

# Summary of the Review for the GlueX Experiment Proposal

## Measuring the Polarizability of the Neutral Pion with GlueX

Barry Ritchie (chair, Arizona State) and Joerg Reinhold (Florida International)  
July 1, 2020

### Motivation

The authors propose a precision measurement of the cross section for the reaction  $\gamma\gamma^* \rightarrow \pi^0\pi^0$  via the Primakoff effect using the GlueX detector in Hall D. The central aim of the measurement is to drastically improve the determination of the cross section in this domain, which is key for constraining the low energy Compton amplitude of the  $\pi^0$  and thus for extracting its polarizability. This will result in the first experimental determination of the neutral pion polarizability  $\alpha_{\pi^0} - \beta_{\pi^0}$  (the difference of the electric and magnetic polarizabilities, respectively), an important prediction of chiral perturbation theory and a key test of chiral dynamics. Notably, these polarizabilities are determined by the one loop chiral contributions in chiral perturbation theory, which are calculable and free of unknown parameters.

The experiment proposes to take data concurrently with experiment E12-13-008, *Measuring the Charged Pion Polarizability (CPP) in the  $\gamma\gamma^* \rightarrow \pi^+\pi^-$  Reaction*.

### Measurements and Feasibility

Compared to standard GlueX run conditions, the proposed experiment will take data with almost the same modified experimental conditions as experiment E12-13-008; i.e., a lower energy for the coherent photon peak and a solid target moved upstream from the nominal position. The only difference between experiment E12-13-008 and the proposed experiment is the trigger required. Both experiments presented their most recent simulated background studies and expected trigger rates at the May 2020 GlueX Collaboration Meeting. This proposal would add an additional 10 kHz to the  $\sim 30$  kHz trigger rate of CPP. With the capabilities of the current DAQ system, this should add little dead time to the system.

Based on the *ad hoc* review for the proposed experiment, the proposals were found to be compatible in terms of target, beam, and trigger, and the proposal presented sufficient evidence that the measurements proposed were feasible in the beam time requested in the proposal, resulting in a projected uncertainty of 39% for  $\alpha_{\pi^0} - \beta_{\pi^0}$ .

### Summary

The proposed experiment complements an already approved experiment, taking advantage of the same modifications to the standard running conditions for the GlueX experiment. The experiment should be able to take data with almost no interference with E12-13-008.

Additionally, there is overlap between the spokespersons for both experiments. Though different final states are being studied, the analysis techniques required are similar; with the same core group leading the experiments, this overlap will lead to significant efficiencies in analyzing both experiments. These increase the “return on investment” of resources when running concurrently with E12-13-008.

Therefore, the proposal has been recommended for collaboration approval.