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SND detector for experiments at VEPP-2000 e^+e^- collider

Spherical Neutral Detector (SND) is a general purpose non-magnetic detector for experiments at VEPP-2000 e^+e^- collider in Novosibirsk in the energy range $2E$ = 0.4–2.0 GeV. Charged particle track parameters are measured using drift and proportional chambers placed in common cylindrical gas volume. Particle identification is performed using energy deposition in drift chamber at particle momenta p $leqslant$ 300 MeV/c and aerogel threshold counters at p $geqslant$ 300 MeV/c. Photon energies are measured using 3-layer spherical electromagnetic calorimeter. Muons penetrating through the detector and cosmic background muons are detected by the muon system based on proportional tubes and plastic scintillator counters. At present the detector is under commissioning, which includes tests of detector operation with cosmic rays and collider beams.

Summary (Additional text describing your work. Can be pasted here or give an URL to a PDF document):

Spherical Neutral Detector (SND) is a general purpose
non-magnetic detector for experiments at VEPP-2000
e^+e^- collider in Novosibirsk in the energy range
$2E$ = 0.4–2.0 GeV. Its main subsystems are
the tracking system, particle identification system,
electromagnetic calorimeter and muon system.
At present the detector is under commissioning,
which includes tests of detector operation with cosmic
rays and collider beams.

The main differences between the present detector
and the previous one used in experiments at VEPP-2M collider
in 1995–2001 are the new drift and proportional chambers placed
in common gas volume, new particle identification system based
on aerogel Cherenkov counters and muon system proportional tubes
instead of streamer ones.

The SND tracking system consists of 9-layer cylindrical drift chamber
with jet-type cells and proportional chamber placed in common cylindrical
gas volume. On the inner and outer walls of the volume cathode strips are placed.
Track coordinates in the plane perpendicular to the beam axis
are measured using the ionization drift time.
Track coordinates along the beam axis are measured using charge
division on anode wires in drift chamber and charge distribution on cathode strips
in proportional chamber. Energy deposition in drift chamber
is used for particle identification at momenta p
$leqslant$ 300 MeV/c.
During the SND tests with cosmic rays and collider beams in 2008–2009
the following values of coordinate and angular resolution
were achieved: σ_R (drift time) = 100÷200 μm,
σ_z (charge division) = 1.5÷2.0 mm,
$\sigma_\theta = 1.56^\circ \pm 0.16^\circ$,
$\sigma_\varphi = 0.91^\circ \pm 0.01^\circ$,
which are close to the tracking system design parameters.

The particle identification system is intended
for effective π/K separation in the momentum range
300 MeV/c
$leqslant p$
$leqslant$ 870 MeV/c.
It consists of 9 threshold aerogel Cherenkov counters
placed around the tracking system. Each counter is based on the

Aerogel, wavelength SHIfter and PHotomultiplier tube (ASHIPH).
The refractive index of the aerogel is 1.13, the photomultiplier tubes
are based on microchannel plates.
The time resolution of the system achieved in SND test runs
with cosmic rays is about 2 ns, which is determined by the wavelength shifter
fluorescence lifetime.

The three-layer spherical electromagnetic calorimeter consists of 1632 NaI(Tl) crystals
with vacuum phototriode readout. The total calorimeter thickness for particles
originating from the interaction region is 13.4 X_0, the total solid angle is
90 % of 4π. The energy and angular resolution of calorimeter
is $\sigma_E/E = 4.2\%/\sqrt[4]{E(\text{GeV})}$,
$\sigma_\varphi = 0.82^\circ/\sqrt{E(\text{GeV})} \oplus 0.63^\circ$,
where E is the photon energy. The calorimeter was used for VEPP-2000 luminosity
measurements in 2007–2009.

The muon system is intended for detection of muons penetrating through the detector
and cosmic background suppression. It consists of 16 barrel and 2 endcap
modules. Each barrel module consists of 16 proportional tubes and plastic scintillator
counter with photomultiplier tube readout.

The planned future upgrade of the SND detector includes
Flash-ADC readout of calorimeter crystals allowing
to detect events of electron-positron annihilation
into neutron-antineutron pair by the time-of-flight technique.

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