

Alternative Ideas to protect circuits with small time constants



Recalling the parameters of the warm D1 magnets:

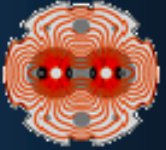
$R \sim 60 \text{ m}\Omega$, $L \sim 150 - 170 \text{ mH} \rightarrow \text{Time constant} \sim 2.5 \text{ s}$

Tracking studies for failures in D1:

	Time constant	Detection level	Damaging collimators	Time to dump the beam
D1 of	[s]	[turns]	[turns]	[turns]
IP 1	2.5	8	11	3
IP 5	2.5	13	21	8

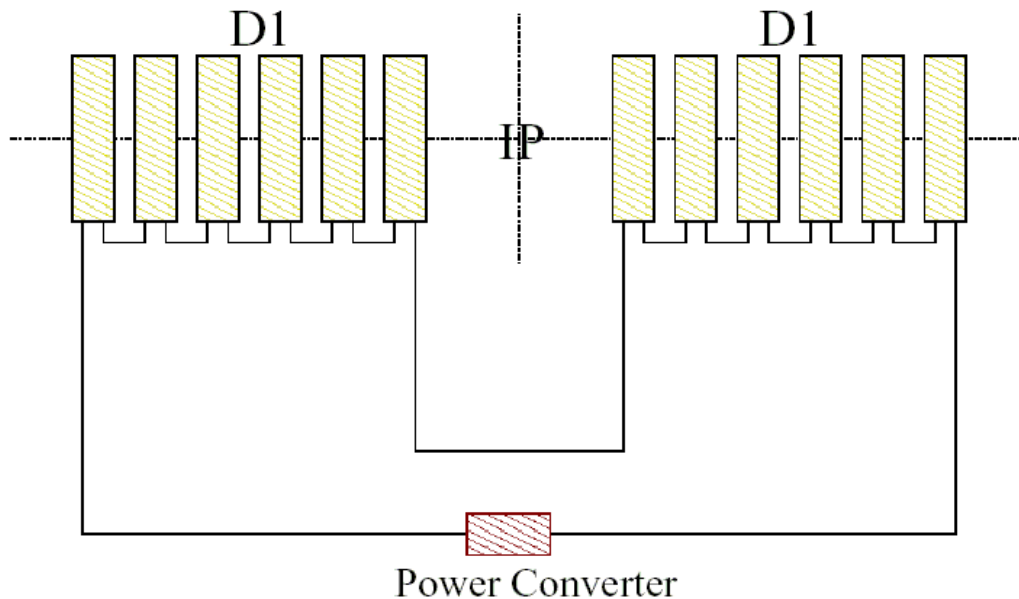
Only 3 turns to react for:

- Detection by the BLM (integrating half a turn)
- Sending the request to the dump system in point 6
- Beam dump: waiting for the beam abort gap (up to turn)



	1.5	7	8	1
	5	18	25	7
	1.5	8	13	5
	5	27	40	13

Adding Inductance to the Circuit



- An additional inductance of 5H in the circuit would result in a time constant of around 9s

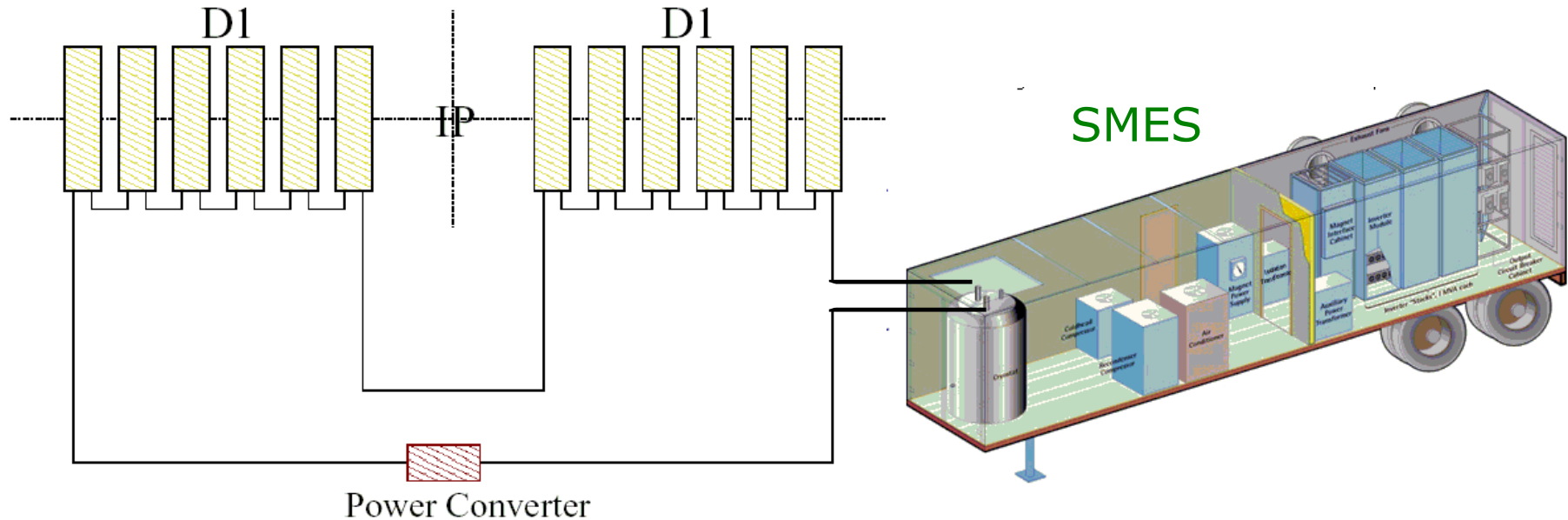
- A simple sc solenoid coil, added in series into the circuit could do the job

- Additional 5H would also lower the current ripple by a factor of 4

Assumption: $d=0.6\text{m}$, $l=1\text{m}$

- To reach 3 H we would need around 3750 turns of the coil (7000m) with a wire that could carry around 1000 A
- The wire for the 600A circuits could be reused (I_c more than 1000A), cost around 1CHF/m
- The total cost (integration in cryostat, current leads, wire, QPS?) would be approximately ?kCHF per system

Adding Inductance to the Circuit



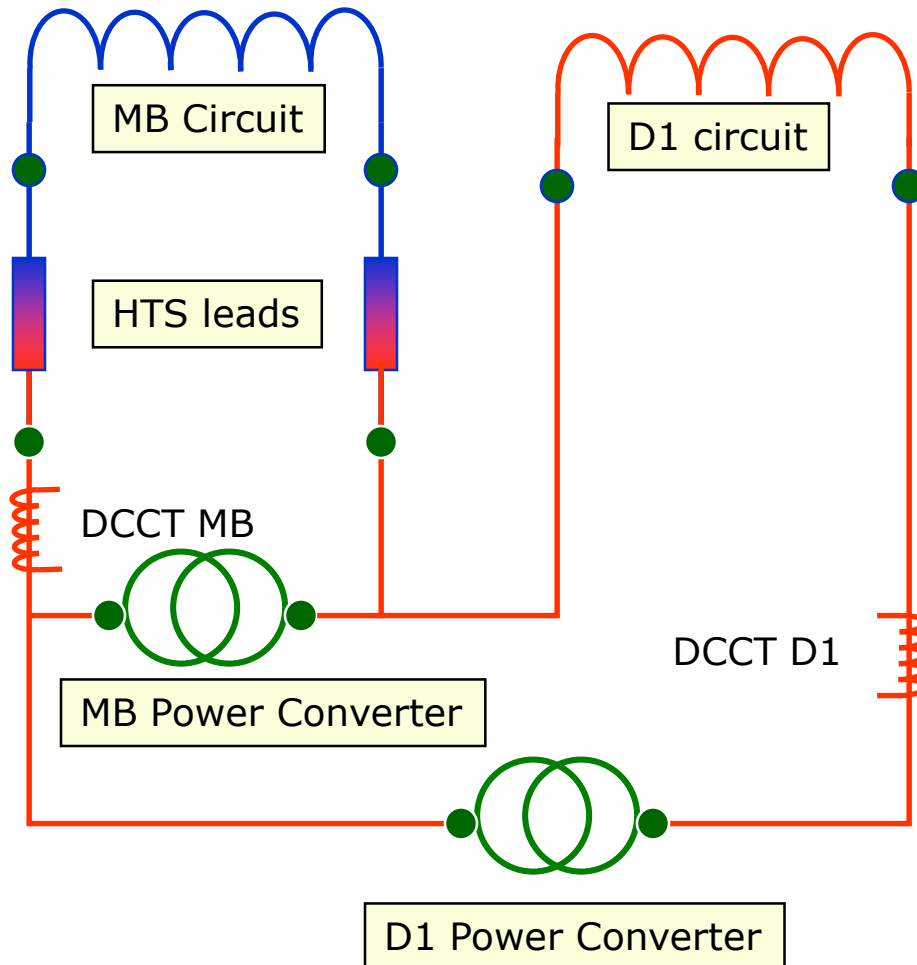
- Stand alone solution (no cryogenic available in points 1 and 5)
- Industrial standard solution
- For these circuits, the Power converter is located in the surface buildings, enough place for integration on surface, but maybe as well in the tunnel?

Standard Solutions on the market



Seen at American Superconductor

Series connection with existing circuit



Only RB circuit would have a considerable inductance

Time constant of $>20s$

Disturbance of PS idea

Additional cabling between DFBA/UA and D1 magnet

But: Creating 2 'special' sectors in terms of powering

Tracking information needs to be sent between the D1 converter (SR1) and the dipole converter (UA23)

Dipole converter delivering only nominal current – 1kA of D1

Conclusions



- The Power converter group would only be happy to have more load inductance in the circuit (PC type would be able to deliver additional voltage), but would prefer solution 1
- Possibility to reduce the current ripple and thus the orbit distortion by these D1 magnets (AP is investigating the problem)
- Adding inductance would be a 'passive' solution, giving us more time to react instead of relying on a very fast measurement system (inductances could be $> 10\text{H}$)
- Could be used in other circuits if it becomes necessary at a later stage