Why We Need Meson Beams

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White Paper in progress

- Reliable **theoretical** and **phenomenological** analyses need **hadron-induced** measurements such as
  πN→πN, ηN, KΛ, KΣ, and
  KN→KN, πΛ, πΣ, ηΛ, ηΣ, and also **multi-meson** final states.

- Measurements with pion and Kaon beams make possible studies of **baryon** and **meson spectroscopy** that are complementary to programs underway worldwide at major **EM** facilities such as **JLab**, **Mainz**, **SPring-8**, **Bonn**, and elsewhere.

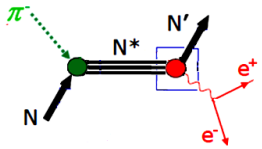
- The **key** instrument is a **coupled-channel** analysis that requires precise data for several channels at many energies and angles.

$\pi^- p \to \eta n$

- $\gamma p \to \eta p$ is one of the **key reactions** for which colleagues in the **EM** community hope to do a ``***complete measurement***".
  Any **coupled-channel analysis** of those measurements will need precise data for $\pi^- p \to \eta n$.
- Most of the available data for that reaction come from measurements published in the **1970**s, which have been evaluated by several groups as being **unreliable** above **1620** MeV.
- Precise new data were measured by the **Crystal Ball** Collaboration (Prakhov 2005), but these extend only up to the peak of the first S_{11}-resonance.

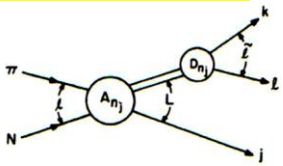
- **Very few polarization data for these reactions exist.**
- Available data for $\pi^- p$ reactions with **KY**, $\eta' N$, ωN, and ϕN final states are generally as **bad** or **worse**.

$\pi^- p \to e^+ e^- n$



- **IPE** is the **only process** that allows the determination of **EM nucleon** and **pion form-factors** in the intervals: $0 < k^2 < 4M^2 = 3.53\ \text{GeV}^2$ $0 < k^2 < 4m_\pi^2 = 0.08\ \text{GeV}^2$ which are **kinematically unattainable** from e^+e^- initial state.
- **IPE** measurements will significantly complement **electroproduction** $\gamma^* N \to \pi N$ studies.

$\pi N \to \pi\pi N$



- For most established **N** and **Δ** resonances, their dominant inelastic decays are to $\pi\pi N$ final states. A large experimental **database** (including **pol** measurements) is **needed** to determine precisely the PW amplitudes because so many amplitudes are needed to describe **three-body** final states.
- **241,214** **Bubble Chamber** events for $\pi N \to \pi\pi N$ have been analyzed in **Isobar-model PWA** at W = **1320** to **1930** MeV [Manley, Arndt *et al* Phys Rev D **30**, 904 (1984)] .
- This **30**-yr old result remains the main source of our knowledge about $\pi N \to \pi\pi N$.

- The **Hadronic Complex** can longer keep the **JLab** *MEIC* **pre-Booster** and **Linac** busy [to use more than ``**several minutes**" a day], which would be much more effective use of the *MEIC* facility.