Requirements for a ‘proper’ beam dump

- A proper beam dump can only be performed if
  - The beam dumping system functions according to specification
  - Other elements outside the beam dumping system perform according to specification
  - Certain beam parameters are within specification
- The MPWG is asked to coordinate some of those system checks

Extraction Kick Overshoot

- Aperture of the extracting channel has been calculated assuming a 10 % tolerance of the deflecting angle given by the MKDs
  - See LHC Project Note 320 (August 2003) on the aperture of the extraction channel
- This 10 % is composed of many contributions, 7.5 % comes from the actual magnetic field overshoot
  - See Beam Physics Note 75 (February 2004)
- Systems outside the LHC Beam Dumping System (LBDS) which contribute to this 10 % tolerance are
  - The Q4 kick enhancement
  - The energy of the beam relative to the energy assumed by the LBDS

The Q4 kick enhancement

- The Q4 enhances the MKD kick by about 23 % as the extracted beam passes off-axis through Q4
  - ± 0.5 % tolerance on the Q4 kick is taken into account in the 10 % overall extraction deviation
  - For this reason the quadrupole can not be used to adjust the optics
  - As Q4 is superconducting, a short should 'not be possible' in a working magnet
  - A reliable surveillance of the Q4 current within a window of ± 0.5 % is required !
  - This surveillance should not be relative to a setting which can be changed like the other p.c. settings

Energy Error of the Beam

- Normally the beam energy is determined by the main dipole current which is surveyed by the BEM system. Perturbations on this system are:
  - Orbit correctors: need a check in orbit correction program. First estimate: 1 % energy error is possible before beta-beating is likely to give problems (JW)
  - RF frequency: before beam hits vacuum chamber due to dispersion rel. energy error of 0.8 % possible
  - Total error in energy: 2 * (1 + 0.8) = 3.6 %. This is unacceptable

Interlocks on 'Energy'

- Interlock on integrated corrector field to an energy error of ± 0.2 %
- Interlock on relative momentum change due to RF frequency of ± 0.2 %
  - Allows chromaticity measurements
  - Relative error in frequency:
    α_c x 0.2 % = $6 \cdot 10^{-7}$
    This gives a Δf = 240 Hz
- Precision of BEM: 0.1 %
- Total error on energy 2 * (0.2 + 0.2) +0.1 = 0.9 %.

Other systems which should trigger a beam dump if outside tolerance

- Closed orbit error LSS6 < 4 mm. Assumption in aperture calculation of the extraction channel
  - Special redundant BPMs foreseen
- Position of the beam relative to TCDQ jaw
  - Movable jaw which should be between 8 – 10 σ relative to the beam to protect the arc in the event of an asynchronous dump
  - Need worked out how to do this yet…

Optics

- **Asynchronous dump: swept beam will experience MKD kick twice**
  - **MG in MPWG August 2003**
  - **Fractional tune limited to 0.28 ± 0.09, otherwise swept beam will hit the septum**
- **Local beam size depends on**
  - **Emittance**
  - **Local β-value:**
    In aperture calculation assume (general, not only LBDS)
    - Change in β due to tune variation: 17 %
    - Change in β due to β-beating: 20 %
- **Do we need to check on fractional tune and local beam size?**

Deflection in the vertical plane by the septa (MSD)

- **Rough estimate is that the total MSD kick needs to be within 1 % to stay within the good region on the dump block**
  - **Need surveillance of current up to the % level**
  - **Need surveillance of voltage to detect short circuit of the conventional magnet**
    - Use similar system as for the Quench Protection System comparing voltages between adjacent magnets
  - **Should protect against fast changes (while switched on) and slow changes (after switch off – switch on)**

Other systems to interface via BIS

- N_2 pressure in TDE
- Vacuum in beam dump lines TD62 and TD68

Summary: Request to MPWG

- The LBDS should receive a beam dump request from the quoted systems with a ‘relatively high’ level of reliability
- The MPWG is asked to coordinate
  - The surveillance of these signals
  - The transmission of the interlock signal via the BIS
  - Determine and guarantee the required level of reliability of the generation and transmission of these signals

Request to MPWG

- Systems concerned
  - Q4 current: -> different reference, more reliable (?), PO
  - RF frequency: -> check P.Baudrenghien, who makes it?
  - MSD current and voltage -> similar QPS (V), PO (I)
  - Integral horizontal orbit corrector field -> JW
  - Absolute beam position dump region -> JW / BDI (?)
  - Relative beam position w.r.t .TCDQ jaw -> ??
  - N_2 pressure TDE -> BT/TDE, AT/VAC
  - Pressure dump lines -> AT/VAC
  - Fractional tune ??
  - Local beta's / beam size ??