Hadron spectroscopy at an upgraded JLab

Multi-quark candidates, *XYZP* states, observed mainly in the charmonium spectrum have revolutionised hadron spectroscopy

- observed in reactions involving complicated production and/or decay processes
- interpretation of signal may be difficult due to kinematic effects (resonance mimic?)

Existence of these states would be confirmed via observation in photo- or electro-production and yield more information on their nature

- at 24 GeV many states with charmonium content are within kinematic reach
- electron-proton scattering leads to generation of all I, J^{PC} quantum numbers
- higher energy (~24 GeV), (quasi-real) photoproduction is especially appealing since many of the *XYZP* states could be produced directly and observed decaying to relatively simple final states (eliminating some of the kinematical effects and resonance mimicry)
- utilise polarisation of beam and target to achieve a precise separation of the various production mechanisms (not possible at hadron colliders)
- scan centre-of-mass energies by detecting the scattered electron at different momenta (beam remains at the nominal energy)

Photoproduction cross sections for these states estimated to be of the order of O(1 nb) for photon energies $E\gamma \sim 24$ GeV, widths O(100 MeV)

- requires large acceptance, high-luminosity, good momentum and vertex resolution
- ~24 GeV with high-luminosity more efficient in producing *X* and *Z* states (*Y* states benefit from even higher energies due to diffractive production)
- "It is clearly a great help to detect (tag) the scattered electrons with momentum in the range 0 - 14 GeV below 1 degree" - Zero-degree energy tagging system

Is the hadron spectroscopy programme sufficiently unique and complementary to make a strong case?