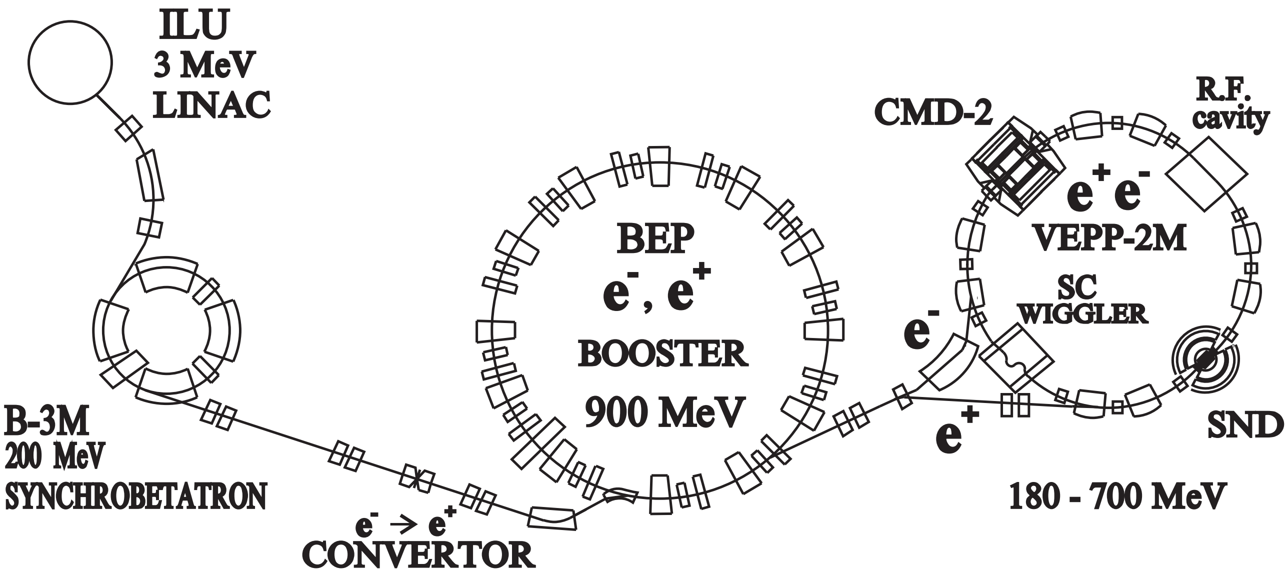
S. I. Redin

(for CMD–3 collaboration)

HADRONS AT VEPP–2M

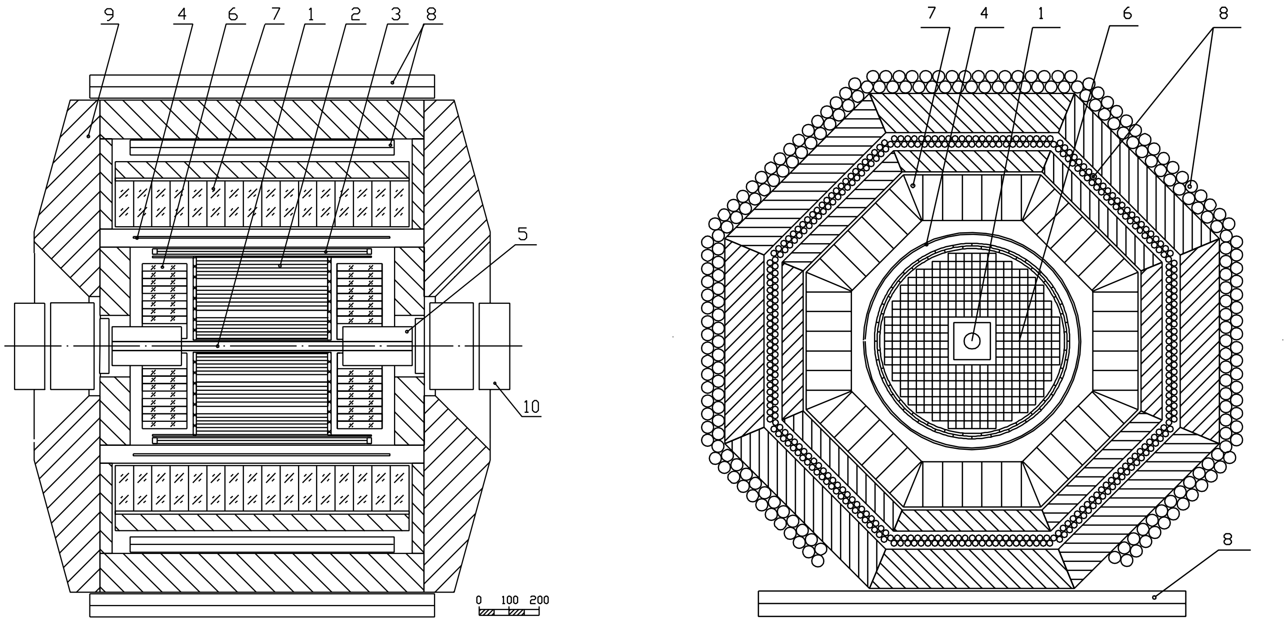
CERN, October 9–11, 2006

VEPP-2M accelerator complex (1974 - 2000)



Energy range	—	0.36 - 1.4 GeV
Luminosity	—	$3 \cdot 10^{30}$ cm^{-2} s^{-1}
Injection period	—	1 s
Beam revolution period	—	60 ns
rf harmonics	—	12^{th}

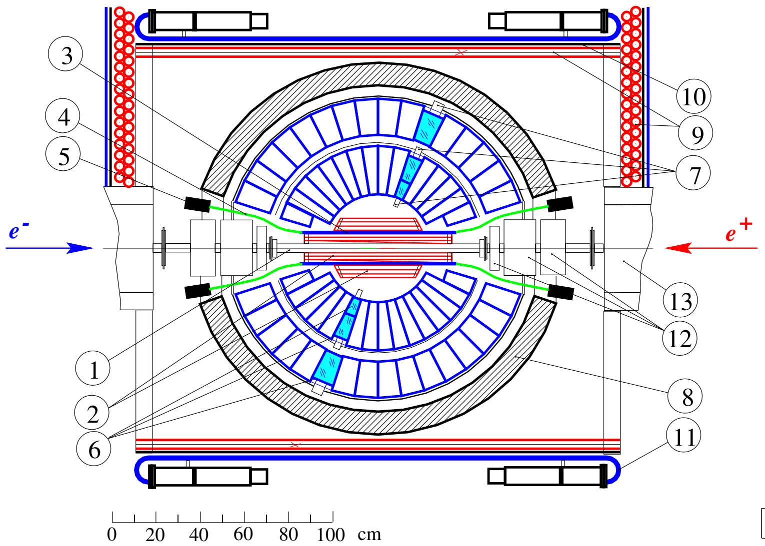
Detector CMD-2 (1992-2000)

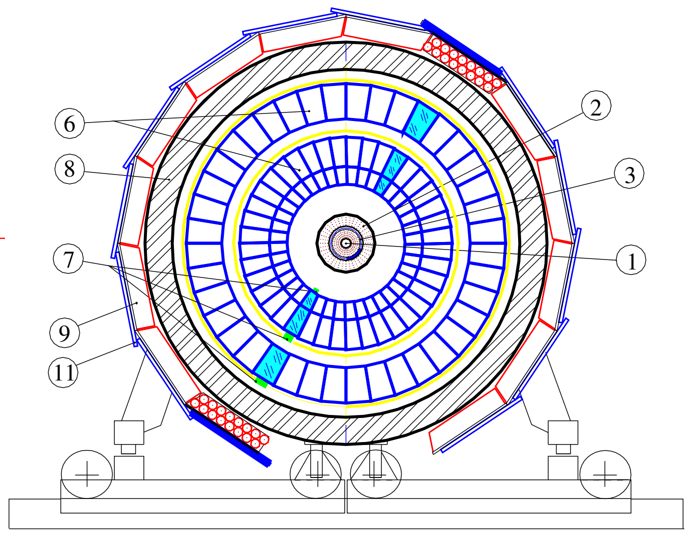


1 — beam tube
2 — drift chamber
3 — Z chamber
4 — SC magnet
5 — Compensating magnet

6 — BGO calorimeter
7 — CsI calorimeter
8 — drift tubes (range system)
9 — Magnet's Yoke
10 — Quadrupole Lens

Detector SND (1995-2000)

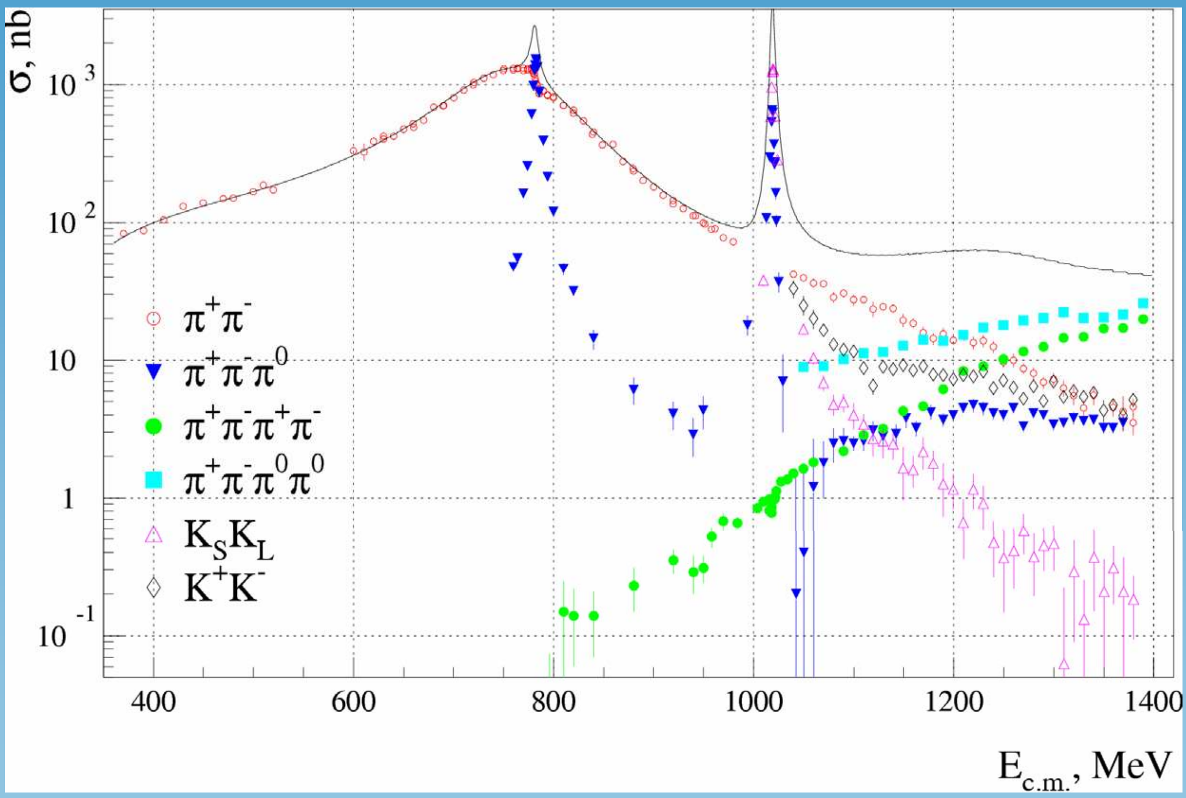




1 — beam pipe
2 — drift chamber
3 — scintillation counter
4 — light guides
5 — PMTs
6 — NaI(Tl) crystals
7 — vacuum phototriodes
8 — iron absorber
9 — strimer tubes
10 — 1 cm iron plates
11 — scintillation counters
12, 13 — elements of the collider magnetic system

1 — beam pipe
2 — drift chambers
3 — scintillation counter
4 — NaI(Tl) crystals
5 — vacuum phototriodes
6 — iron absorber
7 — strimer tubes
8 — scintillation system

Measurement of R in Novosibirsk



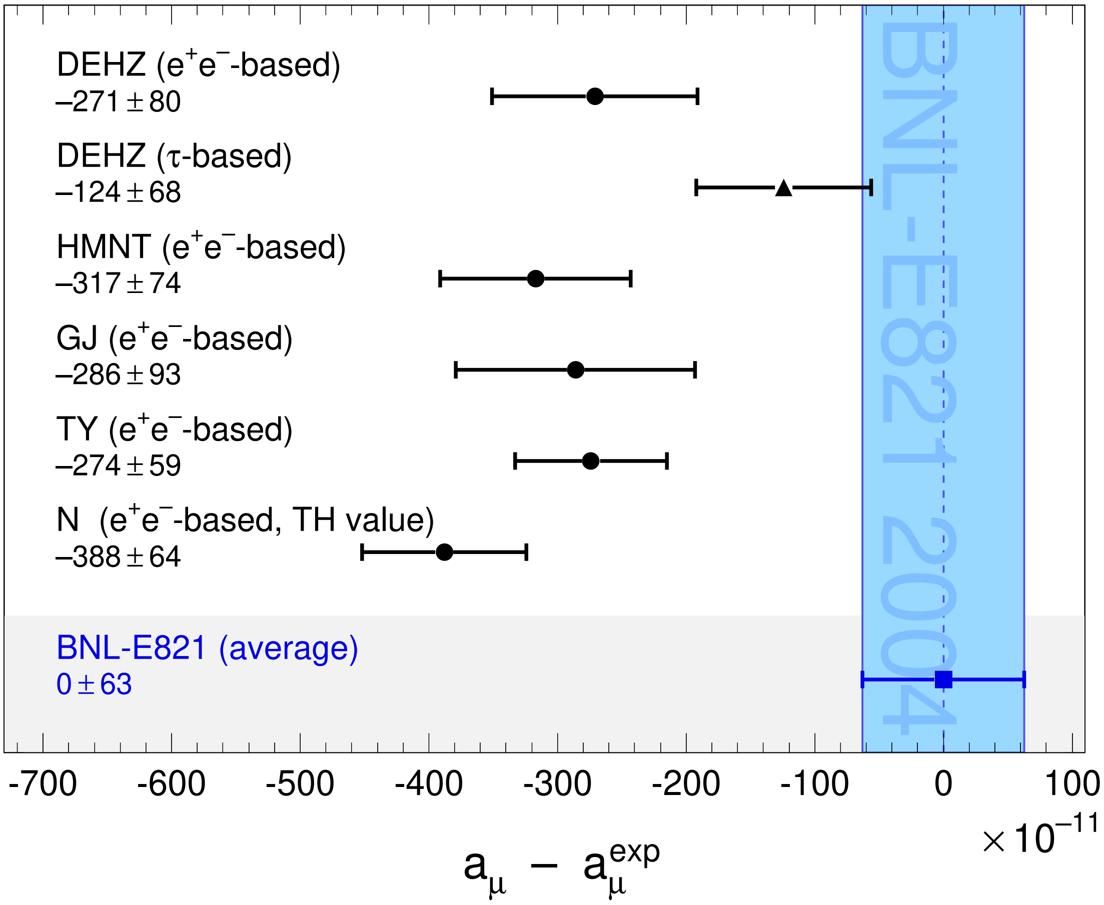
Total hadronic cross-section measured by CMD-2 and SND

Muon Anomalous Magnetic Moment

$$
\begin{aligned}
a_\mu^{QED} &= 116584719.1(0.1)(0.4) \times 10^{-11} \\
a_\mu^{EW} &= 154(1)(4) \times 10^{-11} \\
a_\mu^{Had}[LO] &= \frac{1}{3}\left(\frac{\alpha}{\pi}\right)^2 \int_{m_\pi^2}^{\infty} ds\, \frac{K(s)}{s}\; R^{(0)}(s) = \\
&= 7110(50)(8)(28) \times 10^{-11} \\
a_\mu^{Had}[NLO] &= 22(35) \times 10^{-11}
\end{aligned}
$$

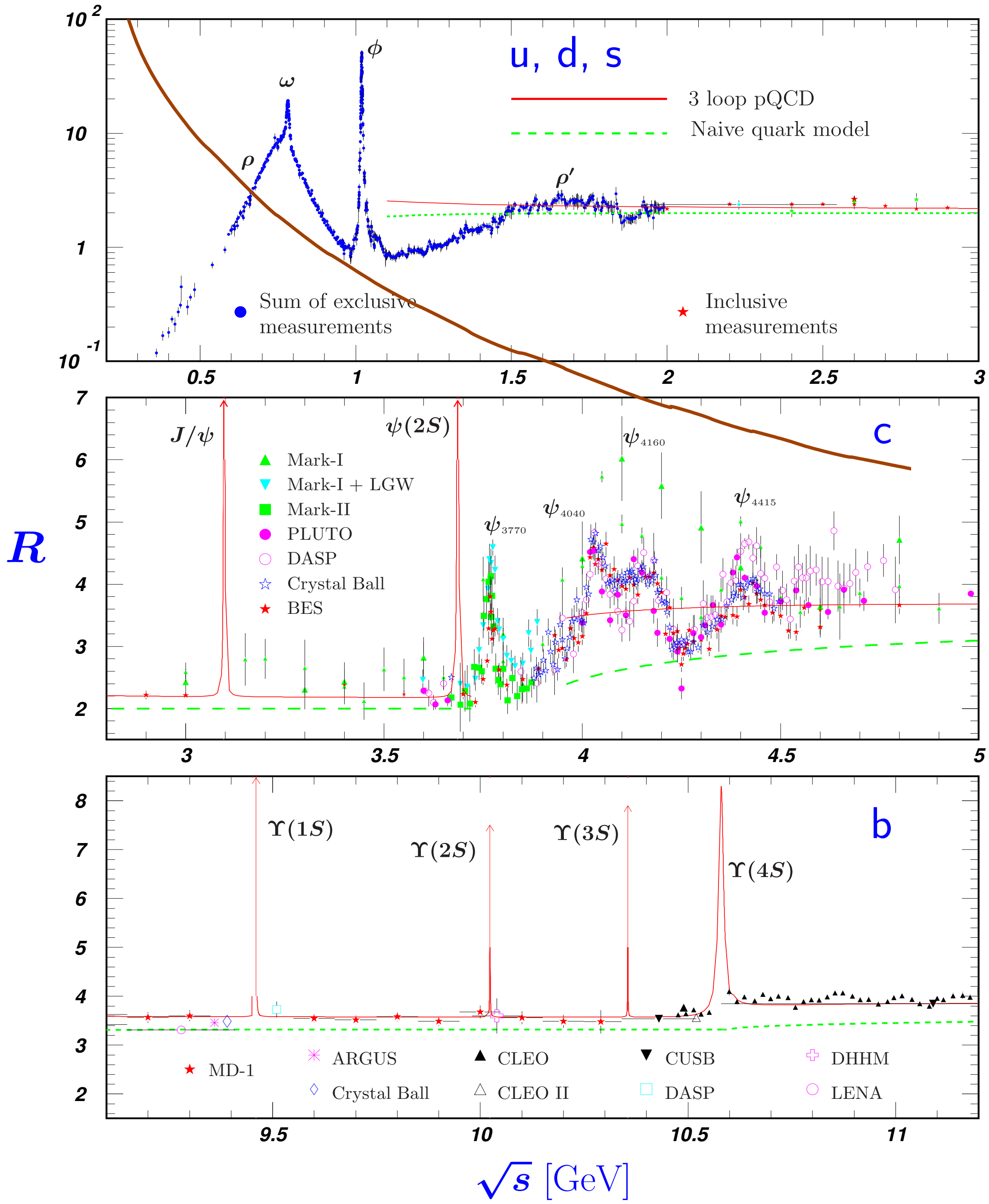
$$a_\mu^{New\ Physics} = ????$$

$$\text{where}\quad R^{(0)}(s) \equiv \frac{\sigma(e^-e^+ \longrightarrow hadrons)}{\sigma(e^-e^+ \longrightarrow \mu^-\mu^+)}$$



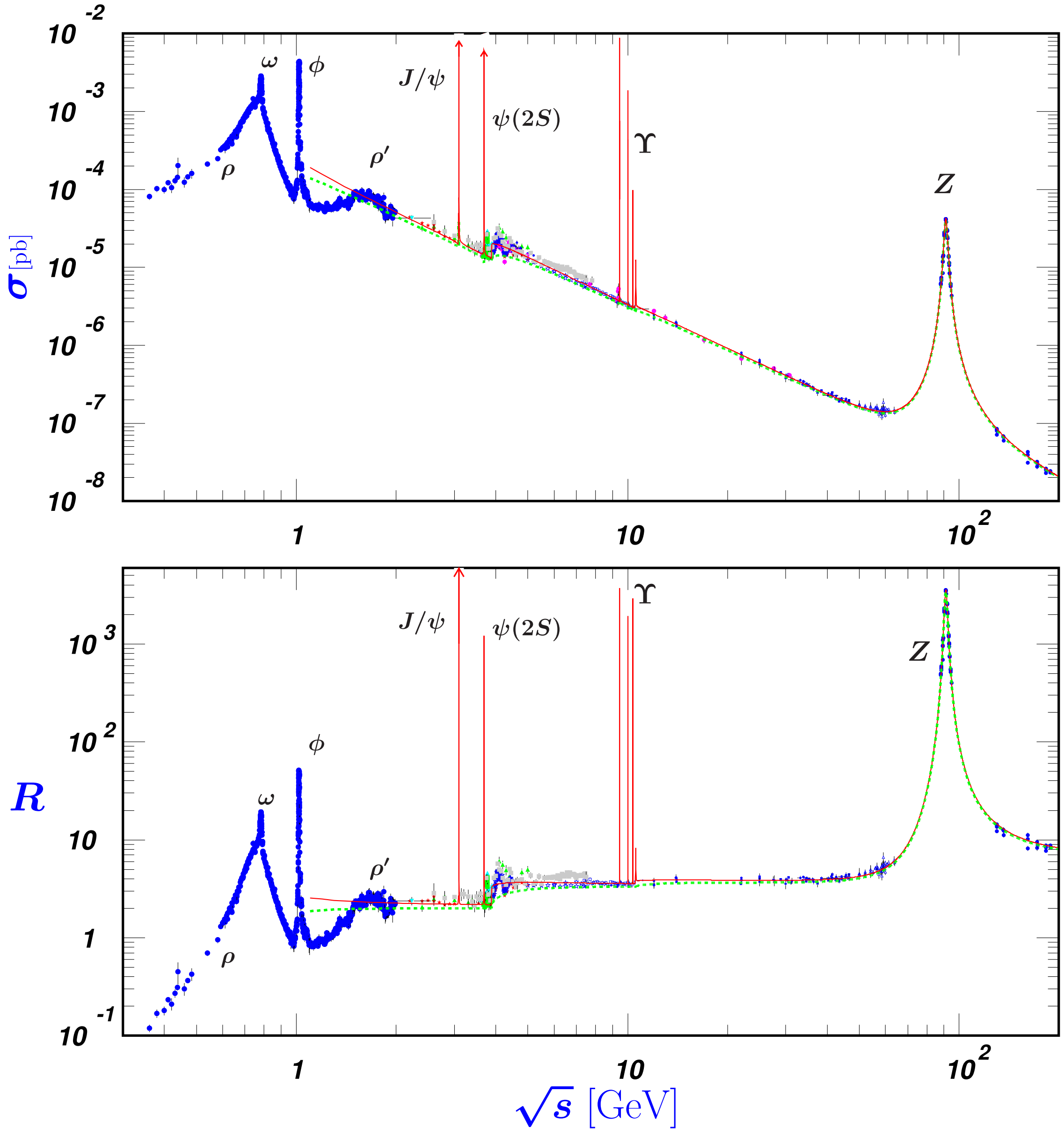
Function $\mathbf{K(s)/s}$ and

$\mathbf{R} = \sigma(e^+e^- \longrightarrow hadrons)/\sigma(e^+e^- \longrightarrow \mu^+\mu^-)$

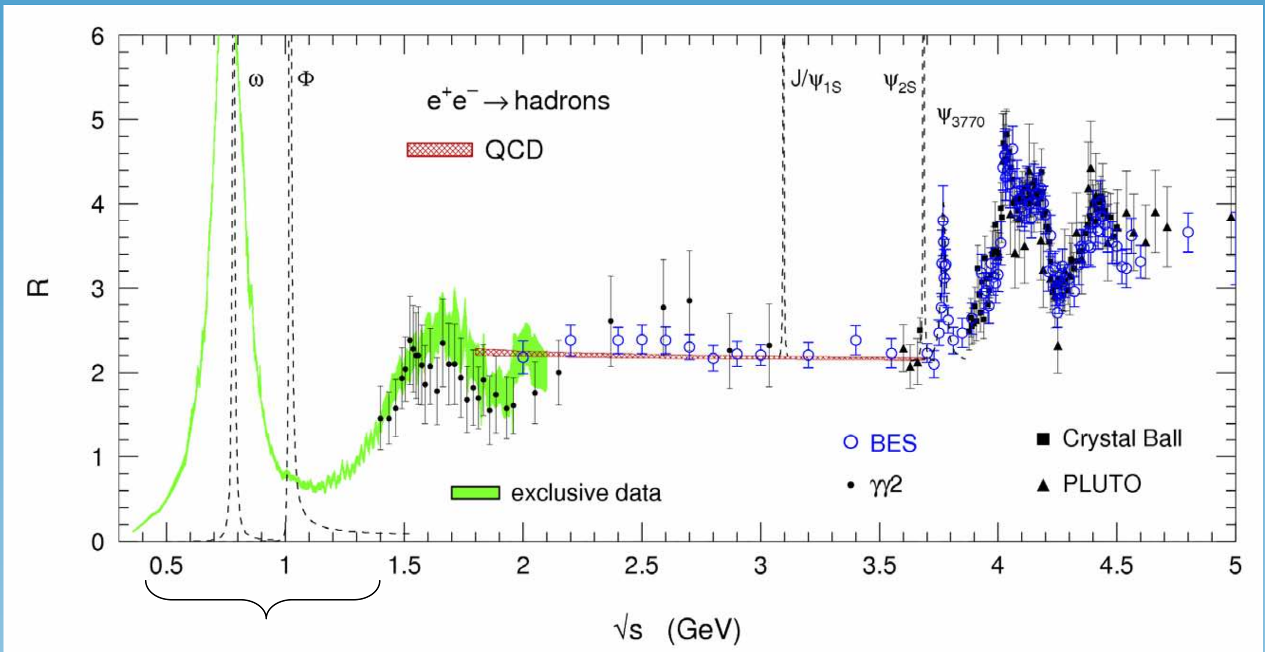


$\sigma(e^+e^- \longrightarrow hadrons)$ and

$\mathbf{R} = \sigma(e^+e^- \longrightarrow hadrons)/\sigma(e^+e^- \longrightarrow \mu^+\mu^-)$

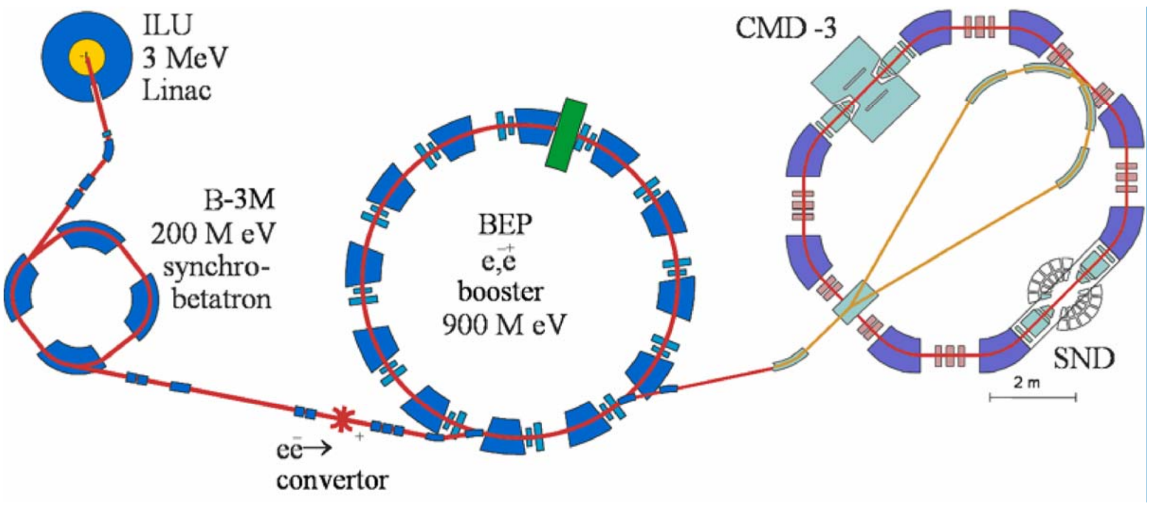


R, the current status

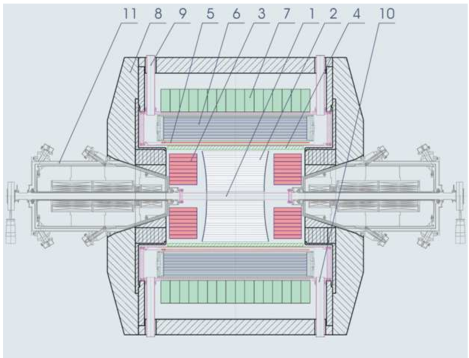


VEPP-2M energy region

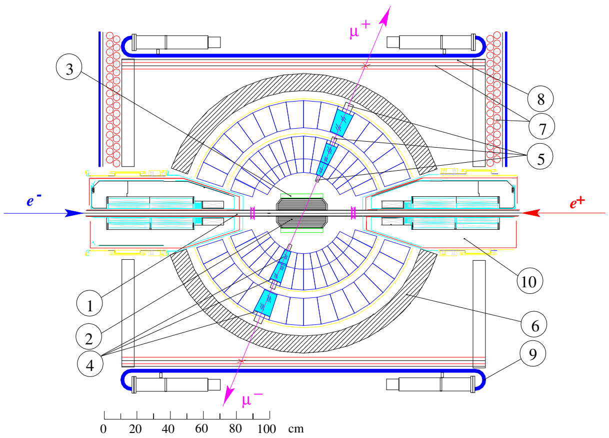
Next Generation Collider: VEPP–2000



Next Generation Detectors:

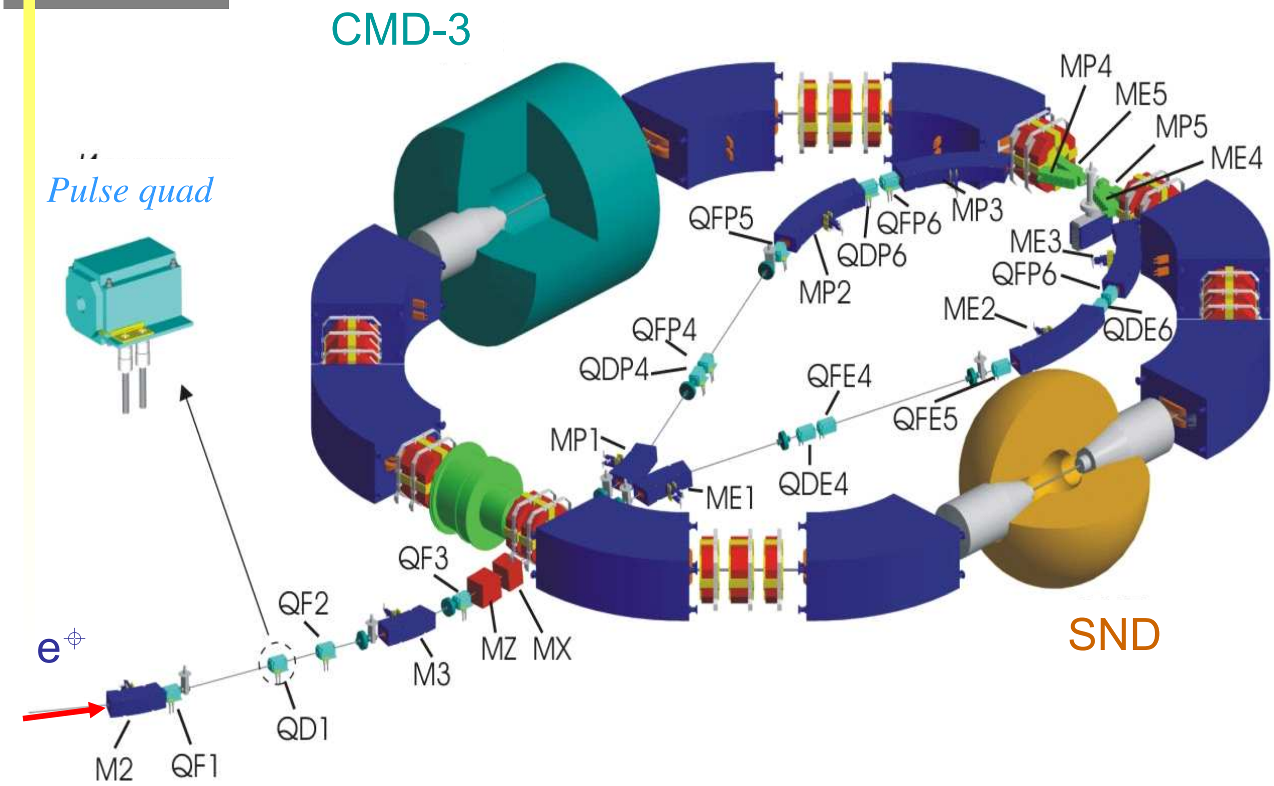


CMD-3



SND

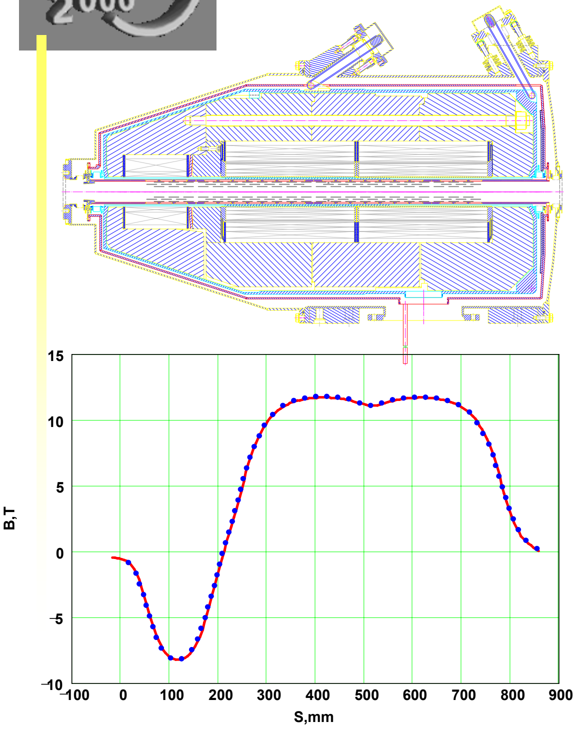
Cartoon lay-out of VEPP-2000



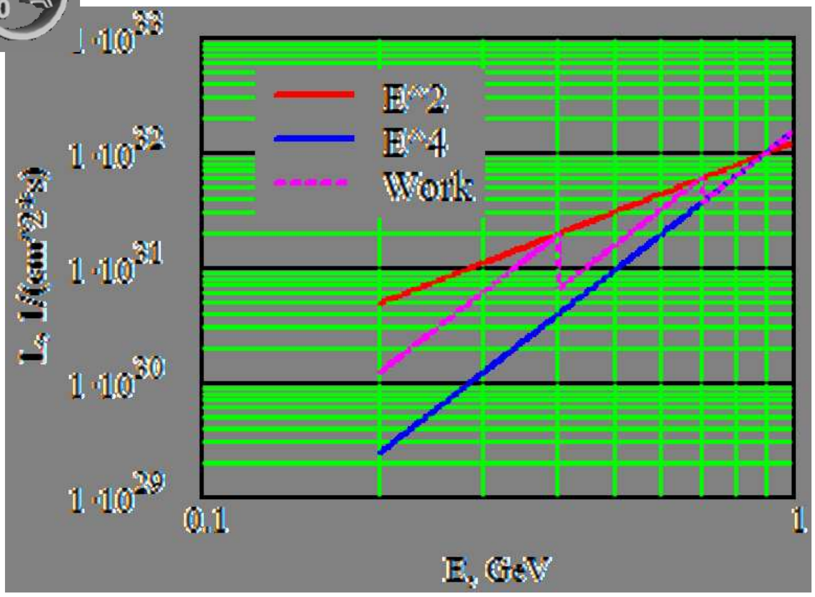
Main parameters of VEPP-2000

Parameter	Value
Circumference	24.38 m
RF frequency	172 MHz
RF voltage	100 kV
RF harmonic	14
Momentum compaction	0.036
Synchrotron tune	0.0035
Energy spread	6.4×10^{-4}
Beam emittances (x,y)	1.29×10^{-7} m rad
Dimensionless damping decrements (x,y,z)	$2.19\times10^{-5}, 2.19\times10^{-5}, 4.83\times10^{-5}$
Betatron tunes	4.05, 2.05
Betatron functions @ IP	10 cm
Particles per bunch	1×10^{11}
Beam-beam parameter (x,y)	0.075, 0.075
Luminosity per IP (at 1GeV)	$1\times10^{32}\,cm^{-2}s^{-1}$

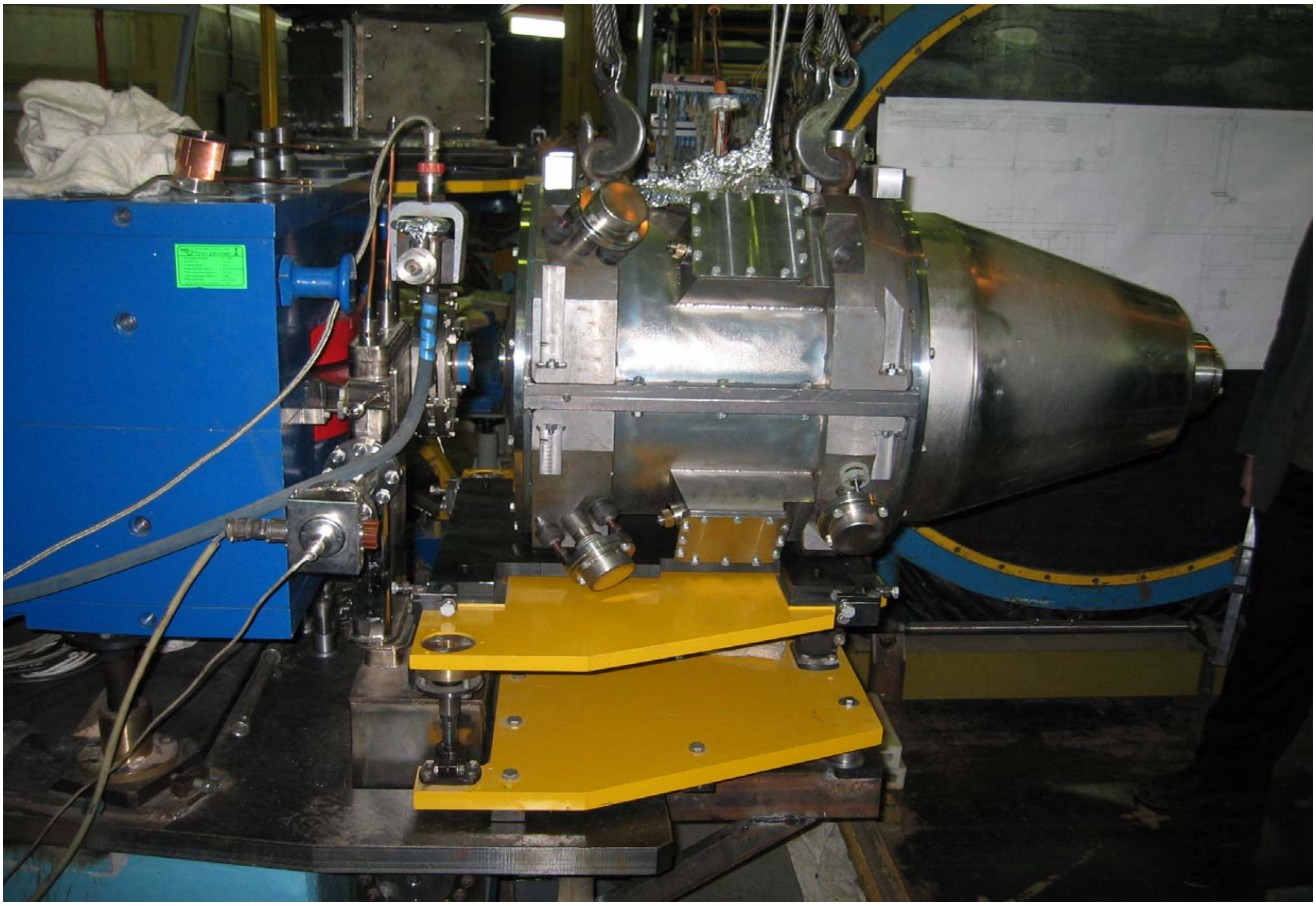
Solenoid 13.0 T



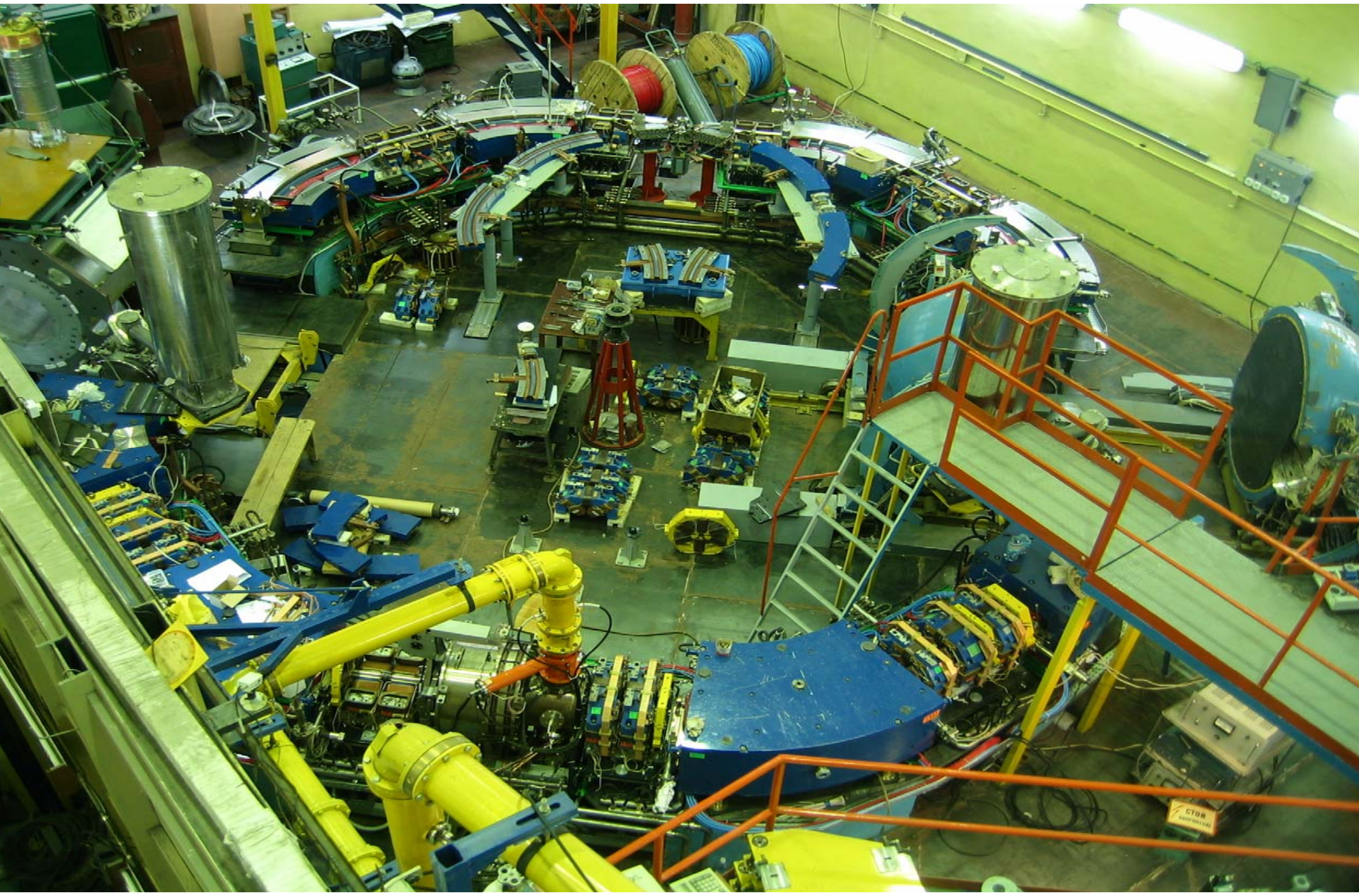
VEPP-2000 luminosity



Solenoid #1



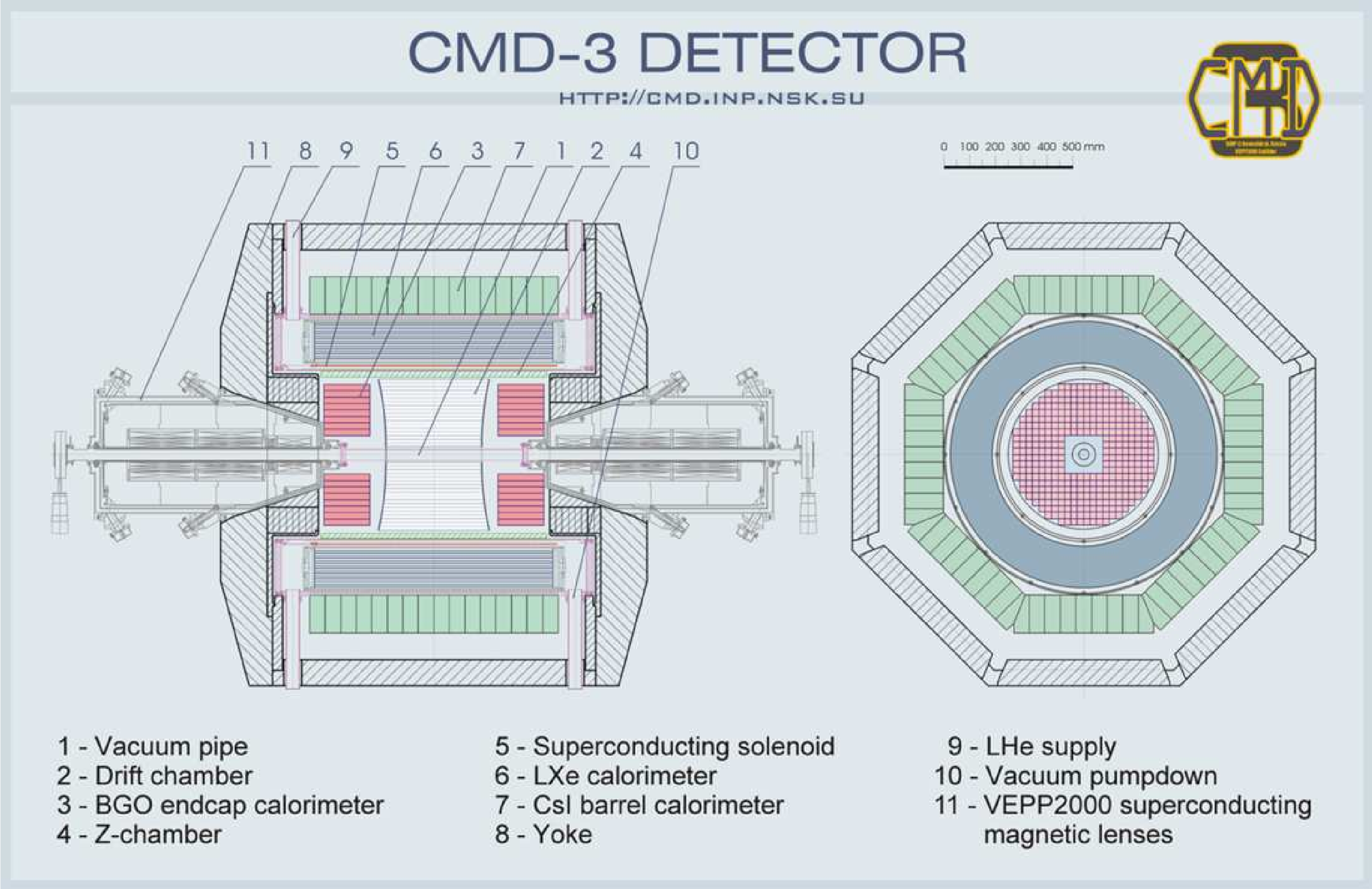
VEPP-2000 bird's eye view
02.03.06



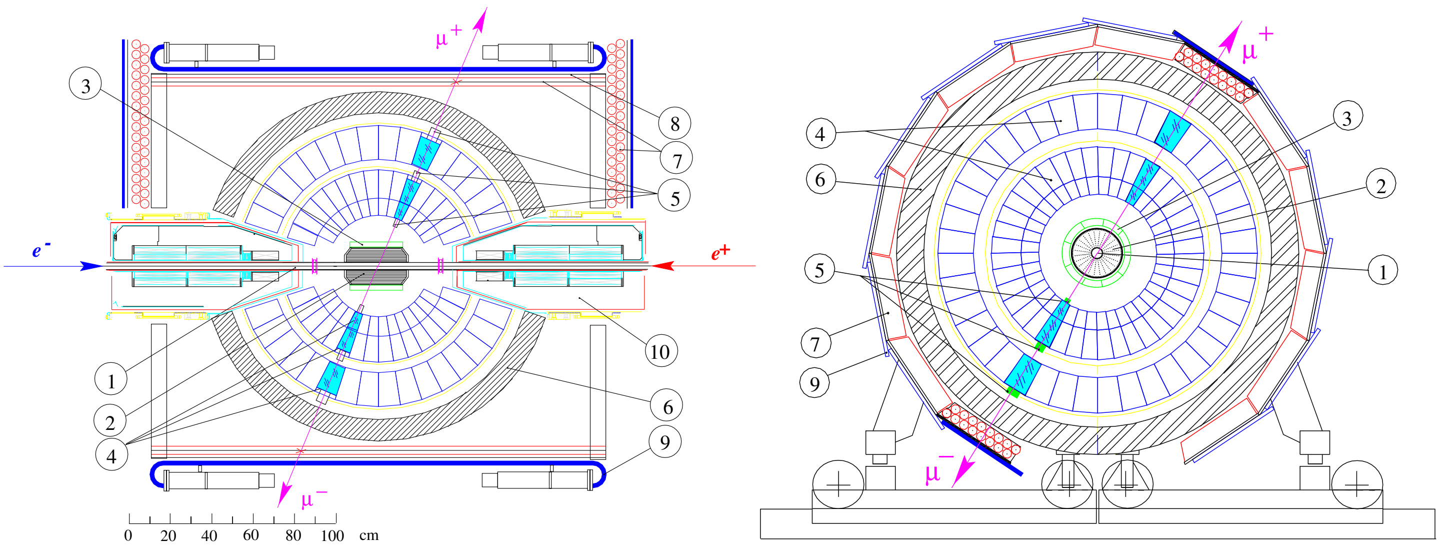
VEPP–2000 current status

- VEPP-2000 commissioning starts successfully
- The aim is to inject electrons in temporary optics to get closed orbit and to tune up the beam diagnostics
- Beam already passes through transfer line
- New power supplies and computer control system are in operation
- Two solenoids are ready and tested in place, two other solenoids will be connected to the helium storage vessels soon
- Machine study will start soon
- First luminosity – end of 2006
- Games with luminosity and polarized beams

(Yuri Shatunov talk at RuPAC, September 10-14, 2006, Novosibirsk, Russia)


CMD-3 DETECTOR
HTTP://CMD.INP.NSK.SU
11 8 9 5 6 3 7 1 2 4 10
0 100 200 300 400 500 mm
1 - Vacuum pipe
2 - Drift chamber
3 - BGO endcap calorimeter
4 - Z-chamber
5 - Superconducting solenoid
6 - LXe calorimeter
7 - CsI barrel calorimeter
8 - Yoke
9 - LHe supply
10 - Vacuum pumpdown
11 - VEPP2000 superconducting magnetic lenses

Detector SND (upgrade)



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VEPP-2000 physical program

(S. Serednyakov review at Photon-2003)

1. Precise measurement of the quantity
   R=σ(e+e-- > hadrons)/ σ(e+e-->μ+μ--)

2. Study of hadronic channels:
   e+e-- > 2h, 3h, 4h …, h= π,K,η,…

3. Study of ‘excited’ vector mesons: ρ’, ρ’’, ω’, φ’,..

4. CVC tests: comparison of e+e-- > hadr. (T=1) cross section with τ-decay spectra

5.Study of nucleon-antinucleon production –
   nucleon electromagnetic formfactors,
   search for NNbar resonances, ..

6. Hadron production in ‘radiative return’ (ISR) processes

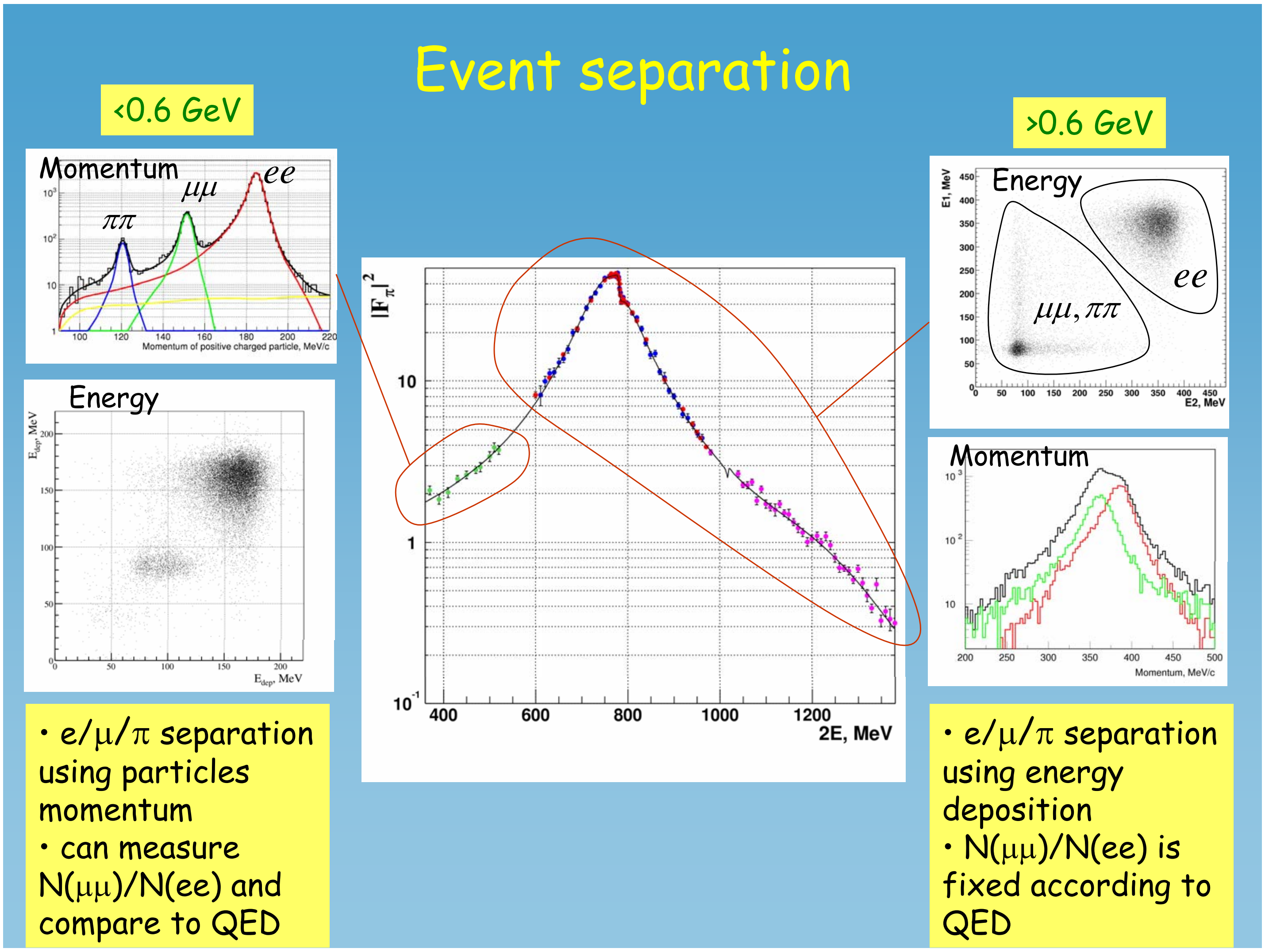
7. Two photon physics

8. Test of the QED high order processes 2->4,5

9. Study of round colliding beam concept

10. Radiative polarization (including longitudinal)

Backup projections


Event separation
<0.6 GeV
>0.6 GeV
Momentum
ππ
μμ
ee
Momentum of positive charged particle, MeV/c
Energy
E_dep, MeV
|F_π|^2
2E, MeV
Energy
E1, MeV
E2, MeV
μμ, ππ
ee
Momentum
Momentum, MeV/c
• e/μ/π separation using particles momentum
• can measure N(μμ)/N(ee) and compare to QED
• e/μ/π separation using energy deposition
• N(μμ)/N(ee) is fixed according to QED

Systematic errors

Source of error	$\sqrt{s}$<0.6 GeV	0.6<$\sqrt{s}$<1.0 GeV	$\sqrt{s}$>1.0 GeV
Event separation	0.4%	0.2%	0.2-1.5%
Fiducial volume	0.2%	0.2%	0.2-0.5%
Energy calibration	0.3%	0.1% / 0.3%	0.7-1.1%
Efficiency correction	0.2%	0.2% / 0.5%	0.5-2.0%
Pion losses (decay, NI)	0.2%	0.2%	0.2%
Bremsstrahlung on beam pipe	0.2%	<0.1%	0.05-1.7%
Background	-	-	0.6-1.6%
Radiative corrections	0.3%	0.4%	0.5-2.0%
Total	**0.7%**	**0.6% / 0.8%**	**1.2-4.2%**