HERA ep (eN) Options

- HERA is a worldwide unique facility
- Accelerator still exists (pre-accelerator not anymore)
- HERA was shut down due to 'political' reasons when discussion was made
- There is still significant interest in doing ep/eN collider physics
  - In particular, QCD (forward) physics, diffraction, GPDs,….
- Future ep(N) facilities under discussion
  - EIC (eRHIC, ELIC)
  - LHeC
  - ENC at GSI
- Would HERA operation still make any sense?

HERA Low Luminosity Operation

Major challenge of ep collider design and physics program:

- High luminosity requires focusing magnets close to the IP
- Physics requires detector acceptance down to very small angles
- HERA I:
  - $L \sim 2\ 10^{31}\ cm^{-2}s^{-1}$, detectors with some forward/backward acceptance
- HERA II:
  - $L \sim 5\ 10^{31}\ cm^{-2}s^{-1}$, detectors with very limited forward/backward acceptance
- H1 and ZEUS detectors were designed for high-x, Q^2 physics. Emphasis was on central detector, not on small angle coverage.
- Low x, Q^2 QCD studies require full acceptance, but not very high luminosity
  - $L \leq 1\ 10^{31}\ cm^{-2}s^{-1}$, i.e. HERA I like with new full acceptance IR would be sufficient
  - Need new, dedicated (small) detector, as proposed by A.Callwell, H.Kowalski et al. for HERA III proposal and recently for eRHIC
- Using deuterons or ions was discussed within the DESY III proposal

High Luminosity Options

Recent progress in ep collider design

eRHIC :

- Design started with ring-ring version (E_e = 10GeV on 250 GeV p (100 GeV/n ions)) with L~10^{32}
- After detailed study found that linac-ring version has 5-10 times higher luminosity
- Other significant advantage of linac-ring is larger distance of electron focusing magnets from IP due to much smaller electron beam emittance. IR layout with much better forward/backward detector acceptance possible

	MeRHIC	eRHIC
E p e (GeV)	250 4	325 20
L 10^{33} ($cm^{-2}s^{-1}$)	0.1 (1)	2.8 (14)

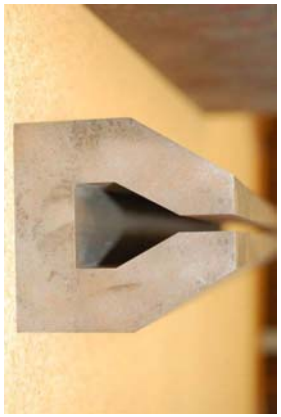
(with coherent electron cooling)

- Expect that similar luminosity would be possible with HERA

ERL-based eRHIC Design

V. Litvinenko

Gap 5 mm total
0.3 T for 30 GeV



(M)eRHIC detector

10-20 GeV e x 325 GeV p
130 GeV/u Au
possibility of 30 GeV @ low current operation

2 x 200 m SRF linac
4 (5) GeV per pass
5 (4) passes

Coherent e-cooler

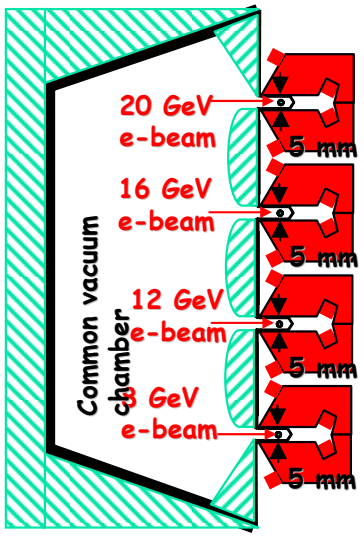
MeRHIC detector

PHENIX

STAR

MeRHIC E_e 4 GeV, L 10^{32}-10^{33}

eRHIC E_e 20 (30)GeV, L 10^{33}-10^{34}



4 to 5 vertically separated recirculating passes

Conclusion

- "Low" ($\leq 1\ 10^{31}\ cm^{-2}s^{-1}$) ep HERA operation would still be very interesting with a dedicated detector with emphasis on small angle acceptance (similar to one of the HERA III proposals)
- Would need
  - New proton pre-accelerator
  - Electron transfer line DESY to HERA
  - Upgrades of HERA components ((new) control system, RF systems,…
  - New interaction region
  - New detector
- High luminosity operation (10^{33} - $10^{34}\ cm^{-2}s^{-1}$) with full acceptance detector in principle possible using linac-ring technology
- Would need, in addition to "low" luminosity option
  - New energy recovery linac with SC cavities based on TESLA/ILC/XFEL technology
  - Coherent electron cooling for very high luminosity