Measurement of (Anti-) Hyperon-Nuclei/Nucleon Scattering at BESIII

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Phys. Rev. Lett. 130 (2023) 25, 251902
Phys. Rev. C 109 (2024) 5, L052201

SPICE: Strange hadrons as a Precision tool for strongly InteraCting systEms

CONTENT

Why to measure

From Hyperon to Neutron Stars

Hyperons in neutron stars

Phys.Lett.B 747 (2015) 43-47

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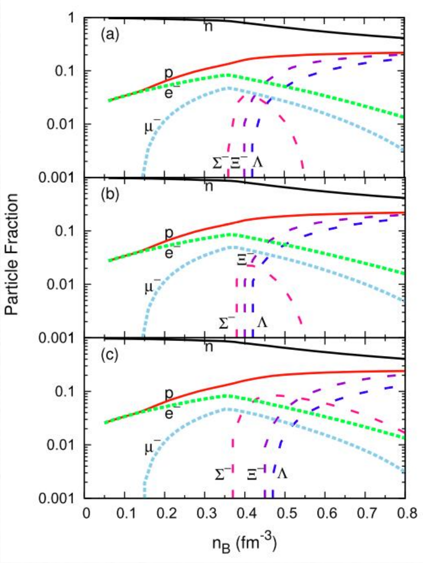
The Hyperon Puzzle in Neutron Stars

Ignazio Bombaci[1,2,3]

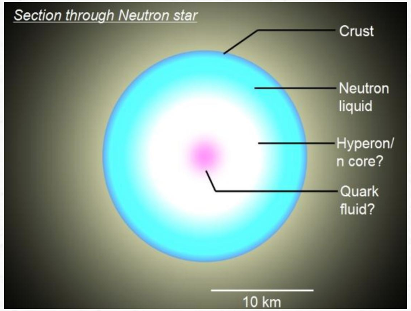
Nucl.Phys.News 31 (2021) 3, 17-21



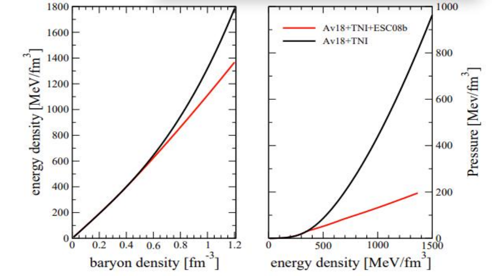
Neutron stars need hyperon! (Pauli exclusion principle)

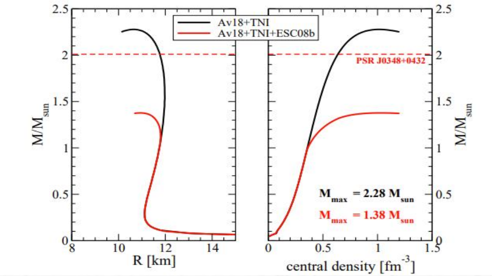
contradiction

The existence of hyperons will reduce the neutron star density. Inconsistent with observation!



Hyperon Puzzle





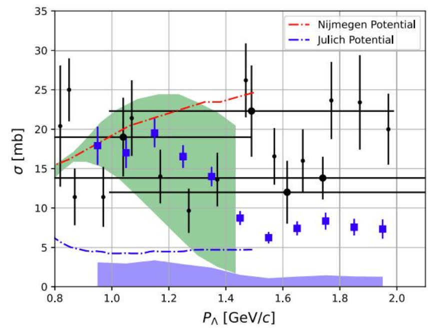
Hyperon-nucleon Interaction

The Hyperon Puzzle in Neutron Stars

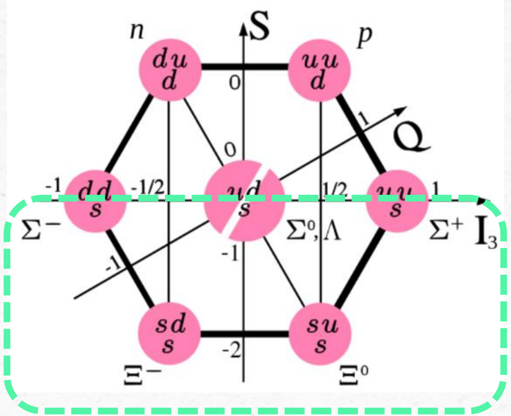
Ignazio Bombaci[1,2,3]

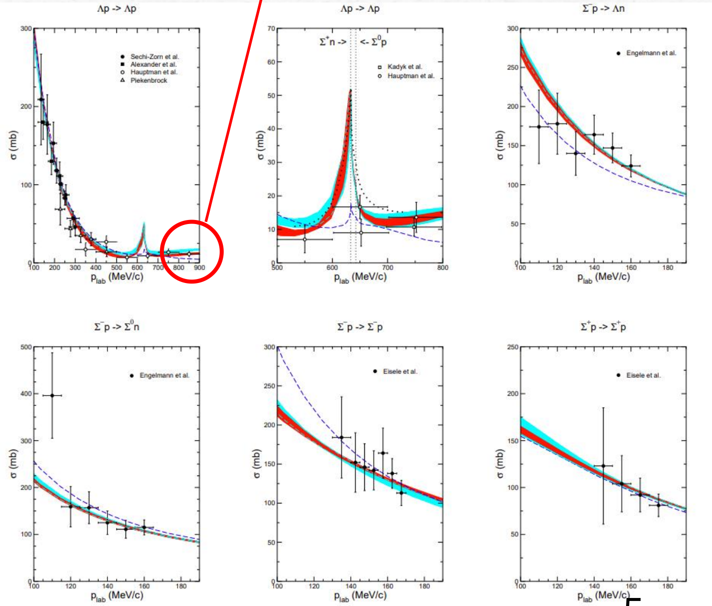
Nucl.Phys.News 31 (2021) 3, 17-21

Clearly, one should try to trace back the origin of this problem to the underlying YN and YY two-body interactions or to conceivable hyperonic three-body interactions (YTBIs) of the type YNN, YYN and YYY. Unfortunately, these two- and three-body strangeness $S \neq 0$ baryonic interactions are rather uncertain and poorly known. Basically this is due to the scarce amount of experimental data and to the considerable difficulties in their theoretical analysis. This situation is in sharp contrast to the case of the NN interaction, which is satisfactorily well known mostly due to the large number of NN scattering data and to the huge amount of measured properties of stable and unstable nuclei. The study



The vast majority of experiments came from fixed-target experiments before the 1980s.

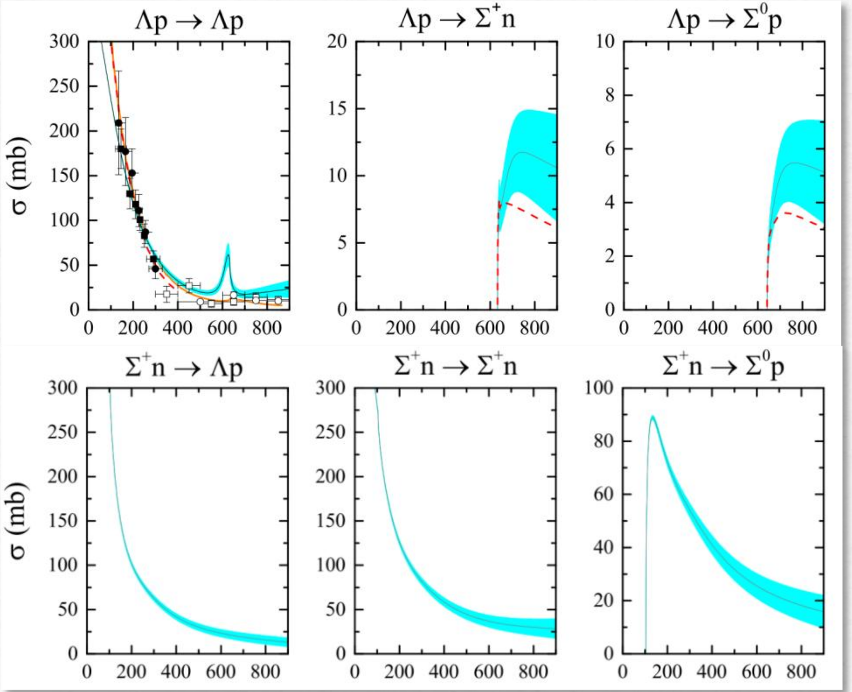




More studies of hyperon-hyperon (Y-Y) and hyperon-nucleon (Y-N) interactions are needed.

Theoretical Work

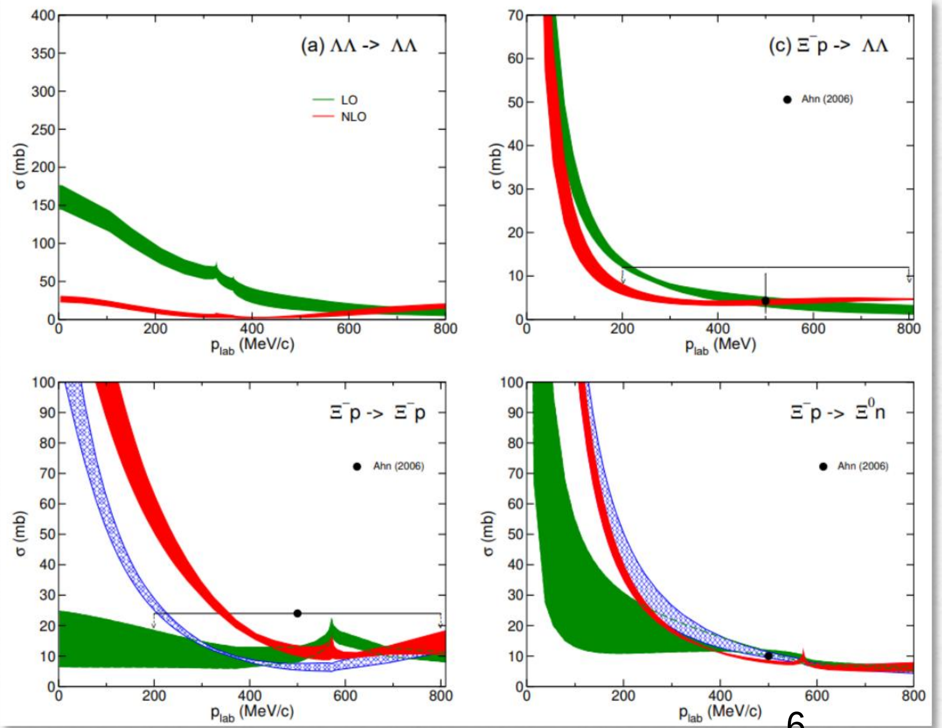
Phys. Rev. C 105, 035203 (2022)



LO : H. Polinder, J.H., U.-G. Meißner, PLB 653 (2007) 29

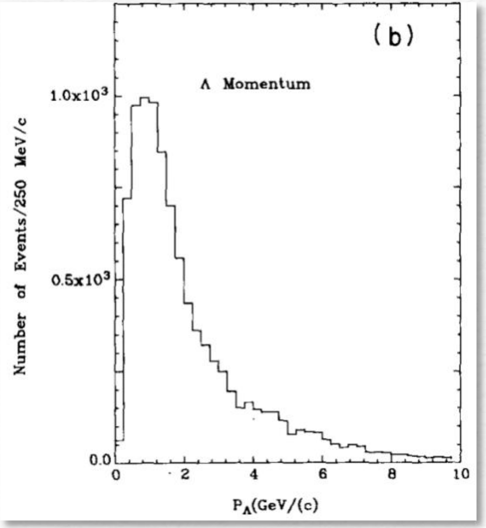
NLO16: J.H., U.-G. Meißner, S. Petschauer, NPA 954 (2016) 273

NLO19: J.H., U.-G. Meißner, EPJA 55 (2019) 23

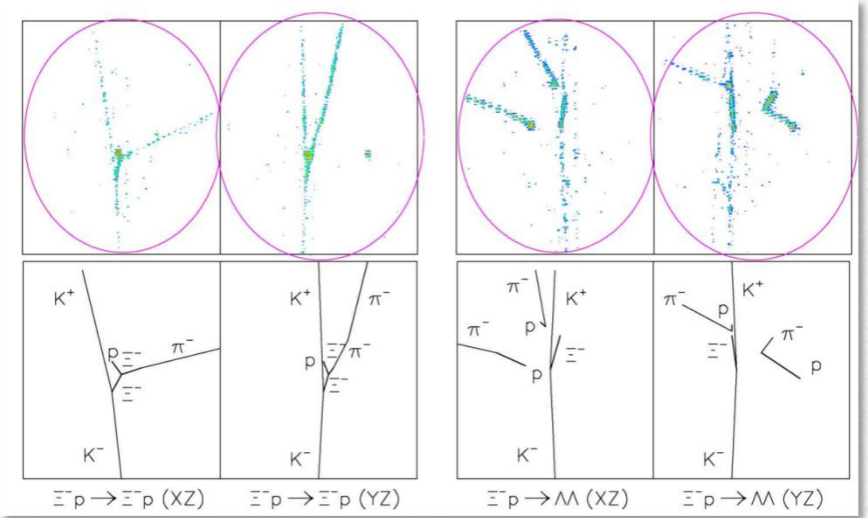


Early Measurement

- Hyperons are obtained by bombarding hydrogen bubble chamber or scintillating fiber target with K^-
- Low statistics and high background



Nucl. Phys. B 125, 29 (1977)



Phys. Lett. B 633, 214 (2006)

Early Measurements

Reaction	Number of events	
$\Lambda p \to \Lambda p$ (elastic)	584	(1)
$\Lambda p \to \Sigma^- p \pi^+$	132	(2)
$\Lambda p \to \Sigma^+ p \pi^-$	60	(3)
$\Lambda p \to \Lambda p \pi^+ \pi^-$	181	(4)
$\Lambda p \to \Sigma^0 p$	35	(5)
various $\Xi^0 p$ interactions	25	

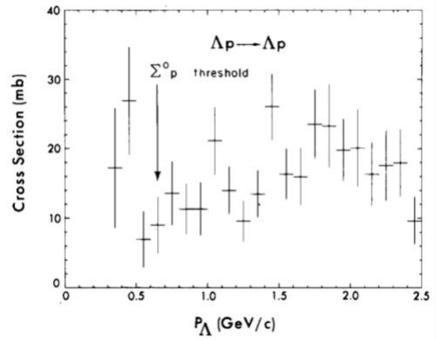
Phys. Lett. B 32, 720 (1970)

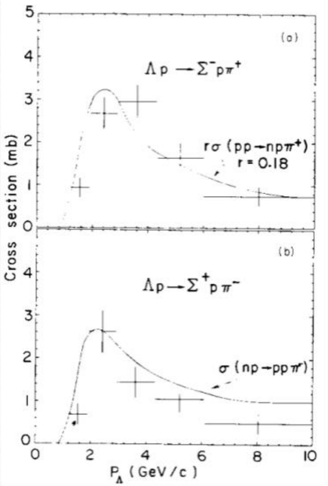
Phys. Lett. B 38, 123 (1972)

reaction	events *	signature	cross-section events **	cross-section (mb)
$\Xi^0 + p \to \Xi^0 + p$	2	K, Λ	1	8
$\Xi^0 + p \to \Lambda + \Sigma^+$	6	Λ	4	24
$\Xi^0 + p \to \Sigma^0 + \Sigma^+$	1	Λ	1	6
$\Xi^0 + p \to \pi^+ + \Lambda + \Lambda$	1	K, Λ	1	6
$\Xi^0 + p \to \pi^0 + \Lambda + \Sigma^+$	1	Λ	1	6
$\Xi^0 + p \to \pi^+ + \Xi^- + p$	1	K or Λ	1	5
$\Xi^0 + p \to \pi^+ + \pi^+ + \Xi^- + n$	1	K, Λ	1	6
$\Xi^0 + p \to \Xi^- + p$	2	Λ	2	8
$\Xi^0 + p \to \Sigma^- + \Sigma^+$	1	K	1	4
$\Xi^0 + p \to \Sigma^- + K^0 + p$	1	K	1	4

Reaction	Momentum interval (GeV/c)	Number of events	σ (mb)
$\Lambda p \to$ all	0.5 → 1.0		25.8 ± 6.2
	1.0 → 1.5		31.3 ± 6.5
	1.5 → 2.0		42.8 ± 7.1
	2.0 → 2.5		37.5 ± 7.2
	2.5 → 3.0		34.1 ± 8.3
	3.0 → 4.0		41.8 ± 10.0
$\Lambda p \to \Lambda p$	0.5 → 1.0	20	22.2 ± 5.0
	1.0 → 1.5	21	12.9 ± 2.8
	1.5 → 2.0	37	22.0 ± 3.6
	2.0 → 2.5	28	16.1 ± 3.1
	2.5 → 3.0	12	11.0 ± 3.2
	3.0 → 4.0	13	12.5 ± 3.4
$\Lambda p \to \Sigma^0$	0.66 → 4.0	11	1.5 ± 0.5
$\Lambda p \to \Lambda p \pi^0$	0.88 → 4.0	29	4.1 ± 0.8
$\Lambda p \to \Lambda p \pi^+ \pi^-$	1.36 → 4.0	12	1.9 ± 0.6
$\Sigma^+ p \to \Sigma^+ p$	0.5 → 1.5	10	31.2 ± 10.1
	1.5 → 2.5	8	18.7 ± 6.6
	2.5 → 4.0	4	15.3 ± 7.8
$\Sigma^- p \to \Sigma^- p$	0.5 → 1.5	6	13.2 ± 4.7
	1.5 → 2.5	11	13.9 ± 4.1
	2.5 → 4.0	4	7.5 ± 3.8
$\Xi^- p \to \Xi^- p$	1.0 → 4.0	6	13 ± 6
$\Xi^0 p \to \Xi^0 p$	1.0 → 4.0	4	19 ± 10

Nucl. Phys. B 125, 29 (1977)





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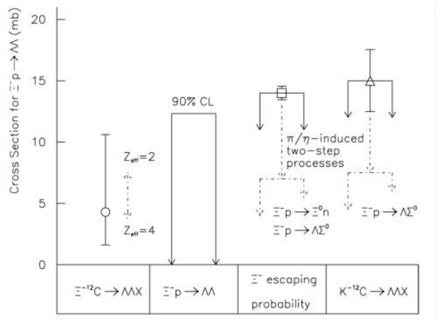


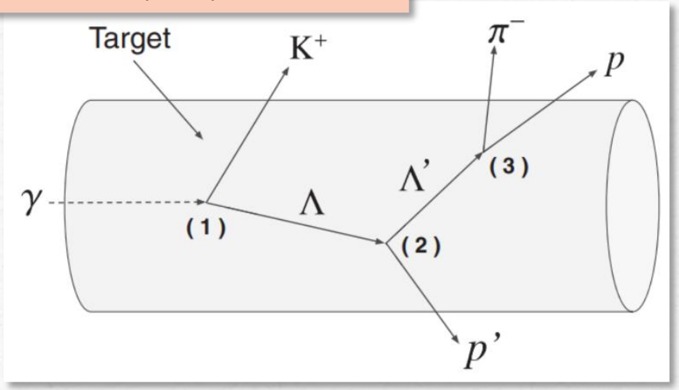
Recent Measurement

PHYSICAL REVIEW LETTERS **127,** 272303 (2021)

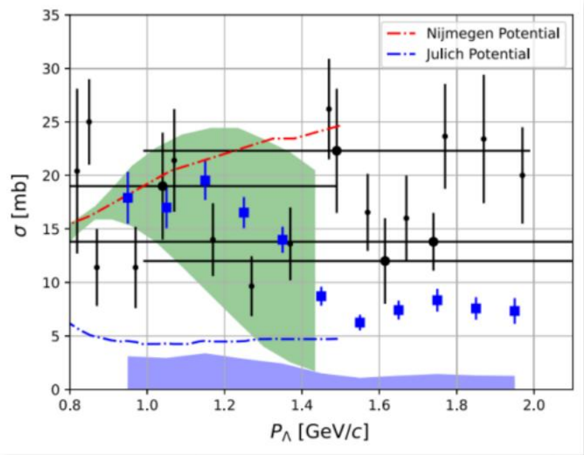
(CLAS Collaboration)

Improved Λp Elastic Scattering Cross Sections between 0.9 and 2.0 GeV/c as a Main Ingredient of the Neutron Star Equation of State

Phys.Rev.Lett. 127 (2021) 27, 272303



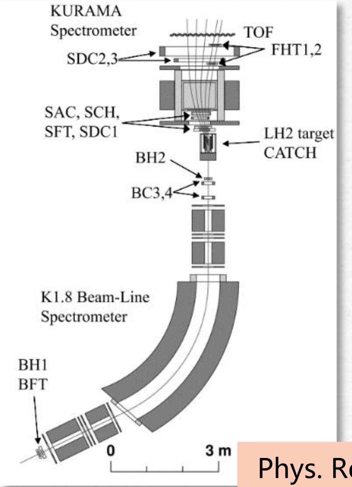
$\Lambda p \rightarrow \Lambda p$



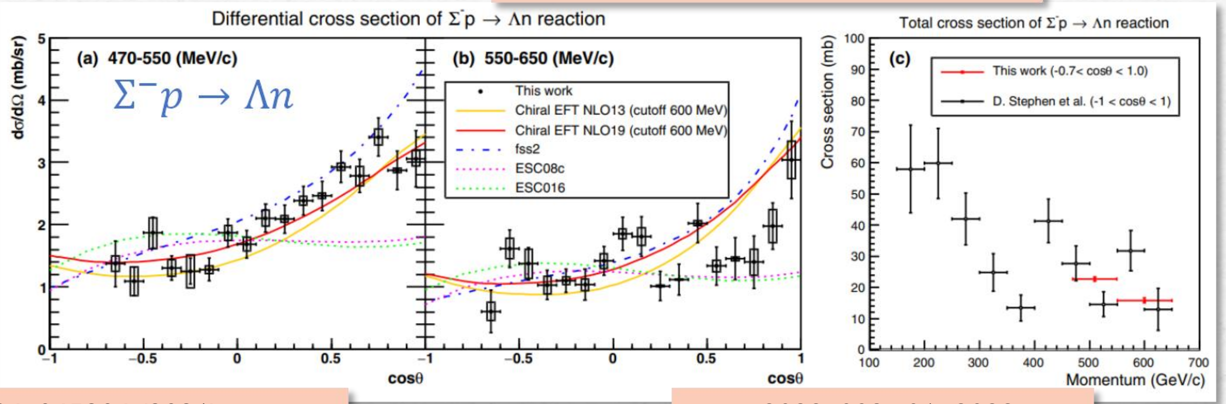
This is the first data on this reaction since the 1970s.

Recent Measurement

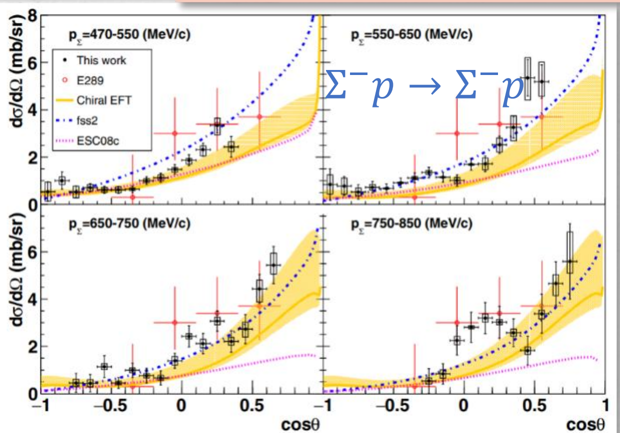
J-PARC E40 Collaboration



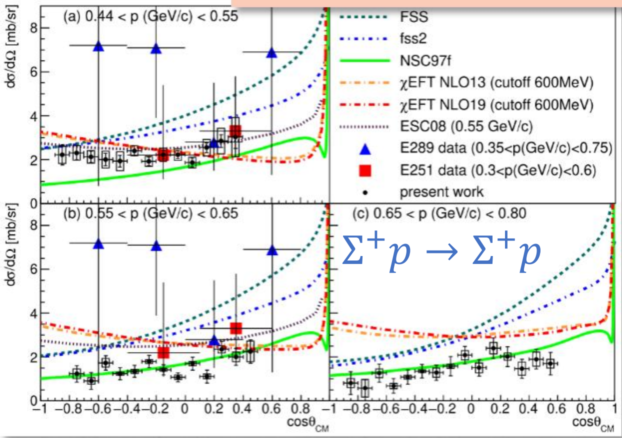
Phys. Rev. Lett. 128, 072501 (2022)



Phys. Rev. C 104, 045204 (2021)

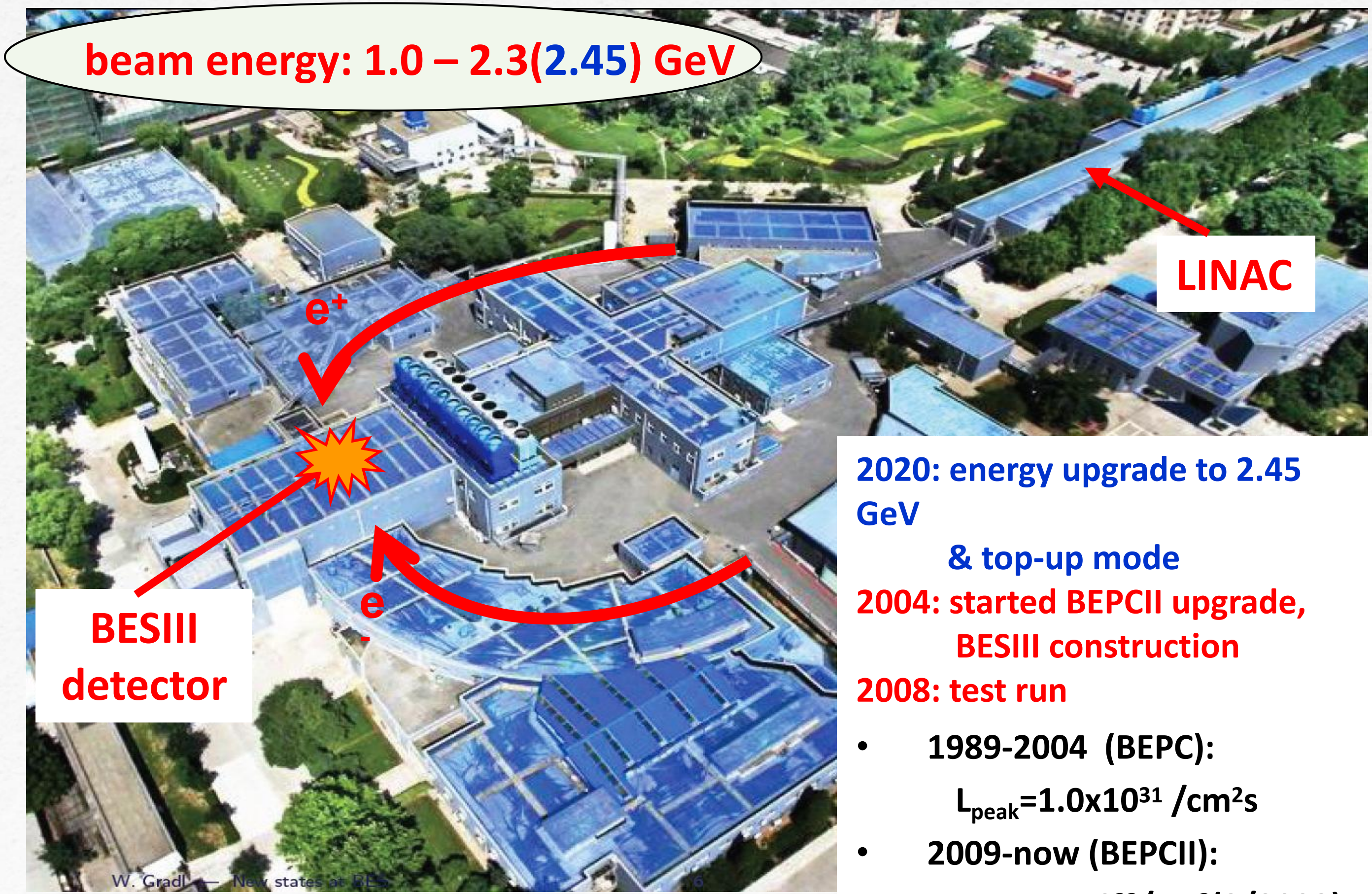


PTEP 2022, 093D01 (2022)



How to measure

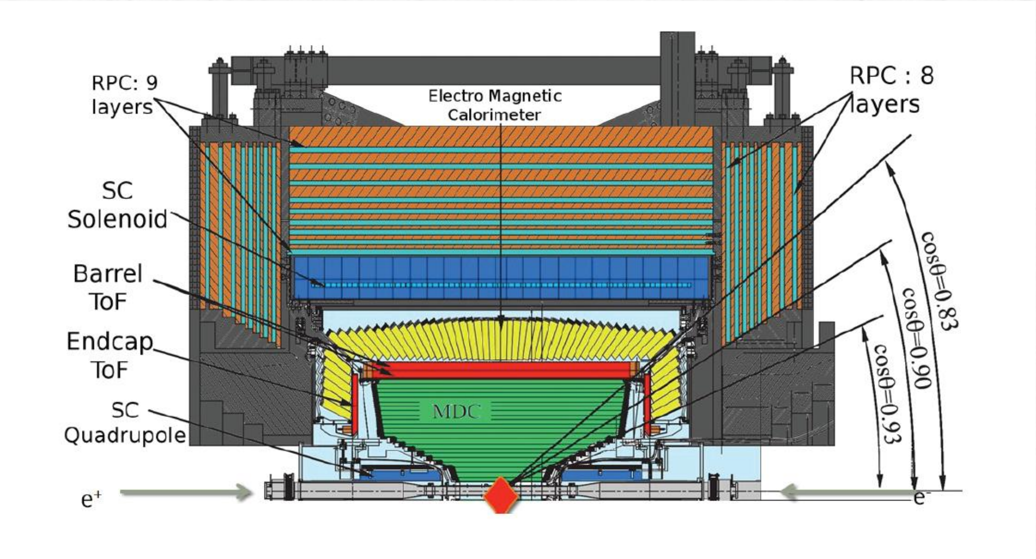
Beijing Electron-Positron Collider II (BEPCII)



2020: energy upgrade to 2.45 GeV
& top-up mode
2004: started BEPCII upgrade,
BESIII construction
2008: test run

- 1989-2004 (BEPC):
  L_{peak}=1.0x10^{31} /cm^{2}s
- 2009-now (BEPCII):
  L_{peak}= 1.1 x10^{33}/cm^2(3/2023)

Beijing Spectrometer III (BESIII) Experiment



- **MDC:**
  - Material<$0.05X_0$, $\sigma_{xy} < 130\ \mu$m
  - $\sigma(p)/p < 0.5\%$@1 GeV/c
  - $\sigma_{dE/dx} < 6\%$

- **TOF:**
  - σ_t~70 ps (barreal two layers)
  - σ_t~110(60) ps (endcap)

- **EMC:**
  - $\sigma_E/\sqrt{E} < 2.5\%$ @ 1 GeV
  - $\sigma_x < 0.6$ cm

- **MUC**
  - No. of layers (barrel/endcap) 9/8
  - Cut-off momentum (MeV/c) 0.4

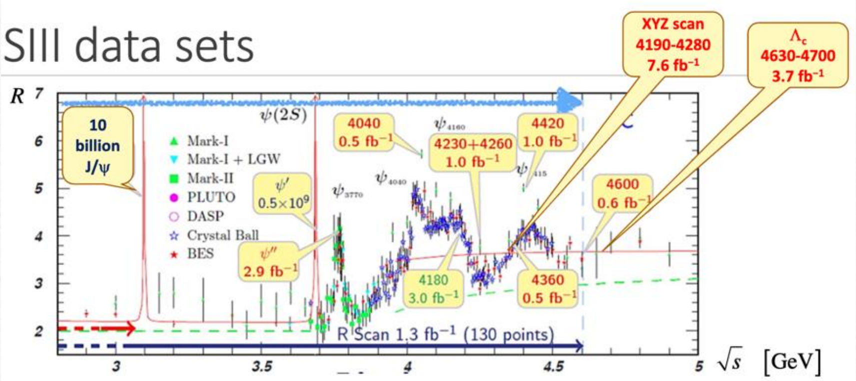
Beijing Spectrometer III (BESIII) Experiment

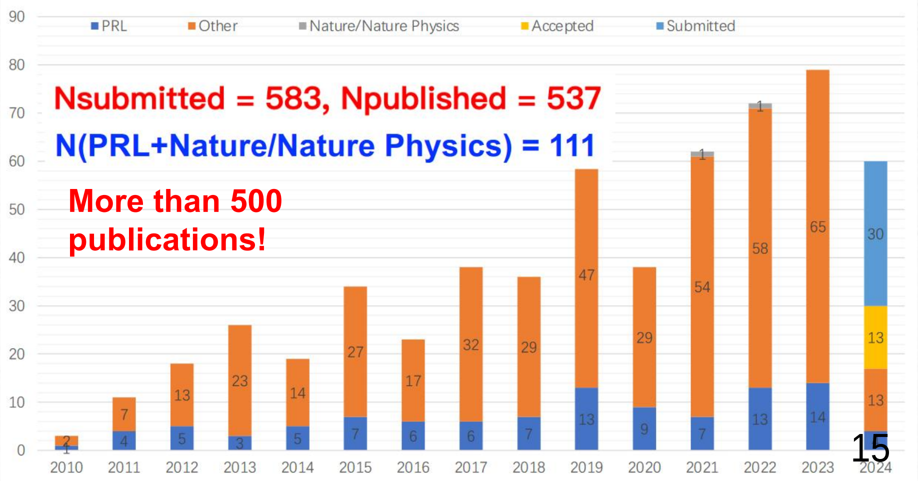
BESIII Data Sample

2009: 106M $\psi(2S)$
225M J/ψ
2010: 975 pb^{-1} at $\psi(3770)$
2011: 2.9 fb^{-1} *(total)* at $\psi(3770)$
482 pb^{-1} at 4.01 GeV
2012: 0.45B *(total)* $\psi(2S)$
1.3B *(total)* J/ψ
2013: 1092 pb^{-1} at 4.23 GeV
826 pb^{-1} at 4.26 GeV
540 pb^{-1} at 4.36 GeV
10×50 pb^{-1} scan 3.81 — 4.42 GeV
2014: 1029 pb^{-1} at 4.42 GeV
110 pb^{-1} at 4.47 GeV
110 pb^{-1} at 4.53 GeV
48 pb^{-1} at 4.575 GeV
567 pb^{-1} at 4.6 GeV
0.8 fb^{-1} R-scan 3.85 — 4.59 GeV
2015: R-scan 2 — 3 GeV + 2.175 GeV
2016: ~3fb^{-1} at 4.18 GeV (for D_s)
2017: 7×500 pb^{-1} scan 4.19 — 4.27 GeV
2018: more J/ψ *(and tuning new RF cavity)*
2019: 10B *(total)* J/ψ
8×500 pb^{-1} scan 4.13, 4.16, 4.29 — 4.44 GeV

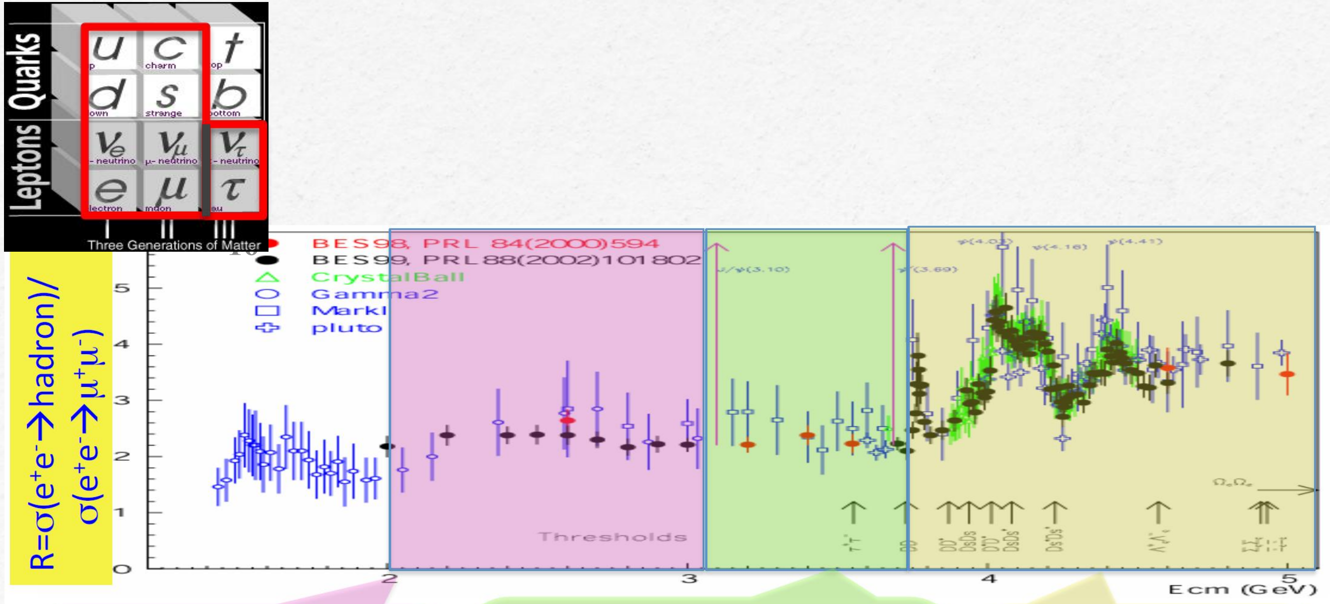
Many topics!
spectroscopy (light and heavy),
flavor physics,
new physics,
R scans,
τ physics, etc.

2020: 3.8 fb^{-1} scan **4.61-4.7 GeV**
2021: 2 fb^{-1} scan **4.74-4.95 GeV**; 2.55B ψ(2S)
2022: 5.1 fb^{-1} at $\psi(3770)$
2023: ~8 fb^{-1} will be taken at $\psi(3770)$





Physics at BESIII



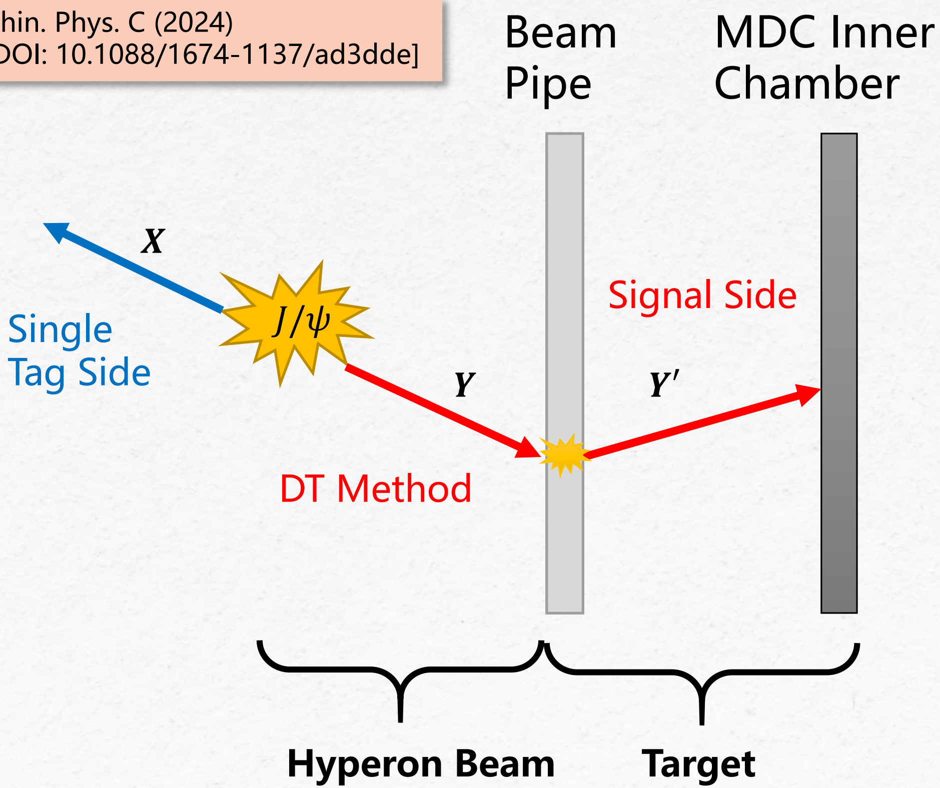
- Hadron form factors
- Y(2175) resonance
- Mutltiquark states with s quark, Zs
- MLLA/LPHD and QCD sum rule predictions

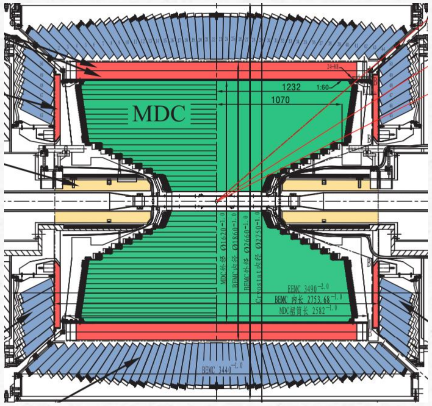
- Light hadron spectroscopy
- Gluonic and exotic states
- Process of LFV and CPV
- Rare and forbidden decays
- Physics with τ lepton

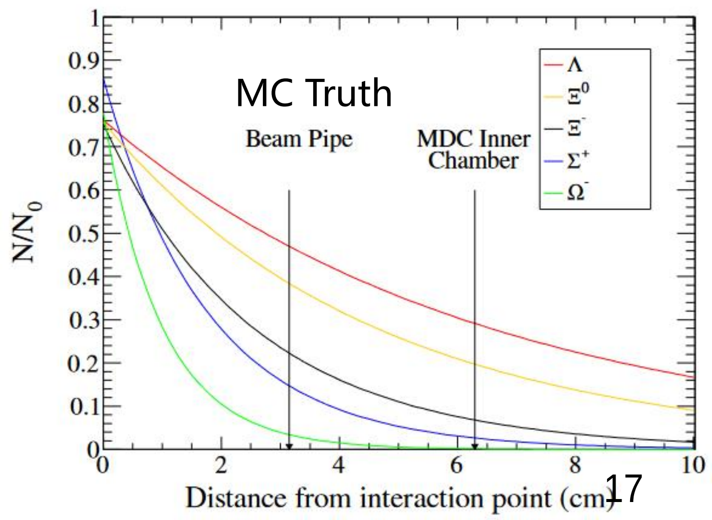
- XYZ particles
- D mesons
- f_D and f_{Ds}
- D_0-D_0 mixing
- Charm baryons

General Thought

Chin. Phys. C (2024)
[DOI: 10.1088/1674-1137/ad3dde]







Potential Channels

J/ψ
$\psi(2S)$

- $pK^-\bar{\Lambda}$
- $\Lambda\bar{\Lambda}$
- $\Sigma^+\bar{\Sigma}^-$
- $\Xi^-\bar{\Xi}^+$
- $\Omega^-\bar{\Omega}^+$

Hyperon Beam

$\Lambda + p$ → $\Sigma^+ n$ (**Our Study**), $K^+\Lambda\Lambda$, $K^+\Xi^- p$

$\Lambda + n \rightarrow \Sigma^- p$

$\Sigma^- + p \rightarrow \Sigma^0 n,\ \Lambda n$

$\Sigma^+ + n \rightarrow \Sigma^0 p,\ \Lambda p$

$\Xi^- + p \rightarrow \Xi^0 n,\ \Lambda\Lambda$

$\Xi^0 + n \rightarrow \Xi^- p,\ \Lambda\Lambda$

Scattering Process

Double-Tag Method

Double Tag Events:

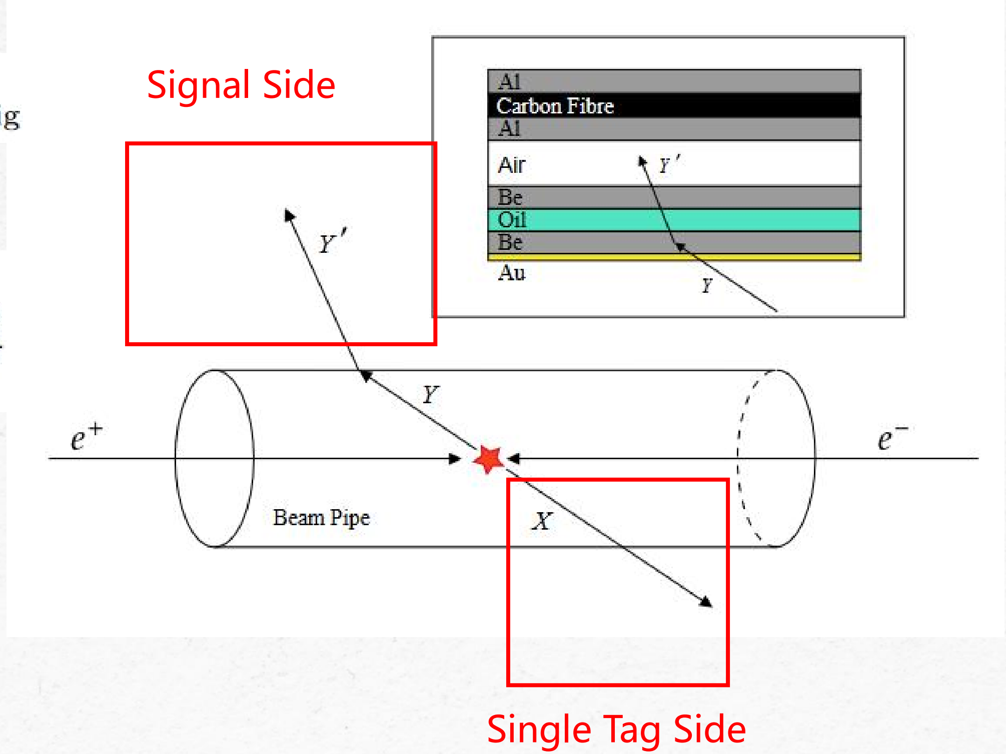
$$N_{\mathrm{DT}} = \mathcal{L}_Y \cdot \sigma(YA \to Y'A') \cdot \mathcal{B}(Y') \cdot \epsilon_{\mathrm{sig}}$$

Effective Luminosity of Λ beam:

$$\mathcal{L}_Y = N_{\mathrm{ST}} \cdot \frac{N_A}{N_{\mathrm{ST}}^{\mathrm{MC}}} \cdot \sum_j^7 \sum_i^{N_{\mathrm{ST}}^{\mathrm{MC}}} \frac{\rho_T^j \cdot l^{ij}}{M^j} \cdot \mathcal{R}_\sigma^j$$

Cross section:

$$\sigma(YA \to Y'A') = \frac{N_{\mathrm{DT}}}{\epsilon_{\mathrm{sig}} \cdot \mathcal{L}_Y} \cdot \frac{1}{\mathcal{B}(Y')}$$



Effective Luminosity

$$\mathcal{L}_Y = N_{\mathrm{ST}} \cdot \frac{N_A}{N_{\mathrm{ST}}^{\mathrm{MC}}} \cdot \sum_j^7 \sum_i^{N_{\mathrm{ST}}^{\mathrm{MC}}} \frac{\rho_T^j \cdot l^{ij}}{M^j} \cdot \mathcal{R}_\sigma^j$$

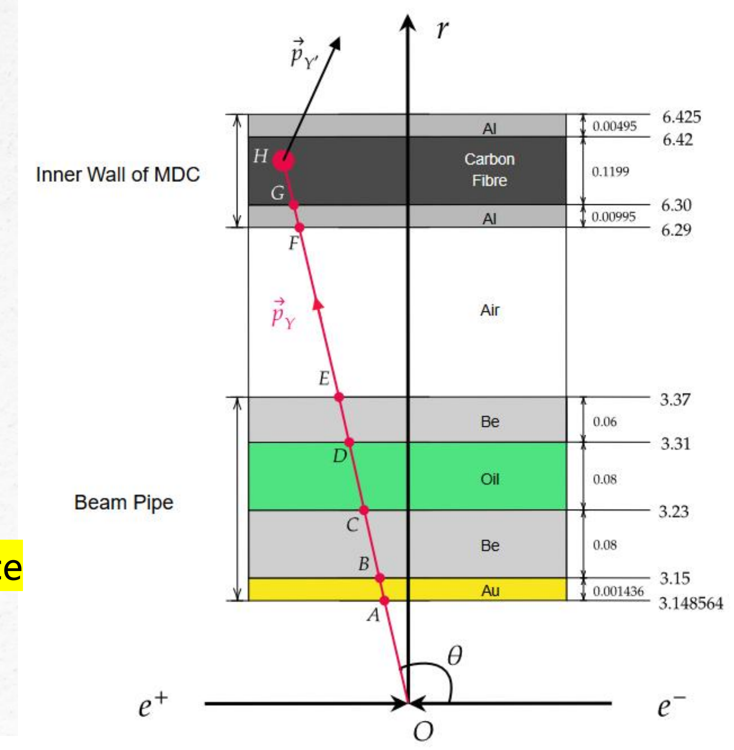
ρ_T^j - density of the j_{th} layer

M^j - molar mass of the j_{th} layer

l^{ij} - path length of the i_{th} event in the j_{th} layer (will be 0 if the incident hyperon does not reach the j_{th} layer)

R_σ^j - the ratio of the cross sections between layers

- proportional to the number of nucleons in the nuclei surface
- proportional to the number of nucleons in the nuclei
- Eikonal Approximation

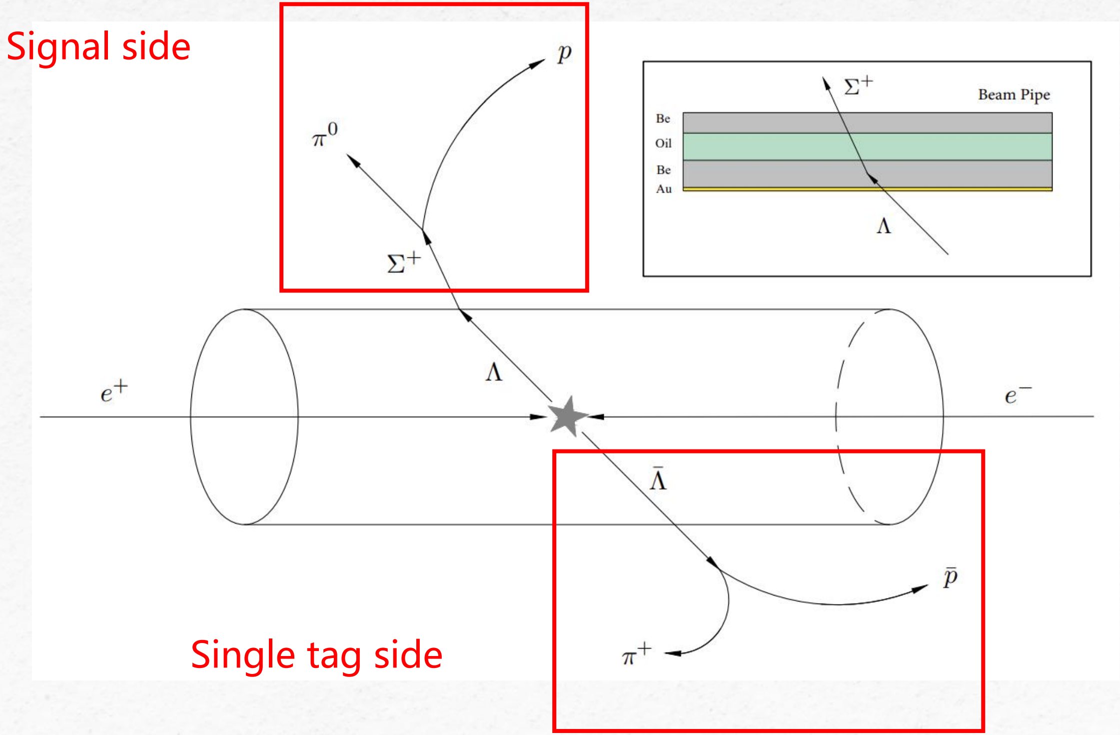


$$N_{\mathrm{eff}}(Z_{\mathrm{eff}}) = \frac{N(Z)}{A} \int \rho(\mathbf{r}) \exp\left\{-\bar{\sigma}_i \int_{-\infty}^{z} \rho(x,y,z')\,dz' - \bar{\sigma}_f \int_{z}^{\infty} \rho(x,y,z')\,dz'\right\} d^3\mathbf{r}$$

What have been measured

Reaction chain :

$J/\psi \to \Lambda\bar{\Lambda}$, $\bar{\Lambda} \to \bar{p}\pi^+$, $\Lambda + N(\text{nucleus}) \to \Sigma^+ + X(\text{anything})$, $\Sigma^+ \to p\pi^0$, $\pi^0 \to \gamma\gamma$.



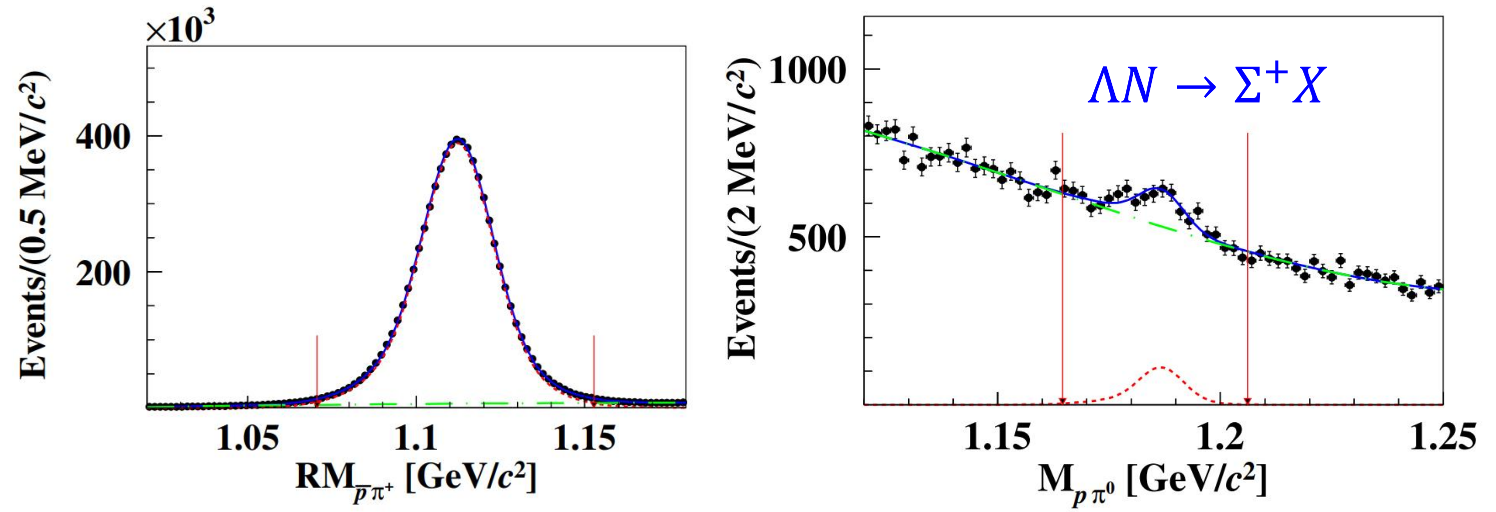
Two-body decay, $P_\Lambda \approx 1.074\ \text{GeV}/c$,

Very small horizontal crossing angle of 11 mrad for e^+ and e^- beams

↓

Very small range of $0.017\ \text{GeV}/c$ above and below $1.074\ \text{GeV}/c$ for P_Λ.

$\Lambda N \to \Sigma^+ X$



$N_{\mathrm{ST}} = 7207565 \pm 3741$

$N_{\mathrm{DT}} = 795 \pm 101$

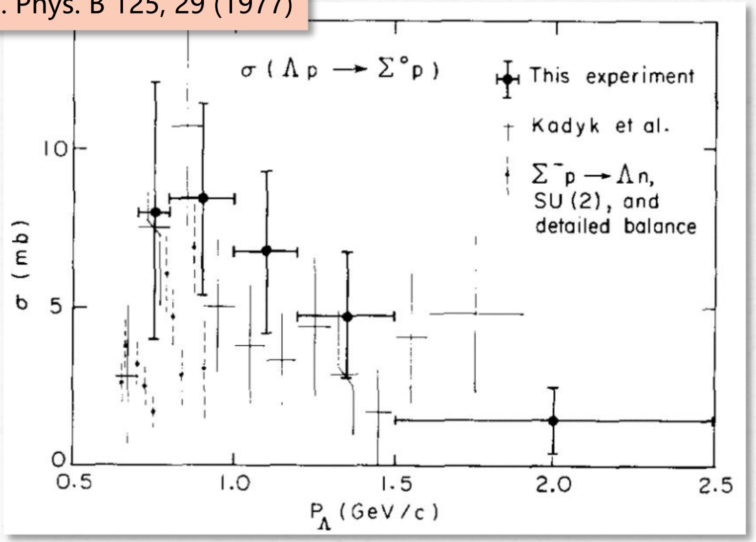
Parameter	Value
N_{DT}	795 ± 101
ϵ_{sig}	24.32%
$\mathcal{L}_{\Lambda}$	$(17.00 \pm 0.01) \times 10^{28}\ \mathrm{cm}^{-2}$
$\mathcal{B}(\Sigma^+ \to p\pi^0)$	$(51.57 \pm 0.30)\%$

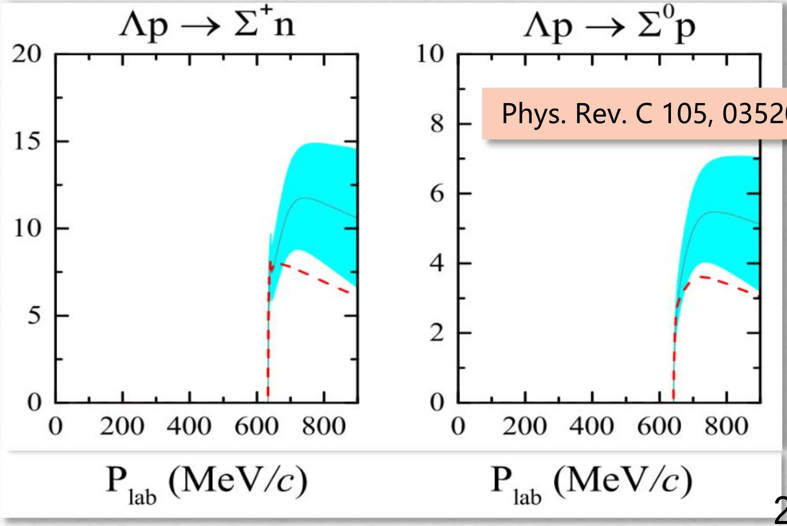
$\Lambda N \to \Sigma^+ X$

- $\sigma(\Lambda + {}^9\mathrm{Be} \to \Sigma^+ + X) = (37.3 \pm 4.7_{\mathrm{stat}} \pm 3.5_{\mathrm{sys}})$ mb at $P_\Lambda \approx 1.074$ GeV/c. The first attempt to investigate Λ-nucleus interaction at an e^+e^- collider.
- Taking the effective number of reaction protons in ${}^9\mathrm{Be}$ nucleus as 1.93, the cross section of $\Lambda p \to \Sigma^+ X$ for single proton is $\sigma(\Lambda p \to \Sigma^+ X) = (19.3 \pm 2.4_{\mathrm{stat}} \pm 1.8_{\mathrm{sys}})$ mb.

$\sigma(\Lambda p \to \Sigma^+ n)$ is twice of $\sigma(\Lambda p \to \Sigma^0 p)$

Nucl. Phys. B 125, 29 (1977)

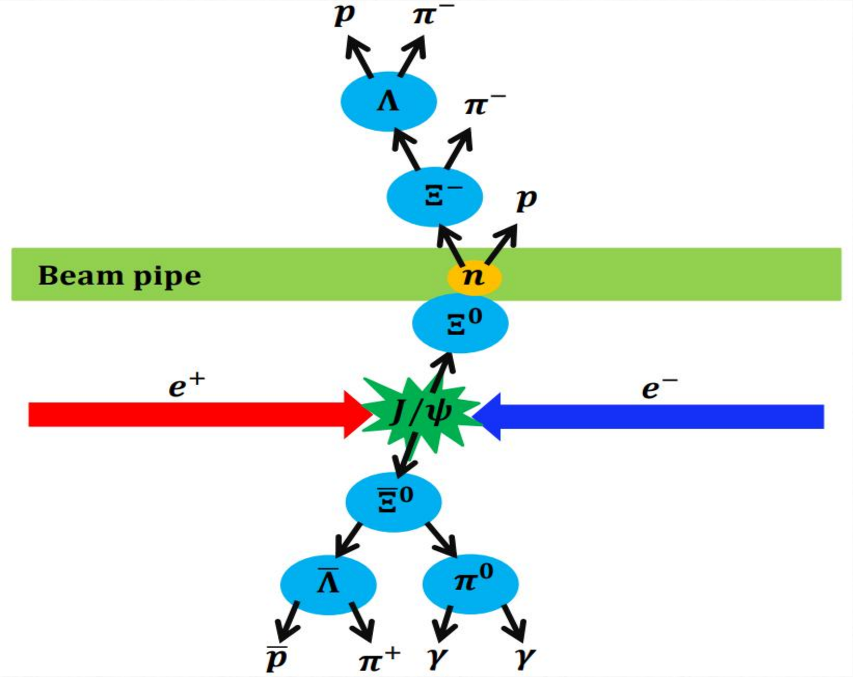




Phys. Rev. C 105, 035203 (2022)

Reaction chain :

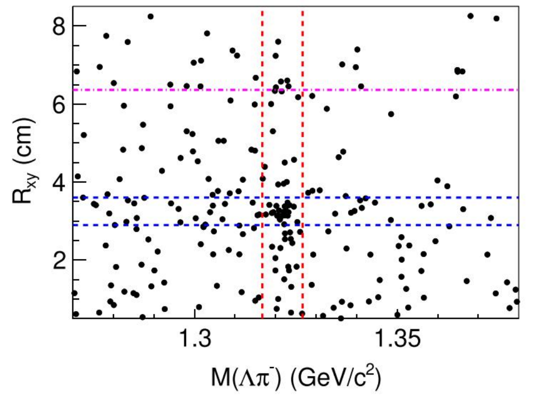
$J/\psi \to \Xi^0\bar{\Xi}^0$, $\bar{\Xi}^0 \to \bar{\Lambda}\pi^0$, $\bar{\Lambda} \to \bar{p}\pi^+$, $\pi^0 \to \gamma\gamma$, $\Xi^0 n \to \Xi^- p$, $\Xi^- \to \Lambda\pi^-$, $\Lambda \to p\pi^-$.



10 billion J/ψ data

Two-body decay, $P_{\Xi^0} \approx 0.818\ \mathrm{GeV}/c$

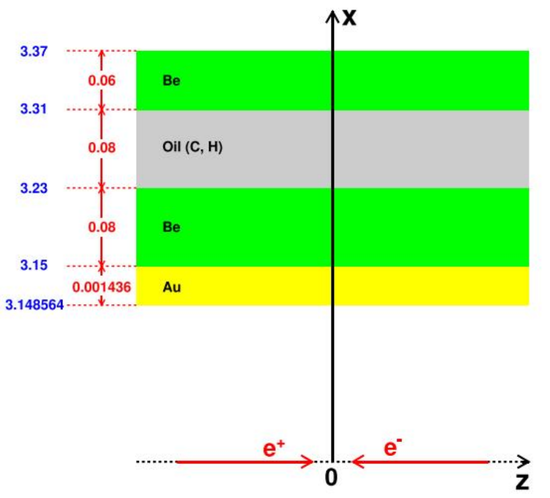
$\Xi^0 n \to \Xi^- p$

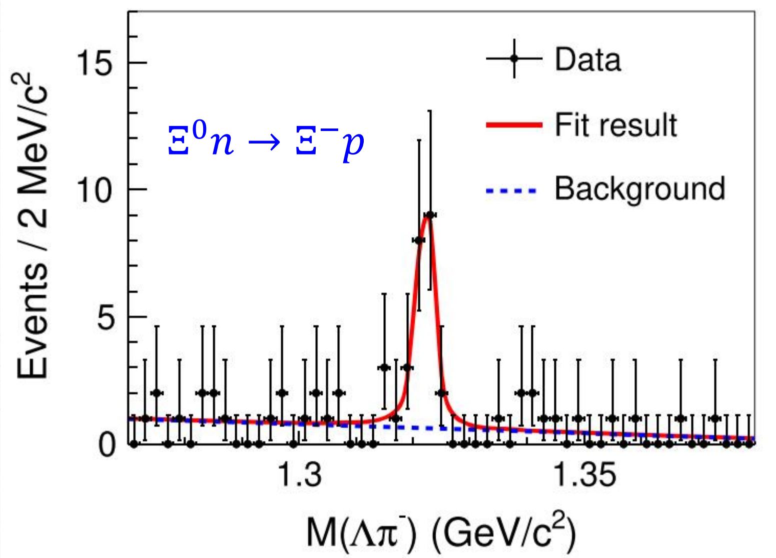


Inner wall of MDC

Beam pipe

R_{xy} is distance from reconstructed $\Xi^- p$ vertex to z axis



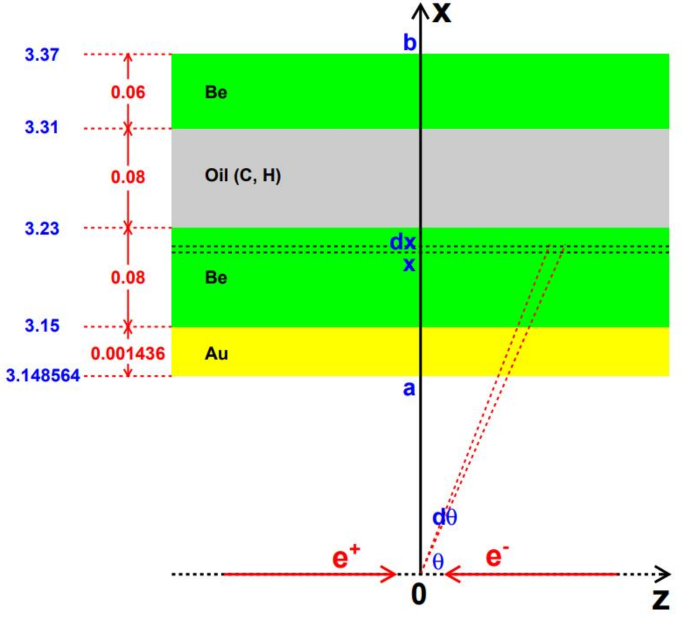


$$N = 22.9 \pm 5.5$$
$$S = 7.1\sigma$$

$\Xi^0 n \to \Xi^- p$

$$\sigma(\Xi^0 + {}^9\mathrm{Be} \to \Xi^- + p + {}^8\mathrm{Be}) = \frac{N^{\mathrm{sig}}}{\epsilon \mathcal{B} \mathcal{L}_{\mathrm{eff}}}$$

$$\mathcal{L}_{\mathrm{eff}} = \frac{N_{J/\psi}\mathcal{B}_{J/\psi}}{2+\frac{2}{3}\alpha}\int_a^b\int_0^\pi (1+\alpha\cos^2\theta)e^{-\frac{x}{\sin\theta\beta\gamma L}}N(x)C(x)d\theta dx$$

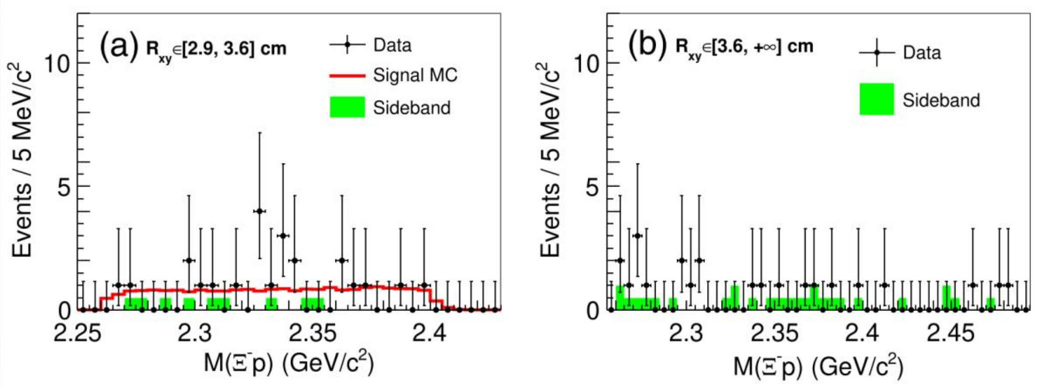


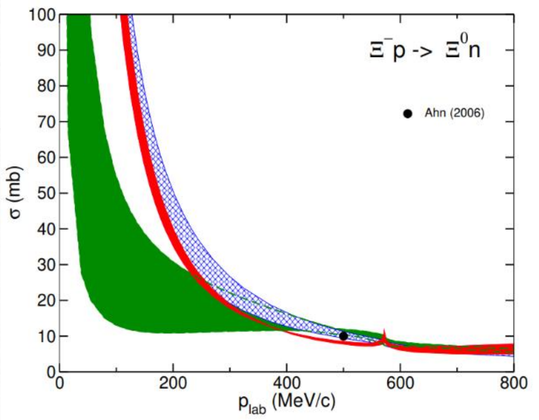
pure surface process assumption (proportional to number of neutrons)

Parameter	Result
N^{sig}	22.9 ± 5.5
ϵ	1.873%
$\mathcal{B}$	$(40.114 \pm 0.444)\%$ [53]
$N_{J/\psi}$	$(1.0087 \pm 0.0044) \times 10^{10}$ [46]
$\mathcal{B}_{J/\psi}$	$(0.117 \pm 0.004)\%$ [53]
α	0.514 ± 0.016 [56]
L	(8.69 ± 0.27) cm [53]
E_{beam}	1.5485 GeV
m_{Ξ^0}	$(1.31486 \pm 0.00020)\ \mathrm{GeV}/c^2$ [53]
a	3.148564 cm [45]
b	3.37 cm [45]
$N(x)$	$\begin{cases} 5.91 \times 10^{22}\ \mathrm{cm}^{-3}, & 3.148564 \le x \le 3.15\ \mathrm{cm} \\ 1.24 \times 10^{23}\ \mathrm{cm}^{-3}, & 3.15 < x \le 3.23\ \mathrm{cm} \\ 3.45 \times 10^{22}\ \mathrm{cm}^{-3}, & 3.23 < x \le 3.31\ \mathrm{cm} \\ 1.24 \times 10^{23}\ \mathrm{cm}^{-3}, & 3.31 < x \le 3.37\ \mathrm{cm} \end{cases}$
$C(x)$	$\begin{cases} 8.437(23.6), & 3.148564 \le x \le 3.15\ \mathrm{cm} \\ 1.000(1.00), & 3.15 < x \le 3.23\ \mathrm{cm} \\ 1.090(1.20), & 3.23 < x \le 3.31\ \mathrm{cm} \\ 1.000(1.00), & 3.31 < x \le 3.37\ \mathrm{cm} \end{cases}$

$\Xi^0 n \to \Xi^- p$

- $\sigma(\Xi^0 + {}^9\text{Be} \to \Xi^- + p + {}^8\text{Be}) = (22.1 \pm 5.3_{\text{stat}} \pm 4.5_{\text{sys}})$ mb at $P_{\Xi^0} \approx 0.818$ GeV/c.
- Taking the effective number of reaction neutrons in ^{9}Be nucleus as 3, $\sigma(\Xi^0 n \to \Xi^- p) = (7.4 \pm 1.8_{\text{stat}} \pm 1.5_{\text{sys}})$ mb, consistent with theoretical predictions.





LO : H. Polinder, J.H., U.-G. Meißner, PLB 653 (2007) 29

NLO16: J.H., U.-G. Meißner, S. Petschauer, NPA 954 (2016) 273

NLO19: J.H., U.-G. Meißner, EPJA 55 (2019) 23

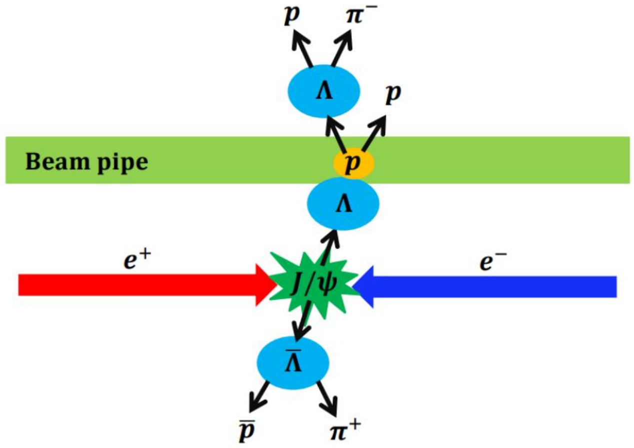
This work is the first study of hyperon-nucleon interaction in electron-positron collisions, and opens up a new direction for such research.

No significant H-dibaryon signals are seen

$\Lambda(\bar{\Lambda})p \to \Lambda(\bar{\Lambda})p$

Reaction chain :

$J/\psi \to \Lambda\bar{\Lambda}$, $\Lambda p \to \Lambda p$, $\Lambda \to p\pi^-$, $\bar{\Lambda} \to \bar{p}\pi^+$.

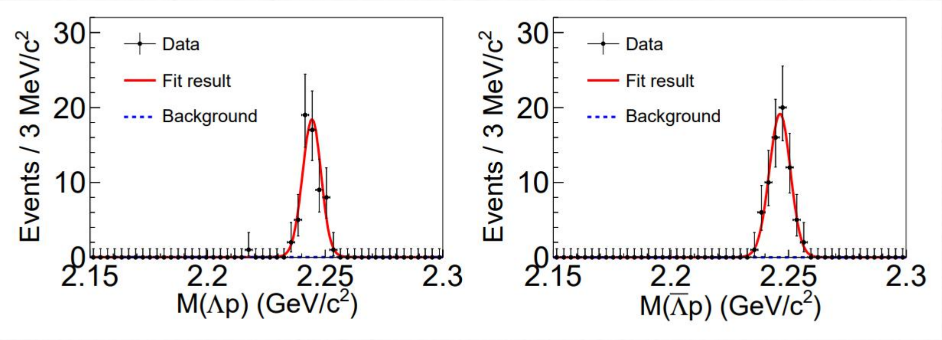


Two-body decay, $P_\Lambda \approx 1.074\ \mathrm{GeV}/c$,

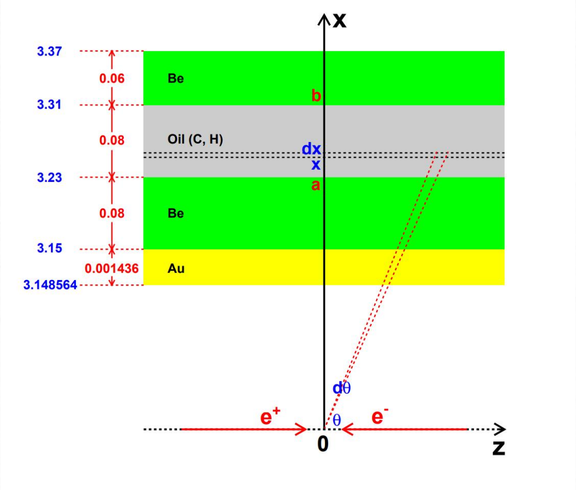
Very small horizontal crossing angle of 11 mrad for e^+ and e^- beams

Very small range of $0.017\ \mathrm{GeV}/c$ above and below $1.074\ \mathrm{GeV}/c$ for P_Λ.

$\Lambda(\bar{\Lambda})p \rightarrow \Lambda(\bar{\Lambda})p$



$$N(\Lambda p \rightarrow \Lambda p) = 60.9 \pm 7.8$$
$$N(\bar{\Lambda} p \rightarrow \bar{\Lambda} p) = 72.0 \pm 8.5$$



The center-of-mass energies for the incident $\Lambda/\bar{\Lambda}$ and a static p are all 2.243 GeV/c^2 within a range of ±0.005 GeV/c^2

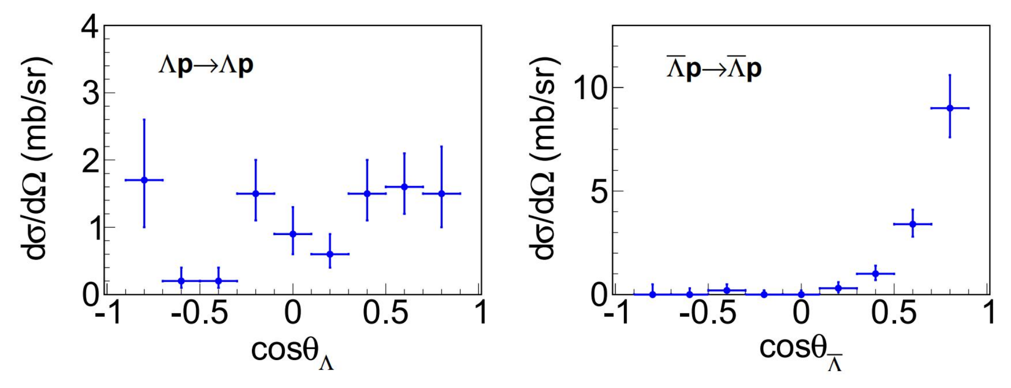
Clear enhancements are seen around $2.243\ \mathrm{GeV}/c^2$, corresponding to the reactions $\Lambda(\bar{\Lambda})p \rightarrow \Lambda(\bar{\Lambda})p$, respectively

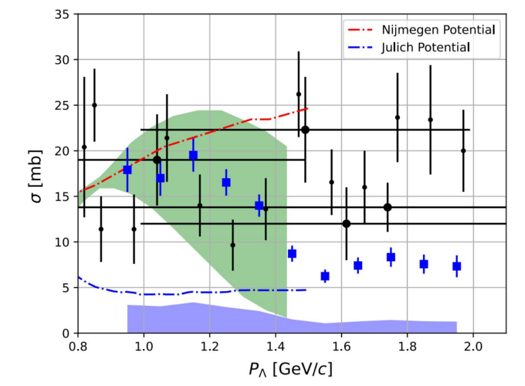
$\Lambda(\bar{\Lambda})p \rightarrow \Lambda(\bar{\Lambda})p$

First measurement of antihyperon-nucleon scattering!

- $\sigma(\Lambda + p \rightarrow \Lambda + p) = (12.2 \pm 1.6_{\text{stat}} \pm 1.1_{\text{sys}})$ mb and $\sigma(\bar{\Lambda} + p \rightarrow \bar{\Lambda} + p) = (17.5 \pm 2.1_{\text{stat}} \pm 1.6_{\text{sys}})$ mb at $P_\Lambda \approx 1.074$ GeV/c within $-0.9 < cos\theta_\Lambda < 0.9$.
- The differential cross sections of the two reactions are measured within $-0.9 < cos\theta_\Lambda < 0.9$, while there is a slight tendency of forward scattering for $\Lambda p \rightarrow \Lambda p$, and a strong forward peak for $\bar{\Lambda}p \rightarrow \bar{\Lambda}p$

Consistent results from CLAS experiment





What will be studied

BESIII Analyses

- $\boldsymbol{\Sigma^+ n \to \Lambda p, \Sigma^+ n \to \Sigma^0 p}$

- $\boldsymbol{\Xi^0 n \to \Lambda\Lambda, \Xi^- p \to \Lambda\Lambda}$

……

More results will come out soon !!!

Super Tau Charm Factory (STCF) in China

- Peak luminosity $>0.5\times10^{35}$ $cm^{-2}s^{-1}$ at 4 GeV
- Energy range E_{cm} = 2-7 GeV
- Potential to increase luminosity & realize beam polarization
- Total cost: 4.5B RMB

- 1 ab^{-1} data expected per year
- Rich physics program, unique for physics with *c* quark and τ leptons
- Important playground for study of QCD, exotic hadrons, flavor and search for new physics.

Prospects at STCF

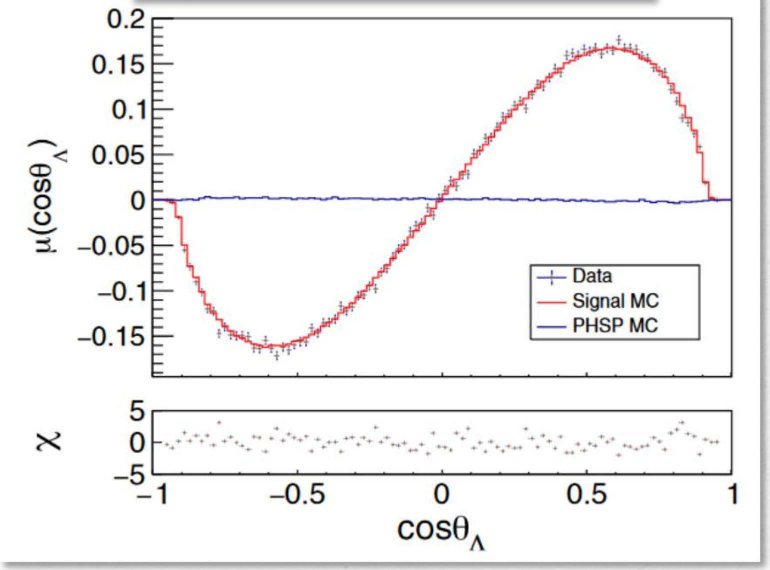
- Far more precise measurements thanks to the gaint statistics
- First measurement of the interaction between Ω^- and nuclei/nucleon (three strange quarks, spin-3/2)
- Measurements of the differential cross sections and momentum-dependent cross section
- Search for potential hypernucleus

Hyperon	$c\tau$ (cm)	decay mode	$\mathcal{B}_{decay}$ [65] ($\times 10^{-3}$)	$p_{\max}$ (MeV/c)	n^{Y}_{BP} ($\times 10^5$ for BESIII or $\times 10^8$ for STCF)	$\mathcal{B}_{tag}$ (%)	$\mathcal{L}_Y/N_{\mathrm{ST}}$ ($10^{21}\cdot$ cm^{-2})	Estimated signal yield ($\times 10^3$ for STCF)
Λ	7.89	$J/\psi \to \Lambda\bar{\Lambda}$	1.89 ± 0.09	1074	26	64	23.59	5290
Σ^+	2.40	$J/\psi \to \Sigma^+\bar{\Sigma}^-$	1.07 ± 0.04	992	4	52	4.83	537
Ξ^0	8.71	$J/\psi \to \Xi^0\bar{\Xi}^0$	1.17 ± 0.04	818	7	64	15.81	2368
Ξ^-	4.91	$J/\psi \to \Xi^-\bar{\Xi}^+$	0.97 ± 0.08	807	3	64	7.44	924
Ω^-	2.46	$\psi(3686) \to \Omega^-\bar{\Omega}^+$	0.056 ± 0.003	774	0.05	43	2.61	3

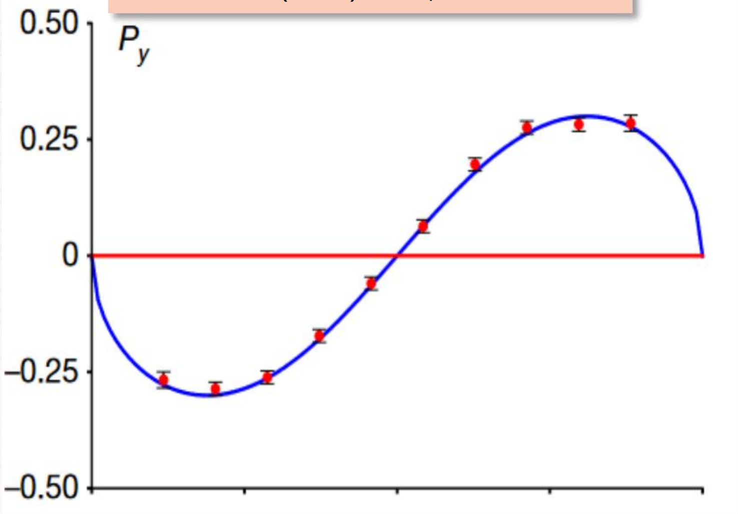
Prospects at STCF

- Potential measurement of the differential cross sections with respect to the polarization of the incident hyperons

Phys.Rev.Lett. 129 (2022) 13, 131801



Nature 606 (2022) 7912, 64-69



$\cos\theta_{\Xi^-}$

Summary

Summary

- The first measurement of $\Xi^0 n \to \Xi^- p$ is firstly measured with Ξ^0 beam from the decay $J/\psi \to \Xi^0\bar{\Xi}^0$ based on 10 billion J/ψ data at BESIII. $\sigma(\Xi^0 + {}^9\mathrm{Be} \to \Xi^- + p + {}^8\mathrm{Be}) = (22.1 \pm 5.3_{\mathrm{stat}} \pm 4.5_{\mathrm{sys}})$ mb. The first study of hyperon-nucleon interaction in electron-positron collisions, opening a new direction for such research.
- The cross section of $\Lambda + {}^9\mathrm{Be} \to \Sigma^+ + X$ is studied with Λ from $J/\psi \to \Lambda\bar{\Lambda}$ to be $\sigma(\Lambda + {}^9\mathrm{Be} \to \Sigma^+ + X) = (37.3 \pm 4.7_{\mathrm{stat}} \pm 3.5_{\mathrm{sys}})$ mb. The first attempt to investigate Λ-nucleus interaction at an e^+e^- collider.
- The first measurement of the antihyperon-nucleon interaction. $\sigma(\Lambda + p \to \Lambda + p) = (12.2 \pm 1.6_{\mathrm{stat}} \pm 1.1_{\mathrm{sys}})$ mb and $\sigma(\bar{\Lambda} + p \to \bar{\Lambda} + p) = (17.5 \pm 2.1_{\mathrm{stat}} \pm 1.6_{\mathrm{sys}})$ mb
- With more statistics in future STCF, the momentum-dependent cross section and differential cross sections can also be studied.

Thank you !

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