

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 → beam steering & movable collimators
- backscattered synchrotron light → synchrotron radiation masks
- e -gas events → vacuum
- p -gas events → 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 antisoloids at ZEUS and H1
- operating at polarization tunes difficult : strong synchrotron sidebands
 - \Leftarrow non perfect optical conditions → new luminosity optics & more refined procedures

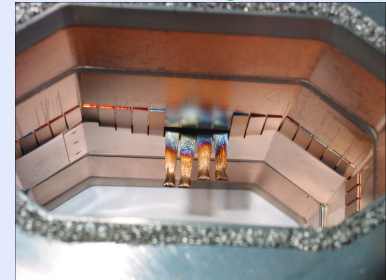
Modifications during the Shutdown

- 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 \Rightarrow 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 CH_4 in IRs \Rightarrow 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 (\Rightarrow 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 ↗

RF contact with radiation damage



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**

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



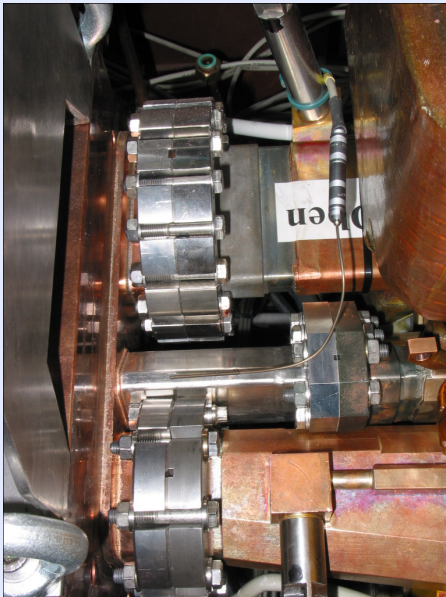
BU magnet (NR 60–80m) after removing the e -RF

Recommissioning after the Shutdown

- set up p -ring : (25.07.2003—20.08.2003)
- set up e -ring : (06.08.2003—20.08.2003)
- vacuum conditioning (HOM loss baking at 12 GeV) : (20.08.2003—12.09.2003)
- set up collisions : (13.09.2003—16.09.2003)
- 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** (2-nd 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 \Rightarrow exotic orbit in IR \Rightarrow
 - 20mm horizontal offset in GI magnet SR \Rightarrow
 - more (power) and harder (E_{crit}) synchrotron radiation downstream ZEUS \Rightarrow



↙ **Absorber 4 (SR 11m)** : the flange to the e -beam pipe got asymmetrically heated and **vented** the south IR

INSERT : Technical Issues during Recommissioning (2)

Flanges of Absorber4 (SR/NR 11m)

- venting of flange at NR 11m happened before (end 2002)
- \Leftarrow 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 ≈ 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)

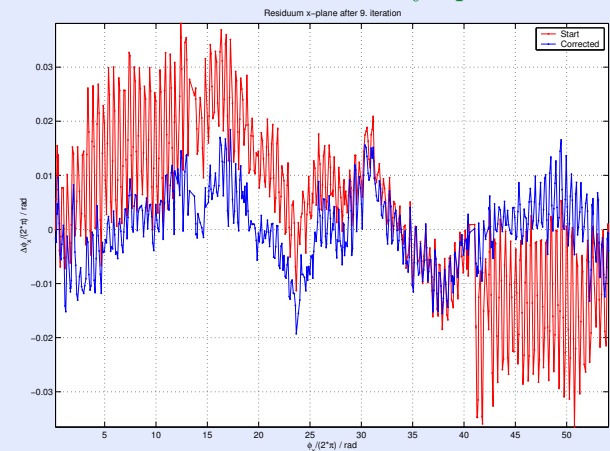
HERA-p

- 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



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 180×189 bunches
- current limits **start of run period** : detectors : $60 \times 30 \text{ mA}^2$
- 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 \Leftarrow dispersion not yet perfect
 - current limitations

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 ≈ 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
 - analysis is in progress & more conditioning needed
- \Rightarrow current limits at start of run period : detectors : $60 \times 30 \text{ mA}^2$
- background tuning still an issue

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 \Rightarrow 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 \Rightarrow **nothing critical**
- several, partly severe, technical problems during shutdown, recommissioning and early running
 - ground faults in BU sections NR and NL \rightarrow short term fix (virtual ground) & mid term : **new coils ordered**
 - venting of south IR through heated flange at absorber SR 11m \rightarrow better monitoring & beam interlock \Rightarrow **solved**
 - transmitter SL not functional (modulator room destroyed) \rightarrow **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 \rightarrow dispersion, optics fine tuning, etc.
 - going to increase e^+ currents soon

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