A Proposal to Measure the Resonance Parameters of $\psi(3770)$

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1. Motivation and goals

2. Strategy of the scan

3. Manpower and organization

1. Motivation

The resonance parameters of $\psi(3770)$ were measured by three experiments in late 70's and early 80's as listed in table 1, and Figure 1-3 shows the resonance reported, as well as what was measured by BES collaboration.

Table 1. Measured resonance parameters of $\psi(3770)$.

Experiment	Ref.	Mass (MeV)	Γ_{total}(MeV)	Γ_{ee}(MeV)
MARKI	PRL 391(1977)1301	3772 ± 6	28 ± 5	345 ± 85
DELCO	PRL (1978) 671	3770 ± 6	24 ± 5	180 ± 60
MARKII	PRD 21(1980)2716	3764 ± 5	24 ± 5	276 ± 50
BES	1999	3773 ± 3	27 ± 9	214 ± 70

During the finer R scan done by BES collaboration, we intended to perform the measurement of the $\psi(3770)$ resonance parameters as a side product of the R scan. Unfortunately, due to the limited beam time, the points scanned over the resonance are not sufficient for improving the measured parameters, as one can see from the table 1.

Base on our experience on the R scan, we propose to measure the $\psi(3770)$ resonance parameters once more, using the beam time left from accumulating 50 M J/ψ events. Our goal is to improve the accuracy of the measured parameters. In the mean time, the re-measurement of the $\psi(3770)$ resonance parameters will simultaneously measure the DDbar production cross section of e^+e^- annililation.

Following is some data from R scan which may useful for beam time estimation. Event selections are the same as R project applied.

Table 2. Useful event rate from R scan done in 1999.

E_{cm}(MeV)	N(had)/hour	N(Bhabha)/hour
3000	63	275
3700	116	254
3850	95	407

2. Strategy for the scan

- Energy calibration

  In principle one can use the well-measured mass of J/ψ and $\psi(2S)$ to calibrate the mass of $\psi(3770)$. The sequence of the scan is proposed to be $J/\psi \rightarrow \psi(2S) \rightarrow \psi(3770)$. The uncertainty of the energy calibration should be better than 1 MeV.

- Energy point to be scanned

  The scan should cover sufficient energy points extending over the resonance far enough to both sides of the resonance to account for the radiative return effect from $\psi(2S)$, the radiative tail of $\psi(3770)$ itself and the subtraction of the background. In addition, a certain number of points is required to guarantee a good fit to the resonance curve. The proposed energy points to be scanned is plotted in Figure 4.

- Background subtraction

  Separated beam operation in 3.0, 3.12, 3.67, 3.85 GeV will held understand beam associated background from the data. However, Z component of the event vertex distribution will be utilized in the data analysis to subtract beam- associated background, as what has been done for the R-value measurement.

- Beam time estimation

(a) Scan the J/ψ resonance: 18 (pts) × 3 (hrs) = 54 (hrs)
(b) Scan the $\psi(2S)$ resonance: 12 (pts) × 4 (hrs) = 48 (hrs)
(c) Scan the $\psi(3770)$ resonance: 20 (pts) × 6 (hrs) = 120 (hrs)
(d) Separated beam operation: 4 (pts) × 4 (hrs) = 16 (hrs)
Sum = 238 (hrs)

For the R scan done in 1999
$\varepsilon \equiv$ (BES pure data taking time) / (beam time to BES) $\approx$ 55 %.
Since the performance of both BEPC and BES are good so far, one can assume ε=65%.
In this case, the total beam time required is about 238/0.65 = 366 (hrs) = 15.2 day

- Data analysis and anticipated publications:

The method technique of data analysis is mature. We have existing programs for the event selection, measurement of intergraded luminosity via larger angle Bhabha events, determination of the detestation efficiency for the hadronic events, as well as the calculation of the radiative correction. The program for fitting the resonance parameters has been tested and used for fitting the J/ψ, $\psi(2S)$ and $\psi(3770)$.

The result is expected to be published on PRL and quoted by PDG.

3. Manpower and responsibilities

The manpower to be used is mainly based on R working group. The project will be a Ph. D. thesis for Mr. X.P. Chi.

Zhengguo Zhao will lead the project. Shaopeng Chi and L. Zhou are responsible for the online data quality check, inspect all the conditions of BEPC and BES performance, trace the necessary data concerning the status of the beam and detector, and tag the run status. Gang Rong is responsible for the online fast data reconstruction.

Shaopeng Chi, Zhiyong Wang, Webiao Yan, Haiming Hu and Guangshun Huang will perform the data analysis.

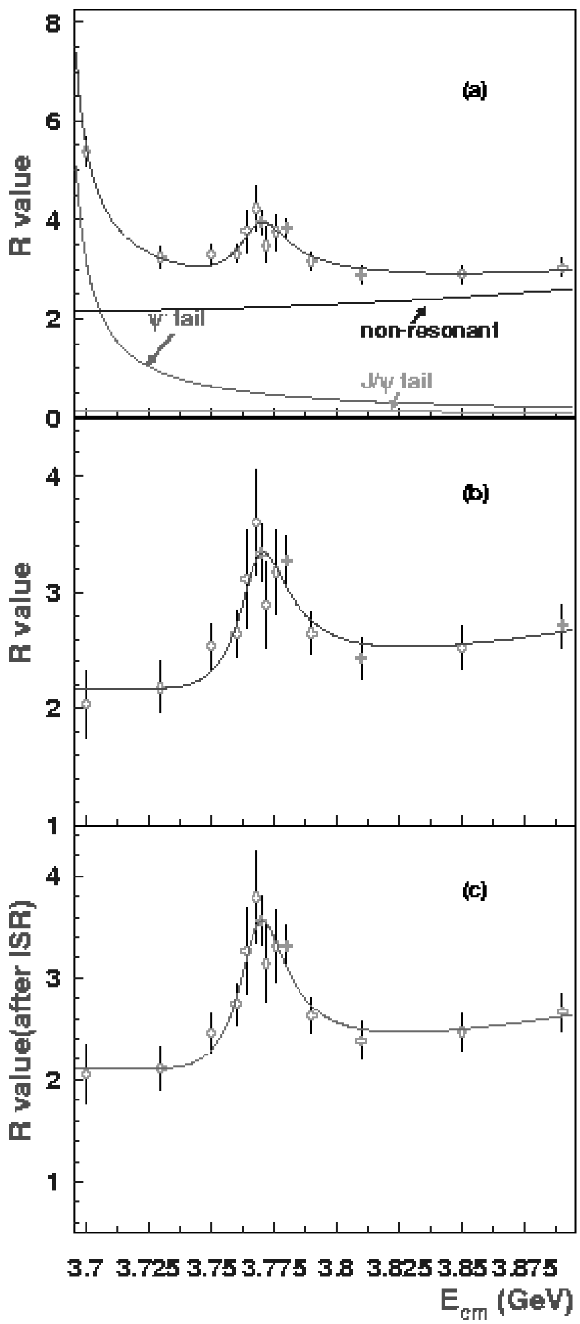


Figure 1. ψ(3770) resonance curve measured by BES

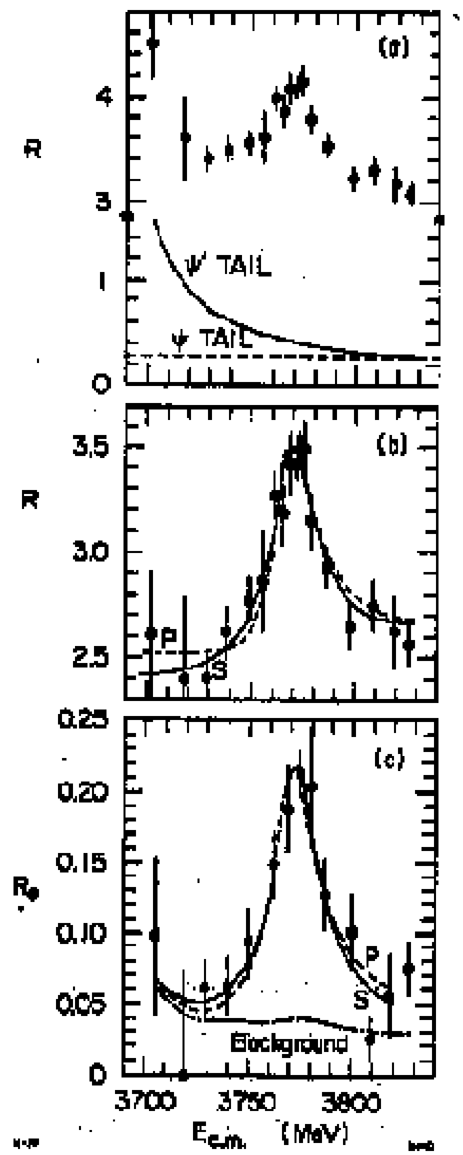


Figure 2. ψ(3770) resonance curve measured by DELCO.

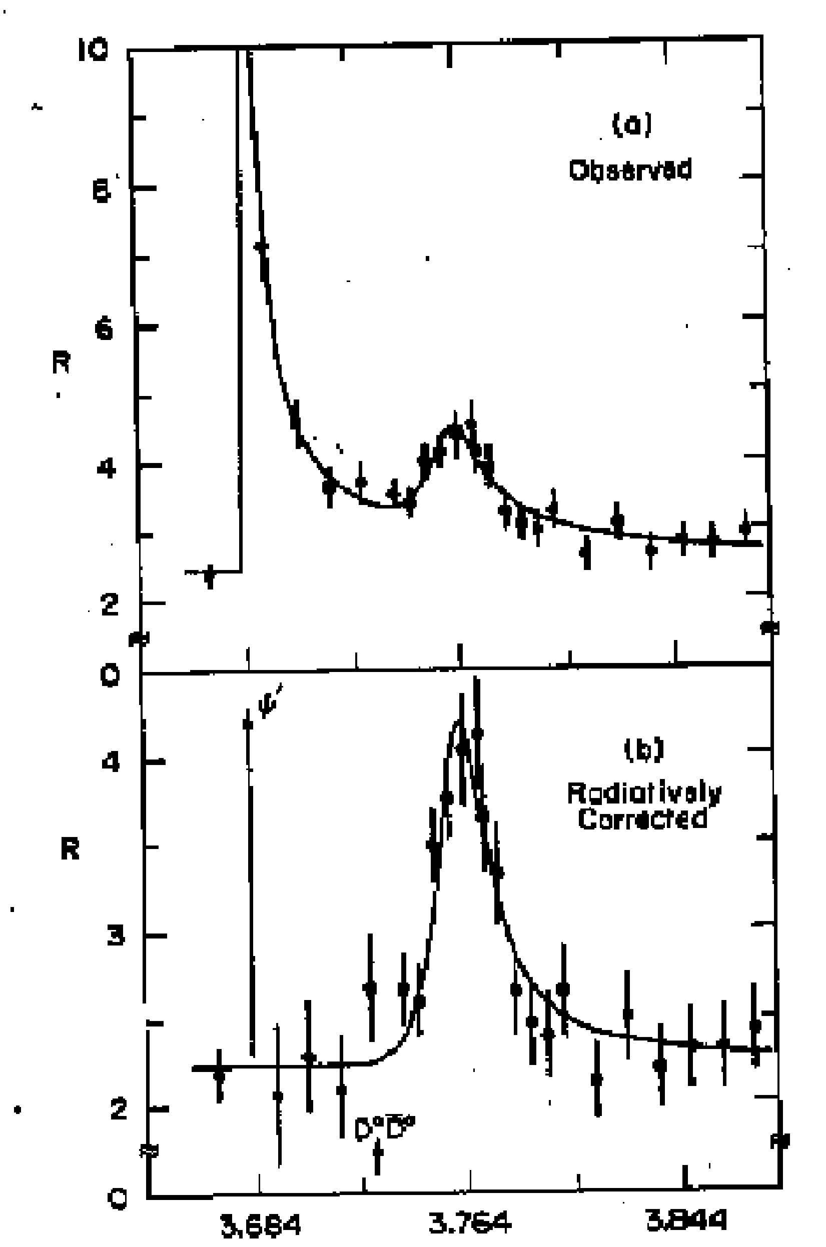
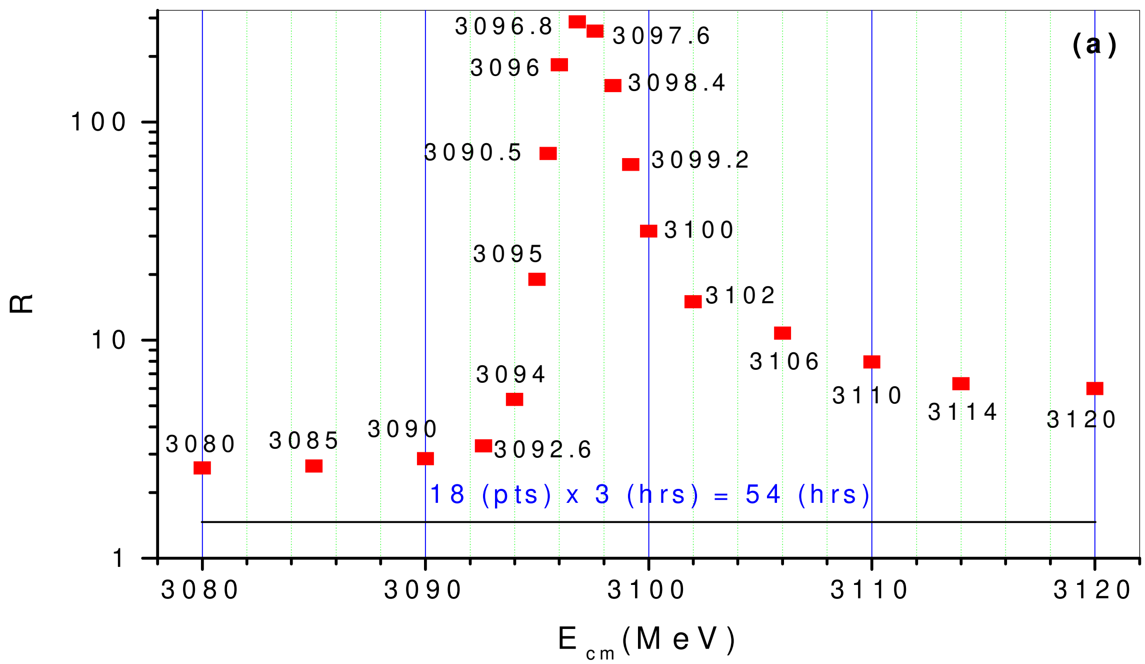
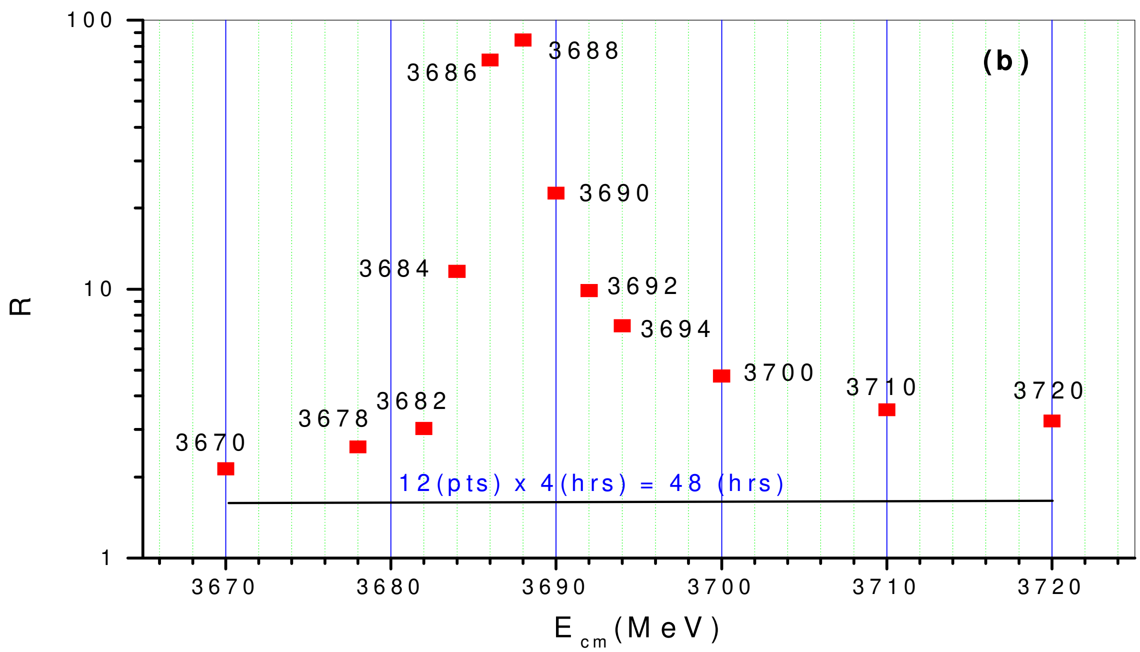


Figure 3. ψ(3770) resonance curve measured by MarkII.



(a)
R
100
10
1
3096.8
3097.6
3096
3098.4
3090.5
3099.2
3100
3095
3102
3106
3094
3110
3114
3120
3080
3085
3090
3092.6
18 (pts) x 3 (hrs) = 54 (hrs)
3080
3090
3100
3110
3120
E_{cm}(MeV)



(b)
R
100
10
1
3686
3688
3690
3684
3692
3694
3700
3710
3720
3670
3678
3682
12(pts) x 4(hrs) = 48 (hrs)
3670
3680
3690
3700
3710
3720
E_{cm}(MeV)

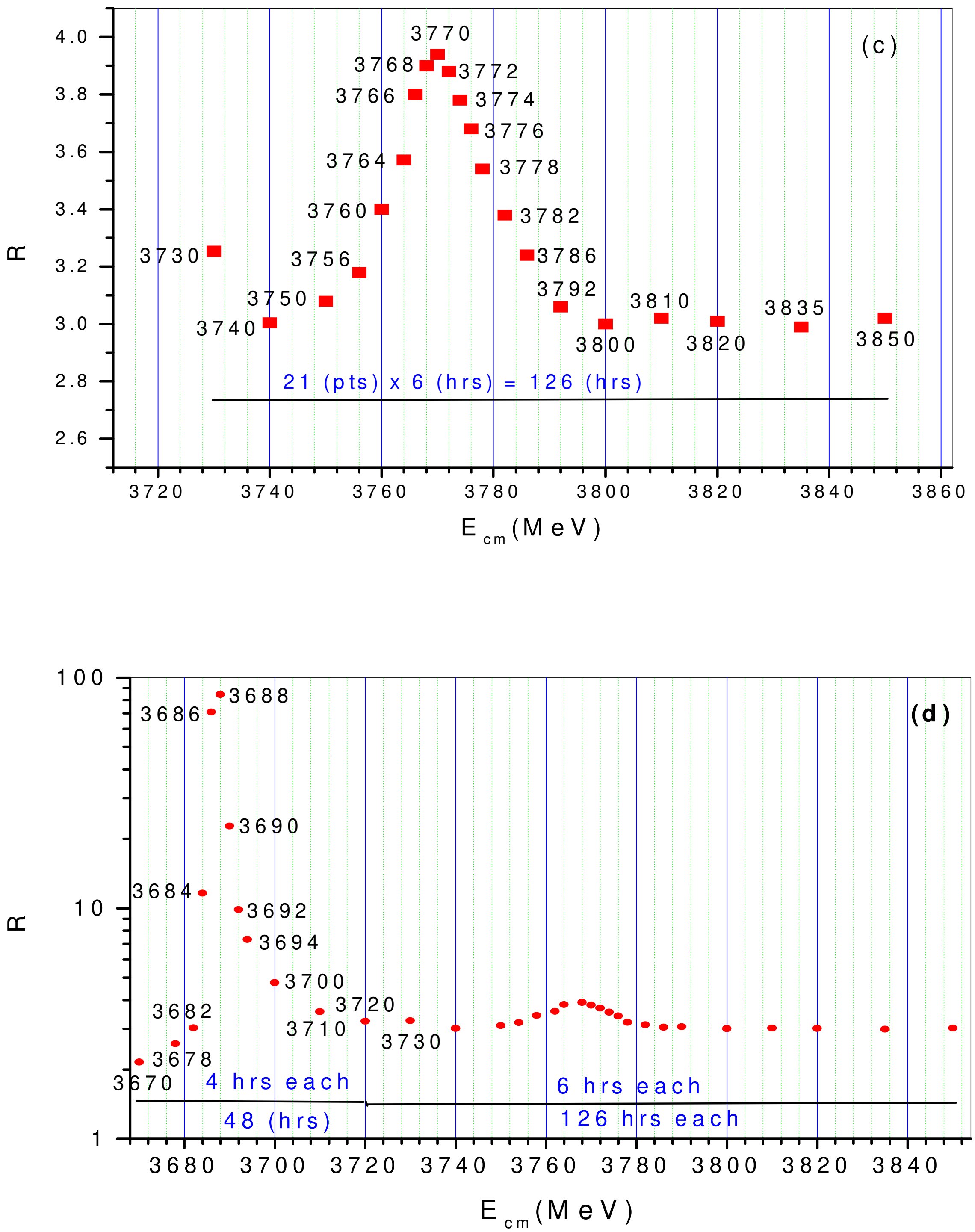


Figure 4. Energy points to be scanned and the corresponding time estimated.