Data taking proposal: Search for $e^+e^- \to \chi_{c2}$

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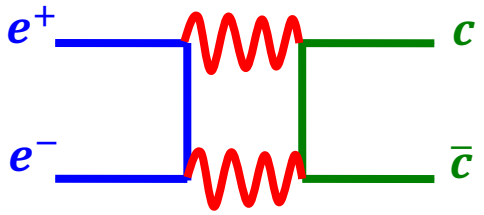
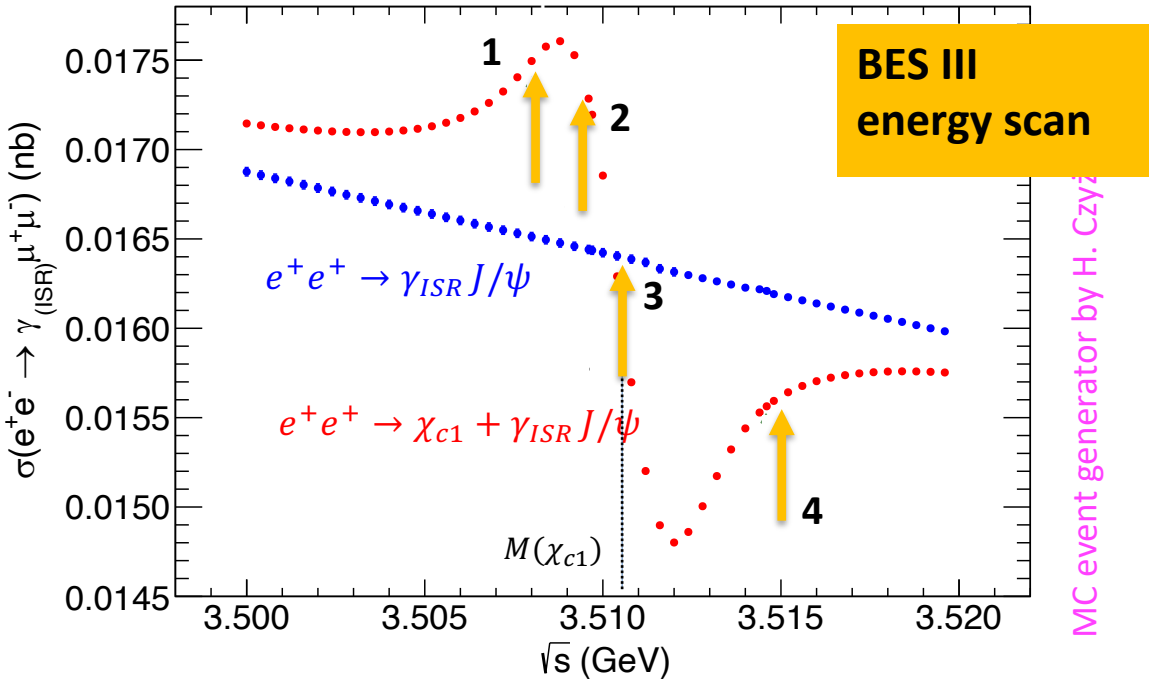
What we already have: $e^+e^- \to \chi_{c1}$



$e^+e^- \to \chi_{c1}$ ($J^{PC}=1^{++}$)
M=3.51 GeV/c²

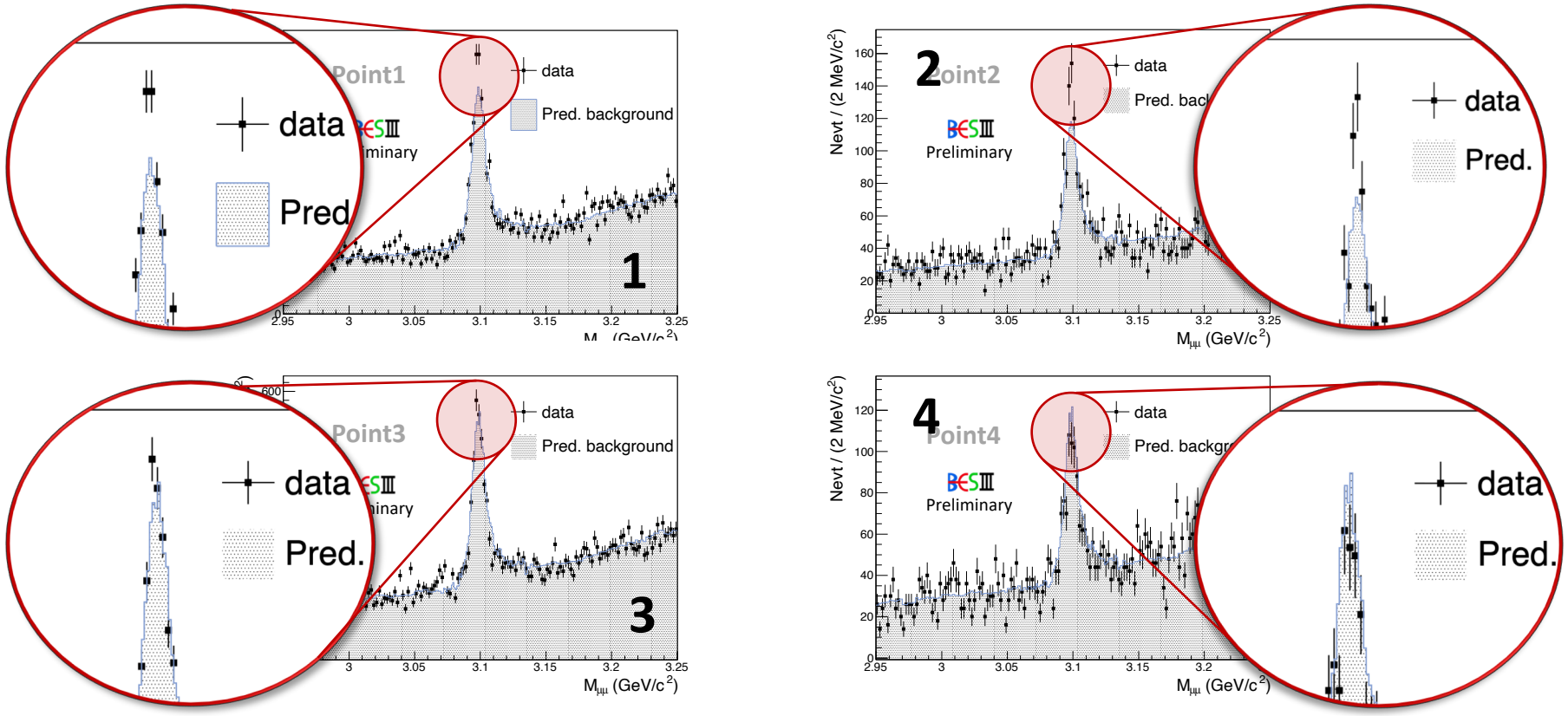
- Unitarity limit: $\Gamma_{ee} > 0.044$ eV J. Laplan, J. H. Kühn, PLB78, 252 (1978)
- Vector Dominance Model: $\Gamma_{ee} = 0.46$ eV; OR $\Gamma_{ee} \sim 0.1$ eV A. Denig, F. K. Guo, C. Hanhart, A. V. Nefediev, PLB736, 221 (2014)
- Non-relativistic QCD: $\Gamma_{ee} \sim 0.1$ eV N. Kivel, M. Vanderhaeghen, JHEP02, 032 (2016)
- Latest prediction: $\Gamma_{ee} = 0.43$ eV; interference with background process! H. Czyż, J. H. Kühn, S. Tracz,PRD94, 034033 (2016)

- Search for $\chi_{c1} \to \gamma\, J/\psi \to \gamma\, \mu^+\mu^-$
- Background from $e^+e^- \to \gamma_{\rm ISR}\, J/\psi \to \gamma_{\rm ISR}\, \mu^+\mu^-$ (Phokhara)



What we already have: $e^+e^- \to \chi_{c1}$

BESIII preliminary



Discovery of $e^+e^- \to \chi_{c1}$ ($J^{PC}=1^{++}$) with >5σ significance

$\Gamma_{ee}=0.12^{+0.13}_{-0.08}$ eV and $\phi=205^{+15.4}_{-22.4}$ degree

Paper draft for Phys. Rev. Lett. in preparation!

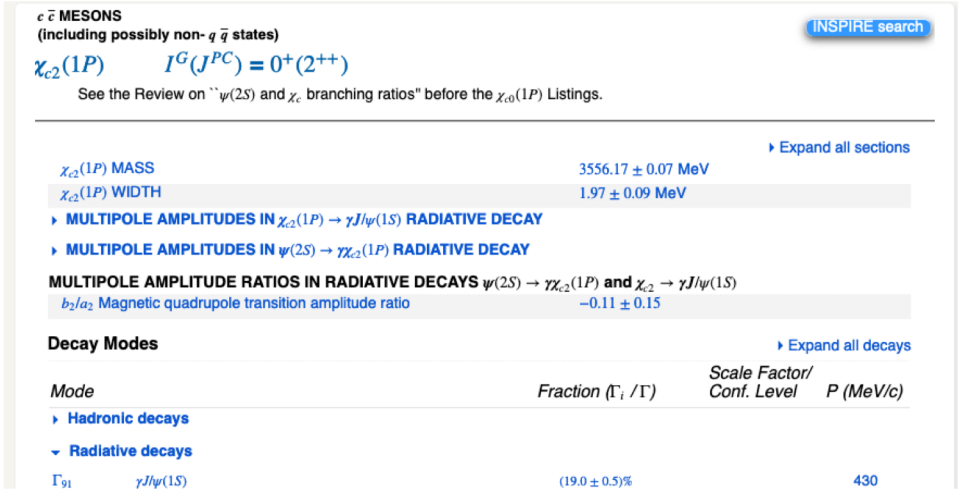
Why embark now on $e^+e^- \to \chi_{c2}$?

- Preliminary results on χ_{c1} have been shown at conferences
  → very strong interest from the community

- Next step after confirmation of χ_{c2} is to apply method for XYZ states, e.g. X(3872)
  → determine line shape of resonance and gain information on internal nature
  → establish a new approach in hadron spectroscopy at e+e- colliders
  (Super-tau-charm colliders)

- Finally confirm our findings on χ_{c1} with a second charmonium resonance
  → χ_{c2} with $J^{PC}=2^{++}$, i.e. differnet quantum numbers
  → use same decay mode: radiative decay into J/psi (19% BR)
  → very straight-forward continuation of previous analysis

- New: two-photon production of resonances can be related to HLbL-contribution of muon g-2
  (see recent workshop of g-2 theory initiative)


$c\bar{c}$ MESONS
(including possibly non-$q\bar{q}$ states)

INSPIRE search

$\chi_{c2}(1P)$ $I^G(J^{PC}) = 0^+(2^{++})$

See the Review on "$\psi(2S)$ and χ_c branching ratios" before the $\chi_{c0}(1P)$ Listings.

Expand all sections

$\chi_{c2}(1P)$ MASS	3556.17 ± 0.07 MeV
$\chi_{c2}(1P)$ WIDTH	1.97 ± 0.09 MeV

▸ MULTIPOLE AMPLITUDES IN $\chi_{c2}(1P) \to \gamma J/\psi(1S)$ RADIATIVE DECAY

▸ MULTIPOLE AMPLITUDES IN $\psi(2S) \to \gamma\chi_{c2}(1P)$ RADIATIVE DECAY

MULTIPOLE AMPLITUDE RATIOS IN RADIATIVE DECAYS $\psi(2S) \to \gamma\chi_{c2}(1P)$ and $\chi_{c2} \to \gamma J/\psi(1S)$

b_2/a_2 Magnetic quadrupole transition amplitude ratio	-0.11 ± 0.15

Decay Modes — Expand all decays

Mode	Fraction (Γ_i/Γ)	Scale Factor/ Conf. Level	P (MeV/c)
▸ Hadronic decays			
▾ Radiative decays			
Γ_{91} $\gamma J/\psi(1S)$	$(19.0 \pm 0.5)\%$		430

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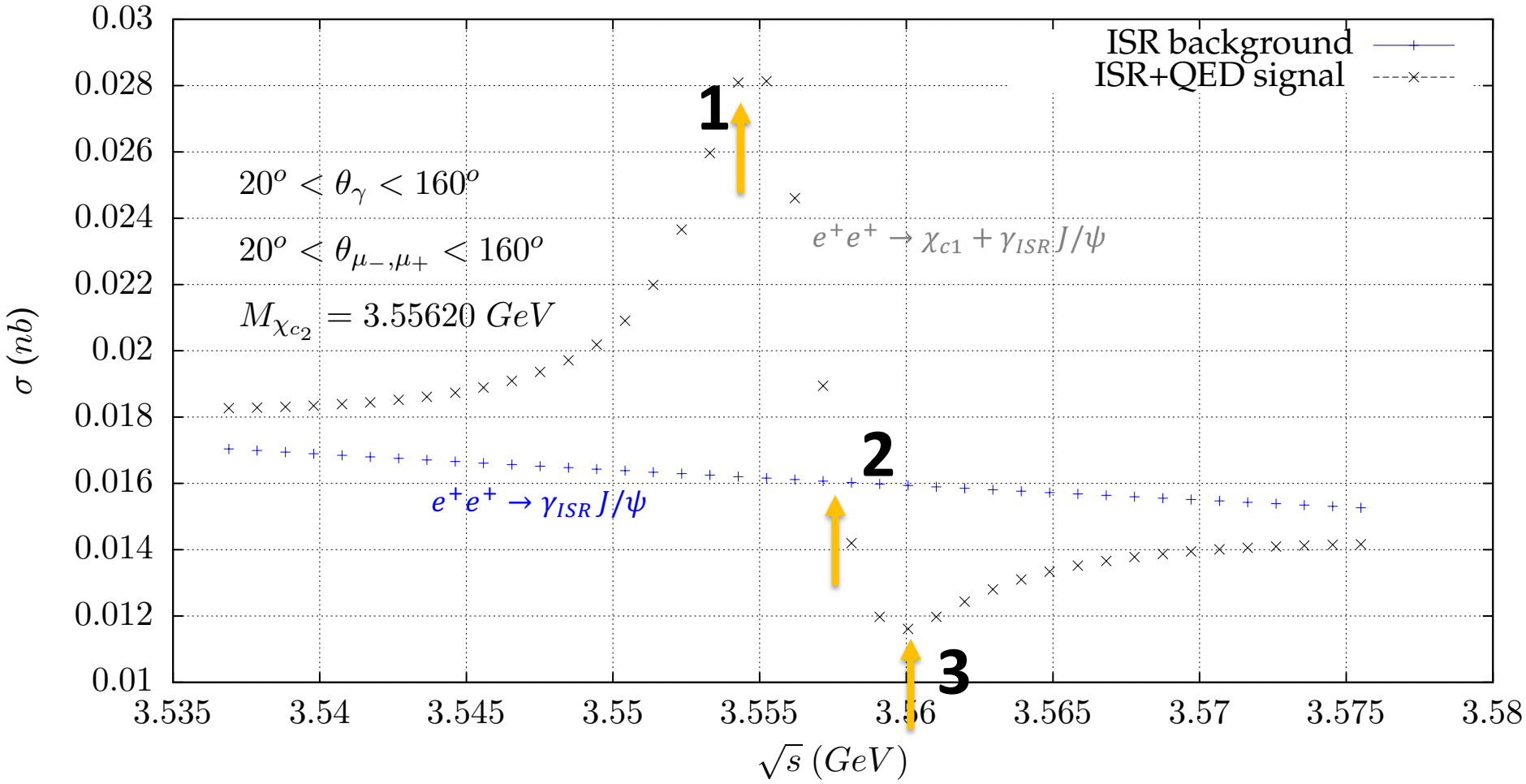

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BEMS needed (assume 1 day per data point --> 3 days)

cms energy / GeV	Int. Luminosity /pb-1	Time* / day
3.554	240	6
3.558	160	4
3.560	200	5

* assuming an effective and realistic performance of 40 pb^{-1} / day (→ see email Hai-Bo)

We request 18 days of data taking for $e^+e^- \rightarrow \chi_{c2}$ scan

Should this not be possible before the shutdown of the machine, we request 1 additional point for the χ_{c1} scan, namely 200 pb^{-1} of data at point 4 (3.515 GeV) to verify destructive interference!