

## Minutes of the 15th "ILC-CLIC e+ studies" meeting

Date: July 22nd, 17:00(JST) 10:00(CET), 2010

A part of Attendees (whom Omori was able to hear the voices):  
Louis(CERN), Eugene(NSC-KIPT), Peter(NSC-KIPT),  
Chehab(IPNL/LAL), Chenghai(IHEP/LAL), Chaikovska(LAL),  
Sabine(DESY), Andreas(DESY), Andriy(DESY-Z),  
Takahashi(Hiroshima), Kataoka(Seikei), Urakawa(KEK),  
Suwada(KEK), and Omori(KEK)

### Agenda:

1. Analytical study of pol. e+ production by Compton sources: Eugene-san
2. Summary of POSIPOL 2010 : Omori
3. CHANNELING 2010 conference : Chehab-san

### Presentations:

[http://www-jlc.kek.jp/~omori/ILC-CLIC-e+Studies/20100722/20100722-EugeneBulyak\\_theory.pdf](http://www-jlc.kek.jp/~omori/ILC-CLIC-e+Studies/20100722/20100722-EugeneBulyak_theory.pdf)

[http://www-jlc.kek.jp/~omori/ILC-CLIC-e+Studies/20100722/20100722-Omori\\_POSIPOL2010Summary](http://www-jlc.kek.jp/~omori/ILC-CLIC-e+Studies/20100722/20100722-Omori_POSIPOL2010Summary)

[http://www-jlc.kek.jp/~omori/ILC-CLIC-e+Studies/20100722/20100722-Chehab\\_Channel2010Announce.pdf](http://www-jlc.kek.jp/~omori/ILC-CLIC-e+Studies/20100722/20100722-Chehab_Channel2010Announce.pdf)

1. Analytical study of pol. e+ production by Compton sources:

Eugene-san presented the analytical study of pol. e+ production by Compton sources.

Please look at "20100722-EugeneBulyak\_theory.pdf".

#### (a) Why analytical study?

- \* Main output parameters  
yield (current) of positrons,  
polarization
- \* determined with
  - (1) spectrum of gammas (max energy)
  - (2) preselection (collimation)
  - (3) thickness (and geometry) of conversion target
  - (4) material of conversion target
  - (5) postselection - selection of subspectra of pol. e+

Simulations produce very precise parameters of feasibility for a given set of input parameters (see, e.g. Wei Gai-san simulations or Sabine-san's group ones, or other colleagues), but unable to indicate an optimal set for required yield and/or polarization.

Adreas-san pointed out that "unable to indicate an optimal set" was too strong words. We can make optimization by simulations.

(b) A priori reduction of number of parameters

- \* Two parameters from the list in (a) considered as given
  - (1) max energy of gammas limited by the beam dynamics in Compton storage rings (the higher the better);
  - (4) material of the target (the heavier the better).
- \* Remaining 3 parameters (3D space)
  - (2) preselection (collimation)
  - (3) thickness (and geometry) of conversion target
  - (5) postselection – selection of subspectra of pol. e+

(c) Analytical Model

Positron at output is born from laser photon as a result of subsequent transformations/selections. Each step may change polarization and/or intensity. The steps are described with simplest possible model aimed at obtaining the result in a closed form (at least in quadratures) to allow search for optimum.

- (i) Monochromatic laser photons
- (ii) Ideal Compton spectrum of gammas (scattering off monochromatic electrons with parallel trajectories)
- (iii) Preselection discards gammas with energies lower than  $E_{pre}$
- (iv) Pair production cross section independent on the energy of gammas, uniform distribution of positrons over energy
- (v) Linear energy losses of positrons traversing the target (ionization losses)
- (vi) Post-selection discards e+ with energies lower than  $E_{post}$

Louis-san made a question:

The approximation "pair production crosssection independent on the energy of gammas" seemed too rough.

Eugene-san's answer:

When the gamma energy is high, roughly  $> 15$  MeV, the approximation is not bad, because the energy dependence is logarithmic. Low energy gamma-rays

are thrown away by the preselection. So, the approximation has no problem.

(d) Distributions assumed/obtained in the Analytical Model:

(1) Gamma-ray distribution (laser is circularly pol.).

Eugene-san discussed effect of the preselection (effect of the gamma-ray collimation).

(2)  $e^+$  distribution (assume gamma-ray is monoenergetic).

Omori-pointed out that the distribution (2), slide #6, was not correct. In slide #6, number of "+" polarized positrons and number of "-" polarized were the same. However, if we start from the "+" polarized gamma-rays, the number of "+" polarized positrons should be larger than the number of "-" polarized positrons.

(3)  $e^+$  distribution (assume gamma-ray dist. of (1))

Eugene-san discussed treatment of the target thickness.

(4)  $e^+$  distribution (include target thickness)

Eugene-san discussed effect of the post-selection (effect of positron energy selection) and optimization.

(5) Yield as a function of post-selection (thin target).

(6) Optimal target thickness ( $r_l$ ) vs. energy of post-selection.

(e) Summary:

- \* Simple analytical model able to localize volume of parameters where to search for optimum.
- \* Given polarization degree require optimal target and selections
- \* Examples: tungsten,  
E<sub>g</sub>:max = 20MeV
  - (i) E<sub>post</sub> = 15MeV -->  
yield 1.7e-3; polarization 0.82;  
optimal thickness 0.185  $r_l$
  - (ii) E<sub>post</sub> = 10MeV -->  
yield 1.25e-2; polarization 0.62;  
optimal thickness 0.344  $r_l$

Plots of the yield and the polarization were presented as a function of the post-selection energy. At each post-selection energy, optimal target thickness for the energy was assumed.

(f) Outlook:

- \* The rod target seems to be effective if high polarization required.
- \* Theoretical curves to validate in a few points with simulations (realistic Compton spectra, positron dynamics in the target, etc.)  
(10MeV gammas with 2MeV post-selection; 0.4 r1 Ti target shows good agreement with Sabina-san et al. simulations)

2. Summary of POSIPOL 2010:

Omori made a summary of POSIPOL 2010.

Please look at "20100722-Omori\_POSIPOL2010Summary.pdf".

(a) POSIPOL 2010 outline:

Date: 31/May-2/June

Place: KEK

44 participants (including 4 via WebEx/Phone)

36 presentations with discussions

<http://atfweb.kek.jp/posipol/2010/>

(b) 36 Presentations distributed in 10 sessions:

- \* Welcome and Scope: (2 talks)
- \* Status of e+ sources for colliders :(3 talks)
- \* Compton-based e+ sources for colliders(ILC&CLIC):(10 talks)
- \* Physics: (1 talk)
- \* R/D Plan (ILC-CLIC working group) : (1 talk)
- \* Compton-based X-ray and gamma-ray sources : (4 talks)  
(including appl. to material physics)
- \* Undulator-based e+ source for ILC:(4 talks)
- \* Hybrid and channeling e+ sources (CLIC&ILC): (7 talks)
- \* Liquid Pb and Pure Conventional e+ sources (ILC): (3 talks)
- \* Summary: (1 talk)

(c) Summary of each session:

In the summary, Omori presented a slide from Louis-san's talk. The slide expressed that how the requirements to the CLIC and ILC e+ source were large, in the comparison with SLC.

- Number of e+ per second:  
CLIC = 18xSLC  
ILC = 65xSLC

In the following, in (c-1) to (c-10), each session is

summarized.

(c-1) Welcome:

- \* K. Nishikawa (KEK)
  - The JAHEP community's master plan  
Highest priority is given to ILC  
Before ILC, promote flavor physics at KEKB and J-PARC
  - Action before the ILC approval
    - ILC R&D
    - Completion/commissioning/improvements of J-PARC
    - Upgrade of KEKB/Belle
    - Collaboration in LHC/ATLAS

(c-2) Status of e<sup>+</sup> Sources for Colliders (3 talks):

- \* Status of ILC e<sup>+</sup> Source: K. Yokoya (KEK)
  - Design reconsideration: SB2009  
undulator location, matching device, , , ,
  - R/Ds
    - Prototype undulator
    - Target prototype (in Air)
    - Target Mockup (in Vacuum)
    - Flux concentrator (design study)
- \* Status of e<sup>+</sup> Sources for Super B factories: T. Kamitani(KEK)  
Plans of Super KEKB and SuperB of INFN
- \* Status of BEPC II e<sup>+</sup> Source : G. Pei (IHEP)  
Impressive progress from BEPC to BEPC II

(c-3) Compton-based e<sup>+</sup> sources for colliders (10 talks):

- \* Compton-based e<sup>+</sup> sources for ILC: M. Kuriki (Hiroshima)  
Overview of Compton sources: Linac scheme, Compton ring,  
and ERL scheme
- \* Linac-based Compton e<sup>+</sup> source for ILC: V. Yakimenko (BNL)  
CO<sub>2</sub> laser + Linac : Polarized e<sup>+</sup> source & High Intensity  
X-ray Source
- \* Optimal Compton ring for e<sup>+</sup> production: E. Bulyak (KIPT)  
Laser-cooled Compton ring and it's optimization
- \* Compton ring for e<sup>+</sup> production w/2-micron-laser: P. Gladkikh (KIPT)  
Compton ring with 2-micron laser seems as realizable at  
attractive ring acceptance and gamma-beam intensity, but  
with "Crazy" parameters.
- \* Energy compression to optimize the stacking: R. Chehab  
New scheme of energy compression:  
an isochronous line + Deflector

- \* Status of 4-M cavity for ATF : F. Zomer (LAL)  
The 4-mirror cavity and the laser is ready at LAL and coming to KEK
- \* 3D 4-M cavities for intense photon gen.: T. Akagi (Hiroshima)  
Construct a calculation model incorporating the effects of image rotation, and compare the model and measurements.
- \* Stacking simulation update: F. Zimmermann (CERN)  
Stacking simulation for CLIC "two stacking ring" scheme.  
See the minutes of the phone meeting on 24-June-2010.
- \* e<sup>+</sup> production and capture with a mult-IPs: I. Chaikovska (LAL)  
Photons flux with multiple IPs line. 10 IPs with 2 crossing LASERs. Optimal -> 5 IPs: detailed study for 5 IPs
- \* Experiment with the 2-M cavity at KEK-ATF: S. Miyoshi (H)  
The enhancement factor was improved from 250 to 760.  
Next step will be Bunch by bunch gamma ray measurement.

(c-4) Physics:

- \* New from physics with polarized beams: G. Moortgat-Pick (DESY)  
Benefits of the e<sup>+</sup> beam polarization in ILC and CLIC were summarized.

(c-5) R/D plan:

- \* New milestones for the CLIC/ILC e<sup>+</sup> generationWG: L. Rinolfi (CERN)  
Plan 2010 - 2011 for Asian, American, and European labs were reviewed.

(c-6) Compton-based X-ray and gamma-ray sources:

- \* Compton Programs in KEK: J. Urakawa (KEK)  
Development for Next Generation Compact High Brightness X-ray Source using Super Conducting RF Acceleration Technique
- \* Opportunities for materials science w/inv-Compton X-ray:S. Adachi  
Compact ERL as a laser Compton X-ray source  
Scientific opportunities;
  - Ultrafast X-ray sciences
  - Phase contrast X-ray imaging
- \* Nuclear Applications of Laser Compton X/gamma-rays: R. Hajima  
Mono-energetic X/gamma-ray generated by LCS can be used for nuclear security applications: detection and measurement of nuclear material. Hajima propose an ERL-based gamma-ray source for nuclear safeguards applications in the next-generation nuclear fuel cycle.
- \* Compton ring for nuclear waste management: P. Gladkikh (Compton Ring for Nuclear Resonance Fluorescence)

#### APPLICATIONS:

- nondestructive assay of radioactive nuclides;
- management of nuclear waste;
- advanced safeguard technologies of non-proliferation

#### (c-7) Undulator-based e<sup>+</sup> sources for ILC

- \* Polarization issues with the undulator based sources: W.Gai(BNL)
  - Higher harmonics are important and can influence the overall polarization.
  - Polarization and yields are always conflicting, compromises need to be made.
  - Lower energy drive beam (150 GeV) is more practical in achieving high degree polarization than higher drive beam energy (250 GeV).

Louis-san made question:

Why lower energy drive beam is more practical?

Omori's answer:

Larger angular divergence makes the collimation easier.

- \* Rotation vacuum seal & flux concentrator update:T. Piggott(LLNL)
  - Continued analysis of flux concentrator- extending to different geometries stress, thermal, and B-field are evaluated.
  - Beginning setup and planning for vacuum seal tests.
- \* Status of e<sup>+</sup> Source Simulation in Zeuthen: A. Ushakov (DESY)
  - Polarized Positron Source Simulations (PPS-Sim): Geant4-based application for e<sup>+</sup> source modeling
  - Simulation Results for Conventional Source
- \* Discussion toward re-baseline: All
  - Prototype test of vacuum rotating seal with the real size disk (wheel) is important.

#### (c-8) Hybrid and channeling e<sup>+</sup> sources:

- \* Channeling of Radiations from Leptons to X Photon: S.B.Dabagov
  - Channeling of charged particle and channeling radiation
  - Wave guiding of X-ray and neutron by capillary.
- \* Asym. of bremsstrahlung from moderately relativistic pol. e<sup>-</sup> (e<sup>+</sup>) and its feasibility for polarimetry: A.Potylysyn
  - bremsstrahlung polarimeter
- \* Hybrid target simulation: O. Dadoun (LAL/CERN)
  - to add the crystal simulation inside Geant4
- \* Atomic undulator to generate unpolarized e<sup>+</sup> for CLIC and ILC: R. Chehab
  - An axially oriented crystal having very high fields needs 2 orders of magnitude less energetic e<sup>-</sup> beams

to generate photons.

- Separating the crystal-atomic-undulator from the conversion target, enables use of only photons, decreasing significantly the level of PEDD.
- \* CLIC e+ source for the baseline configuration: L. Rinolfi (CERN)
  - Overall and detailed picture of CLIC hybrid source (baseline).
- \* Optimization of the CLIC Positron Source: A. Vivoli (CERN)
  - Optimization of the capture section for non-polarized e+s is necessary and will be performed soon.
- \* Hybrid Experiment at KEK Linac: T. Takahashi (Hiroshima U.)
  - Experimental study is ongoing at KEK Linac.

(c-9) Liquid Pb and Pure Conventional e+ sources:

- \* Liquid Pb Status: T. Omori
  - BN window test prepared at KEKB ring.
  - System test of Liquid Pb target is planned at ATF linac.
- \* Shockwave simulation of the liquid Pb target: N. Okuda
  - Heat simulation was done based on Geant4 and seemed OK.
  - Shockwave simulation is under developing and still has problems.
- \* Purely Conventional: T. Takahashi
  - survey (again) parameters of conventional targets in the "drive beam energy"-"target thickness" plane
  - See if conventional sources survives the ILC criteria

(c-10) Concluding Remarks:

At the last of the workshop, Omori (LOC chair) expressed the appreciation.

- Thanks, all participants.
- Thanks, all IPC members.
- Thanks, all LOC members.
- Especially to Ms. Ikeda, Ms. Kusama, and Mr. Araki.

(d) Next and Next<sup>2</sup> workshop information:

During the workshp period, the International Program Committee (IPC) had a discussion on the next POSIPOL venue. IPC continued the discussion after the workshp via e-mail exchange. The IPC decided the venues of the next and the next<sup>2</sup> workshop.

- POSIPOL 2011 at Beijing hosted by IHEP.
- POSIPOL 2012 at Hamburg hosted by DESY.



### 3. CHANNELING 2010 conference:

Chehab-san announced the international conference CHANNELING 2010: Charged and Neutral Particles Channeling Phenomena.

Please look at "20100722-Chehab\_Channel2010Announce.pdf".

#### CHANNELING 2010

date: October 3-8

venue: Ferrara, Italy

web-site

<http://www.lnf.infn.it/conference/channeling2010/home.html>

#### TOPICS

- \* Coherent scattering of relativistic charged particles in matter.
- \* Radiation of relativistic charged particles in periodic structures (coherent bremsstrahlung, channeling radiation, resonant transition radiation, diffraction radiation, parametric x-ray radiation, LPM effect).
- \* Crystal channeling, volume capture and crystal reflection of positive ions: theory and experiments; crystal assisted collimation in hadron colliders.
- \* Channeling of radiations in capillary systems (micro- and nanochanneling, nanotubes, nanoporous).
- \* Novel types of sources for electromagnetic radiation (FEL, Thomson scattering, laser plasma acceleration).
- \* Applications of channeling phenomena (bending of the beams, positron sources, powerful radiation sources, x-ray waveguides, capillary/polycapillary optics, novel x-ray table-top instruments.

Chehab-san will make two presentations in CHANNELING 2010; Positron Sources using Channeling (Hybrid target) and Report of POSIPOL 2010.

Chehab-san reminded the colleagues involved in "ILC/CLIC e+ studies" that their participation at CHANNELING 2010 is fully wished. The abstracts must be sent by the end of the month, before July 23d preferably. The registration is open with a wider deadline (up to October 3d)

### 4. Announcement:

Louis-san made an announcement to remind the colleagues the CLIC CDR deadline.

The date of the next phone meeting will be on September/2nd.

Reported by T. OMORI