University of Glasgow

VIA VERITAS VITA

Physics Programme of PANDA at FAIR

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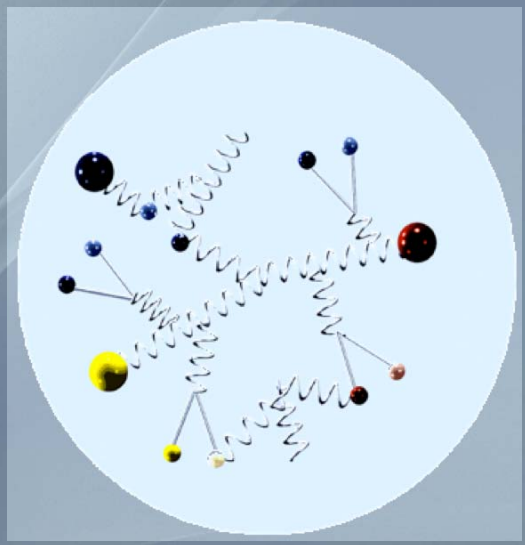
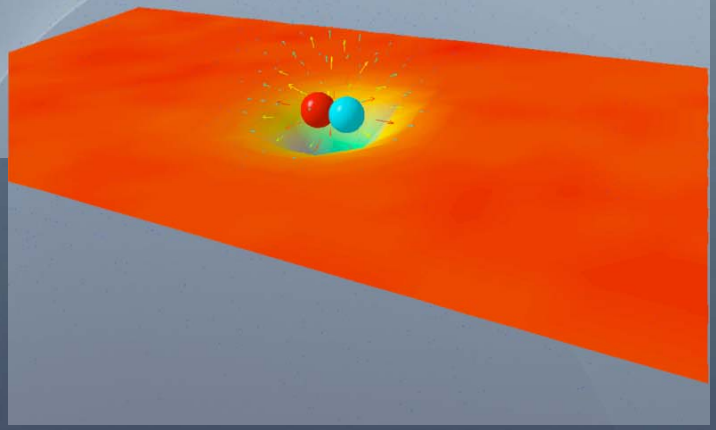
University of Glasgow
For the PANDA Collaboration

10 November 2008
PANIC08, Eilat

Open QCD Questions

- Generation of hadron masses
- Strong interaction at large distances
- Spin puzzle
- Multi-quark systems





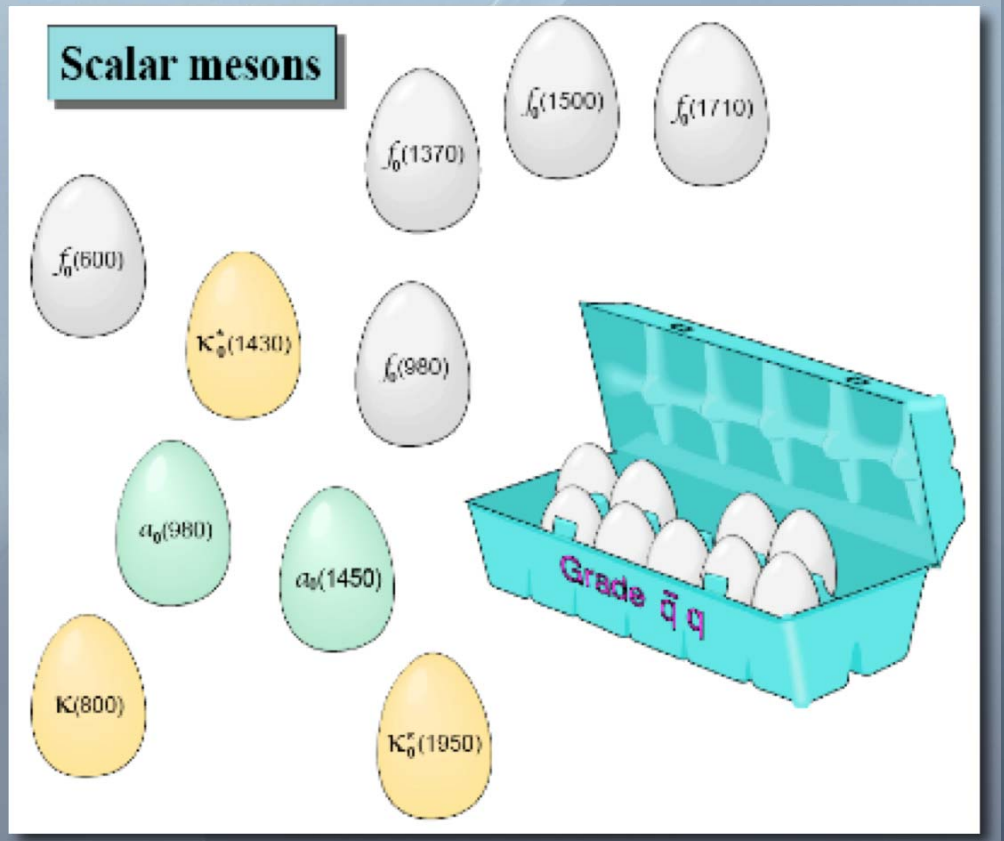
(flux tube animation by D. Leinweber et al.)

Example: Overpopulation

- Light quark sector
  - 7 candidates for 4 states with 0^{++}

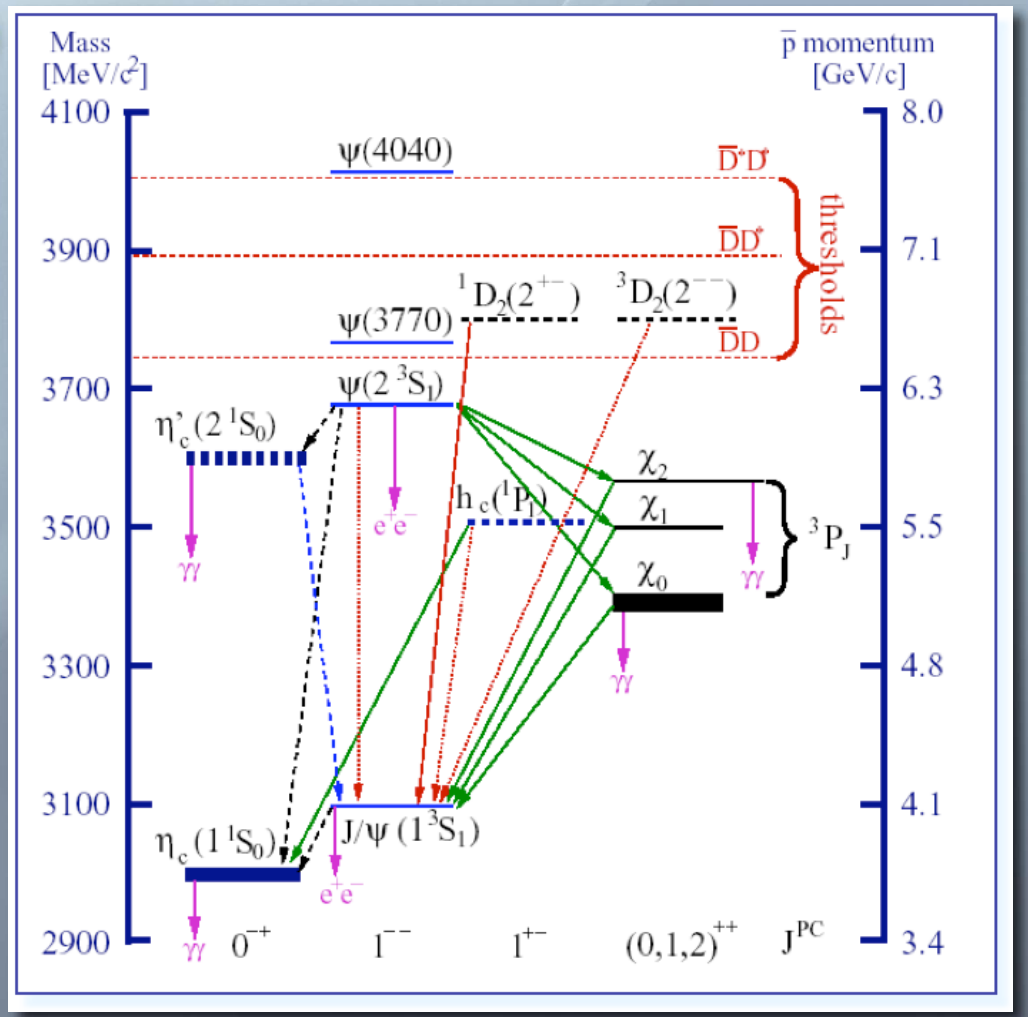
2^{++}	a_2 1320	f_2 1270	f'_2 1525	K^*_2 1430
1^{++}	a_1 1260	f_1 1285	f'_1 1510	K_{1A}
1^{+-}	b_1 1235	h_1 1170	h'_1 1380	K_{1B}
0^{++}	a_0	f_0	f_0	K^*_0 1430
	$a_0(980)$ $a_0(1450)$	$f_0(1370)$ $f_0(1500)$	$f_0(980)$ $f_0(1710)$	

L = 1



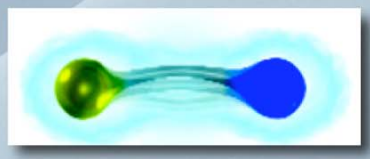
Topics for Investigation

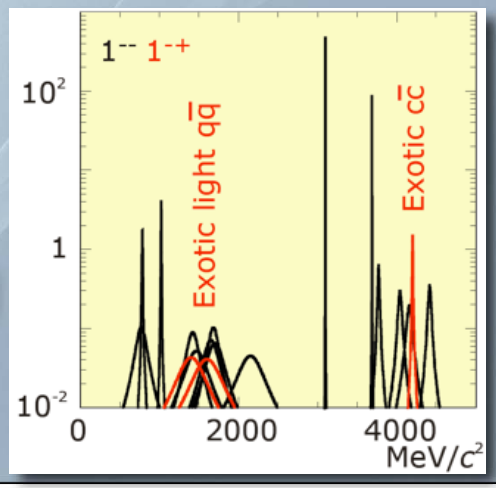
- Charmonium States
  - Positronium of QCD
  - Narrow states
  - Transition region
    - Light - heavy quark
  - Spectrum NOT well understood
    - Findings at B-factories
    - Discussion on interpretation

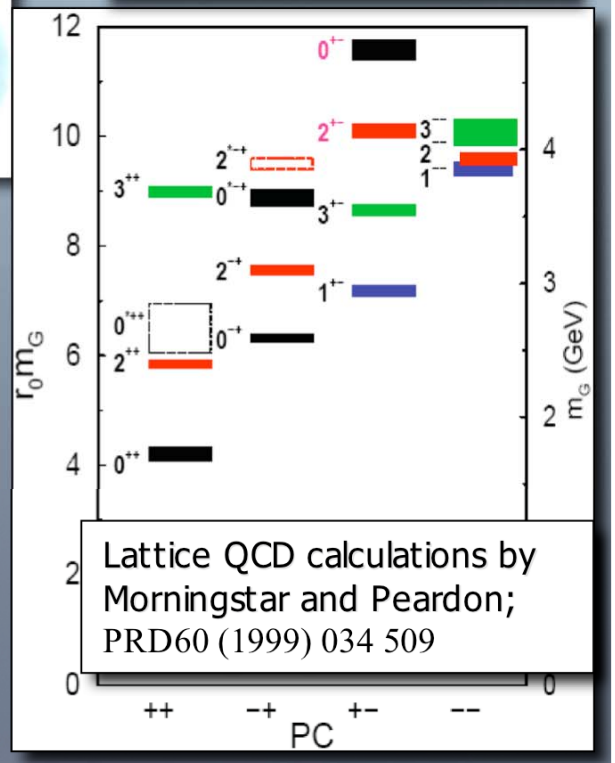


Topics for Investigation

- Charmed hybrids
  - Narrow states expected
  - Exotic quantum numbers - no mixing
  - Around 4 GeV/c^2
- Glueballs above 3 GeV/c^2
  - Few mesonic states
  - Smaller width than low states
  - Less mixing
  - Exotic states around 4 GeV/c^2



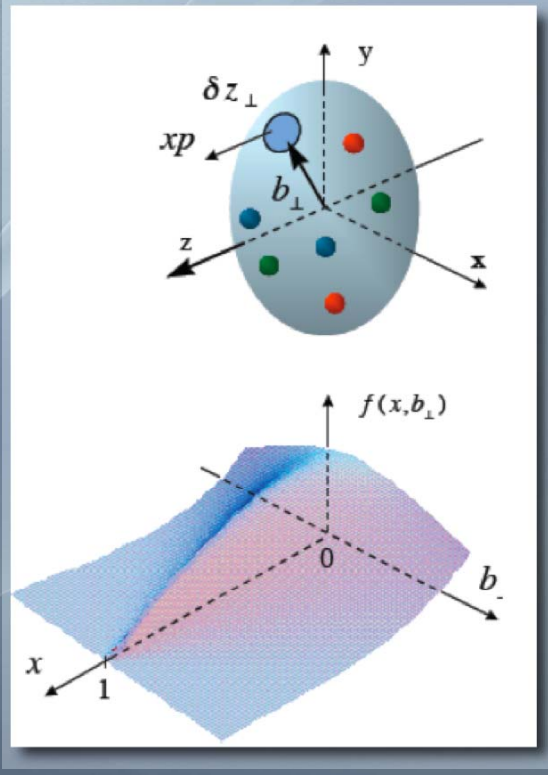


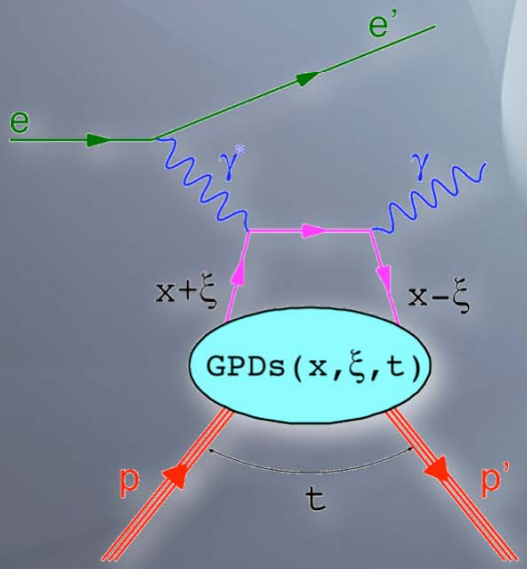


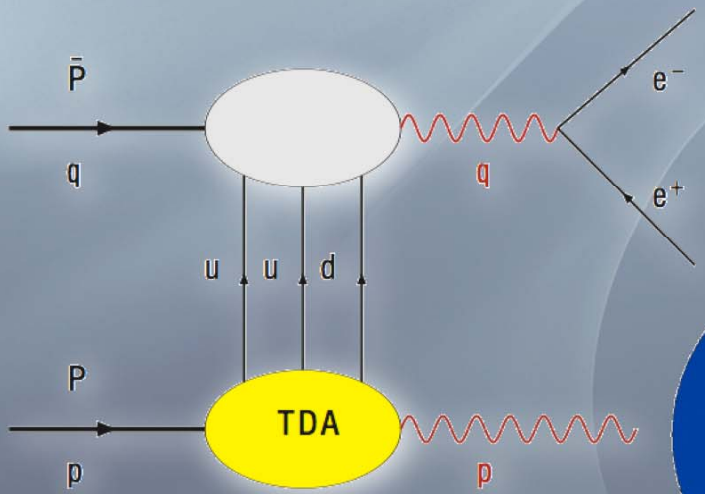
Lattice QCD calculations by Morningstar and Peardon; PRD60 (1999) 034 509

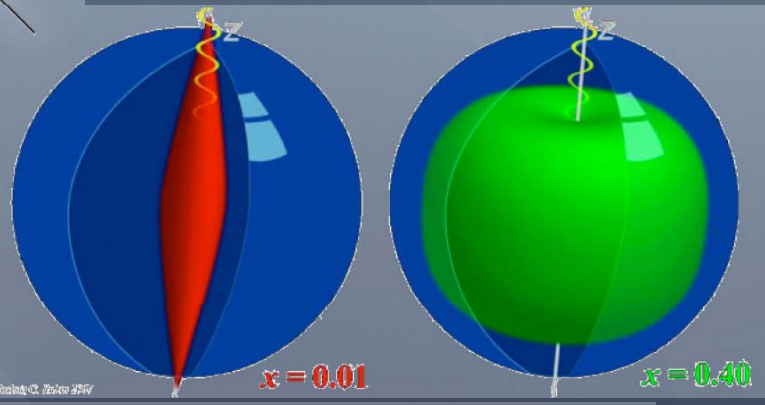
Topics for Investigation

- Nucleon Structure
  - Generalised Parton Distributions in DVCS
  - Cross channel partner in proton-antiproton annihilations





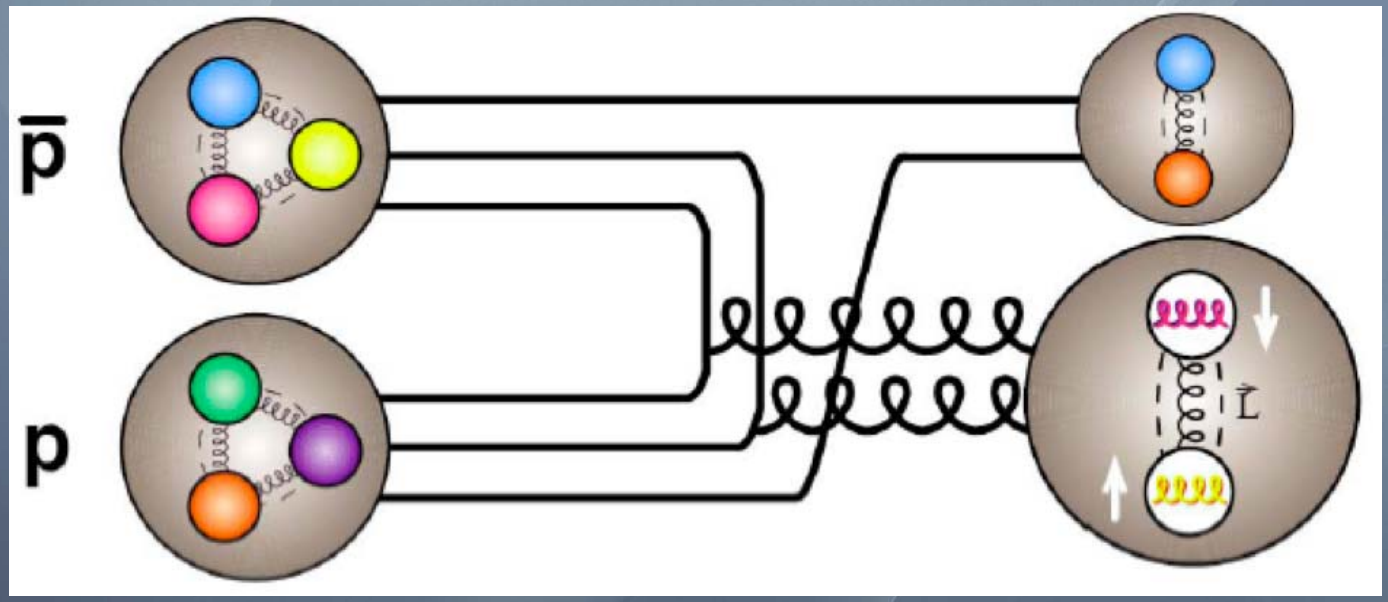




Exp. Requirements

- **Gluon-rich environment**

  ⇒ **Proton-antiproton annihilations**



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- **No restriction on quantum numbers**

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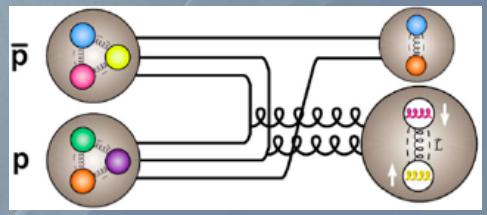

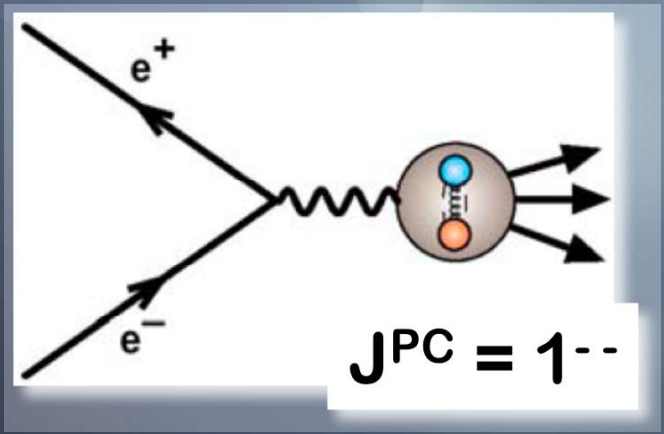

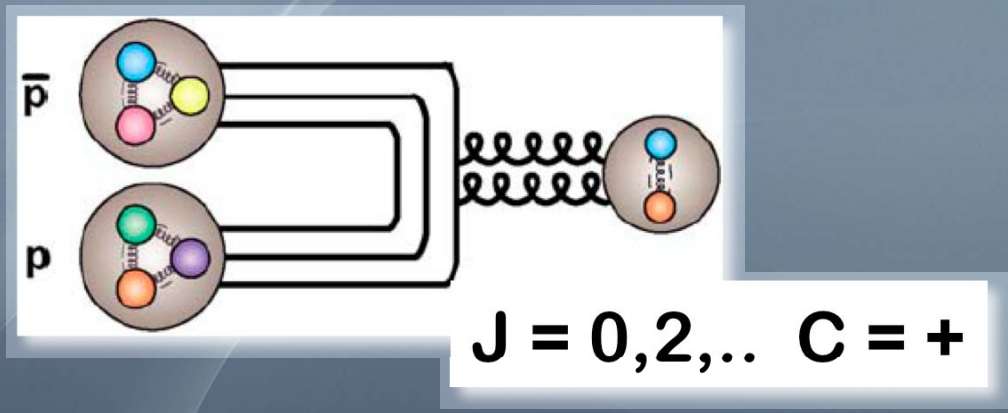

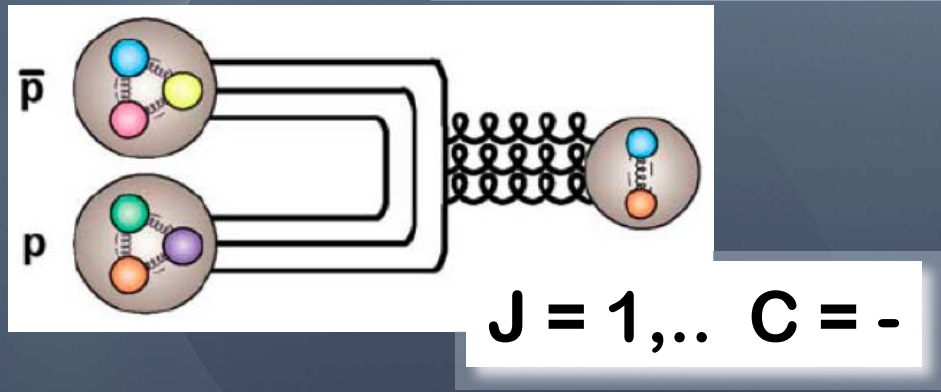

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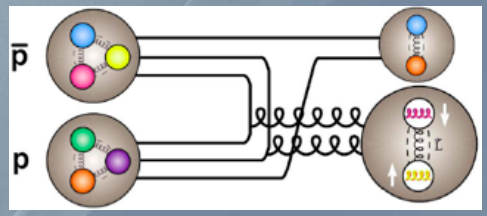
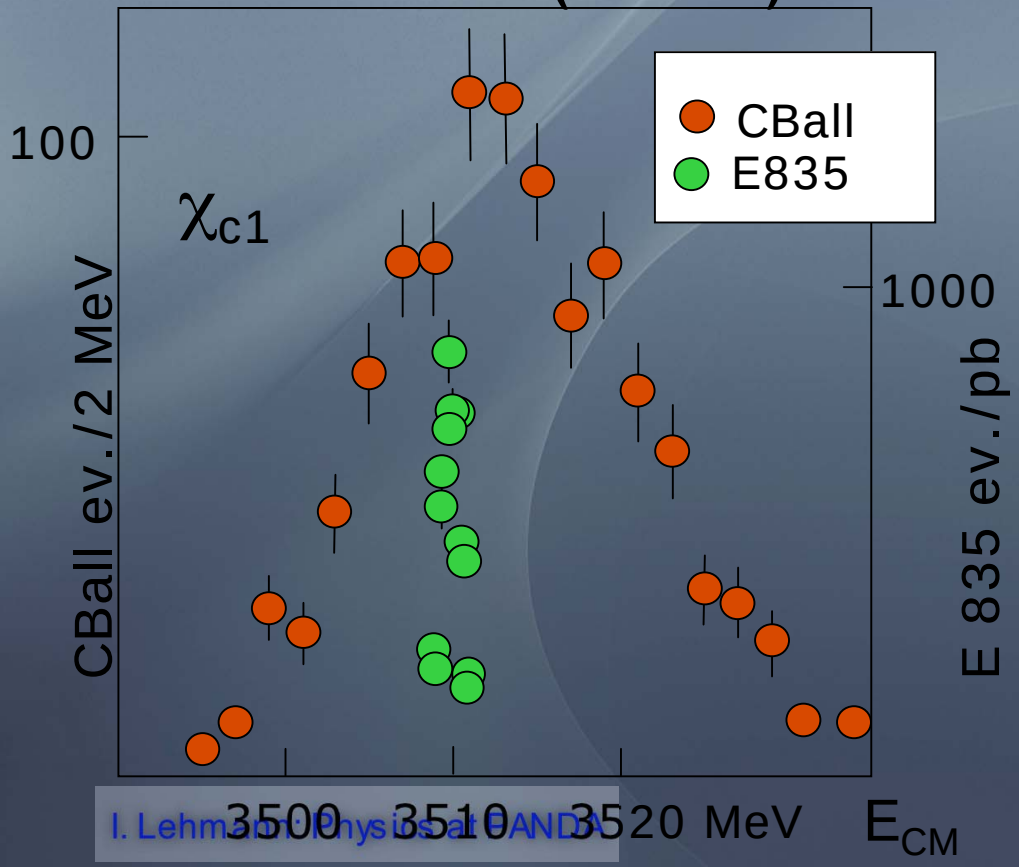
  ⇒ High precision hadron beam (cooled)





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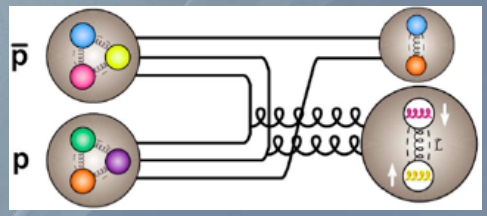
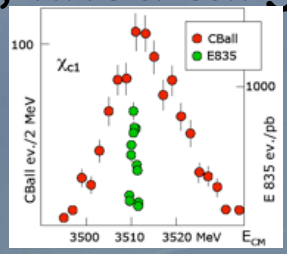
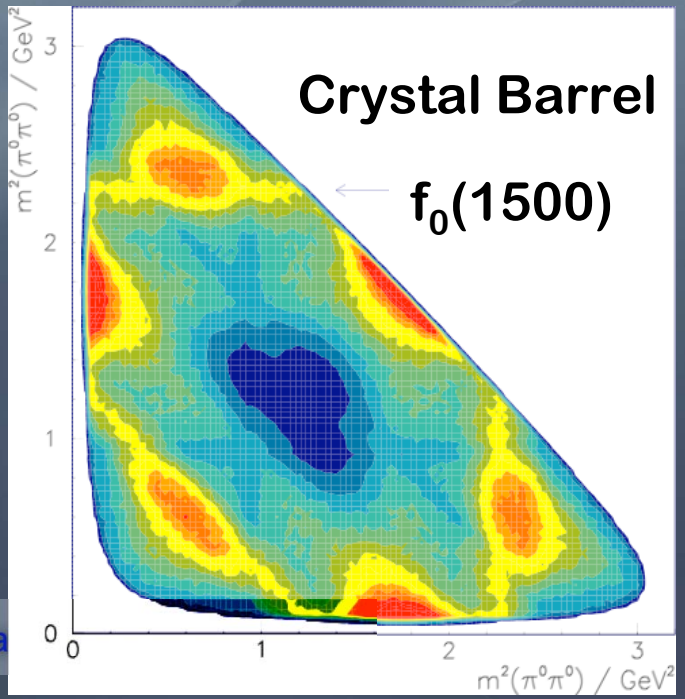
- **High statistics samples**
  - ⇒ High luminosity and production cross section







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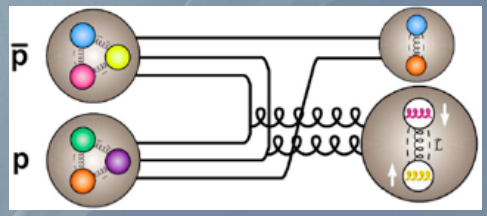
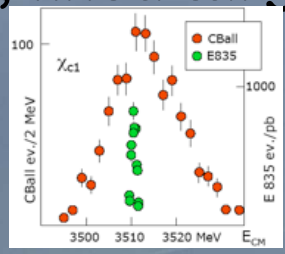
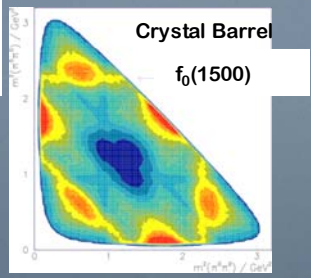
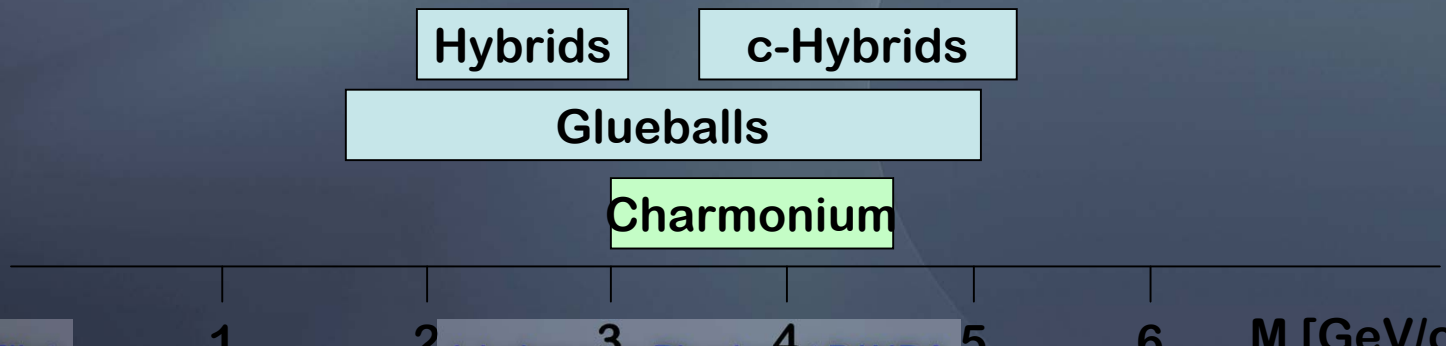
- **Physics topics**
  - ⇒ Energy range $p_{\bar{p}}$ = 1.5 - 15 GeV/c



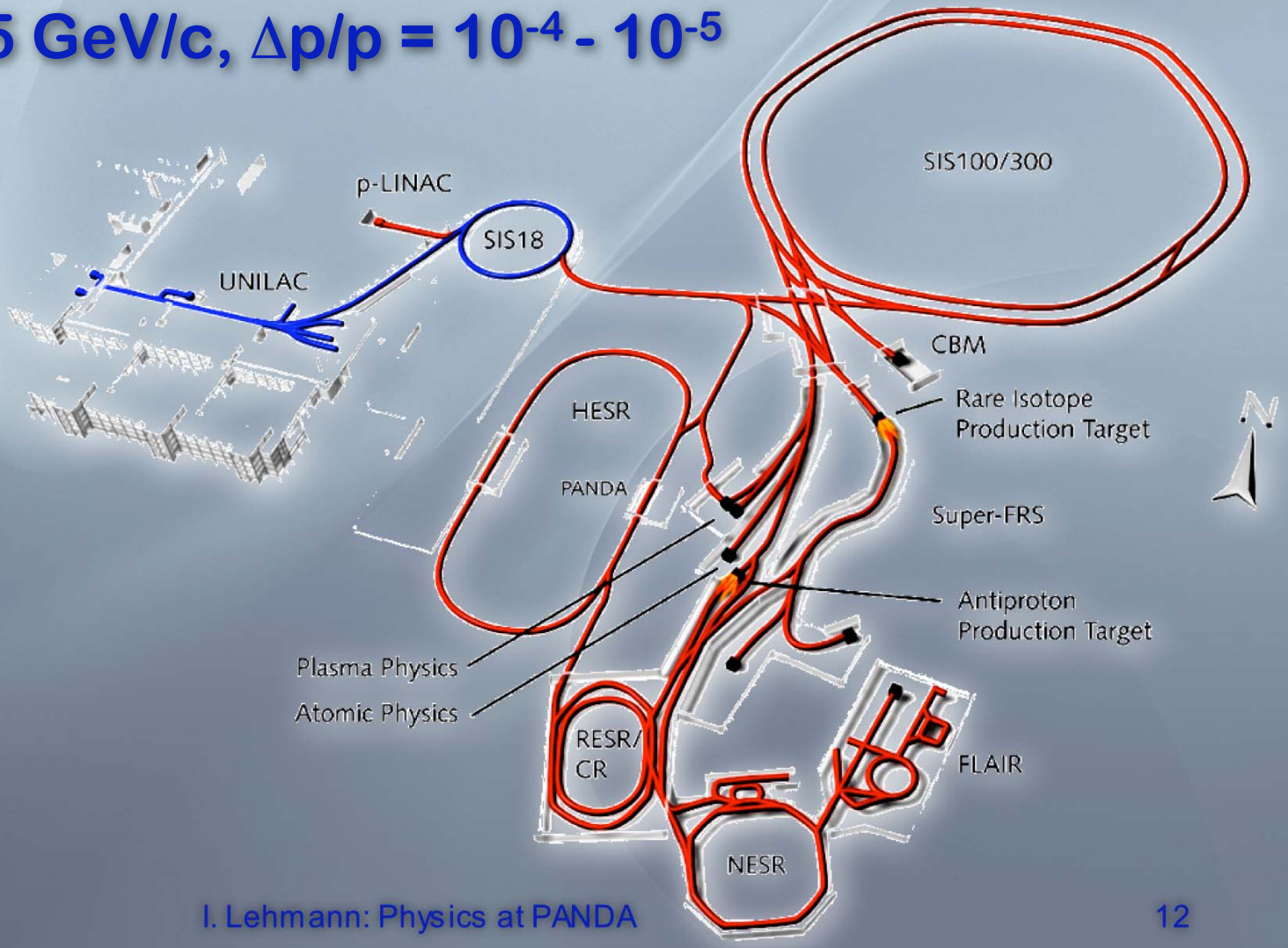






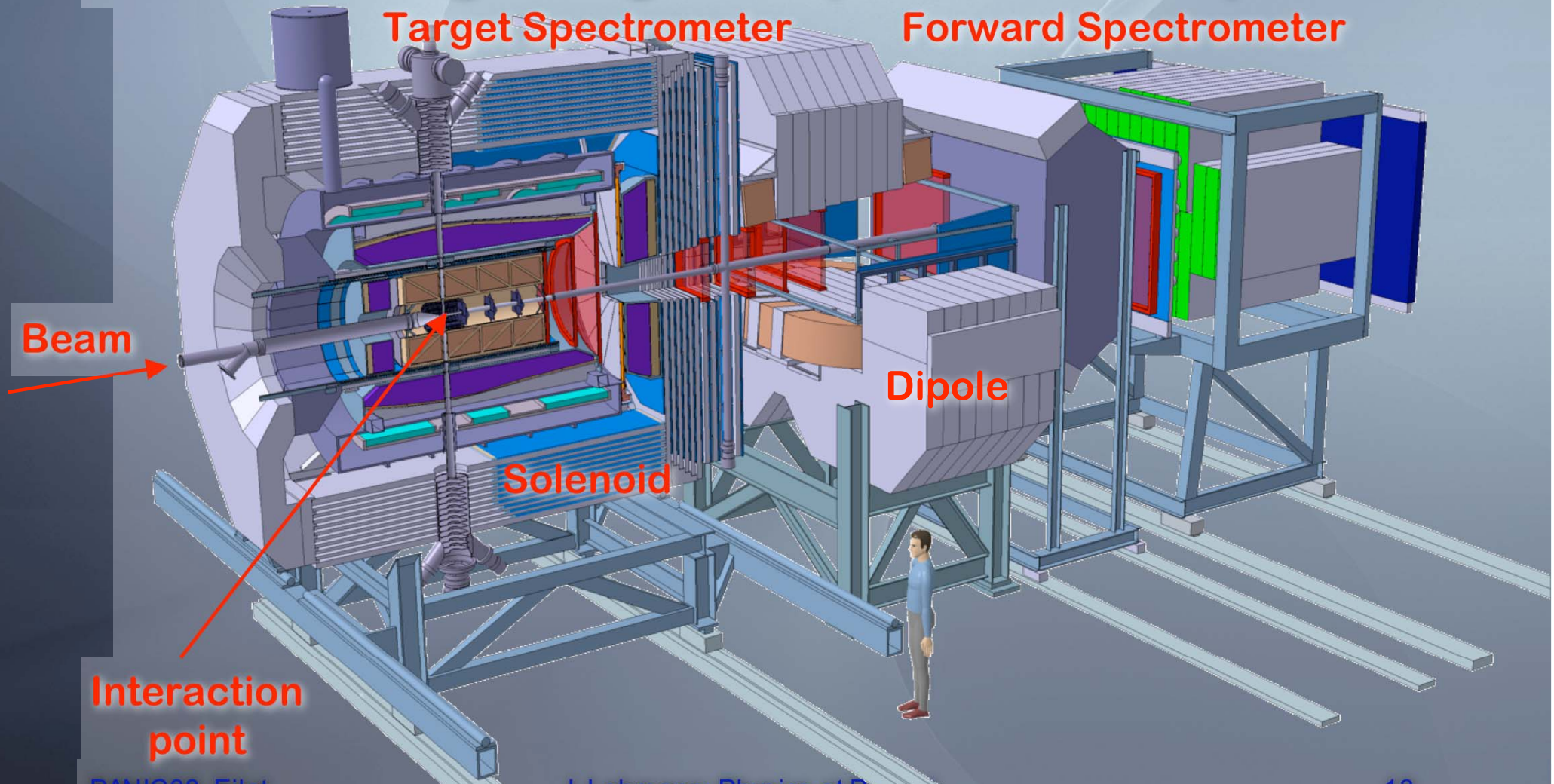
Experimental Facility

- **HESR at FAIR**
  - **Cooled antiprotons**
  - **1.5 - 15 GeV/c, $\Delta p/p = 10^{-4} - 10^{-5}$**



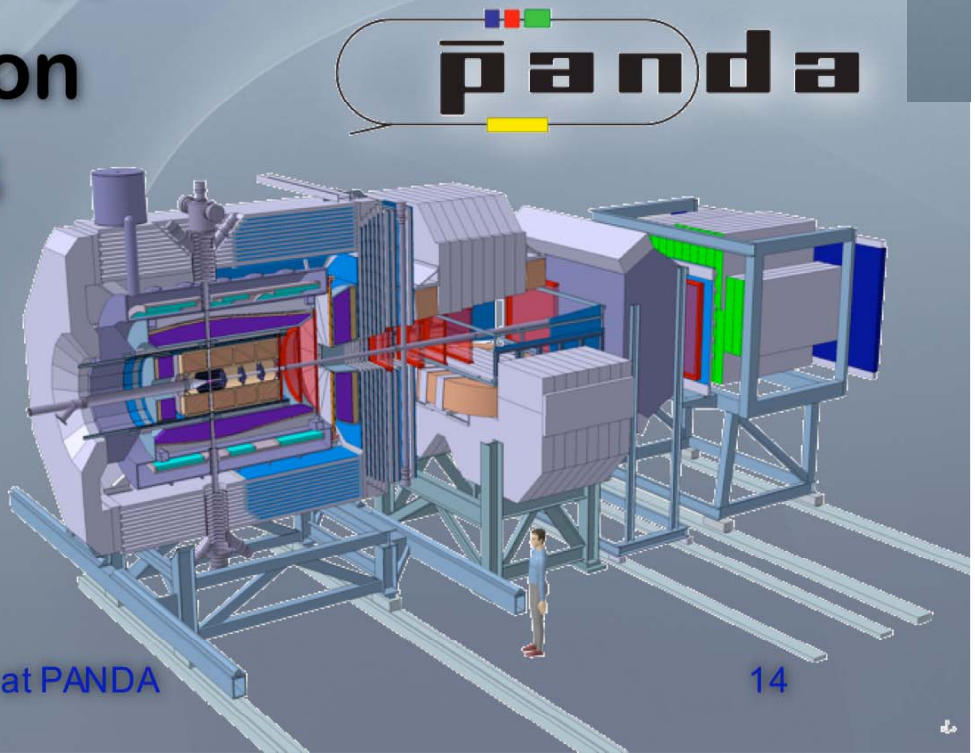
Experimental Facility

- PANDA at HESR
  - Fixed target magnetic spectrometer experiment



PANDA Physics

- Charmonium spectroscopy
- Gluonic excitations (hybrids, glueballs)
- Hadron properties in the nuclear medium
- Strange and charmed baryons
- γ-ray spectroscopy of hypernuclei
- Structure of the nucleon
  - Cross channel of DVCS
  - Time-like form factors
  - Drell Yan processes
- ...



PANDA Collaboration








16 countries, 53 institutions, ~400 scientists

U Basel
IHEP Beijing
U Bochum
IIT Bombay
U Bonn
IFIN-HH Bucharest
U & INFN Brescia
U & INFN Catania
JU Cracow
TU Cracow
IFJ PAN Cracow
GSI Darmstadt
TU Dresden
JINR Dubna
(LIT,LPP,VBLHE)
U Edinburgh
U Erlangen
NWU Evanston

U & INFN Ferrara
U Frankfurt
LNF-INFN Frascati
U & INFN Genova
U Glasgow
U Gießen
KVI Groningen
IKP Jülich I + II
U Katowice
IMP Lanzhou
U Lund
U Mainz
U Minsk
ITEP Moscow
MPEI Moscow
TU München
U Münster
BINP Novosibirsk

IPN Orsay
U & INFN Pavia
IHEP Protvino
PNPI Gatchina
U of Silesia
U Stockholm
KTH Stockholm
U & INFN Torino
Politechnico di Torino
U Piemonte Orientale,
Torino
U & INFN Trieste
U Tübingen
TSL Uppsala
U Uppsala
U Valencia
SMI Vienna
SINS Warsaw
TU Warsaw