Meeting on beam losses and quench levels

The work presented in this meeting has been motivated by the Workshop in March

Workshop on

Beam-generated heat deposition and quench levels in LHC magnets

Held at CERN, 3-4 March 2005

Workshop organised in the frame of the CARE-HHH-AMT network

Organisers: R. Assmann, L. Rossi, R. Schmidt & A. Siemko

Scienftific secretary: P.Pugnat

http://indico.cern.ch/conferenceDisplay.py?confId=0516

Some Objectives for the Workshop on beam generated heat deposition and quench levels for LHC magnets – relevant for this meeting

This workshop will address **quench margins, for nominal** and ultimate **parameters**, taking into account

- **as-built parameters for different type of magnets**
- **different operating temperatures**
- **spatial and temporal distribution of beam losses**
- **other beam related heat loads**
- **operating point of the magnet (e.g. LHC energy)**

Why do we need to know the quench levels ? Some questions….

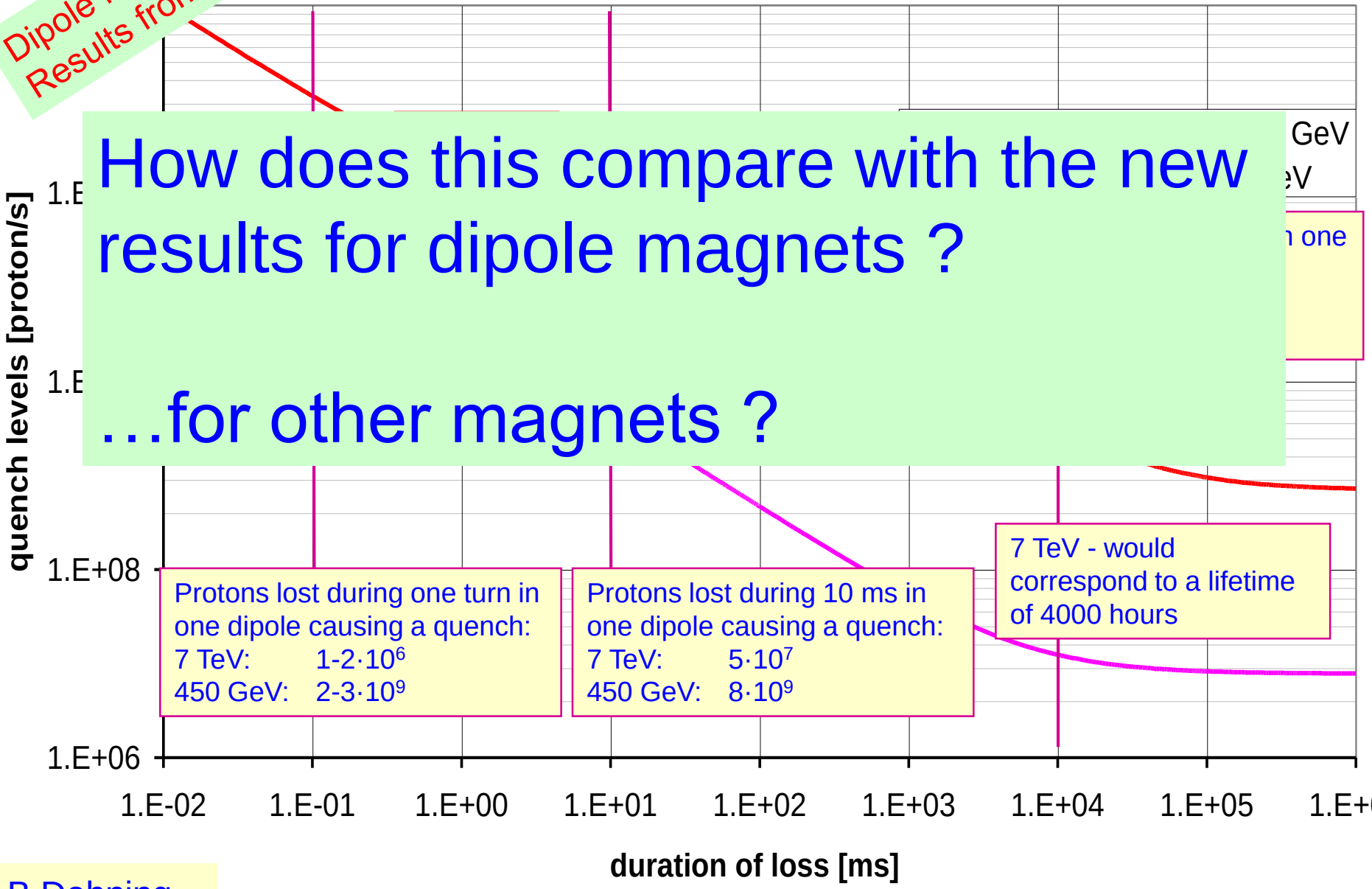
- Can we operate the LHC at nominal luminosity with the anticipated cleaning efficiency and beam lifetime ?
- Can we operate with ions at nominal luminosity ?
- How to set BLM thresholds ?
- Pilot beam at injection: what intensity is below the quench level ?
- How many particles are tolerable in the beam abort gap without quenching during a beam dump ?
- How clean must we inject without quenching ?
- Can we operate the triplets at nominal luminosity ?

Why do we want to know the quench levels ? Some questions….

Question	Continuous	Transient	Energy
Can we operate the LHC at nominal luminosity with the anticipated cleaning efficiency and beam lifetime ?	yes	yes	450-7000
Can we operate with ions at nominal luminosity?	yes	no	7000
How to set BLM thresholds?	yes	yes	450-7000
Pilot beam at injection: what intensity is below the quench level?	no	yes	450
How many particles are tolerable in the beam abort gap without quenching during a beam dump?	no	yes	450-7000
How clean must we inject without quenching?	no	yes	450
Can we operate the triplets at nominal luminosity?	yes	no	7000

Quench levels versus loss duration

Dipole magnets
Results from 1995



How does this compare with the new results for dipole magnets ?

…for other magnets ?

Protons lost during one turn in one dipole causing a quench:
7 TeV: $1\text{-}2\cdot10^{6}$
450 GeV: $2\text{-}3\cdot10^{9}$

Protons lost during 10 ms in one dipole causing a quench:
7 TeV: $5\cdot10^{7}$
450 GeV: $8\cdot10^{9}$

7 TeV - would correspond to a lifetime of 4000 hours

B.Dehning

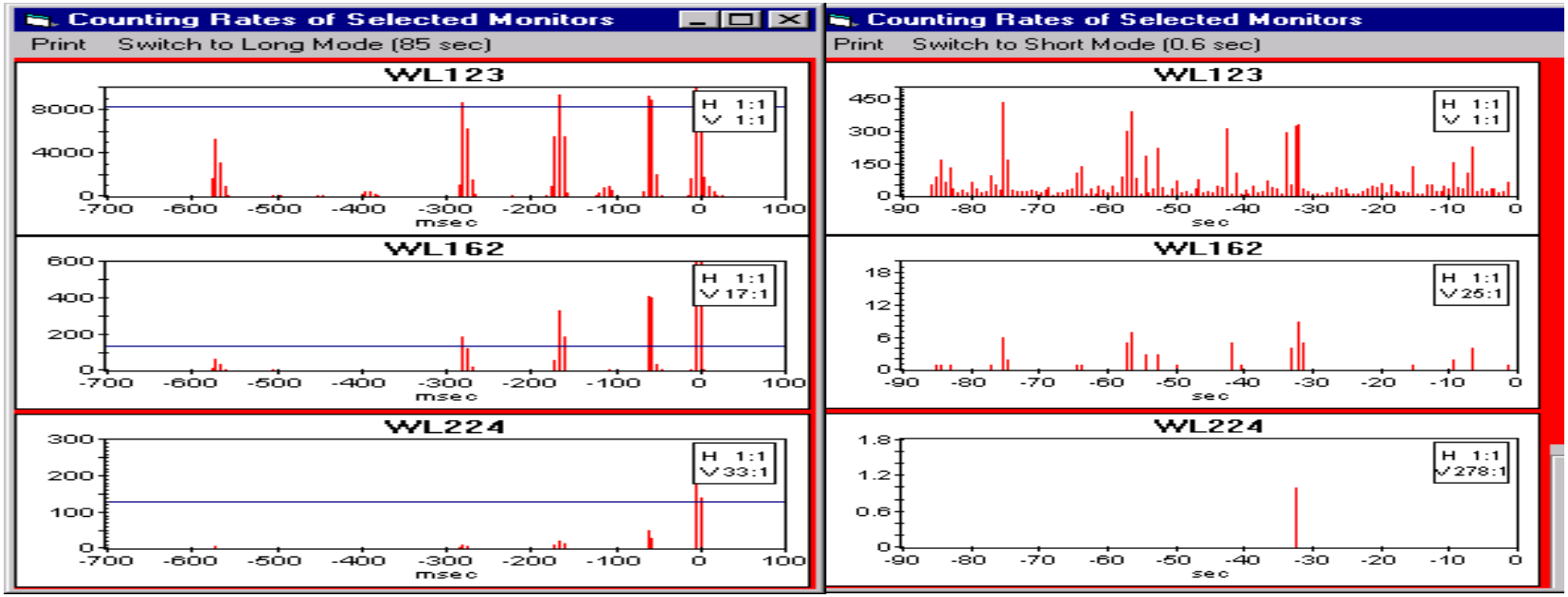
Beam losses: continuous or transient ?

HERA experience

- A constant loss rate cannot be expected – much too naive
- All kind of frequencies: 50, 150, 300, 450, 600 Hz, also higher frequencies plus random spikes. Sources: Hamburg train, ground movements, Northern sea, cryostat vibrations, vacuum pumps, ...

- M.Seidel und K.H.Mess: Collimators as diagnostic tools in the proton machine HERA, NIM A351 (1994) 279-285
- O.Brüning, M.Seidel, F.Willeke und K.H.Mess: Measuring the effect of an external tune modulation on the particle diffusion in the proton storage ring HERA), DESY HERA 94-01

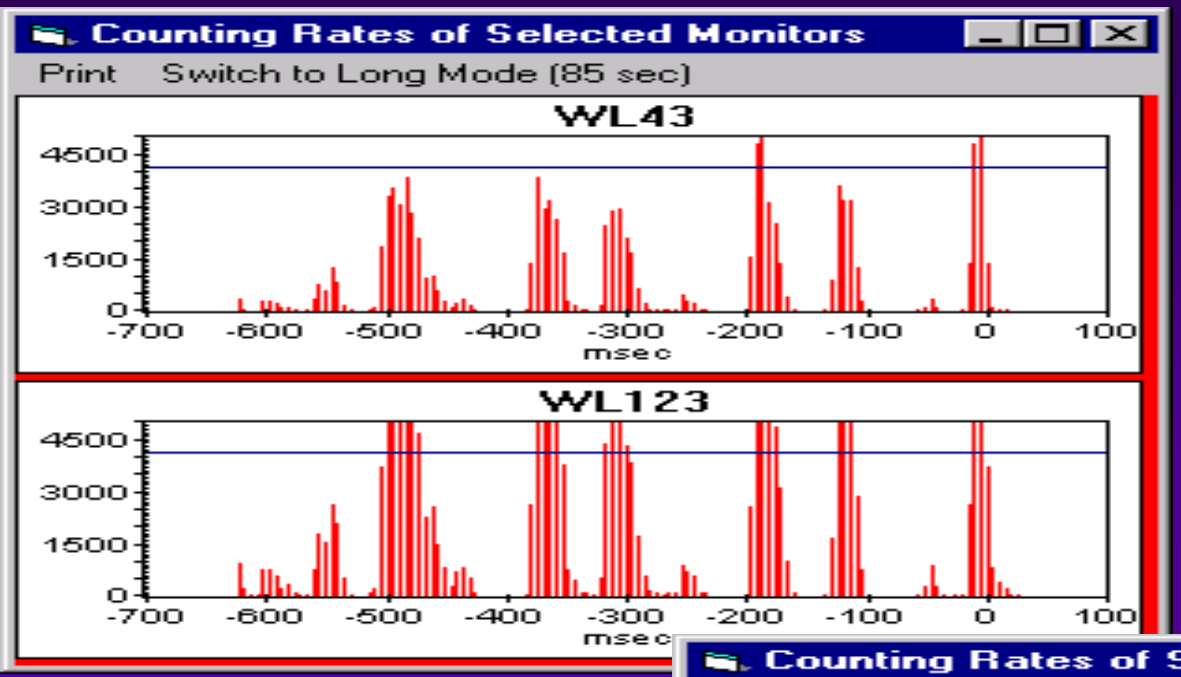
Stable p at 920 GeV 31.July.00

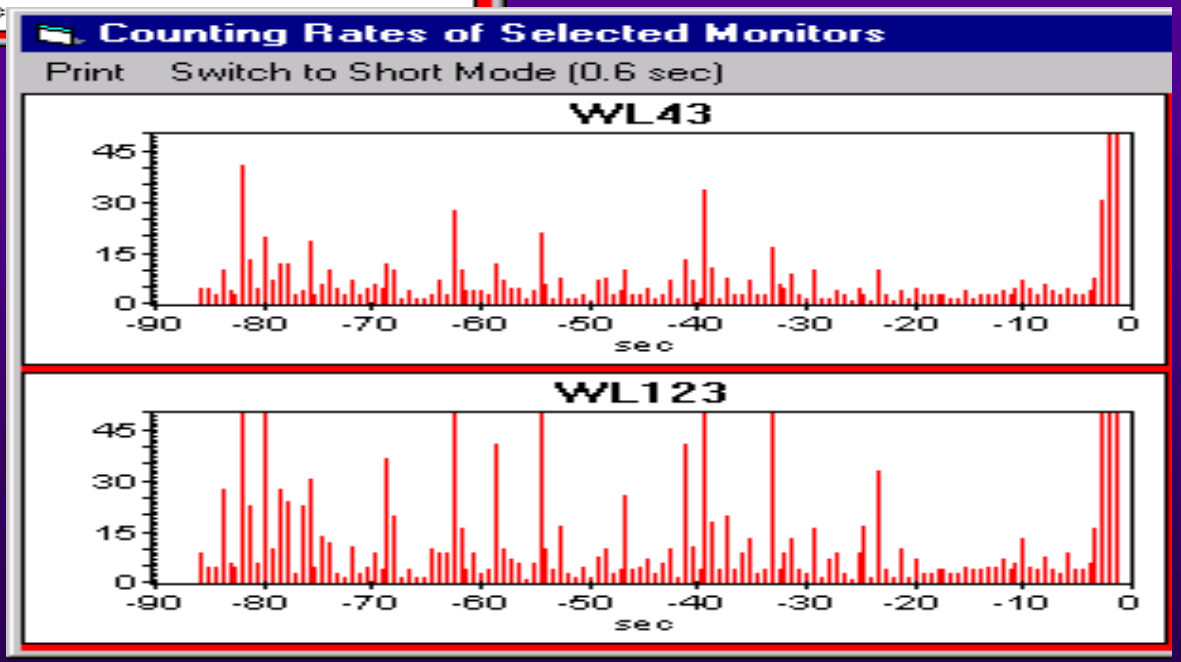


<u>Frequency of Oscillations</u>: 5 - 15 Hz

<u>Experience of HERA-B scraping Coasting (unbunched) Proton Halo with the Wire Target</u>: Violent rate fluctuations until the wire reaches the bunched part of the halo...

HERA: BLM versus time





LHC Injection

Transient (~8μs) beam losses possible at

- Transfer line collimators TCDI
- Injection dump TDI
- Auxiliary collimators TCLI
- LHC aperture (arc)

Scraping of tails during normal injection

Losses when a failure occurs

Halo load (next talk)

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LHC Beam dump

- Transient (~3-86 μs) beam loss mechanisms
  - Spurious abort gap population for normal dump
  - Swept bunches for asynchronous beam dump
    - Extraction septum protection diluter TCDS
    - Q4 protection diluter system TCDQ
    - LHC arc / aperture
  - Not covered: TCDQ system halo load (part of TCDQ case study presented tomorrow)

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My expectation for the beam losses

- Beam losses with be neither only continuous nor only transient, but both continuous and transient
- Depending on the lifetime of the beams, there will be a "baseline" of continuous losses – the lower the lifetime, the higher this baseline
- Taking into account this baseline, transient beam losses must be considered
- To have stable operation, the baseline must be substantially below the quench level, to have some margin for transient losses

- Transient losses for the LHC might be very important for the LHC
  - the collimator jaws are so close to the beams
  - beam-beam effects when bringing beams together
  - many other reasons ….

Conclusion: Both, continuous losses and transient losses, need to be considered