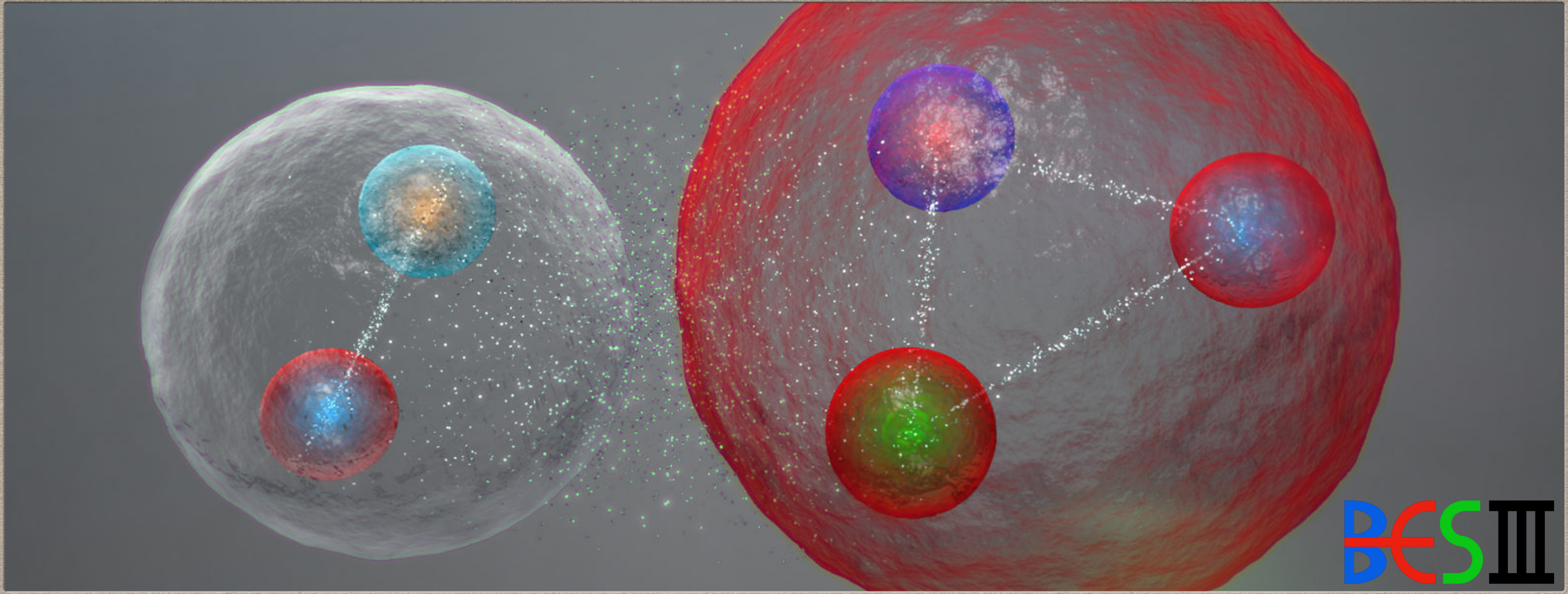


Ph.D. Research Activities

XXXII INTERNATIONAL SEMINAR OF NUCLEAR AND SUBNUCLEAR PHYSICS

MARCO SCODEGGIO - PhD STUDENT @INFN FERRARA

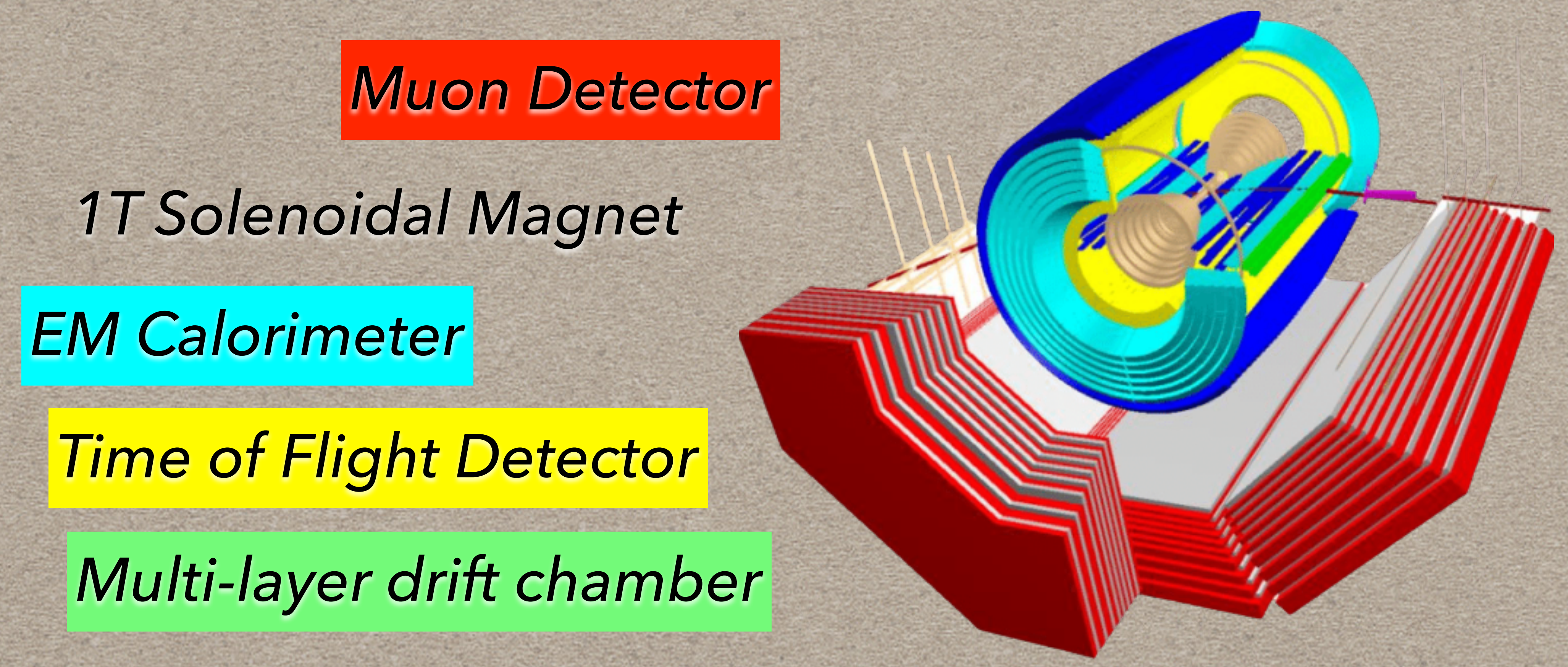
INFN
Istituto Nazionale di Fisica Nucleare

Otranto School

Università degli Studi di Ferrara

BESIII Experiment

BESIII (**BE**ijing **S**pectrometer **III**) is an experiment located on the BEPCII collider line at IHEP (*Institute of High Energy Physics*)

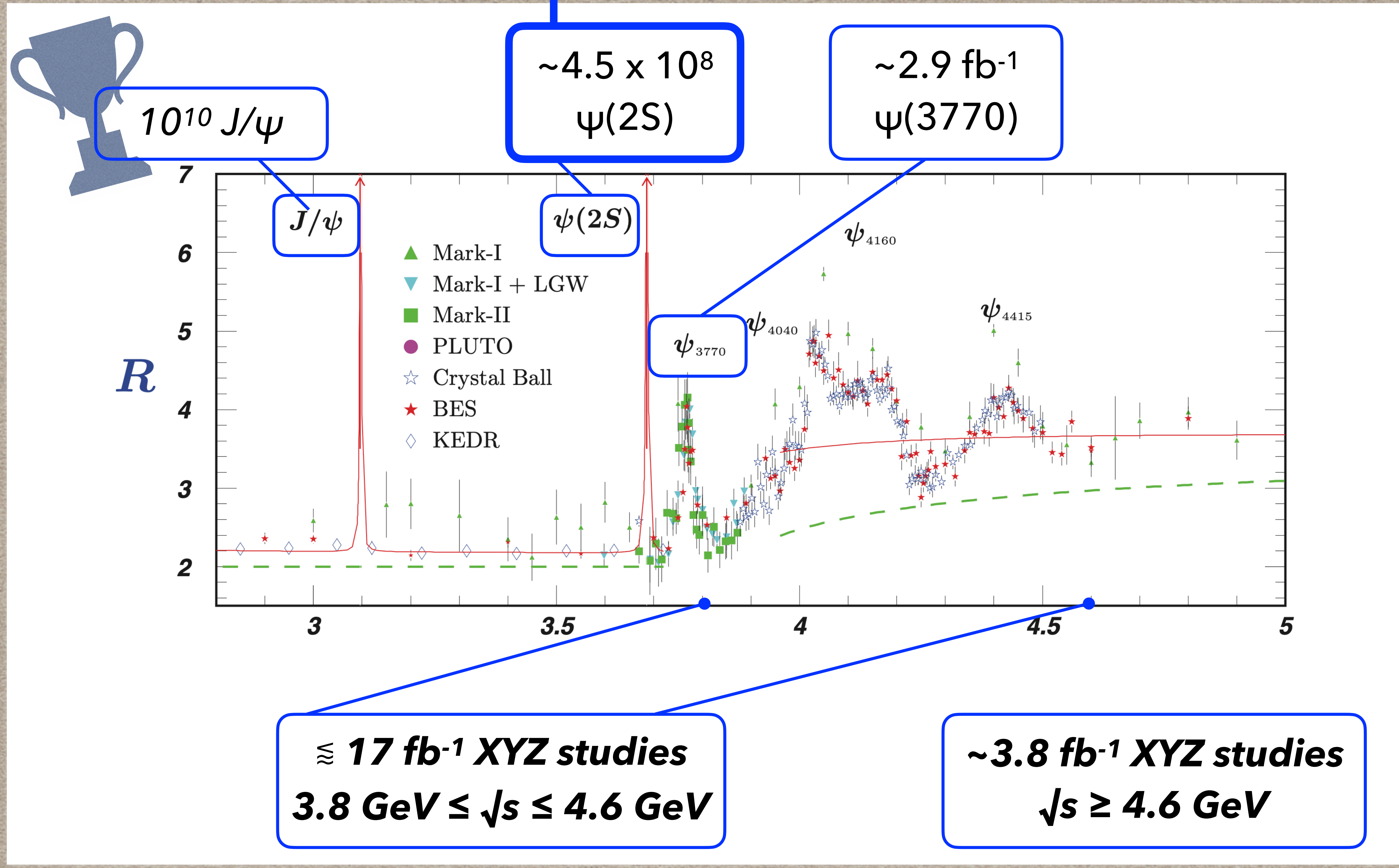


τ-charm factory 2.0 GeV ≤ $\sqrt{s}$ ≤ 4.95 GeV

with a design luminosity

@$\sqrt{s}$ = 3.77 GeV of 10^{33} $cm^{-2}s^{-1}$

Thanks to the next data taking ψ(2S) will reach ~3 x 10^9



IN A FEW WORDS...

My work within the BESIII collaboration focuses **primarily** on **data analysis**

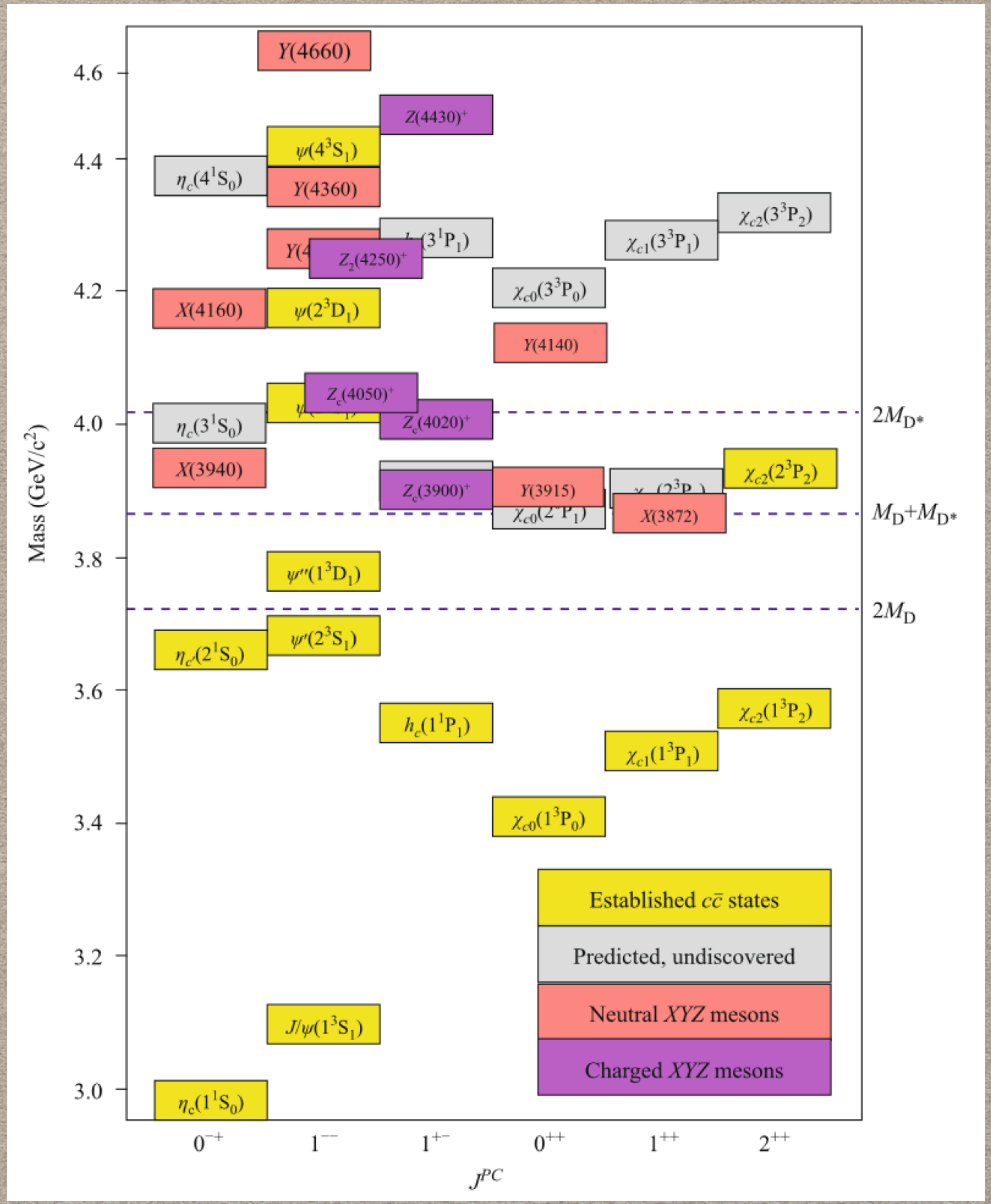
→ "Inclusive measurements of the $\mathbf{h_c(1\,^1P_1)}$ in $\psi(2S)$ decays" is **concluded** and is following the BESIII *internal review* process ←

→ "Search for the $\mathbf{Z_c(4430)}$ in Y(4660) decay" is **ongoing** and at the end of the event selection stage ←

Inclusive measurements of $h_c(1^1P_1)$ in $\psi(2S)$ decay

Preamble

Despite its importance in guiding developments of QCD based models, specifically in explaining the $c\bar{c}$ spectrum, the **measurements** of the $\mathbf{h_c(1^1P_1)}$ state are **sparse**



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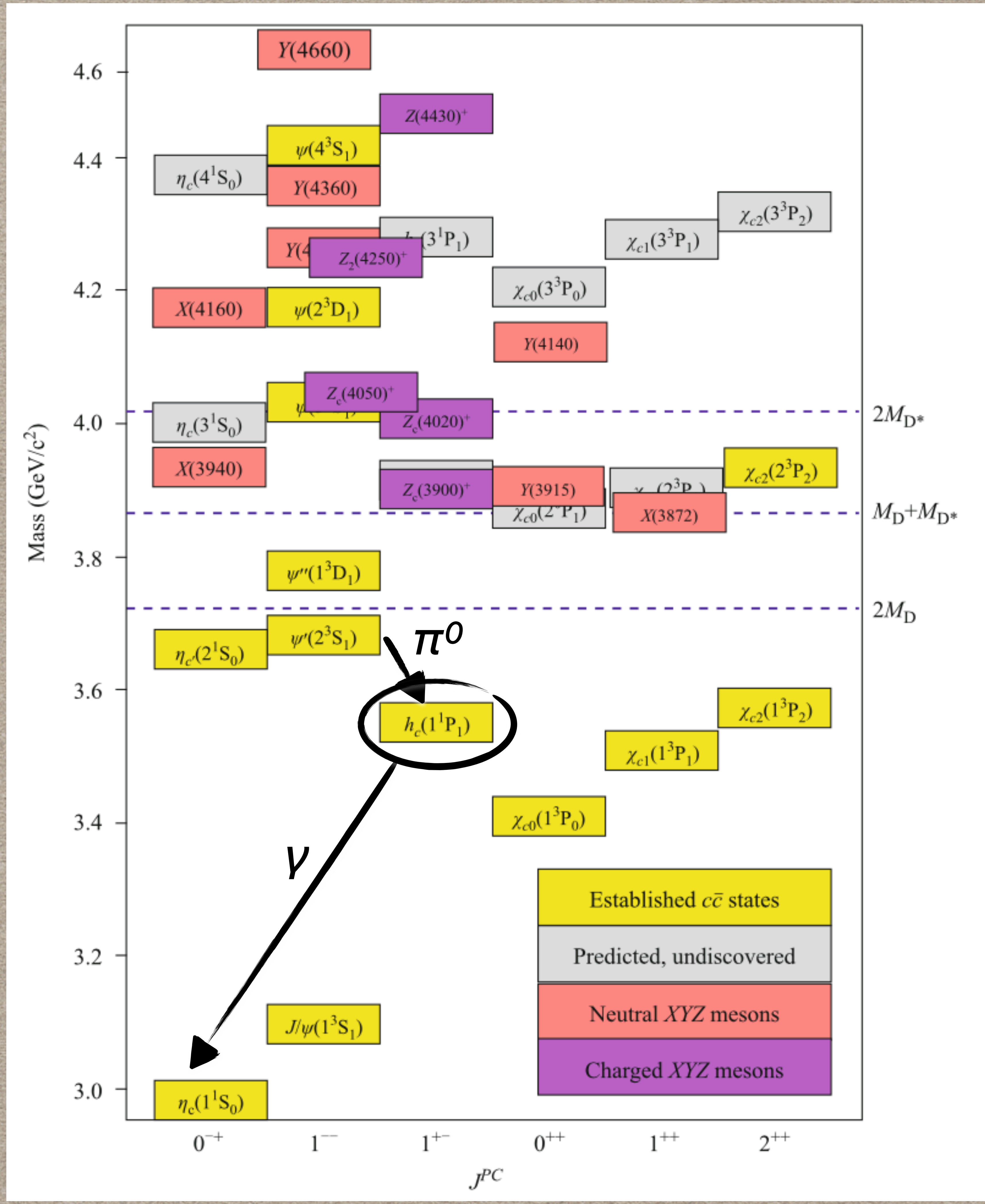
Despite its importance in guiding developments of QCD based models, specifically in explaining the $c\bar{c}$ spectrum, the **measurements** of the **$h_c(1^1P_1)$** state are **sparse**

Goal of my analysis was to **measure** the **$h_c(1^1P_1)$ features** with **high precision**

A **measurement** of **branching ratios** ($\psi(2S) \to \pi^0 h_c$, $h_c \to \gamma \eta_c$) is performed



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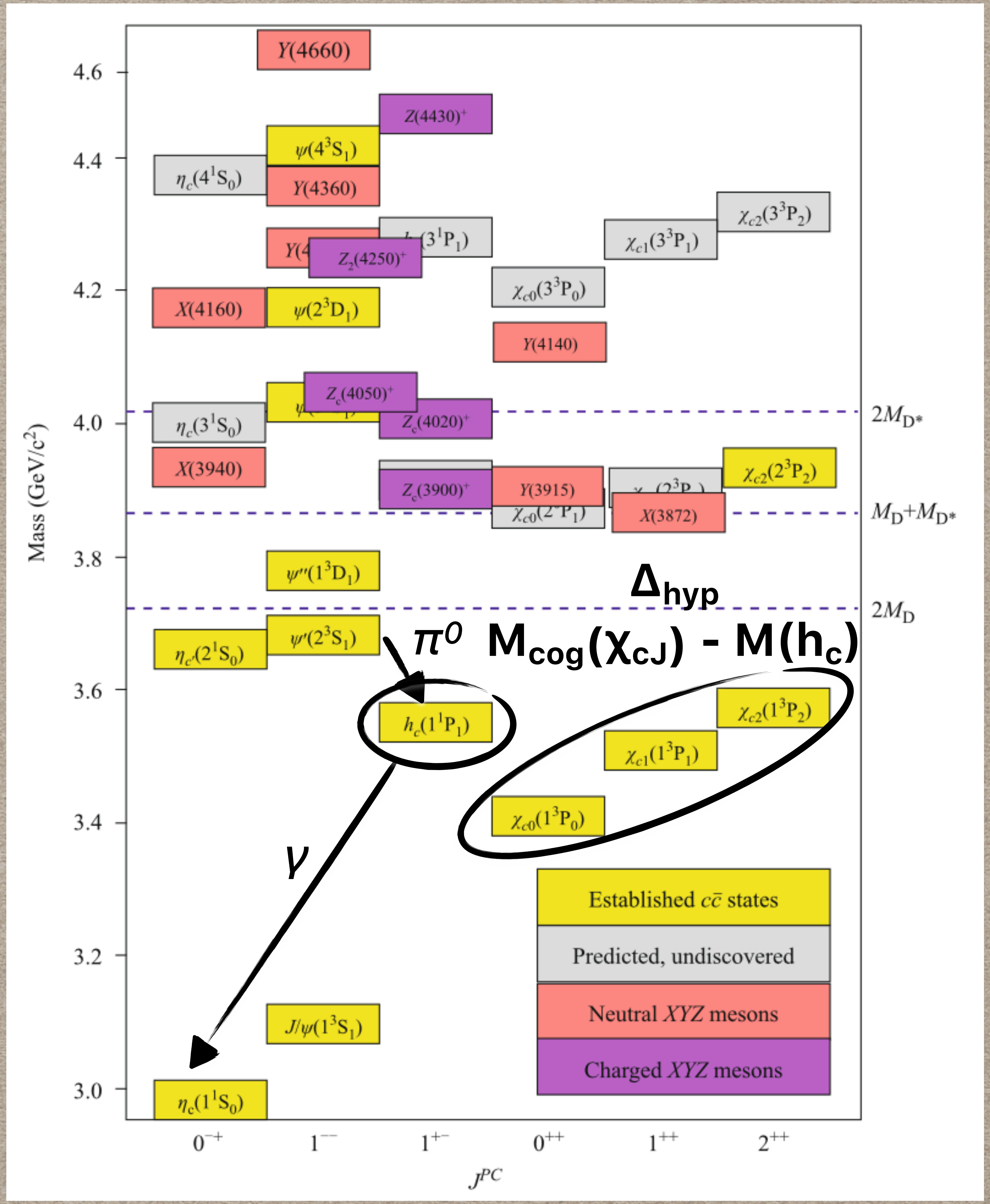
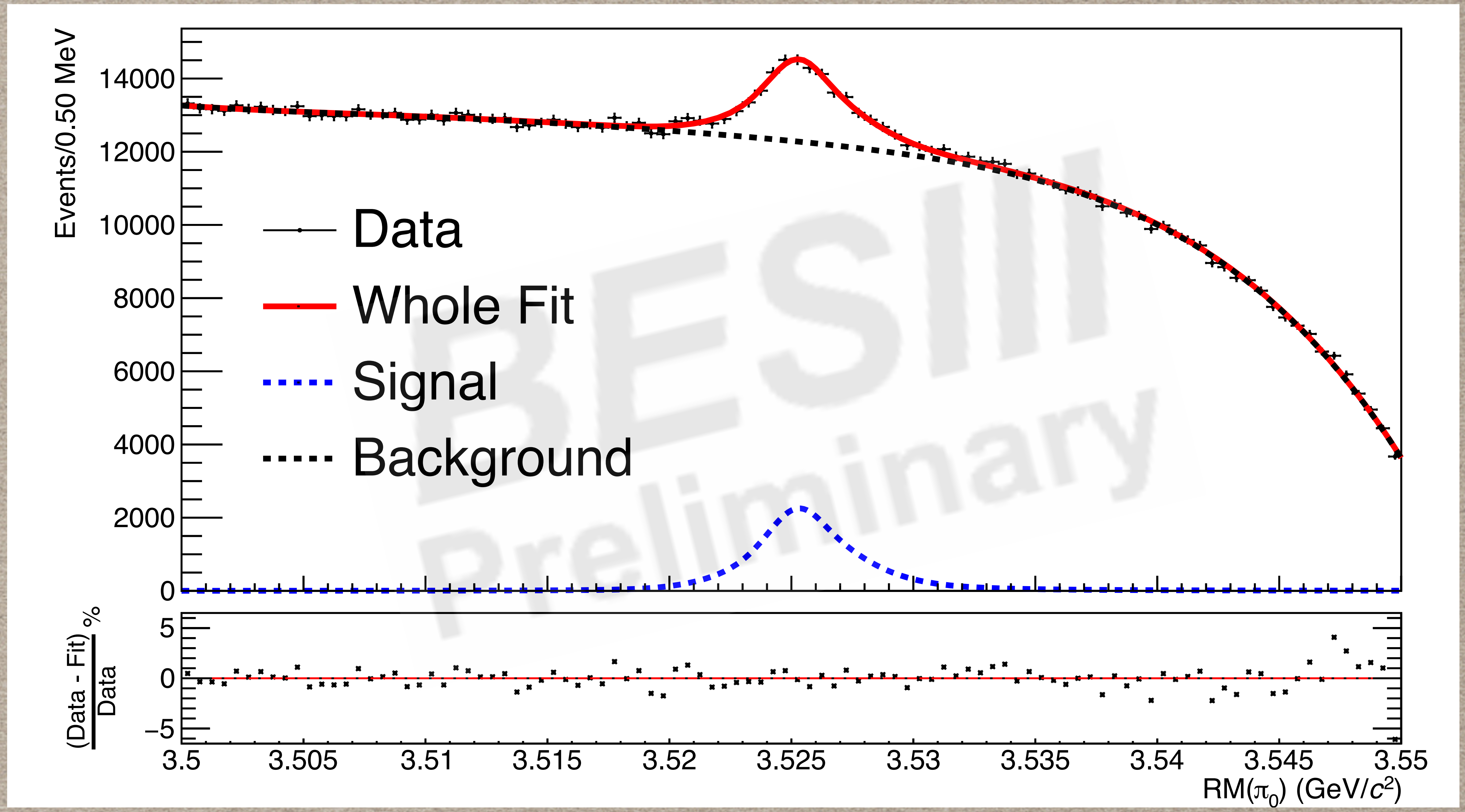
Finally, an estimate of the **1P hyperfine splitting** [$\Delta_{hyp} = M_{cog}(\chi_{cJ}) - M(h_c)$] is given



The h_c **resonance** is reconstructed by looking at the π^0 **recoiling mass** distribution

Two channels are used to reconstruct the π^0 a tagged one ($\psi(2S) \to \pi^0 h_c \to \pi^0 \gamma \eta_c$) and an inclusive decay ($\psi(2S) \to \pi^0 h_c$)

This analysis is essentially a matter of having an high photon detection efficiency as 3 (2) photons are required for the tagged (inclusive) channel



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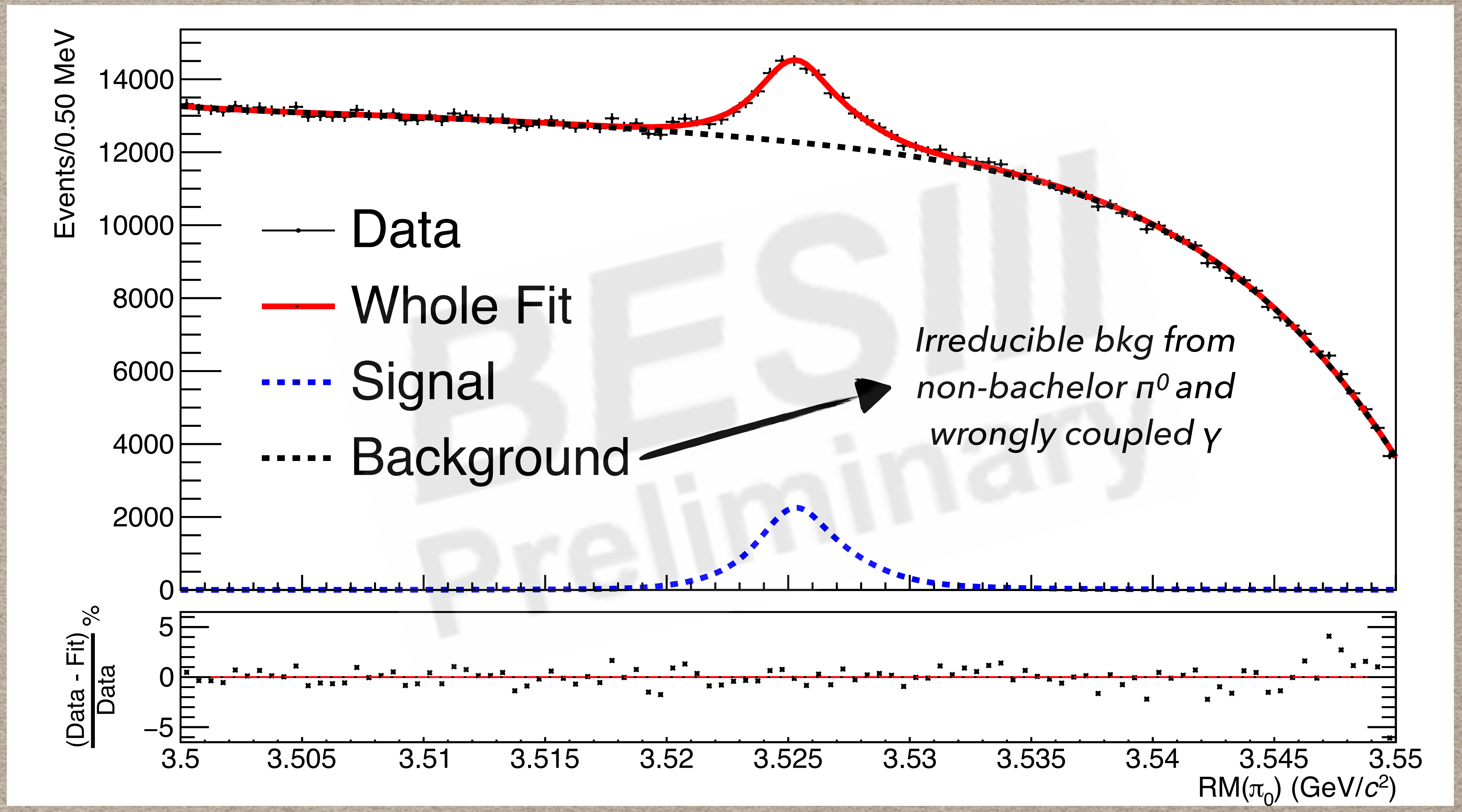

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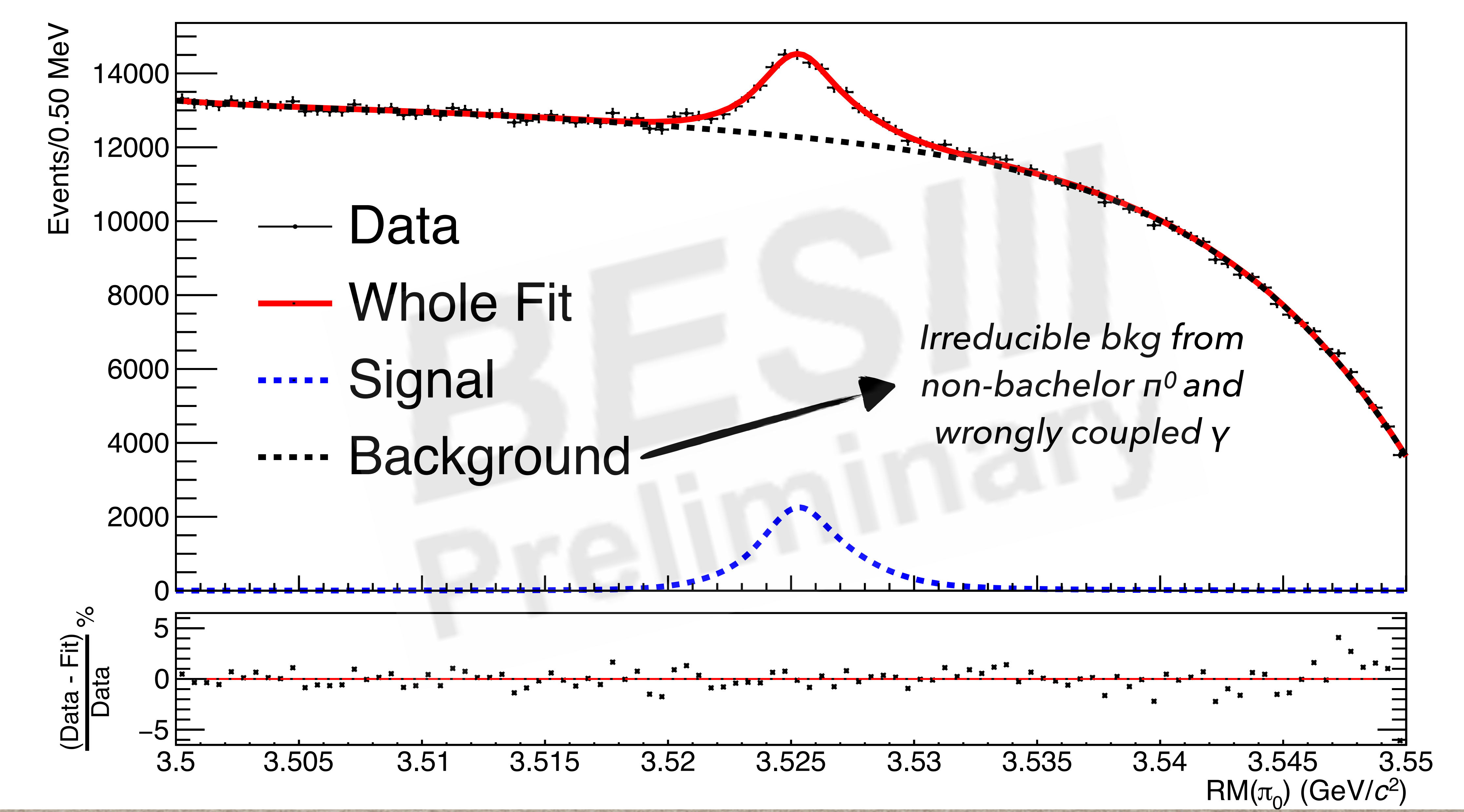


Variable	Value	PDG Value
$\mathrm{M(h}_c)$ (MeV/c^2)	$3525.32 \pm 0.06 \pm 0.15$	3525.38 ± 0.11
$\Gamma(\mathrm{h}_c)$ (MeV/c^2)	$0.78\,^{+\,0.27}_{-\,0.24} \pm 0.12$	0.70 ± 0.28
$\mathrm{N_{Tag}(h}_c)$	$23118\,^{+\,1500}_{-\,1398}$	—
$\mathcal{B}_1 \times \mathcal{B}_2$ (10^{-4})	$4.17\,^{+\,0.27}_{-\,0.25} \pm 0.19$	4.3 ± 0.4
$\mathrm{N_{Incl}(h}_c)$	46187 ± 2123	—
$\mathcal{B}_1$ (10^{-4})	$7.23 \pm 0.33 \pm 0.37$	8.6 ± 1.3
$\mathcal{B}_2$ (%)	$57.66\,^{+\,2.64}_{-\,2.27} \pm 0.58$	51 ± 6

With a 448.1 ± 2.9 millions of $\psi(2S)$ events, BESIII is able to **improve** most of the features **uncertainties by a factor of ~2**

The **1P hyperfine mass splitting** was found to be
$\Delta_{hyp} = -0.03 \pm 0.06\ (\text{stat.}) \pm 0.15\ (\text{syst.})\ \text{MeV}/c^2$
consistent with the lowest-order expectation that Δ_{hyp} is **zero**

Search for the $Z_c(4430)$ in $Y(4660)$ decay

Preamble

XYZ is a family of relatively mysterious states (discovered firstly in 2003) **incompatible** with the **quark-antiquark model**

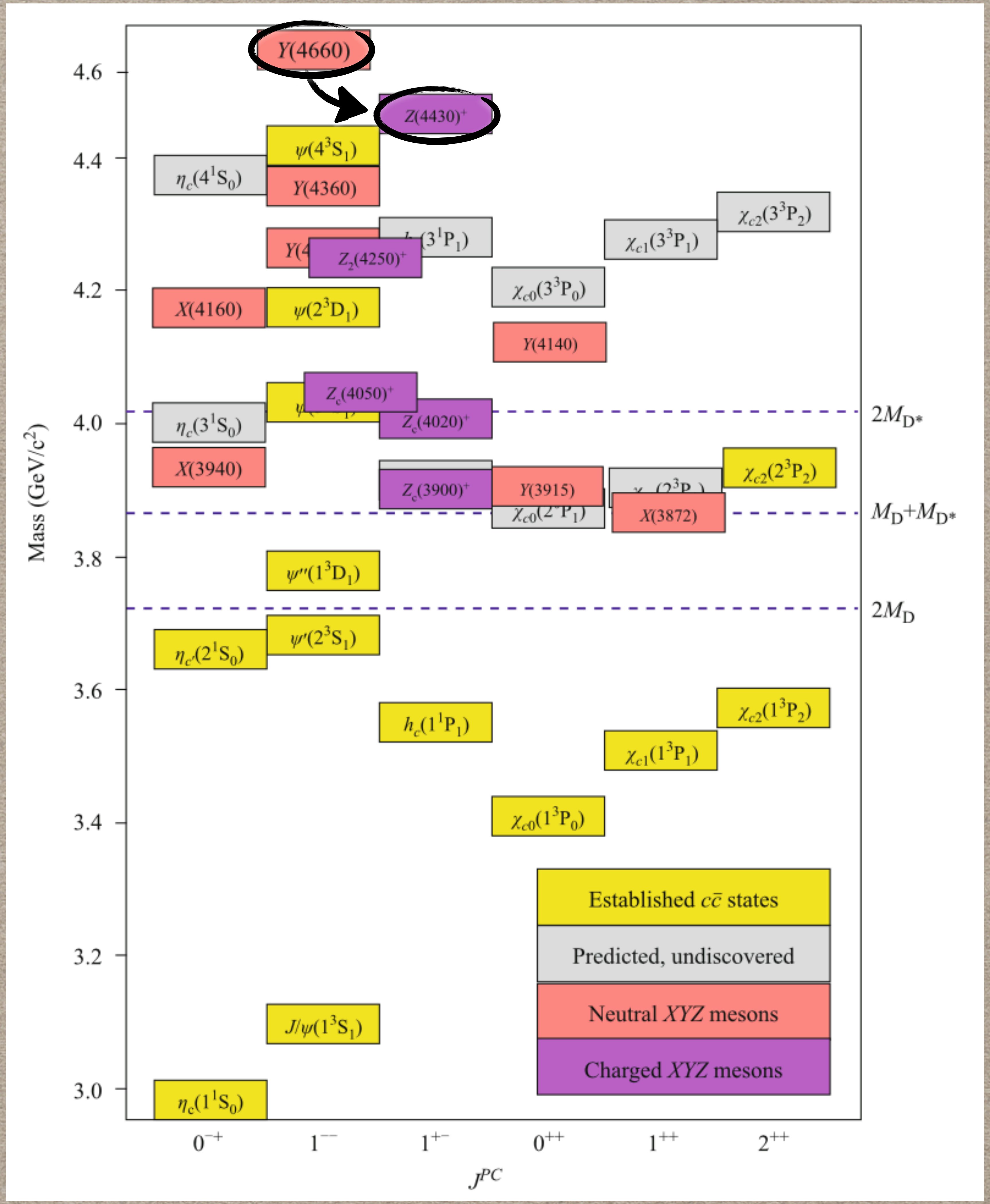
XYZ are possible **candidates for tetraquarks, meson molecules, glueballs or hybrids**

In this analysis I want to investigate a possible connection between the Y and X states (as established in [PRD **102**, 012009]) via:

e^+e^- → **Y(4660)** → **Z_c(4430)** π → ψ(2S) π π → J/ψ π π π π

Y(4660), already **observed by BaBar** [PRD **89**, 111103(R)] and **BELLE** [PRD **91**, 112007], was **hypothesised** to be a **baryonium**

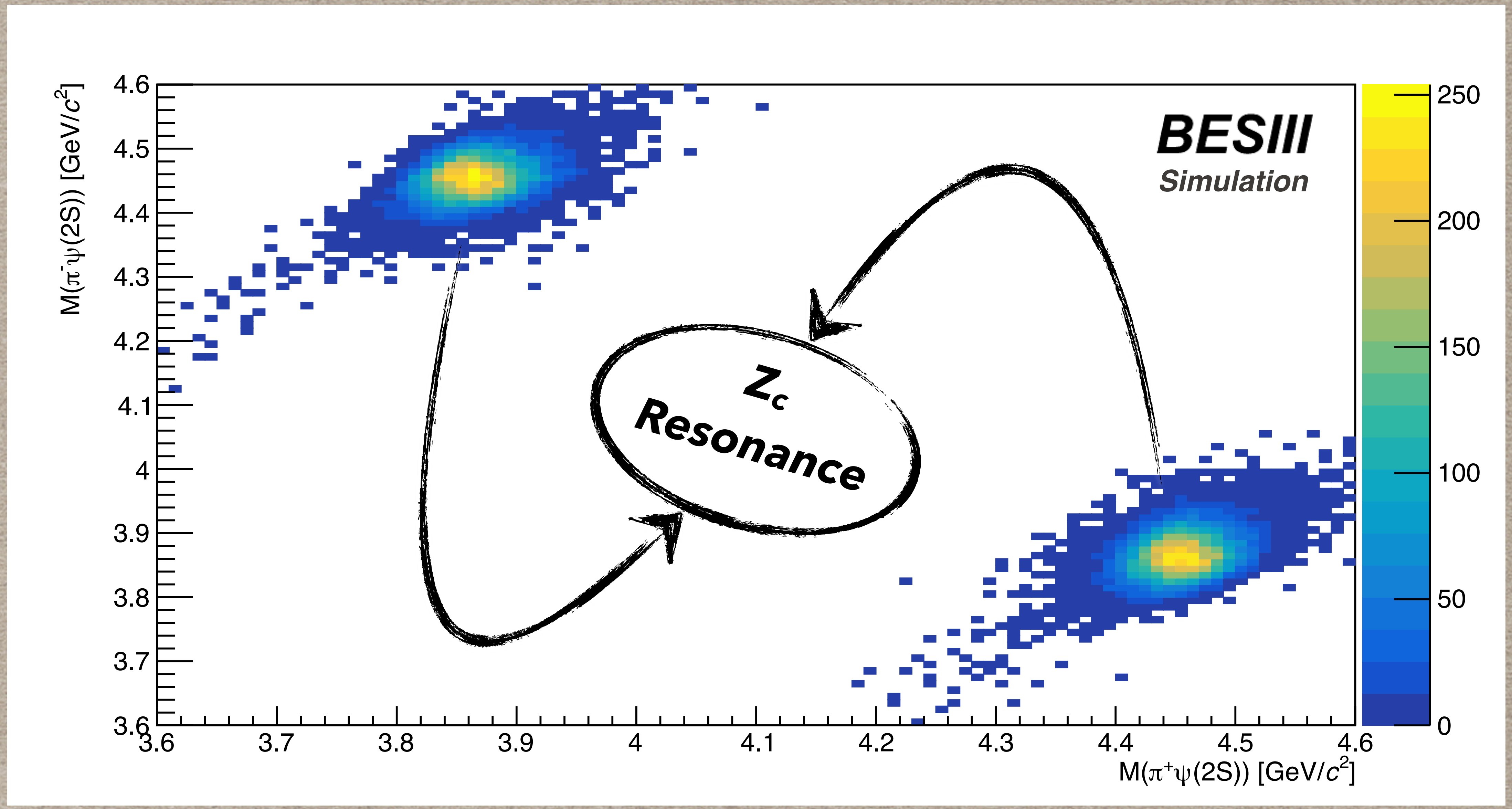
Z_c(4430) was **observed and studied** in the **B meson decays** in the **πψ(2S) invariant mass** by **BELLE** [PRD **88**, 074026] (and by **LHCb** [PRL **112**, 222002])

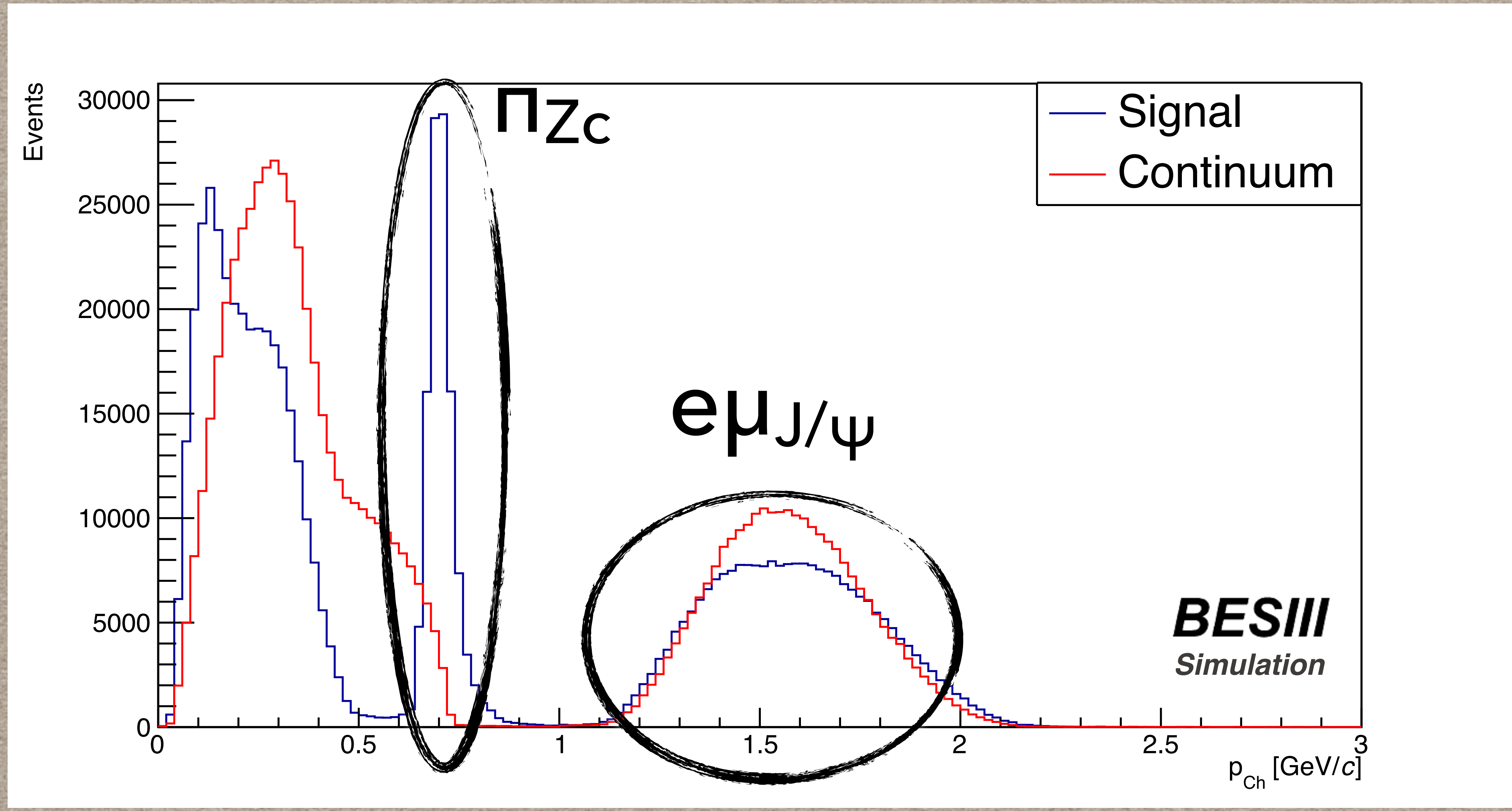


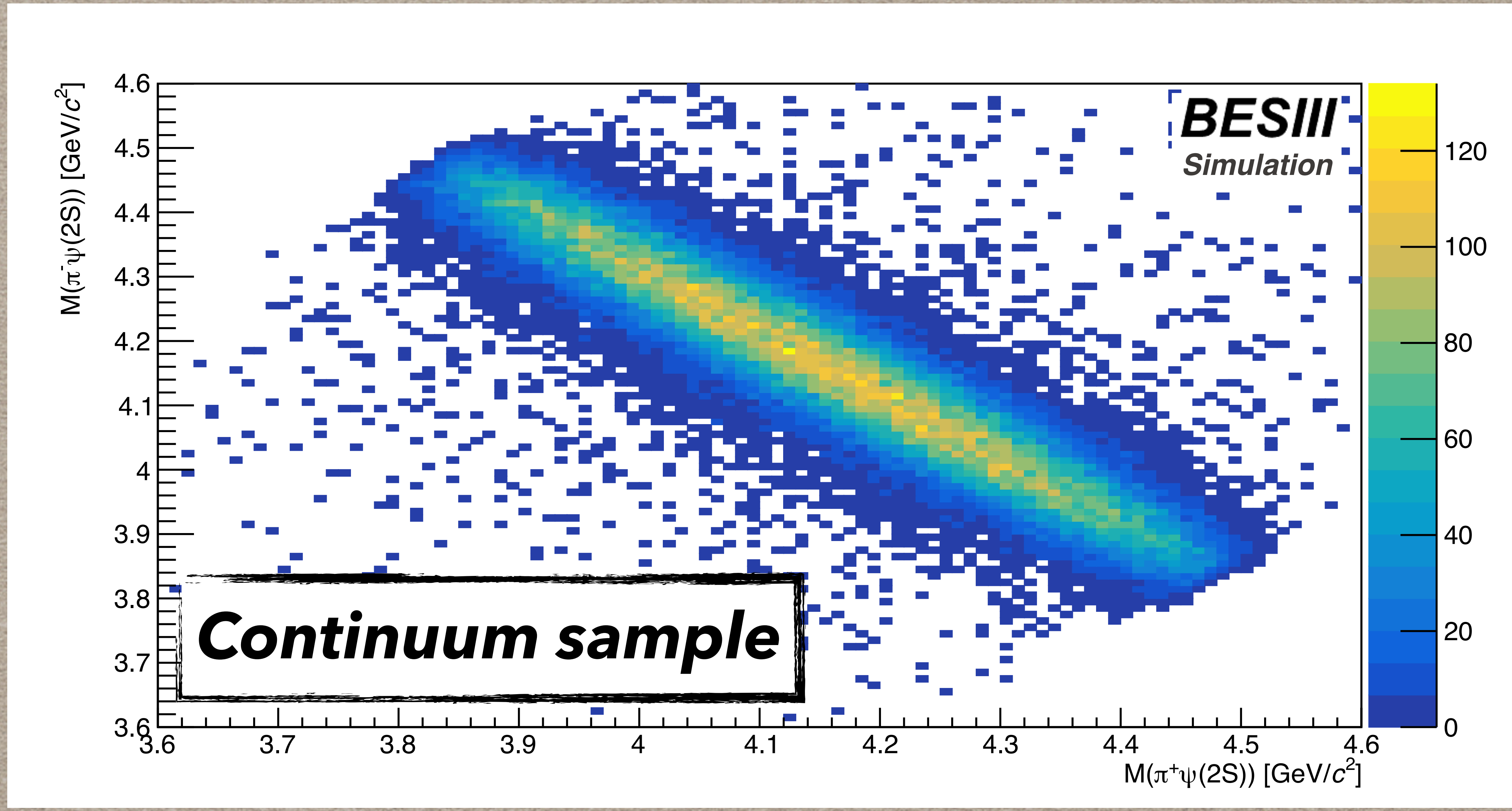
Ongoing analysis, at the **event selection stage**

6 (5) charged tracks, 2 leptons and 4 (3) π, are required

Signal and Continuum MonteCarlo datasets are under study to understand **differences** in kinematic distributions







WELL, IT'S NOT OVER...

FE

@pifeatwork

WELL, IT'S NOT OVER…

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Detector oriented service tasks, within the so-called *CGEM-IT project* for the BESIII experiment

WELL, IT'S NOT OVER...

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FCC benchmark analysis of a flavour physics channel to define constraint and challenges for the *next-gen* detectors

Detector oriented service tasks, within the so-called *CGEM-IT project* for the BESIII experiment

FCC
hh ee he

WELL, IT'S NOT OVER…

Organisation of the INFN dissemination project *"What Next? Giovani che raccontano il futuro"*

FCC benchmark analysis of a flavour physics channel to define constraint and challenges for the *next-gen* detectors

FE
@pifeatwork

Detector oriented service tasks, within the so-called *CGEM-IT project* for the BESIII experiment

What Next
GIOVANI CHE RACCONTANO IL FUTURO

FCC
hh ee he

Many Thanks
for
Your Attention

Back-up slides

Facebook: @pifeatwork
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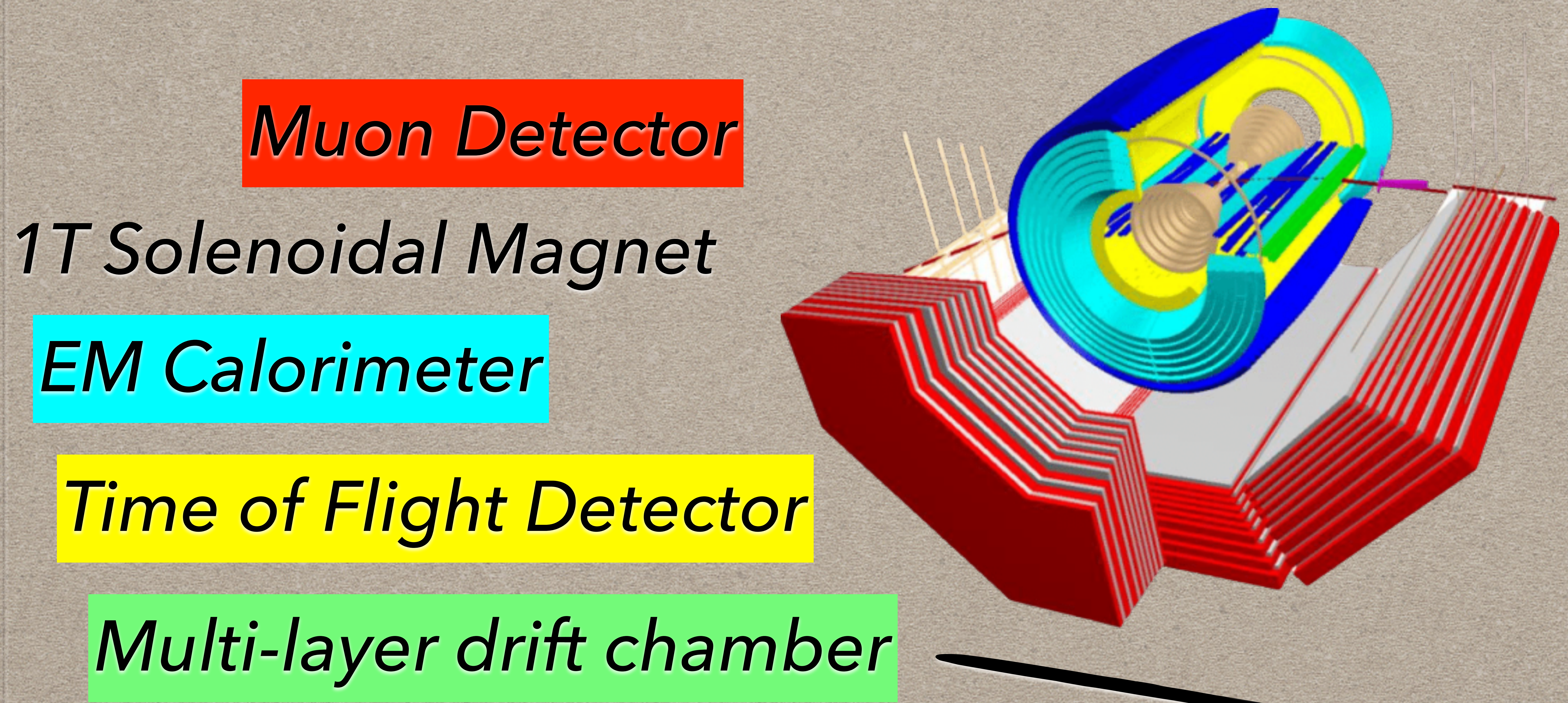
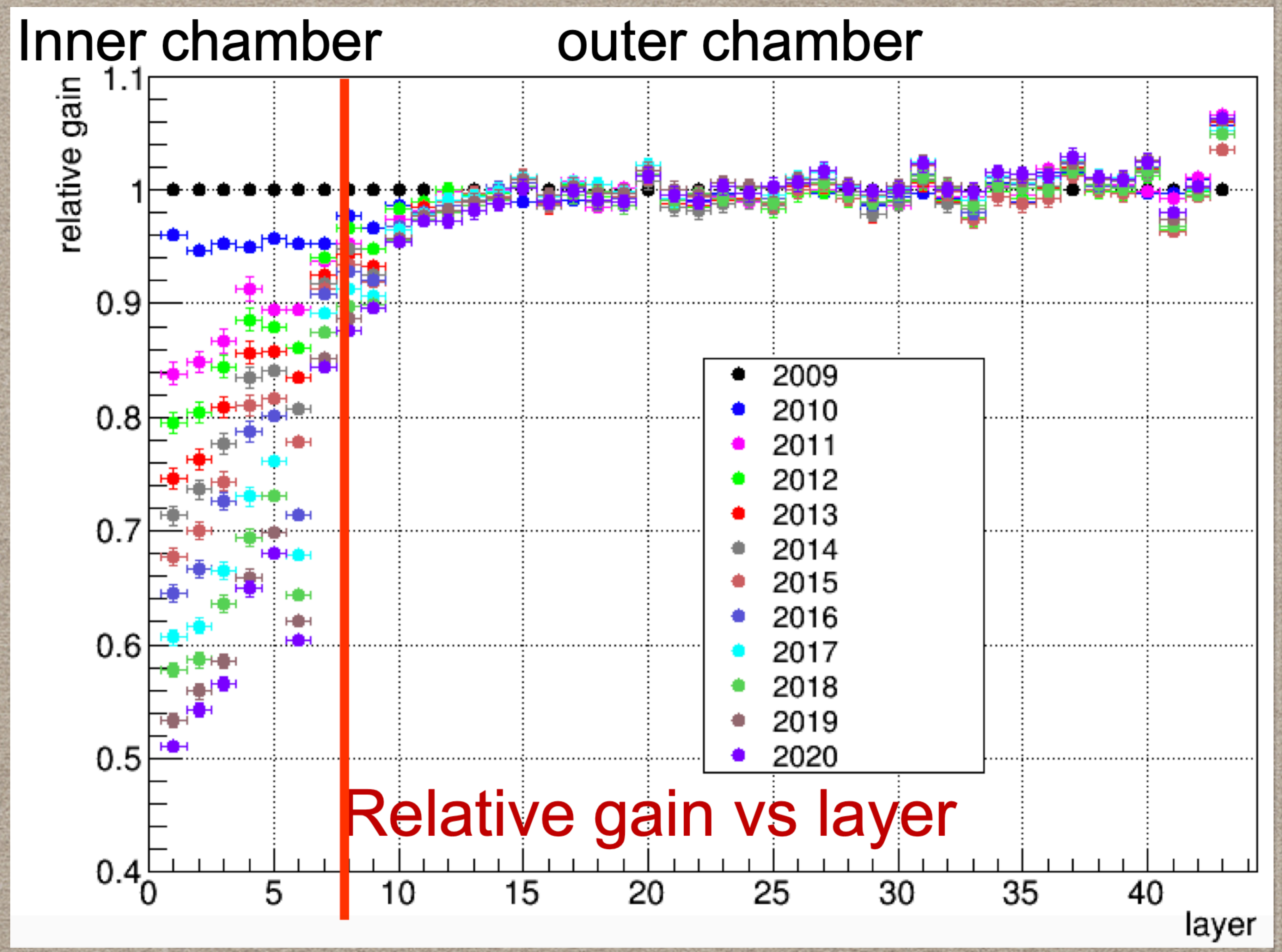
TikTok: pifeatwork

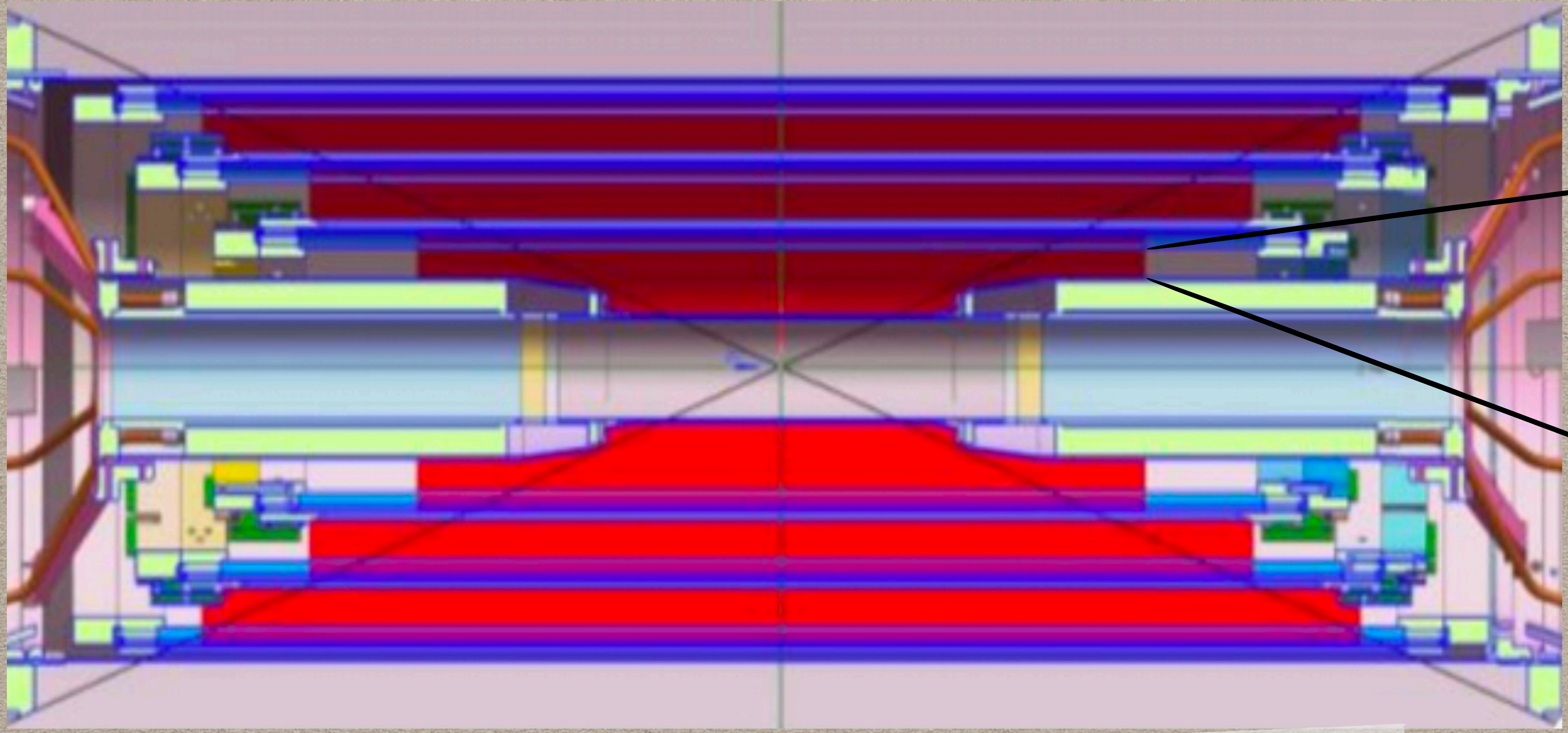
Check it out!!!
next.infn.it/iniziativa

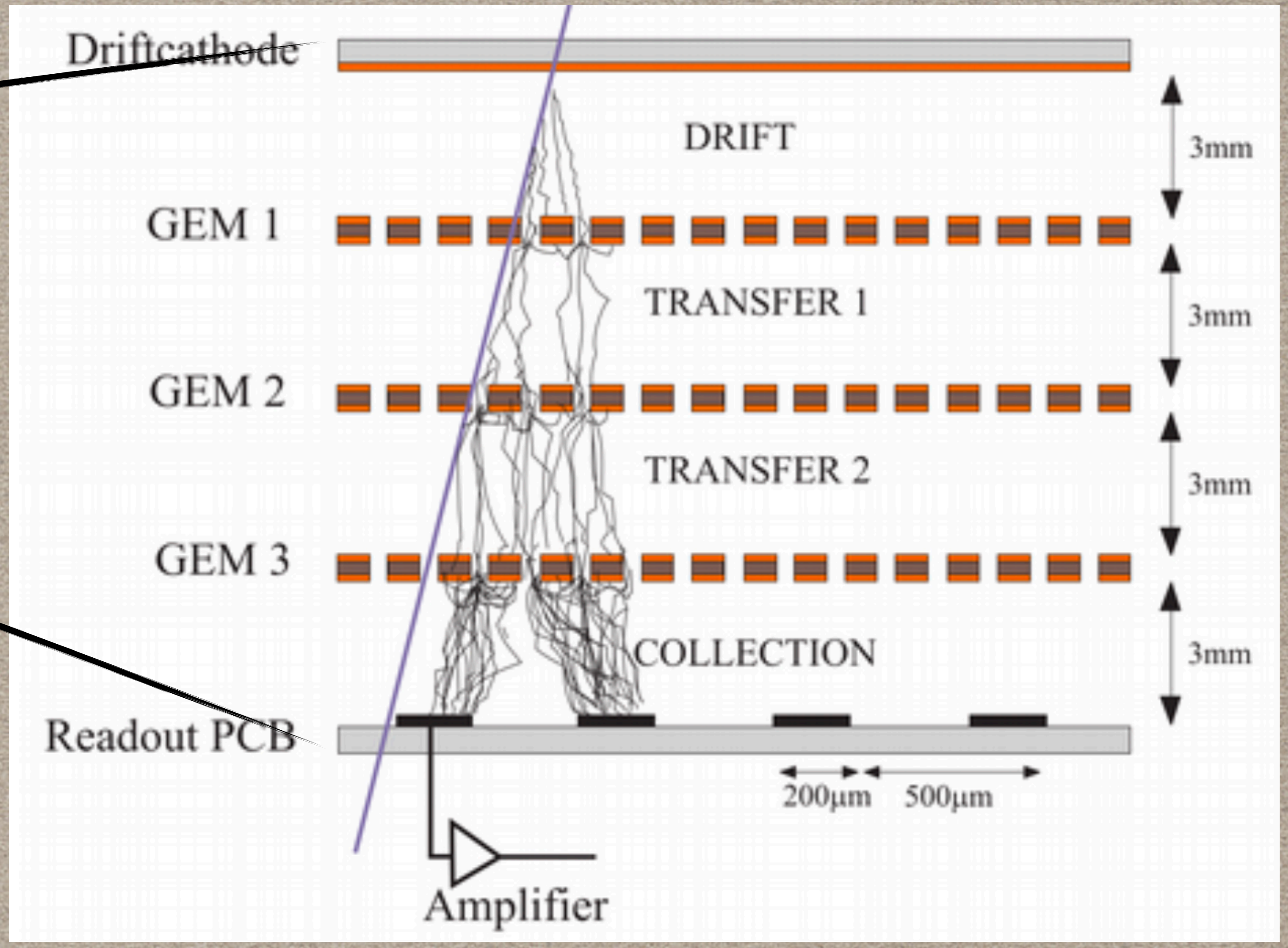
CGEM-IT Project

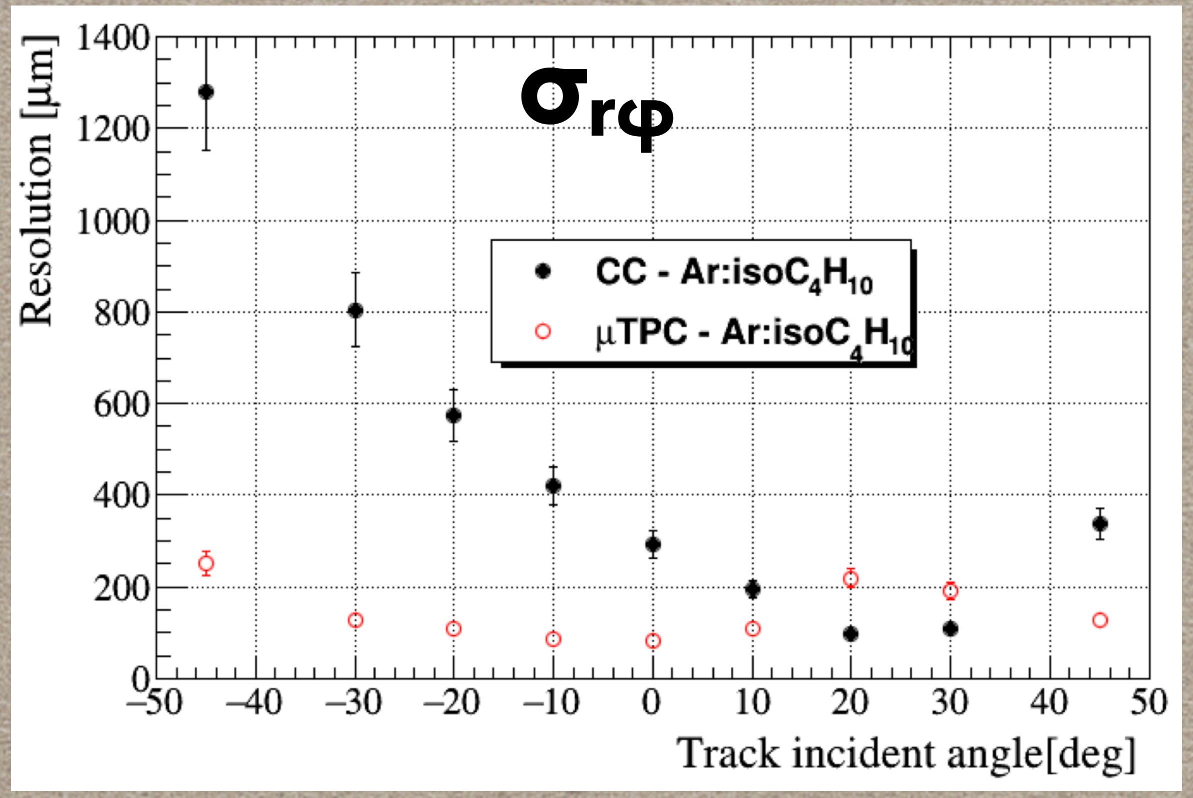




CGEM-IT Project







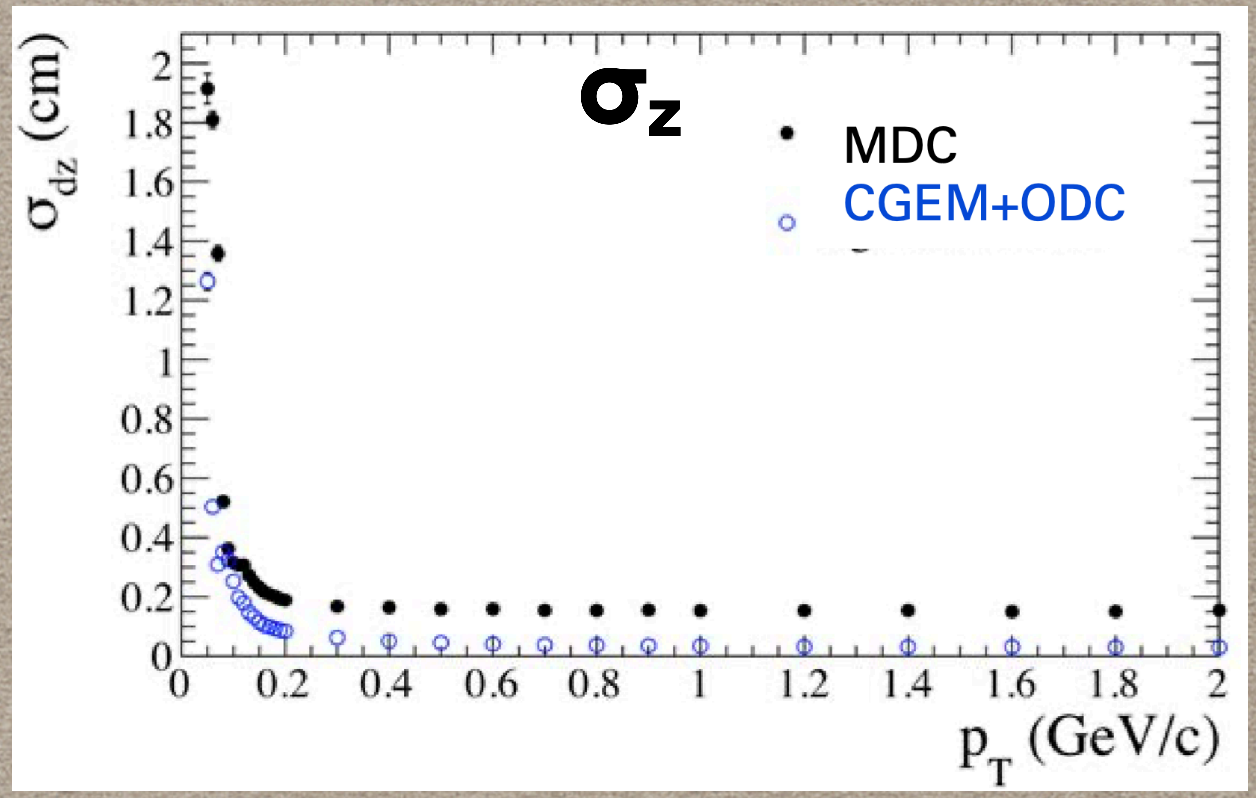
Up to 10^4 Hz/cm^2

$\sigma_{r\varphi} < 130$ µm & $\sigma_z < 1$mm

$\sigma_{p_T}/p_T \sim 0.5\%$ @ 1 GeV

ε > 98%

Material budget < 1.5% X_0

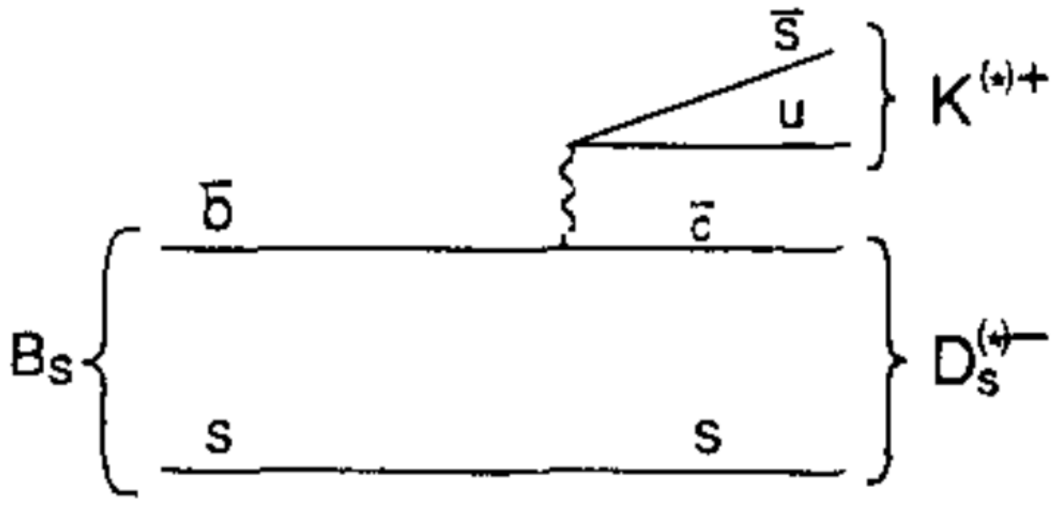


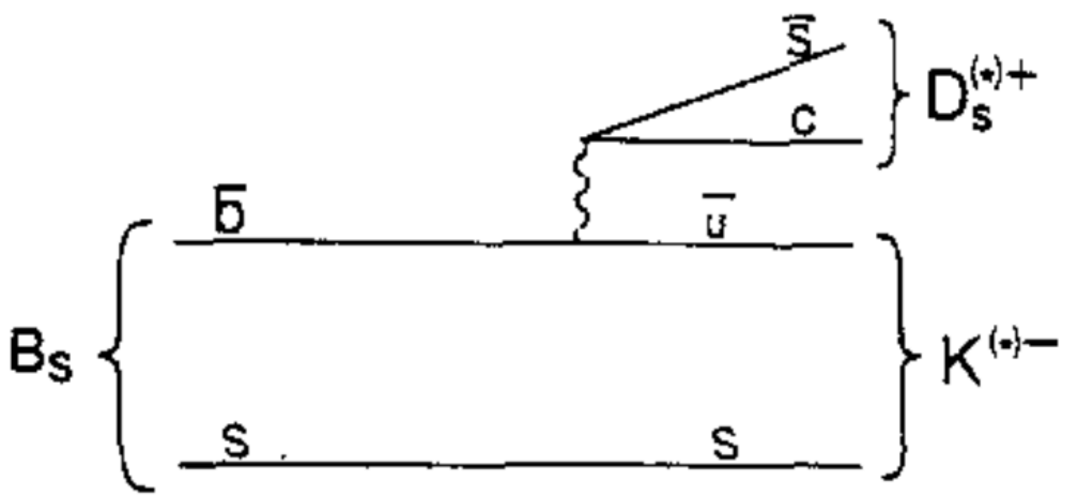
THE ANALYSIS

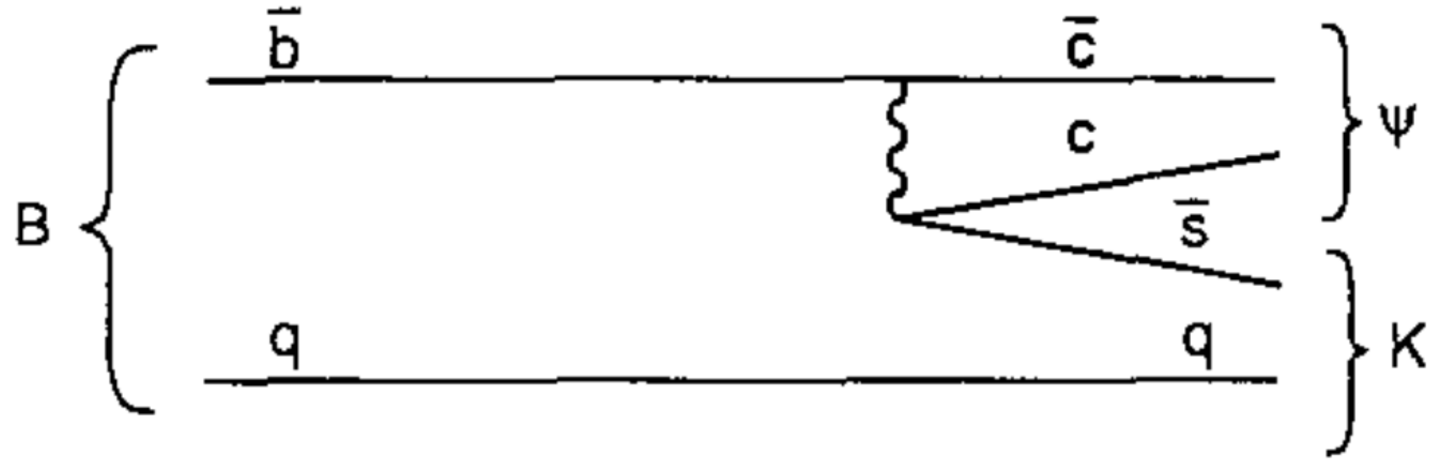
Study the decays:

1. $B^0_s \to D^{\pm}_s K^{\mp}$
2. $B_s \to J/\psi\ \varphi$

with the final objective (for the *fast-sim*) to estimate $\varphi = \gamma_{CKM} + \gamma_{ds} - 2\beta_s$ and $2\beta_s$







With 75 (310) billions of B^0_s (B^0) a statistical precision of 0.4° on γ (3.4° x 10^{-2} on β_s) is expected and can be compared with the present measurements…

$$\gamma = (72.1^{+4.1}_{-4.5})^\circ \qquad 2\beta_s = 0.051 \pm 0.023$$

$$2\beta_s = 0.0383^{+0.0012}_{-0.0011}$$

To be tested against a very precise SM prediction

2021 PLAN

Familiarise with the software k4SimDelphes

Reproduce and develop the many results already presented in the meetings

Simulate the signal decay chain and produce the necessary datasets

Perform a preliminary analysis on the *fast-sim* to understand the behaviour of the two channels