Data taking of psi(2S) - first studies

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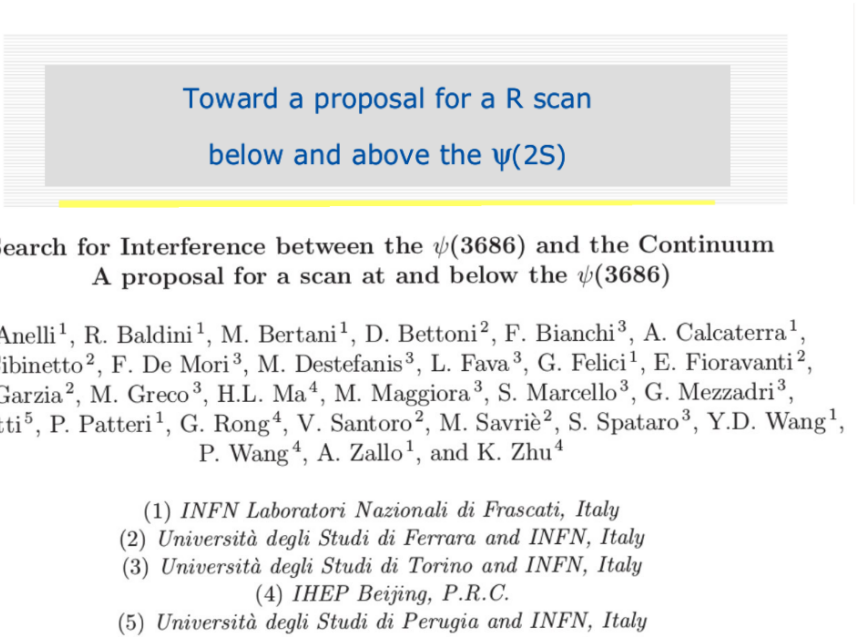
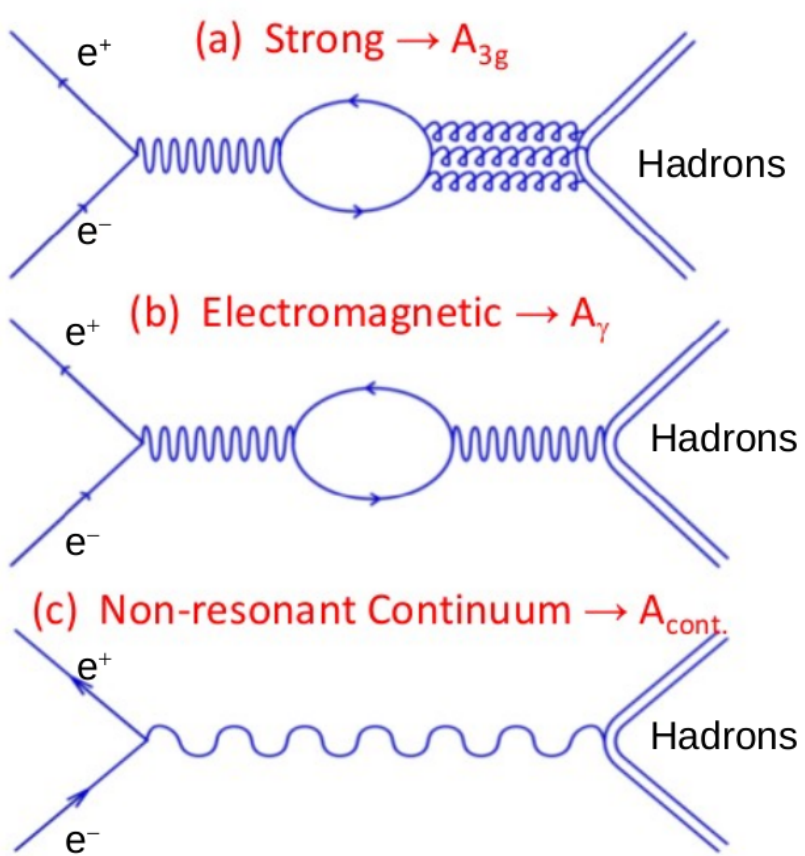
Weekly Charmonium Meeting

Outline

- Introduction
  - Status of J/psi analysis
- Motivations for the psi(2S) scan
- Data taking summary
- First results



Introduction to the relative phase measurement



Hadronic cross section around charmonia can be described with three diagrams

Experimental and theoretical agreement around EM contributions

Still questions around the strong (A_{3g}) amplitude:
- pQCD predicts almost real
- experiments have different results for J/psi, pointing towards 90° relative phase

Status of J/psi analyses

In BESIII several analyses are on-going to extract the relative phase by means of studying the cross-section lineshape around J/psi

- Yadi Wang's $\mu^+\mu^-$ and 5π study is in Spokeperson's Approval stage
- Marco Destefanis $p\bar{p}$ study is in Memo stage, soon finish the answer of the referee and move to Draft Stage
- Francesca De Mori K^+K^- study is finalizing the memo after finding consistent results in psi(2S) $\rightarrow \pi+\pi-$ J/psi $\rightarrow \pi+\pi-$ K+K- study of the branching ratio
- My $\Lambda\bar{\Lambda}$ will be finalized once the Montecarlo generator will be updated (missing angular distribution)

All these analyses points towards 90° phase

(with the exception of the pure EM $\mu^+\mu^-$ and $\eta'\pi+\pi-$)

A motivation

From the experimental point of view, based on $SU(3)_F$ and isospin breaking violation models:

- At J/psi
  - VP (1^-0^-) (e.g. J/psi → ρπ) phase = 106° ± 10°
  - PP (0^-0^-) (e.g. J/psi → ππ) phase = 89.6° ± 9.9°
  - BB (½ ½) (e.g. J/psi → $p\bar{p}$) phase = 89° ± 8°

- At psi(2S)
  - VP (1^-0^-) phase = 159° ± 12°
  - PP (0^-0^-) phase = 95° ± 11°

Experiments points towards a non unique phase for psi(2S)
(but highly model dependent)

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Possible explaination of ρπ puzzle?

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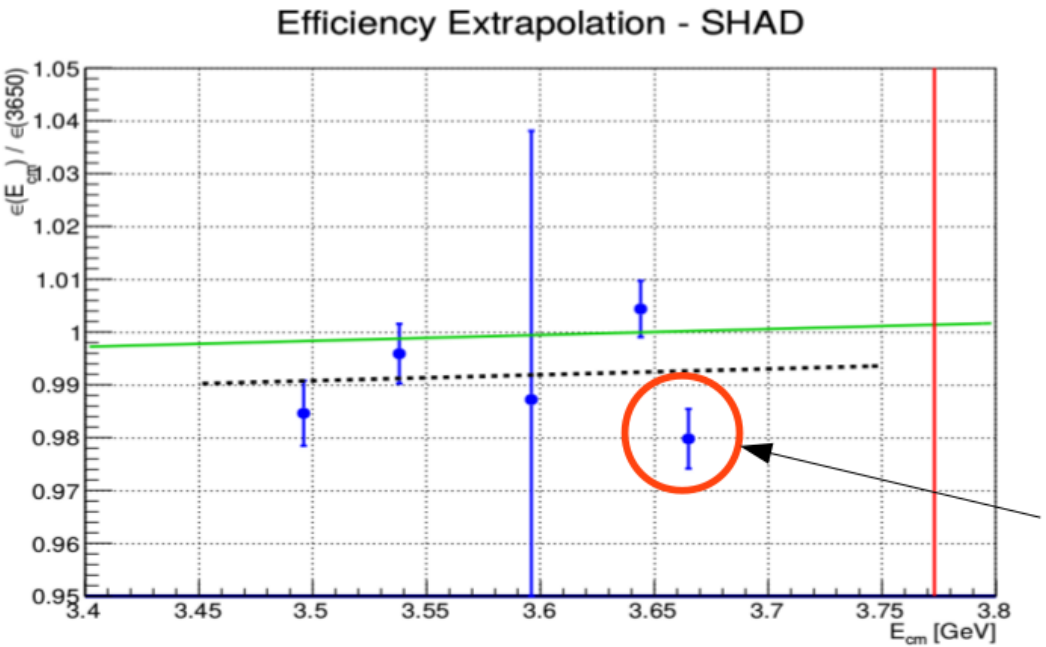
Continuum conundrum

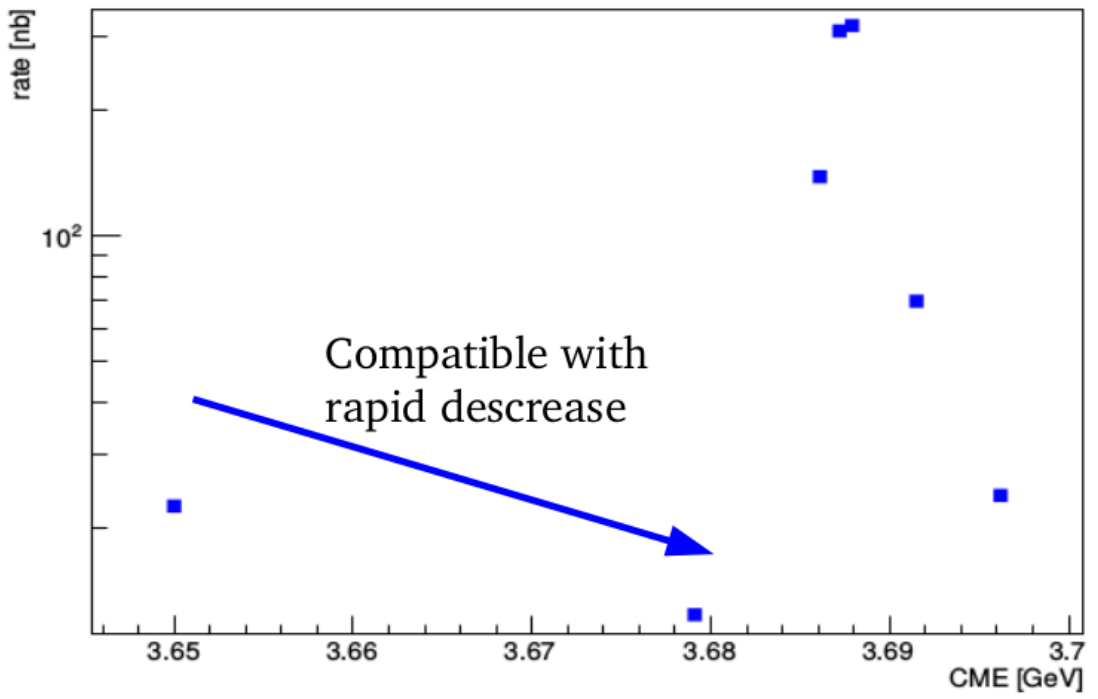


Extremely lower than expected [11]

Analysis done by Minnesota Group (Ron Poling) to understand the non-DD continuum at psi(3770)

Continuum conundrum

In 2016 analysed few scan points taken for BEMS studies.
Very simplified selection: 4 charged good tracks, no requirements for the photon candidates



The plan

Continuum constrained

ψ' Dip and Minnesota interest

ρπ optimal point

Energy (MeV)	Luminosity (pb^{-1})
3580	85
3650	44
3671	85
3681	85
3683 (*)	25
3685.5	25
3686.6	25
3691 (*)	85
3710	85

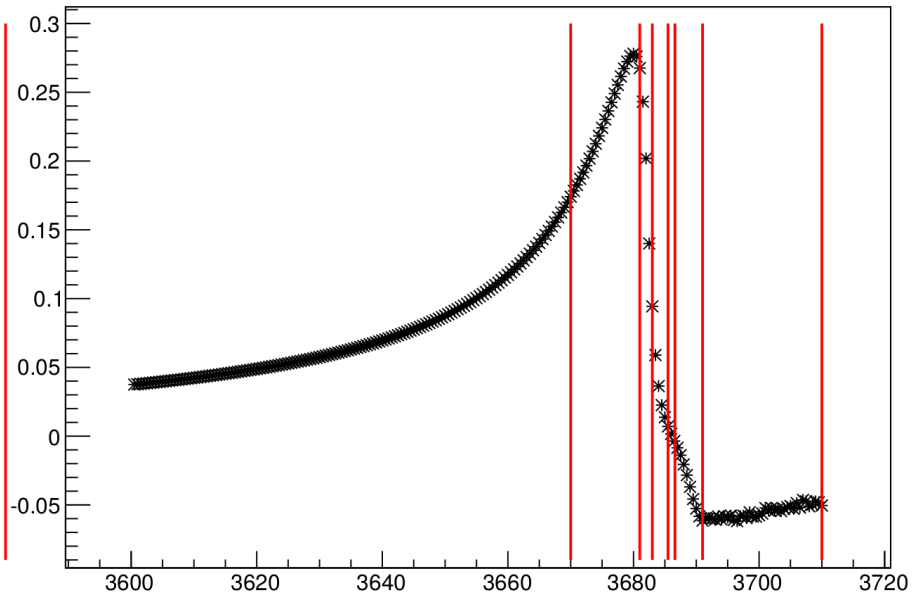
Already collected

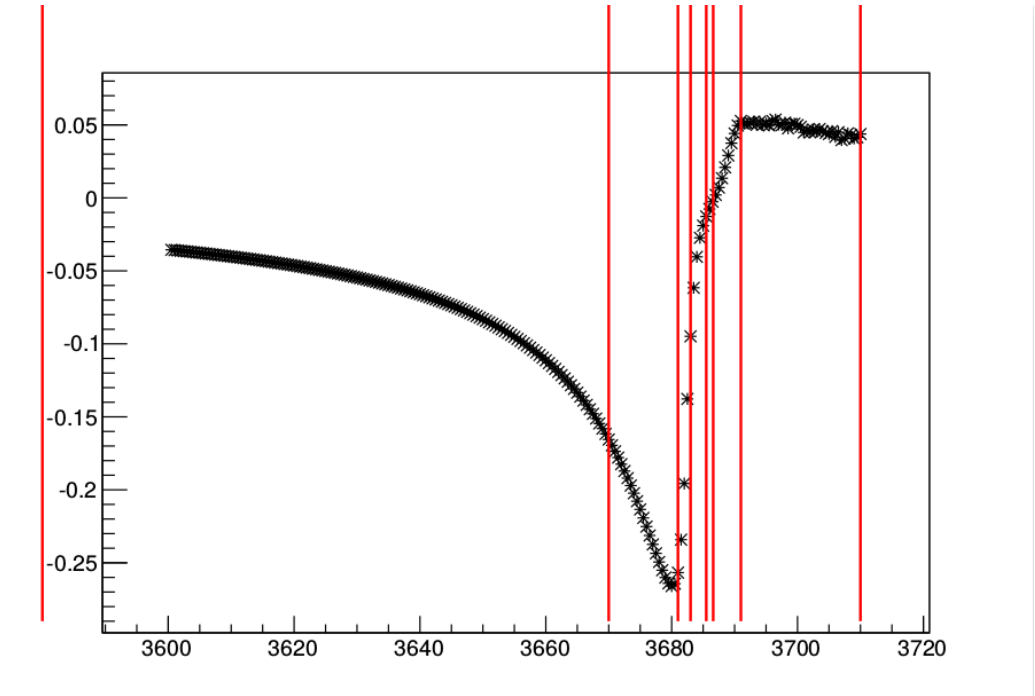
Trade-off between $p\bar{p}$ and K^+K^- from our optimization

(*) 3683 and 3691 intended to have a better measurement of the width of ψ'

Tail of ψ(3770)

Addressing the sensitivity

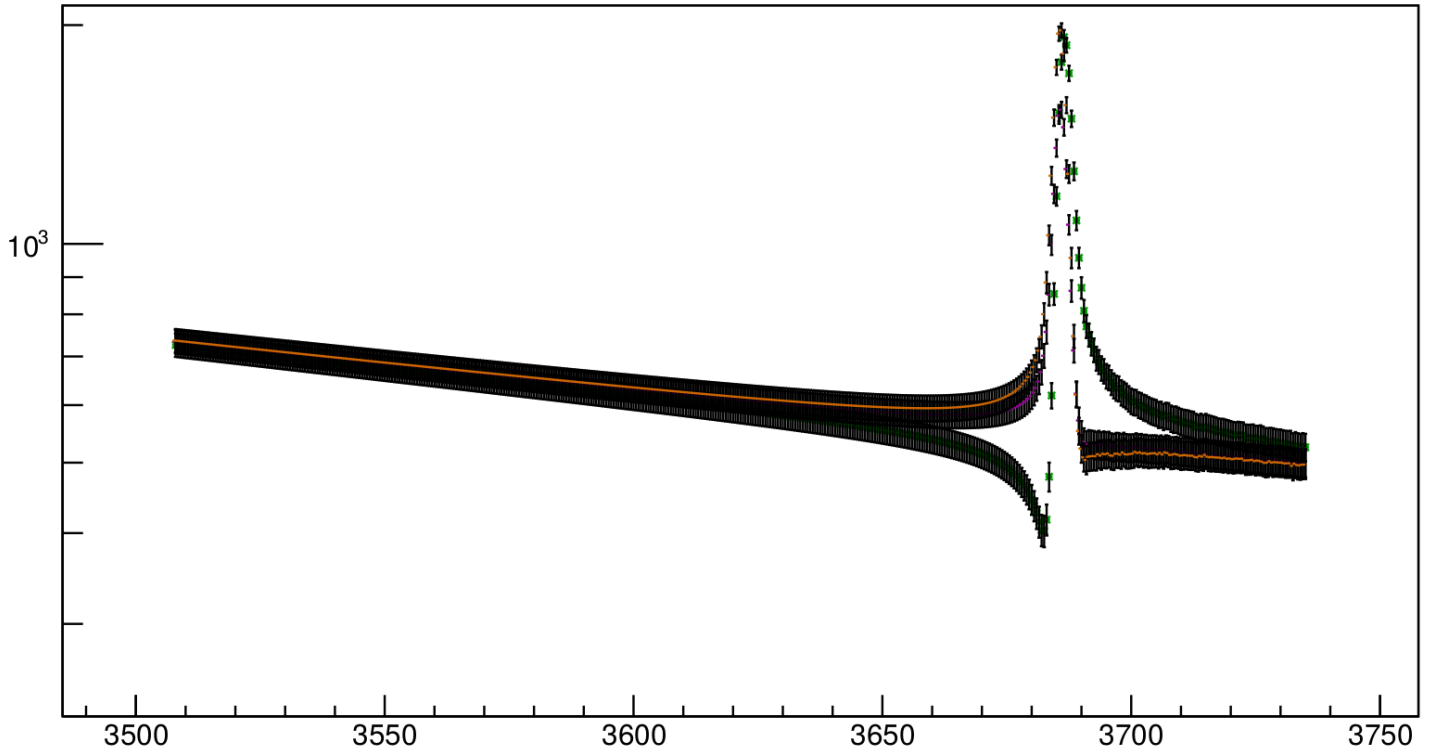




The red lines represents the energy values. The black dots the relative difference between two phase hypothesis

Addressing the sensitivity -II

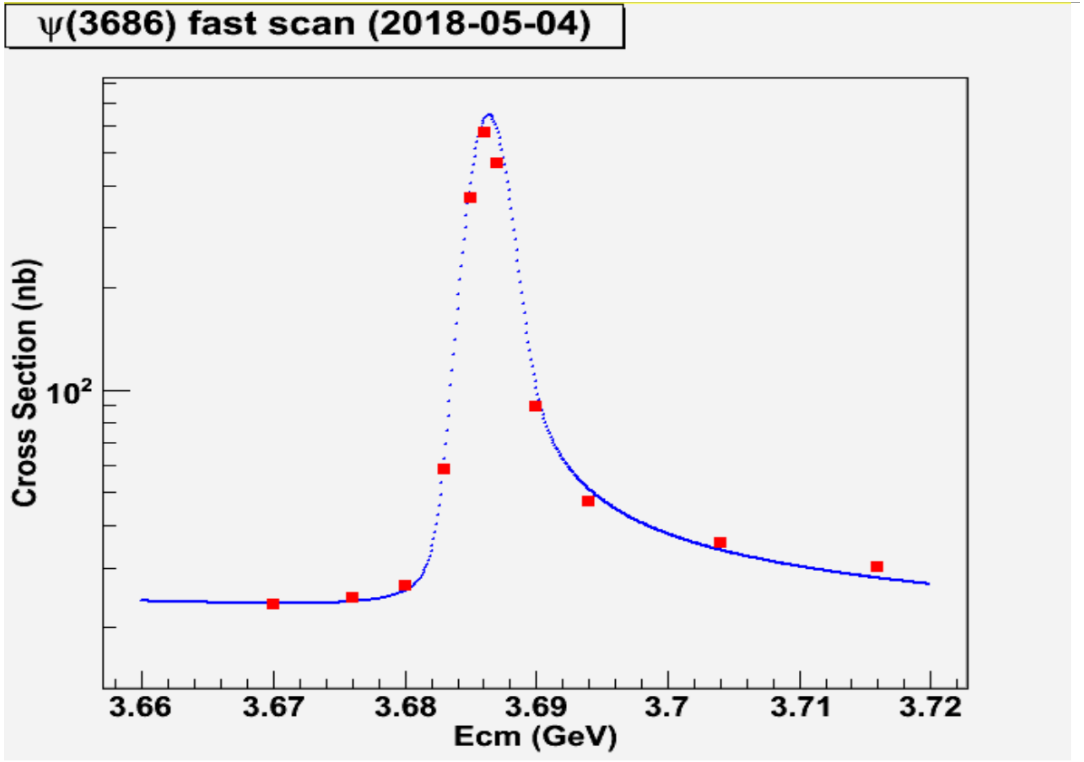
Comparison of the three cross sections: 0°, 90°, 180°



The data taking

Data taking information

Data taking started in the night of May 4 with a fast scan of psi(2S)



$$\Delta E_{cm} = M_{\psi}^{FIT} - M_{\psi}^{PDG} = (3686.2 - 3686.097)Mev = 0.103Mev$$

$$\Delta E_{beam} = \Delta E_{cm}/2 = 0.0515\text{Mev}$$

Beam energy calibration

Thanks to Lipeng, Guangyi, Xingyu, Jianyond and Haimin

Data taking information

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Later that morning we started with the first energy value (3580 MeV)

- Energy of the beam and energy spread is measured with BEMS
- Smooth operations, roughly 7/pb per shift
- Only few interruptions due to beam lost, or DAQ crashed (I am preparing the logbook to have run-by-run status)

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- Only few interruptions due to beam lost, or DAQ crashed (I am preparing the logbook to have run-by-run status)
- One electrical fault interrupted the #4 energy value. Once recovered, the energy was set to a different value. So we have one additional point. Total luminosity unchanged

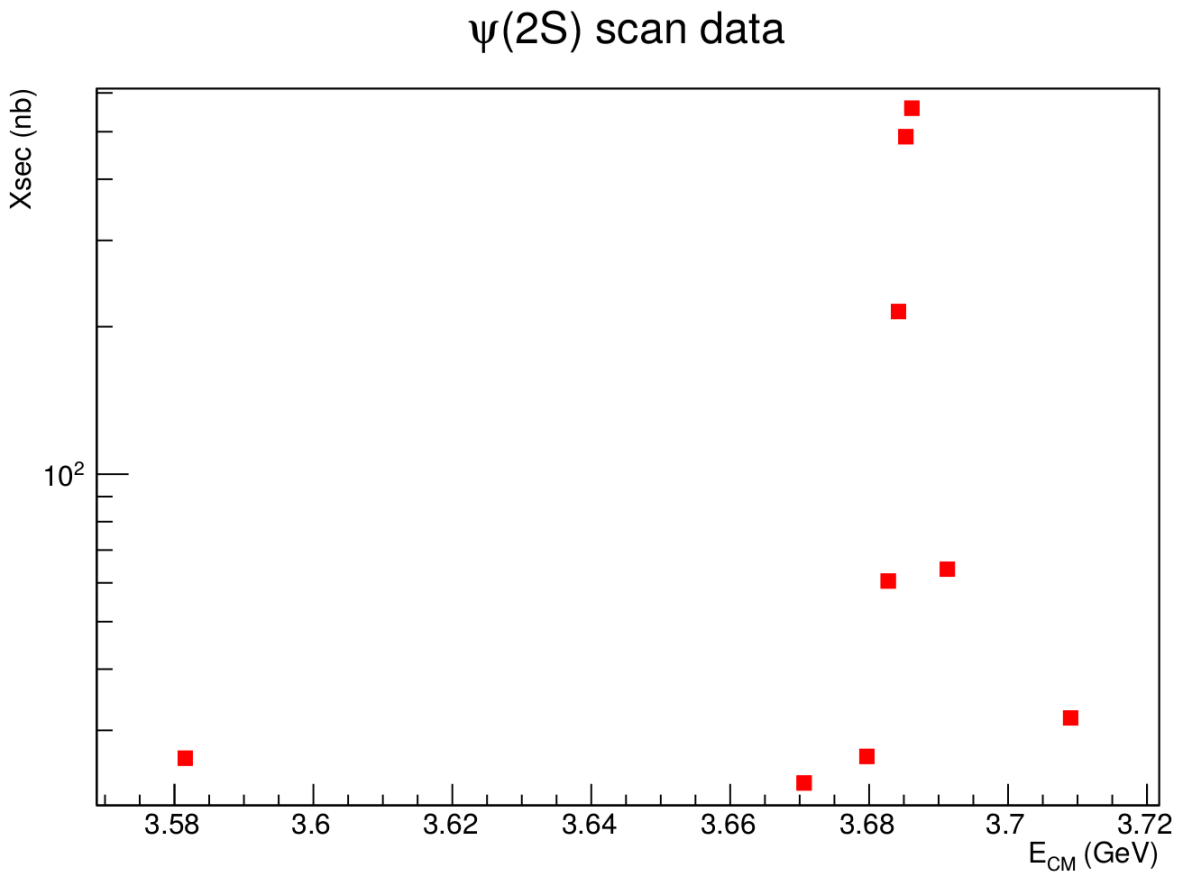
Final table of the runs

Thanks to Zhang Jianyong and BEMS, precise measurements of the beam energies.

Run number	Energy (MeV)	Spread (MeV)	Luminosity (nb)
55375-55461	3581.543 ± 0.060	1.493 ± 0.060	85665.6
55462-55541	3670.158 ± 0.063	1.410 ± 0.053	84719.7
55542-55635	3680.144 ± 0.061	1.517 ± 0.060	84814.5
55636-55662	3682.752 ± 0.115	1.710 ± 0.104	28668.3
55663-55690	3684.224 ± 0.119	1.547 ± 0.122	28651.6
55691-55716	3685.264 ± 0.105	1.478 ± 0.111	25982.8
55717-55737	3686.496 ± 0.120	1.594 ± 0.117	25055.1
55738-55795	3691.363 ± 0.075	1.541 ± 0.074	69374.6
55796-55859	3709.755 ± 0.074	1.460 ± 0.075	70326.7

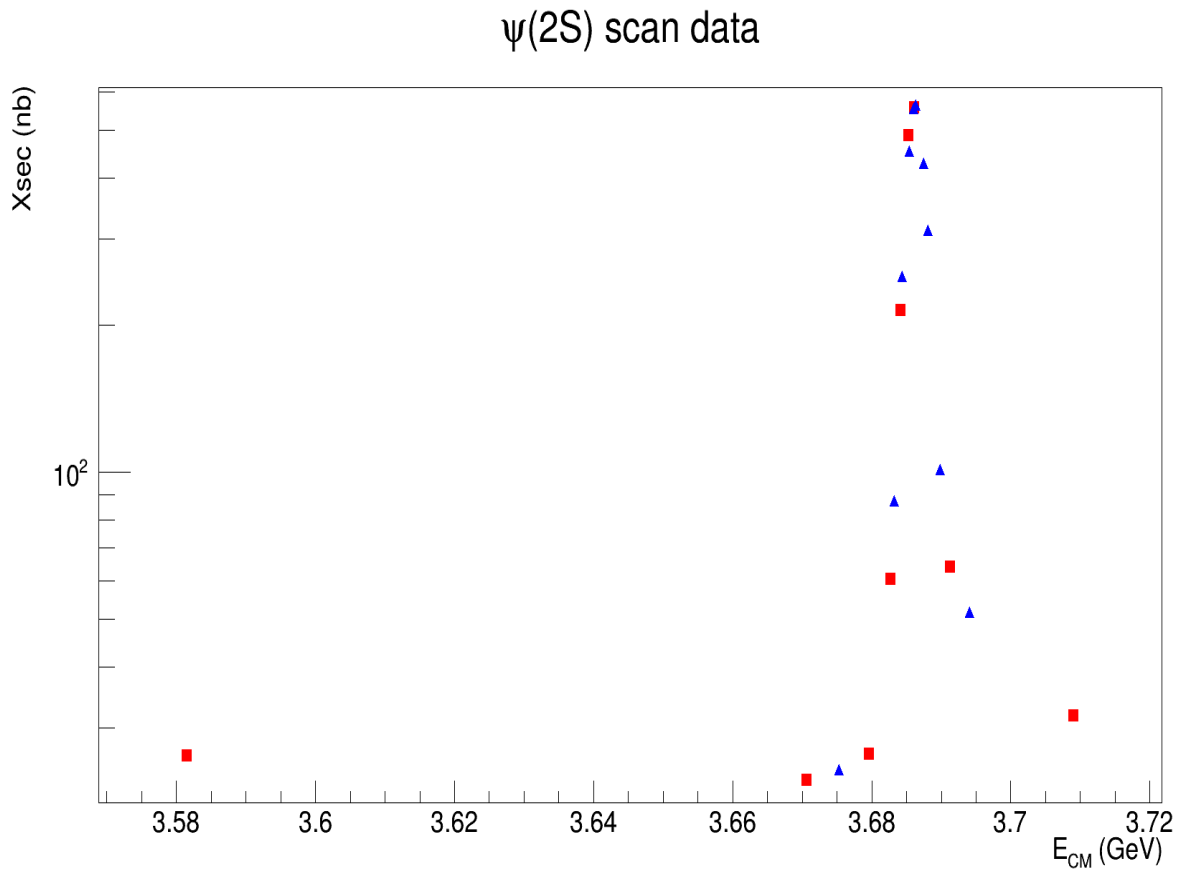
First results

Online hadronic cross-section



Based on
online hadron numbers
divided by *luminosity*

Online hadronic cross-section



It is possible also to add psi-prime scan during tau mass analysis

First fit

Based on original fitting procedure used for phase analysis

Fit procedure can extract:

- relative phase (p0)
- Cross section at continuum (p1)
- Branching fraction (p2)

In the next figure there is **no correction** due to the **efficiency.**

ISR is taken in account with **Bonneau-Martin** approximation in **simulation**

Few hypothesis:

- cross section behaviours scales as E^{-2}
- Energy spread simulated as gaussian
- Mass fixed at value found by the fast scan
- Width fixed at PDG value

100000 extraction for each energy value to determine the cross section of the fit

First fit

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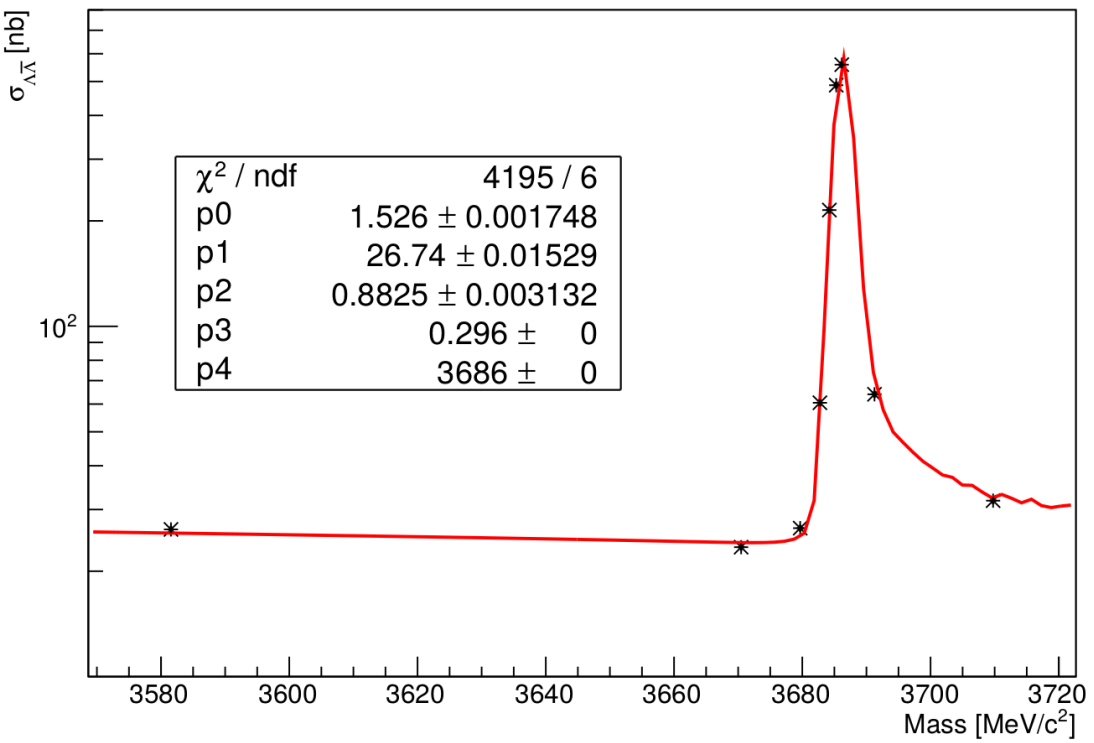

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First summary

- First look at psi(2S) online data seems promising, we are eager to analyse the first data (for data quality)
  - Cross section around 3.67 GeV seems still lower than expected
  - Phase is close to 90°, as expected for inclusive hadronic cross section
  - Branching ratio a little bit lower than PDG measurement

First summary and next steps

- First look at psi(2S) online data seems promising, we are eager to analyse the first data (for data quality)
  - Cross section around 3.67 GeV seems still lower than expected
  - Phase is close to 90°, as expected for inclusive hadronic cross section
  - Branching ratio a little bit lower than PDG measurement
  - Generation and simulation under ConExc frame (inclusive decay mode used for R-scan simulation)

- Data will then be reconstructed with the most recent BOSS version in August or September.
  - In addition to this year scan data, data at 3.65 GeV will be re-analysed, we will have 10 energy values for the fit (plus possibily the tau-scan psi(2S) data)

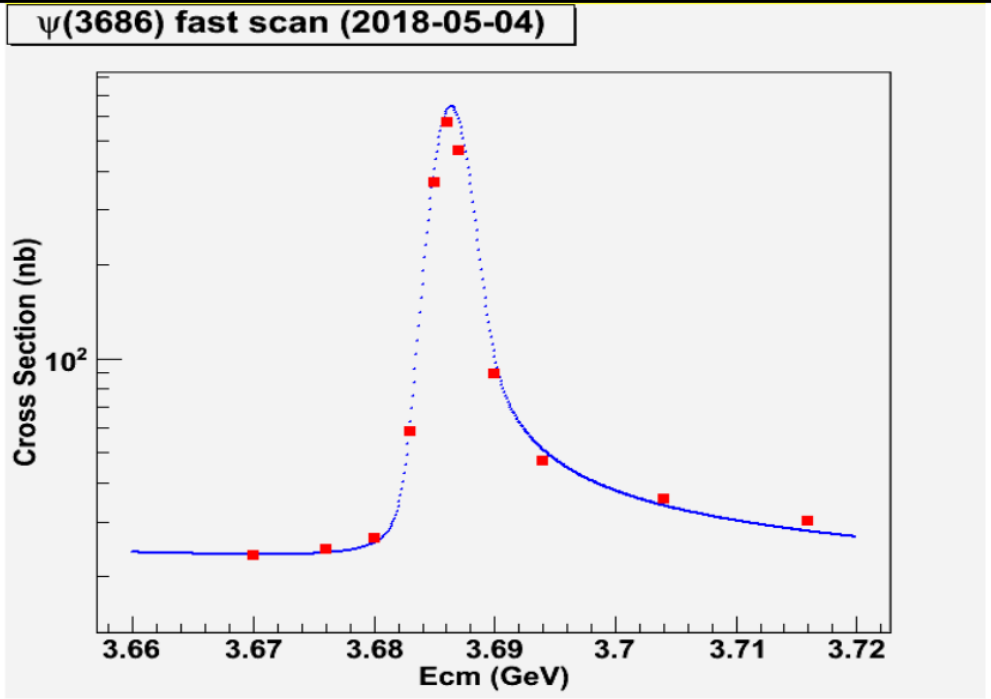
THANKS for your ATTENTION!

Special thanks to Haimin and Jianyong, that helped us a lot during the data taking, and to all the Haimin group for the fast scan calibration

谢谢你们

Additional material

Psi(3686) line shape fast scan



FCN= 13.83859 FROM MIGRAD STATUS=CONVERGED 96 CALLS 1010 TOTAL
EDM= 0.65E-05 STRATEGY=1 ERROR MATRIX UNCERTAINTY= 0.8%

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	MASS	3.6862	0.68923E-04	0.87760E-06	0.19453
2	WDEE	0.23400E-05	constant		
3	WDTT	0.29600E-03	constant		
4	C0	16.727	0.18244	-0.12034E-04	0.68099
5	C1	0.83328	0.11616E-02	-0.80640E-06	-0.67244
6	C2	-0.62453	0.78051E-03	-0.73242E-07	-0.69983
7	ESPD	0.12939E-02	0.36297E-04	0.88228E-05	-0.84596E-02

No	Ecm (MeV)	Eb (MeV)	ΔEb	Nhad	L nb^{-1}	σ nb
1	3670.0	1835.00	3.00	5162	220.013	23.46225
2	3676.0	1838.00	2.00	5219	212.511	24.55873
3	3680.0	1840.00	1.50	5349	205.615	26.01464
4	3683.0	1841.50	1.00	6219	106.302	58.50313
5	3685.0	1842.50	0.55	11507	31.3027	367.6041
6	3686.1	1843.05	0.45	16873	29.5629	570.7491
7	3687.0	1843.50	1.50	26605	57.3707	463.7385
8	3690.0	1845.00	2.00	18318	205.044	89.33692
9	3694.0	1847.00	5.00	6438	137.473	46.83101
10	3704.0	1852.00	6.00	5291	149.007	35.5084
11	3716.0	1858.00		5246	173.68	30.20497

$$E_{cm}^{reset} = E_{cm}^{preset} + \Delta E_{cm}$$

$$E_{beam}^{reset} = E_{beam}^{preset} + \Delta E_{beam}$$

$$\Delta E_{beam} = \Delta E_{cm}/2$$

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