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Report of the Review Committee regarding the follow-up response of the proponents of the Hall A E12-17-004 (GEn-RP) experiment dated June 5, 2020

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Observers: Ed Folts, Javier Gomez

The Committee Report from the E12-17-004 Experimental Readiness Review was sent to the proponents on May 29, 2019. Their first response from Aug 11, 2019 satisfied most of the recommendation. However, the committee expected to see **quantitative measures** for the performance of the GEM detectors and their evaluation with respect to the acceptable values for running this experiment, including fallback scenarios requiring detector reconfigurations. Follow-up questions requesting specific values that characterize the GEM detector performance were sent to the proponents on Aug 14, 2019. This report addresses the response to the follow-up questions.

Note that due to the retirement of the Chair, Howard Fenker, the Review Committee, only for this report, was reorganized.

Despite of the delay in the response, the Review Committee recognizes the significant work the proponents of the experiment have done in characterizing the performance of the GEM detectors, both types, originating from UVa and INFN. The detailed information provided in the response, including references to the full set of characterization plots, helped the Committee in evaluating the presented results.

Findings:

- The requested complete list of performance parameters with results from test measurements was provided. The achieved values are evaluated with respect to the expected detector performance.
- It was demonstrated, through direct measurements and additional simulations and evaluations of the experimental conditions and detector settings, that the required detector efficiency can be achieved.
- The high-rate performance with respect to the related gain drop satisfies the conditions of the experiment.
- The noise rates were measured in different conditions, reasons for some elevated levels were identified, and plans for their improvement were made.
- The track resolution was estimated using runs with cosmics and also test beams. The deterioration of the resolutions with beams was explained using MC taking into account the specific experimental conditions.
- During the tests, important findings related to the HV stability and grounding of the detectors were made and corresponding corrective measures were planned.

- Several scenarios were discussed in case some of the detectors could not achieve the required performance. The **worst case scenario** would be when two UVa GEM layers from one of the two recoil-proton detectors will be used to replace the two INFN veto layers in front of the copper analyzer. This would increase the statistical uncertainty of the form-factor ratio, extracted using the method of the large-angle recoil polarimetry, by a factor of sqrt(2).
- The experiment uses three polarimetry methods to determine the neutron form-factor ratio. The “deep fallback scenario” discussed above will affect one of them. Depending on the values of Figure Of Merit achieved from the other two methods, the impact of such scenario can be minimal with respect to the physical result. On the other hand, from a methodical point of view, the results from the charge-exchange polarimeter that is not affected by this scenario, may have significant positive impact on the other form-factor experiments that use recoil polarization within the SBS program.
- The progress of the collaboration in the production and integration of such a large number of GEM detectors is quite impressive. At the same time it does seem to be a fair amount of work to do and problems to solve to have a fully functioning detector system.

Comments:

- The achieved tracking resolution of better than 100 um cited in the response was estimated from the beam test in Hall A in 2016 using UVa GEM detectors. The achieved resolution of about 250 um was partially explained using MC, by the domination of the multiple scattering in this test. However, from the same simulations it follows that the multiple scattering contribution should be of the order of 200-210 um, which doesn’t add up to 250 um if assuming only 100

um “intrinsic” resolution. The cosmic tests show resolutions, using the “exclusive” method, between 200 and 350 um (depending on the position of the chambers within the stack) for the UVa detectors and slightly worse for the INFN ones. We understand the complications in estimating the tracking resolution and encourage the proponents to continue working on improving the procedure. At the same time we suggest the simulations use the more realistic resolution in order to estimate the effect on the measured quantities.

- An additional safety concern was raised by the Committee regarding the design of the UVa detectors, in which the HV elements are outside of the gas volume. This is an advantage with respect to the maintenance of the detector, but also requires all the safety measures to be taken to eliminate the risk related to the HV parts of the detector.

Recommendations:

- Provide by October 15, 2020 an update on the detector status for both, UVa and INFN GEM chambers, that includes:
  - the number of layers assembled and the number of layers tested with cosmics.
  - characterization plots for the layers tested with cosmics in the same format as in the latest collaboration response.
  - the schedule for finishing the detector assembly and characterization that includes also time frame for modifications of the detectors (grounding, HV dividers) if needed, and the manpower involved in these activities.

- Provide the manufacturer/model# of the HV supply you plan to use along with a simple schematic of the HV connection method.