Central Exclusive Production (CEP) of J/ψ at LHCb

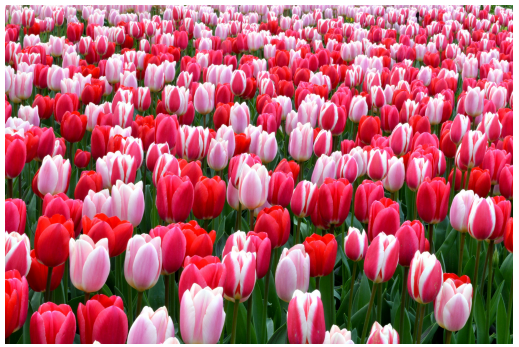
Pieter Braat
pieter.julius.braat@cern.ch

Supervisors:
Patrick Koppenburg
Cristina Sánchez Gras

August 7, 2018

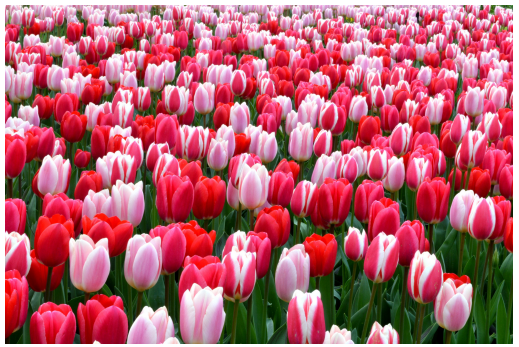
About me

- Amsterdam, the Netherlands
- Physics and Astronomy bachelor at University of Amsterdam
- UvA GRAPPA master in September
- LHCb this summer



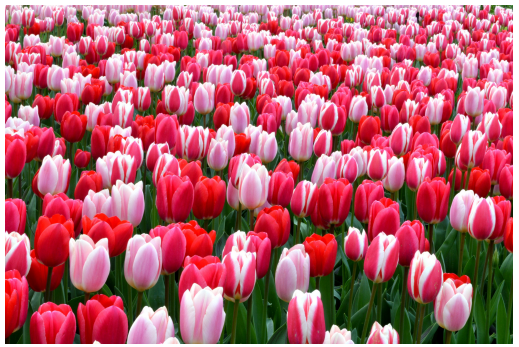
About me

- Amsterdam, the Netherlands
- Physics and Astronomy bachelor at University of Amsterdam
- UvA GRAPPA master in September
- LHCb this summer



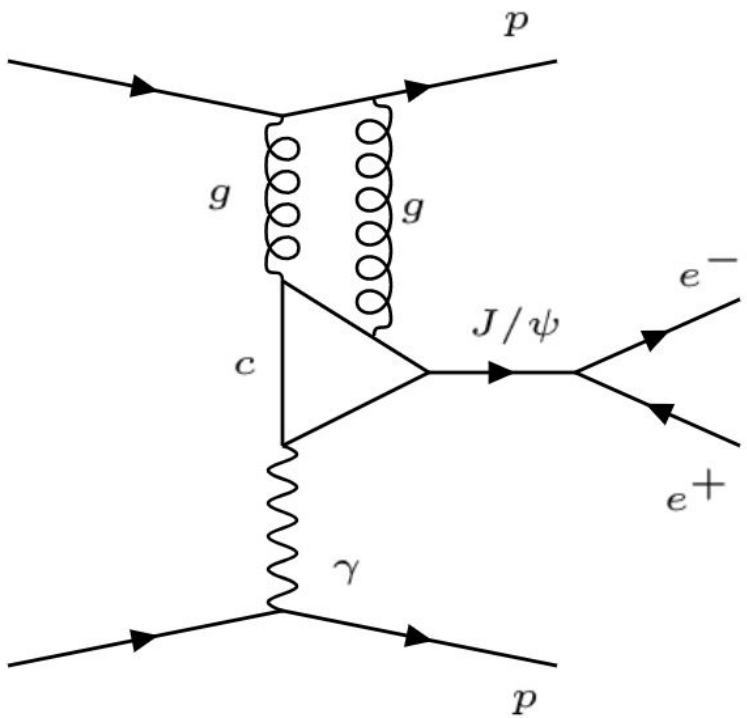
About me

- Amsterdam, the Netherlands
- Physics and Astronomy bachelor at University of Amsterdam
- UvA GRAPPA master in September
- LHCb this summer



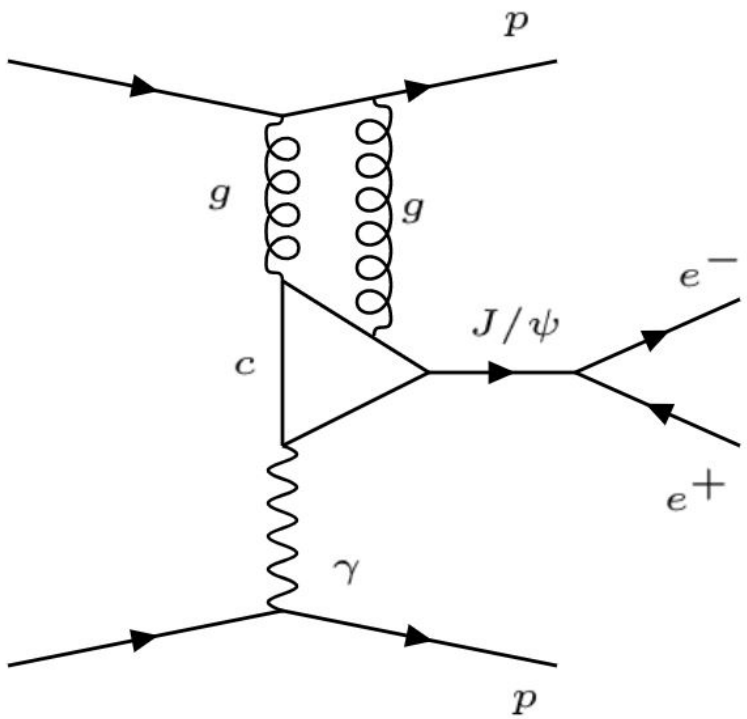
Goal of this research

- Understand electron reconstruction using $J/\psi \to ee$ cross section measurement in CEP



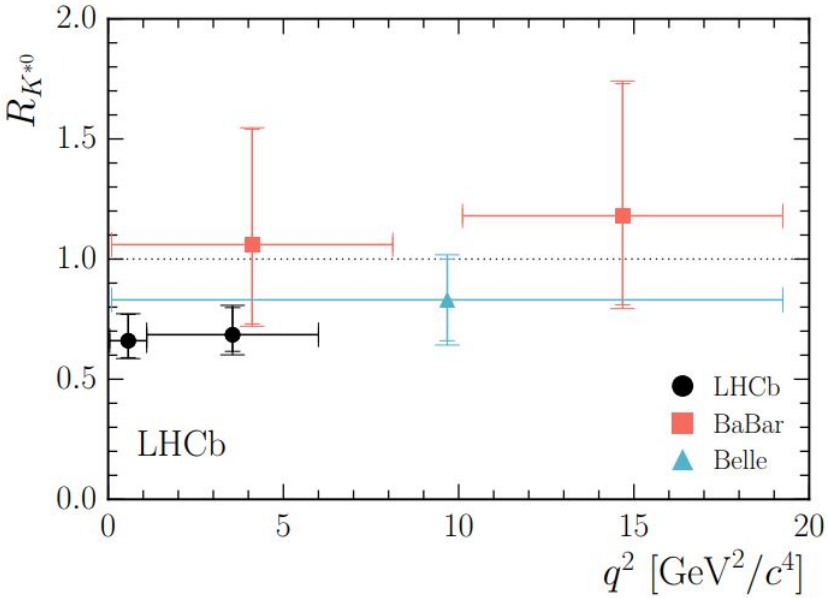
Goal of this research

- Understand electron reconstruction using $J/\psi \to ee$ cross section measurement in CEP
- $J/\psi \to \mu\mu$ has recently been measured:
  $\sigma_{J/\psi \to \mu\mu} = 399 \pm 10 \pm 10 \pm 16$ pb
  (arXiv:1806.04079)
- We expect this to be the same for $J/\psi \to ee$

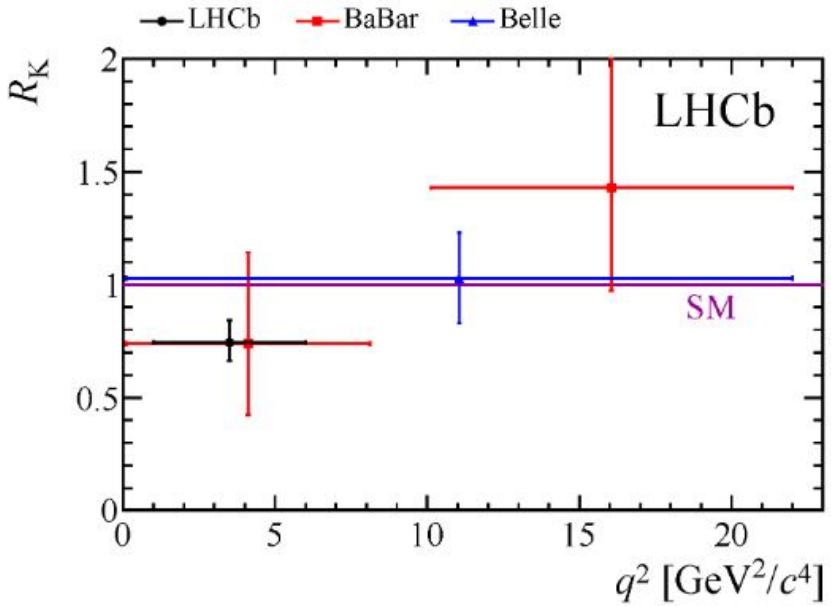


Motivation: Lepton flavour universality violation

- Recent hints of lepton flavour universality violation found in the $B^* \to K^{*0}\ell\ell$ and $B^+ \to K^+\ell\ell$ channels



arXiv:1705.05802
JHEP 08 (2017) 055



arXiv:1406.6482
PRL. 113, 151601 (2014)

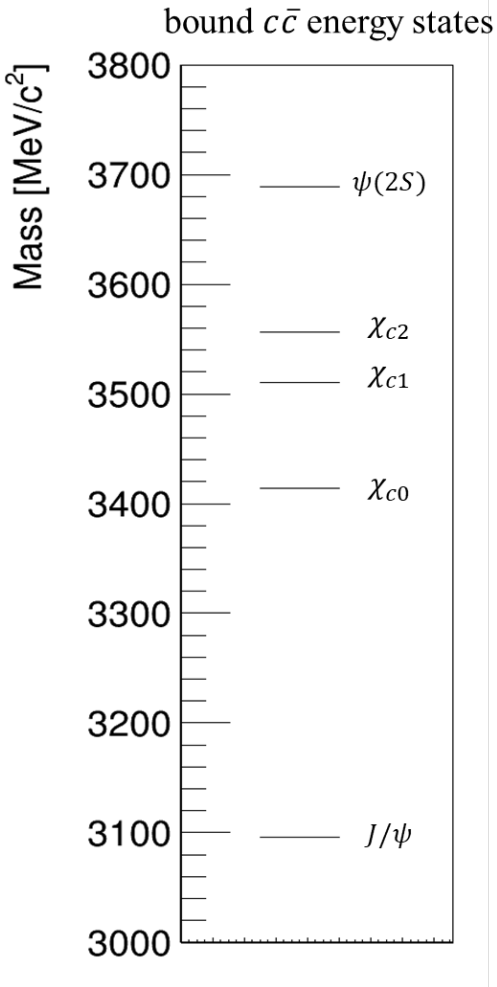
$$R_{K^{(*0)}} = \frac{\Gamma(B^{+(*)} \to K^{+(*0)}\mu\mu)}{\Gamma(B^{+(*)} \to K^{+(*0)}ee)}$$

My research: feed down from χ_c

- Sometimes feed down from $\chi_c \to J/\psi\ \gamma$
- This γ can be mistaken for Bremsstrahlung, throwing off the reconstructed mass of the J/ψ

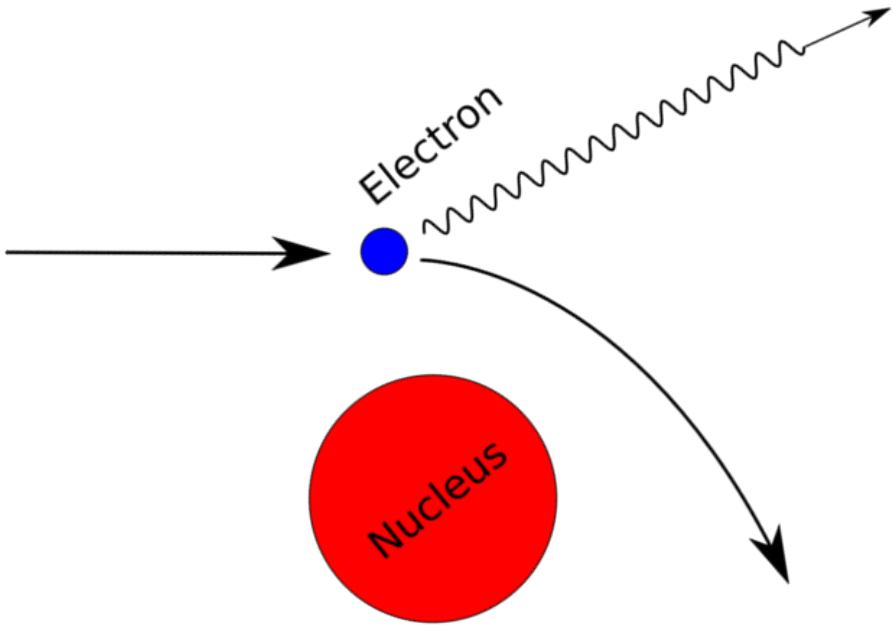
Branching ratios

χ_c	$\Gamma(\chi_c \to J/\psi\ \gamma)$
χ_{c0}	1.30 %
χ_{c1}	33.9 %
χ_{c2}	19.0 %



Short recap: Bremsstrahlung

- Bremsstrahlung: deflection of electron trajectory by atoms, causing electron to radiate photons and lose energy
- This complicates the electron reconstruction

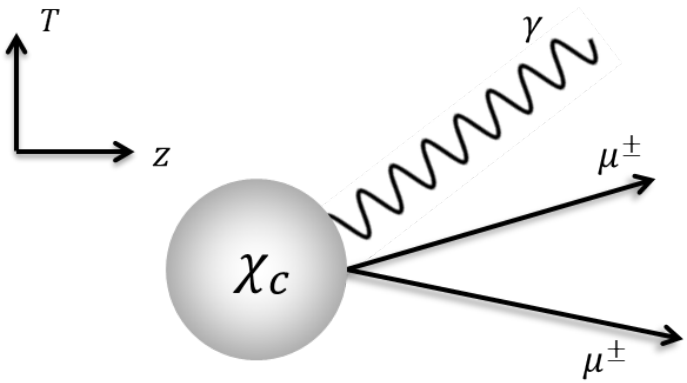


Method

- Use MC data of $\chi_c \to J/\psi\ (\to \mu\mu) + \gamma$ to study spatial distribution of the photon wrt the daughter particles ($\mu\mu$ or ee)

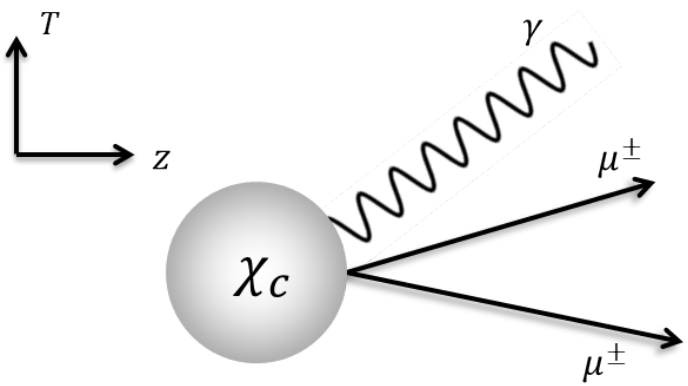
Method

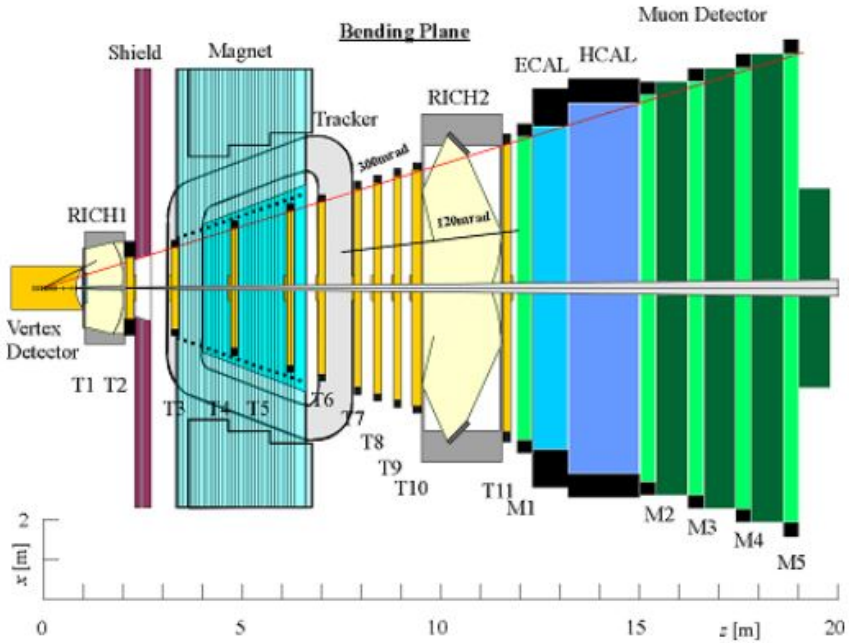
- Use MC data of $\chi_c \to J/\psi\ (\to \mu\mu) + \gamma$ to study spatial distribution of the photon wrt the daughter particles ($\mu\mu$ or ee)
- Muon with the closest angle to the photon is chosen as the muon of interest



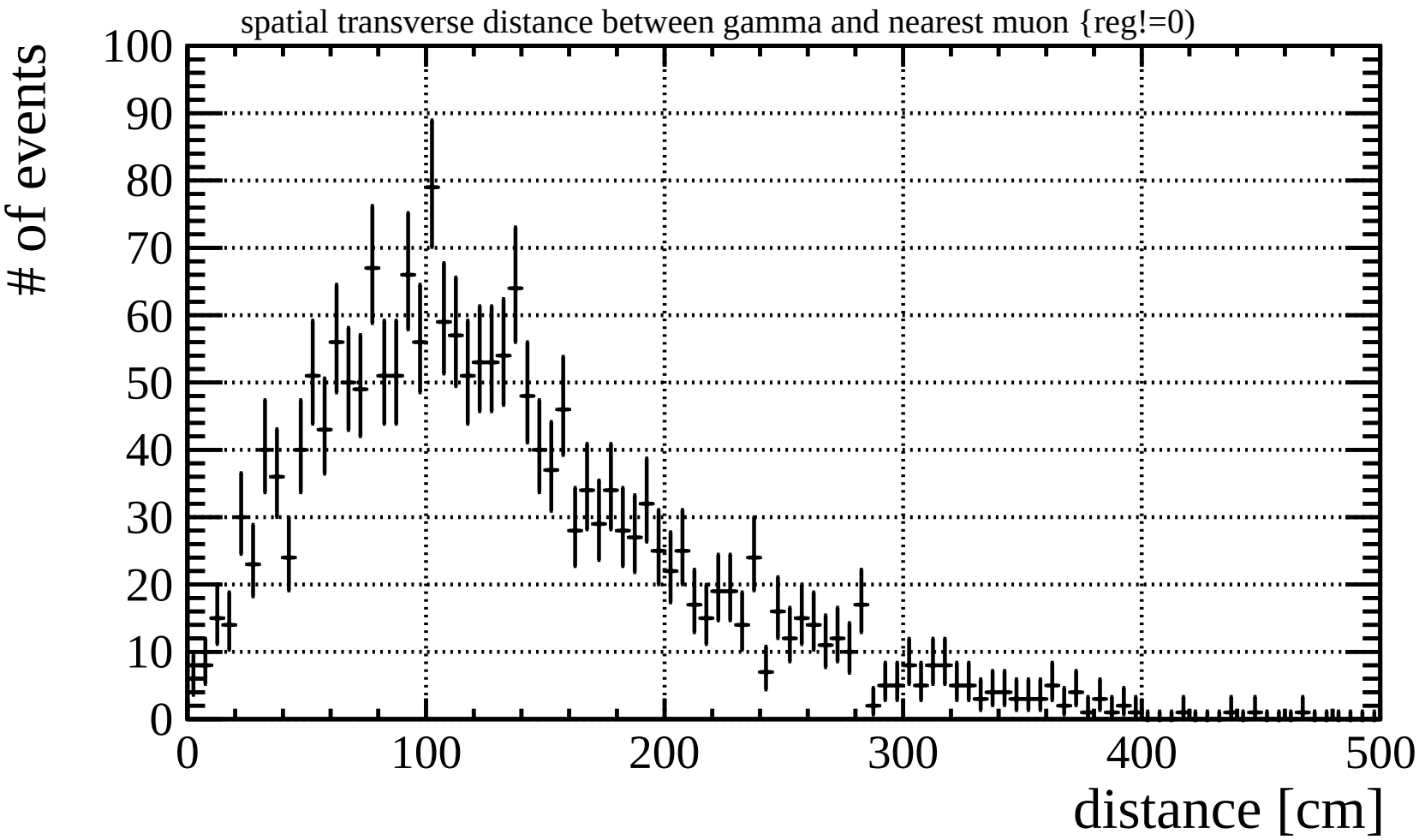
Method

- Use MC data of $\chi_c \to J/\psi\ (\to \mu\mu) + \gamma$ to study spatial distribution of the photon wrt the daughter particles ($\mu\mu$ or ee)
- Muon with the closest angle to the photon is chosen as the muon of interest
- Distance between muon and photon on the Ecal (where the Bremsstrahlung reconstruction happens) is calculated



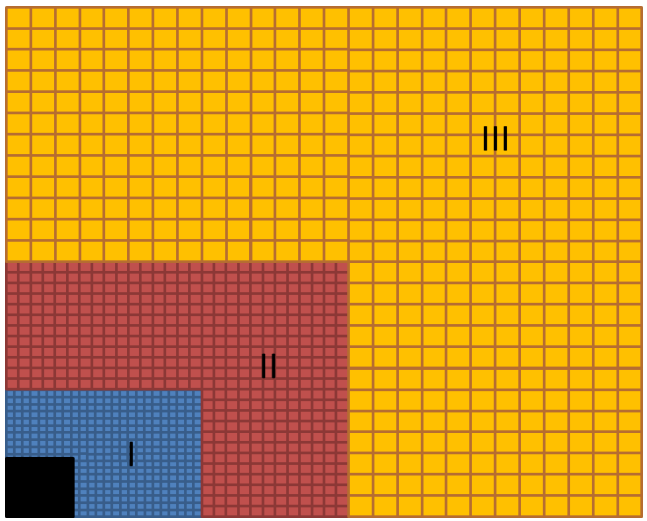


Results: spatial transverse distance distribution



Ecal structure

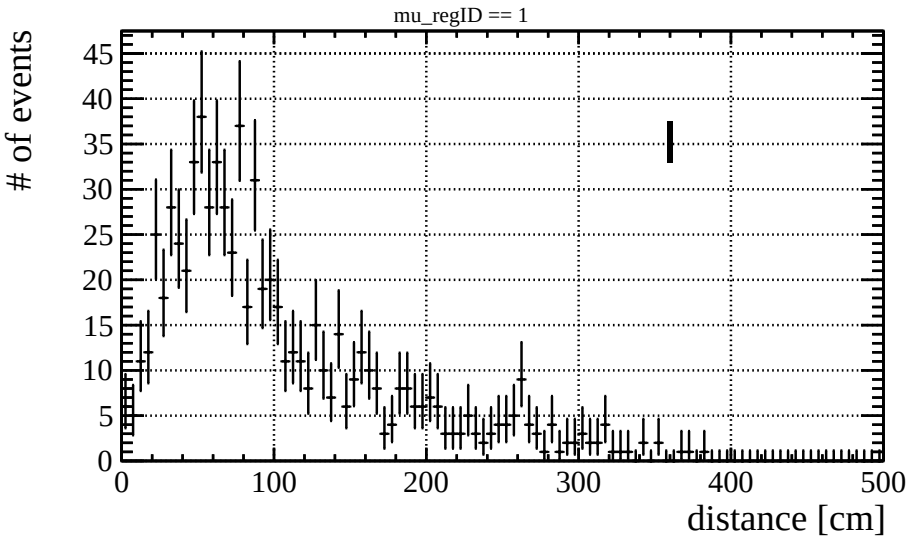
- Ecal is not isotropic: three different regions in Ecal with different cell and cluster sizes

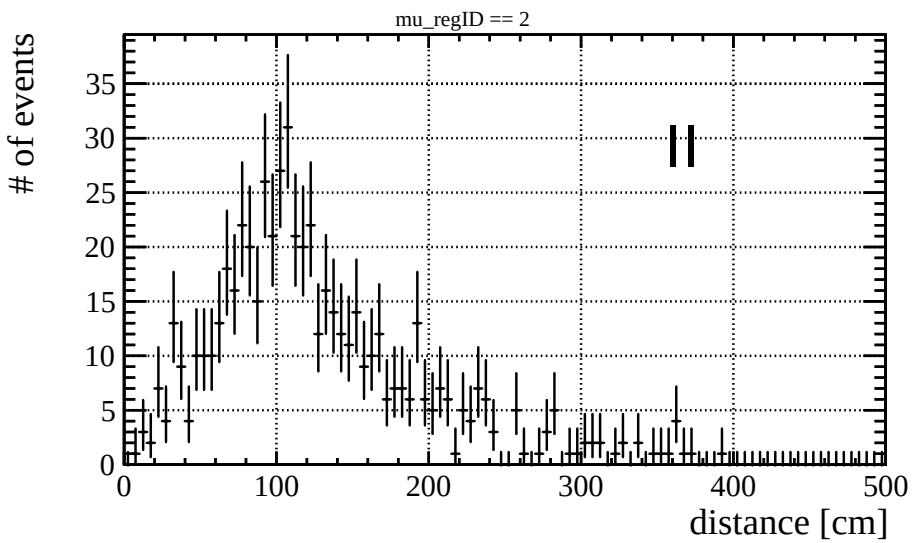


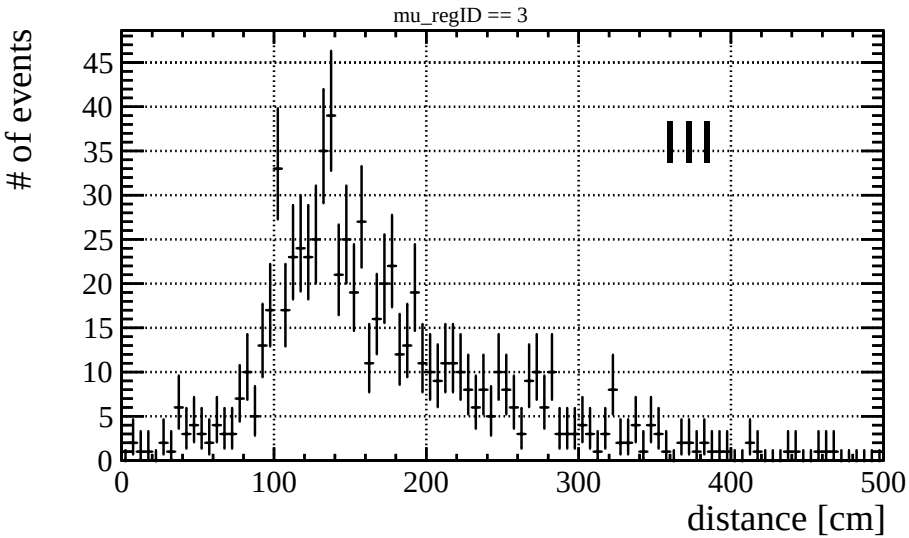
Ecal cell sizes

region	cell size (cm^2)	cluster size (cm^2)
I	4.04 x 4.04	12.12 x 12.12
II	6.06 x 6.06	18.18 x 18.18
III	12.12 x 12.12	36.36 x 36.36

Results: Ecal structure







Ecal cluster sizes

region	cluster size (cm^2)
I	12.12 x 12.12
II	18.18 x 18.18
III	36.36 x 36.36

Summary

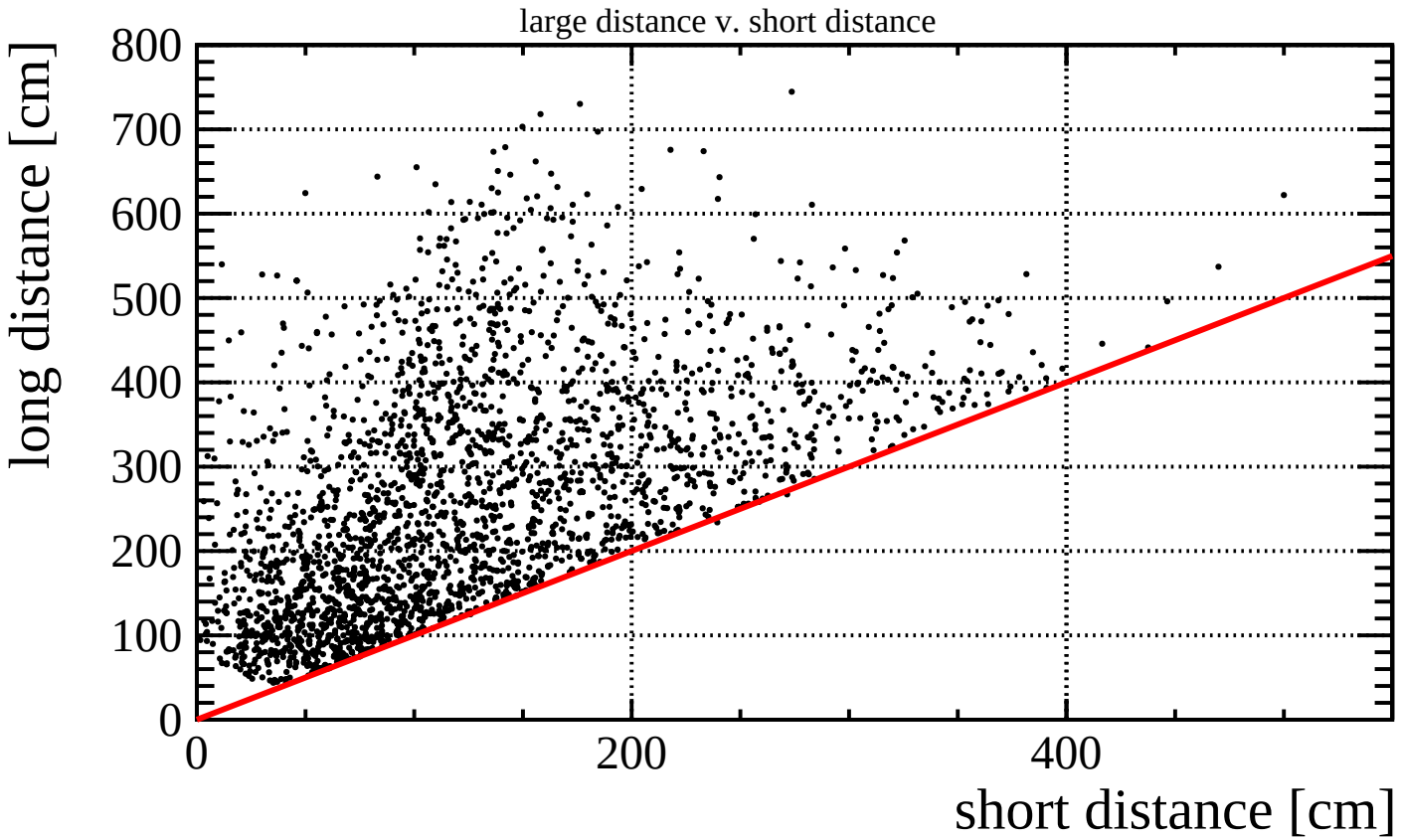
- CEP J/ψ production as control channel for lepton flavour universality (clean channel and no new physics expected)
- Feed down signal from $\chi_c \to J/\psi\ \gamma$ production, where γ can be mistaken for Bremsstrahlung photon
- Small contribution of χ_c in each of the Ecal regions ($< 5\%$)

Summary

- CEP J/ψ production as control channel for lepton flavour universality (clean channel and no new physics expected)
- Feed down signal from $\chi_c \to J/\psi\ \gamma$ production, where γ can be mistaken for Bremsstrahlung photon
- Small contribution of χ_c in each of the Ecal regions ($< 5\%$)

- Next up:
  - Look at Bremsstrahlung reconstruction using $J/\psi \to ee$ MC data
    - Infer spatial distribution on Ecal and quantify contribution of χ_c
  - Look at $J/\psi \to ee$ data, continue the work of Alvaro Loya Villalpando

BACK UP

Muon identification check

- Muon selection is based on angle between muon and photon
- This figure shows the calculated distance for the closest muon ('short distance') and the furthest out muon ('long distance')