Beam Energy Meter (BEM)
&
(Beam Energy Tracking (BET))

Only a few words

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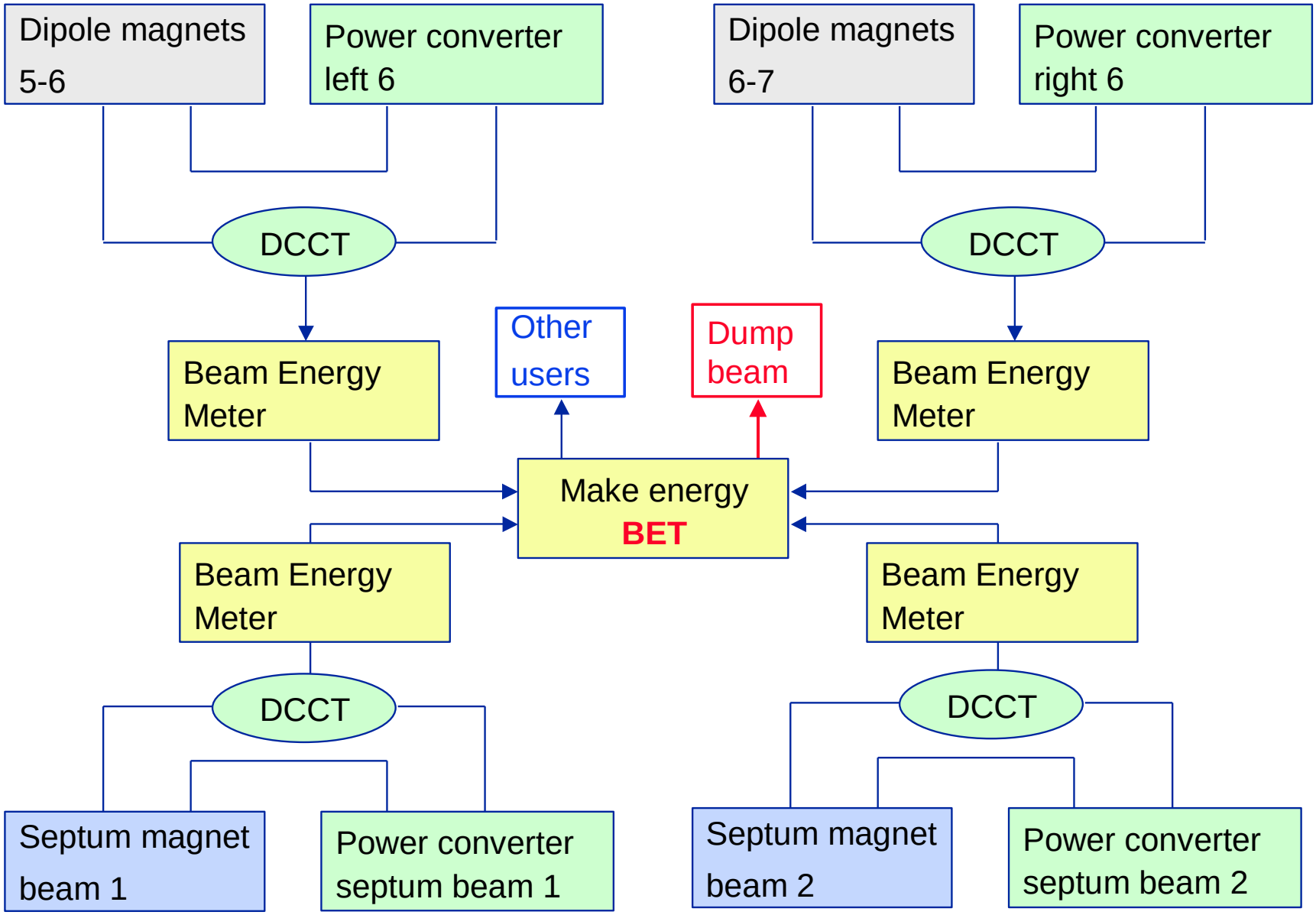
AB/BT

26/05/2003


Dipole magnets 5-6
Power converter left 6
Dipole magnets 6-7
Power converter right 6
DCCT
DCCT
Other users
Dump beam
Beam Energy Meter
Beam Energy Meter
Make energy BET
Beam Energy Meter
Beam Energy Meter
DCCT
DCCT
Septum magnet beam 1
Power converter septum beam 1
Septum magnet beam 2
Power converter septum beam 2

Definition

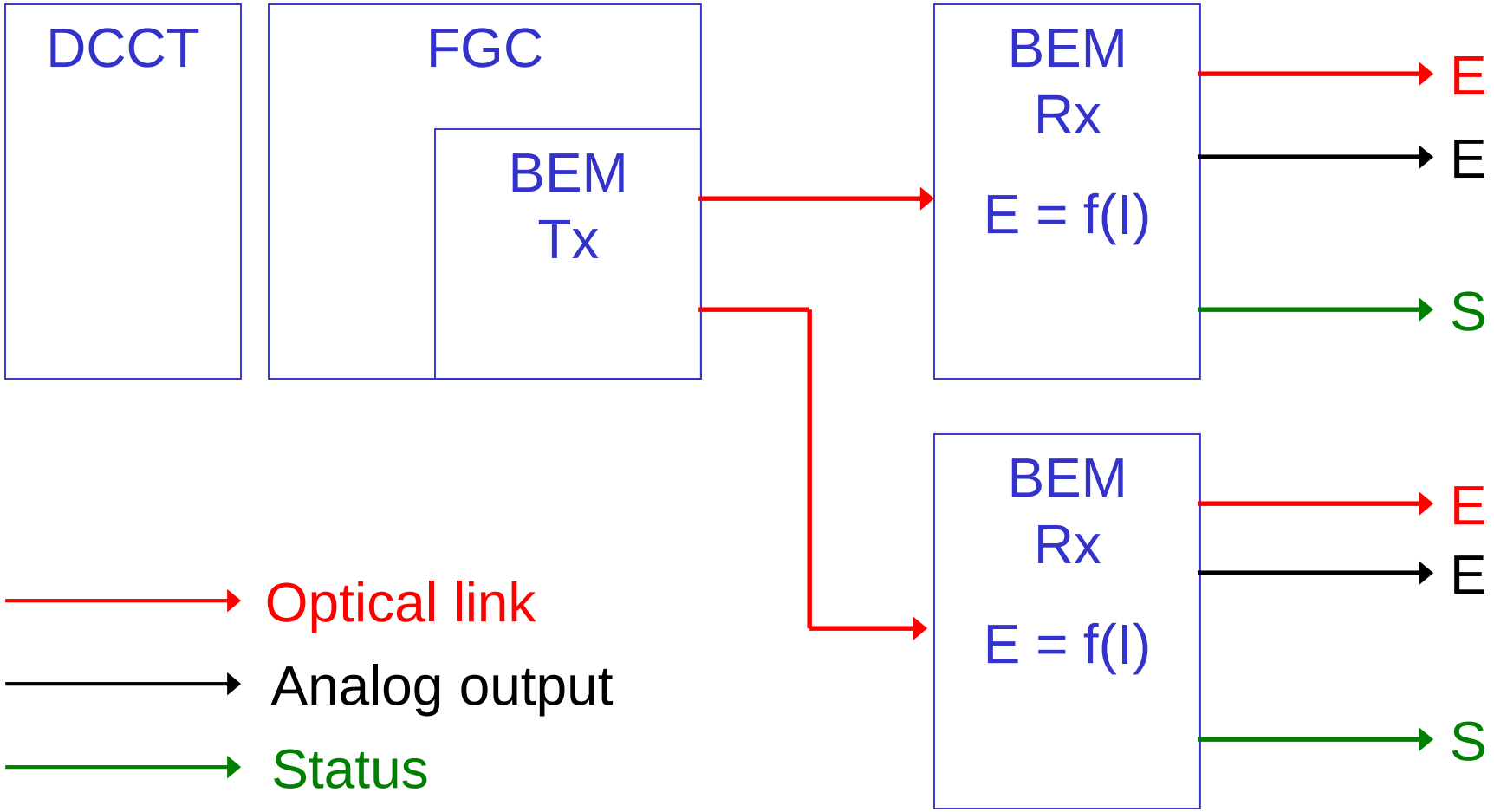
- Beam Energy Meter
  - → Instrument that **converts,** through a look-up table (transfer function), a physical measurement dynamically linked to the beam energy (current or voltage) into a corrected normalized value **proportional** to the beam energy.
  - → It is **not** a real measurement of the beam energy.

$$\mathbf{E = f(U)}$$

- Beam Energy Tracking
  - → Instrument that **compares** if different corrected values proportional to the beam energy retrieved from different equipment are within a predefined tolerance window.

Beam Energy Meter

Bending Magnets Power Converters



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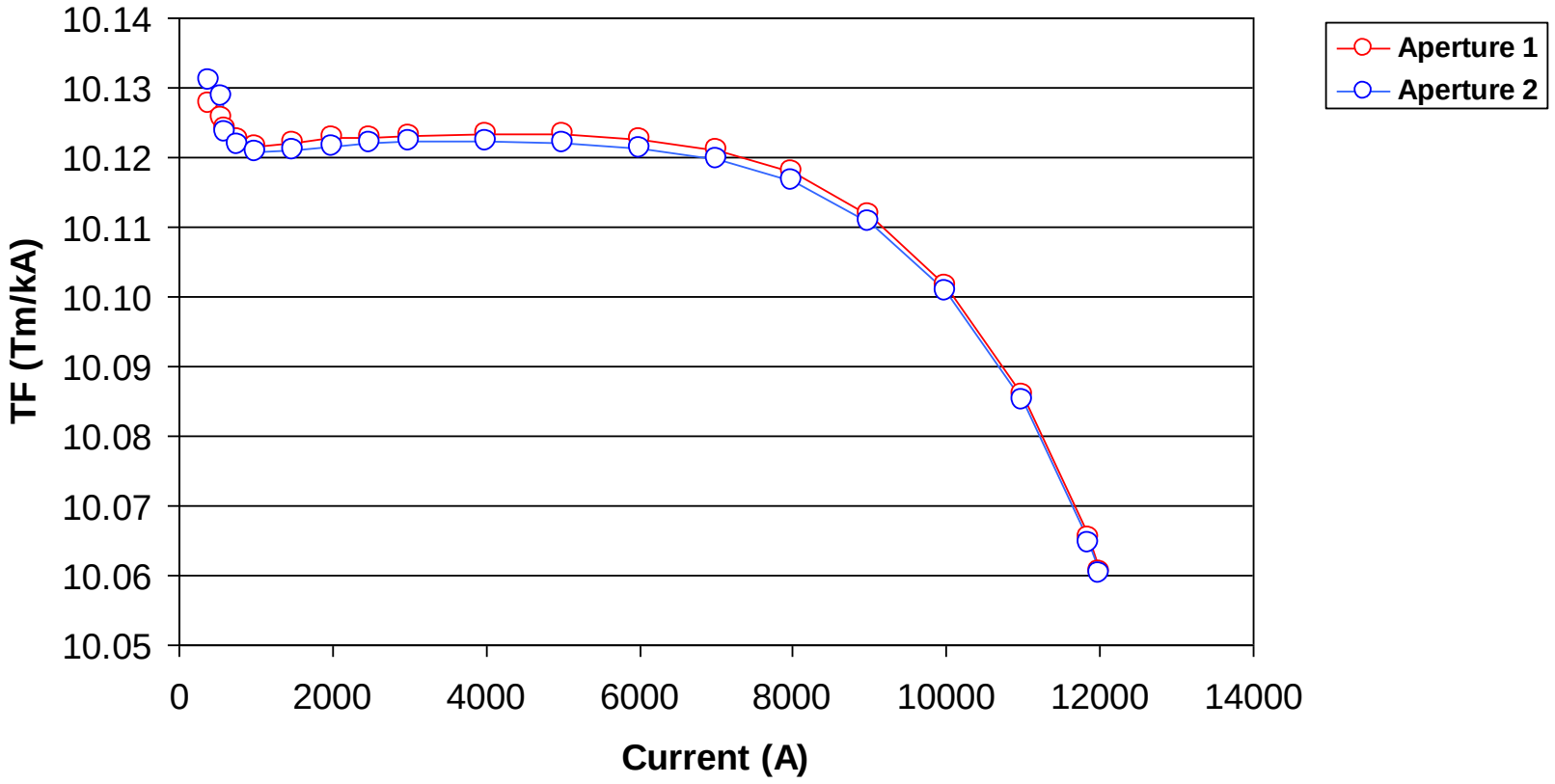
Bending Magnets – Transfer Function



→ Linear extrapolation give an error greater than 0.1% (typ. 0.5%)

DCCT

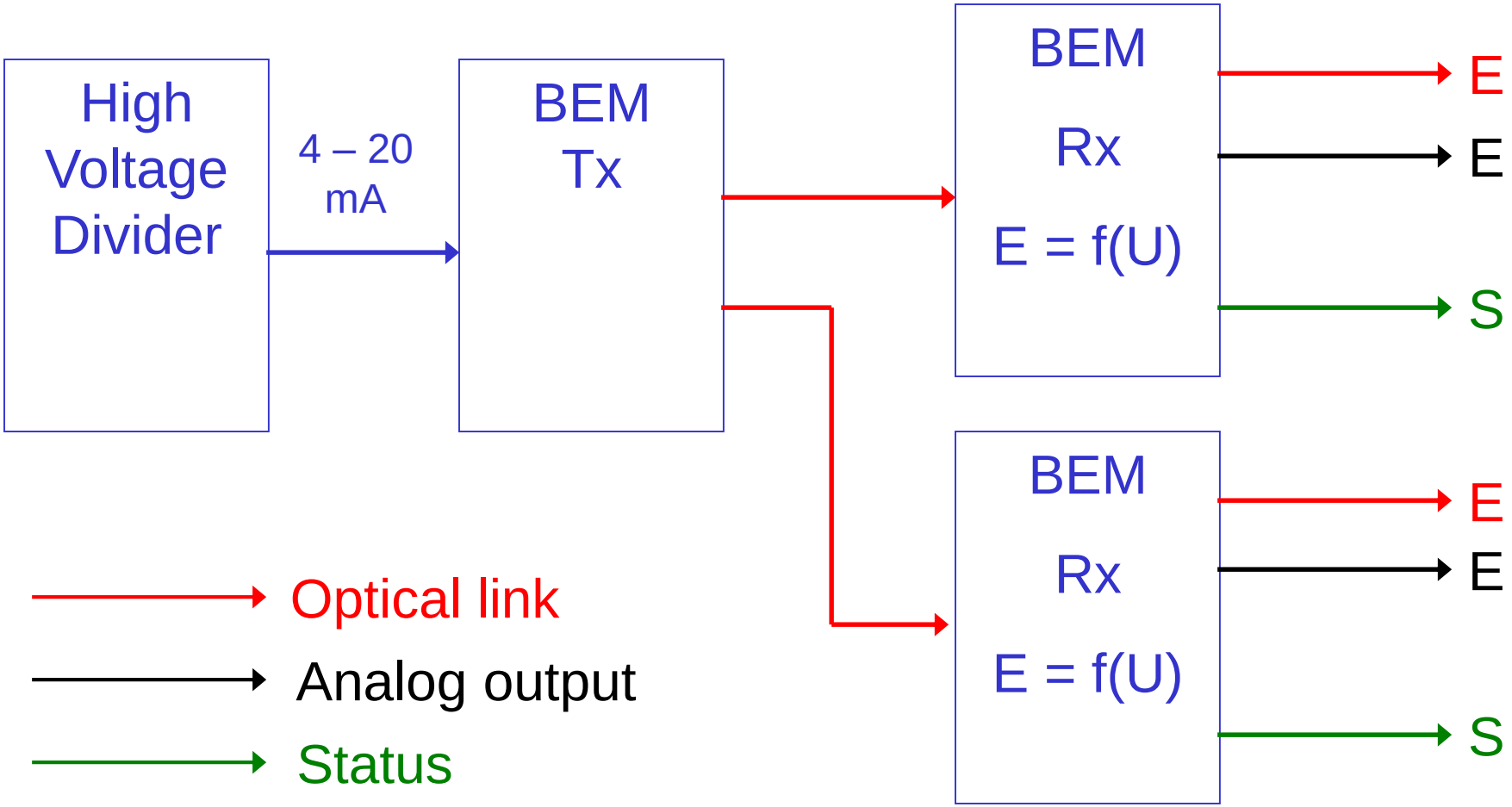
- “Low precision” burden resistor included within the DCCT electronics for BEM.
- No access to the MB power converter high precision DCCT is possible.
- The “Low precision” DCCT tollows the main output signal (“high precision”) to **0.1%** tolerance (all errors and instabilities included)
- For MSD power converters, the “low precision” DCCTs are used feedback loop
  - Fail-safe situation
  - No redundancy needed
- For MB power converters, the “low precision” DCCTs are not feedback loop and are only foreseen for the BEMs.
  - Unsafe situation
  - Redundancy for the MB current measurements (IP6 left and right)

Calibration

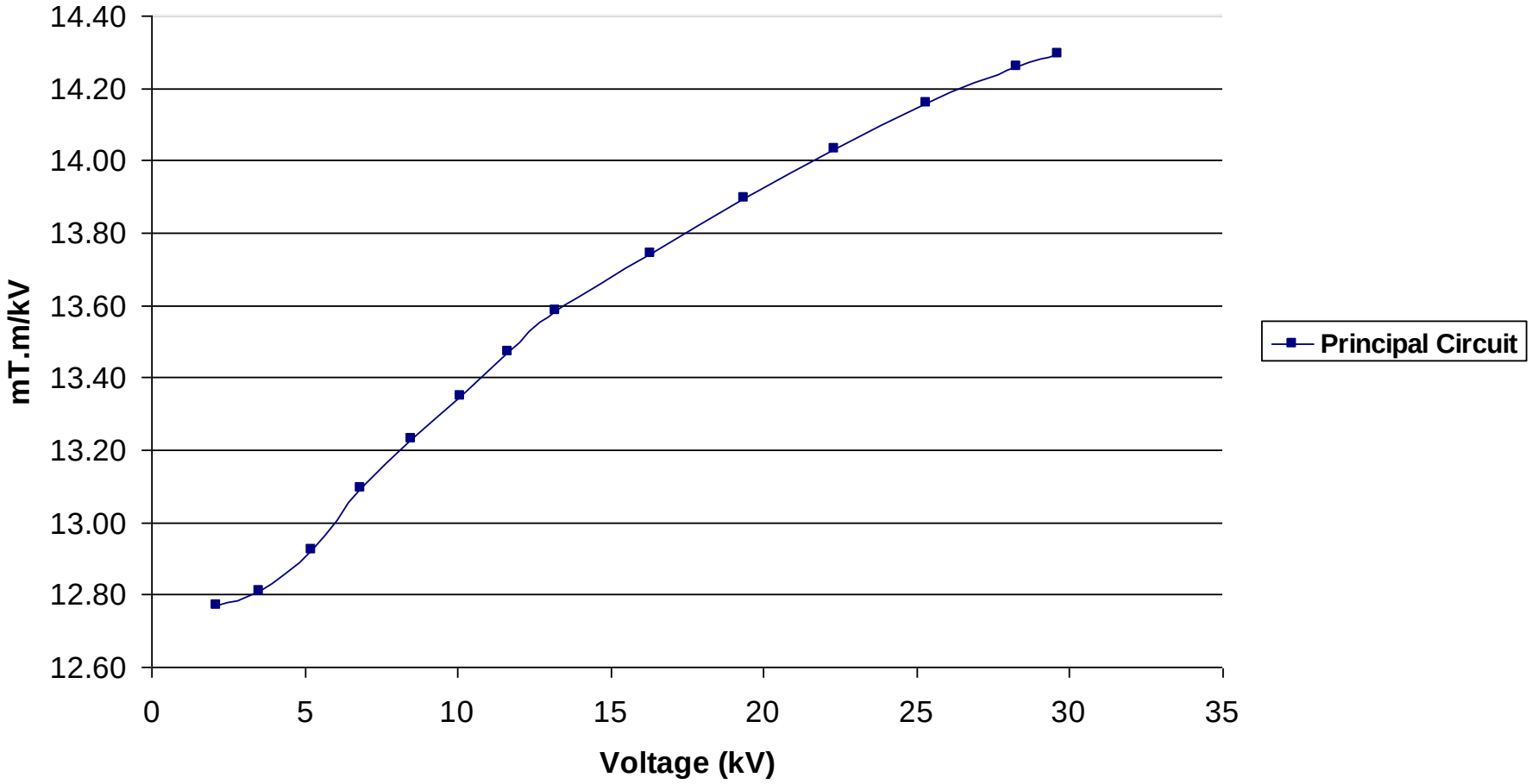
- FGC includes calibration facilities (+/- 10 V, +/- 200 μV, Vref DAC) that can be used to calibrate the BEM system
  - Remotely controllable
  - Depends on FGC firmware
- Calibration facilities can be used for MSD power converters.
- Calibration facilities can not be used for MD power converter
  - Power converter can ramp while the “low precision” DCCT is still in calibration mode
- Continuous calibration mechanism will be included within the BEM Tx, BEM Rx & BET

Beam Energy Meter

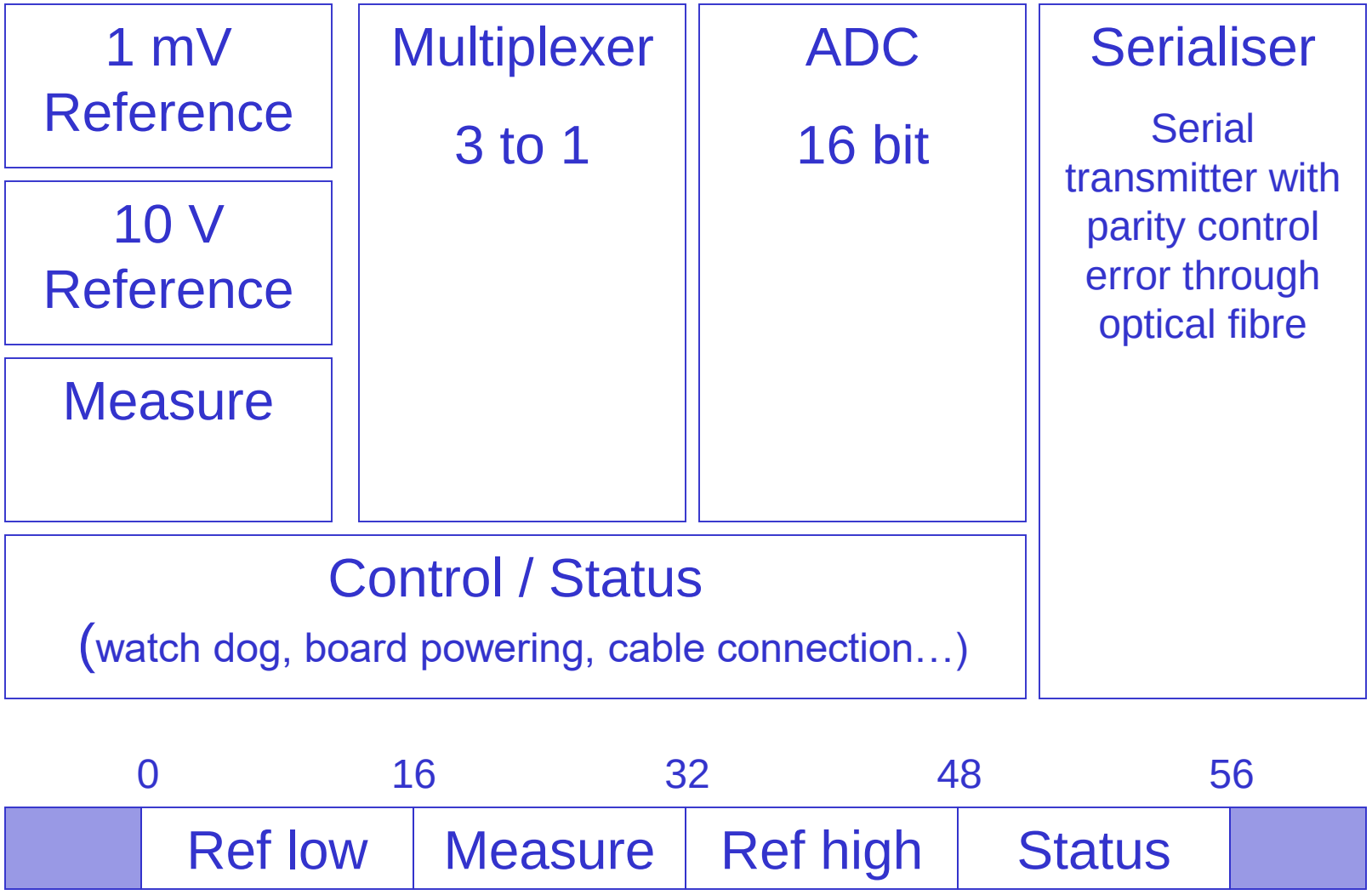
Kicker Generators



Kicker Magnets – Transfer Function



BEM Tx


1 mV Reference
10 V Reference
Measure
Multiplexer
3 to 1
ADC
16 bit
Serialiser
Serial transmitter with parity control error through optical fibre
Control / Status
(watch dog, board powering, cable connection…)
0
16
32
48
56
Ref low
Measure
Ref high
Status

BEM Rx

De-serialiser

Serial receiver with parity control error through optical fibre

Measure

Look-up Table

Energy

Control / Status

(watch dog, board powering, cable connection…)

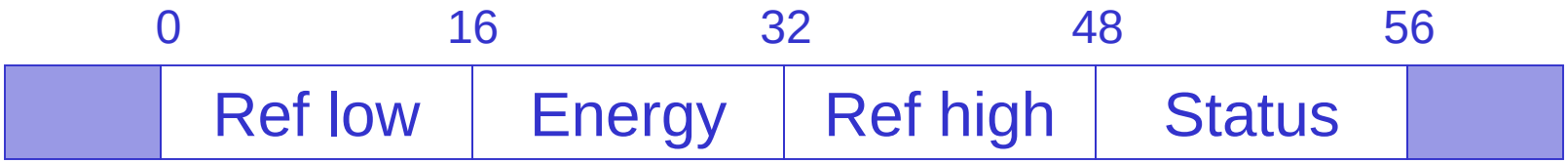
References surveillance

Serialiser

Serial transmitter with parity control error through optical fibre

Analogue Outputs

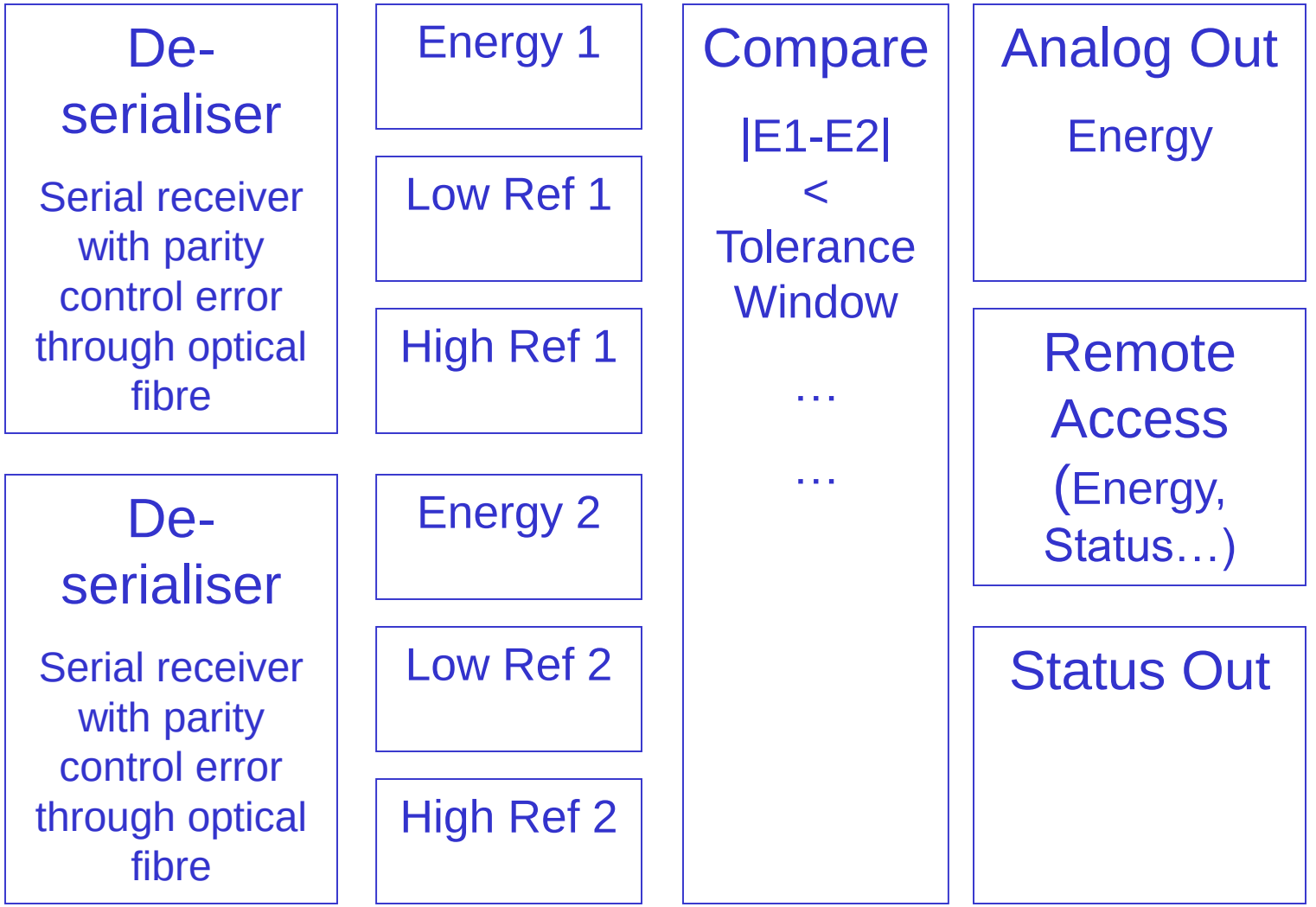
Energy, Ref low, Ref high, Global status



BEM Parameters

Power converter DCCT precision	0.1 %
Kicker HV divider precision	0.1 %
Sampling frequency	1 kHz
Digital resolution	16 bit (12 bit needed)
Transmission rate	64 kBaud
Error during ramp (10 A/s)	Lower than 0.001%
Analog output	0 to 10 V or 4 to 20 mA
Scaling	0 to 10 V for 0 to 10 TeV

BET


De-serialiser
Serial receiver with parity control error through optical fibre
De-serialiser
Serial receiver with parity control error through optical fibre
Energy 1
Low Ref 1
High Ref 1
Energy 2
Low Ref 2
High Ref 2
Compare
|E1-E2| < Tolerance Window
…
…
Analog Out
Energy
Remote Access
(Energy, Status…)
Status Out

Energy - Distribution