VI International Conference on INSTRUMENTATION FOR EXPERIMENTS AT $e^+ e^-$ COLLIDERS

Budker Institute of Nuclear Physics, Novosibirsk, Russia
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The Conference is organized by the Russian Academy of Sciences and Budker Institute of Nuclear Physics and is held at Novosibirsk. This is the sixth in a series of conferences, which were held in INP and SLAC in turn started at Novosibirsk in 1977. Its purpose is to report and discuss advances in experimental methods for colliding beam physics.

TOPICS:

- **Detectors and Colliders**
- **Tracking and Vertex Detectors**
- **Particle Identification**
- **Calorimetry**
- **Electronics, Trigger and Data Aqcuisition Systems**

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1 Status Reports

1.1 Status of e^+e^- Colliders at Novosibirsk

A. Skrinsky
Budker Institute of Nuclear Physics
Novosibirsk, Russia

In the talk, the status of the operating e^+e^- Novosibirsk complexes VEPP-2M with its CMD-2 and SND detectors and VEPP-4M with KEDR detector and high precision tagging system is presented.

The VEPP-2M upgrade in prepapration for "round beam" option with the aim to reach $1 \cdot 10^{32}\ cm^{-2}s^{-1}$ luminosity is described briefly.

The short review of the new VEPP-5 e^+e^- project, now under development and construction at Novosibirsk, presents description of the high productivity injector complex, the ϕ Factory, the Charm/τ factory and, also, the high luminosity VEPP-4M option for two-photon physics.

1.2 DAΦNE Project Status Report

R. Baldini and F.L. Fabbri
Frascati, Italy

A status report of the DAFNE project is presented, summarizing collider, detectors and physics goals of the new Frascati Φ-Factory.

DAFNE is a two rings, symmetric e^+e^- collider, planned to deliver a $10^{33}cm^{-2}s^{-1}$ luminosity at the Φ mass. Two flat beams, circulating in ~ 100 bunches in two coplanar rings, collide in two intersection regions with a ~ 12 mr crossing angle.

Three detectors are under construction, to be installed in the interaction regions:

- KLOE is a general purpose detector mainly devoted to study CP and CPT symmetries in K decay. The main items are:

  a very large drift chamber, ~ 4 m diameter and ~ 3.5 m length, filled with a He based mixture in a 6 KG longitudinal magnetic field;

  an e.m. calorimeter, made of scintillation fibers and fully surrounding the drift chamber, achieving good efficiency for detecting low energy photons and good timing resolution for a better neutral vertex reconstruction.

  The e.m. calorimeter is almost completed and the drift chamber is under construction.

- FINUDA is a detector mainly devoted to hypernuclei physics and low energy KN interactions. The main items are:

  a thin target around the beam pipe, sandwiched by thin scintillation and silicon counters;

1.9 Detector KEDR Tagging System for Two–Photon Physics

L. Romanov

Budker Institute of Nuclear Physics
Novosibirsk, Russia

A special system to tag scattered electrons from $\gamma\gamma$–processes is described. The tagging system (TS) is intended for the experiments with detector KEDR at the VEPP–4M storage ring. TS has a high detection efficiency for zero angle scattered electrons and invariant mass resolution approximately an order of magnitude better than in the previous systems.

Special laser setup, which was developed for another experiments and adjusted for our needs, allows to calibrate TS and to measure its energy resolution using process of backward Compton scattering. The useful by–product of this process is a beam of photon with known energy.

Principle, construction, and present status of TS are presented. Also TS calibration results and some past and current experiment, in which TS is involved, are discussed.

1.10 A Laser Based Beam Profile Monitor for the SLC/SLD Interaction Region

Marc Ross, SLAC
(presented by T. Mattison)

Beam size estimates made using beam-beam deflections are used for optimization of the Stanford Linear Collider (SLC) electron- positron beam sizes. Typical beam sizes and intensities expected for 1996 operations are 2.1 × 0.5 um (x,y) at 4.0×10^{10} particles per pulse. Conventional profile monitors, such as scanning wires fail at charge densities well below this and since the beam-beam deflection does not provide single beam size information another method is needed for Interaction Region (IP) beam size optimization. The laser based profile monitor uses a finely focused 350 nm. tripled YAG pulse that traverses the particle beam path about 29 cm away from the e^+/e^- IP. Compton scattered photons and degraded e^+/e^- are detected as the beam is steered across the laser pulse. The laser pulse has a transverse size of 380 nm and a Rayleigh range of about 2 um. This is adequate for present or planned SLC beams. Design and preliminary results from the new monitor will be presented.

1.11 Detector Requirements for Linear Colliders

R. Settles (MPI, Munich)

1.12 Coherent Bremsstrahlung and a New Possibility to Monitor Collisions of Beams at Colliders

G.L. Kotkin and V.G. Serbo
Novosibirsk State University, Russia

We consider the coherent bremsstrahlung (CBS) at colliders with short bunches. CBS is radiation of particles of one bunch in the collective electromagnetic field of the oncoming bunch. We give the simple qualitative description of CBS.

It seems that CBS can be a potential tool for fast control over collisions and for measuring beam parameters. The bunch length σ_z can be found from the critical energy of the CBS spectrum $E_c \propto 1/\sigma_z$; the transverse bunch size $\sigma_\perp$ is related to the photon rate $dN_\gamma \propto 1/\sigma_\perp{}^2$. A specific dependence of dN_γ on the impact parameter between the beams allows for a fast control over the beam displacement.

We present the main characteristics of CBS calculated for B and ϕ factories, LHC (in the p–p and Pb–Pb modes), RHIC, VEPP-2M and VEPP-4M.

2 Tracking and Vertex Detectors

2.1 Tracking with Micro-Strip Gas Chambers

L.I. Shekhtman

Budker Institute of Nuclear Physics
Novosibirsk, Russia

Micro-Strip Gas chambers (MSGC) are new powerfull position-sensitive detectors based on achievements of semiconductors' technology. After its introduction in 1987 by A.Oed (ILL. Grenoble) for neutron detection, MSGC were extensively studied and developed by many groups. Due to high granularity of sensitive electrodes this device has very high spatial resolution, up to 30 um rms for high energy charged particles. Small size of basic cell helps to overcome the main problem of wire gas detectors, limited rate capability. This parameter was demonstrated to be as high as 1 MHZ/mm^2 of the detector. One of the main problems of MSGC is aging, i.e. irreversible degradation of the detector due to polimerization of gas components or other effects in an insulating support after very high irradiation dose. This effect is being investigated carefully by several groups and some solutions have been found.

In this talk I will make a review of R&D efforts listed above. Some working experiments using MSGC as well as large future projects will be described.

2.2 The MicroGap Chamber: Development and Applications

F. Angelini, R. Bellazzini, A. Brez, M.M. Massai, R. Raffo, G. Spandre, M. Spezziga

INFN-Pisa and University of Pisa, Italy

The concept of MicroGap Chamber (MGC) is introduced. In this gas detector the separation between anode and cathode is only a few microns. The collection time of the ions is very short and the speed of the signal is therefore very high if compared with other gas detectors. Truly two-dimensional devices have been built, with the anode pitch ranging between 100 and 200 μm. The rate capability is extremely high ($2X10^7 counts/mm^2$). With Neon-Dimethilether gas mixtures, very high gain can be obtained ($> 10^4$) and long term stability (ageing) of the gain is very good if gold elctrodes are used. Three applications are presented.A large area MGC with two-dimensional stereo read-out for the tracker of CMS, a UV light photo-detector based on a MGC with single electron response and a MGC as X-ray polarimeter.

2.11 KEDR Drift Chamber

S.E. Baru, V.E. Blinov, V.R. Groshev, G.M. Kolachev,
V.N. Kozlov, G.D. Minakov, A.P. Onuchin, A.V. Rylin,
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The design features of the KEDR drift chamber are described. The 1m long and 1m outer diameter cylindrical chamber consists of 7 radial super layers. Measurement of spatial resolution and aging tests were performed at a prototype with a DME gas. The influence of desorption of different construction materials and gas flow rate on aging with DME was investigated. In the tests with a drift tube under rather clean conditions the relative gain drop R was measured to be $1.7\%/(C \cdot cm)$. For a cell of the KEDR drift chamber R is $45\%/(C \cdot cm)$. Such value of the gain drop will correspond to 2% pulse height decrease per year at a gas gain of 10^5 and a flux of charged particles of 1 kHz/cm^2.

2.12 The KLOE Drift Chamber

M. Primavera
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for the KLOE Collaboration

The main goal of the KLOE tracking chamber is the reconstruction, with high efficiency and good resolution, of the charged decays of the K mesons, even at the low momenta of the particles produced at the DAΦNE (Frascati, L.N.F.) e^+e^- accelerator. These requirements have led to the design of a detector with a large active volume, because of the K_L long decay path, uniformely filled by only stereo cells of $2. \times 2.\ cm^2$ and $3. \times 3.\ cm^2$ size, in order to preserve granularity and to maximize homogeneity and isotropy of the tracking volume. Moreover, the further requirement of keeping the detector transparency as high as possible, minimizing the multiple scattering effects, has been fulfilled by choosing helium as main component of the chamber operating gas mixture.

A prototype of the KLOE chamber, 3.2 m long, with 500 single sense wire, square cells arranged in 30 stereo layers, has been constructed and operated under test beam, at CERN.

Details of the KLOE chamber design and construction, together with preliminary results from the test of its full scale prototype will be presented and discussed.

2.13 Drift Chamber System for the FINUDA Experiment

M. Agnello
(Torino, Italy)

FINUDA, which is one of the two experiments approved for running at DAΦNE, the Frascati Φ Factory, in the coming years, is a non-focusing magnetic spectrometer with a cylindrical geometry around the beam pipe at the intersection point of the e^+ e^- beams. The main physics aims are the hypernuclear spectroscopy, mesonic and non mesonic decay of the hypernucleus, hypernucleus production with neutron excess, and K-N scattering. The foreseen production of hypernuclei is 75 per hour and the momentum resolution for pions of $250 - 270$ MeV/c is nearly 0.3% FWHM over a solid angle larger than 2π. Sixteen planar Low Mass High Resolution Drift Chambers are the central part

3.2 Particle Identification in the CERN-LHC Experiment ALICE

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Particle identification (PID) over a large part of the phase space and for many different particles is an important design feature of ALICE. It is of crucial importance for a number of signals (e.g. flavour composition and chemical equilibrium, lepton pairs, strangelets) and extremely useful for most others (e.g. momentum spectra, HBT, charm, jet quenching). We have two detector systems dedicated exclusively to PID, a TOF array optimized for large acceptance and average momenta and a small system specialized on higher momenta.

The technological choices for the barrel are Pestov Counters as the baseline design and Parallel Plate Counters (PPC) as the fall-back solution. The present status of the Pestov detectors as well as the uncertainties in the overall performance of a 100 m^2 detector make it essential to keep an alternative design of lower resolution but still acceptable for the physics goals. A final choice between the two technologies will be made before the end of 1996, based on test results and operational experience gained with large prototypes.

The Pestov Spark Counter [1] is a single-gap, gaseous parallel-plate detector working in the streamer/spark mode. It makes use of a semi-conductive anode and of a special gas mixture that keeps the discharge local, thus increasing the rate capability. The time resolution improves with decreasing gap size. For the ALICE TOF a gap of 100 μm between the electrodes will give sufficient pulse amplitude (necessary for the front-end readout electronics) and the desired time resolution. With this configuration, a resolution as good as 25 ps (r.m.s.) is possible at twice the threshold voltage ($\sim$6 kV). The counter operates at a pressure of 12 bar, which yields 4–5 primary electrons from a minimum ionizing particle (MIP). The spark discharges only a limited area of the semi-conductive anode ($\sim$1–2 mm^2), while the remaining area of the anode remains sensitive. The counter is read out via strip lines, which allows a two-dimensional reconstruction of the spark location. The longitudinal position is deduced from the difference between the signal arrival times at the two ends of the strip, while the transverse position is obtained from the centre of gravity of the strips exited.

This type of counter has been pioneered by Yu. Pestov at BNIP Novosibirsk. Over the last two years several prototypes have been built in collaboration with Yu. Pestov in order to develop a simplified design of similar performance which is suitable for mass production and large-scale applications. Our prototypes have as an essential new feature a strip line readout enabling a good transverse position resolution in addition to the excellent timing properties.

The counter provides position resolution in two dimensions. The position resolution σ_{long} of a discharge in the strip direction, i.e., longitudinally, is limited by the resolution of the electronics, and here mainly by the binning of the time digitizer. The walk of the discriminator is of less importance, since the signals seen at the two ends of a strip come from the same spark and do not fluctuate against each other. For a TDC with 50 ps binning, as used in our tests, and a signal velocity of 14 cm/ns, one can expect $\sigma_{\mathrm{long}} \approx 2$ mm as a lower limit. A value of $\sigma_{\mathrm{long}} \leq 2.5$ mm has indeed been reached

The transverse position resolution σ_{trans} is based on charge sharing between adjacent strips (centre of gravity method). With a 2 mm anode and 2.54 mm strips, the signal will be distributed on average over 2–3 channels. The resolution obtained from the coincidence of two spark counters is $\sigma_{\text{trans}} \approx 320\ \mu$m.

The efficiency of the Pestov spark counters was measured by comparing the counting rate of two detectors in a test beam. At 4.9 kV, the intrinsic detection efficiency is 96 %, which is in agreement with previous results from Novosibirsk.

Employing a new type of discriminator, which was specially developed for the Pestov counters, a resolution of the order of 40 ps is reached 4.9 kV. This performance compares favorably with other TOF technologies and easily surpasses the target specification of < 100 ps.

[1] E. Badura et al., accepted for publ. in NIM., and ref. therein

3.3 Particle Identification for the BaBar Experiment: The DIRC (Detection of Internally Reflected Cerenkov Light)

R. Wilson

Colorado State University, USA

First, I will present the physics requirements of a particle identification system for the BaBar experiment. The DIRC (Detection of Internally Reflected Cerenkov light) is a new device, based on well understood principles, which is well-matched to these requirements. I will describe the basic principles of the DIRC and present an overview of the current mechanical design for BaBar.

3.4 Beam Test Results of the BaBar DIRC Pototype

P. Besson

CE Saclay, France

Particle identification in the BaBar experiment will be done, in the barrel region, with the DIRC (Detection of Internally Reflected Cherenkov radiation). It is an innovative new detector concept where the photons are created and propagated in quartz bar radiators then are allowed to expand across a standoff region filled with water and finally are imaged with an array of closely packed photomultipliers. A large scale prototype has been successfully tested at CERN. The prototype will be described as well as the test beam setup and the data taking. Results will be presented in terms of photon yield, angular resolution and particle identification. The principal engineering issues for the final detector will be also presented.

3.5 Operational Experience with the SLD Cherenkov Ring Imaging Detector at the Stanford Linear Collider

David Aston

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Stanford University, Stanford, CA 94309

representing the **SLD CRID Group**

We discuss the problems encountered and lessons learned in obtaining stable operation of the SLD CRID for the past four years. During the 1994—95 run of the SLC, we achieved stable operation of liquid (C_6F_{14}) and gas (85% C_5F_{12} / 15% N_2) radiators with good UV its physics program on B physics, requires a very good pion/kaon identification capability up to 4.3 GeV/c able to work inside a 1.5 Tesla magnetic field. We have proposed to complete the angular coverage of the particle identification system in the forward region with an aerogel threshold counter using the combination of 2 refractive indices (1.055 and 1.007). Two geometries have been tested: one with 1 layer of each index read by photo-detectors on the sides of the counter, and another one with 2 layers of each index, where the photo-detectors are placed inside the counter itself. Two options of photo-detectors have been considered: one with Hamamatsu finemesh photo-multipliers and one with proximity focusing Hybrid Photo-Diodes (HPD). An important work has been done in order to optimize the light collection system (air guides, reflective walls, wavelength shifters...). Finally, prototypes for each option have been tested in a CERN beam test.

After a description of the different detector geometries, the aerogel material and the photo-detectors, we will give results on the measured number of photo-electrons has a function of the impact point position and, on the achieved pion/kaon rejection.

3.10 Project of Aerogel Cherenkov Counters for KEDR

A. Buzykaev, K. Cherepanov, A. Danilyuk, S. Ganzhur, T. Gorodetskaya, G. Kolachev, E. Kravchenko, V. Mikerov, T. Muraviova, A. Onuchin, A. Shamov, V. Tayursky, V. Teplygin, A. Vorobiov, V. Yurchenko

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Detection of Cherenkov light by wavelength shifters (WLS) allows to decrease a number of photomultipliers in comparison with diffuse light collection.

The wavelength shifter KN-18 has been developed in collaboration with the Institute of Polymers. It has a light attenuation length better than the Bicron scintillator BC-408. Aerogel with $n = 1.05$ was produced in the Institute of Catalysis with optical parameters better than aerogel from Airglass. A method of absorption length measurement in aerogel has been developed. The light reflectivity was measured for teflon PTFE and KODAK paint. The single-electron and noise spectrum of HAMAMATSU PMT R6150 were measured.

A system of aerogel counters based on the WLS light collection for the KEDR detector has been designed. Measurements with the prototype of the counter were performed at the 5 GeV/c π-meson beam at CERN.

3.11 Developments of Phototubes for INP Detectors

V.V. Anashin, P.M. Beschastnov, V.B. Golubev, I.I. Goldberg, V.P. Druzhinin, M.S. Dubrovin, L.A. Mironenko, E.A. Pyata, S.I. Serednyakov, Z.K. Silagadze

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The results of tests of vacuum phototriodes and photomultipliers with microchannel plates (MCP-PMTs), developed in INP for collider detectors, are presented. About 3000 phototriodes now operate successfully in NaI(Tl), BGO and CsI(Na) calorimeters of SND, CMD-2 and KEDR detectors. Achieved parameters of MCP-PMTs are compared with those of ordinary PMTs. Some very recent results are also presented: the sample multianode MCP-PMT was manufactured and preliminary measurements of its parameters were done, a number of hybrid PMTs with planar silicon diode as an amplifying device were assembled and tested.

4.3 The Study of BELLE CsI Calorimeter Prototype with BINP Tagged Photon Beam

V.M. Aulchenko, A.E. Bondar, A.Yu. Garmash, I.I. Ivanov, G.Ya. Kezerashvili, S.G. Klimenko, A.S. Kuzmin, A.M. Milov, N.Yu. Muchnoi, T.A. Purlatz, L.V. Romanov, N.I. Root, M.A. Shubin, B.A. Shwartz, Yu.V. Usov, V.N. Zhilich

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H. Hayashii, H. Ikeda, K. Miayabayashi

Nara Women's University, Japan

K. Kaneyuki, Y. Oshima

Tokyo Institute of Technology, Japan

The results of the BELLE barrel calorimeter prototype test with tagged photon beam are presented. The prototype consisted of 36 CsI(Tl) counters with the same readout system as for the BELLE calorimeter. The measurement were carried out at VEPP-4 collider with the tagged photon beam provided by the ROKK-1M facility. The energy and position resolution for photons were measured in the energy region 40 - 800 MeV. The results are in good agreement with Monte-Carlo simulation.

4.4 Tests and Calibration of the BGO Endcap Calorimeter with Phototriode Readout for the CMD-2 Detector

R.R. Akhmetshin, D.N. Grigoriev, V.F. Kazanin, I.B. Logashenko, V.P. Smakhtin, Yu.V. Yudin.

Budker Institute of Nuclear Physics Novosibirsk, Russia

Tests and calibration of the endcap calorimeter of the CMD-2 detector for the VEPP-2M collider is described. The endcap calorimeter contains 680 BGO crystals with phototriode readout and works in 1T magnetic field. All crystals, phototriodes and preamplifiers were tested before the installation. Electronics calibration and calibration by cosmic rays were regularly performed.From the calibration by cosmic rays the average energy equivalent of noise is about 1 MeV in accordance with the design value. Long term stability of the calorimeter was studied.

4.8 Liquid Krypton Calorimeter for KEDR Detector

KEDR-Collaboration
presented by V.S. Panin

A description of the LKr calorimeter for the KEDR detector and experimental results on energy and space resolution obtained with a prototype are presented. The energy resolution comparable to that resolution of crystal calorimeters was achieved at the much better space resolution for photons in an energy region 50 - 625 MeV. Data are in good agreement with the Monte Carlo expectations.

4.9 Scintillation LXe/LKr Electromagnetic Calorimeter. Results of the Beam Tests and Future Improvement of Characteristics

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Spokesperson: V.N. Solovov

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An electromagnetic scintillation LXe/LKr calorimeter has been built in the ITEP and tested at the ITEP and MIT (BATES) accelerators. The detector tested consists of a PMT matrix and 45 light collecting cells made of aluminized Mylar covered partially with a wavelength-shifter (WLS). Each pyramidal cell has dimensions of $(2.1 \times 2.1) \times 40 \times (4.15 \times 4.15)$ cm and is viewed by an FEU-85 glass-window photomultiplier.

The detector has been exposed with electrons of energies 106–400 MeV. The energy resolution is sigma(E)/E = 5%/sqrt(E) in this energy range for LXe filling; the coordinate resolution is sigma(X) = 0.7 cm; the time resolution (for a single cell) is sigma(T) = 0.6 ns.

Possible ways of improvement of energy characteristics of a LXe/LKr scintillation calorimeter are discussed.

4.10 Liquid Xenon Calorimeter for the New Detector CMD-2M

L.M. Barkov, N.S. Bashtovoy, G.S. Filimonov, A.A. Grebenuk, N.M. Ryskulov, P.Yu. Stepanov, S.G. Zverev

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A possible upgrade of the detector CMD-2 at e^+e^- collider VEPP-2M in Novosibirsk are discussed. New element of the upgraded detector is a liquid xenon calorimeter. For gamma-quanta it will improve space resolution by approximately one order of magnitude and energy resolution by a factor of two. Current status of calorimeter and its infrastructure as well as results on the space resolution obtained in a test volume and results of the test of different materials to be possibly used in the calorimeter construction are presented.

5.3 Transputer Based Data Acquisition System for the CMD-2 Detector

G.A. Aksenov, V.S. Banzarov, T.B. Bolshakov, A.G. Chertovskikh, I.B. Logashenko, A.V. Maksimov, Yu.I. Merzlyakov, V.A. Monich, V.V. Shilo, E.P. Solodov, I.V. Sorokin, V.G. Zavarzin
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S. Levitan, J.A. Thompson, C.M. Valine
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This paper describes a new data acquisition system for the Cryogenic Magnetic Detector (also referred to as CMD-2) which is located at the Budker Institute of Nuclear Physics, Novosibirsk, Russia. The system was necessitated by plans to increase the luminosity of the VEPP-2M collider which CMD-2 is located on. A scalable parallel system was implemented to achieve the design goals.

The data acquisition system includes a VME based microprocessor farm which is interfaced to the experiment's UNIX workstations. The number of processors in the farm can be scaled according to the demands of the experiment.

5.4 Trends in the Front-End Electronics for LHC Using VLSI Technologies

F. Anghinolfi (CERN)

A large effort has been initiated in the particle physics community for the development of ASIC frontend electronics using advanced VLSI technologies. The electronic readout channels for the LHC experiments (ALICE,ATLAS,CMS) have specific features like precise time identification (25ns bunch crossing rate), high channel density (over 3 millions in subdetector parts), limitation in power consumption, dynamic range requirements and moreover certain levels of radiation resistance to ionizing particles (up to 10 Mrads) and neutrons (10^{14}n/cm^2).

A new type of tracking detector has pixel geometry and readout has now been proven to work. The attractive feature of very low noise comes at the cost of complexity of the readout due to the very high detector segmentation. A realisation using CMOS chips, each one with 2000 pixel cells on 85mm^2 of silicon, bump bonded to silicon detectors, is running at CERN. Several architectures of pixel readout at LHC are now under evaluations. Readout chips for silicon strips detectors corresponding to the LHC detector requirements have been investigated in terms of power, noise and density, using different technologies. Realisations in radsoft or radhard technologies are demonstrating the feasability of 128 channels on 80-100mm^2 chips with a signal-to-noise ratio 10 to 20 and a power dissipation of about 4mW per channel. For the calorimeter part of the detectors, analogue pipeline systems with 12 bits dynamic range are presently demonstrating interesting results. Another option is the FERMI digital readout which can be a powerful system with a large degree of integration. A compression amplifier, a 40MHz ADC with 10 bits dynamic range on each channel, followed by complex digital signal processors for mismatch corrections, LVL1 and LVL2 trigger identification, are installed on multi-chip modules located near the calorimeter detecting elements.

The various readout systems present different tradeoffs between their characteristics and the commercially available technologies, in order to fullfill the basic physics requirements.

6 Poster session

6.1 Performance of the BGO Luminosity Monitor of the CMD-2 Detector

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V.S. Letunov, V.P. Smakhtin, Yu.V. Yudin
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The based on BGO crystals luminosity monitor of the VEPP-2M collider at the CMD-2 detector is described. The monitor consists of two identical total absorption counters which detect bremsstrahlung photons. The counter is based on 8 X_0 BGO crystal with phototriode readout. The crystals were grown by the special tecnology to achive high radiation hardness. Phototriod readout allowed to achive high stability of output signal and high rate capability. The low noise electronics with signal shaping on delay line produce 50 ns risetime pulse, so the on-line time resolution of device is better than the beam turn period (60 ns). The energy resolution of monitors is sufficient to measure the threshold energy of detected photons by left edge of bremsstrahlung energy spectrum. Experience of monitor operation during the 94/95 data taking run is disscused.

6.2 The Ttest of the Calorimeter for Single Bremsstrahlung Photons at Collider VEPP-4M

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A.S. Kuzmin, A.M. Milov, N.Yu.Muchnoi, T.A. Purlatz,
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The scintillator sandwich calorimeter was installed at zero angle of the VEPP-4M collider. It serves for two tasks. One, operative measurements of the collider luminosity with the single bremsstrahlung process. Second, suppression of the background from the Single Bremsstrahlung process in the tagging system for scattered electrons.

The results of the test runs are reported. The measurement were carried out with the tagged photon beam provided by the ROKK-1M facility.

6.3 Calibration of CMD-2 Drift Chamber

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The expierence gained through 4 years of CMD-2 drift chamber operation is reported. The calibration procedure of readout electronics and DC patrameters by means of pulse generator as well as by means of recorded events is described. Fine corrections to the Lorentz angle and shape of isochrone lines allows to improve momentum resolution. The systematic error in polar angle definition were substantialy decreased when information from the Z-chamber cathods have been used for calibration purposes.

6.4 Absolute Calibration of the SND NaI(Tl) Calorimeter with Cosmic Muons

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The absolute energy calibration procedure of a three layer spherical electromagnetic calorimeter of SND detector, consisted of 1632 individual NaI(Tl) crystals, is described. For calibration events with cosmic muons producing tracks in calorimeter were used. The calibration constants needed for calculation of energy losses in crystals from corresponding ADC codes are determined using comparison between the measured amplitudes distributions and Monte-Carlo simulation. The systematic error of the calibration is of the one per cent level. The analysis of factors on which the precision depends was done.

6.5 BGO Crystals Grown by a Low Thermal Gradient Czochralski Technique

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A low thermal gradient Czochralski technique developed in the Institute of Inorganic Chemistry was applied for growing of the BGO crystals. These crystals was used in some experiments at BINP. For example, the endcap calorimeter of the CMD-2 detector consists of 680 BGO crystals with total weight about 450 kg. The grown technique was improved permanently to achive better scintillation parameters and radiation hardness and to increase size of the ingot crystals. Now this technique allows to grow water transparent, radiation hard crystals with size up to 400 mm in length and up to 150 mm in diameter.

6.6 Development of a Light-Collecting Technique for a Condensed Noble Gas Scintillation Electromagnetic Calorimeter

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A development of a technique for an electromagnetic scintillation calorimeter of UV light-collection in a condensed noble gas (Xe and Kr) with the use of a wave-length shifter deposited on a Mylar reflector is described. Uniformity of light- collection along 40–60 cm cell of ±5% is achieved. An influence of different types of light-collection nonuniformity on the energy resolution is discussed.

6.7 Experience with CsI(Na) Crystals for Calorimetry

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The construction and parameters of a CsI(Na) endcap calorimeter for the KEDR detector are presented. The first beam tests with the part of the calorimeter as well as the investigation of its crystals aging were performed. It is also reported the results of the study of a calorimeter element consisting of a CsI(Na) crystal coupled with a vacuum phototriode.

6.8 Electronics of the BGO Endcap Calorimeter of CMD-2 Detector

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The electronics of the endcap calorimeter of the CMD-2 detector is described. It consists of 680 channels. Each channel includes readout of a BGO crystal by a vacuum phototriode, charge sensitive preamplifier, shaping amplifier and ADC. A shaping amplifier unit provides signals for both energy deposition measurements and trigger purposes. For the best noise performance preamplifiers were placed inside the detector. All preamplifiers were tested after manufacturing and showed design parameters. Further studies of the preamplifiers revealed their good reliability and long term stability. Special care was taken about low sensitivity to external noise and decreasing crosstalk. As a result, the noise of the electronics during operation inside the detector at the collider appeared to be close to that measured under laboratory conditions.

6.9 Electronics of the Liquid Xenon Calorimeter for the New Detector CMD-2M

Presented by *S.G. Zverev*

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The problems related to the front-end electronics of liquid xenon calorimeter of the CMD-2M detector are discussed. A scheme of the electronics channel (charge sensitive amplifier, amplifier shaper and "free walk" discriminator) is suggested.

The results received are: noise of coordinate channel (at a shaping time of 4mks) is about 2000 electrons, noise of amplitude channel (at a shaping time of 500 ns) is about 4500 electrons, the expected time resolution for 100 MeV gamma-quanta is about 8 ns.

6.10 Charged Trigger for CMD-2 Detector at Novosibirsk VEPP-2M Collider

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This paper describes the Charged Trigger System for the Cryogenic Magnetic Detector (CMD-2) located at the Budker Institute of Nuclear Physics, Novosibirsk, Russia. The system is under developing now and consists of the Track-Finder and First Level Trigger Interface modules.

The new trigger system provides increasing of safety, simplifying of testing and improvement of quality of events selection. Besides, the system will have interface with the new Neutral Trigger System.

6.11 Transverse Energy Profile of Electromagnetic Showers

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The Monte Carlo investigation of spatial resolution for electromagnetic showers of the calorimeter of the Spherical Neutral Detector (SND) has been performed. For description of the transverse distribution of energy in an electromagnetic shower the function $\exp(-\beta \cdot \sqrt{r})$ is introduced. On its base the method of estimation of shower angles and the criterion of close photon separation have been worked out. It is shown that for the photons with the energy less than 700 MeV this method provides the best results compared to the other methods.

6.12 Test of the Calorimeter Prototype Based on CsI(Na) Crystals

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6.13 Measurement of the Refractive Index of Liquid Xenon for Internal Scintilation Light

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Preliminary results of measurement of the refractive index of liquid xenon for internal scintilation light are presented.