Recent results from KEDR

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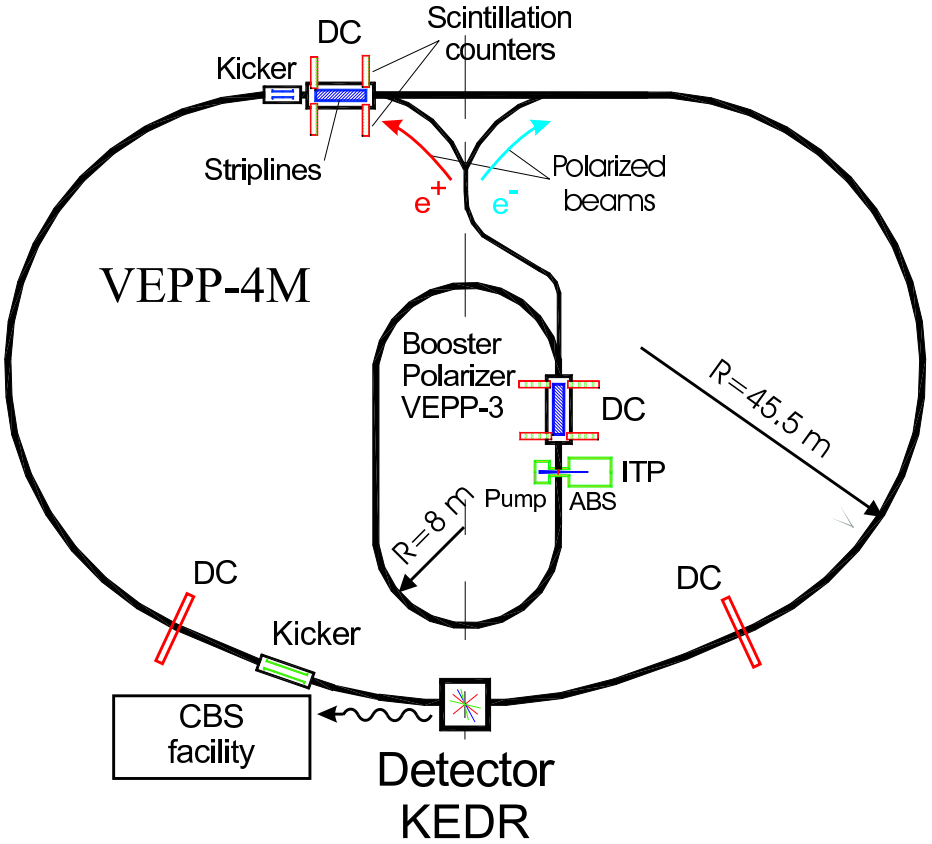
Outline

- VEPP-4M collider and KEDR detector
- Physical program
- Results for $\psi(2S)$ and $\psi(3770)$
- R measurement and search for narrow resonances below J/ψ
- Conclusions and prospects

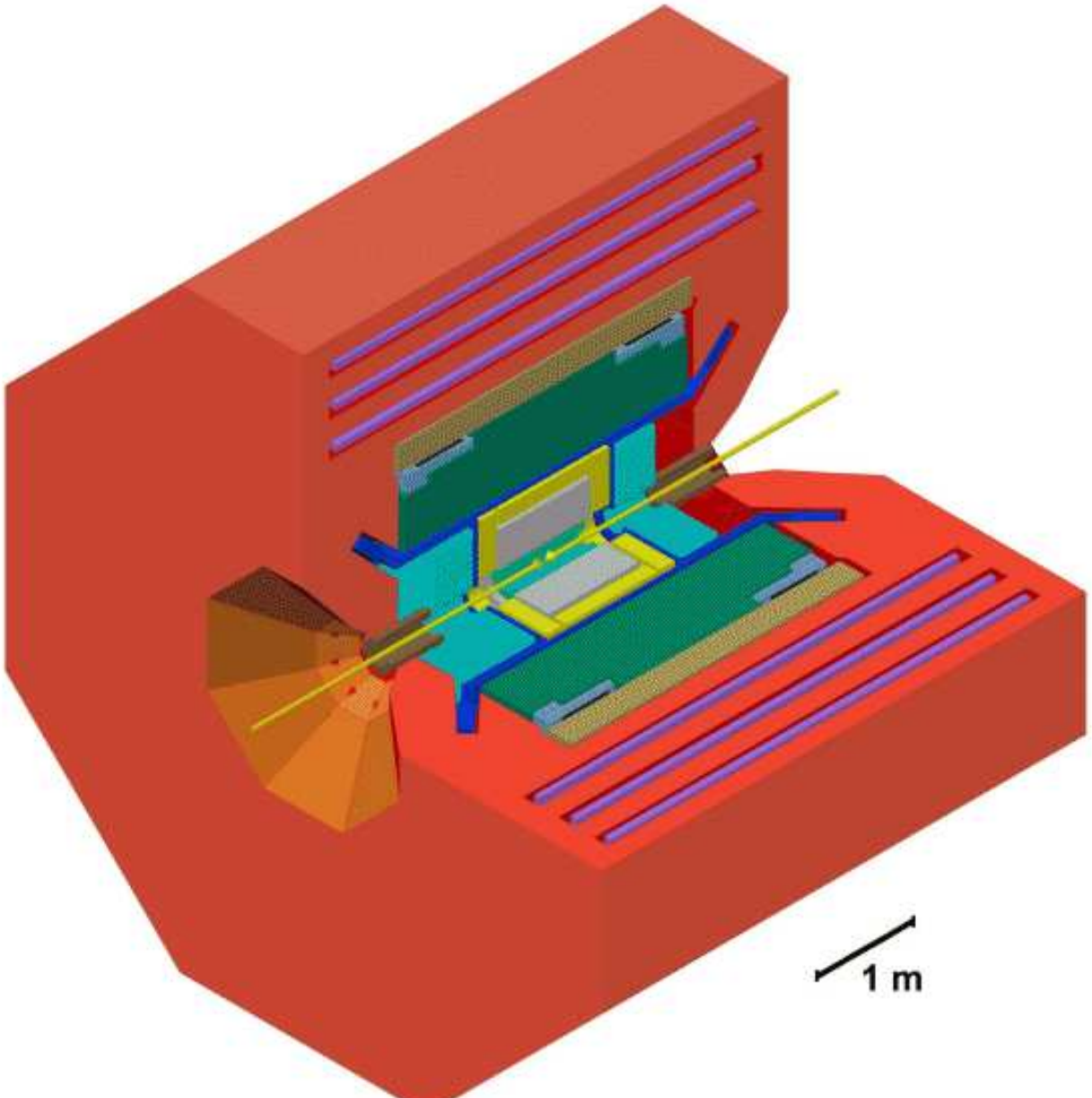
VEPP–4M collider



Beam energy	$1 \div 5.5$ GeV
Number of bunches	2×2
Beam current, $E = 1.8$ GeV	2.0 mA
Luminosity, $E = 1.8$ GeV	$1.5 \cdot 10^{30} \frac{1}{cm^2 \cdot s}$

- Resonant depolarization technique:
  - Instant measurement accuracy $\simeq 1 \times 10^{-6}$
  - Energy interpolation accuracy $(5 \div 15) \times 10^{-6}$ $(10 \div 30$ keV$)$
- Infra-red light Compton backscattering (2005):
  - Statistical accuracy $\simeq 5 \times 10^{-5}$ / 30 minutes
  - Systematic uncertainty $\simeq 3 \times 10^{-5}$ $(50 \div 70$ keV$)$

KEDR detector

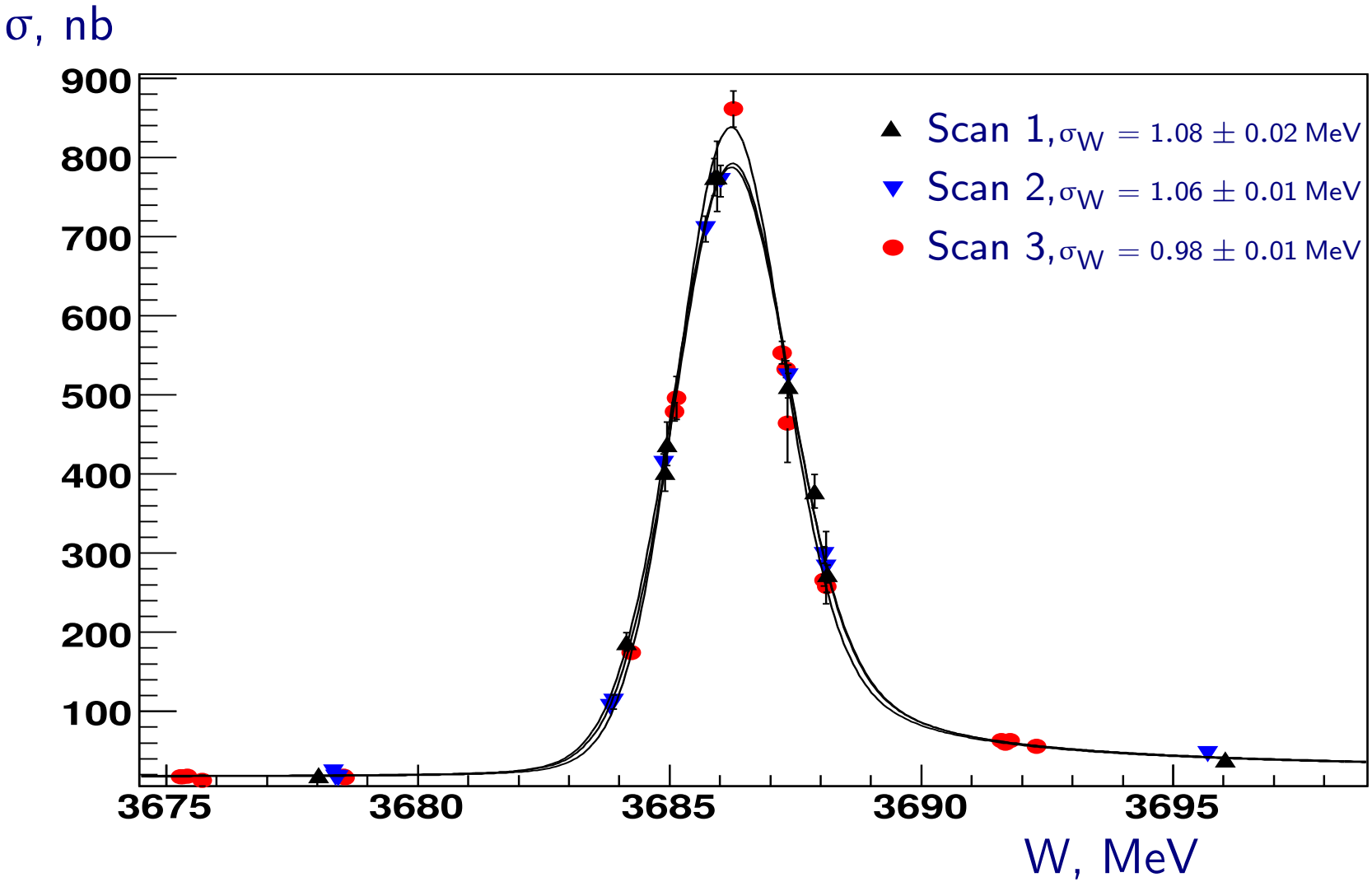


- Vertex detector
- Drift chamber
- Aerogel threshold counters
- ToF counters
- Lkr calorimeter
- Superconducting coil
- Yoke
- Muon chambers
- CsI calorimeter
- Compensating solenoid

Physical program

- High-precision measurement of $J/\psi, \psi(2S), \psi(3770), D^0, D^{\pm}, \tau$, $\Upsilon(1S), \Upsilon(2S), \Upsilon(3S), \Upsilon(4S)$ masses
- Leptonic widths measurement for ψ and Υ
- J/ψ and $\psi(2S)$ radiative transitions ($J/\psi \to \gamma\eta_c, \psi(2S) \to \gamma\chi_c$, ...)
- R measurement $W = 2 \div 10$ GeV
- $\gamma\gamma$ physics

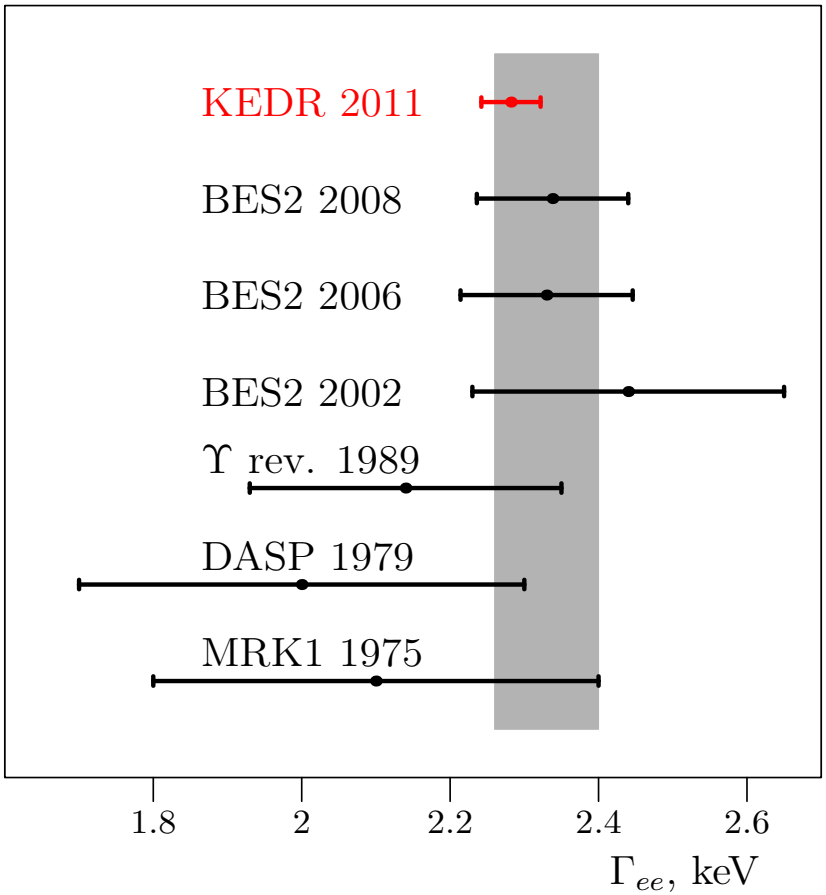
Measurement $\Gamma_{e^+e^-}(\psi(2S)) \cdot \mathcal{B}(\psi(2S) \to \textit{hadrons})$

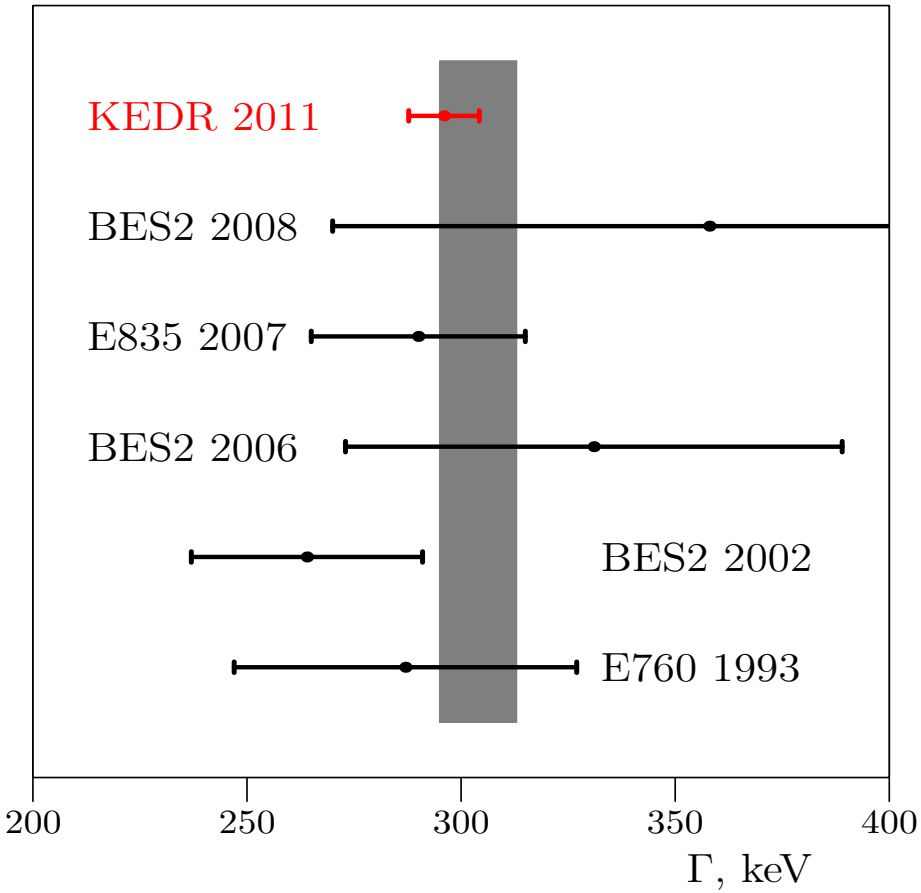


Scans 2004, 2006 $\int \mathcal{L} dt \simeq 0.5$ pb^{-1}.

$$\Gamma_{ee} \times \mathcal{B}_{hadrons} = 2.233 \pm 0.015 \pm 0.036 \,\text{keV}$$

Results for $\psi(2S)$





There is only **MARK-I** result for $\Gamma_{ee} \times \mathcal{B}_{hadr.}$ in PDG.

Taking into account $\mathcal{B}^{PDG}_{hadr.} = 0.9785 \pm 0.0013, \mathcal{B}^{PDG}_{ee} = 0.00772 \pm 0.00017$

$$\Gamma_{ee} = 2.282 \pm 0.015 \pm 0.037\,\text{keV}$$
$$\Gamma = 296 \pm 2 \pm 8\,\text{keV}$$

Incomplete compilation of results on $\psi(3770)$ *mass*

Analysis	$M_{\psi(3770)}$ [MeV/c^2]	Comments
MARK-I	3774.1 ± 3	$e^+e^- \to$ hadrons [(a)]
DELCO	3772.1 ± 2	$e^+e^- \to$ hadrons [(a)]
MARK-II	3766.1 ± 2	$e^+e^- \to$ hadrons [(a)]
BELLE (2003)	$3778.4 \pm 3.0 \pm 1.3$	$B \to D^0\overline{D}{}^0K^+$ [(b)]
BES-II (2006)	$3772.4 \pm 0.4 \pm 0.3$	$e^+e^- \to$ hadrons [(a)]
BES-II (2007)	3772.0 ± 1.9	$e^+e^- \to$ hadrons
BELLE (2007)	$3776.0 \pm 5.0 \pm 4.0$	$B \to D^0\overline{D}{}^0K^+$
BABAR (2007a)	$3775.5 \pm 2.4 \pm 0.5$	$B \to D\bar{D}K$
BABAR (2007b)	$3778.8 \pm 1.9 \pm 0.9$	$e^+e^- \to D\overline{D}\gamma$ [(c)]
Hai-Bo Li *et al.* 2009, data of BES+BELLE	$3776.0 \pm 1.0 \pm ?$	$e^+e^- \to D\overline{D}$ + $e^+e^- \to D\overline{D}\gamma$ [(c)]
Yu.-Ji. Zhang *et al.* 2009, BES data	$3774.0 \pm 1.0 \pm ?$	$e^+e^- \to D\overline{D}\gamma$ [(c)] $e^+e^- \to D\overline{D}$ [(c)]

[(a)] — omitted in the latest PDG edition

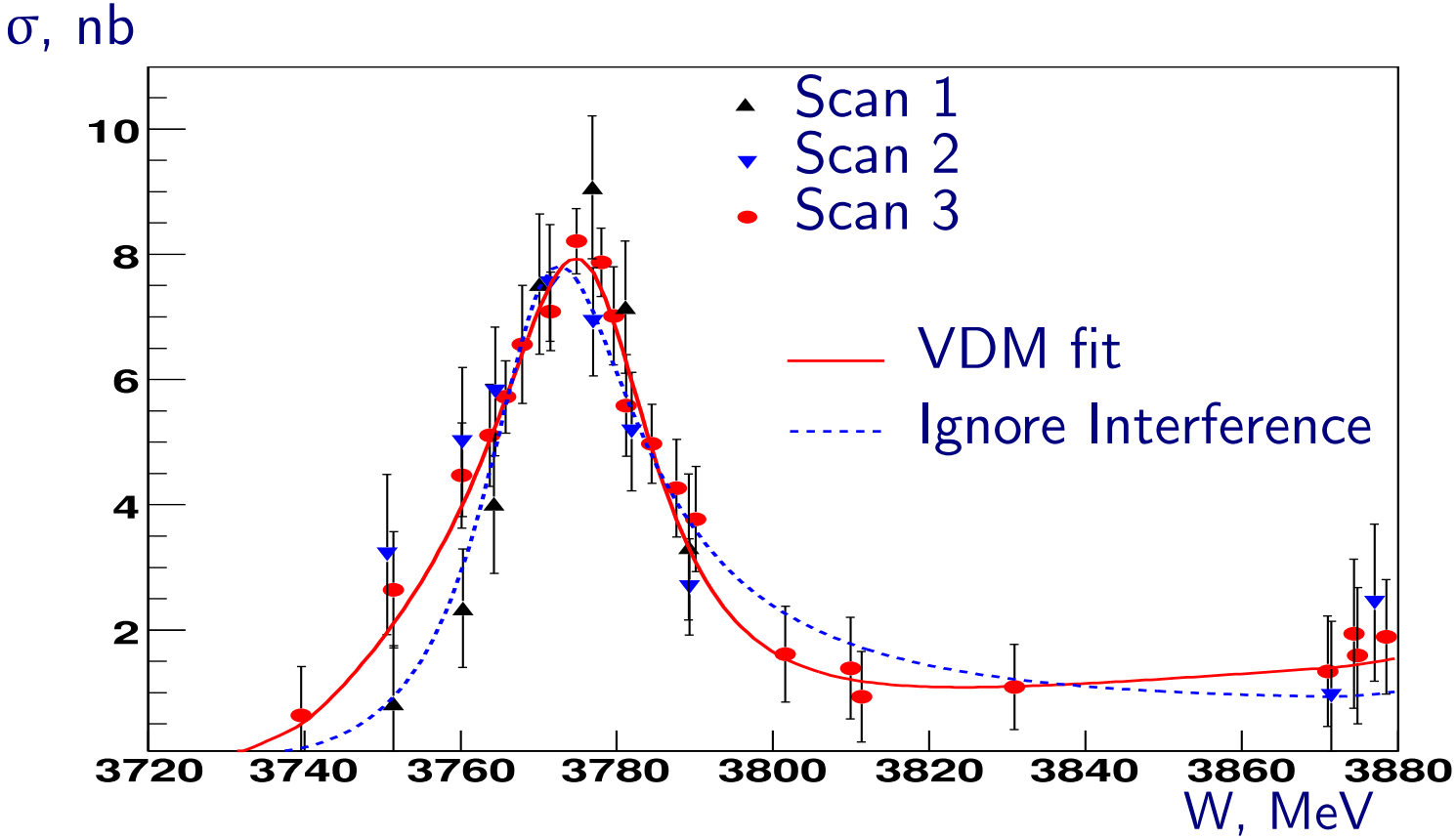
[(b)] — the result on $\mathcal{B}(B \to D^0\overline{D}{}^0K^+)$ is superseded by BELLE (2007)

[(c)] — interference between resonant and nonresonant $D\overline{D}$ production is taken into account

Cross section near of $\psi(3770)$

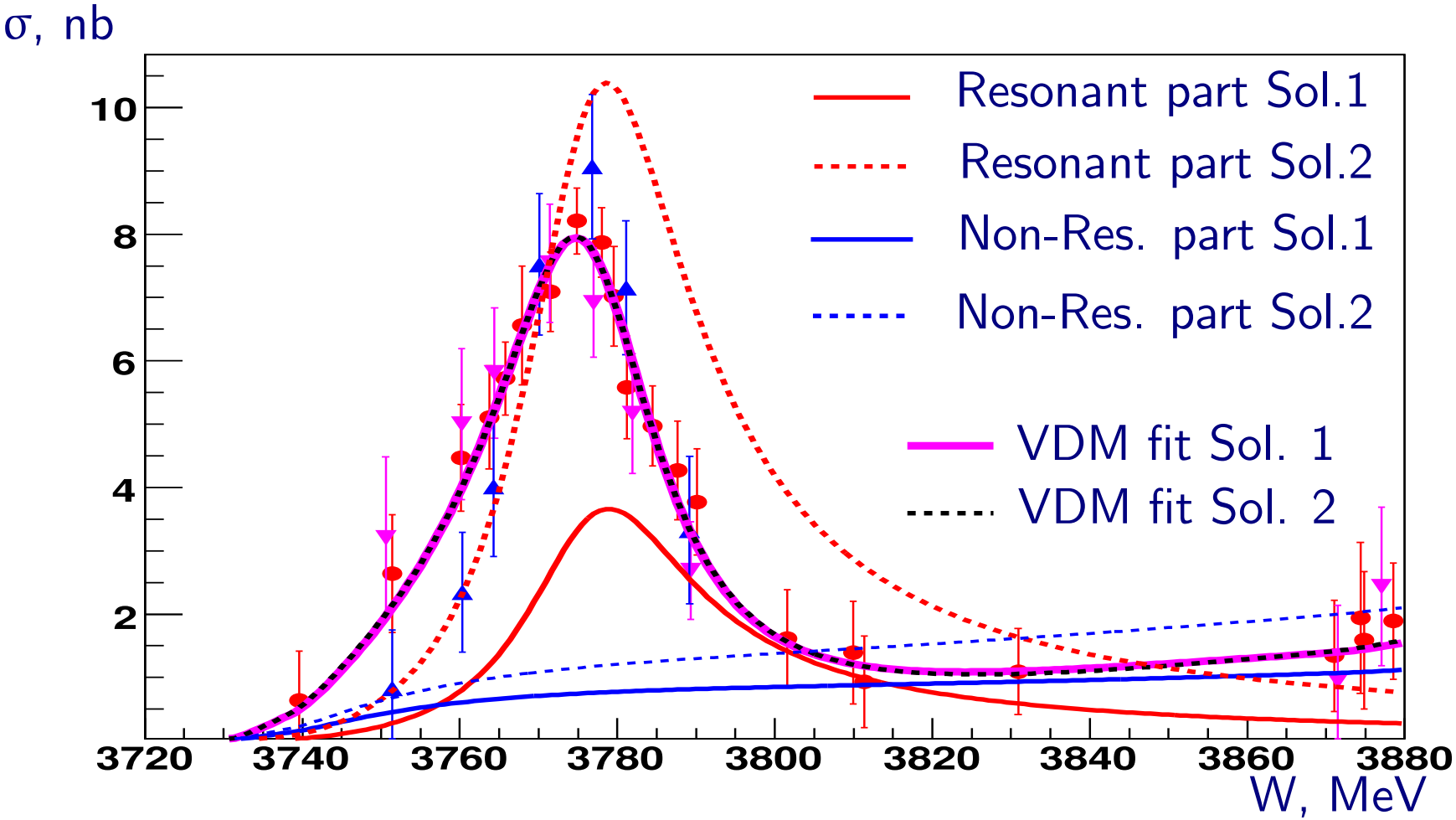
Scans 2004, 2006 $\int \mathcal{L} dt \simeq 1.9$ pb^{-1}.

The data consistent analysis takes into account the interference between the resonant and nonresonant $D\overline{D}$



Cross section of $e^+e^- \to$ *hadrons* vs. c.m. energy in the vicinity of $\psi(3770)$ with the light quark, τ and QED backgrounds subtracted.

Ambiguity of resonance parameters



There are two solutions for any model of non-resonant $D\overline{D}$ cross section.

Results for $\psi(3770)$

$$M = 3779.1\ ^{+1.8}_{-1.7}\ \pm 0.6\ ^{+0.2}_{-0.3}\ \text{MeV}/c^2,$$
$$\Gamma = \quad 25.2\ ^{+4.6}_{-4.1}\ \pm 0.5\ ^{+0.5}_{-0.2}\ \text{MeV},$$

where the first, second and third uncertainties are statistical, systematic and model, respectively. For the electron partial width two possible solutions have been found:

$$(1) \quad \Gamma_{ee} = 147\ ^{+97}_{-62}\ \pm 13\ ^{+11}_{-10}\ \text{eV},$$
$$(2) \quad \Gamma_{ee} = 415\ ^{+59}_{-58}\ \pm 38\ ^{+160}_{-10}\ \text{eV}.$$

Our statistics are insufficient to prefer one solution to another.

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KEDR 2011	$3779.1\ ^{+1.8}_{-1.7} \pm 0.6\ ^{+0.2}_{-0.3}$	$e^+e^- \to$ hadrons

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Maybe we should to rename $\psi(3770) \to \psi(3779)$

R measurement

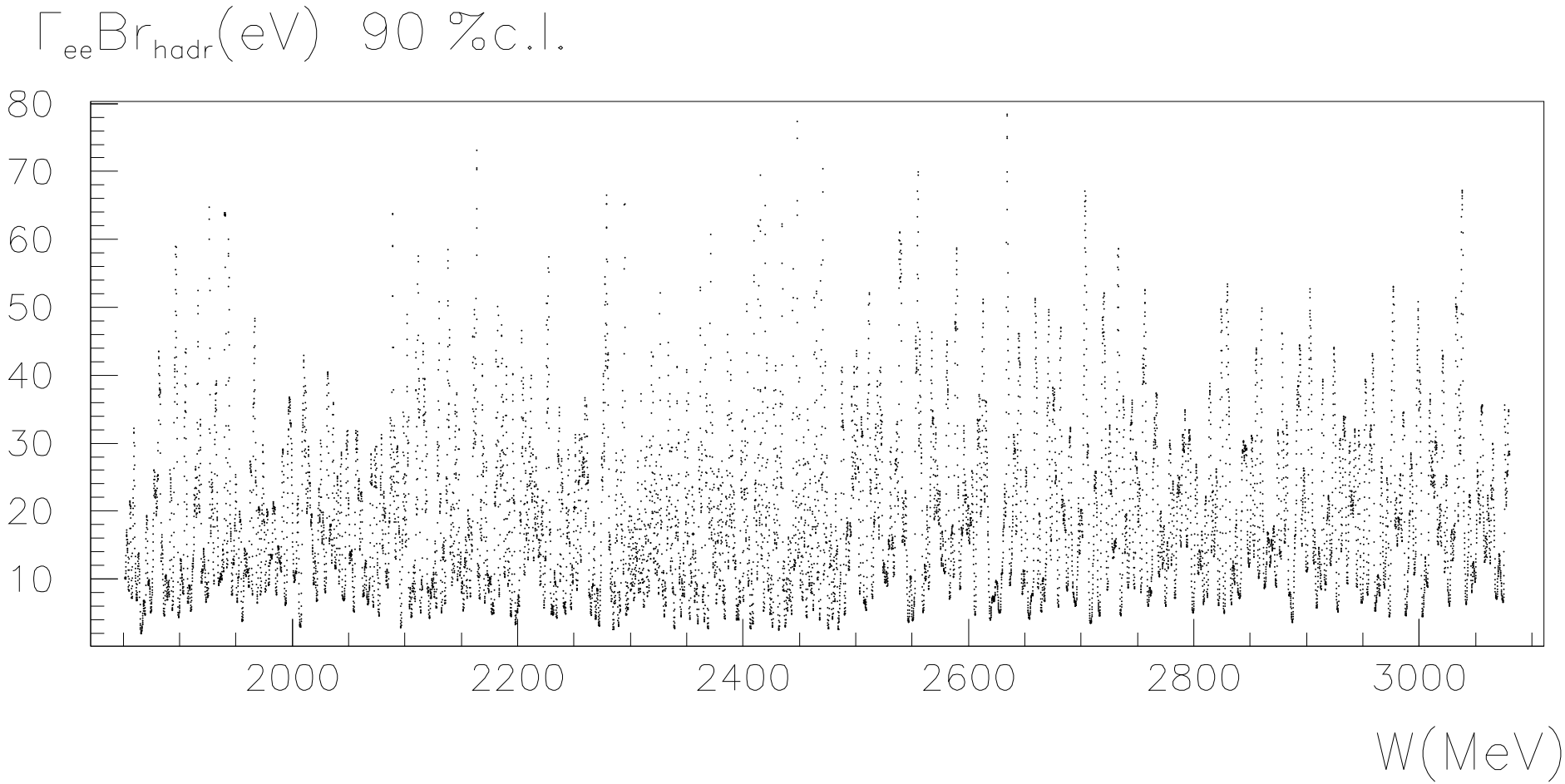
- A region from 3.1 GeV to 3.75 GeV. Energy beam step $E^{step}_{beam} = 50\ MeV$. $\int \mathcal{L}dt \simeq 1.4\text{pb}^{-1}$
  Error $3-4\%$ is expected.

- A region from 1.85 GeV to 3.1 GeV Energy beam step $E^{step}_{beam} = 50\ MeV$. $\int \mathcal{L}dt \simeq 0.9\ \text{pb}^{-1}$.
  Error $4-6\%$ is expected.

- $\int \mathcal{L}dt \simeq 0.6\text{pb}^{-1}$ with energy beam step $E^{step}_{beam} = 50\ MeV$ and $\int \mathcal{L}dt \simeq 0.3\ \text{pb}^{-1}$ is collected during scan with energy beam step $E^{step}_{beam} = 0.7 \div 0.95\ MeV (\sim 10^3$ points)

- 90 % upper limit for $\Gamma^R_{ee} \cdot \mathcal{B}(R \to hadr) \simeq 500\ eV$ in this energy region (experiments at the ADONE,Frascati)

Search for narrow resonances below J/ψ



90 % upper limit for $\Gamma^R_{ee} \cdot \mathcal{B}(R \to hadr) \simeq 120$ eV in W range between 1.85 GeV and J/ψ.

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Conclusions and prospects

- High-precision determination of the main parameters of the $\psi(2S)$ resonance has been performed
- The parameters of the $\psi(3770)$ meson have been measured. The interference of resonant and nonresonant production essential in the near-threshold region has been taken into account.
- Search for narrow resonances in e^+e^- annihilation between 1.85 and 3.1 GeV performed. An upper limit obtained for the leptonic width of possible resonances is four to five times more stringent than that obtained in this energy range in earlier experiments.

Plans

- Delay of repair and upgrading subsystems.
- Collect $\int \mathcal{L}dt \simeq 200 \div 300$ pb^{-1} for $\gamma\gamma$ physics
- $\Upsilon(1S), \Upsilon(2S), \Upsilon(3S), \Upsilon(4S)$ mass measurement.