REPORT FROM THE INTERACTION WORKING GROUP

CONVENORS:

CHARLES HYDE (ODU), VASILIY MOROZOV (JLAB),

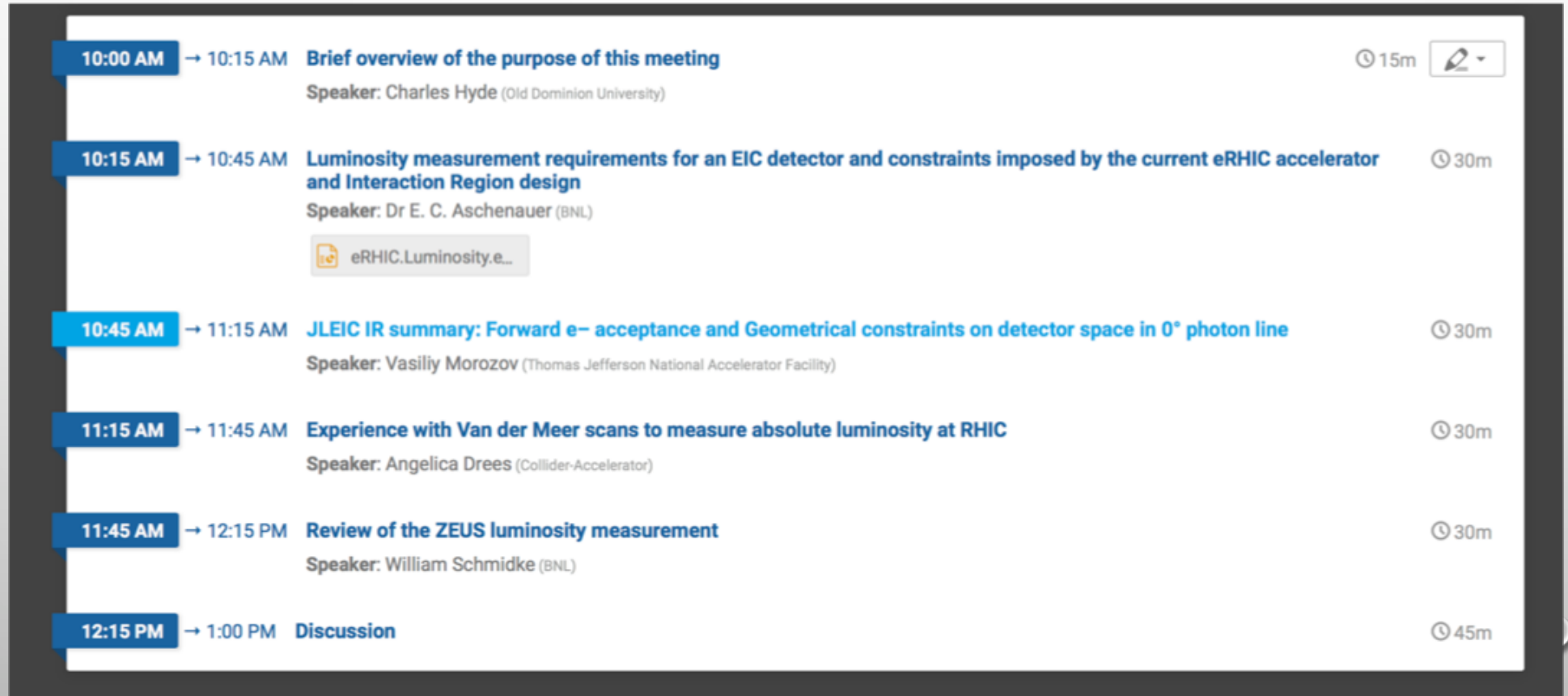
ALEXANDER KISELEV (BNL), CHRISTOPH MONTAG (BNL)

WORKING GROUP GOALS

- Point of contact with Laboratory based Interaction-Region design efforts
- Engage the EICUG Community
  - Luminosity measurement is a physics experiment(s) requiring interaction between Accelerator and Nuclear Physicists
- UNIQUE Challenges for EIC
  - Absolute Precision < 2%, Relative Precision < 1%
  - Luminosity (and its measurement) are (p, d, ^{3}He, Li) Polarization dependent
  - Bunch-Bunch dependencies?
  - Techniques required for *ep* to *eU*

FIRST GENERAL MEETING (VIDEO)
15 FEBRUARY 2019
LUMINOSITY MEASUREMENT

- [HTTPS://INDICO.BNL.GOV/EVENT/5743/](https://indico.bnl.gov/event/5743/)



VAN DER MEER (VERNIER) SCANS

- Absolute determination of Luminosity
  - Monitor a physics rate as the colliding beams are scanned across each other in 2D
  - Requires precision measurement of beam currents and collision centroid stability (3-D)
  - Does not require *a priori* knowledge of cross section.
- **Interupts experimental data taking:** Not a continuous monitor
- V. BALAGURA, NIM A **654** (2011) 634–638
  - RHIC: (IPAC'10, KYOTO JAPAN, PROCEEDINGS)
    - K.A. DREES, S.M. WHITE, VERNIER SCAN RESULTS FROM THE FIRST RHIC PROTON RUN AT 250 GEV,
  - LHC:
    - M. FERRO-LUZZI, DETERMINATION OF THE LUMINOSITY AT THE LHC EXPERIMENTS, IN: PROCEEDINGS OF ICHEP'10, PARIS, JULY 2010, PUBLISHED IN POS (ICHEP 2010) 010:
    - S.M. WHITE, ET AL., FIRST LUMINOSITY SCANS IN THE LHC, IN: PROCEEDINGS OF IPAC'10, KYOTO, JAPAN, MAY 2010.

HERA SUMMARY

Luminosity Detector

Concept:

Use Bremsstrahlung ep → epγ as reference cross section

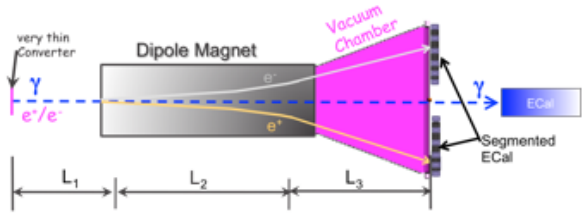
- different methods:
- Bethe Heitler, QED Compton, Pair Production
- Hera: reached 1-2% systematic uncertainty

Goals for Luminosity Measurement:

- Integrated luminosity with precision $\delta L/L < 1\%$
- Measurement of relative luminosity:
  physics-asymmetry/10 → $\sim 10^{-4} - 10^{-5}$

EIC challenges:

- with 10^{33} $cm^{-2}s^{-1}$ one gets on average 23 bremsstrahlungs photons/bunch for proton beam
  → A-beam Z^2-dependence
- Need more sophisticated solution
- BH photon cone < 0.03 mrad
  → acceptance completely dominated by lepton beam size

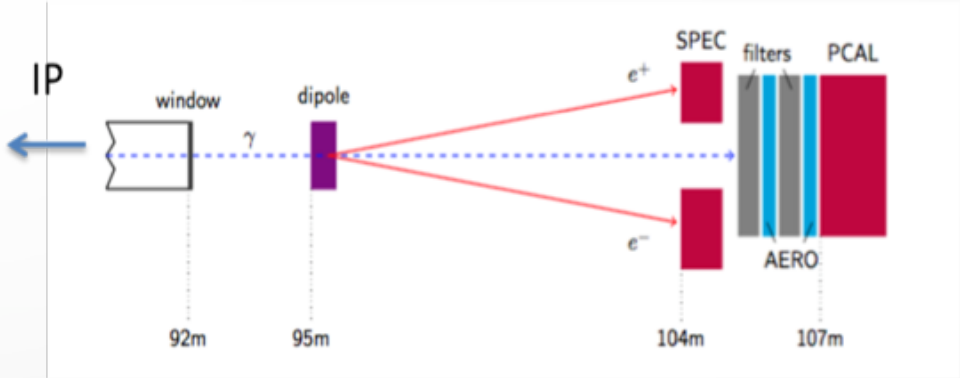


pair spectrometer
low rate
- High precision measurement for physics analysis
- The calorimeters are outside of the primary synchrotron radiation fan

zero degree photon calorimeter
high rate
- Fast feedback for machine tuning
- measured energy proportional to # photons
- subject to synchrotron radiation

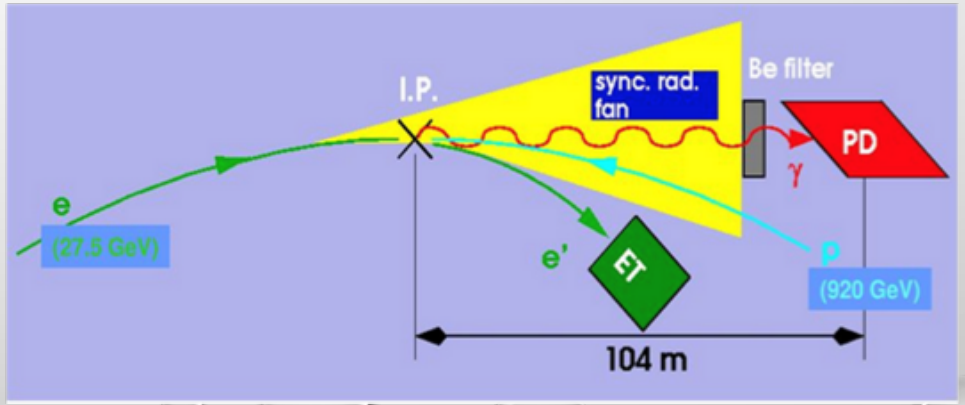
E.C. Aschenauer

Set up at ZEUS



R. Yoshida

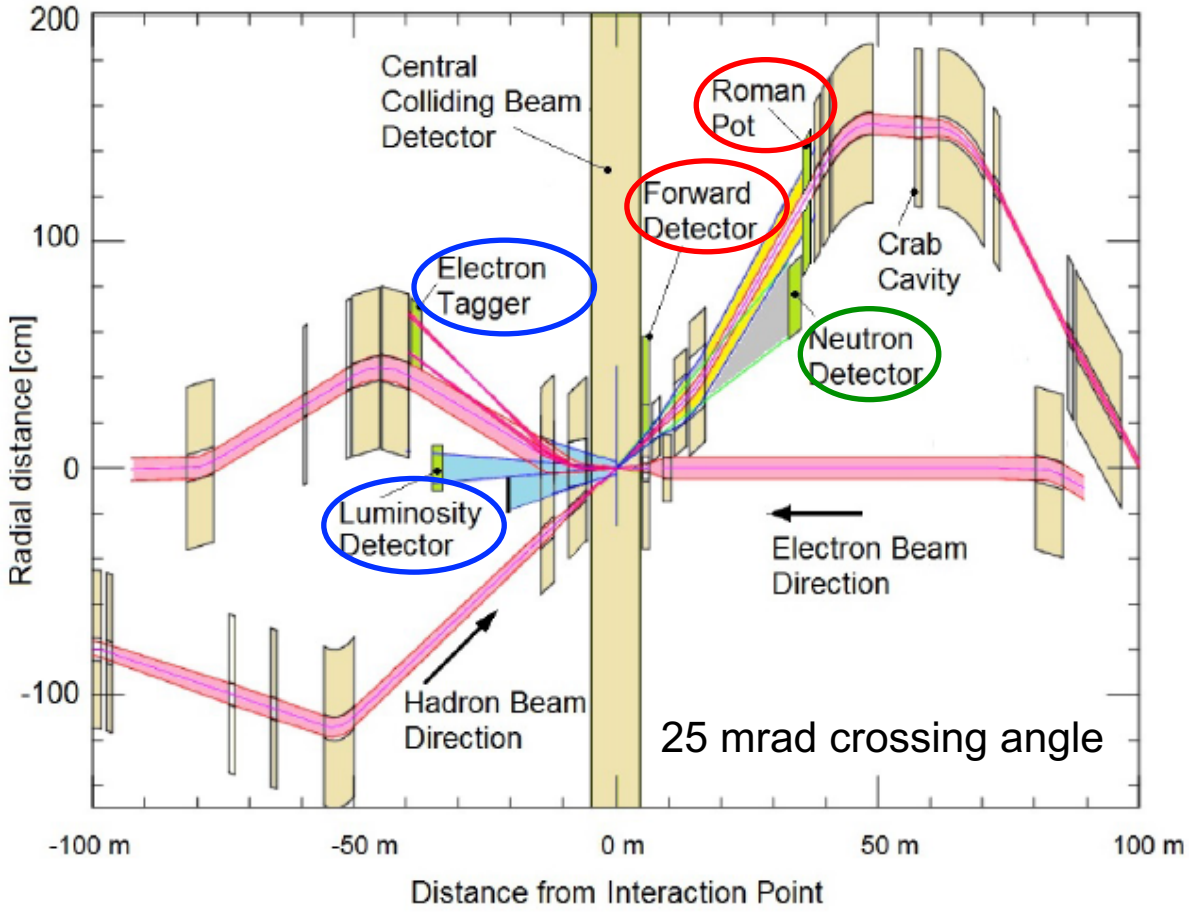
At H1

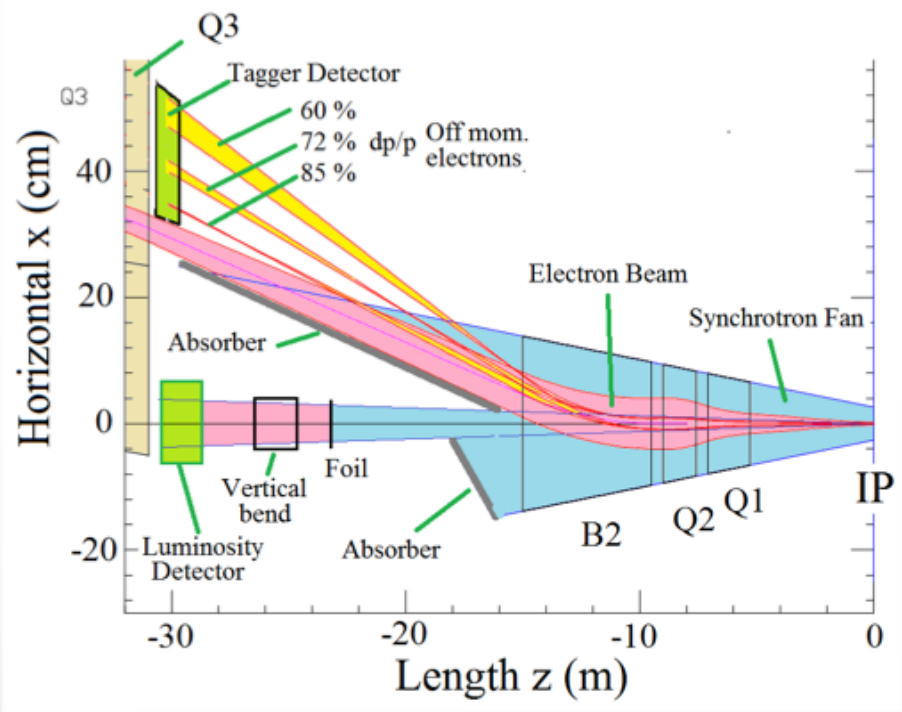


REFERENCES: QED COMPTON, ETC

- E. AARON (H1 COLLABORATION) EUR. PHYS. J. C (2012) **72**:2163
  - DOI 10.1140/EPJC/S10052-012-2163-2, ERRATUM DOI 10.1140/EPJC/S10052-014-2733-6
  - ELECTRON GAMMA DETECTION AT 10° TO 25° FROM E^- BEAM
- THEORY:
  - A. COURAU, P. KESSLER, PHYS REV D 46 (1992) P. 117
  - K. GAEMERS, M. VAN DER HORST, NUCLEAR PHYSICS B **316** (1989) 269-288: (SMALL ANGLE THEORY, SIMULATION)
- COMPTON22 GENERATOR:
  - V. LENDERMANN, *ET AL.*, EUR. PHYS. J. C **31**, 343 (2003). HEP-PH/0307116

ERHIC: IR DESIGN



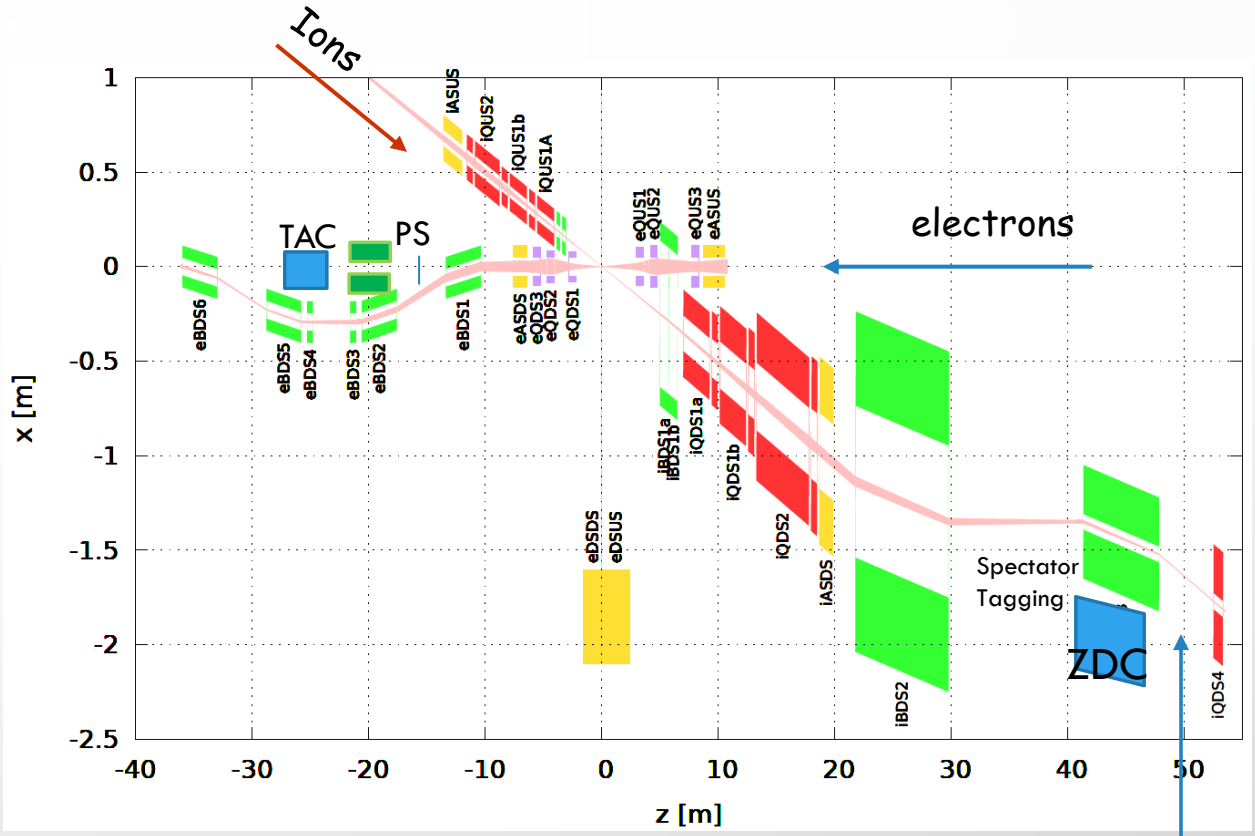


- main emphasis on integrating requirements for hadron beam direction
  - B0Fp: Forward Spectrometer (6 - 20 mrad)
  - Roman pots (Sensitive 1 to 5 mrad) Neutron Detector (0 to 4 mrad)
- B1Re and B2Re: separate BH photons from beam, separate low Q^2 electrons from beam and lepton beam from SR-fan

→ electron and hadron polarimetry at IP-12

JLEIC IR DESIGN

- 0° LINE IN EBDS1
  - VACUUM LINE TO TAC
- BREM FLUX INTO TAC
  5 GEV/BUNCH @ $L=10^{34}/CM^2/SEC$
  - TOTAL ABSORPTION CALO (TAC) CHALLENGING,
    - LIQUID AR IONIZATION?
    - QUARTZ-W SAMPLING?
- VERTICAL BEND PAIR-SPECTROMETER (PS)
- QED-COMPTON IN CENTRAL DETECTOR, OR DEDICATED SMALL ANGLE ECAL.
- Y. Sharabian (JLAB): Add Optical Transition Radiation (OTR) detector: bunch-bunch luminosity monitor



2ND GENERAL MEETING IN PREPARATION: BACKGROUNDS (DATE TBD)

- SYNCHROTRON RADIATION
  - VERTEX TRACKER OCCUPANCY
  - BEAM-PIPE DESIGN
  - IMPACT ON 0° BREMSSTRAHLUNG CALORIMETER
- BEAM-GAS,
  - BEAM-PIPE DESIGN
  - LOCAL PUMPING
  - BACKGROUNDS FROM SMALL ANGLE FAR UPSTREAM SCATTERING
- NEUTRON "GAS"
  - LIFETIME OF CRITICAL COMPONENTS, FRONT-END ELECTRONICS

Suggestions of Speakers, Topics Welcome