Intensity Frontier Fellowship Research Proposal

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Experiment E-989, the new muon g-2 Intensity Frontier experiment at Fermilab, requires the precise measurement of anomalous spin precession frequency, ω_a in the magnetic field of dedicated storage ring, and knowledge of field strength integral itself characterized in terms of the Larmor precession frequency in the ring, ω_L. This allows computing the anomalous magnetic moment $a_m = (g - 2)/2$ to remarkable precision of 0.14 parts per million (ppm).

Injection in the ring occurs at ~80 mm apart from the equilibrium orbit, which requires ~12,8 mrad kick for ~3.09 *GeV* muon bunch. At this energy the difference of $\omega_L - \omega_a$ becomes insensitive to the electric field presence at the beam orbit.

1. The kicker strength and timing requirements

Previous experiment carried at Brookhaven E-821, indicated insufficient amplitude of kick, so in E-989 the kick will be doubled by choosing new shape of kicker plates and increase of feeding current. New experiment E-989 will require kick angle up to 12.8 *mrad* with integral ~1.3 *kG-m*. The kicker split into three segments, ~127 cm each feed by individual Blumlein-type generator. Pulse width should be less, than the period of revolution of muons in accumulating ring, which is ~149 *ns*. All these require delivering ~70 *kV* pulse in 12.5 Ohm line impedance, so the current in kicker plates comes to ~5.5 *kA*. Repetition rate of pulsing reaches 100*Hz* in two trains, having 8 pulses in each one, with 1.33*sec* time periodicity coming to 12 *Hz* average.

2. Scope of work performed at Cornell

At Cornell the triaxial Blumlein generator was chosen to serve as a HV pulser. Preliminary calculations were carried out, the drawings were generated and the parts were fabricated at Cornell machine shop. The Blumlein assembled with six sections, 60 inch each, with 6 inch outer diameter. Internal volume of tri-axial line is filled with Castor oil, having permittivity $\epsilon \sim 4.7$ for longer pulse duration. Coaxial tubes supported by profiled spacers optimized for HV operation. Out-impedance of Blumlein is 12.5 Ohm, so four 50-Ohm cables link the Blumlein and the kicker. For charging the Blumlein the pulsed system was developed and fabricated also. This system includes primary 1*kV* PS, thyristor switch and HV transformer immersed into oil. After assembling the system of Blumlein, cabling and the kicker itself, it was tested for full voltage up to 70 kV.

On a basis of this full-scale prototype, three more Blumlein generators should be fabricated at Cornell and delivered to Fermilab beginning at spring of 2016.

3. Work should be done at Fermilab

The Fellowship would support the numerous visits to Fermilab from Cornell, staying at Fermilab site for installation of Blumlein generators in a ring hall at the wall, one above another. First delivery to Fermilab expected the spring of 2016. Three-HV transformer tanks assembled at Cornell, should be delivered to Fermilab and located in the hall nearby the Blumlein. Three minitowers containing the three primary PS, three primary HV pulsers and the set of three thyratron power supplies with individual triggering will be installed nearby. All this equipment should be delivered to Fermilab and installed there as well.

The Fellowship would also support the experimental work of better grounding the kickers inputs at place, so the grounding will be chosen on the basis of minimal noise delivered to the entire equipment.

4. Integration of kicker system into Fermilab network control system

The kicker controls will be integrated into the Fermilab control system, so the operator will be able to turn on/off and control the voltage of each Blumlein separately. Approximately ten cables will link each minitower with g-2 control room. The Fellowship will support this activity as well.