Hadron spectroscopy and exotic searches: from the photon point to Q^2 evolution

Leading questions and why they matter

- Lattice QCD predicts hybrid mesons with exotic quantum numbers and hybrid baryons with an excited gluonic field.
- Their existence, together with the nature of the hidden-charm X and Z states, is a decisive test of QCD in the confinement regime.
- Hybrid baryons share quantum numbers with ordinary three-quark states: they can only be identified through their dynamics.
- The X and Z states are still debated: compact multiquark states, molecules or kinematic effects?

Example measurements

1. **Light meson spectrum**
   High-statistics mapping, including exotic J^{PC} states and channels with several neutral particles
2. **Hybrid baryons**
   Searches through the Q^2 dependence of their electrocouplings
3. **Strange baryons**
   Spectroscopy of strange and multi-strange baryons
4. **Hidden charm - with some financial help**
   high-statistics J/ψ program
   Photoproduction of X(3872), Z_c and related states;

Why CEBAF: one facility from real photons to finite Q^2



$Q^2 = 0$
Real photons

$Q^2 \approx 0$
Quasi-real photons

Finite Q^2
Electroproduction

The same final states are measured continuously, with high luminosity and large acceptance

Q^2 evolution: a model-independent tool

- Production amplitudes and transition form factors evolve with Q^2 according to the size and internal structure of a state.
- This identifies exotic baryons and mesons without relying on a specific model.

A moderate energy increase (~1–2 GeV)

- Raises J/ψ yields to the level needed for precision studies.
- Crosses the X(3872) and Zc photoproduction thresholds (~12 GeV), opening hidden-charm spectroscopy at much lower cost than the full 22 GeV option.

Connections Complements COMPASS/AMBER, BESIII, Belle II, LHCb and PANDA, which use different production mechanisms, and relies on close collaboration with lattice QCD and amplitude analysis. The EIC will study the same states at higher Q^2 and energy, with lower luminosity.