Date: April 28, 2019

For Proposal for JLab PAC47
Strange Hadron Spectroscopy with Secondary KL Beam in Hall D

Compact Photon Source for Hall D: Conceptual Design

An intense high-energy gamma source is a prerequisite for the production of the KL beam needed for the new experiments described in this proposal. In 2014, the Neutral Particle Spectrometer (NPS) Collaboration started the development of a novel concept of a Compact Photon Source (CPS) [**1**]. It was originally developed for a *Wide-Angle Compton Experiment* proposed to PAC43 [**2**], but additional science possibilities have been discussed since.

The details of the CPS can be found in a document by the CPS Collaboration Working Group [**3**]. We present here a part of the document to illustrate the main aspects of the conceptual design. The CPS design combines in a single properly shielded assembly all elements necessary for the production of the intense photon beam, such that the overall dimensions of the setup are limited and the operational radiation dose rates around it are acceptable. Compared to the alternative, the proposed CPS solution presents several advantages: much lower radiation levels, both prompt and post-operational due to the beamline elements radio-activation at the vault. The new design provides much less disturbance of the available infrastructure at the Tagger Area, and better flexibility in achieving high-intensity photon beam delivery to Hall D. The new CPS solution will satisfy the proposed KL beam production parameters; we do not envision any significant technical or organizational difficulties in the implementation of the conceptual design.

The new setup utilizes the Hall D Tagger vault, properly shielded by design to accommodate the medium power beam-dump capable of accepting up to 60 kW of 12 GeV electron beam, assuming that proper local shielding is set around the dump. The presently installed dump is placed behind the iron labyrinth walls, and is surrounded by a massive iron shielding, made of iron blocks available at the time of construction. The standard GlueX setup is optimized for operations using very thin radiators producing relatively low intensity photon beam such that the beam electrons losing energy to photon production in the radiator may be detected and counted in the tagger hodoscope counters. The present setup is not suitable for production of massively more intense photon beams needed for the KL production, due to the expected overwhelming radiation and activation levels in the vault.

The CPS will be located downstream of the tagger magnet. The tagger alcove has more space than that available in Halls C/A, so positioning and shielding placement are simpler. Indeed, the CPS implementation in Hall D may have a different length and magnet field, as well as shielding. A total floor loading of the implementation up to 100 t is acceptable. Hall D would require implementation of the rastering system in the beam line leading to the vault, that should be optimized.

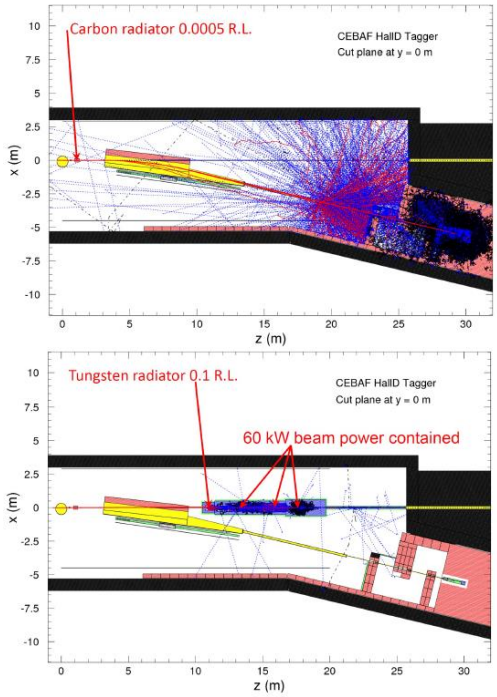

Figure **1**: Plane cut of the Tagger vault model built using the GEANT3 detector simulation package. Black areas correspond to the concrete walls. Red hatch style is used for iron shielding blocks. Yellow areas correspond to the beam vacuum. Top panel: The simulation of 2000 beam electrons at 12 GeV for the current Hall D setup. Red tracks show charged particles, mostly electrons, blue tracks are gammas, and neutrons are tracked in black. Bottom panel: The CPS assembly and the simulation of 2000 beam electrons at 12 GeV. This Figures are taken from Ref. [**4**] (Figures 3 and 6).

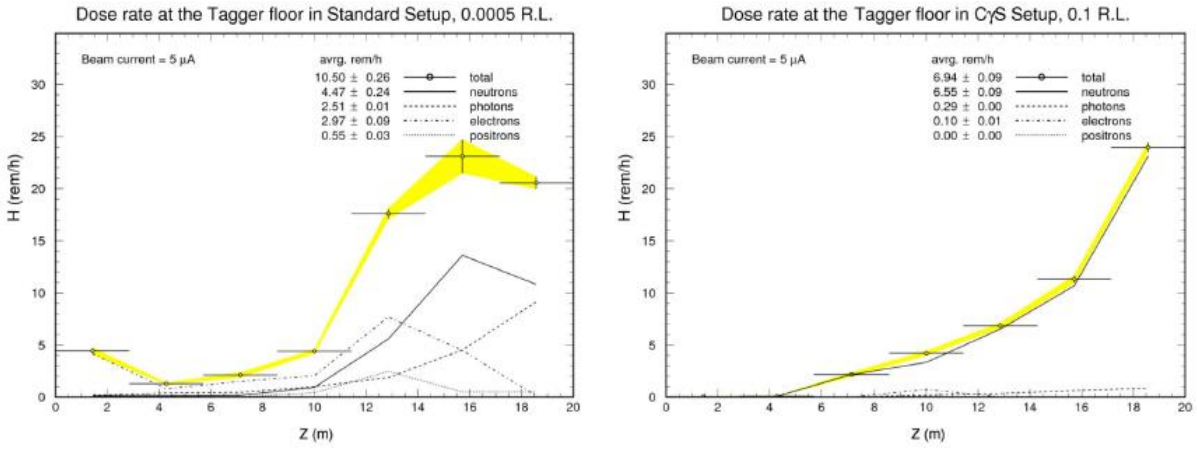

Figure **2**: A comparison of dose rate estimates in the Tagger Area in the two conditions: Left panel: Nominal Hall D operation with the standard amorphous radiator at 0.05 % R.L. and Right panel: Radiator at 10 % R.L., used as part of the CPS setup. This Figure is taken from Ref. [**4**] (Figure 7).

For the Hall-D adaptation, the 5 μA beam current is limited by the design of the Hall D Tagger Magnet alcove. This corresponds to a 60 kW power limit. Note that the ceiling shielding of the

Tagger hall above the CPS position is the same as it is above the existing 60 kW dump. No radiation increase at the site boundary is thus expected with respect to 60 kW operations using the existing dump. Figs. **1** and **2** illustrate how the CPS stops the electron beam and absorbs almost all beam energy inside, and therefore provides excellent shielding. Running the CPS at full beam power produces radiation fields in the Hall D tagger area, comparable with running regular Hall D experiment utilizing a very thin radiator upstream of the tagger magnet. A 30 kW CPS has been designed for Halls C/A. For Hall D, the dose rates in the vault during full 60 kW beam operations are comparable to the nominal running conditions in the vault, as shown in Fig. **2**. The latter device has to be somewhat larger, but the Tagger hall provides more available space than the Hall C location.

References

[**1**] https://wiki.jlab.org/cuawiki/images/3/32/Sergey□Abrahamyan□WACS□NPS□2014□update.pdf

[**2**] *Polarization observables in wide-angle Compton scattering at photon energies up to 8 GeV*, Spokespersons: B.Wojtsekhowski, S. Abrahamyan, and G. Niculescu [Neutral Particle Spectrometer Collaboration], JLab Proposal PR12–15–003, Newport News, VA, USA, 2015.

[**3**] T. Horn, D. Day, P. Degtiarenko, R. Ent, D. Hamilton, D. Keller, C. Keppel, G. Niculescu, P. Reid, I. Strakovsky, B. Wojtsekhowski, and J. Zhang, Preprint GlueX-doc-36xx, 2018.

[**4**] P. Degtyarenko and B. Wojtsekhowski, in: *Workshop on Physics with Neutral Kaon Beam at JLab: mini-Proceedings*, arXiv:1604.02141 [hep–ph] (February, 2016), p. 214.