Status of HERA

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- Status before the Shutdown 2003 (brief summary)
- Modifications during the Shutdown 2003
- Recommissioning after the Shutdown
- First Weeks of Run Period
- Conclusion and Outlook
Status before shutdown 2003

Background in detectors

• direct synchrotron light $\rightarrow$ beam steering & movable collimators
• backscattered synchrotron light $\rightarrow$ synchrotron radiation masks
• $e$–gas events $\rightarrow$ vacuum
• $p$–gas events $\rightarrow$ vacuum $\leftarrow e^+$–beam induced

Luminosity, Polarization and Operating

+ peak luminosity of $2.7 \cdot 10^{31}\text{s}^{-1}\text{cm}^{-2}$ verified
  – routinely specific luminosity of $1.7 \cdot 10^{30}\text{s}^{-1}\text{cm}^{-2}\text{mA}^{-2}$ with high currents
  – currents limited by background

+ 51% longitudinal polarization at three IPs (HERMES, ZEUS, H1) with collisions and w/o antisolenoids at ZEUS and H1
  – operating at polarization tunes difficult : strong synchrotron sidebands
  $\leftarrow$ non perfect optical conditions $\rightarrow$ new luminosity optics & more refined procedures

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Modifications during the Shutdown

- **Action**: installation of NEG pumps into the GA e–chambers NL/SL
  **Aim**: reduction of vacuum pressure 10m left of IPs by a factor of 10 ⇒ reduce e–gas background
  **Status**: done

- **Action**: coating (Cu(substr.)-Ni-Ag-Ni) of absorber 4 (SR/NR 11m)
  **Aim**: reduction of backscattered synchrotron light by a factor of 1.6
  **Problem**: coated surface gets distorted during consecutive soldering processes needed to assemble absorber
  **Status**: solution with enlarged thickness of first Ni layer seems promising replacement of old absorbers postponed

- **Action**: enlargement of pumping slits of absorbers 1 (SR/NR 3.8m) and 2 (SR/NR 6m) & installation of new getter pumps
  **Aim**: increase the pumping power for inert gases like CH₄ in IRs ⇒ reduction of p–gas background
  **Status**: done
Modifications during the Shutdown (2)

- **Action:** movable absorber SL/NL 66m  
  **Aim:** more flexible beam orbit at 66m & complete shielding of detectors against synchrotron fan from BI magnet SL/NL 90m  
  **Status:** done

- **Action:** installation of new C5 collimators in H1 and ZEUS  
  **Aim:**  
  - closing shielding gap (ZEUS)  
  - reduction of backscattering (H1, ZEUS)  
  - reduction of HOM losses (⇒ vacuum) by tapering and cooling (H1) and coating (ZEUS)  
  - installation of a new getter pump (H1)  
  **Status:** done

- **Action:** installation of synchrotron light masks to protect RF contacts of bellows  
  **Aim:** increase run efficiency  
  **Status:** done

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Modifications during the Shutdown (3)

Experiments

- **Action:** re-alignment of GO magnet (H1)
  - **Aim:** better orbit at IR & no more local coupling
  - **Status:** done but one more iteration still desirable

- **Action:** installation of cryo bypass for H1 VFPS
  - **Aim:** create insertion space for H1 VeryForwardProtonSpectrometer
  - **Status:** done

- **Action:** install **new** longitudinal polarimeter
  - **Aim:** increase accuracy and time resolution of polarization measurement
  - **Status:** installed, not yet fully functional
Modifications during the Shutdown (4)

Diagnostics

- **HERA–p**
  - rebuild/repair electronics for BPM system
    → production on the way & old systems repaired
  - installation of a synchrotron light monitor
    → installed, not yet commissioned
  - installation of fast OTR monitor (← shape oscillations)
    → in progress, uncritical

- **HERA–e**
  - new electronics for BPM system → delay in production
    → only small number of prototypes installed
  - synchrotron light monitor repaired

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Modifications during the Shutdown (5)

Maintenance

• HERA–\(e\)
  – commissioning of additional fast injection kickers
  – installation of bipolar chopper power supplies for VO & VG magnets S/N
  – improved cooling of cavities

• HERA–\(p\)
  – improved cooling of QR magnet
  – fix (tiny) vacuum leak SR 28m
  – RF : new power tubes, tuner PS changed
  – replacement of the (warm) current connections for the (cold) \(p\)–corrector magnets

all completed
INSERT : Technical Issues during Technical Commissioning

- BU NR : ground fault → replacement took 4 weeks
- ⇒ cavities NR : vacuum conditioning during recommissioning
- e–RF modulator room for transmitter SL basically burned down → reconstruction finished not before end 2003
- ⇒ transmitter SR contaminated → not operational until early recommissioning

BU magnet (NR 60–80m) after removing the e–RF
Recommissioning after the Shutdown

- set up $e$–ring : (06.08.2003—20.08.2003)
- vacuum conditioning (HOM loss baking at 12 GeV) : (20.08.2003—12.09.2003)
- initial polarization tuning : (16.09.2003—until...)
- ...ground fault at BU NL (the second!) → see “Technical Issues” (25.09.2003)
INSERT : Technical Issues during Recommissioning

• BU NL : ground fault (2nd BU magnet in two months)
  – replacement too time consuming
  – virtual ground of p–main circuit shifted towards real ground fault
  – 9 new coils (= 1/4 of HERA) ordered (production going on)

• in the wake of the ground fault
  – lack of stray field from BUs ⇒ exotic orbit in IR ⇒
  – 20mm horizontal offset in GI magnet SR ⇒
  – more (power) and harder $E_{\text{crit}}$ synchrotron radiation downstream ZEUS ⇒

\[ \text{Absorber 4 (SR 11m)} : \text{the flange to the } e-\text{beam pipe got asymmetrically heated and vented the south IR} \]
Flanges of Absorber 4 (SR/NR 11m)

- Venting of flange at NR 11m happened before (end 2002)
- Exotic orbits while trying to understand sudden energy- and intensity-dependent \( e^+ \) beam losses
- Potentially severe problem \( \Leftarrow \) venting of IRs !!!!

**Cure:**
- Stricter orbit control in IRs \( \Leftarrow \) better understanding and better online display of IR–orbits
- Temperature monitoring at all flanges of these absorbers
- Tuning of beam interlock / auto–dump levels
- \( \Rightarrow \) start of run period: very conservative dump levels
  \( \Rightarrow \) \( e^+ \) current limited to \( \approx 18 \) mA
- Additional cooling

**Status now:** gained confidence in understanding and monitoring dump levels more relaxed \( \Rightarrow \) no more current limitations
Recommissioning after the Shutdown (2)

**HERA–p**
- geometric aperture at injection
- optics verification/correction (ORM) at injection

**HERA–e**
- geometric aperture at injection
- optics verification/correction (ORM) at injection
- commissioning of fast injection kickers
- installation of a new luminosity optics
- optics verification/correction (ORM) at luminosity optics
- dispersion measurement at luminosity optics
- measurement of the center frequency
- beam based alignment in IRs N/S
- procedures to allow stable operation at the polarization tunes

ORM at $e^+$–luminosity optics

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First Weeks of Run Period : Luminosity

• started running for experiments on 11.10.2003

• fill pattern : $120 \times 126 \rightarrow n_{\text{coll}} = 114$
  
  \[ \mathcal{L} \propto \frac{I_p I_e}{n_{\text{coll}}} \]

  - background has components $\propto I_e$, $\propto I_e^2$, $\propto I_p I_e$
  
  $\Rightarrow$ bound on $(I_p I_e)_{\text{max}}$

  - optimum luminosity with background constraints not at $180 \times 189$ bunches

• current limits start of run period : detectors : $60 \times 30$ mA$^2$

• achieved $\mathcal{L}_s = 1.6 \cdot 10^{30} \text{s}^{-1} \text{cm}^{-2} \text{mA}^{-2}$

  and peak luminosity $\mathcal{L} = 1 \cdot 10^{31} \text{s}^{-1} \text{cm}^{-2}$

  this is not yet perfect :

  - optics errors just recently corrected

  - $\epsilon_x^{(e)}$ too large $\iff$ dispersion not yet perfect

  - current limitations

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First Weeks of Run Period: Background

- HERMES, H1 and ZEUS have taken data
- after long shutdown & venting: fast recovery & decent conditions
  - pressure in IRs: improved by factor $\approx 0.5$
  - backscattered synchrotron light: problem seems solved
- despite good vacuum at IRs: $p$-background still 2–3 times too high for operation at full currents
  $\rightarrow$ analysis is in progress & more conditioning needed
- $\Rightarrow$ current limits at start of run period: detectors: $60 \times 30$ mA$^2$
- background tuning still an issue

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First Weeks of Run Period (3)

Polarization

• routinely operate at polarization tunes
• already achieved 40% polarization (before BU incident)
• now tuning parasitically

Operational Performance

• $p$–injection/ramp efficiency good: so far 61mA/120 bunches at 920 GeV
• $e^+$–injection efficiency improved: 40% — 60%
• $e^+$–ramp more stable: no more dumps triggered by radiation interlocks of micro vertex detectors
• improved online diagnostics, controls, data exchange with experiments, . . .
INSERT : Recent Technical Issues

- last Saturday (25.10.2003) failure of computer hardware in cryogenic system warms up north half ring.
- hardware changed ⇒ plant operational again
- $p$-ring not recovered until morning 29.10.2003
Summary and Outlook

- program of shutdown successfully completed

- except
  - replacement of absorber 4 (new concept seems promising)
  - upgrade of some of the diagnostic systems ⇒ nothing critical

- several, partly severe, technical problems during shutdown, recommissioning and early running
  - ground faults in BU sections NR and NL → short term fix (virtual ground) & mid term: new coils ordered
  - venting of south IR through heated flange at absorber SR 11m → better monitoring & beam interlock ⇒ solved
  - transmitter SL not functional (modulator room destroyed) → end 2003

- during first weeks already achieved \( \mathcal{L}_s = 1.6 \cdot 10^{30} \text{s}^{-1} \text{cm}^{-2} \text{mA}^{-2} \) and \( \mathcal{L} = 1 \cdot 10^{31} \text{s}^{-1} \text{cm}^{-2} \)
  - still lots of room for optimization → dispersion, optics fine tuning, etc.
  - going to increase \( e^+ \) currents soon

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Summary and Outlook (2)

- background: experiments take data
  - quick recovery after shutdown and venting
  - reason for $p$ background not fully understood
  - also plenty room for optimization and conditioning

- achieved 40% polarization during recommissioning
  with three rotators active and uncompensated solenoids
  - polarization tuning interrupted by BU & flange incidents
  - now tuning parasitically
  - confident that $P > 50\%$ can soon be recovered with collisions