Considerations on performance of extraction elements

MTE workshop, 24.09.2010

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TE/ABT

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- ABT equipment used for Multi-Turn Extraction
- ABT assumptions about the systems
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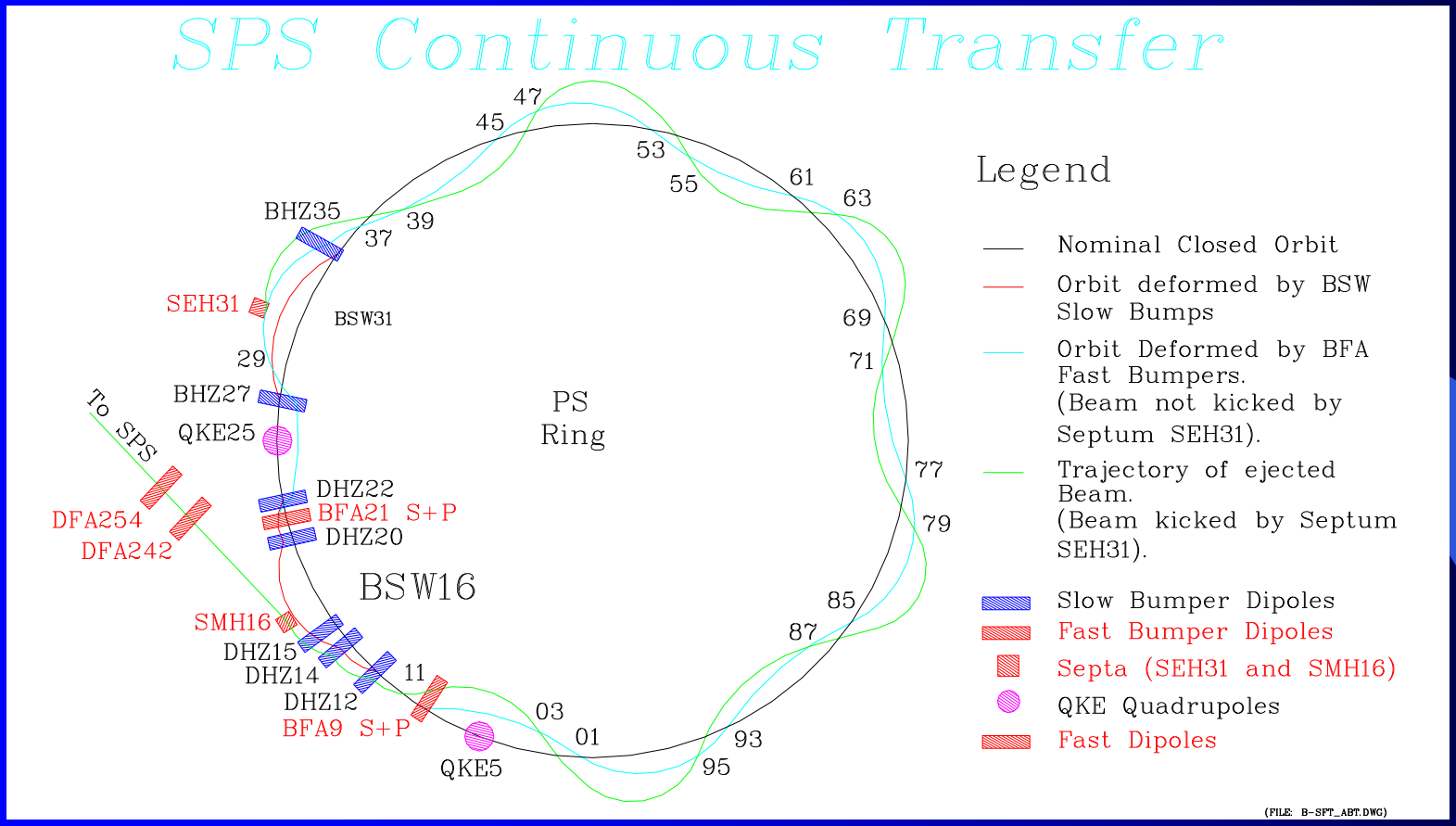
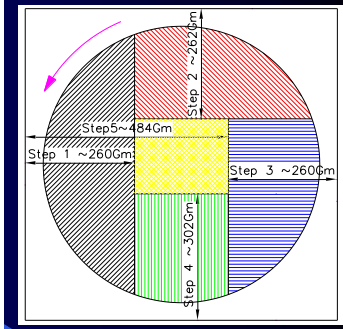
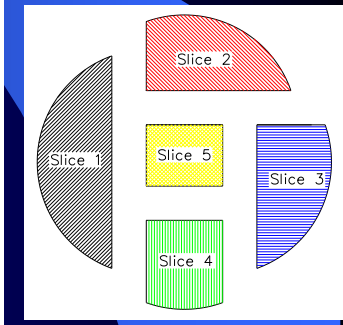
Continuous Transfer

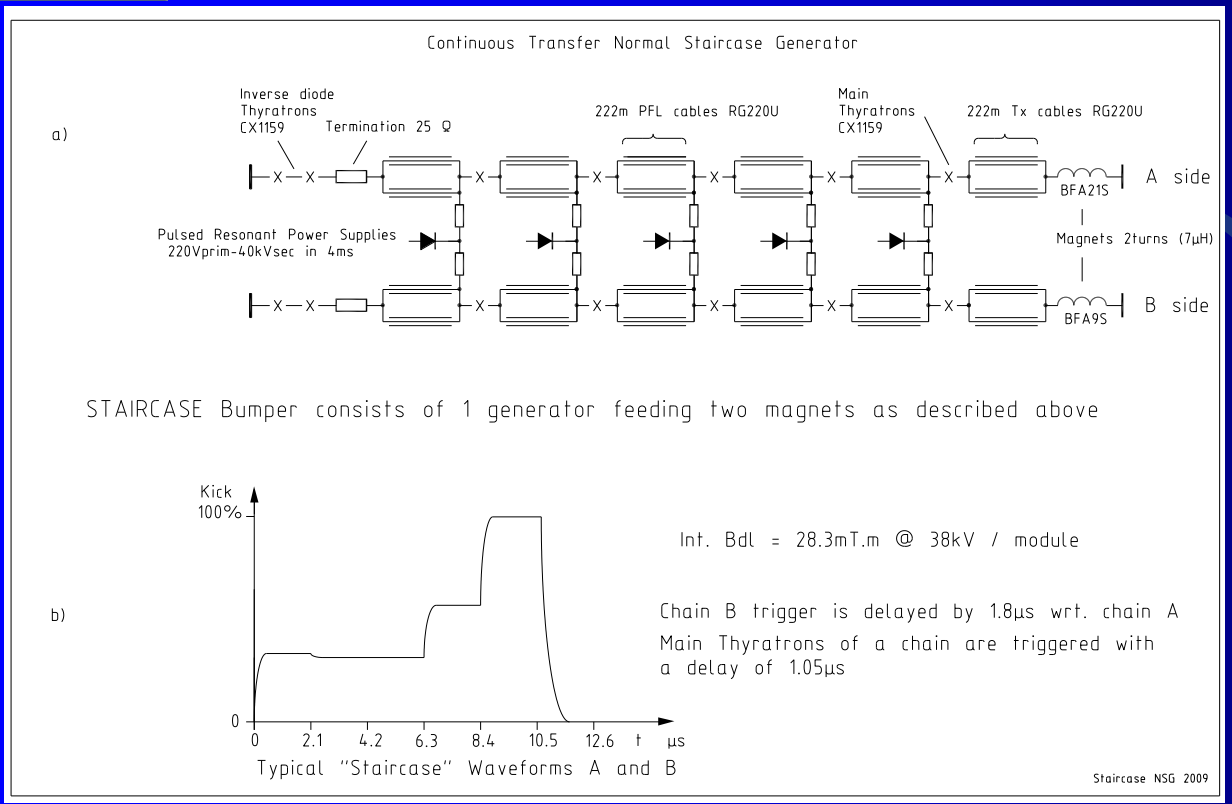


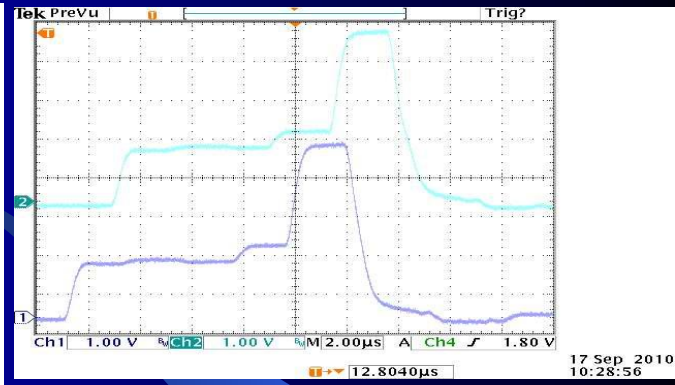




Filament beam cut into 5 slices by electrostatic septum SEH31

Staircase BFA21-9



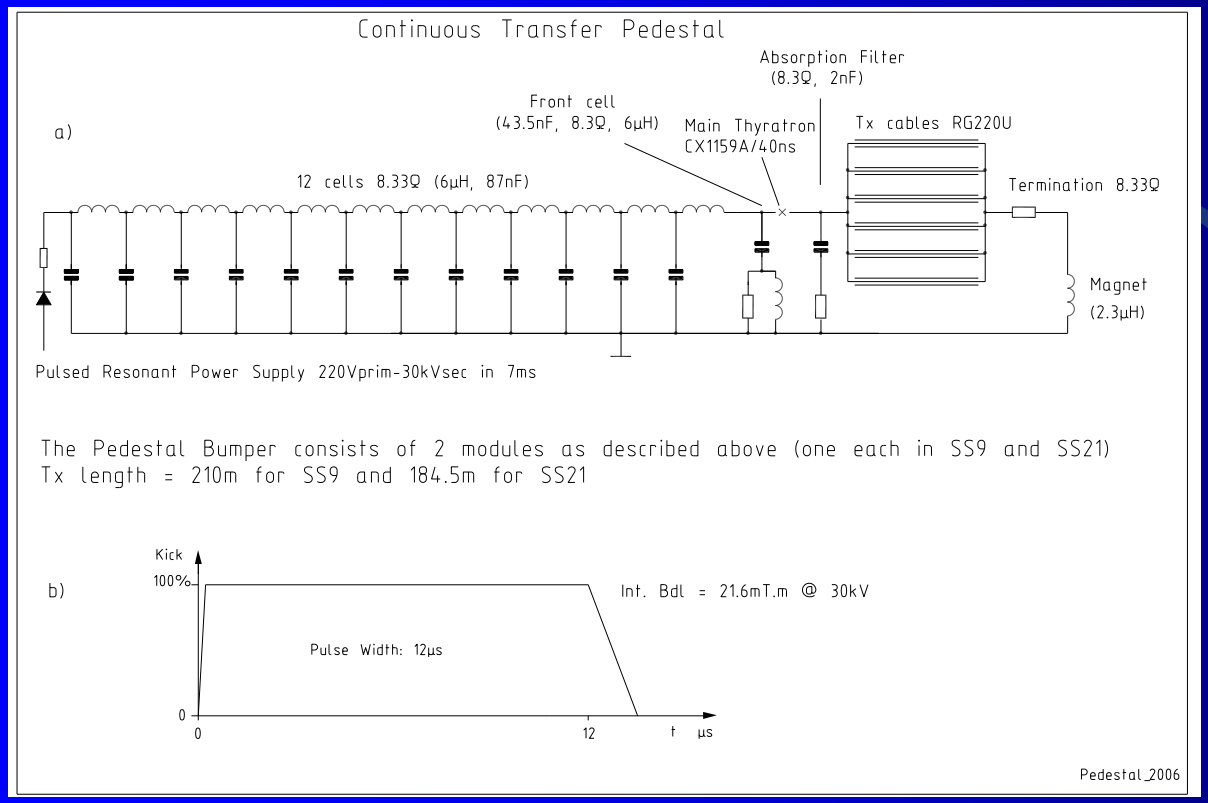


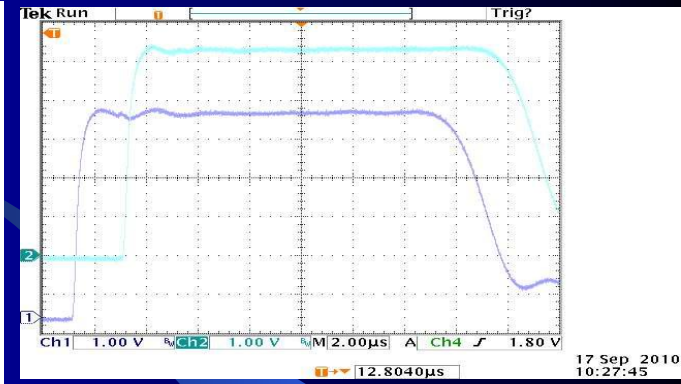
Magnets 21 & 9 currents (user SFTPRO)

Features:

- 2 x 5 Pulse Forming Lines in series to supply magnets 21S & 9S (for 5 PS turns)
- same voltage on both sides (ppm controllable with limitations)
- maximum voltage on S1: 30 kV, S2 to S5: 38 kV; minimun 6 kV each
- maximum ΔV between adjacent steps +30 kV
- minimum ΔV between adjacent steps -5 kV
- delay between steps and sides ppm controllable with 1 ns resolution

Pedestals BFA21P & BFA9P



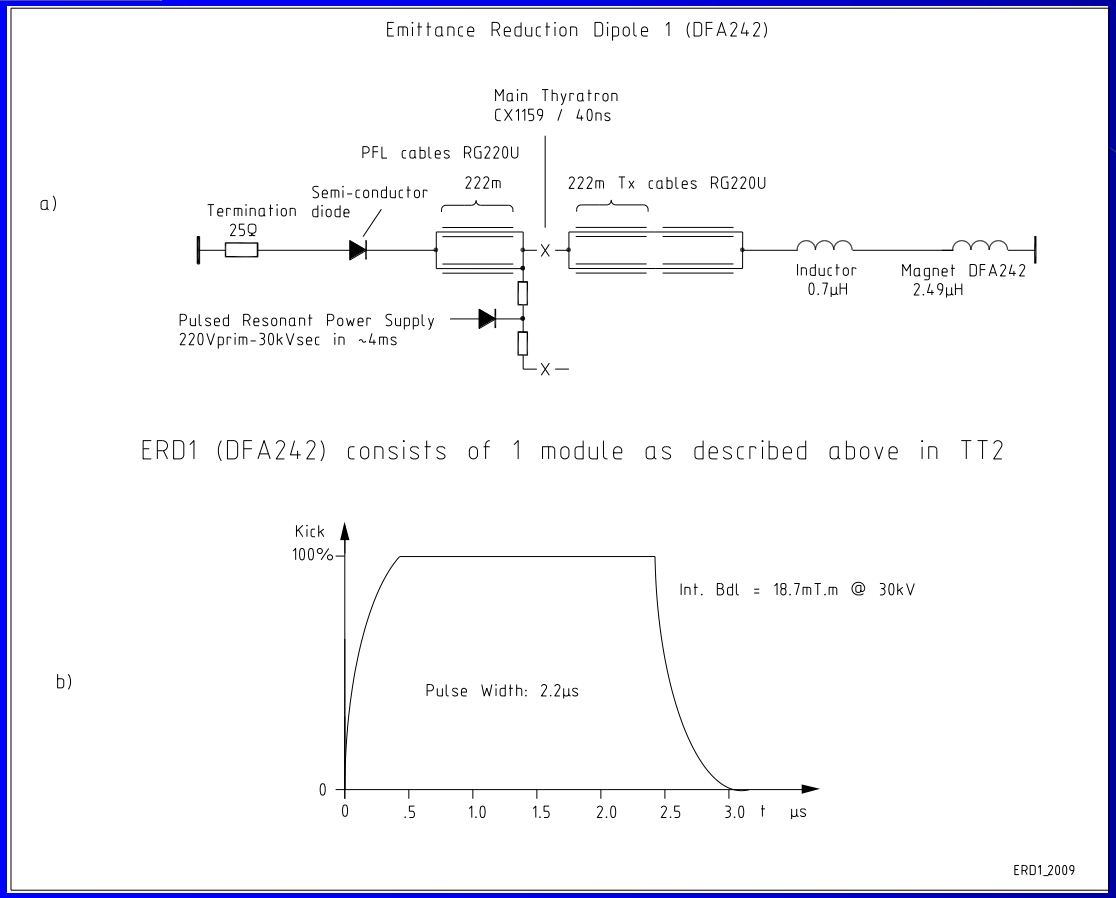


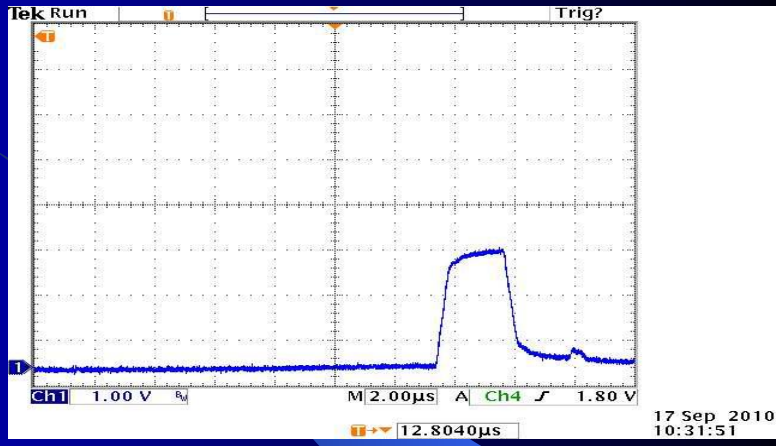
Magnets 21 & 9 currents (user SFTPRO)

Features:

- 2 independent generators to supply magnets 21P & 9P (for 5 PS turns)
- maximum voltage: 30 kV (ppm controllable with limitations)
- minimum voltage: 5 kV
- delay between generators ppm controllable with 1 ns resolution

Fast dipole DFA242



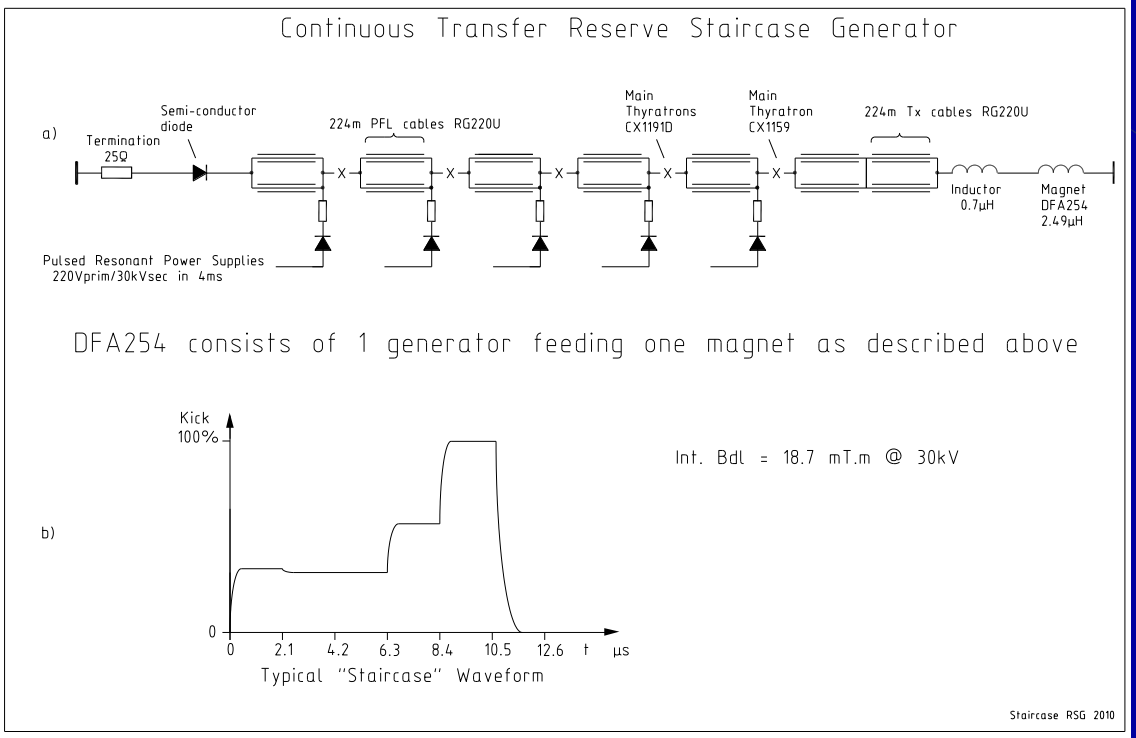


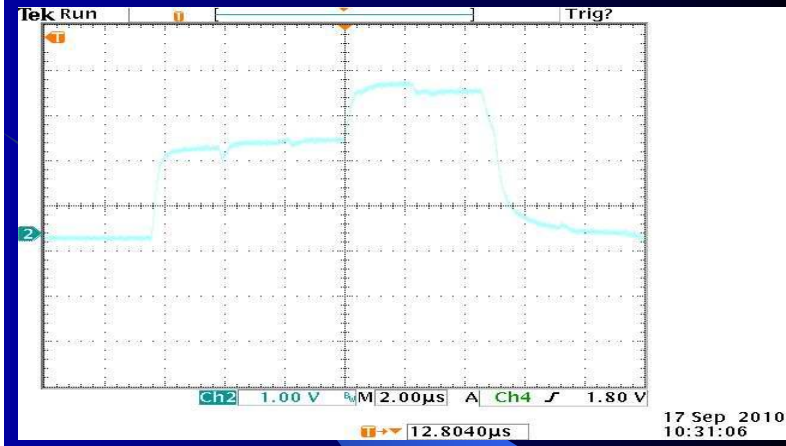
Magnet current (user SFTPRO)

Features:

- 1 generator to supply the magnet 242 in TT2
- maximum voltage: 30 kV (ppm controllable with limitations)
- minimum voltage: 5 kV
- kick duration: 1 PS turn (used to correct the fifth turn of SFTPRO or CNGS)

Fast dipole DFA254



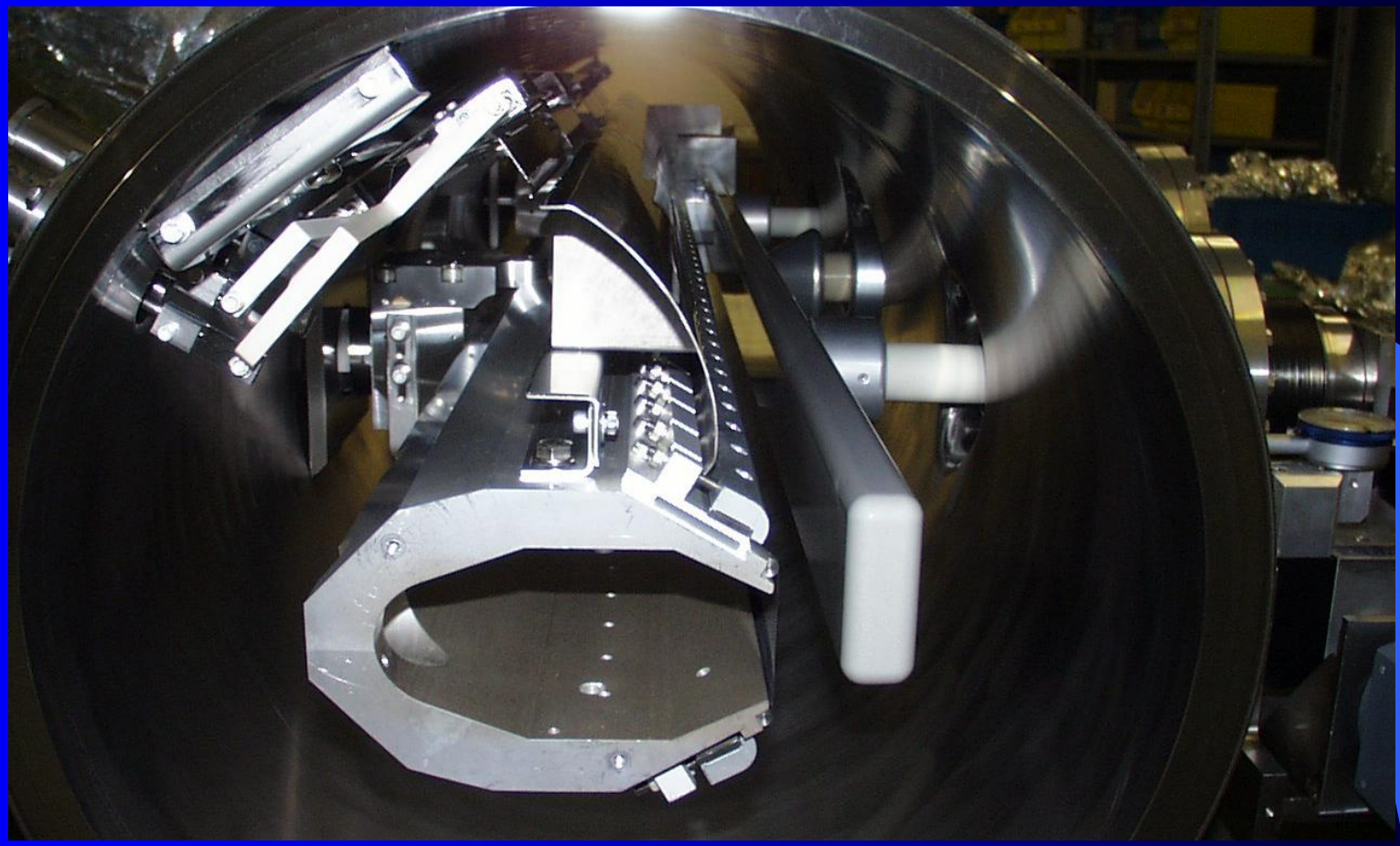


Magnet 254 current (SFTPRO)

Features:

- 5 Pulse Forming Lines in series to supply the magnet 254 in TT2 (for 5 PS turns)
- voltage of each step ppm controllable with limitations
- maximum voltage on each step: 30 kV; minimun 6 kV
- minimum ΔV between adjacent steps -5 kV
- delay between steps manually controllable with 1 ns resolution

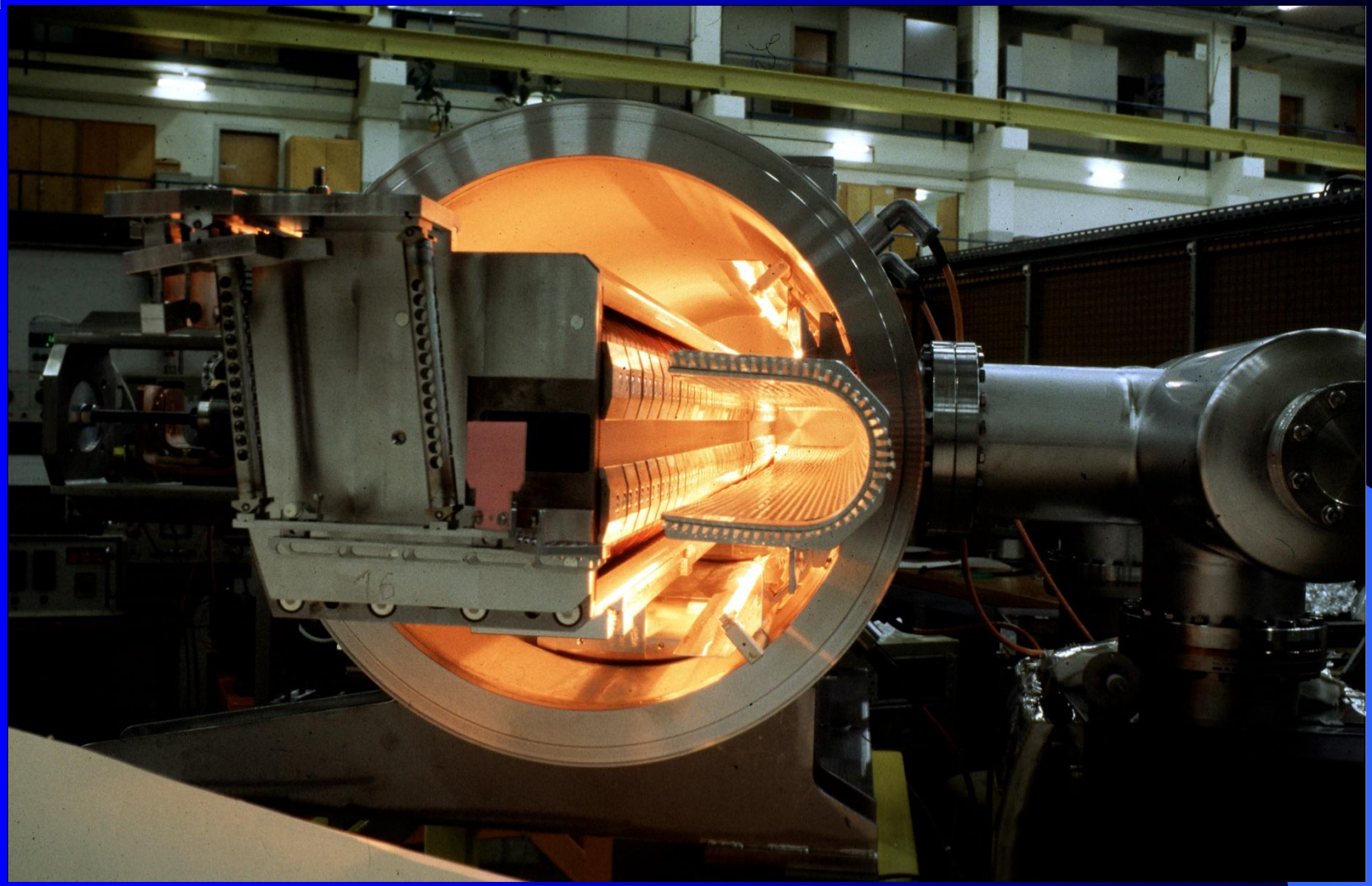
PS beam slicing septum SEH31



Aperture and strength margins SEH31

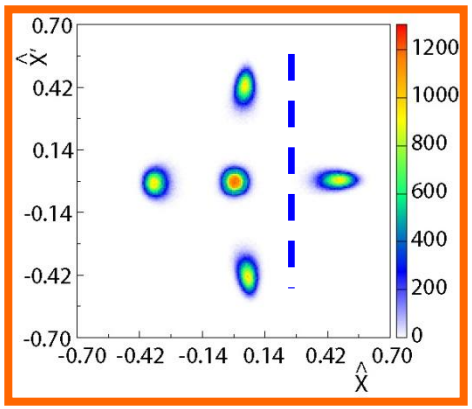
- Operational septum parameters with respect to central orbit:
  - Septum position: 71 [56, 79] mm
  - Cathode position: 88 [71, 93.5] mm
    - →Gap width: 17 mm
  - Septum angle: -0.8 [-1.6, 1.6] mrad
  - Operational Voltage: 170 kV
  - Max. field $\leq$ 10 MV/m

PS extraction septum SMH16

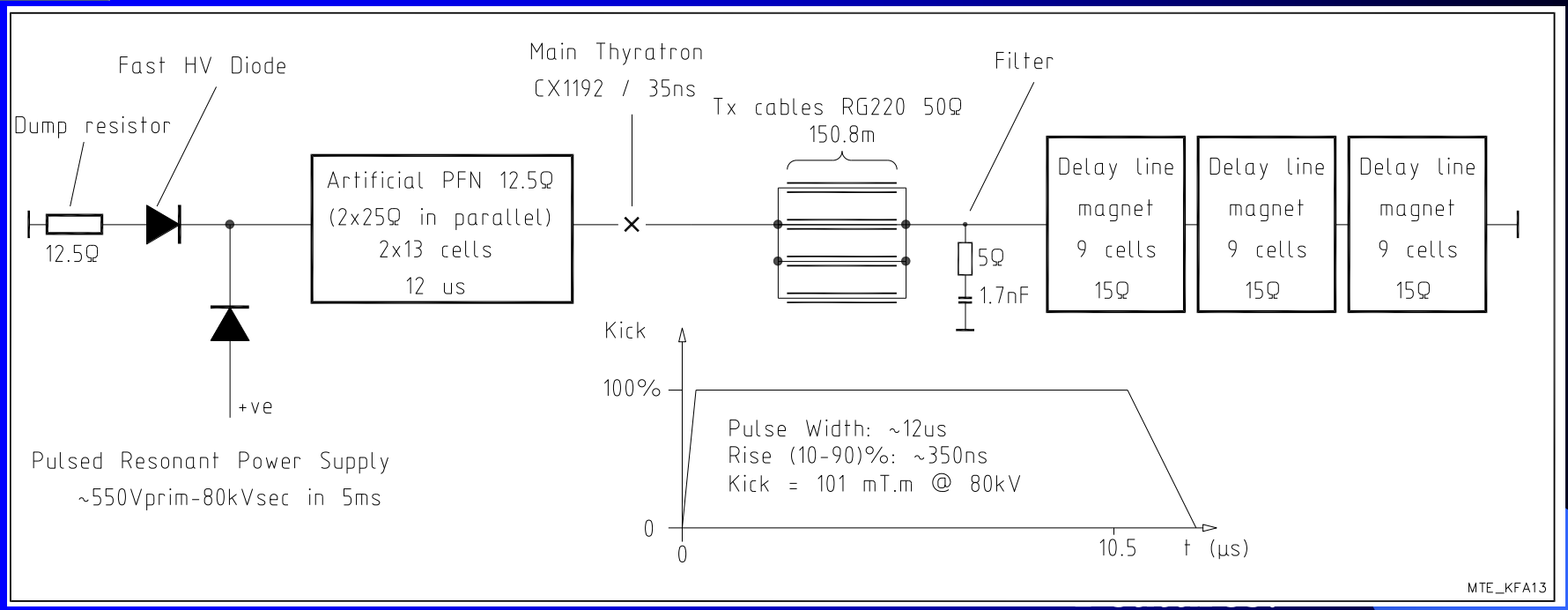


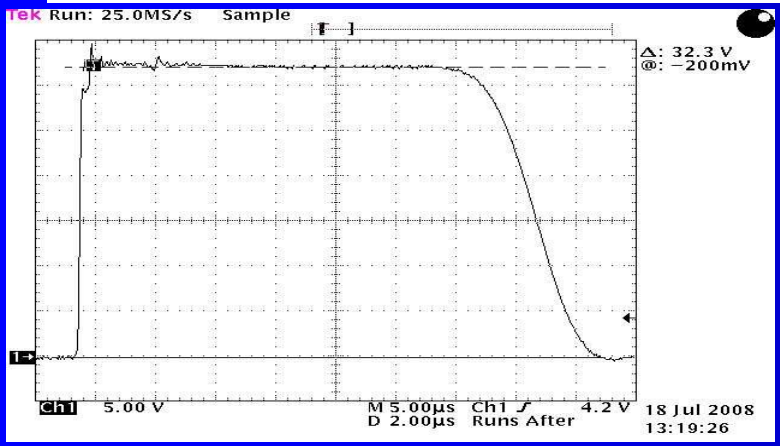
two identical magnets powered in series

ABT equipment for MTE



KFA13 & KFA21

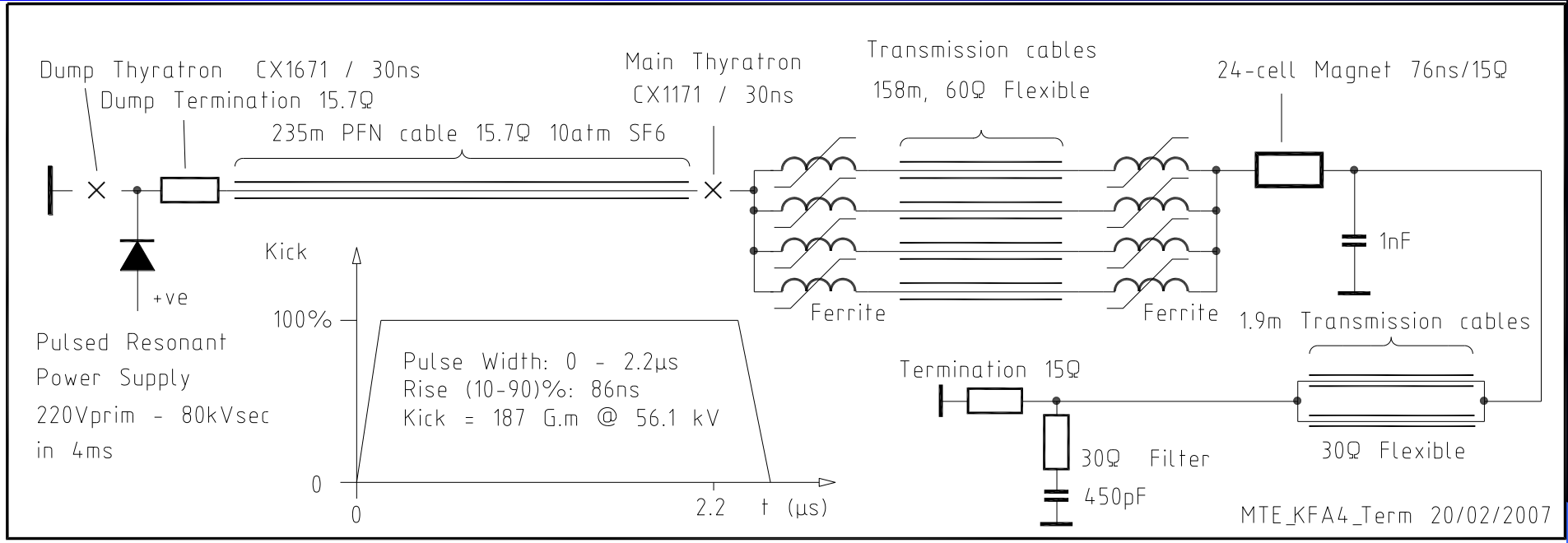




Magnet 13 current

- artificial PFN, 12 μs (for 5 PS turns)
- maximum voltage 75 kV (ppm)
- two independent systems
- delay between 13 and 21 ppm controllable with 1 ns resolution

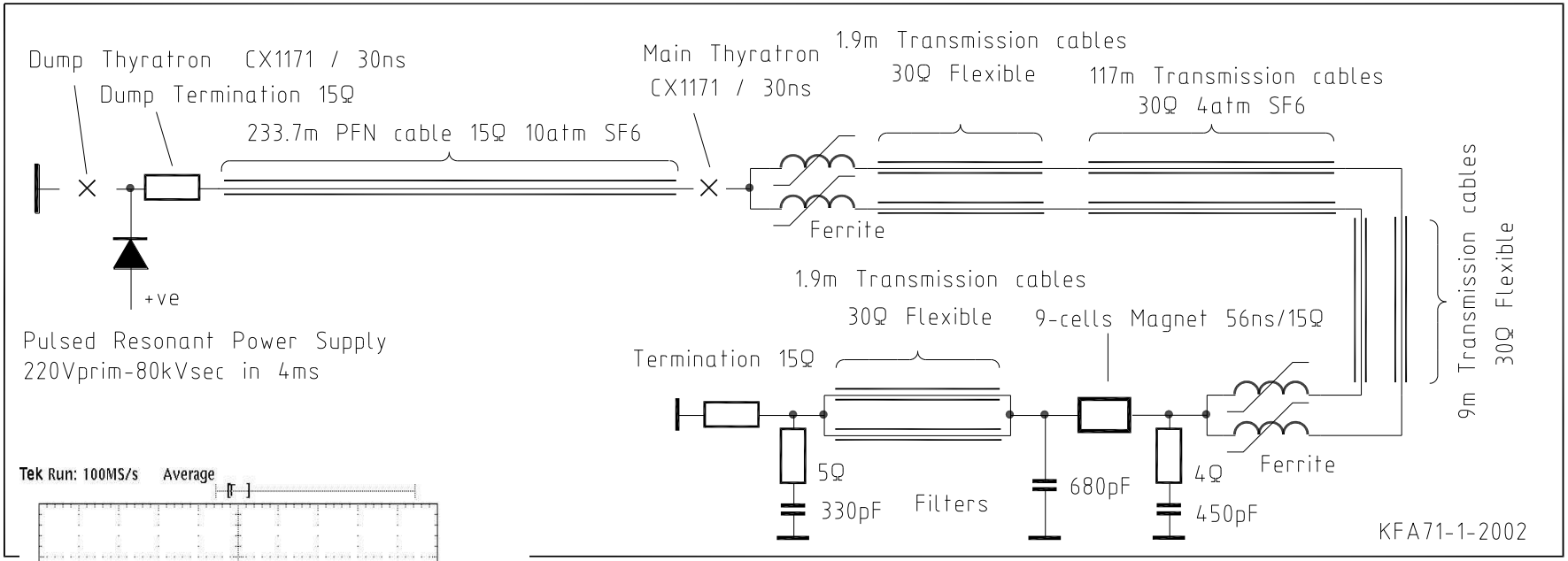
KFA4

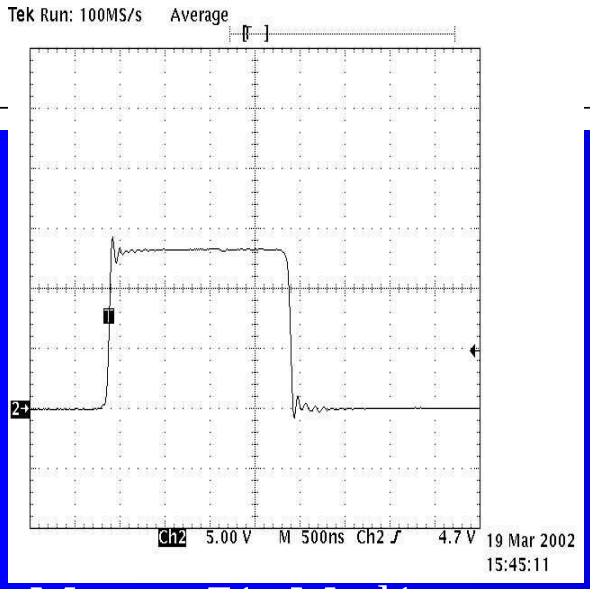


Features:

- PFL, 2.2 µs (for 1 PS turn)
- one magnet
- maximum voltage 80 kV (ppm)
- ppm controllable with 1 ns resolution

KFA71 & 79





Magnet 71- Mod1 current

Features:

- PFL, 2.2 μs (for 1 PS turn)
- maximum voltage 80 kV (ppm)
- 9 + 3 independent modules available
- ppm controllable with 1 ns resolution
- modules can be triggered one by one

Kicker data table

System	Pulse Shape	Pulse length	Kick strength (mT.m) @max voltage (kV)	Kick angle at 14 GeV/c (mrad)	Kick direction	Rise time (10-90)% (ns)
BFA9P & 21P	Rectangle	5 PS turns	21.6 @ 30	0.46	inside	~340
BFA21-9	Staircase	5 PS turns	28.3 @ 38	0.6	inside	~600
DFA242	Rectangle	1 PS turn	18.7 @ 30	0.4	inside	~350
DFA254	Staircase	5 PS turns	18.7 @ 30	0.4	inside	~350
KFA4	Rectangle	1 PS turn	26.7 @ 80	0.57	inside	~86
KFA13 & 21	Rectangle	5 PS turns	94 @ 75	2	outside	~350
KFA71 & 79	Rectangle	1 to 12 PS turns	13.9 @ 80 per module 166.8 total	0.3 per module 3.57 total	inside	~56

ABT baseline assumptions until the halt of MTE operation earlier this year

- Scrap CT when MTE is fully operational
  - SEH31 to be phased out in 2012
- complete "phase II" for the kickers (implementation/upgrade of staircase generators for the DFAs in transfer line)
- Septum 16 remains unchanged

Are these the new assumptions to take?

- Keep the CT equipment operational.
- CT systems should be adapted to allow MTE extraction using SEH31 in present location.
- CT and MTE/CT extractions to operate on ppm basis.
- No full switching from CT to MTE operation in the near future.
- No new magnets planned for MTE.

Implications to the kicker systems

- All the CT kickers are still controlled by the obsolete Camac system. (not optimum for ppm operation)
- ppm operation with very different voltages would require the implementation of two primary capacitor banks driven independently.
- Idea of reusing the BFA staircase HV switches to supply the DFA254 not feasible any more. Consolidation of present switches needed.
- B359 CT zone infrastructure has to be improved for safety reasons.
- KFA21 (and 13?) needs a polarity change to kick the beam to SEH31. Intervention in the ring needed to swap the HV connection boxes filled with SF_6 gas.

KFA21 polarity change

SF_6 connection

Connection boxes to be swapped

Minimum intervention time in the ring: 2 to 3 hours
+ 2 to 3 hours in B367

Risk of breaking a HV vacuum feed-through

Risk of SF_6 leak difficult to solve

Potential improvements during the 2010-2011 stop

Provided this is compatible with other priority work

- New DFA242 generator installation to have staircase (4 steps) waveform (old one kept as fall back solution). Could be ready before Easter.
- Pedestal generators: modification to operate with two capacitor banks to ease ppm operation + eradication of Camac. Could also be ready before Easter.

Note: BFA21-9 staircase and DFA254 will stay with Camac

Spare policy SMH16 (1/2)

- Present situation:
  - Installed SMH16.2 since January 2010. Exchange was foreseen for 2014.
  - Operational spare SMH16.3, newly built.
  - Second choice spare SMH 16.1, removed from PS in January 2010. Beam observation incomplete. Magnets to be renovated.

    VERY RADIOACTIVE. Stored in PS ring!

Spare policy SMH16 (2/2)

- Preventive exchange every 4 years based on past experience. But the annual number of pulses increased as from 2009:
  - 2007, 2008: 2.9 M pulses / yr.
  - 2009 : **6.0 M** pulses / yr.
- Septum already “plug-in”: no re-alignment required, quick disconnect vacuum flanges and hydraulic connections.
- Intervention time dominated by bake-out and vacuum recovery.
- Collective dose for intervention dominated by vacuum , connection/reconnection and transport activities (VSC/ABT/HE).

Aperture margins for SMH16

- MTE design report proposed new septum with septum thickness of 1.7 mm (presently 3 mm).

  Thinner SMH16 of any use?
- Cost:
  - **MUCH** higher complexity (reliability?)
  - ~ 1 MCHF (2005 level) + 3 MY + 2 new power supplies
- Horizontal aperture can be reviewed (presently 56 mm).
- Vertical gap remains limited to 30 mm.
- If required, in the present design 130 mm upstream from the septum are available for a spoiler / scatterer.

  (any advantage for radiation?)

Spare policy SEH31

- Present situation:
  - Installed in PS SEH31.1 since January 2010. Exchange foreseen for 2012. (if not to be abolished)
  - Spare SEH31.2. Removed from ring in January 2010, to be renovated. Stored under N_2. Activation 05/01/2010: 7 mSV on contact.
  - Spare SEH31.3. Killed in operation in 2008. Many components missing since. Stored under N_2.
- If CT needs to be maintained, SEH31 spares need to be rebuilt.

SEH31 system limitations

- Operational voltage could be increased to ~ 210 – 220 kV, but diagnostics for sparking will be needed (spark counters, fixed display).

- If SEH31 field strength needs to be varied, bear in mind that this is NOT ppm:

  →ΔV of 30 kV can take ~35 seconds

- High operational voltage requires conditioning at higher voltages (presently 250 kV), with more stress on HV cables. Cable between generators and ring are still old ‘pp300b’ type.

SEH31 required consolidation if CT equipment needs to be kept operational

- Present Fluorinert™ insulation system is scheduled to be moved to SEH23.
- Need regeneration system and control electronics consolidation if SEH31 is to keep this system. (it is presently only capable to supply one system)
- HV cables running between PS ring and Generators are still old “pp300b” type.

Questions to the workshop (1/2)

- What needs absolutely to be done during the short 2010-2011 stop? (taking into account that the ABT resources will be very busy in the SPS and LHC)
- Present baseline is still to scrap CT when MTE is fully operational and complete phase II for the DFAs. Will that ever happen now or is that no longer realistic?
- If CT and MTE will have to coexist, will that only be for a while or long term?

Questions to the workshop (2/2)

- Reorganization of the kicker MTE/CT zone in B359 has to be done during the long shut-down 2012. We need very soon a complete view (with timetable) of the systems to maintain or to scrap to start preparation of the work (long lead times).

  Will the money and manpower be available?

  The additional effort for ABT will be significant.

  An estimate will be given as soon as possible after the conclusions of this workshop.
- Is a thinner SMH16 of any use?
- Is a spoiler upstream from SMH16 of any use?