

## For Proposal for JLab PAC48

### *Strange Hadron Spectroscopy with Secondary KL Beam in Hall D*

#### **List of New Equipment and of Changes in Existing Setup Required**

The CEBAF and Hall D transport line do not require any upgrades or additional equipment beyond that planned for the tagger enclosure and CPS. The following major changes to existing equipment are summarized below.

##### **New equipment**

- Compact Photon Source (**CPS**) is used to produce the high-intensity photon beam. The CPS contains a 10% RL radiator, a magnet, an electron beam dump, and a block of tungsten shielding. It will be installed in the Tagger Hall, downstream of the tagger magnet. A similar CPS is being designed for Halls A/C by the CPS Collaboration. The estimated cost is **\$2.7M**.
- Kaon Production Target (**KPT**) is used to produce kaons in interactions of the photon beam with a Be target. It contains a 40 cm long Be target and a shielding block. It will be installed in the collimator cave. The estimated cost is **\$261k**.
- The Kaon Flux Monitor (**KFM**) is used to measure the flux of kaons. It consists of a superconducting magnet and a set of detectors. It will be installed in Hall D, downstream of the Pair Spectrometer magnet. The estimated cost is **\$700k** and the construction labor including power supply and cryo system are expected to be the responsibility of the York Univ. group.
- New liquid hydrogen target cell, 6 cm diameter and 40 cm long, to replace the existing 2 cm diameter cell. It will include minor other modifications to the existing system. The estimated cost is **\$30k**.
- New beamline pipes between the collimator cave and the GlueX solenoid. The estimated cost is **\$20k**.
- In order to build up a beamline delivery system for the secondary KL beam, a rough estimate is for about **\$10k** the pulse picking system and about **\$50k** for the laser amplifier.
- To develop an injector beam delivery system for the secondary KL beam, a rough estimate is about **\$20k** for a low-frequency pulse picking system, about **\$15k** for high-power laser optics, about **\$35k** for a high-power laser amplifier, and about **\$35k** for a spare high-power laser amplifier since these have been known to fail during use and procurement has long lead time (3-6 months).

##### **Modifications to the existing setup and the installation scope**

**Tagger Hall.** Installation of the CPS downstream of the tagger magnet. Removal of the electronics and other radiation sensitive equipment from the Tagger Hall. Estimated labor is 11 wks of 3 MT (0.75 FTE).

**Collimator Cave.** Removal of all the equipment. Installation of the KPT and of two concrete walls. Re-installation of the permanent magnet in a new place. Estimated labor is 23 wks of 3 MT (1.6 FTE).

**Hall D.** Replacement of the beam line pipes from the collimator cave to the LH2 target. Removal of the Pair spectrometer detectors. Installation of the KFM. Additional costs for accommodation of the Hall-D infrastructure to a KFM need were evaluated to be about **\$5k** for the cooling system and **\$3k** for electrical infrastructure. This costs as well as the costs of mounting the FM in the Hall-D are expected to be covered by JLab. Modifications to the LH2 target. Estimated labor is 16 wks of 3 MT (1 FTE).

**Injector.** Lower laser rep rate to proposed 8-16 MHz rates. This includes installation of a high-power amplifier to support high bunch charges at reduced repetition rates with lower risk of amplifier failure, installation of high-power laser optics, and gain switching improvements to provide short pulses for required gain switching. Estimated labor is about 6-8 weeks of RF engineering labor (0.15-0.20 FTE) and about 2 weeks of designer time (0.05 FTE). Accelerator and injector physics labor is covered under CEBAF RSR operations accounts to support an approved experiment.

### **Total costs and labor**

Engineering and design: 0.7 FTE ME, 0.15-0.20 FTE RF engineer, and 1.95 FTE MD

Construction on new equipment: **\$3M** plus **\$700k** which is UK responsibility

Installation: 3.35 FTE labor and ?? materials. The estimates installation time for a 3(?) MT crew is 12 months.

### **Description of the items**

#### **CPS**

- The high intensity photon beam will be produced by a CPS, very similar to the one designed by the JLab CPS Collaboration Working Group for Halls C/A.
- 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 simplified. The floor in the area can hold a 100 t CPS. Different length/field magnet. Shielding may differ.
- A 30 kW CPS has been designed for Halls C/A. The CPS Collaboration Working Group intends to provide the design for a 60-kW device for Hall D.
- The beam power can reach 60 kW (the beam current less than 5  $\mu$ A at 12 GeV). 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 expected with respect to 60 kW operations using the existing dump.
- If one uses a 2nd raster system for Hall D to compensate for the initial 1 mm raster, this can be an equivalent essential design.

**Assuming** there is a complete design of CPS and hardware package delivered to JLab, a designer and engineer would have to work with the CPS collaboration to work it into the existing space. A rough estimate would be:

*Design time:* - 1 designer 25% for 12 months - 0.25 FTE

*Engineering time:* - 1 Engineer 10% for 12 months - 0.1 FTE

*Removal and Installation Time:* - 3 Techs 100% for 2.5 months - 0.6 FTE

*Infrastructure materials and equipment:* **\$20K.**

#### **KPT**

- Modifications of the beamline from the beginning of the collimator cave to the cryogenic target, which includes the Be-target assembly, shielding, etc. The scenario is to use smaller pieces of shielding and keeping (but moving) the current sweep magnet and not removing Pair Spectrometer

magnet. All else is removed from the collimator enclosure and the upstream platform. Materials and equipment: **\$261k**. A breakdown of the hardware as follows.

- Beryllium target 6 cm diameter and 40 cm long: **\$11k**.
- Tungsten plug 16 cm diameter and 10 cm long: **\$123k**.
- Lead sheets - use existing 2" sheets in lead shed: **\$6k** to cut to size and paint.
- Borated poly sheets (5 %): **\$8k**.
- Target rail/support system for moving in and out of beamline: **\$20k**.
- Vacuum beam line and valves: **\$16K** (assumes current gauging and pumps reused, 10E-6 torr vacuum requirement).
- Concrete shielding Labyrinth: **\$20k** (**\$10k** if we use small blocks plus support wall (**\$4k**) but more labor required).
- Water Cooling for target: **\$20k**.
- New concrete/steel collimator on US platform: **\$6k**.
- Reinforcement beams for US platform: **\$5k**.
- New collimator stands: **\$6k**.
- We will remove the bulk of tungsten and replace with lead and we would have to buy that additional lead. There is not enough lead in stock to cover this additional amount. Probably about an additional **\$20K** would be needed.

The **manpower** for design and installation are

- Remove existing equipment from beamline - Technician Labor - 0.5 FTE year, 52 calendar days.
- Install new equipment - Technician Labor - 1.1 FTE year, 110 calendar days.
- Engineering - 0.52 FTE year, 1.3 years (assumes 1 engineer working 40 % for a 1.3 years).
- Designer - 1.38 FTE year, 1.3 years (assumes one designer working 75 % for a 1.3 years and a second designer 40 % for a year).
- Scientist check out of reinstalled equipment and electronics is not included in FTE, equipment cost or calendar time. This should be added.

#### **KFM**

- KFM is being designed by the York Univ. team and will cost about **\$700k**. In case of the approval of the proposal at the current PAC meeting, the York team will apply for a grant to build this device using UK financial support.
- Additional charge is for Flux monitor cooling system: **\$5k** and electrical power infrastructure: **\$3k**.
- The KFM will be located downstream the Pair Spectrometer magnet and upstream pair spectrometer shielding wall. Its weight is 1.1 t and it does permit legs for the flux monitor stand.
- Assume KFM delivered to JLab ready for install and only power and cooling needed.
- Assume all JLab labor and use existing tools for the job.
- Assume 5 day/1 shift work week.
- Also, the assumption is that all new equipment is in hand when the installation begins. Engineering time assumes requirements are known at the start of the design.