Communications
Light Mesons (LM), Charmonium (CC) and Charmonium-like Exotics (CCE) PWG

Frank Nerling, Marc Pelizaeus
GU Frankfurt / GSI Darmstadt, U Bochum

Communications

Phase One Paper

- Drafting during lecture week
  - CCE: Xscan

Dedicated CCE paper

- Precision energy scan measurements using the example X(3872)
  - Extension and completion of release:

    → Today's talk by Klaus Goetzen et al.

List of ongoing & planned analyses

- Status of ongoing analyses?
- List of proposed channels on wiki page
  - CCE: Discussion on prioritised list with theorists
  - Input from their side to strengthen physics cases

  => Lets internally complete this list / the lists

Ongoing Analyses

CCE:

- X(3872) → $Z^{\pm}(3730)\pi^{-/+}$ (L.Bianchi et al., FZJ)
  - FullSim studies started/ongoing
  - Nothing yet released (prod. numbers, summarised in IN)
- Zc(3900) production and decays into pbar d (A.Blinov et al., INP)
  - FullSim studies started
  - On hold since a year, nothing yet released
- X(3872) → DDbar decays (M.Barabanov et al., JINR)
  - FullSim studies started/ongoing,
  - Nothing yet released
- X(3872) energy scan (K.Götzen et al., GSI)
  - FullSim studies completed
  - ✓ Released

Ongoing Analyses

CCE ctnd:

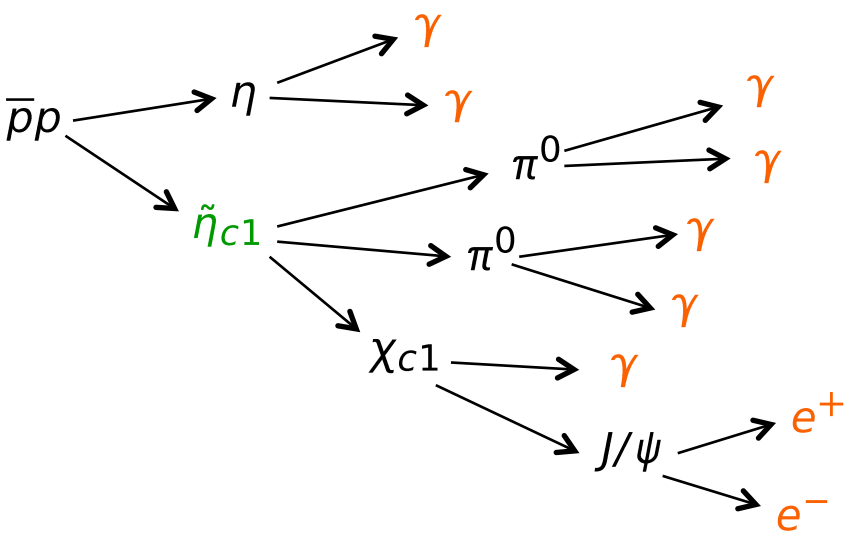
- ppbar → $\eta_{c1}\eta$, with η_{c1} → $\chi_{c1}\ \pi^0\ \pi^0$ (Markus Moritz, U Giessen)
  - Charmonium hybrid state
  - Studied for old performance report and fastSim (KG)
    - *A good channel showing importance of fully equipped EMC*
  - FullSim studies to be started

    (inline with needs of extending the fastSim studies to fullSim)
  - Confirmation by Markus?

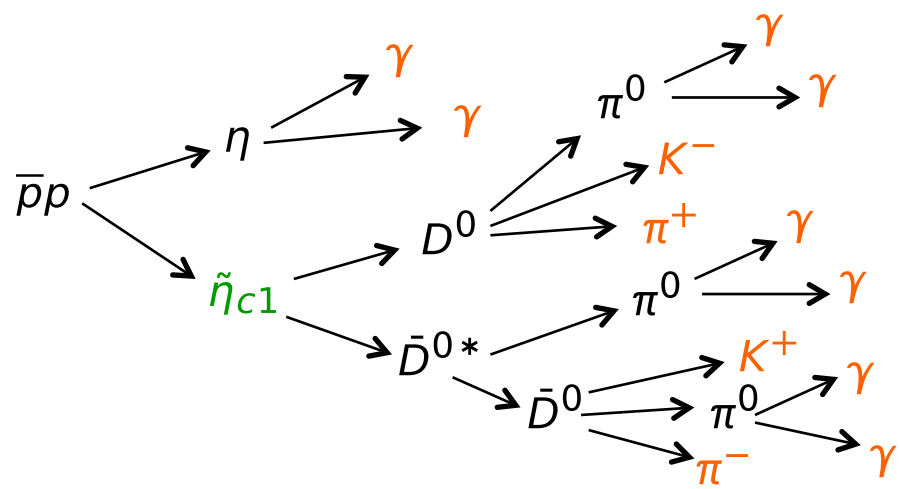
Charmonium Hybrid Candidate $\tilde{\eta}_{c1}$

- From LQCD calculations:
  Spin-exotic hybrid candidate $\tilde{\eta}_{c1}$ with $m \approx 4.3\,\mathrm{GeV}/c^2$, $J^{PC} = 1^{-+}$
- Exclusive reconstruction in two favoured channels:

$$\bar{p}p \to \tilde{\eta}_{c1}\,\eta \to \chi_{c1}\pi^0\pi^0\eta$$



$$\bar{p}p \to \tilde{\eta}_{c1}\,\eta \to D^0\bar{D}^{0*}\eta$$



- Production X-section assumed similar to $\bar{p}p \to \psi(2S)\,\eta$ (33pb)
  → *Need good calorimetry + good particle identification*

Ongoing Analyses

CC:

- $\psi(^3D_2) \rightarrow \gamma\chi_{c1}\ \pi^{-/+} \rightarrow \gamma\gamma J/\psi$ (Z.Liu, U Mainz))
  - D wave charmonium states (X(3823))
  - Sim studies started/ongoing
  - FullSim studies started/ongoing
  - First draft of a release note since a while

List of ongoing/planned analyses

Open Charm Physics

Channel(s)	Measurement	sqrt(s)/Beam momentum	Analyzer	Institute	Reference	Wiki link	Status	Phase	Priority	Comment
psi' -> D+ D-, D+- -> K pi pi	reco quality of D+-	3.770 GeV	NN, for STT TDR	FZ Jülich	TDR		completed	-	-	
pp -> DsJ(2317) Ds, DsJ(2317) -> Ds pi0	Width of state	4.268 GeV	Marius C. Mertens, Elisabetta Prencipe	FZ Jülich	Thesis		in progress with full simulations	3	MED	Unique for PANDA
Ds -> e nu pi/eta/eta'	form factors, V_cd, V_cs	various	LuCao	FZ Jülich	PhD Thesis		in progress	3	LOW	Complex
pp -> D+ D- (K pi pi), non-res.	x-sec of reactions	various	Andreas Herten, NN	FZ Jülich	PhD Thesis		to be followed up	1	HIGH	
ppbar-> D0 Dbar -> exclusive/inclusive	x-sec of reactions	various	Alexandros Apostolou	KVI-CART	PhD Thesis		in progress	1	HIGH	
ppbar -> Lambda_c Lambda_c_bar -> Lambda pi0 pi+ ...	x-sec of reactions	various	Solmaz Vejdani	KVI-CART	PhD Thesis		in progress	2,3	LOW	
ppbar -> D0(->gg/mu+mu-gamma) D0bar	new physics	6.596 GeV/c	Donghee Kang	Mainz	Internal report		completed	3	-	

Edit

More ideas, plans?

List of ongoing/planned analyses

Charmonium-like Exotics

X(3872) -> J/psi rho	width of state	3.872 GeV	Tsitohaina Randriamalala	FZ Jülich	Thesis	done			
X(3872) -> J/psi pi+ pi-	width of state	3.872 GeV	Martin Galuska	U Gießen		done			
X(3872) -> J/psi pi+ pi- / D0 D0b	line shape, structure of state	3.872 GeV	Tobias Weber	HI Mainz		done			
pp -> Y(4260) -> J/psi (->ll) pi+ pi-	angular dist., decay model	4.260 GeV	Elisa Fioravanti	INFN Ferrara	PhysBook	done			
X(3872)->J/psi pi+ pi-	mass, width, line shape	3.872 GeV	Klaus Goetzen et al.	GSI Darmstadt	https://panda.gsi.de/system/files/user_uploads/k.goetzen/RN-QCD-2016-002.pdf	released	1	HIGH	Success will depend on actually cross section
pp -> Y(4260, 4350, 4660,..) -> J/psi (->ll) pi+ pi- or J/psi (->ll) pi0 pi0	Y(4260, 4350, 4660,..) -> DD\bar and their possible combinations as D* D\bar or D D*\bar		Mikhail Barabanov et al.	JINR Dubna		in progress			
charmonium-like exotics			Mikhail Barabanov et al.	JINR Dubna		planned			
pp -> X(3872) -> chi_c1 pi+ pi-	search for Z(3730) -> chi_c1 pi+	3.872 GeV	Ludovico Bianchi	FZ Juelich		in progress			
pd -> Z_c p	Z_c on deuteron target		Alexander Blinov	Dubna		in progress			

More ideas, plans?

List of ongoing/planned analyses

Light Mesons and Exotics

Channel(s)	Measurement	sqrt(s)/Beam momentum	Analyzer	Institute	Reference	Wiki link	Status	Phase	Priority	Comment
pbar p --> phi 3pi, phi 4pi	hybrid candidate X(2175)	3.75 GeV /c	NN				not assigned (fastsim finished; Ch. Motzko)	1	MED	
pbar p --> phi phi energy scan	broad tensor states (PWA)	1.5 to 2 GeV /c	NN				not assigned	1	HIGH	
pbar p --> phi phi pi0	glueball production / PWA	3.75 and 15 GeV /c	NN				not assigned (fastsim finished, M. Albrecht)	1	MED	
pbar p --> K K pi0	glueball production / PWA	3.75 and 15 GeV /c	NN				not assigned (fastsim finished, T. Schroeder)	1	MED	
pbar p --> K K pi0 pi0	glueball production / PWA	3.75 and 15 GeV /c	NN				not assigned	1	LOW	
pbar p --> 4pi	a1(1420) in pbar p / PWA	1.64 GeV /c	NN				not assigned	1	MED	

Edit

More ideas, plans?

Summary

- Only a few analyses ongoing ....
  - Still the staged journal publication plan towards Physics Book
- Common central DPM bkgd mass production started, very efficient
- Need more channels being analysed in fullSim, also better coverage of the 3 physics topics

Charmonium-like Exotics at PANDA in view of "phase-1" paper -- Summary

Charmonium-like exotics at PANDA

- uniquely gluon-rich process: ppbar
  → *high cross section for states with gluonic excitations / exotics*
- unique in precise measurement of widths
  → *sub-MeV range, needed to understand X,Y,Z nature*
- unique in discovery potential for high spins:
  → *no angular momentum barrier (and no restriction spin)*

=> Only PANDA will enable to explore complete multiplets and clarify nature of X,Y,Z

Possible Topics for Early Physics Beam

- X(3872) energy scan (results released)
- X(3872) → $Z^{\pm}(3730)\pi^{-/+}$ (under work)
- Zc(3900) production and decays into pbar d (on hold, to be resumed)
- X(3872) → DDbar decays (first studies started)

=> Depending on timeline, manpower/focus to be strengthened

Charmonium-like Exotics PWG

Who we are:

- Univ. Bochum
  - M.Pelizaeus
- GSI Darmstadt
  - K.Götzen, R.Kliemt, F.Nerling
- JINR Dubna
  - M.Barabanov, A.Luchinsky, A.Zinchenko
- INFN Ferrara
  - E.Fioravanti (on hold)
- Univ. Giessen
  - M.Galuska, S.Lange, tbc
- FZ Jülich
  - E.Prencipe, tbc (on hold for a few month)
- HI Mainz
  - T.Weber (left), others tbc
- BINP Novosibirsk
  - A.Blinov

Charmonium-like Exotics PWG

Who we are:

- Univ. Bochum
  - M.Pelizaeus
- GSI Darmstadt
  - K.Götzen, R.Kliemt, F.Nerling
- JINR Dubna
  - M.Barabanov, A.Luchinsky, A.Zinchenko, tbc
- INFN Ferrara
  - E.Fioravanti
- Univ. Giessen
  - M.Galuska, S.Lange, tbc
- FZ Jülich
  - E.Prencipe, tbc
- HI Mainz
  - T.Weber, tbc
- BINP Novosibirsk
  - A.Blinov, tbc

Charmonium-like Exotics PWG

- Univ. Bochum
  - Study for spin-exotic charmonium hybrid η_{c1}, further channels (PANDA Phys. Perf. Report)
  - Very quick, first look to kinematics at PANDA for Zc(4430)
- GSI Darmstadt
  - Scrutiny studies for X,Y,Z (feasibilty for various charmonia and recoils)
  - X(3872) resonance energy scan (width, lineshapes)
- JNR Dubna
  - PandaRoot QA checks
  - EvtGen modelling for X(3872)
- INFN Ferrara
  - Scrutiny studies for X(3872)
- Univ. Giessen
  - X(3872) resonance energy scan (width)
  - Search for Zc(3730) at PANDA
- FZ Jülich
  - Y(4260) first studies (also Giessen)
  - Search for Zc(3730) at PANDA
- HI Mainz
  - X(3872) resonance energy scan (trial to extract lineshape, importance of precise lumi)
- BINP Novosibirsk
  - Study of pbar d → Z^- p, with additional recoil proton detector
  - Search for Zc(3730) at PANDA (also Jülich)