STRONG-2020 Task 3.1

# Meson Spectroscopy Analysis of New and Exotic States: Search for and study of light exotic mesons, Strangeonia and charmonia

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York - September 2021

UNIVERSIDAD COMPLUTENSE MADRID

IPARCOS

UNIVERSITAT DE BARCELONA

ICCUB Institut de Ciències del Cosmos

JPAC Joint Physics Analysis Center

# Outline



## Groups:

U Glasgow, UC Madrid, U Barcelona,
U Bonn, GSI, U Bochum, TU Munich,
INFN Catania, Ferrara and Torino

## Outline:

Conventional mesons:
strangeonia and charmonia

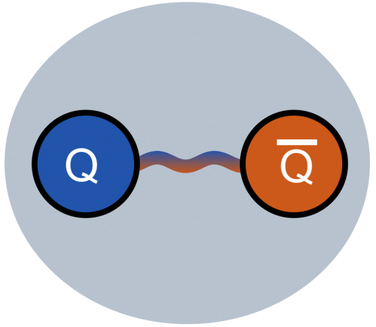
Light exotic mesons:
hybrid mesons and glueballs

Heavy exotic mesons: XYZ

# Light Exotic Mesons, Charmonium and Strangeonium




## Ordinary mesons

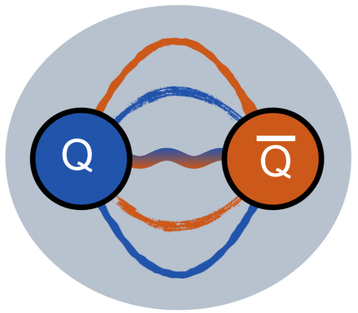



"Exotic" in the quark model sense
meson different from $q\bar{q}$

identification through quantum numbers,
decay modes, and/or analysis

## Tetraquarks


## Hybrid mesons



# Discovery Exotic Mesons



Design and build detectors
Collect data
Build observables
Fit data
Extract pole position,
…

Experiments
Tools

Interpretation


Theory

Lattice QCD,
Constituent Models,
Effective Field Theories,
…

# Conventional mesons: strangeonia



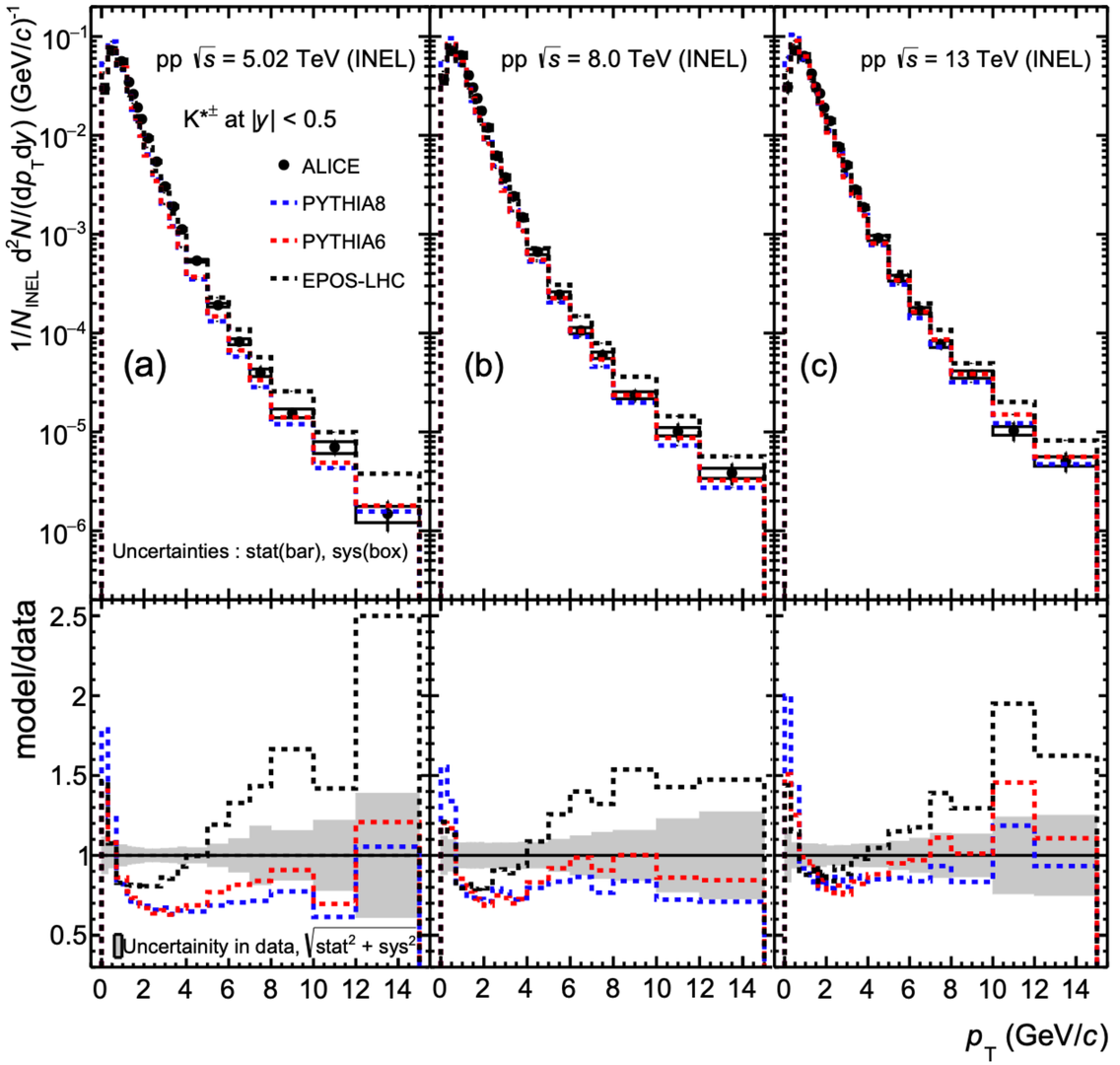
***INFN-Catania***

**ALICE, arXiv:2105.05760**

First time measurement of transverse momentum distributions for charged K*(892) in inelastic pp collisions at $\sqrt{s}$ = 5.02, 8, 13 TeV.

Consistent with previous measurements of neutral K*(892) production

Transverse momentum distribution not very well described by event generators




**Ongoing:** Multiplicity dependence of charged K*(892) in pp collisions at $\sqrt{s} = 13$ TeV

# Conventional mesons



## ALICE publications on meson resonances production

« Production of light-flavor hadrons in pp collisions at $\sqrt{s} = 7$ and $13$ TeV »,
**EPJC81 (2021) 256**

«Unveiling the strong interaction among hadrons at the LHC»,
**Nature 588 (2020) 232**

« Production of $\omega$ mesons in pp collisions at $\sqrt{s} = 7$ TeV»,
**EPJC80 (2020) 1130**

«K*(892)$^0$ and $\phi$(1020) production at mid-rapidity in pp collisions at $\sqrt{s} = 8$ TeV»,
**PRC 102 (2020) 024912**

«Multiplicity dependence of K*(892)$^0$ and $\phi$(1020)production in pp collisions at $\sqrt{s} = 13$ TeV»,
**PLB 807 (2020) 135501**

«Evidence of rescattering effect in Pb-Pb collisions at the LHC through production of K*(892)$^0$ and $\phi$(1020) mesons», **PLB 802 (2020) 135225**

# Conventional mesons: charmonia



***INFN-Ferrara*** Ongoing analysis:

**Inclusive measurement of $h_c(1P)$ in the $\psi(2S)$ decay**

- **Up to January 2020:**
  - Event and track selection validation (done)
  - Systematic uncertainty studies finalised (done)
- **From January 2020 - up to now:**
  - BESIII internal document released
  - Internal review started
  - Paper draft ready and in review
- **PLANS:**
  - Finish the internal review
  - Submission to journal by the end of 2021/ beginning of 2022

Slide by I. Garzia

# Conventional mesons: charmonia



***University of Barcelona***

**Montaña et al PRD102 (2020) 096020**

Properties of open-charm mesons ($D$, $D_s$, $D^*$, $D_s^*$) in a bath of light mesons at temperatures below $T_c$ using effective field theories

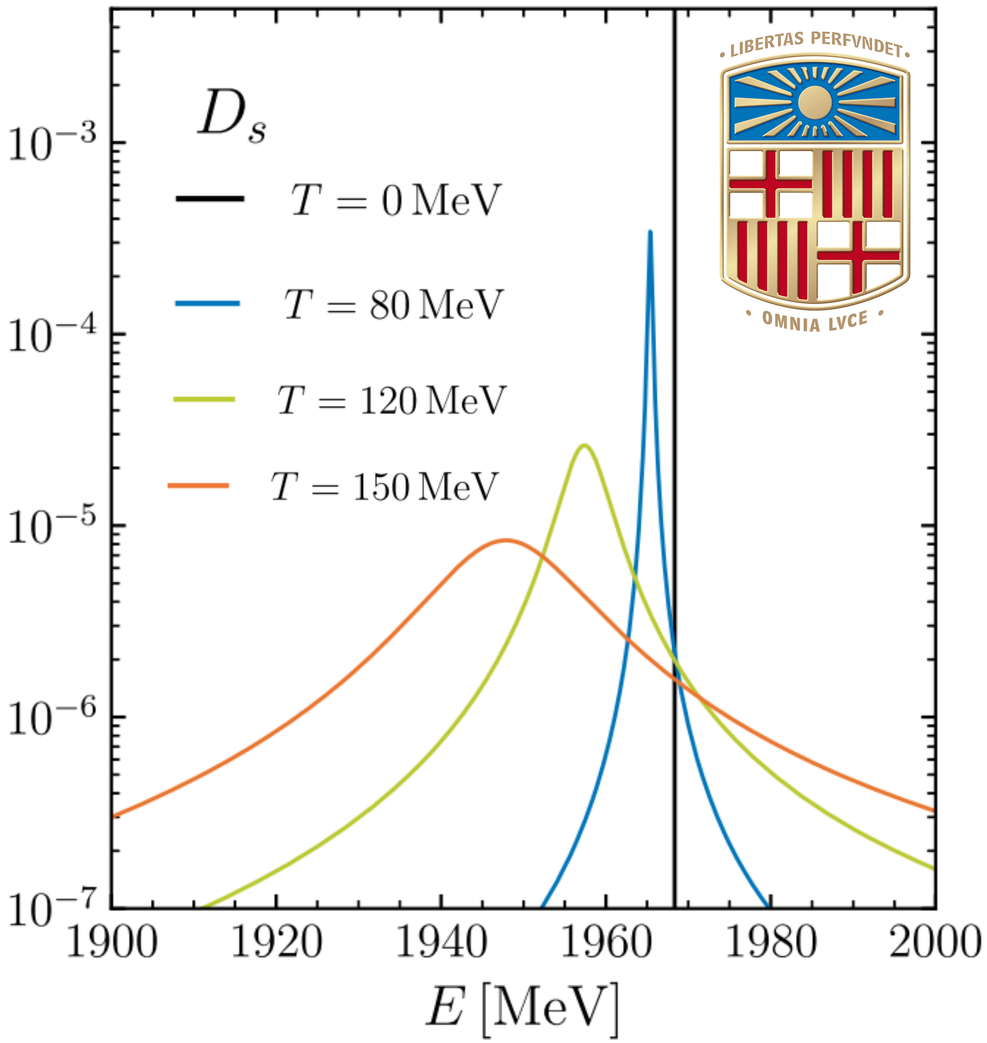
Ground states and excited states decrease their mass and acquire width at temperatures < 150 MeV

Application: Euclidean correlators and transports coef.

**Montaña et al EPJA56 (2020) 294**

**Torres-Rincon et al arXiv:2106.01156**

Spectral function



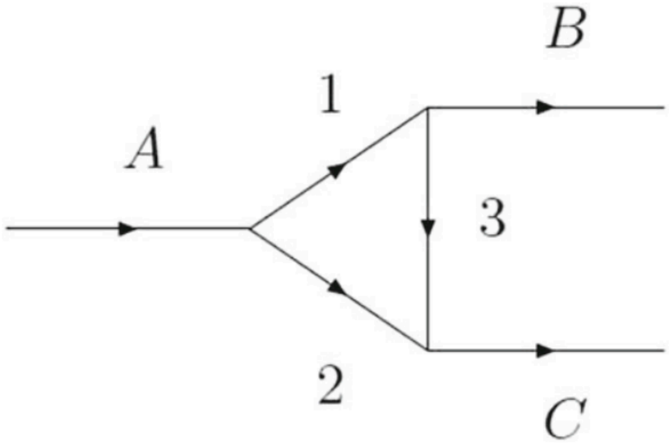
# Temperature effect in triangle singularities



***Complutense University of Madrid***

**Abreu and Llanes-Estrada arXiv:2109.01015**

**Abreu and Llanes-Estrada EPJC81 (2021) 430**



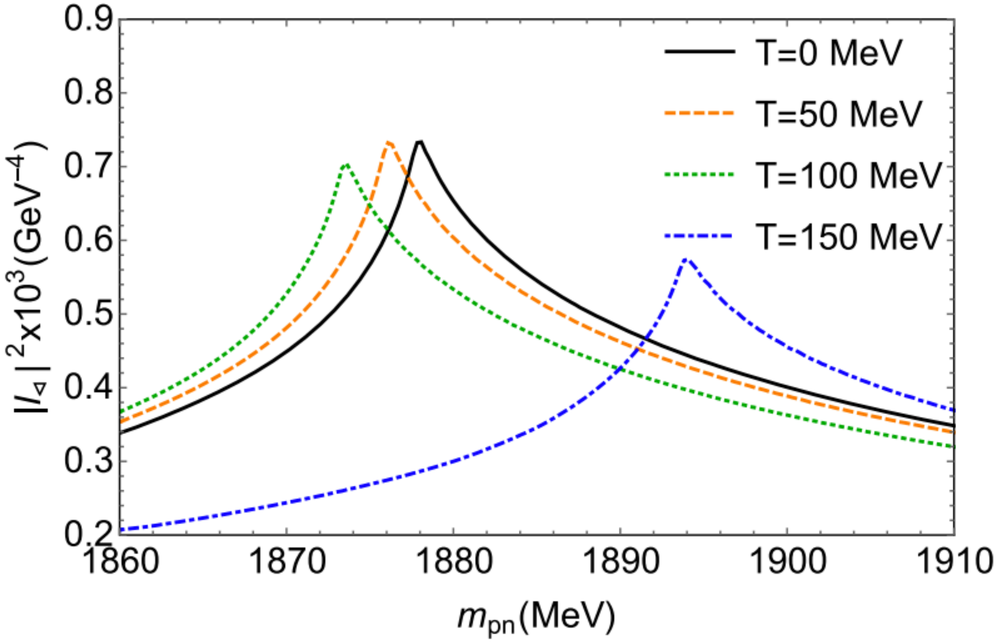

Various cases studied:

$\Lambda(1405)$ in $K^*\Sigma\pi$ triangle

$a_0(1420)$ in $K^*K\bar{K}$ triangle

$X(3872)$ in $D^*D\bar{D}$ triangle

deuteron in $\Delta p\pi$ triangle

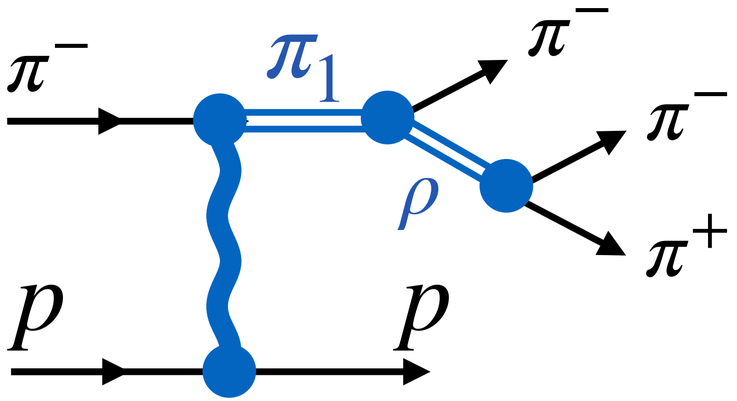


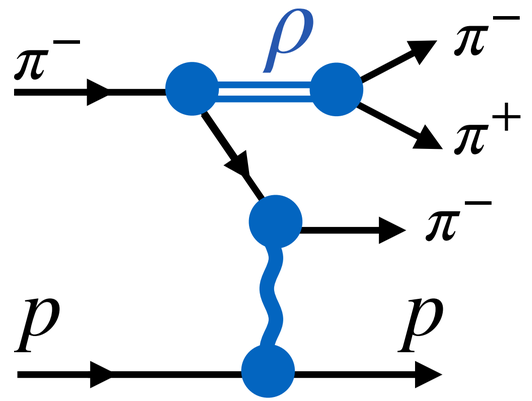
# Light hybrid mesons: Experimental efforts




***T. U. Munich***

**COMPASS, arXiv:2108.01744**



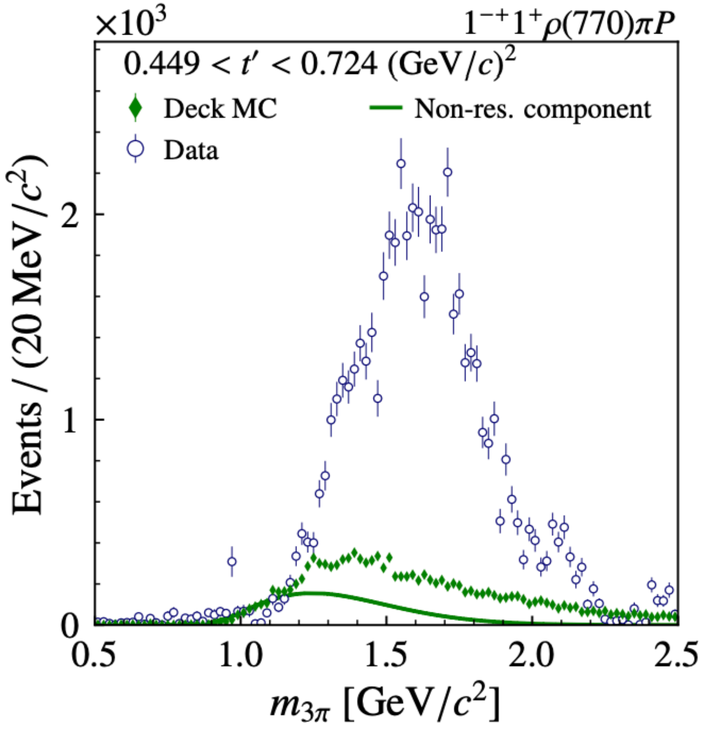



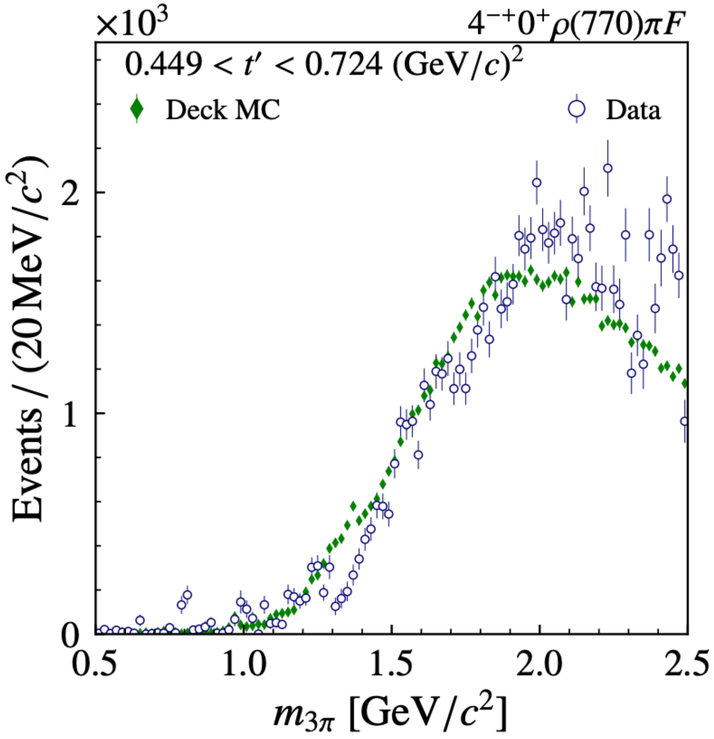

Non-resonant (Deck) mechanisms contributes to all waves

Exotic wave sensitive to number of waves included (88 @COMPASS)

Deck explain most of the $J^{PC} = 4^{-+}$ and $6^{-+}$ waves

Important results for CLAS and GlueX collaboration



# Light hybrid mesons: Experimental efforts




***T. U. Munich*** Isobar formalism for $\tau^- \to 3\pi\nu_\tau$ **Krinner and Paul, arXiv:2107.04295**

Ongoing analyses @CLAS and GlueX: **Search for $\pi_1(1500)$ signal in $\eta^{(\prime)}\pi$ and $3\pi$ final states**


***U. Glasgow, INFN-Genova, etc***


***U. Glasgow*** More details in Pauli's talk

Joint effort with phenomenologists (JPAC, …)

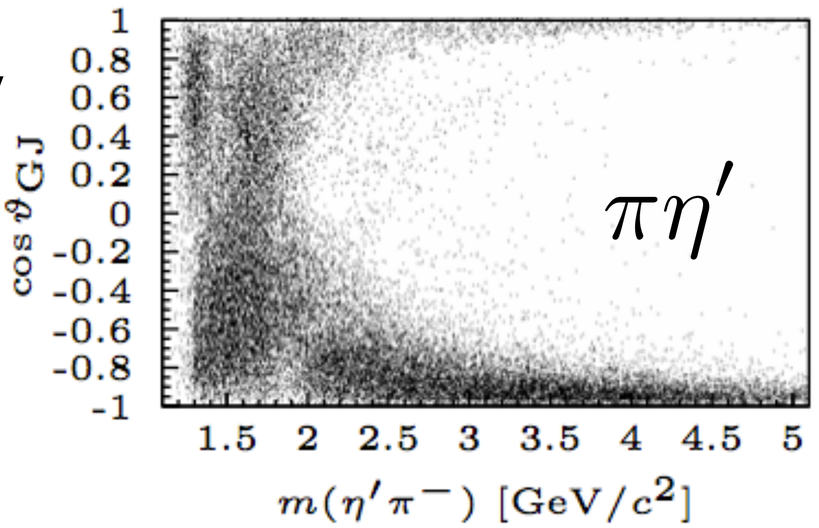
# Light hybrid mesons: Phenomenology

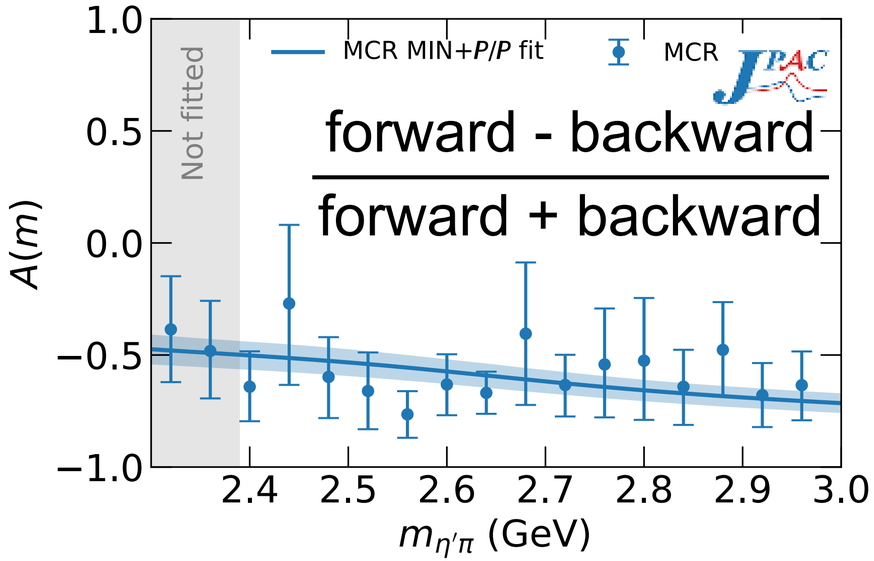


Forward-backward asymmetry related to the existence of (exotic) P-wave

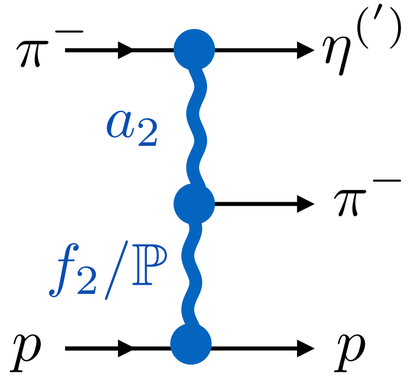
**JPAC, EPJC81 (2021) 647**

More details in Szczepaniak's talk

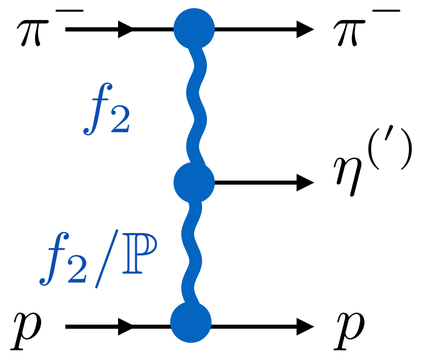


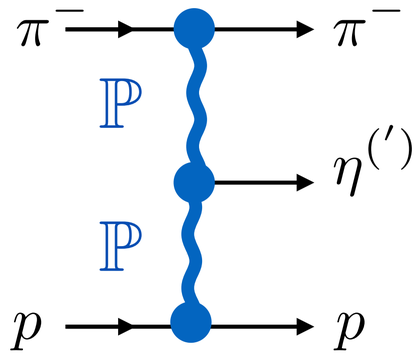

Asymmetry originating mainly from $(a_2, f_2/\mathbb{P}) \neq (f_2, f_2/\mathbb{P})$ and from $(\mathbb{P}, \mathbb{P})$ in $\eta'\pi$




Forward




Backward




Backward

# Glueballs

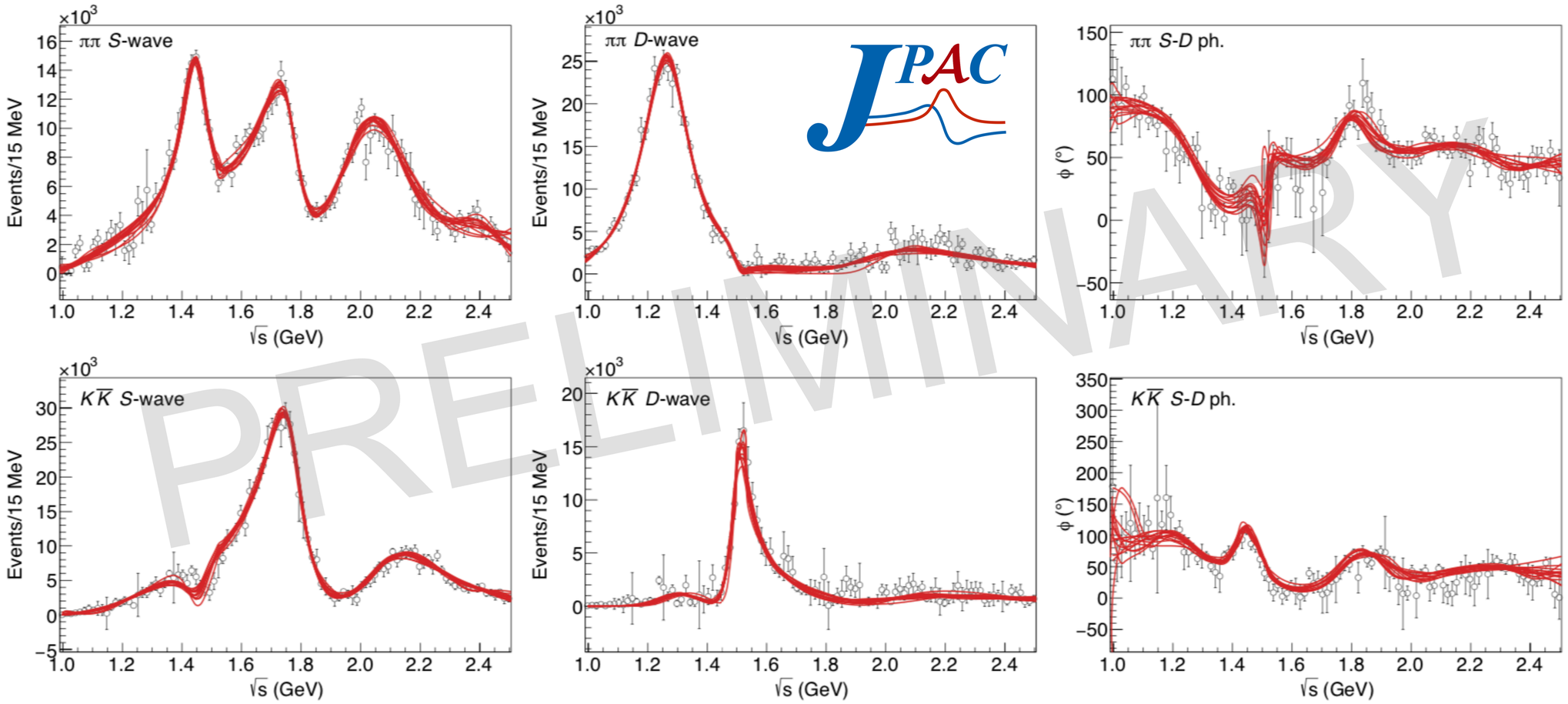


Review by Llanes-Estrada (UC Madrid), **EPJ Special Topics 230 (2021) 1575**

Fit of $J/\psi \to \gamma\pi^0\pi^0, \gamma K_S^0 K_S^0$ multipole, **Rodas, Pilloni et al (JPAC) in preparation**

4 scalar states:
$f_0(1500)$
$f_0(1710)$
$f_0(2020)$
$f_0(2330)$

No $f_0(1370)$



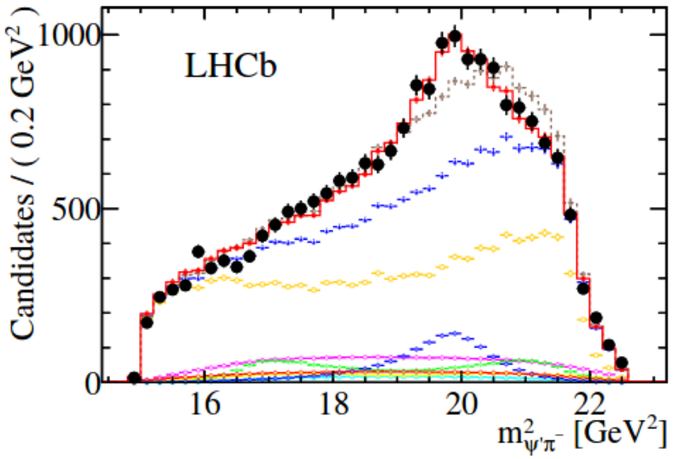
# XYZ efforts by INFN-Ferrara

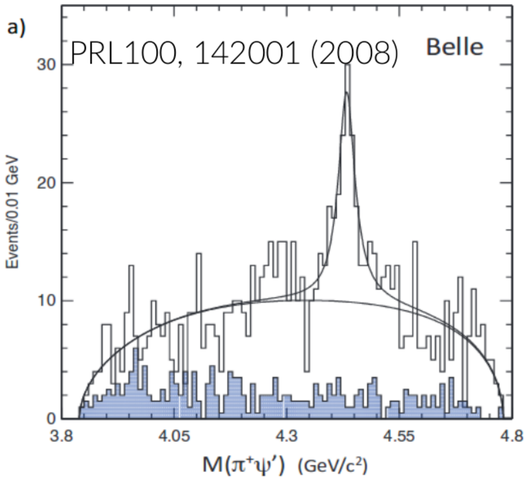


## BESIII - New analysis started recently: $e^+e^- \to Y(4660) \to Z_c(4430)^{\mp}\pi^{\pm} \to \psi(2S)\pi^+\pi^-$

- Zc(4430) observed first by Belle Collaboration and confirmed by LHCb
- In 2020/2021, BESIII took new data up to 4.9 GeV
  - we plan to search for Zc(4430) in BesIII by means of this new data set ($\sqrt{s}$>4.6 GeV BESIII datasets, about 5 fb$^{-1}$) and to study possible connection with the nearby Y(4660) resonance
  - **Up to now:**
    - Study the analysis feasibility (done) ==> for BR > 5% we expect to see the signal
    - start of the analysis: signal MC production done (resonant and non resonant)
    - Event and track selection almost complete (only additional checks are ongoing)
  - **Plans (from Autumn 2021):**
    - Evaluation of background contributions
      - Study of inclusive Monte Carlo
    - Look at the data

PRL112,222002



## Plans for new analyses (with BESIII data)

- New analyses planned by our group for the next years:
  - Search for X(1835) in Jpsi—> ωX(1835), X(1835)→ η'π+π- hadronic decays
    - improve the analysis published on PRD99,071101 (published on April 2019) with the full Jpsi statistics collected by BESIII in the 2018 and 2019 (10 billion of Jpsi data)
  - BR measurement of Jpsi—> $\phi$ η'π+π-, and search for X(1835) into η'π+π- invariant mass spectra (ongoing inside BESIII Collaboration)
  - Study of the rare decay hc-> e+e- eta_c with 2.7 billion of psi(2S) data collected by BESIII: feasibility studies started in September 2021

**Conferences:**
- SIF 2020, SIF 2021, EPS

**Papers:**
- One paper in preparation (it will be submitted in the next days to MDPI-Special issue "High Energy Physics: Standard Model Predictions and Observation of New States")
- One review on XYZ states to be published in Review of Physics

# XYZ efforts by U. Bochum



Exotic candidates $Z_c(3900)^{\pm}$ in $e^+e^- \to J/\psi\pi^+\pi^-$

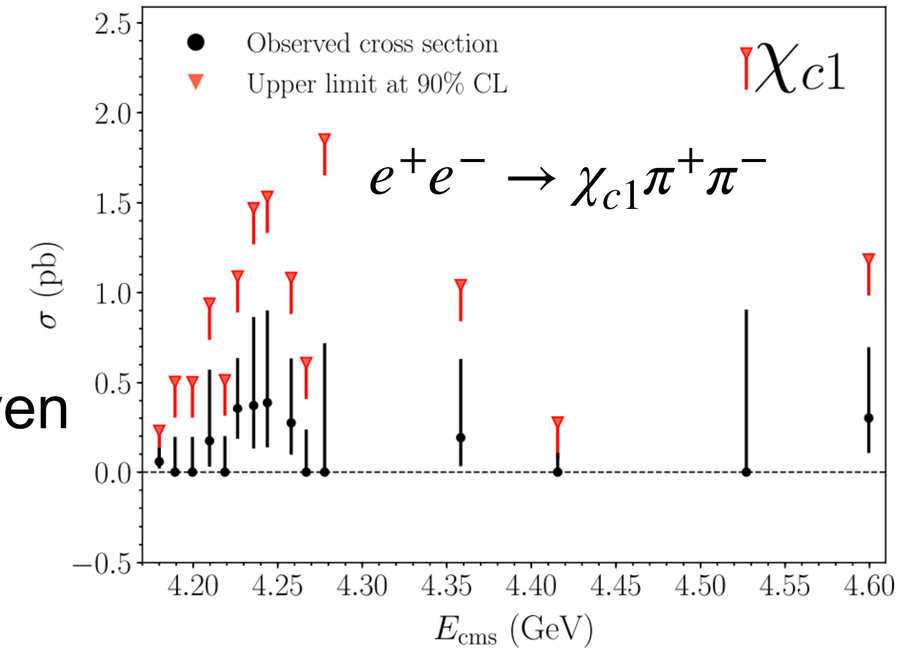
$Z_c(4020)^{\pm}$ $e^+e^- \to h_c(1P)\pi^+\pi^-$

Extraction of partner reactions

$e^+e^- \to \chi_{c\{0,1,2\}}\pi^+\pi^-$

No signal
upper limits (UL) given

**BESIII, PRD103 (2020) 052010**




**BESIII, PRD103 (2020) 032004**

$e^+e^- \to \eta_c\eta\pi^+\pi^-$

No signal, upper limits (UL) given

TABLE II. Observed cross section $\sigma$ and upper limits (ULs) for the reaction $e^+e^- \to \eta_c\eta\pi^+\pi^-$ at the five center-of-mass energies.

| $E_{\rm c.m.}$ [GeV] | $\sigma$ [pb] | UL after all correction [pb] |
|---|---|---|
| 4.23 | $-5.39^{+3.15}_{-2.83}$ | 6.2 |
| 4.26 | $-0.98^{+4.11}_{-3.53}$ | 10.8 |
| 4.36 | $8.59^{+6.72}_{-6.03}$ | 27.6 |
| 4.42 | $3.07^{+5.36}_{-5.12}$ | 22.6 |
| 4.60 | $3.16^{+6.91}_{-6.51}$ | 23.7 |

# Heavy exotic mesons

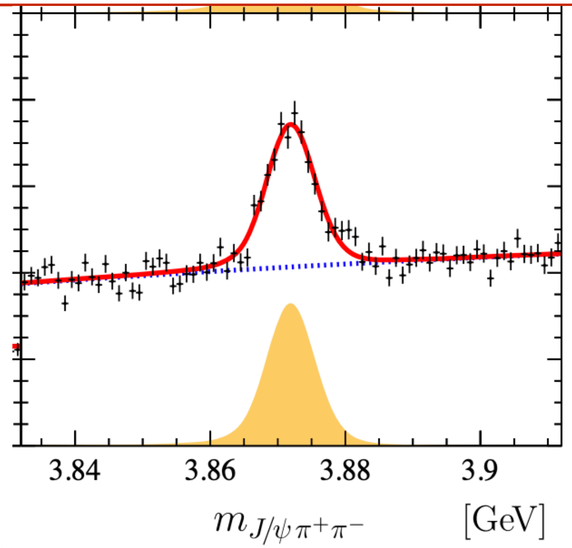


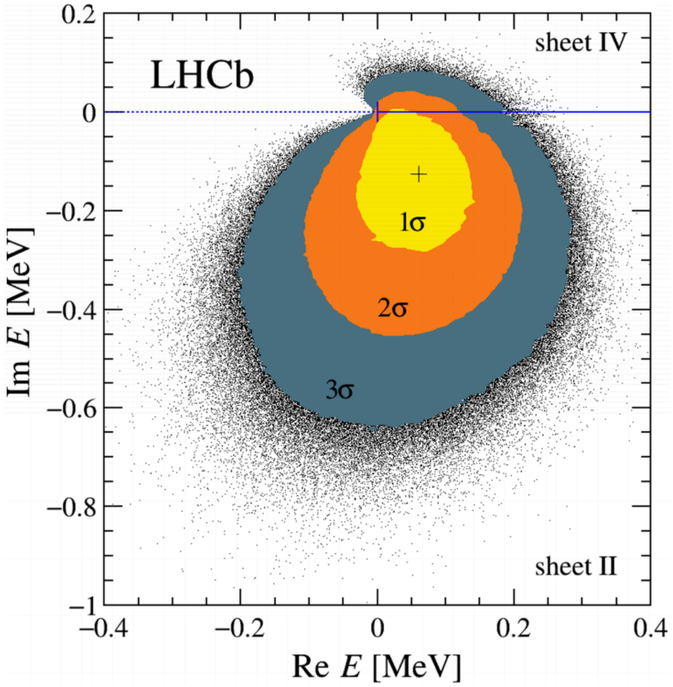

***U. Bonn*** **LHCb, PRD102 (2020) 092005**

Study of the $X(3872) \equiv \chi_{c1}(3872)$ lineshape in pp and pole position extraction

$$m_{\chi_{c1}(3872)} = 3871.695 \pm 0.067 \pm 0.068 \pm 0.010 \text{ MeV}$$

$$\Gamma_{\text{BW}} = 1.39 \pm 0.24 \pm 0.10 \text{ MeV}$$




Experimental efforts in XYZ spectroscopy @GSI

More details in Glötzen's talk


**EIC Yellow Report, arXiv:2103.05419**

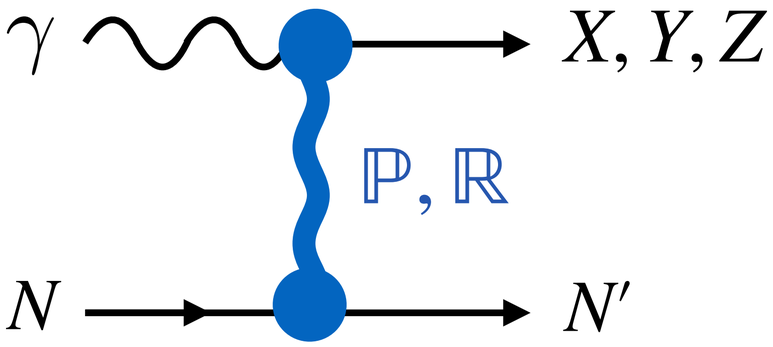
**JPAC, PRD102 (2020) 1107**

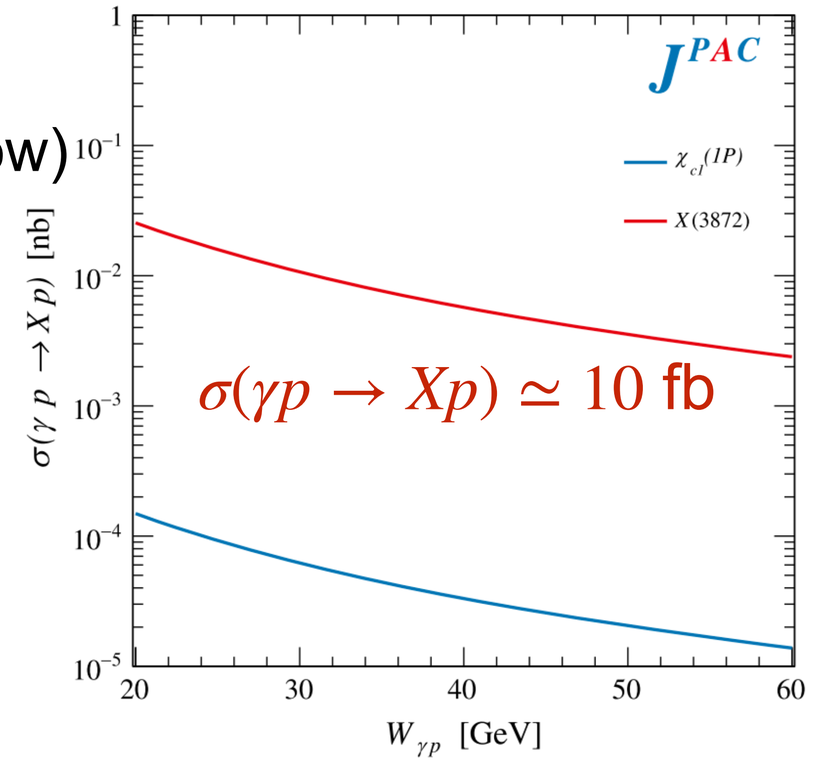
Cross section estimation by JPAC

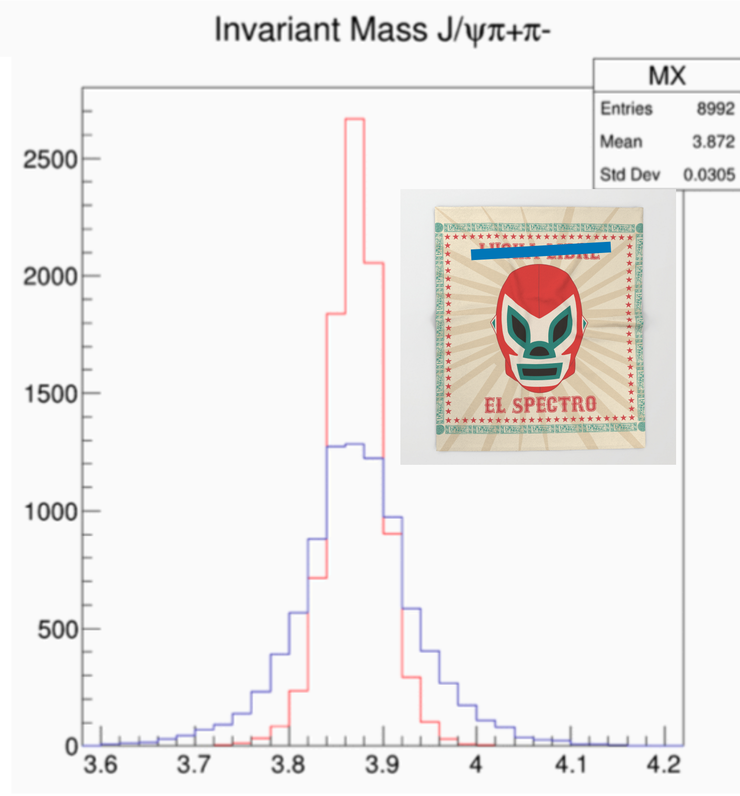
Implementation in event generator (ElSpectro) by D. Glazier (U. Glasgow)

More details in Steven's talk

More details in Pilloni's talk and in Szczepaniak's talk




Centre-of-mass energy

# Heavy exotic mesons: (p)NRQCD



## **TU Munich:** Brambila, Chung, Vairo (and collaborators)

$\overline{\text{MS}}$ renormalization of S-wave quarkonium wavefunctions at the origin, **JHEP12 (2020) 065**

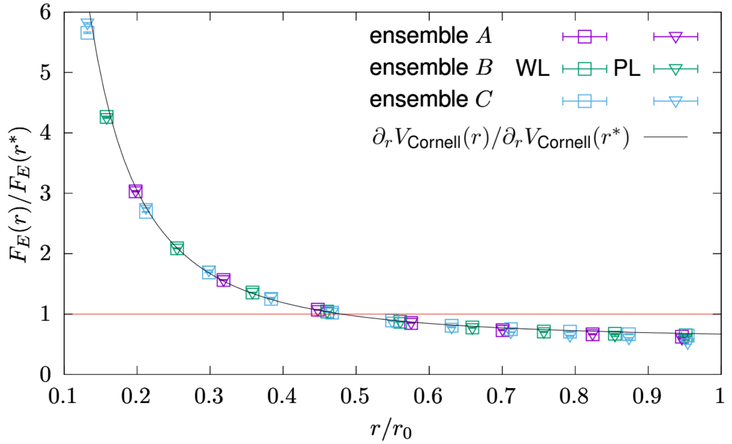
P-wave quarkonium wavefunctions at the origin in the $\overline{\text{MS}}$ scheme, **arXiv:2106.15514**

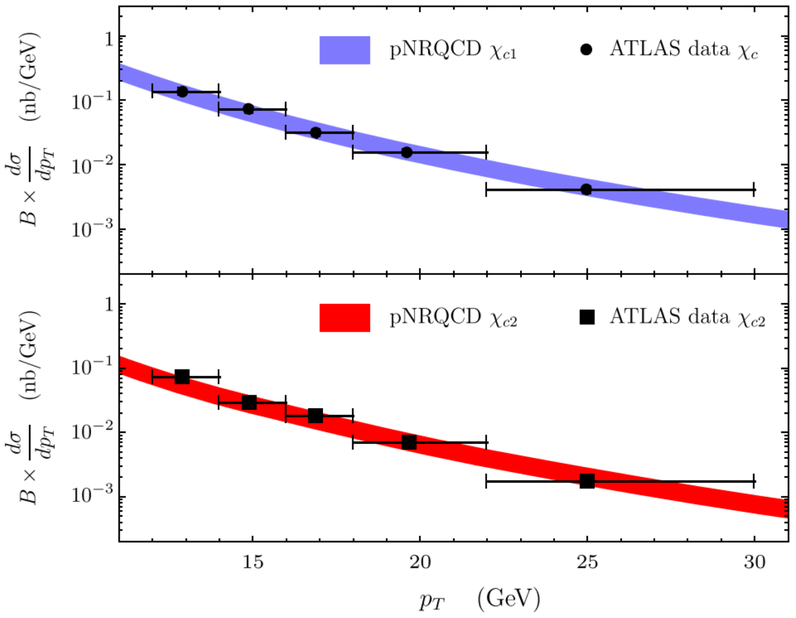
FeynOnium: Using FeynCalc for automatic calculations, in Nonrelativistic Effective Field Theories, **JHEP11 (2020) 130**

Lattice gauge theory computation of the static force, **arXiv:2106.01794**

Inclusive production of heavy quarkonia in pNRQCD, **PRL126 (2021) 082003** and **JHEP09 (2021) 032**

Inclusive production of heavy quarkonia in pNRQCD, **PRL126 (2021) 082003** and **JHEP09 (2021) 032**




## **Barcelona:** Soto and Tarrús Castellà

Nonrelativistic effective field theory for heavy exotic hadrons, **PRD102 (2020) 014012**

# Conclusions



## New developments since January 2020 in the network STRONG-2020

U Glasgow, UC Madrid, U Barcelona,
U Bonn, GSI, U Bochum, TU Munich,
INFN Catania, Ferrara and Torino

Theory

Tools

Analyses

This network has member in

ALICE

COMPASS

LHCb

BESIII

CLAS

GlueX

# Summary

**New developments since June 2019 in the network** STRONG-2020

## Theory

Spectra and decays of light and heavy hybrids from EFT and pNRQCD

## Tools

Moments of photoproduction of 2 pseudo scalar mesons

Kinematics for 3-body decays

Webpages with codes

Particle ID with Machine L.

## Analyses

$K^*(982)$ and $\Omega(2012)$ with ALICE

Test of pQCD in $p\bar{p}$ with BESIII

Pentaquark search in $\Lambda_c$ decay with BESIII

$Z_c(4430)^+$ and $X(1835)$ search with BESIII

**Other developments in Task 3.1 missing? (LHCb from Neubert?)**

**Don't hesitate to contact me**

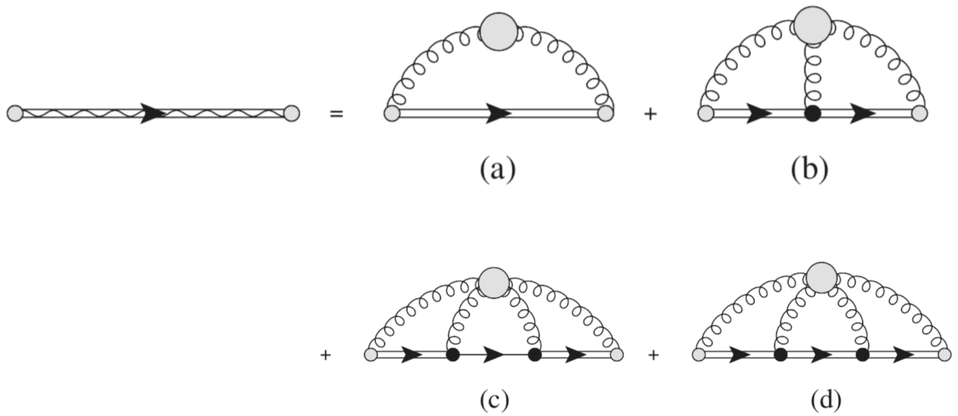
# BACKUP SLIDES

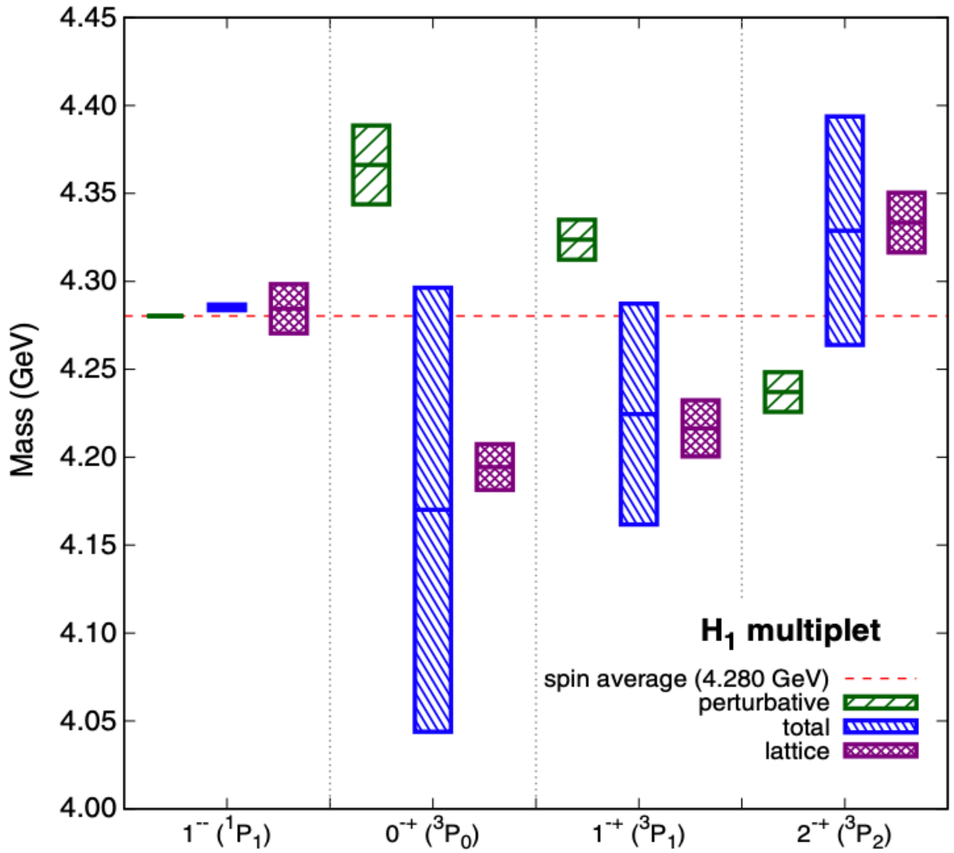
# $c\bar{c}g$ from pNRQCD

## Coordinator: Nora Brambilla (talk at 16:45 and collaborator Hee Sok Chung at 17:45)

Brambilla, Lai, Segovia, Castella and Vairo
PRD101 (2020) 054040

Spectra of exotic charmonium derived from pNRQCD with spin-depend force included



# $q\bar{q}g$ from EFT

## Coordinator: Francesco Giacosa (talk tomorrow at 14:45 )

Eshraim, Fischer, Giacosa and Parganlija
EPJ Plus 135 (2020) 945

Linear Sigma Model
extended with hybrid mesons

$\pi_1 \to b_1\pi, \ldots$

$$\mathcal{L}_{eLSM,1}^{\text{hybrid-linear}} = i2\lambda_1^{hyb} G \left\{ \text{Tr}\left[\Pi_\mu^{hyb}\left[P, B^\mu\right]\right] + \text{Tr}\left[\Pi_\mu^{hyb}\left[V_E^\mu, S\right]\right]\right\} + 2\lambda_1^{hyb} G \left\{ \text{Tr}\left[B_\mu^{hyb}\left\{P, V_E^\mu\right\}\right] + \text{Tr}\left[B_\mu^{hyb}\left\{B^\mu, S\right\}\right]\right\}.$$

| Resonance | Mass [MeV] |
|---|---|
| $\pi_1^{hyb}$ | 1660 [**input** using $\pi_1(1600)$ [9]] |
| $\eta_{1,N}^{hyb}$ | 1660 |
| $\eta_{1,S}^{hyb}$ | 1751 |
| $K_1^{hyb}$ | 1707 |
| $b_1^{hyb}$ | 2000 [**input** set as an estimate] |
| $h_{1N,B}^{hyb}$ | 2000 |
| $K_{1,B}^{hyb}$ | 2063 |
| $h_{1S,B}^{hyb}$ | 2126 |

| Ratio | Value |
|---|---|
| $\Gamma_{\pi_1^{hyb}\to\pi\eta'}/\Gamma_{\pi_1^{hyb}\to\pi\eta}$ | 12.7 |
| $\Gamma_{K_1^{hyb}\to K\eta}/\Gamma_{\pi_1^{hyb}\to\pi\eta}$ | 0.69 |
| $\Gamma_{K_1^{hyb}\to K\eta'}/\Gamma_{\pi_1^{hyb}\to\pi\eta}$ | 5.3 |
| $\Gamma_{\eta_{1,N}^{hyb}\to\eta\eta'}/\Gamma_{\pi_1^{hyb}\to\pi\eta}$ | 2.2 |
| $\Gamma_{\eta_{1,S}^{hyb}\to\eta\eta'}/\Gamma_{\pi_1^{hyb}\to\pi\eta}$ | 1.57 |

| Ratio | Value |
|---|---|
| $\Gamma_{K_1^{hyb}\to Kh_1(1170)}/\Gamma_{\pi_1^{hyb}\to\pi b_1}$ | 0.050 |
| $\Gamma_{b_1^{hyb}\to\pi\omega(1650)}/\Gamma_{\pi_1^{hyb}\to\pi b_1}$ | 0.065 |
| $\Gamma_{K_{1B}^{hyb}\to\pi K^*(1680)}/\Gamma_{\pi_1^{hyb}\to\pi b_1}$ | 0.19 |
| $\Gamma_{h_{1,N}^{hyb}\to\pi\rho(1700)}/\Gamma_{\pi_1^{hyb}\to\pi b_1}$ | 0.16 |

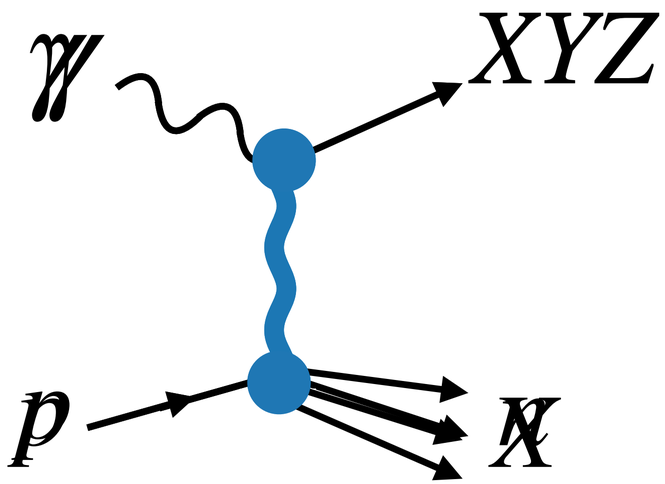
# Estimation of XYZ Cross Sections @EIC

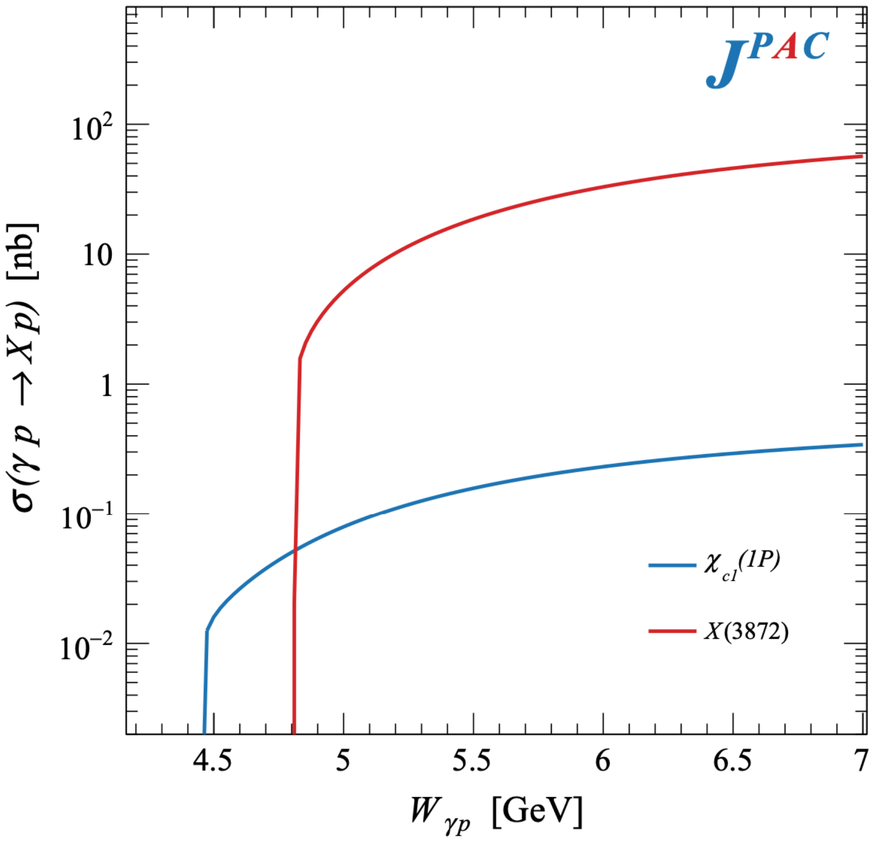
## JPAC collaboration

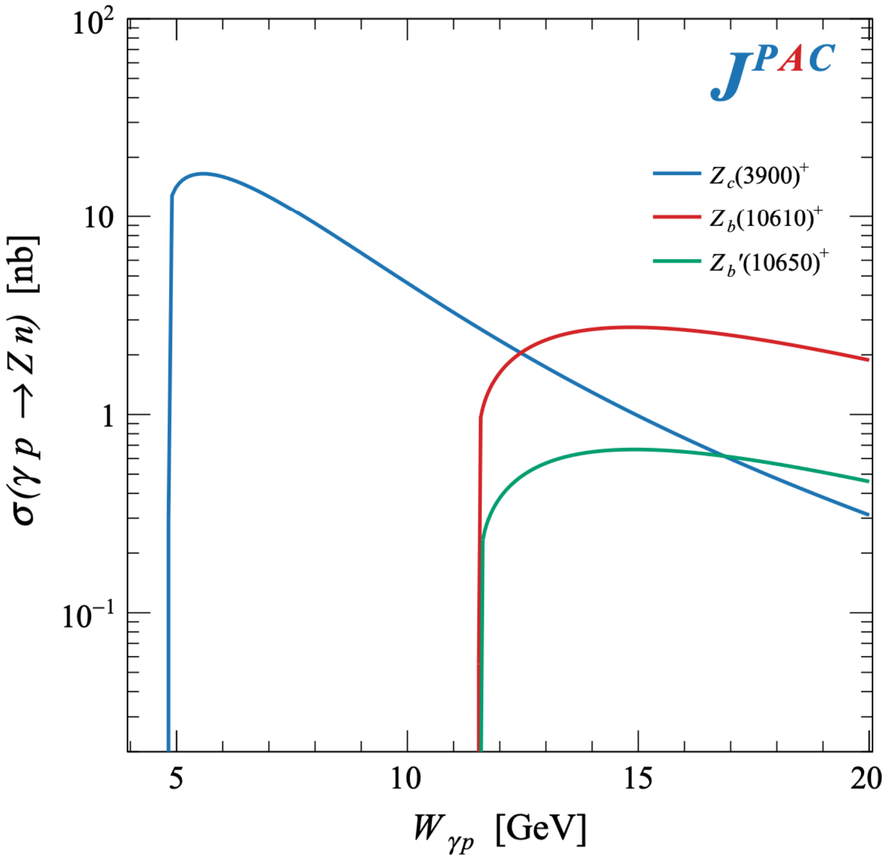
Albaladejo, Hiller-Blin, Pilloni, Winney, Fernández-Ramírez, VM and Szczepaniak
PRD102 (2020) 114010

## Cross sections prediction for

$$X(3872), X(8900), Y(4260)$$
$$Z_c(3900)^+, Z_b(10610)^+, Z_b(10650)^+$$



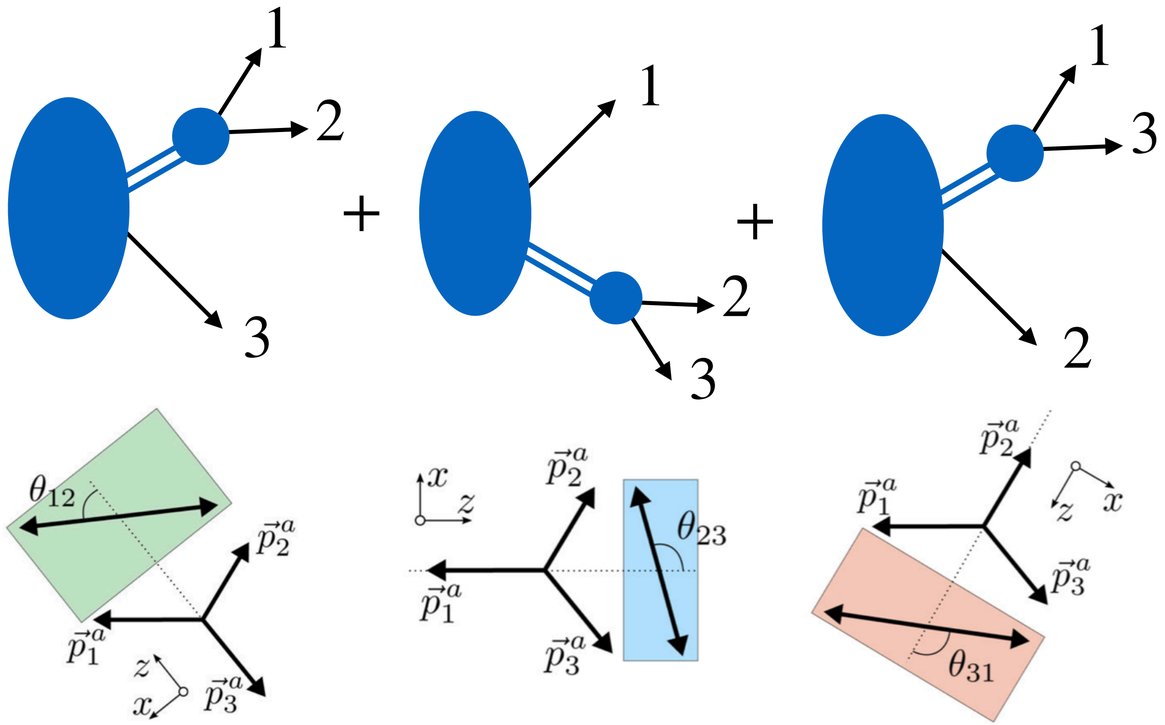



# Formalism for Any Three-Body Decays

## JPAC collaboration

Mikhasenko, Albaladejo, Bibrzycki, Fernández-Ramírez, VM, Mitchell, Papagallo, Pilloni, Winney, Skwarnicki, and Szczepaniak,
PRD101 (2020) 034033




Isobar parametrised in 2-body frame
need to be boosted in the 3-body frame

**All kinematical functions coded and available:**

http://cgl.soic.indiana.edu/jpac/DalitzPlot.php

**Applied to:** $\Lambda_c^+ \to pK^-\pi^+$

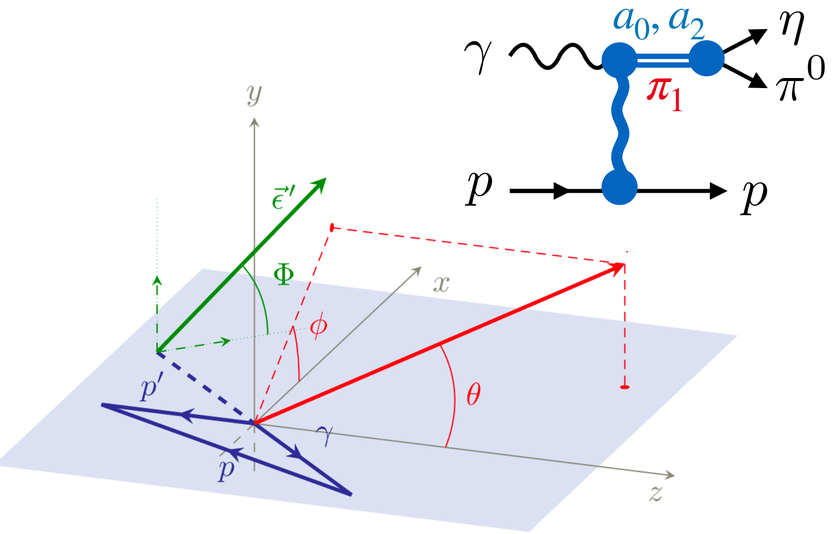
$\bar{B}^0 \to \psi K^-\pi^+$

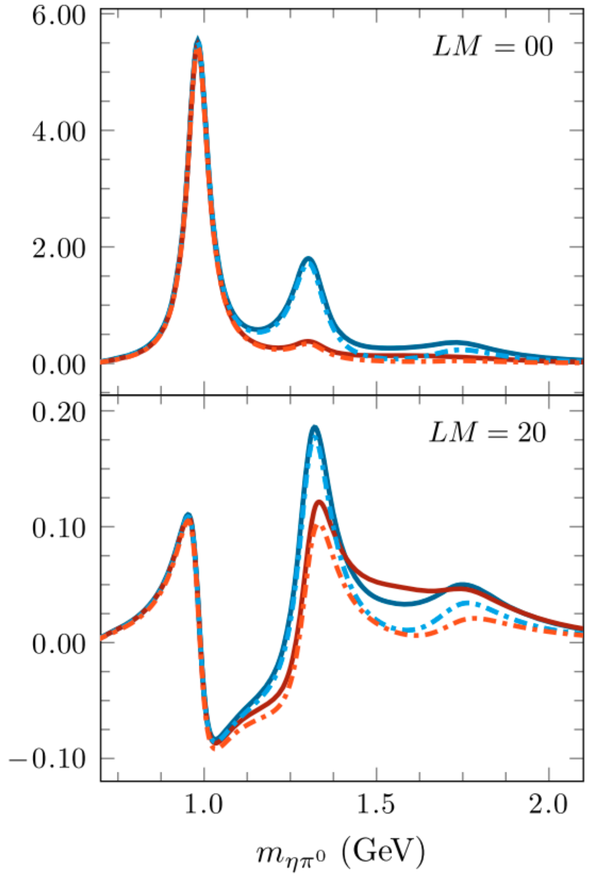
$\Lambda_b^0 \to pK^-J/\psi$

# Moments of 2 Mesons Photoproduction

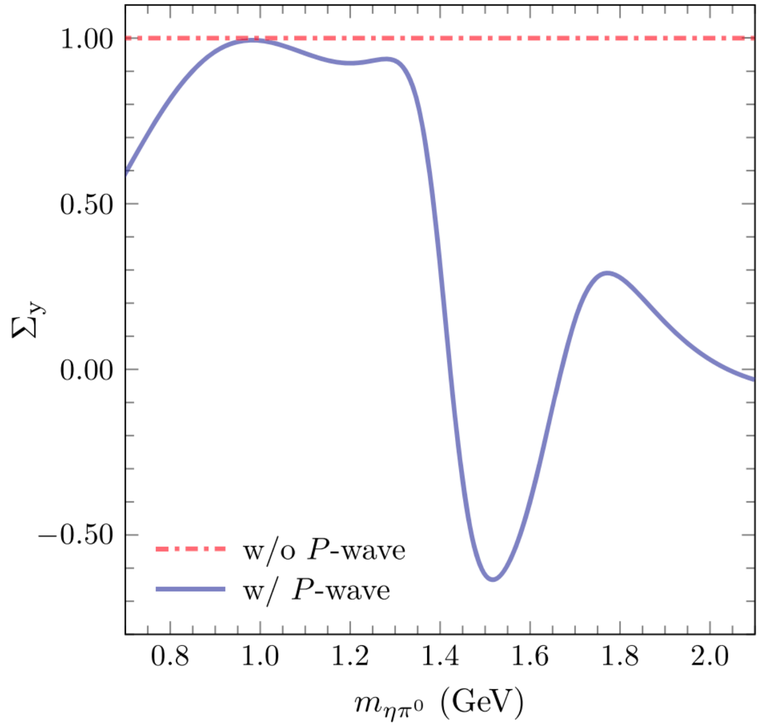
## JPAC collaboration

VM, Albaladejo, Fernández-Ramírez, Jackura, Mikhasenko, Pilloni and Szczepaniak, PRD100 (2019) 054017




## New observable sensitive to exotic waves

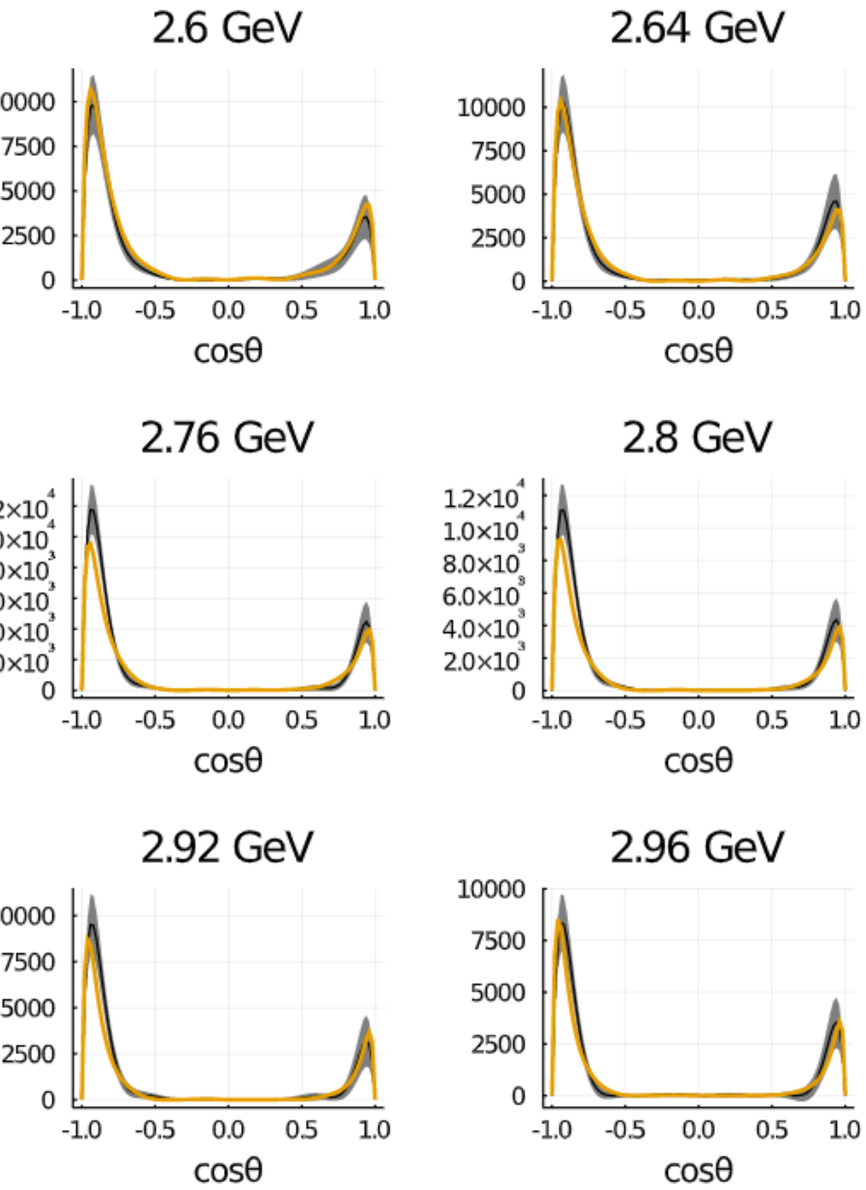



## Formula to extract moments from angular distribution and their relation to partial waves

http://cgl.soic.indiana.edu/jpac/EtaPi_moments.php

Implemented in GlueX analyses $\pi\eta, \pi\pi, \eta\eta$

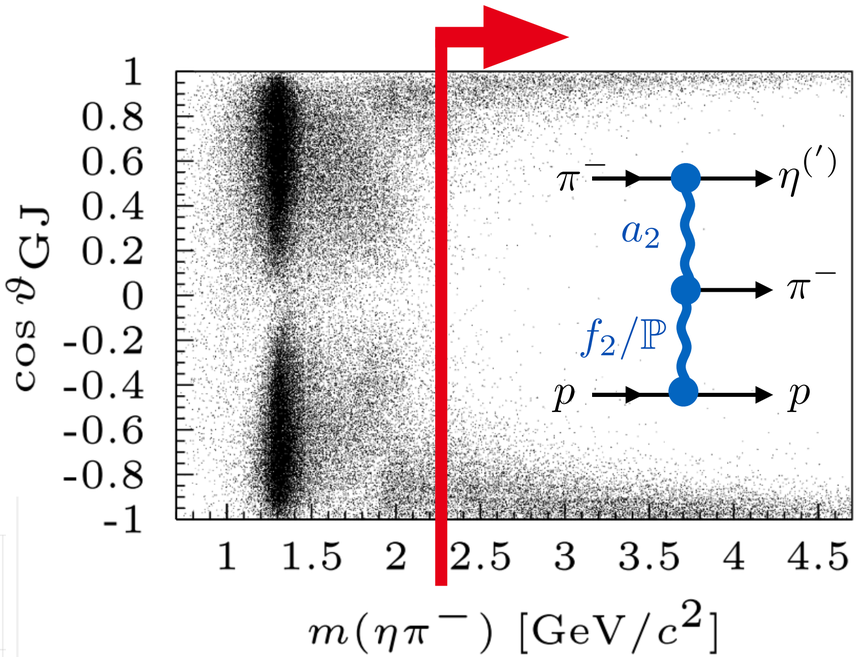
# Double Regge Phenomenology

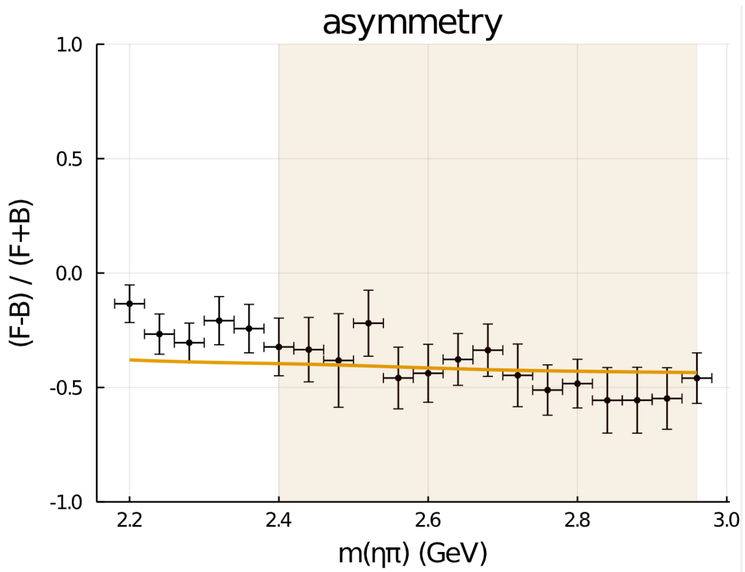



## JPAC collaboration

Bibrzycki, Fernández-Ramírez, Mikhasenko, VM et al
work in progress

**Fit COMPASS data with double Regge amplitudes**




**F/B asymmetry responsible for exotic odd waves**

# Websites

## Event generator for XYZ@EIC

https://github.com/dglazier/elSpectro

## Coordinator: Derek Glazier


## JPAC Interactive webpage

https://ceem.indiana.edu/jpac

## Coordinator: VM

**Photoproduction:**

1. High energy model for tensor meson photoproduction: $\gamma p \to Tp$ page
2. High energy model for $\gamma p \to \eta\pi^0 p$ and di-meson moments: $\gamma p \to \eta\pi^0 p$ page
3. High energy model for $\gamma N \to \pi N$ constrained by FESR: $\gamma N \to \pi N$ page
4. High energy model for $\rho^0, \omega, \phi$ spin density matrix elements: $\gamma p \to Vp$ page
5. High energy model for $\eta'$ beam asymmetry photoproduction: $\gamma p \to \eta^{(\prime)} p$ page
6. High energy model for $\eta$ photoproduction: $\gamma p \to \eta p$ page
7. High energy model for $\pi^0$ photoproduction: $\gamma p \to \pi^0 p$ page
8. Model for $J/\psi$ photoproduction $\gamma p \to J/\psi p$: unpolarized observables ; polarized observables

**Hadroproduction:**

1. Pion-nucleon Scattering:
   - Amplitudes $\pi N \to \pi N$ amplitude page
   - Finite energy sum rules $\pi N \to \pi N$ FESR page
2. Kaon-nucleon scattering: $\bar{K}N \to \bar{K}N$ page

**Three-body Decay:** Isobar decomposition and recoupling coefficients.
**Light Meson Decay:**

1. $\eta$ meson into three pions: $\eta \to 3\pi$ page
2. vector meson into three pions: $\omega, \phi \to 3\pi$ page

**Heavy Baryon Decay:**

1. $\Lambda_b^0 \to J/\psi p K^-$ and the $P_c(4312)^+$: $P_c(4312)^+$ page

# ALICE Group in Catania

## Coordinator: Angela Badalà

Measuring $p_T$ spectra of in different multiplicity bins of $K^*(982)^{\pm} \rightarrow \pi K$ in $pp$ at 13 TeV

## Developing Machine Learning technique to identify resonances

Training on $K^*(892)^0 \rightarrow \pi K$ to improve recognition in $pb\ pb$ collisions

Futur plan: applying on $\Omega(2012) \rightarrow \Xi K$ in $pp$ at 13 TeV

# BESIII Group in Turin

## Coordinator: Marco Destefanis

Matching pQCD with data

Investigation of the interference
between hadronic and electromagnetic processes

## proton-antiproton final states

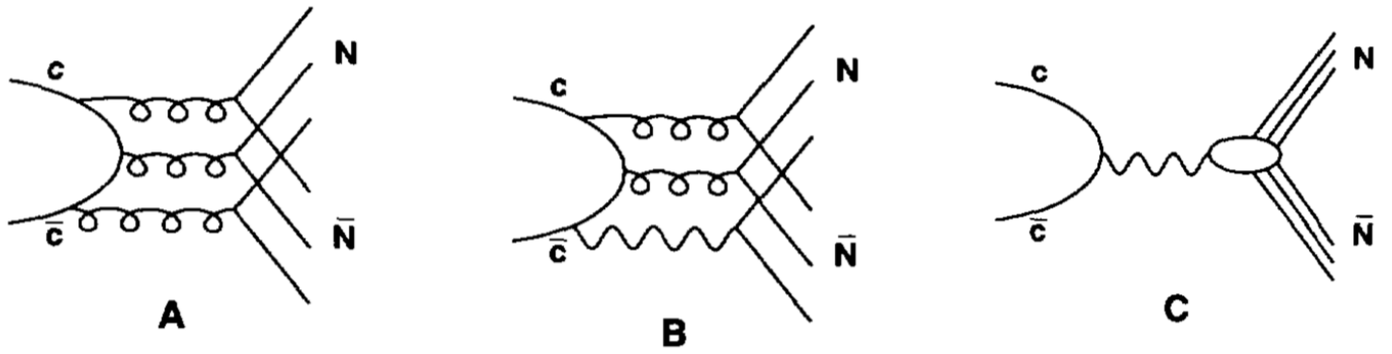
$e^+e^- \to J/\psi \to p\bar{p}$ vs $e^+e^- \to p\bar{p}$

ROOT implementation of fitting routine

M. Ablikim et al. PRD86 032014 (2012)

## Theoretical prediction from

Baldini, Bini and Luppi
PLB404 (1997) 362



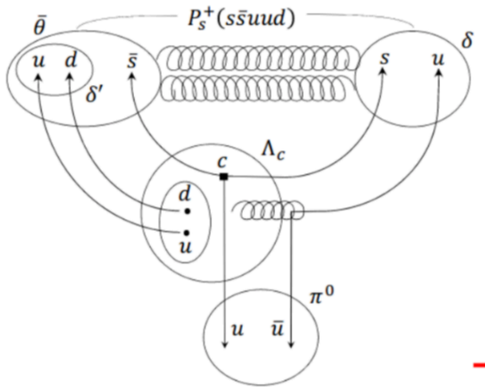
# BESIII Group in Ferrara

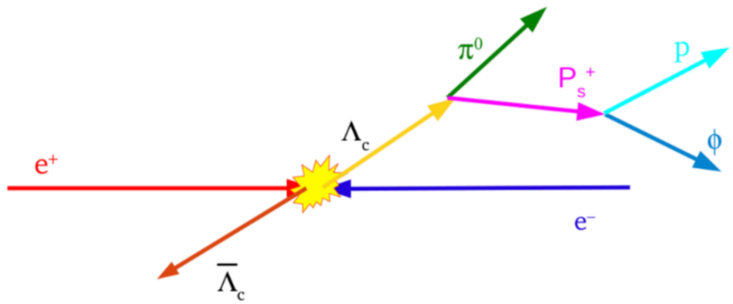
| Ferrara group | Position | Activities |
|---|---|---|
| Isabella Garzia | Researcher (UNIFE) | Coordinator/Analysis |
| Gianluigi Cibinetto | Researcher (INFN) | Coordinator/Analysis |
| Giulio Mezzadri | Postdoc | Analysis |
| Ilaria Balossino | Postdoc | Analysis |
| Marco Scodeggio | PhD student | Analysis |

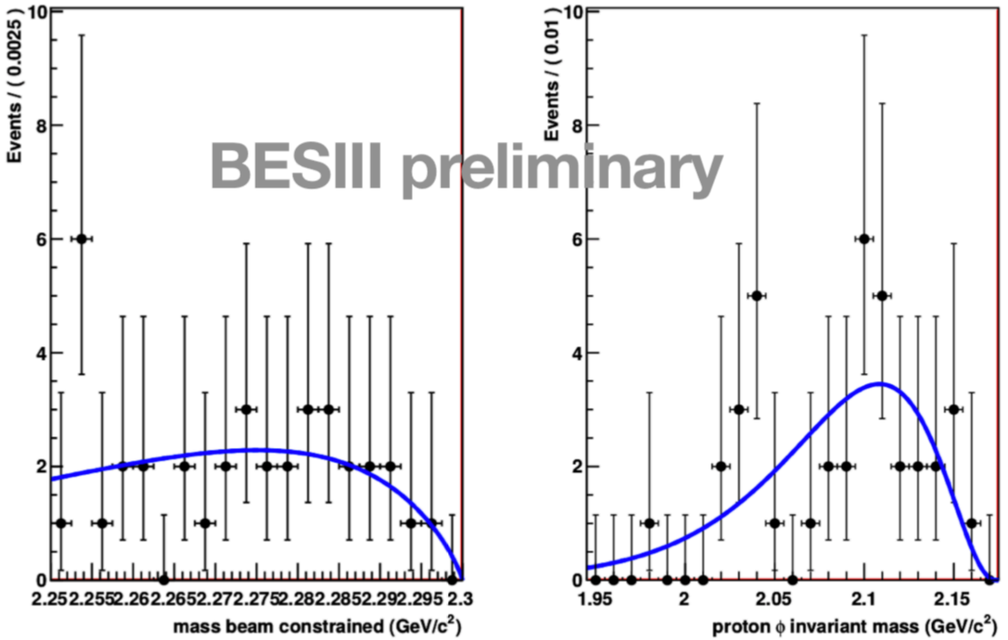
# Search for hidden-strangeness pentaquark in Λc decay at BESIII

Stimulated by LHCb and Belle observation, in BESIII we peached for a hidden-strangeness pentaquark in Λc decay

- In 2014, BESIII has collected 567 $pb^{-1}$ close to $\Lambda_c\overline{\Lambda}_c$ production threshold (4.6 GeV)
  - The pentaquark is searched in the p$\phi$ invariant mass
  - The result is limited by statistic
  - No evidence of signal is found
  - **PLANS: BESIII has collected new data between 4.6 to 4.7 GeV in 2020—> this analysis will be updated**



# BESIII Group in Ferrara

***Inclusive measurement of hc in the psi(2S) decay***

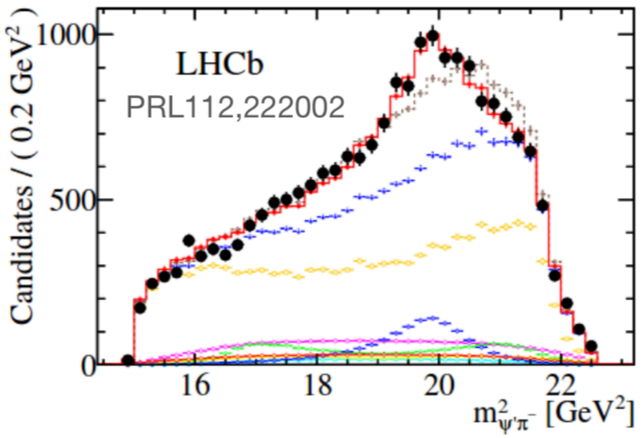
## Ongoing analysis

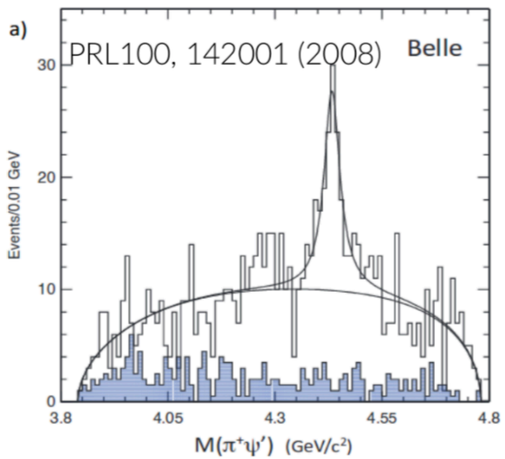
- **From April 2019:**
  - Event and track selection validation
  - Systematic uncertainty studies finalised
- **This year (2020):**
  - BESIII internal document released
  - Internal review started
- **PLANS:**
  - Prepare the draft
  - Submission to journal (2021)

# BESIII Group in Ferrara

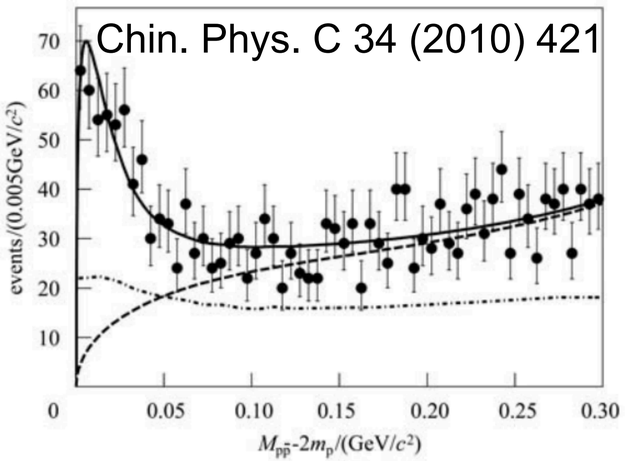
## *BESIII - New analysis started very recently: e+e- -> Y(4660) -> Zc-/+ (4430) pi+/- -> psi(2S) pi+/- pi+/-*

- Zc(4430) observed first by Belle Collaboration and confirmed by LHCb
- In 2020, BESIII took new data up to 4.7 GeV
  - we plan to search for Zc(4430) in BesIII by means of this new data set and to study possible connection with the nearby Y(4660) resonance
  - **PLANS (from Autumn 2020):**
    - start of the analysis: signal MC production ongoing (resonant and non resonant)
    - Study the analysis feasibility
    - Plan to have event selection cut by min winter 2020/2021



# BESIII Group in Ferrara




***Plans for new analyses (with BESIII data)***

- Two new analyses planned by our group for the next year:
  - Search for X(1835) in Jpsi—> ωX(1835), X(1835)→ η'π+π- hadronic decays
    - improve the analysis published on PRD99,071101 (published on April 2019) with the full Jpsi statistics collected by BESIII in the 2018 and 2019 (10 billion of Jpsi data)
  - BR measurement of Jpsi—> $\phi$ η'π+π-, and search for X(1835) into η'π+π- invariant mass spectra

# Summary

**New developments since June 2019 in the network** STRONG-2020

| Theory | Tools | Analyses |
|---|---|---|
| Spectra and decays of light and heavy hybrids from EFT and pNRQCD | Moments of photoproduction of 2 pseudo scalar mesons | $K^*(982)$ and $\Omega(2012)$ with ALICE |
| | Kinematics for 3-body decays | Test of pQCD in $p\bar{p}$ with BESIII |
| | Webpages with codes | Pentaquark search in $\Lambda_c$ decay with BESIII |
| | Particle ID with Machine L. | $Z_c(4430)^+$ and $X(1835)$ search with BESIII |

**Other developments in Task 3.1 missing?**
**(LHCb from Neubert?)**

**Don't hesitate to contact me**

STRONG-2020 Task 3.1

# Meson Spectroscopy Analysis of New and Exotic States: Search for and study of light exotic mesons, Strangeonia and charmonia

**Vincent MATHIEU**

**Universidad de Barcelona**
**Complutense Universidad de Madrid**

York - September 2021