tests @ KEK will bring useful informations on hybrid sources, liquid targets, matching devices (Flux Concentrator,..)**
- **# Improved exchanges and regular meetings between the people working on positron sources : POSIPOL appears as a continuation of an uninterrupted discussion**