

Motivation for Hadron Beams

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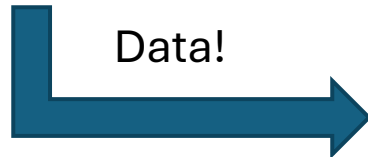
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The role of meson beams in baryon spectroscopy

(Non-strange, light baryon sector)

- Pion-induced reactions

$$\pi N \rightarrow \begin{cases} \pi N \\ \eta N, K\Lambda, K\Sigma \\ \pi\pi N, \pi\eta N, \dots \end{cases}$$



- Photon-induced reactions

$$\gamma^{(*)} N \rightarrow \begin{cases} \pi N \\ \eta N, K\Lambda, K\Sigma \\ \pi\pi N, \pi\eta N, \dots \end{cases}$$

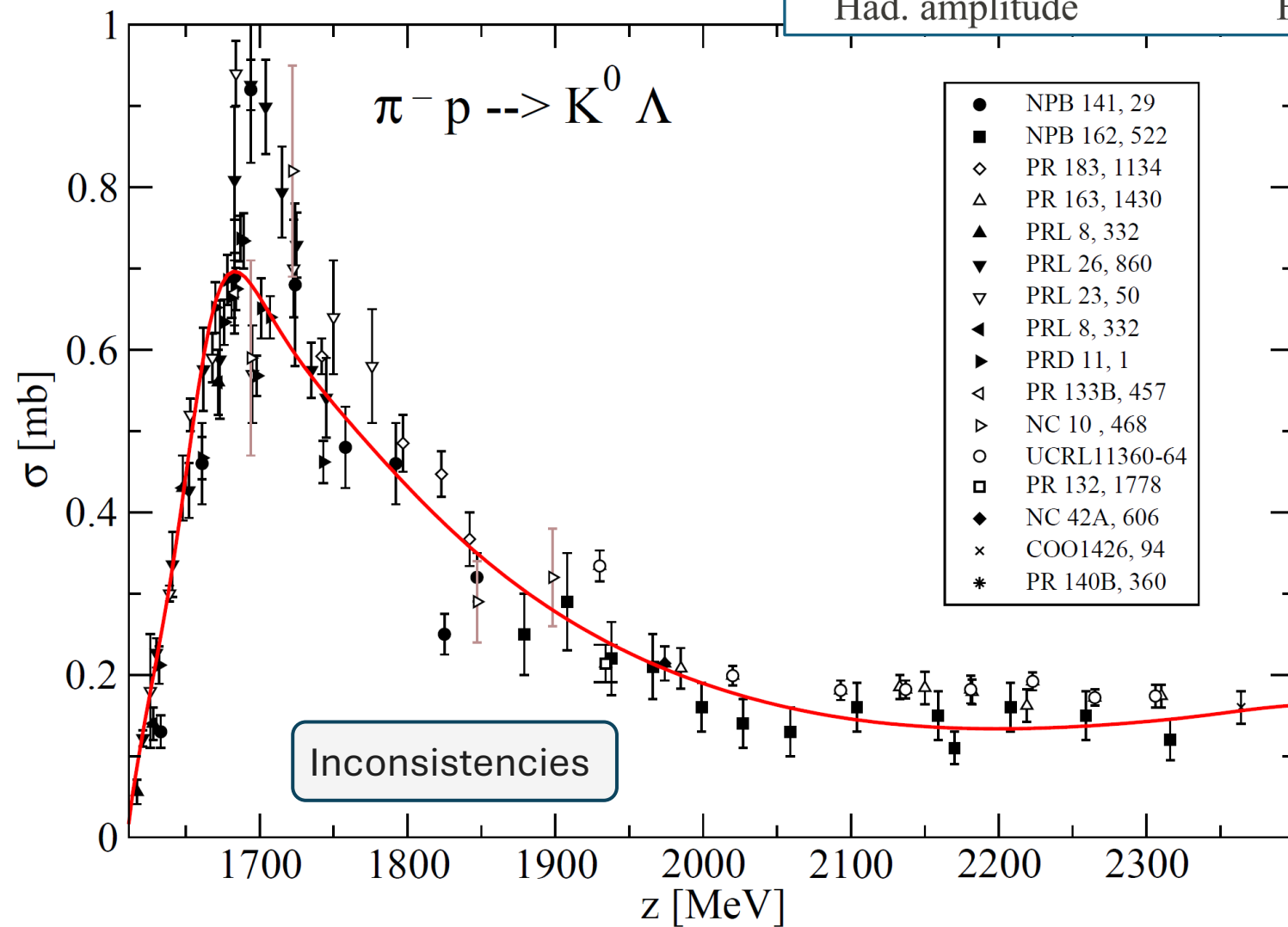
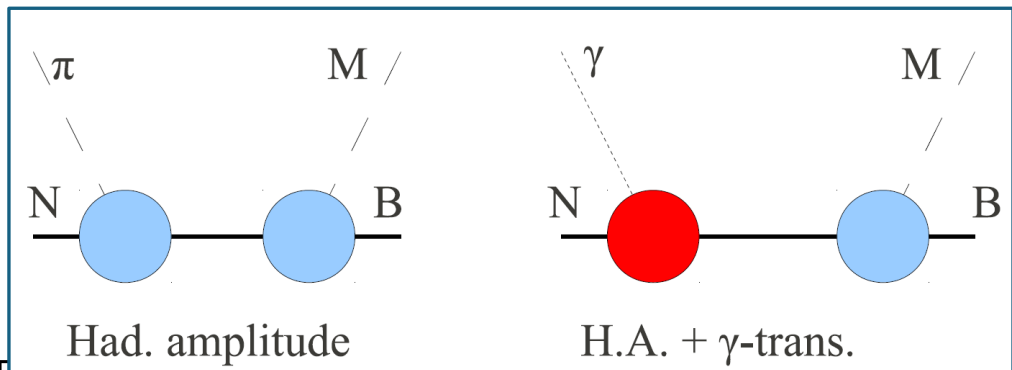
$$\begin{cases} \pi N \\ \eta N, K\Lambda, K\Sigma \\ \pi\pi N, \pi\eta N, \dots \end{cases} \leftrightarrow \begin{cases} \pi N \\ \eta N, K\Lambda, K\Sigma \\ \pi\pi N, \pi\eta N, \dots \end{cases}$$

- **Two** complex amplitudes (g,h)

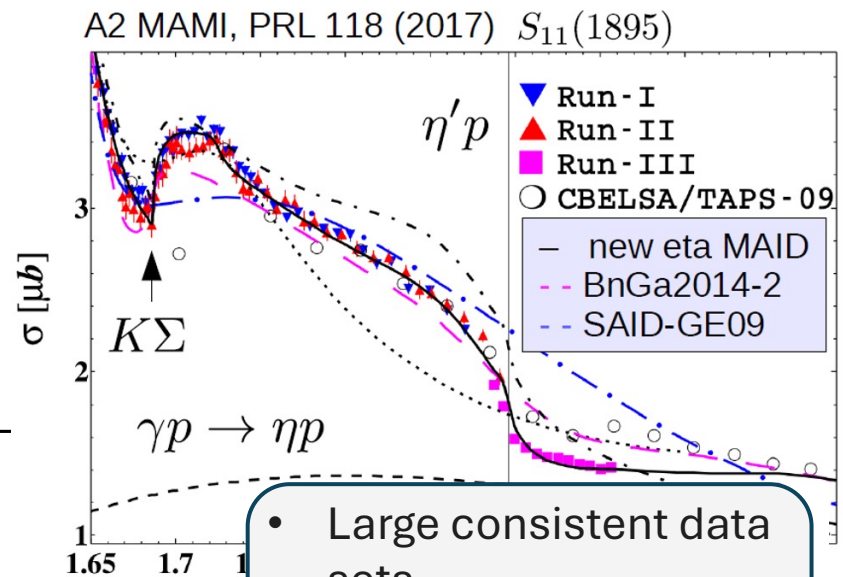
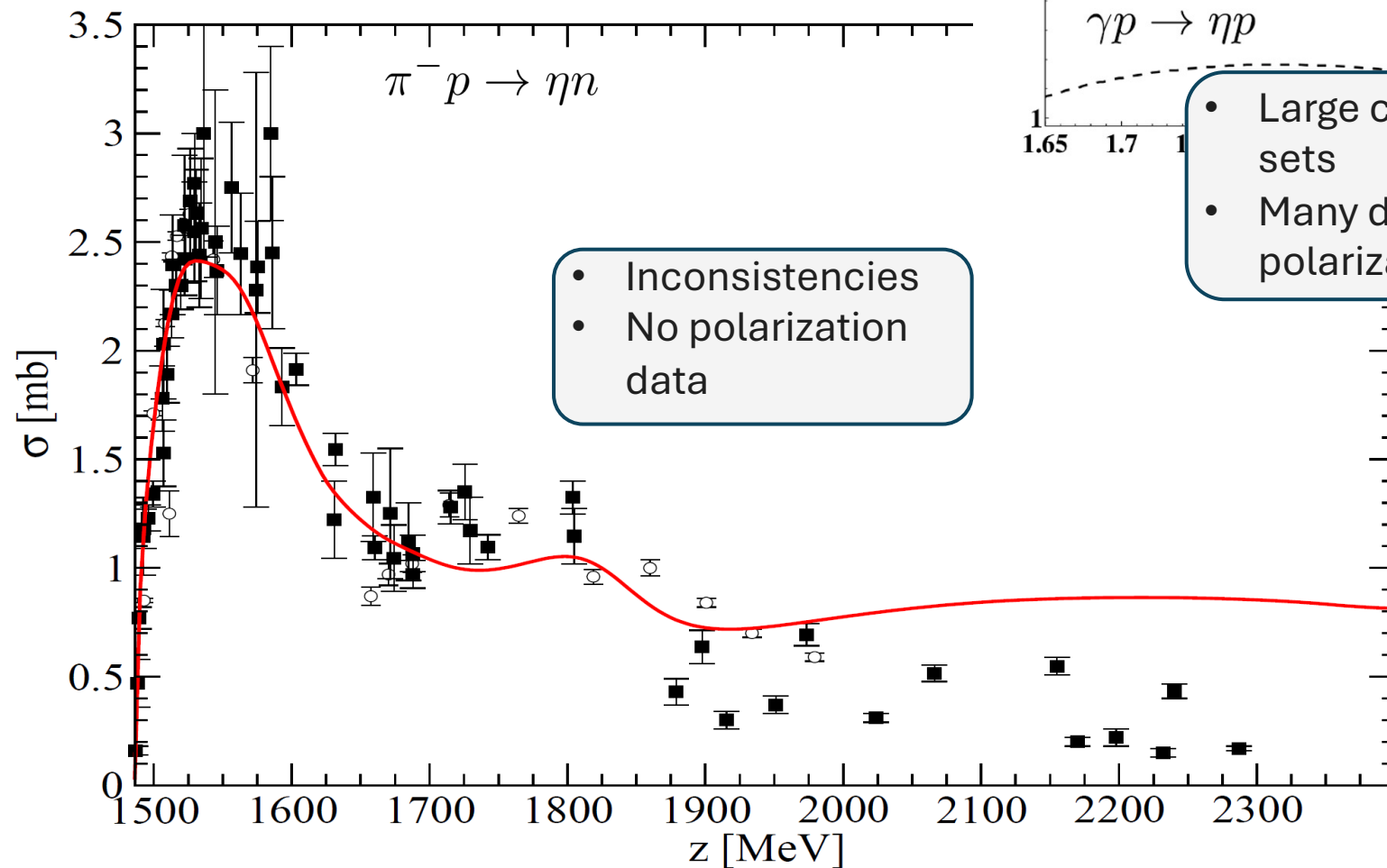
- **Final-state interaction** as sub-process
- **Four** (photo) or **six** (electro) complex amplitudes (CGNL, ...)

Photon-induced reactions have more d.o.f. and their analysis depends on meson-induced reaction data (except complete experiment).

Data



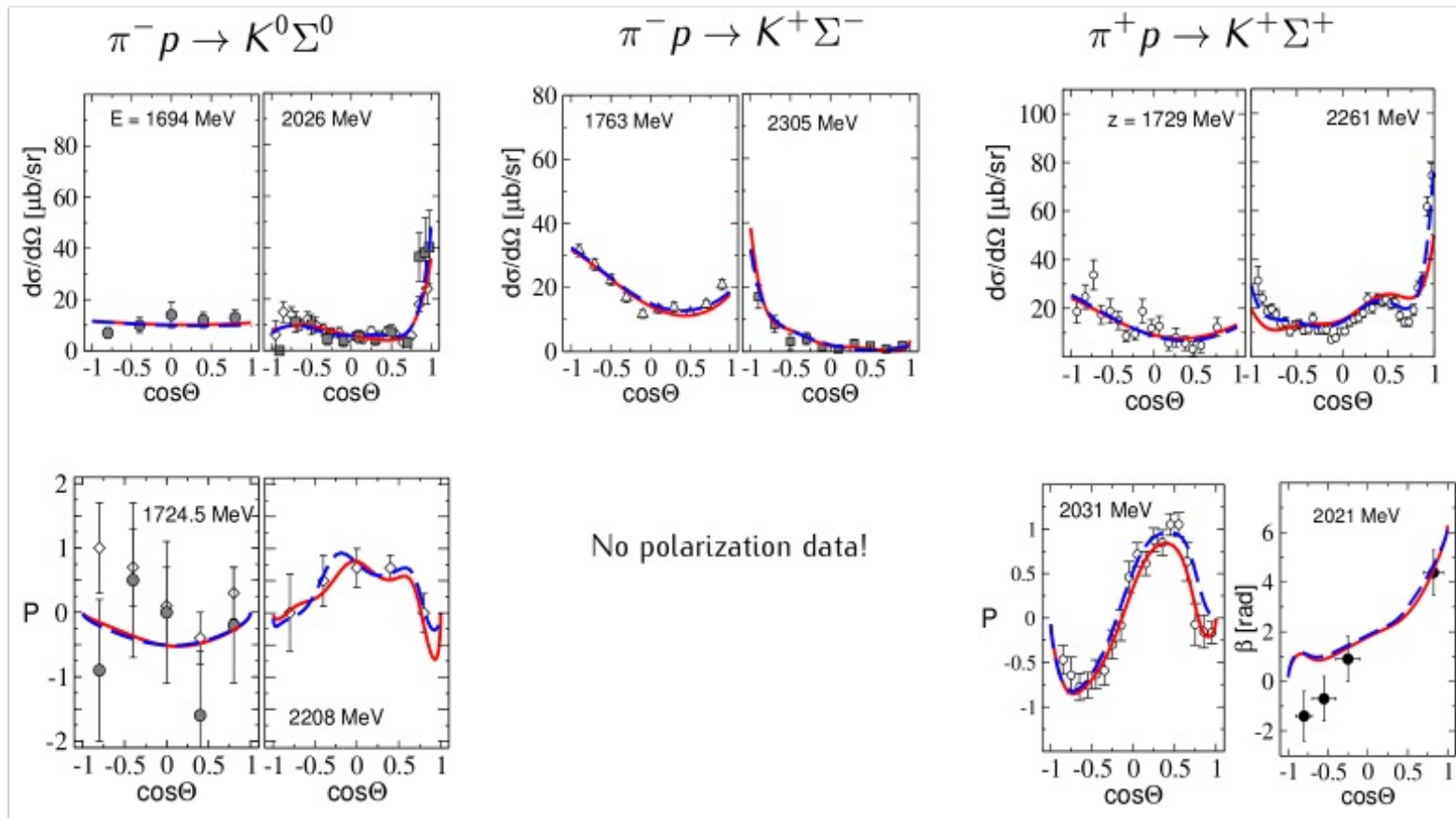
Data: η production



- Large consistent data sets
- Many different polarization data

Re-measuring hadron-induced reactions

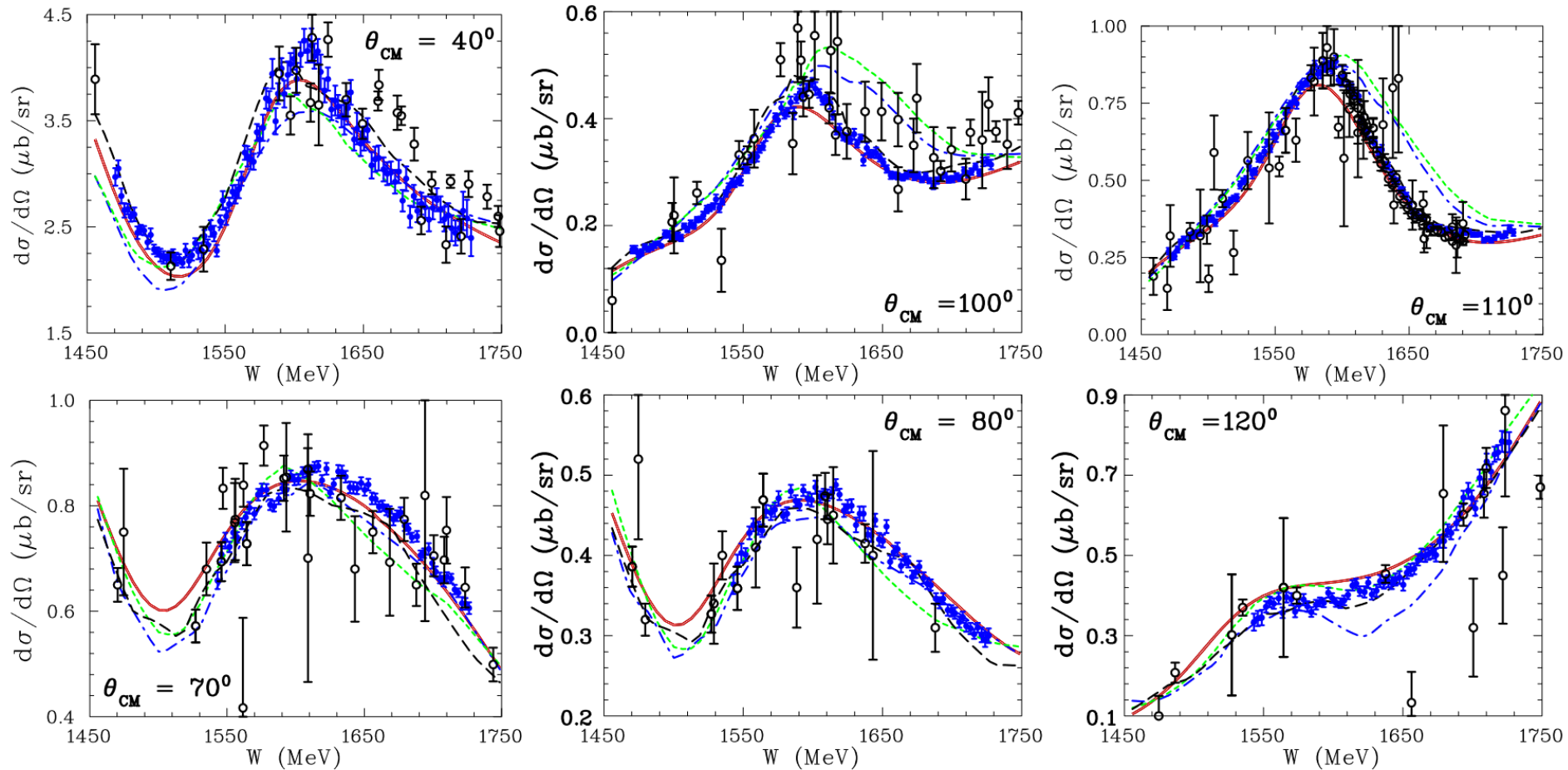
Fits: D. Rönchen, M.D., et al., EPJ A49 (2013)



→ *Physics Opportunities with meson beams*,
 Briscoe, M.D., Haberzettl, Manley, Naruki, Strakovsky, Swanson, EPJ A51 (2015)

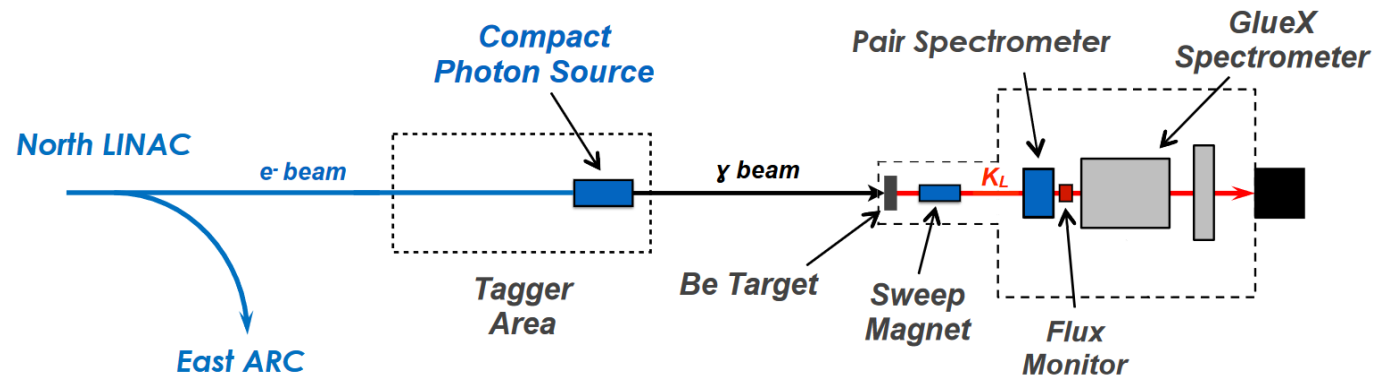
Example of recent improvements

Goal: Reduction of systematic uncertainties/ large body of consistent data



EPECUR experiment [[Alekseev 2015](#)] (**blue**) compared to previous measurements (**black**)

K-Long



KLF Wiki page: [\[https://wiki.jlab.org/klproject/index.php/Main_Page\]](https://wiki.jlab.org/klproject/index.php/Main_Page)

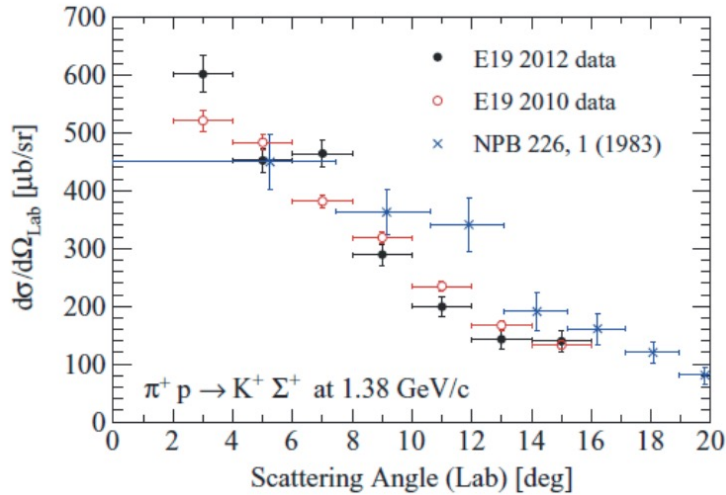
- Overview of current experimental status: [\[Sean Dobbs 2022\]](#)
 - This talk is not about experimental status of approved KL experiment but provides some physics motivation for it.
 - See Wiki page for talks on experimental status.
- Whitepaper [\[2020\]](#) ; secondary meson beam whitepaper [\[Briscoe 2015\]](#)
- Extensive theoretical support:

Alexey Anisovich^{5,44}, Alexei Bazavov³⁸, Rene Bellwied²¹, Veronique Bernard⁴²,
Gilberto Colangelo³, Aleš Ciepły⁴⁶, Michael Döring¹⁹, Ali Eskanderian¹⁹, Jose Goity^{20,49},
Helmut Haberzettl¹⁹, Mirza Hadžimehmedović⁵⁵, Robert Jaffe³⁶, Boris Kopeliovich⁵⁴,
Heinrich Leutwyler³, Maxim Mai¹⁹, Terry Mart⁶⁵, Maxim Matveev⁴⁴, Ulf-G. Meißner^{5,29},
Colin Morningstar⁹, Bachir Moussallam⁴², Kanzo Nakayama⁵⁸, Wolfgang Ochs³⁷,
Youngseok Oh³¹, Rifat Omerović⁵⁵, Hedim Osmanović⁵⁵, Eulogio Oset⁶², Antimo Palano⁶⁴,
Jose Peláez³⁴, Alessandro Pilloni^{66,67}, Maxim Polyakov⁴⁸, David Richards⁴⁹, Arkaitz Rodas^{49,56},
Dan-Olof Riska¹², Jacobo Ruiz de Elvira³, Hui-Young Ryu⁴⁵, Elena Santopinto²³,
Andrey Sarantsev^{5,44}, Jugoslav Stahov⁵⁵, Alfred Švarc⁴⁷, Adam Szczepaniak^{22,49},
Ronald Workman¹⁹, Bing-Song Zou⁴



J-Parc experiments with pion beams

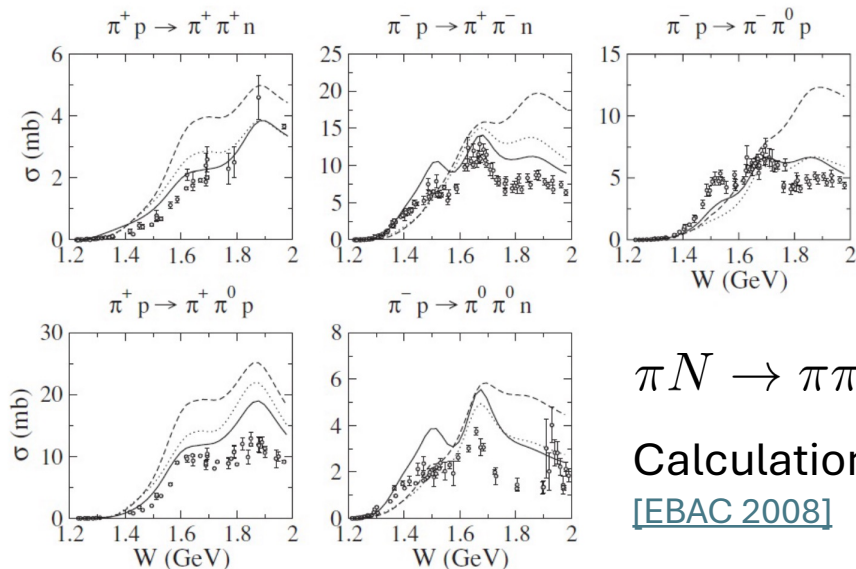
[Ohnishi et al., PPNP 2019]



- J-Parc E19, [Naruki/E19 experiment, 2016]

Very valuable input
for all PWA efforts
in light baryon
spectroscopy

- J-Parc E45 [Proposal 2012]



$\pi N \rightarrow \pi \pi N$

Calculation:

[EBAC 2008]

$\pi N \rightarrow KY$

