

The Near-Threshold Pion Photoproduction Program at MAX-lab

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for the Pions@MAX-lab collaboration**



UMass

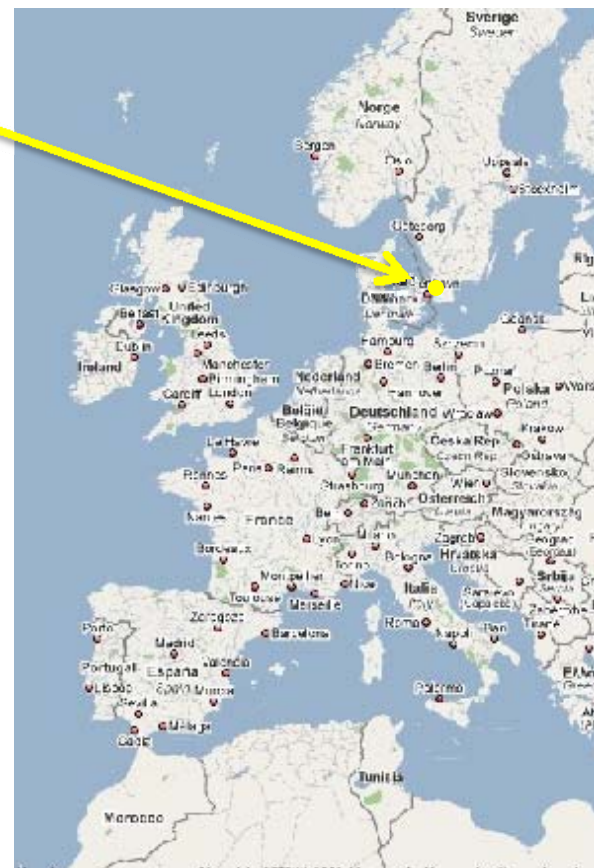
| Dartmouth





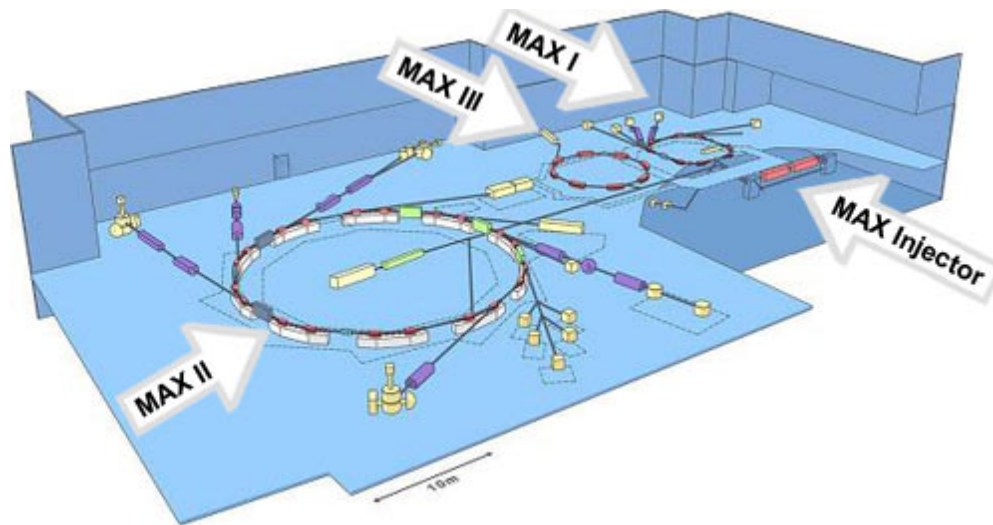
MAX-lab

- ❑ located at Lund University in southern Sweden
- ❑ synchrotron light facility
- ❑ ~ 1/3 time nuclear physics
 - few body systems
 - nuclear compton scattering
 - pion photoproduction



MAX-lab Facility

- 18 weeks/year for Nuclear Physics research



- photon tagging spectrometer
- $E_\gamma < 194 \text{ MeV}$
- $\Delta E_\gamma \sim 0.4 \text{ MeV}$
- $\sim 10^6 \gamma/\text{MeV}/\text{s}$

- E_γ up to $\sim 200 \text{ MeV}$
 - ideal energy for (γ, π) near threshold
- only lab where these measurements will be done

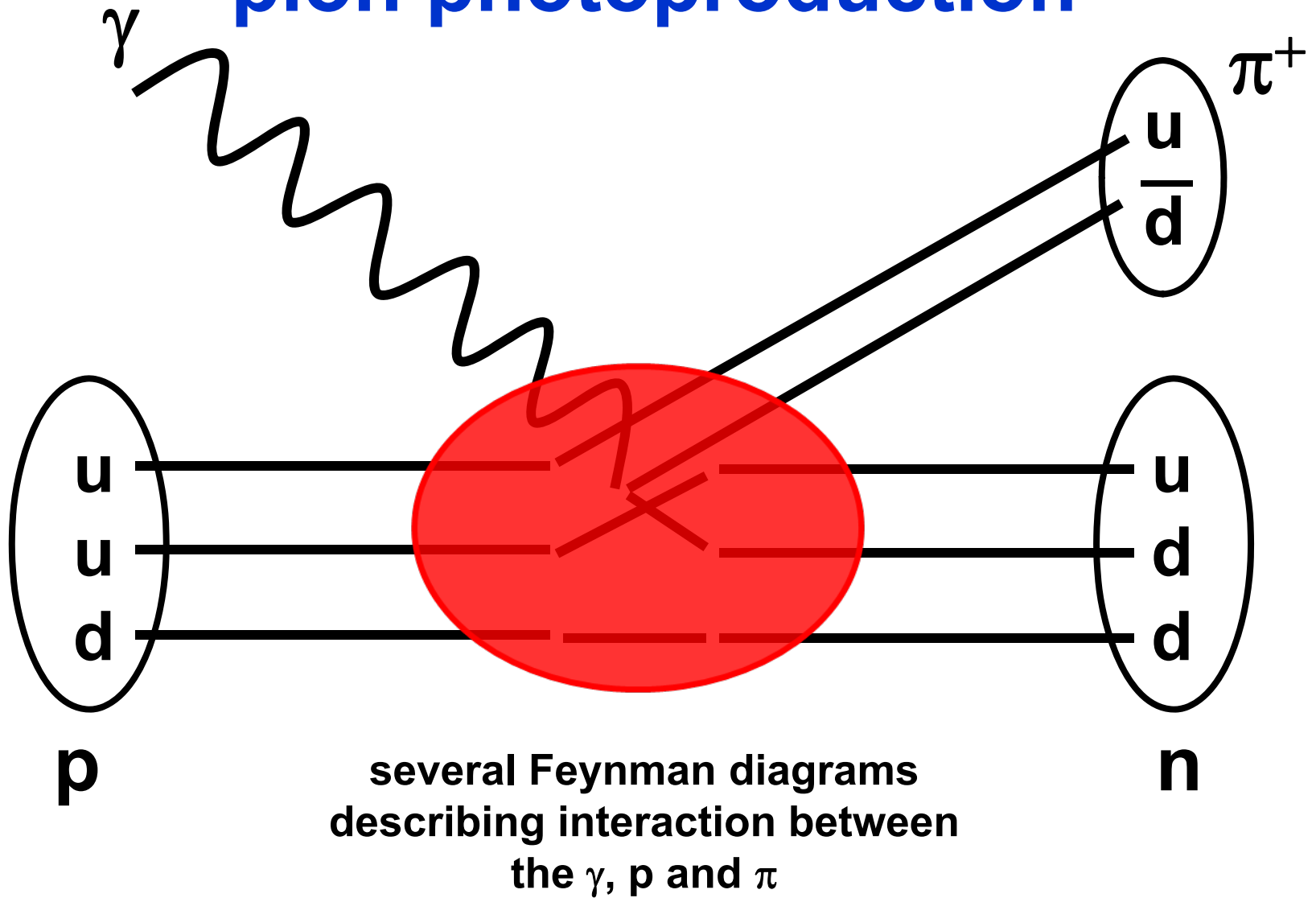
understanding the nucleon

Pion photoproduction near threshold is one of the few low-energy processes where it is possible to formulate QCD-based effective theories.

- involves direct rearrangement of the quarks

The results from these measurements can be compared with the predictions from various quark-based models.

pion photoproduction



understanding the nucleon

- low-energy theorems, dispersion relations
- chiral perturbation theory
- Partial-wave analyses (MAID, SAID)

- ChPT has been used to predict the s- and p-wave contributions to pion photoproduction
 - need to test these against measurements

neutral channel: $\gamma + p \rightarrow p + \pi^0$

■ experiment (Mainz and SAL)

- nearly 1200 data points for $E_\gamma < 200$ MeV
 - cover large energy and angular range
 - good agreement between different experiments

■ theory

- calculations for s- and p-wave multipoles

**good agreement between
theory and experiment**

charged channels: $\gamma + p \rightarrow n + \pi^+$
 $\gamma + n \rightarrow p + \pi^-$

■ experiment

- one recent measurement on each channel
 - < 50 data points on each
 - sparse energy and angular coverage

■ theory

- ChPT calculations are more difficult
- only done to leading order

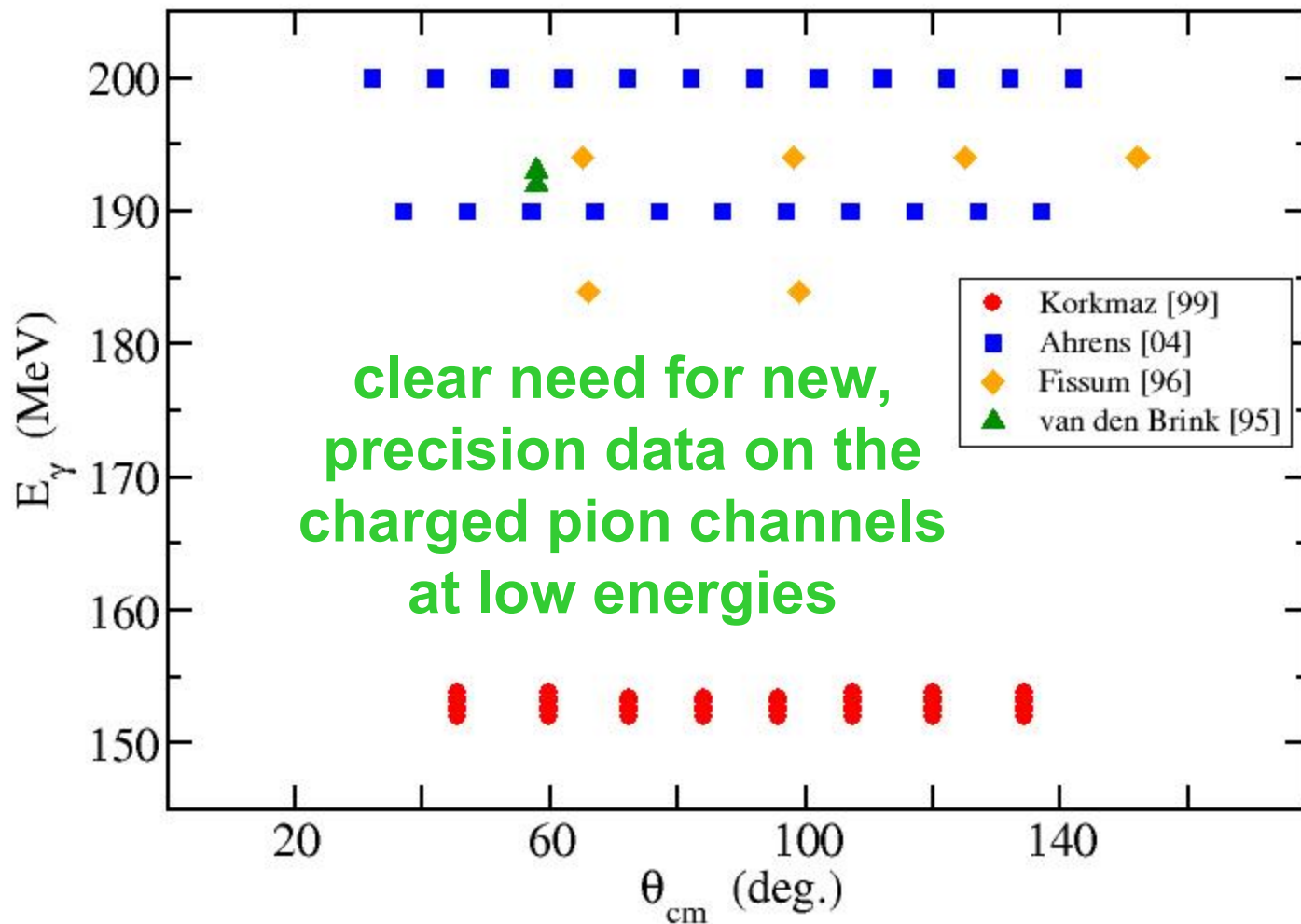
beyond the s-wave

- above threshold, p-waves quickly dominate

$$\frac{d\sigma}{d\Omega} = \left(\frac{q}{k}\right) \left[A(E_\pi) + B(E_\pi) \cos(\theta) + C(E_\pi) \cos^2(\theta) \right]$$

- To get at the p-waves need data on angular distribution

existing data for $\gamma + p \rightarrow n + \pi^+$



Pion program @ MAX-lab

MAX-lab PAC approved 2 experiments

■ NP-014

- (γ, π^+) differential cross sections up to 200 MeV
- detect outgoing π^+ in scintillator counters

■ NP-017

- (γ, π^-) absolute cross sections near threshold
- detect 140 MeV γ from π^- capture in LD₂ target

(γ, π^+) program @ MAX-lab

■ MAX-lab program

- solid targets (CH_2 , C, CD_2 , Ta)
- Detect π^+ in scintillator telescopes at various angles

■ straight-forward measurements

- simple target and detectors
- pion ID and efficiencies easily calculated
- standard analysis methods

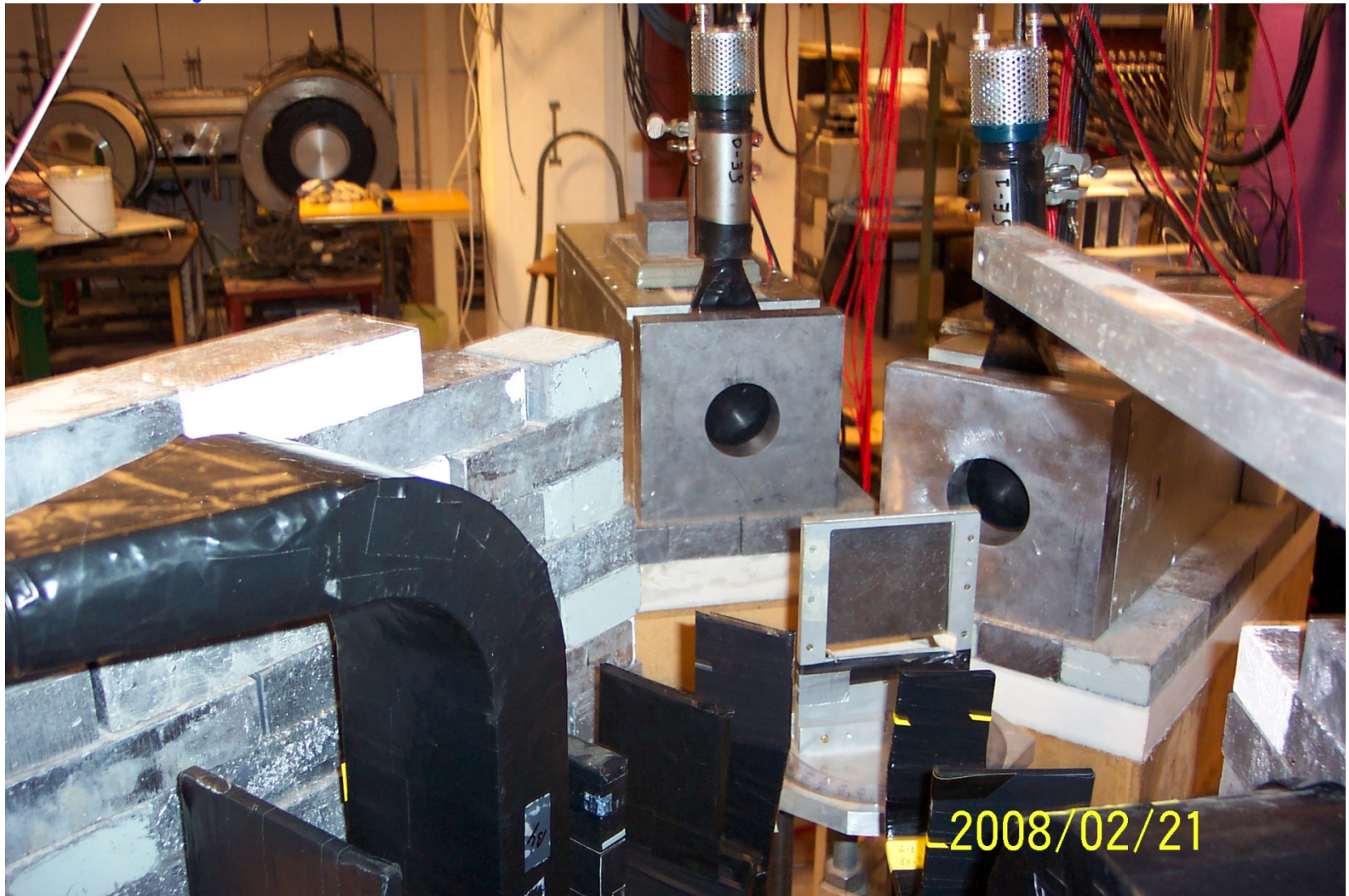
(γ, π^+) program @ MAX-lab

Three independent groups

- xSAL group: ΔE + monolithic E counters
- RANGE group: multiple ΔE -E layers
- CsI group: Si strip (ΔE) + CsI (stopping)
 - different detector systems and analyses
 - different event identification methods
 - Important cross-check on results

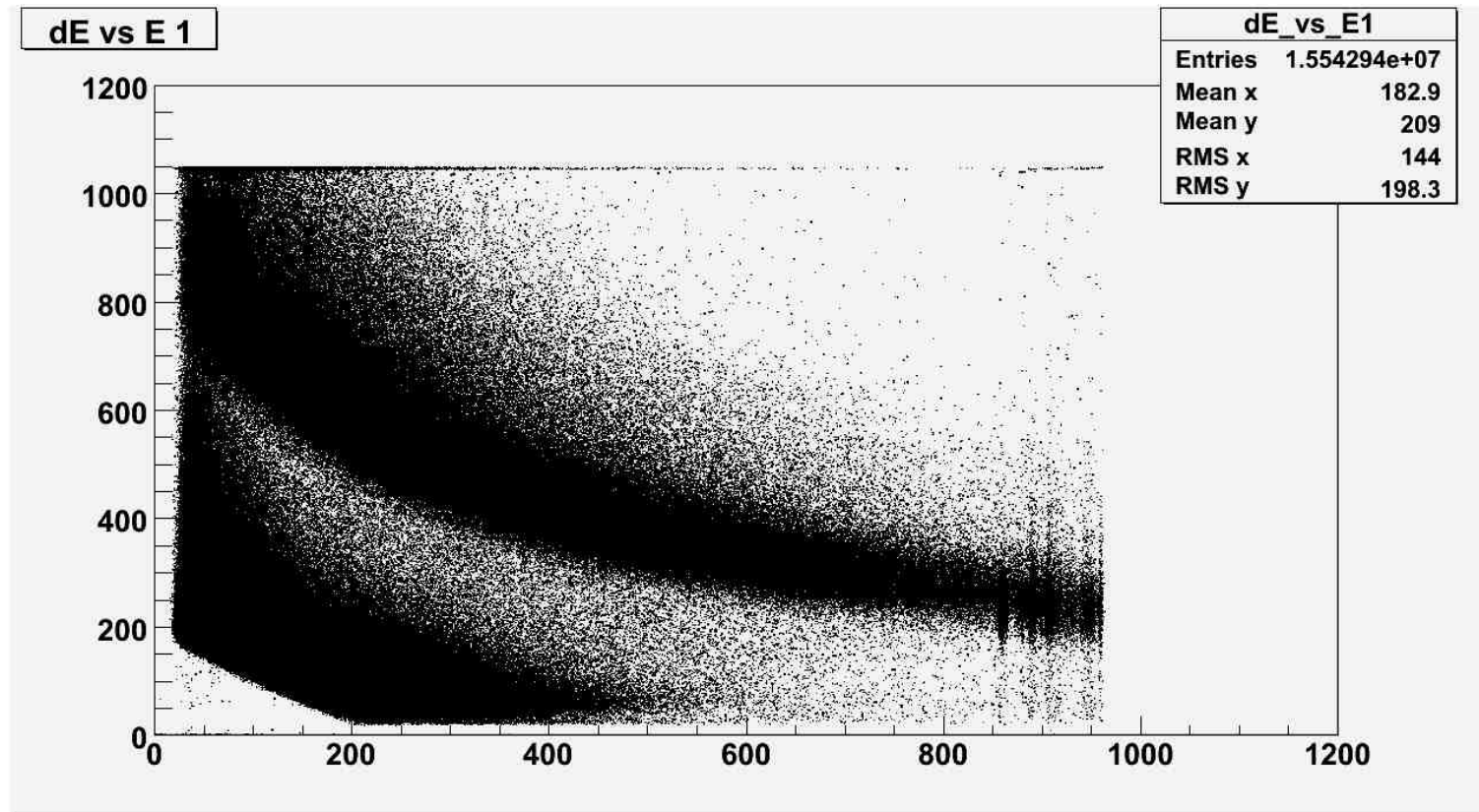
First production run in summer 2009

(γ, π^+) program @ MAX-lab



Data Analysis

- ΔE vs E stopping power

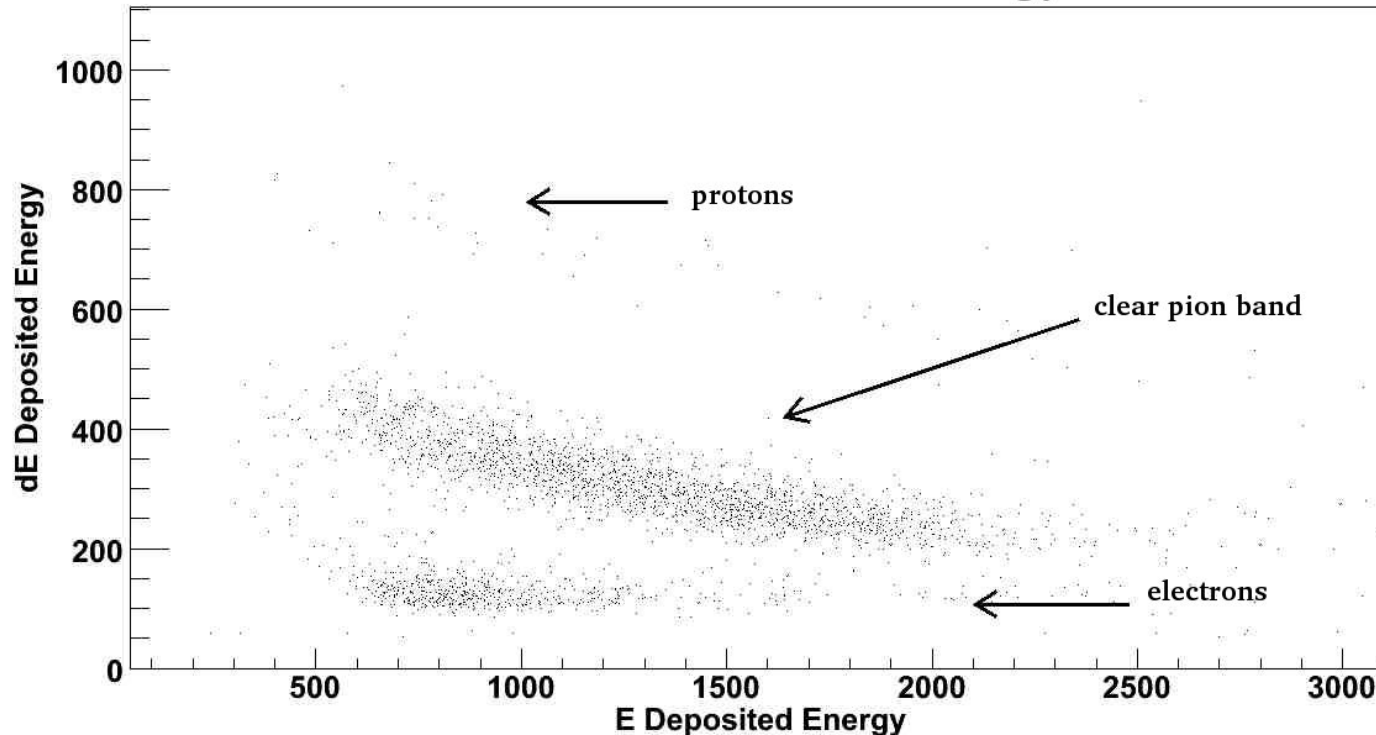


- Can't isolate π^+ events

π identification

- Use the $\pi \rightarrow \mu$ decay

dE vs E with Muon Energy Cut



- See C. Allen's poster this evening

Where we are now

- First production data last summer
 - All detectors systems worked beautifully
 - High-quality data
 - Lower than expected count rate

- Next production run in June 2010
 - More work in March to improve rates
 - Improve beam quality & duty factor
 - DAQ deadtime & detector acceptance

Where we will be

(γ, π^+) program @ MAX-lab

