Energy tracking

- Meeting of the MPWG on 11th May 2001
- subWG Meeting with all those involved in the issue on 8th June 2001

- The field of the septa magnets needs to track the beam energy within about +-0.5 %
- The dump kickers need to track the beam energy with similar accuracy
- Is it possible that the field of the quadrupole magnets Q4 and Q5 between kicker magnets and septum magnet is incorrect, the beam still circulates, and the extraction trajectory is distorted? => M.Gyr one of the next meetings
- It is required to apply trims to the extraction trajectory (as suggested by J.B.Jeanneret and confirmed by M.Gyr)
- What would be the amplitude of such trims ? The order will be about 1-2% => M.Gyr one of the next meetings

Proposal for a safe tracking that allows trimming of the septa magnet strengths in a limited range

Tracking

- Current for the magnet with **standard power converter** / standard **control electronics** with a current versus time function loaded into the controller
- For the energy ramp, the current is ramped producing a **deflection angle** that is **constant during the ramp**. The non-linearity between current of the power converter and magnetic field is taken into account in the definition of the ramp function (as for all other magnets)

What happens in case of failure => Monitoring to ensure safe operation is required

Beam energy meter (BEM)

STEP I:

- The **current** through the **dipole magnets** is measured:
  - left from point 6 in sector 5-6
  - right from point 6 in sector 6-7

  using at each side two standard DCCTs, plus one additional DCCT.
- From the two sets of three DCCTs, **two values for the current** are generated (current in sector 5-6 and current in sector 6-7)

The energy depends only on the current. The transfer function between current and energy could be different for the two sectors (about 10^{-3}, to be specified).

STEP II:

An **electronics module reads the current** - and produces **values proportional to the beam energy** (**B**eam **E**nergy **M**eter) for each adjacent sector

STEP III:

The **current** that is supplied by the PC **for the septum magnet** is measured in a similar way.

The **BEM produces a value proportional to the beam energy**. At least one of the DCCTs could be in the underground area.

When to dump the beam?

STEP IV:

In total, **four values proportional to the beam energy** are available:

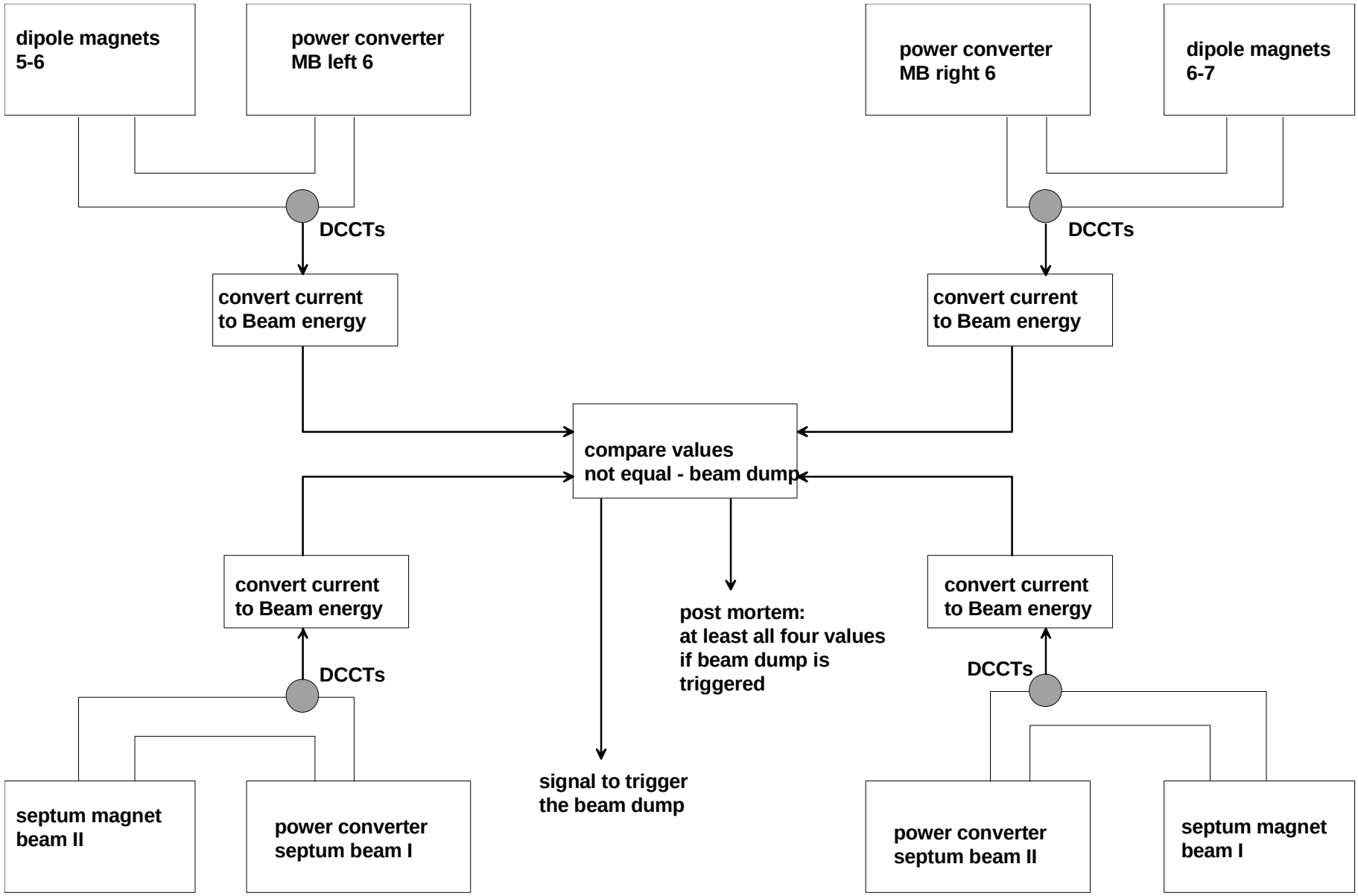
1. From the dipole magnets in sector 5-6
2. From the dipole magnets in sector 6-7
3. From the septum magnets for beam I
4. From the septum magnets for beam II

The values are compared with a comparator. **If the four values are not within a range of, say, 1%, both beam are dumped**.

Obviously, using the elements (**BEM, Comparator**), the architecture can be different and needs to be optimised using **Reliability Engineering**

Discussion of some failure modes

- The function for one of the septum magnets is wrong: if the difference exceeds 1% => the beams are dumped.
- Fault of one set of DCCTs: the value for the beam energy from this set would be outside the tolerance => and the beams are dumped.
- Fault of the function for the current driving the dipole magnets in at least one of the adjacent sectors => the beam will be lost. Beam loss monitor will observe the beam losses, and dump the beam if either the losses exceed a threshold, or the four values (see above) are not within the specified range.
- With the proposed scheme, an operator has the possibility to trim the extraction strength functions: if the trim does not exceed the limits set by comparing the values from the beam energy indicators, no problem. If (for example by mistake) the limits are exceeded, => the beams are dumped.


dipole magnets
5-6
power converter
MB left 6
power converter
MB right 6
dipole magnets
6-7
DCCTs
DCCTs
convert current
to Beam energy
convert current
to Beam energy
compare values
not equal - beam dump
convert current
to Beam energy
convert current
to Beam energy
post mortem:
at least all four values
if beam dump is
triggered
DCCTs
DCCTs
signal to trigger
the beam dump
septum magnet
beam II
power converter
septum beam I
power converter
septum beam II
septum magnet
beam I

Comments

The **BEM** that converts the current or another signal into a signal proportional to the beam energy could be used in other systems (RF, Beam Instrumentation, ….), and could therefore be of general interest

It should be taken into account that the power converters for the septum magnets are at the surface in SR6, whereas the converters for the dipole magnets are in UA63 and UA67

The strength of the dump kicker magnets also needs to track the energy, possibly using the same source that is the current of the dipole magnets. The control of the power converter for the dump kicker magnets follows a similar strategy: the beam energy is used to generate functions that drives the kicker power supplies. In total, 28 different functions are required

What is a **BEM** **=> John Pett**

What happens if the cable or one of the connections between power converter and septum magnet breaks? What is the time constant for the current decay

How is the tracking of magnet strength - beam energy for safety critical systems done for other accelerators such as HERA?

For hardware commissioning, if only one of the sectors is powered, can the septum magnets be operated?

Other systems around the LHC need a signal proportional to the beam energy. Some of the systems might be important for the machine protection. How should they get the beam energy? Via the control systems, via special links, via function generators?

R.Schmidt will get information about the transfer function for the septum magnet and for the dipole magnets, and summarise the ideas for the next MPWG on 13th July 2001.

J.Pett agreed to continue the brainstorming for the electronics module (beam energy indicator) with some colleagues, and present the outcome of the discussions to the next MPWG.