Project name

Polarimetry at LC

Classification (accelerator/detector:subsystem)

Accelerator

Institution(s) and personnel

University of Iowa, Department of Physics and Astronomy:
Yasar Onel (professor), E. Norbeck (professor), J.P.Merlo, A.Mestvirisvili (post-doc), U.Akgun, A.S. Ayan, F. Duru (grad.students), I.Schmidt (Mechanical Engineer), M.Miller (electronics engineer), Jon Olson (undergrad. scholar)

Fairfield University, Department of Physics:
Dave Winn (professor), V.Podrasky (engineer), C.Sanzeni (programmer)

Iowa State University, Department of Physics:
Walter Anderson (professor)

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Bogazici University, Department of Physics, Istanbul, Turkey:
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Project Overview

Introduction:

A high (~80%) and precisely known (at 1% level) electron beam polarization is considered as a key feature at LC to detect and unambiguously interpret new physics signals [1]. Accurate measurements of beam polarization will be needed. Following the remarkable success of Compton backscattering polarimeters [2] at SLC and LEP, this method is a prime choice also at LC [3]. At this early stage, however, additional methods are worth exploring in order to survey other viable solutions to such a demanding task and compare their respective merits. Moeller scattering is often used also, despite limitations associated with a more invasive (magnetized foil) target (with low electron polarization).

Detection schemes

The performance of electron polarimeters in the challenging environment at LC will crucially depend on the detection schemes for scattered electrons or photons. Quartz Fiber Calorimeters [4] have been proposed for a number of applications in extreme experimental conditions of very severe radiation levels both at hadron and lepton machines. Extensive studies have been carried out for the design of large detectors and realistic beam tests on full scale prototypes [5] have been performed recently. In particular, the Iowa group has been leading an effort aimed at building a very forward QFC (HF) for the CMS experiment at LHC [6] since 1994. The available information and know-how collected give evidence that such a type of detector would respond ideally to the highest level of requirements for a LC polarimeter, as already demonstrated at SLC [7]. QFC are radiation hard at the level of more than 2 Grad. The 0.2 MeV Cerenkov threshold makes the detector insensitive to a large fraction of soft radiation. With high-Z absorber material (for instance tungsten), the showers corresponding to high energy electrons or photons are completely contained in a compact device. Their transverse size is so small to provide an excellent position resolution and angle determination. The flexibility in the QF arrangement and in the PM readout can be matched to the required granularity for space resolution and density for energy resolution. The only limitation is a financial one. The basic formalism for Compton and Moeller polarimeters are given in Ref [8].

R&D Program

Our R&D study of a QFC designed for a LC polarimeter will largely benefit from our experience on the QF technology and the calorimetry properties of such devices. We gained this experience in the design and tests of the prototypes for the HF calorimeter of CMS. This extensive work background means substantial savings of time, efforts and costs in case of a specific project for a LC polarimeter detector. We will therefore concentrate our R&D essentially on straightforward developments to improve the granularity and resolution of such a calorimeter. To achieve an adequate balance between physics goals and cost for such a large detector, these properties were not emphasized for HF. We intend to design and build a prototype QFC module of sub-millimetric granularity using multi-anode PMT (16 or 64 channels) for the QF readout. The prototype will be tested over a broad energy range relevant for scattered electrons and backward scattered photons.

Conclusions

A QFC with optimized granularity and energy resolution for high energy EM Showers appears to be an essential component of an electron beam polarimeter at LC. Its advantages are radiation hardness, soft background rejection, good localization, and directional precision as well as energy resolution. Our group has ample experience with this type of detector, as well as with the use of multi-anode PMT [9]. Such accrued competence gives us complete confidence in our ability to design, build and test a prototype in order to demonstrate its suitability for polarimetry at LC in a timely and cost-effective fashion.

Budget-FY03-04

Institution	Item	Cost
Iowa	1/4 post-doc	$12,500
Iowa	1/2 grad. Student	$12,000
Iowa	Quartz fiber (QP) 2km	$5,000
Iowa	Copper absorber	$4,500
Iowa	5 Multi-anode PMT H6568	$9,000
Iowa	6 months engineering salary	$9,000
Iowa	Travel	$4,000
IowaState	6 months engineering salary	$9,000
IowaState	Travel	$2,000
Fairfield	Additional electronics required from rental pool – CERN (FERA ADC rental, DAQ electronics)	$4,000
Fairfield	Secondary emission detector package	$10,000
Fairfield	Partial support for two undergrad. Student	$6,000
Fairfield	Travel	$2,000
Iowa	Iowa total	$56,000
IowaState	Iowa State total	$11,000
Fairfield	Fairfield total	$22,000
	Grand total	$89,000

Available equipment: FERA ADC 160 channels, discriminators, DAQ equipment, 5 16-channel H6568 PMTs, and calibration electronics and equipment to test QF Calorimeter (LED systems, Laser systems, PIN diodes systems, and radioactive source calibration)

References

[1] See for instance: C. Verzegnassi in Proc. Adriatico Research Conf. on Trends in Collider Spin Physics; Ed. **Y. Onel**, N. Paver and **A. Penzo**; World Scientific Publ. (1997) 93 (and references therein);

[2] L. Piemontese (SLD Collaboration) in Proc. Adriatico Research Conf. on Trends in Collider Spin Physics; Ed. **Y. Onel**, N. Paver and **A. Penzo**; World Scientific Publ. (1997) 129 (and references therein); M.Placidi and R. Rossmanith: in Proc. 8th HEP SPIN Symp. MN; AIP 187 (1988) 1395; also NIM A274 (1988) 64

[3] M. Woods, Compton Polarimetry at a 1 TeV Collider, SLAC - PUB - 7744 (1998)

[4] G. Anzivino et al., NIM A357 (1995) 380; P. Gorodetzky et al., NIM A361 (1995) 1; N. Akchurin, **Y. Onel**, et al., NIM A399 (1997) 202

[5] N. Akchurin, **Y. Onel**, et al., NIM A400 (1997) 267

[6] The CMS Collaboration, CERN/LHCC 97-31 (1997)

[7] S. C. Berridge et al., Proc. 13th Int. Symp. On High Energy Spin Physics (Protvino) (1998); Ed. N. E. Tyurin et al.; World Scientific Publ. (1999) 534

[8] M. Preger in Proc. San Miniato Topical Seminar on New Pespectives and Methods for High Energy Spin Physics; Ed. P.Pelfer and **A. Penzo**; Printed by Servizio Riproduzione INFN Trieste (1983) 227.

[9] RD-17 (FAROS Collaboration: CERN, INFN-Trieste, IHEP-Protvino, LAPP-IN2P3, Kyoto-Sangyo University, **University of Iowa**): Fast Readout of Scintillating Fibres using Position-Sensitive Photomultipliers; see also: V. Agoritsas, **Y. Onel, A. Penzo**, et al. NIM A357 (1995) 78.

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