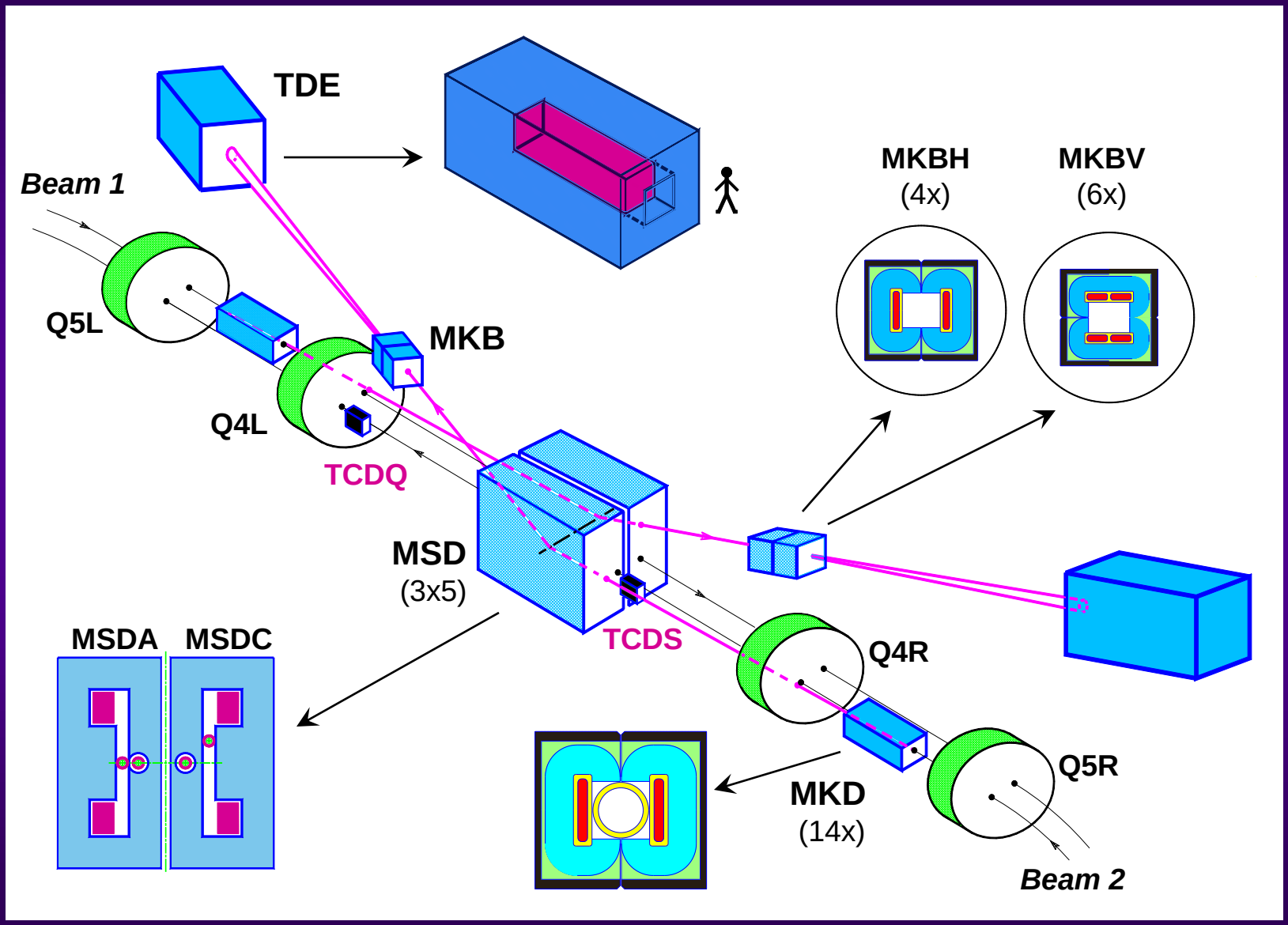
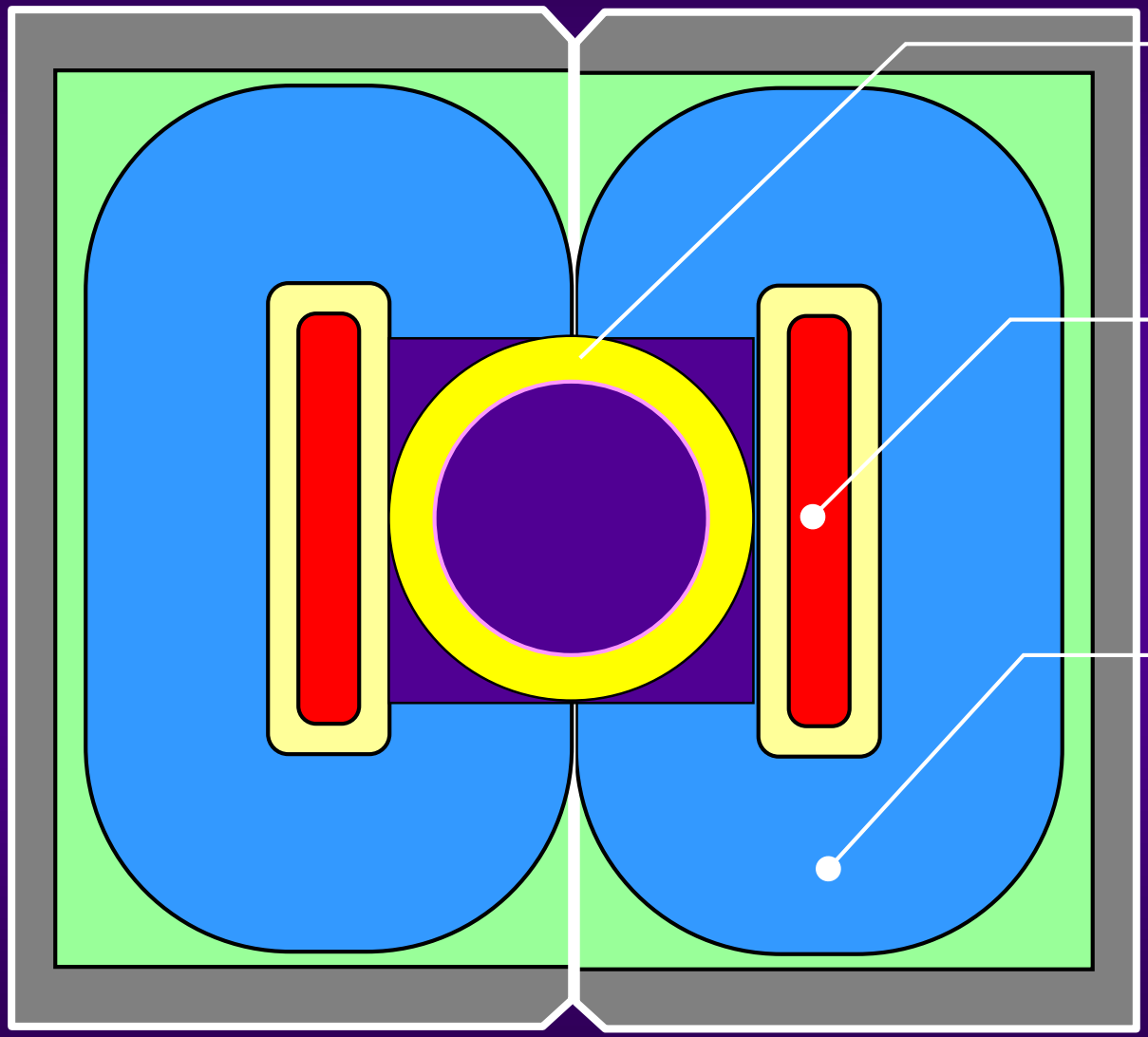
The LHC Beam Dump System

the only System to be tracked with Energy

Schematic Layout



MKD cross section (schematic)



Ceramic Vacuum Chamber

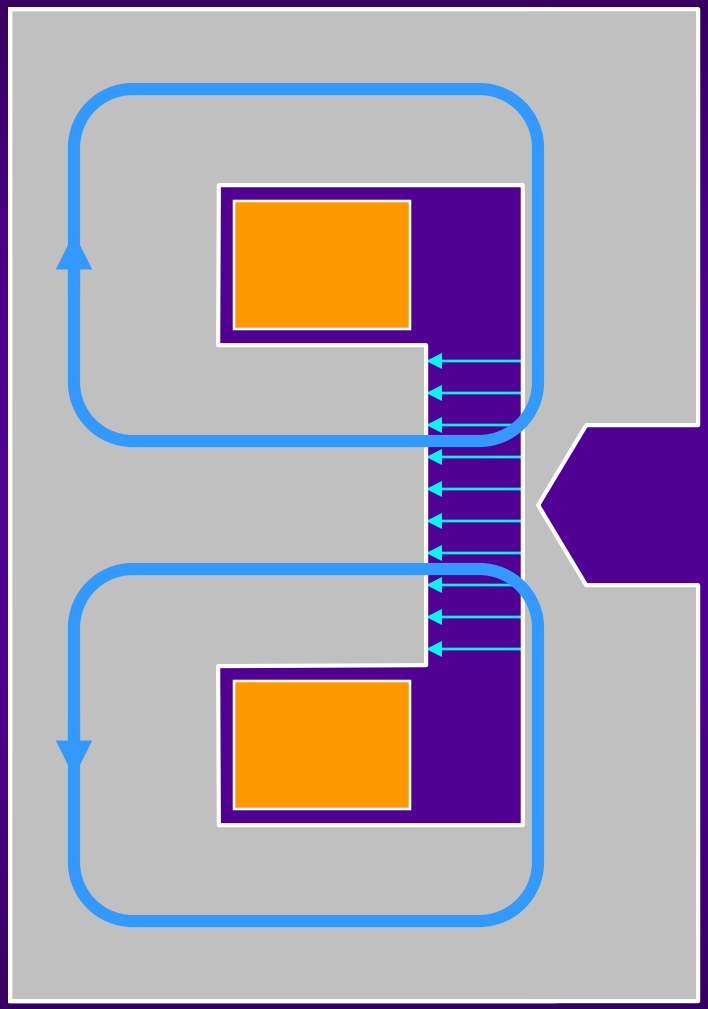
Conductor

Strip Wound Core

k = 0.26 mrad

Lambertson septum magnet (principle)

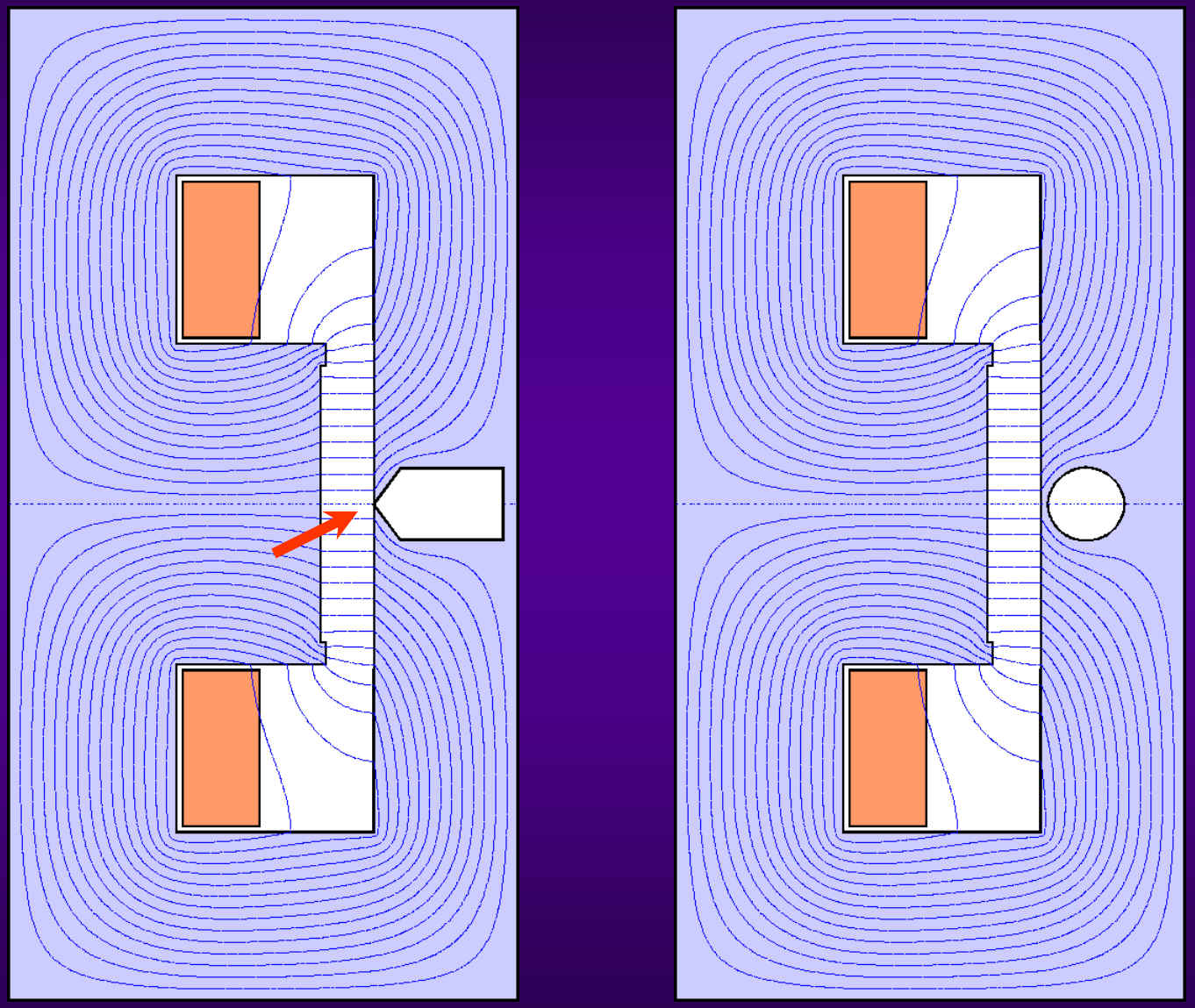
the deflection of the septum is orthogonal to the one of the kicker



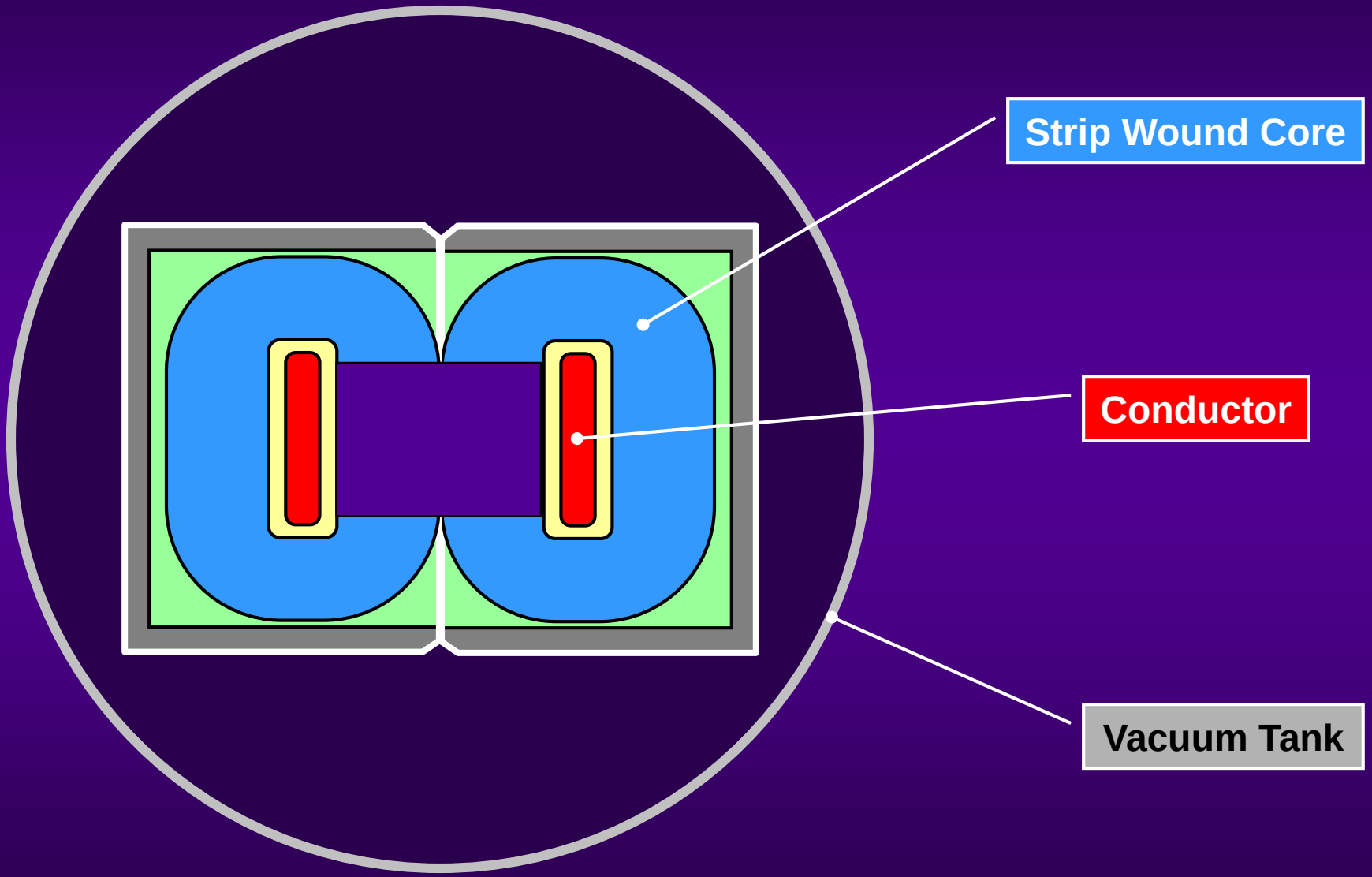
Saturation of septum

Add iron

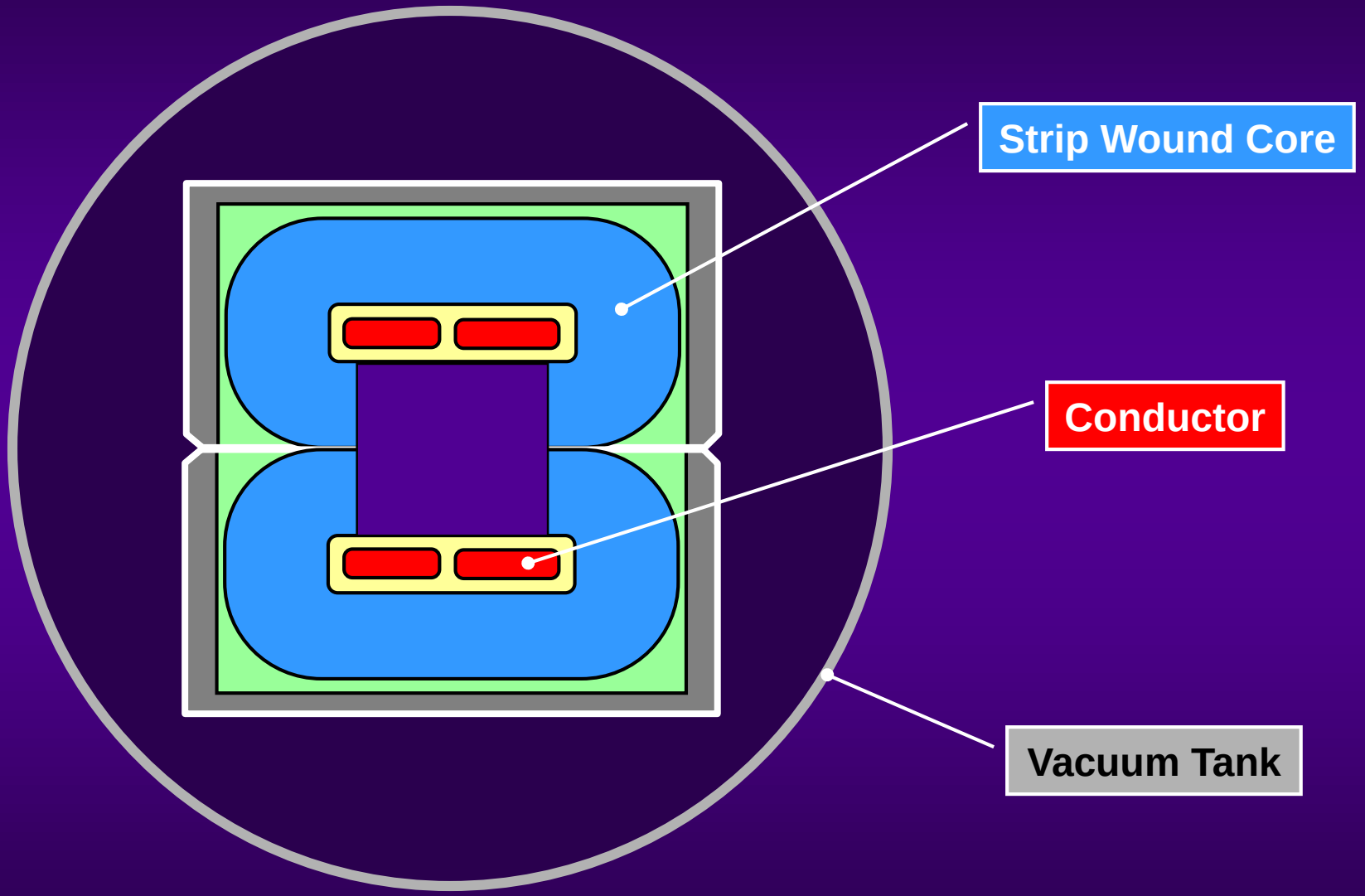
Beam dump septum magnet MSD



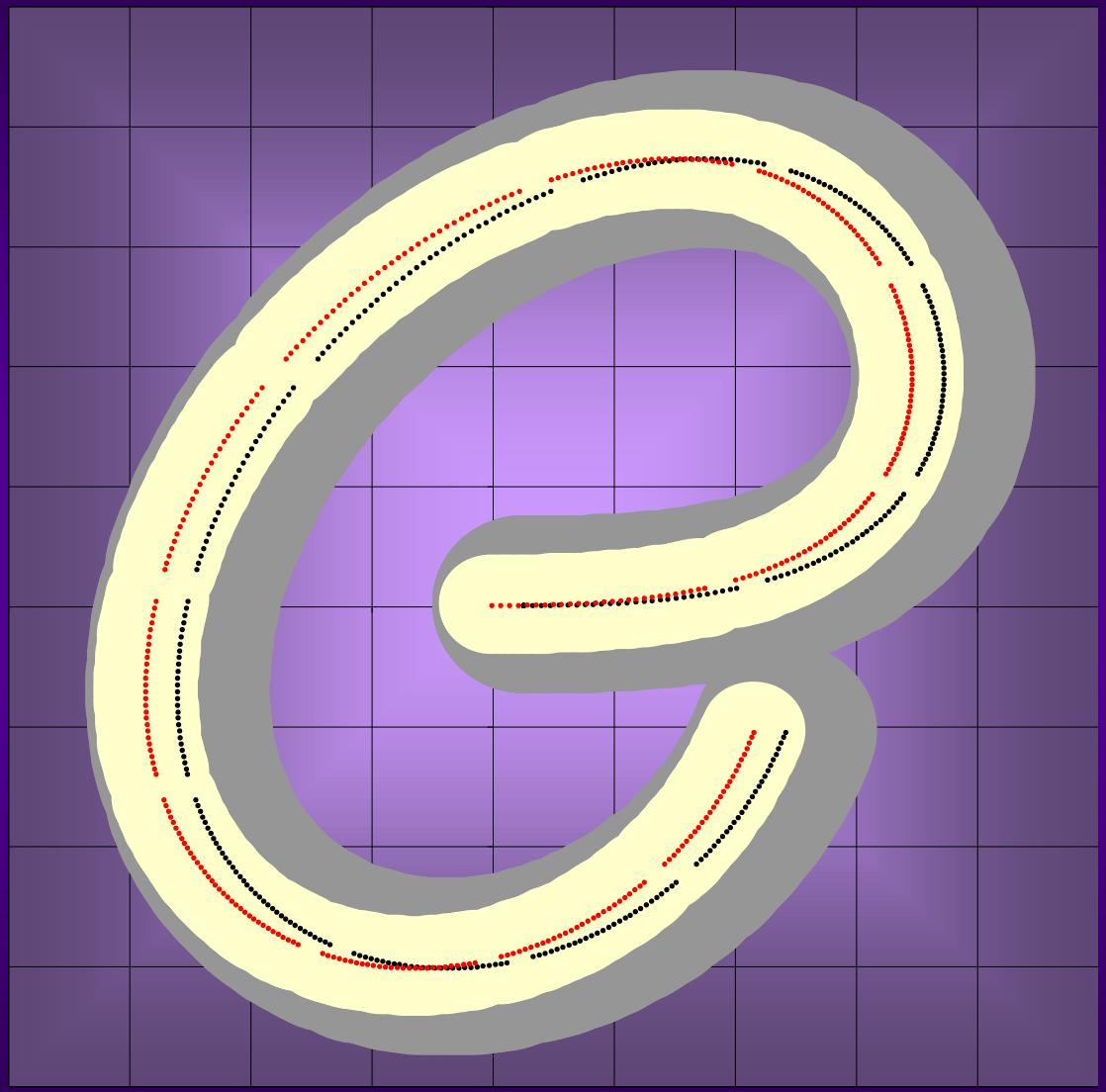
MKBH cross section (schematic)



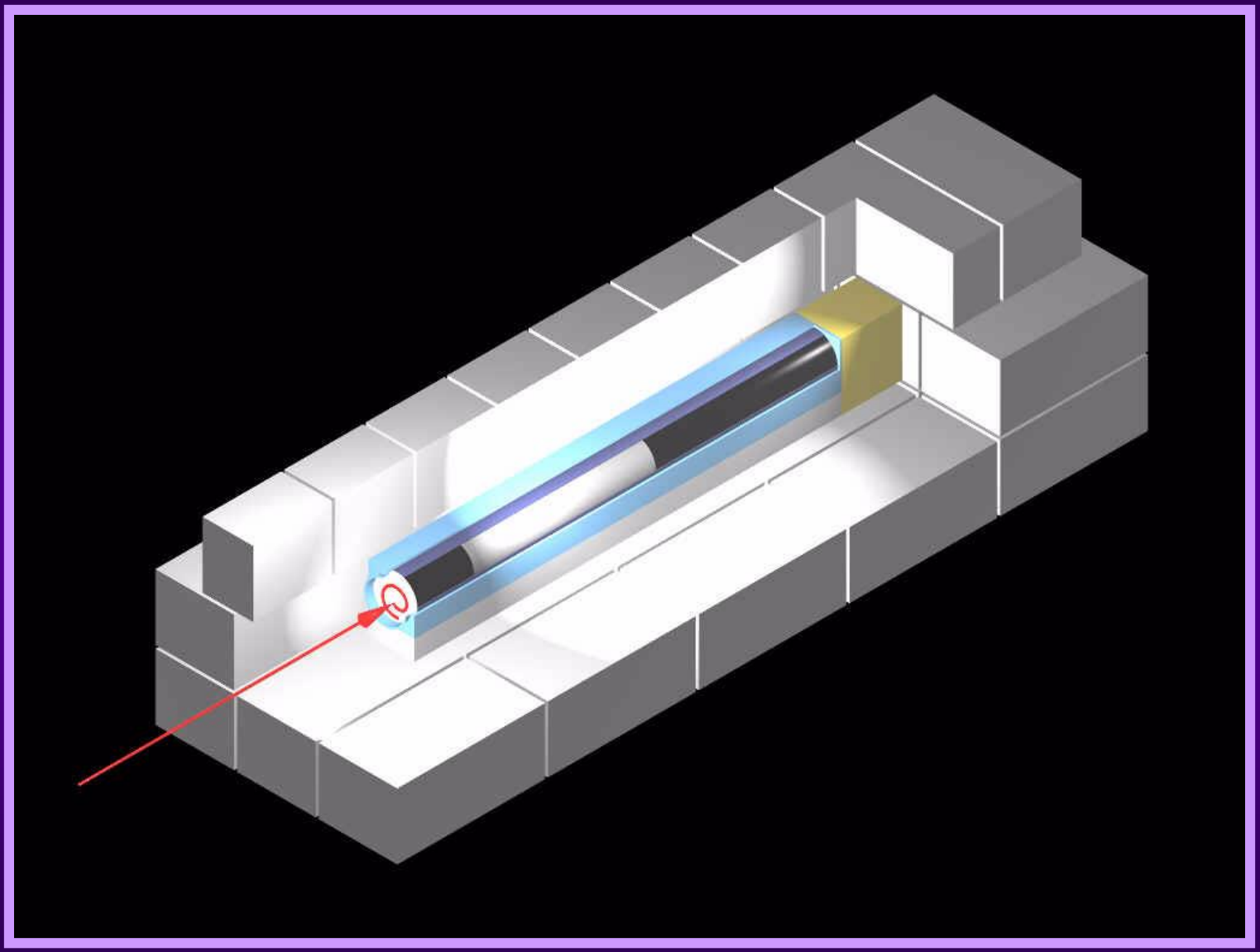
MKBV cross section (schematic)



Beams on TDE



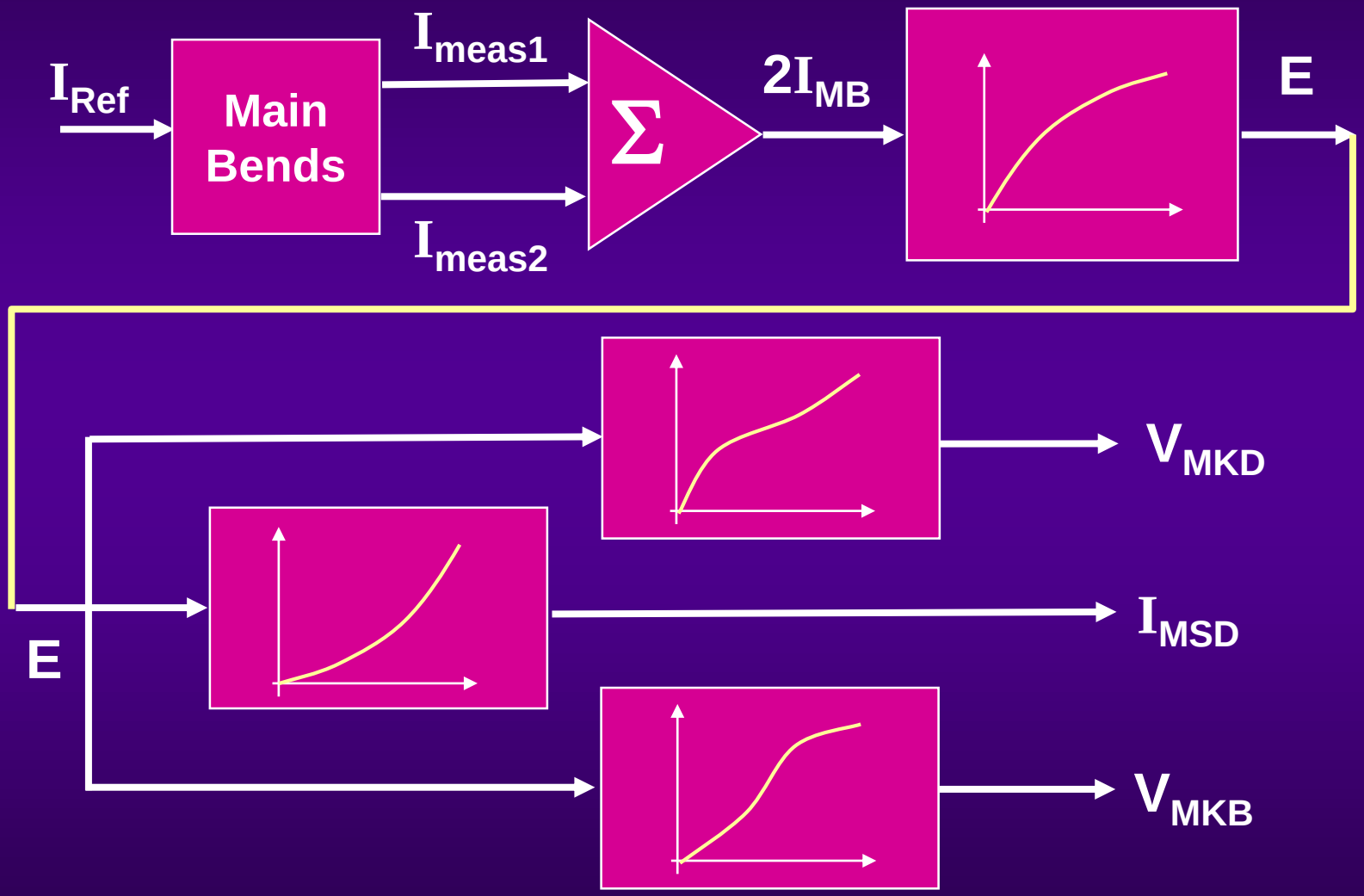
TDE



Different Energy Tracking for

- **Beam Dump Kicker MKD**
  - **less deflection at 7 TeV than at 450 GeV**
    (smaller beam and less overshoot at 7 TeV
    $\rightarrow$ saving kicker strength)
- **Septum Magnet MSD**
  - **must track precisely with Energy:**
    $k_{MSD} = 2.4$ mrad = const. $\neq k_{MSD}(E)$
- **Diluter Kickers MKBH & MKBV**
  - **a priori k_{MKB} = const. , but**
  - **could be smaller for low energies** (to be studied)

References for Energy Tracking



What can go wrong ?

- **Beam Dump Kicker MKD:**
  - error in energy tracking : 7 ‰ r.m.s.
  - flat-top variation within less than 7 %
  - one of the 14 modules is not firing (only 13 modules)
  - unsynchronized dump

"Operational"

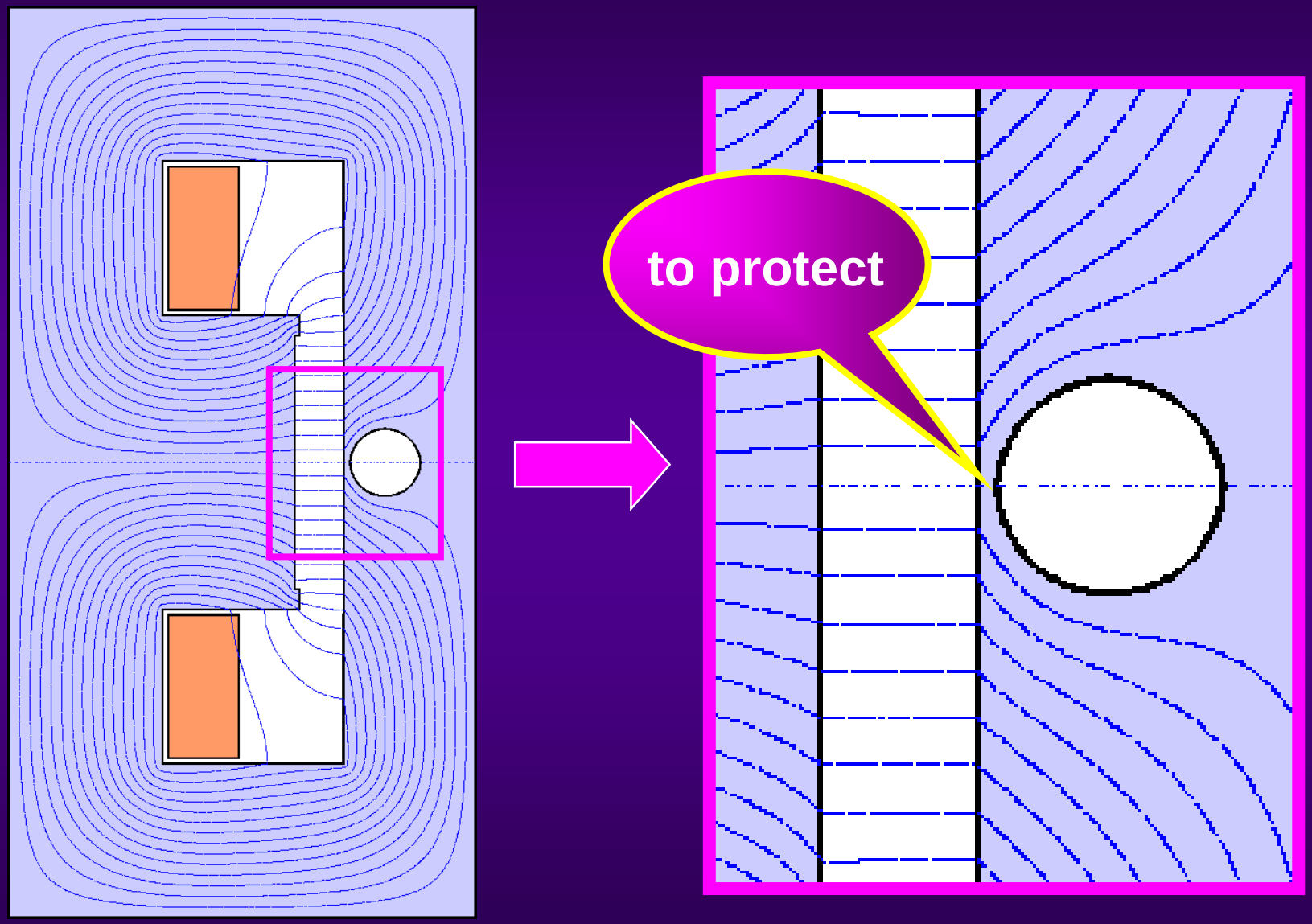
- **Septum Magnet MSD:**
  - septum current out of tolerance
  - short circuit between windings
  - no cooling (thermal interlock)

NOT operational: EMERGENCY DUMP

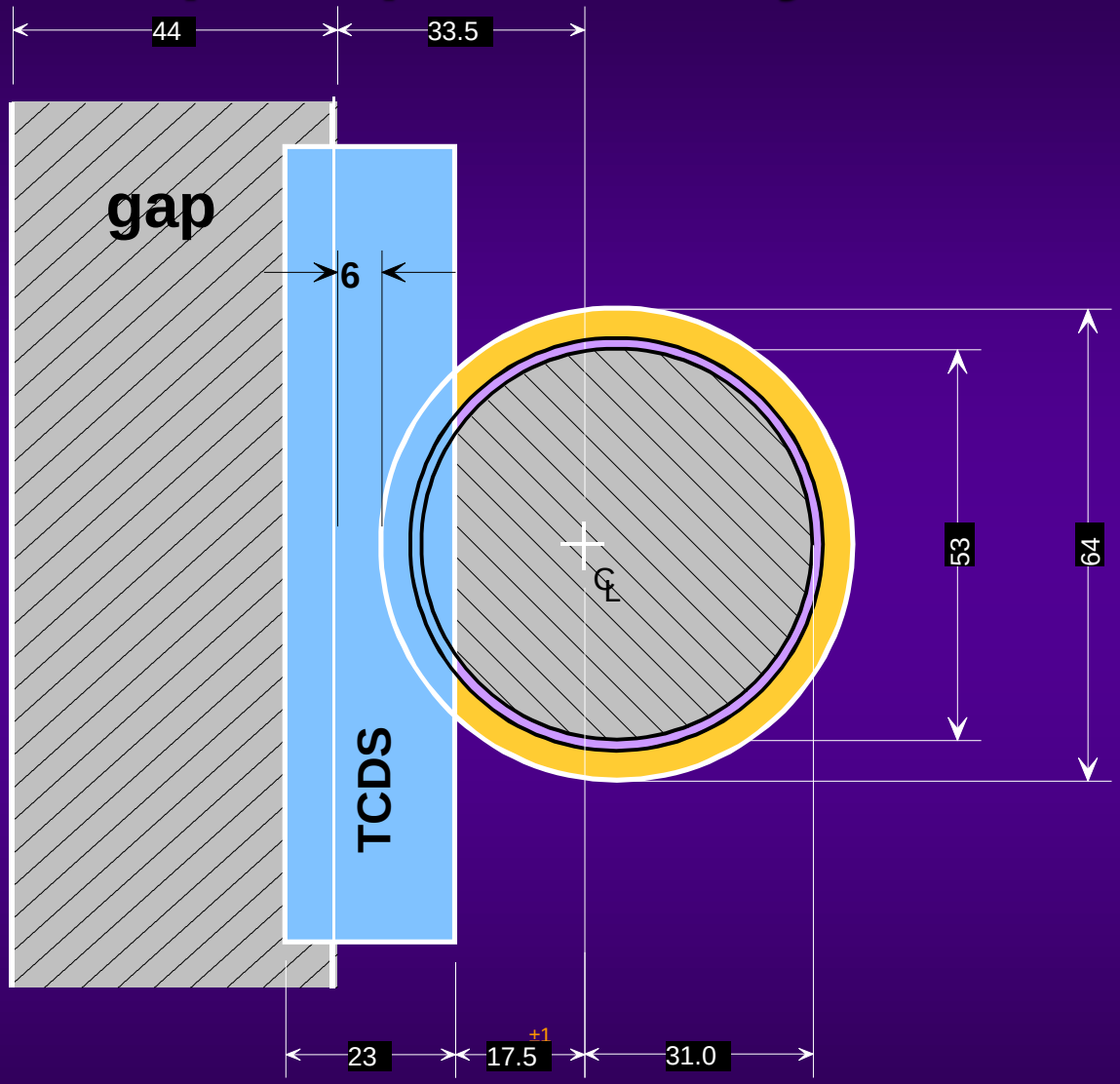
- **Diluter Kickers MKBH & MKBV**
  - one or more modules are not firing

"Operational"

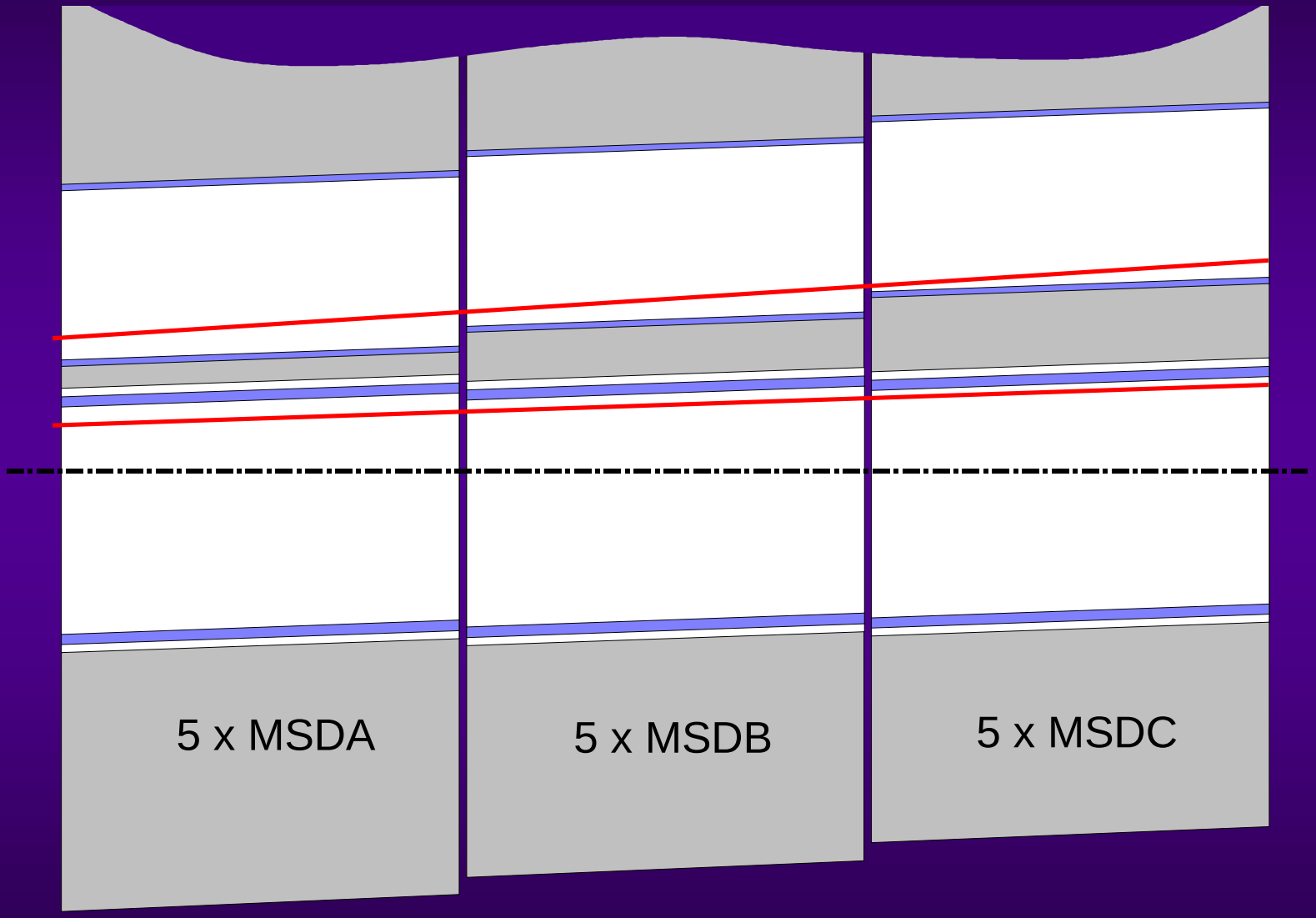
Unsynchronized Beam Dump



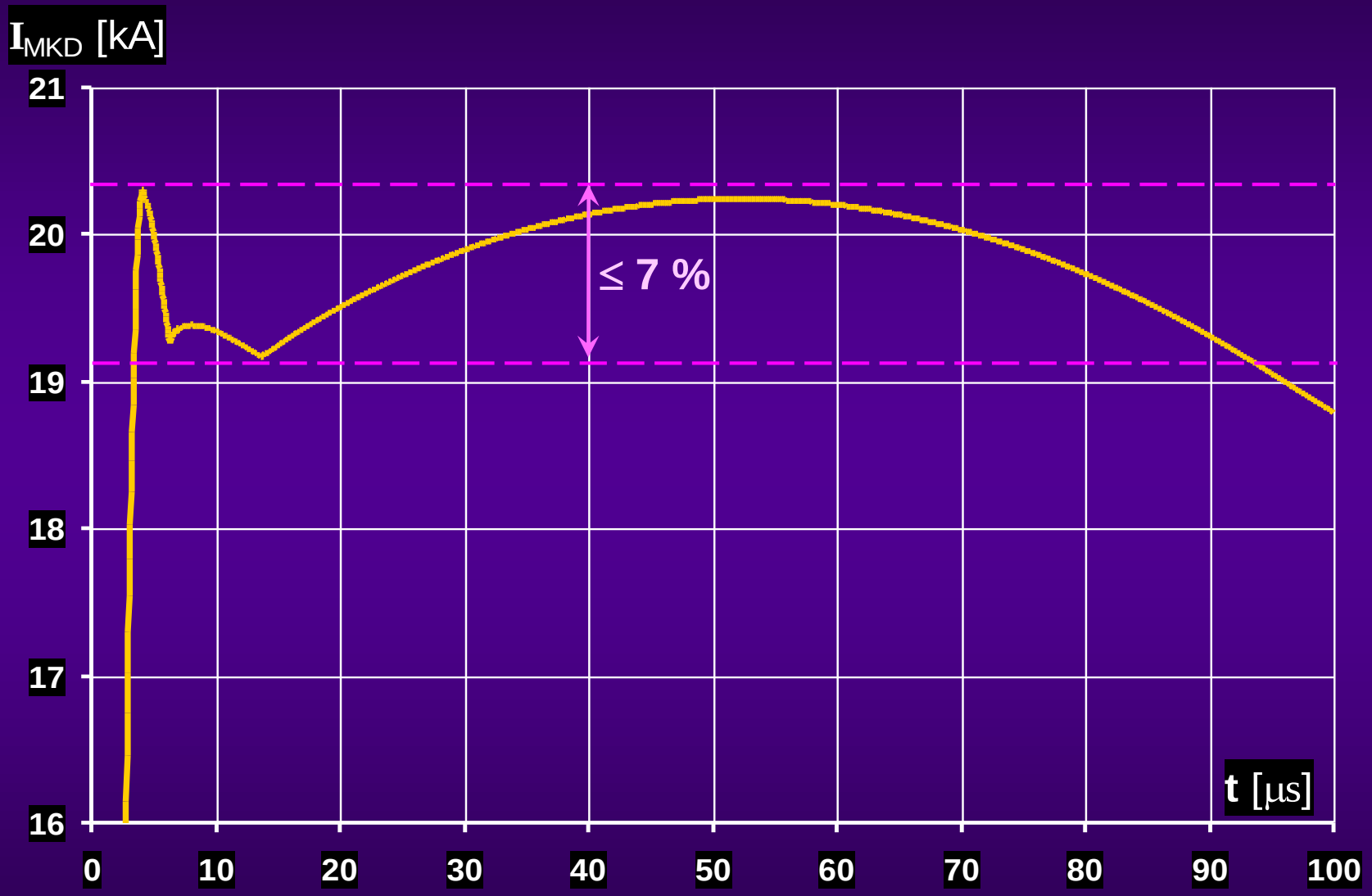
Septum protected by TCDS



MSD Alignment



MKD current

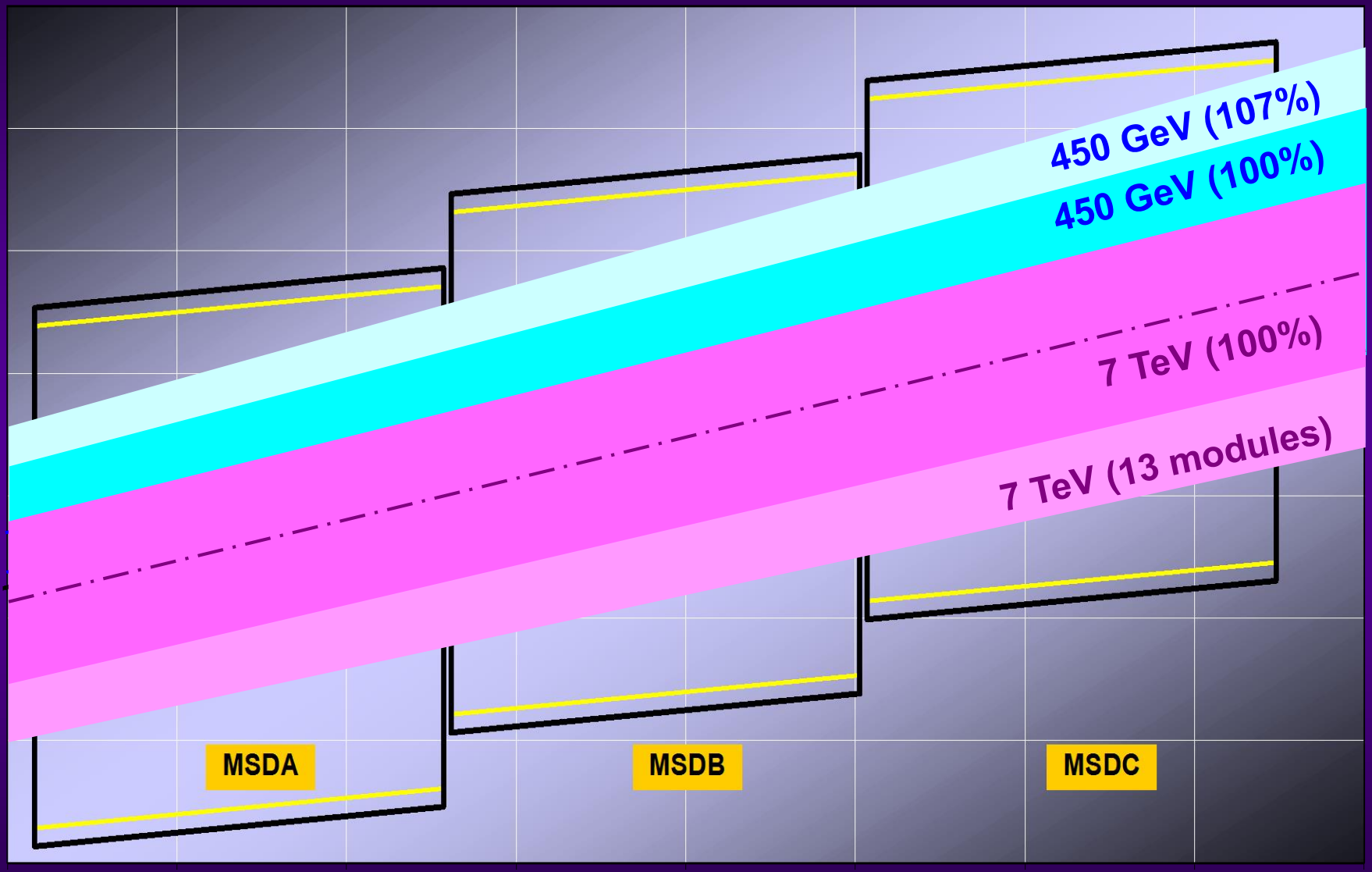


Assumptions for Beam Envelopes

- **Beam size at 450 GeV :** **± 4σ**
- **Beam size at 7 TeV :** **± 6σ**
- **β - beating** (mismatch) **:** **20 %**
- **Closed Orbit at MSD :** **± 2 mm**
  - **at β_{max}** (Quadrupole **Q5**) **:** **± 4.4 mm**
- **Energy-tracking of MKD :** **7 ‰ rms**
  - **per module** (uncorrelated) **:** **1%**

all integrated in envelopes

Beams in Gap (horizontal)



Energy Tracking of MSD

Max. tolerable Error $\Delta k_{MSD}(E) = \pm 2\ \%$

- **vertical aperture of Diluter Kickers MKBH and MKBV**
- **dimension of graphite core of the TDE** (Ø = 700 mm)

Contributions :

- **Tracking errors: ± 1 %**
  - **difference between reference and actual current**
  - **calibration of dipole field $B(I_{MSD})$**
- **Power Converter fault** (worst case)**: < 1%**
  - **100% voltage drop → dI/dt ≈ 0.5 ‰ per ms → < 20 ms !**
- **Load error, short circuit :**
  - **between 2 conductors: ≈ 1.7 ‰**
  - **between 2 layers: ~ 2.7 %**

Conclusions

In order to guarantee the the vertical deflection of the MSD to be 2.4 mrad ± 2 %, independent of the energy:

- **it is necessary** (but not sufficient) **to control the MSD current with a precision of ± 1 %**
- **a load surveillance (short circuit detection) is also necessary**
- **the DUMP request in case of "*current out of tolerance*" must be sent from the power supply**