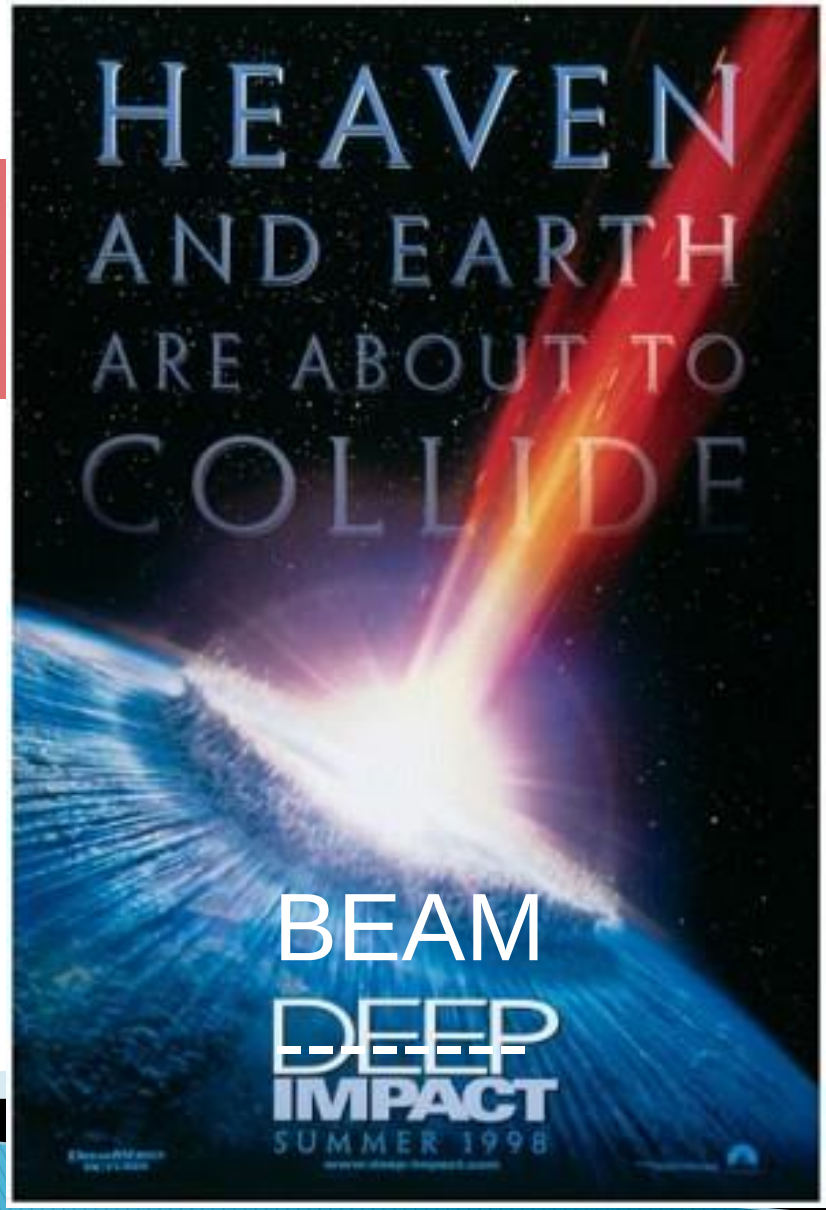
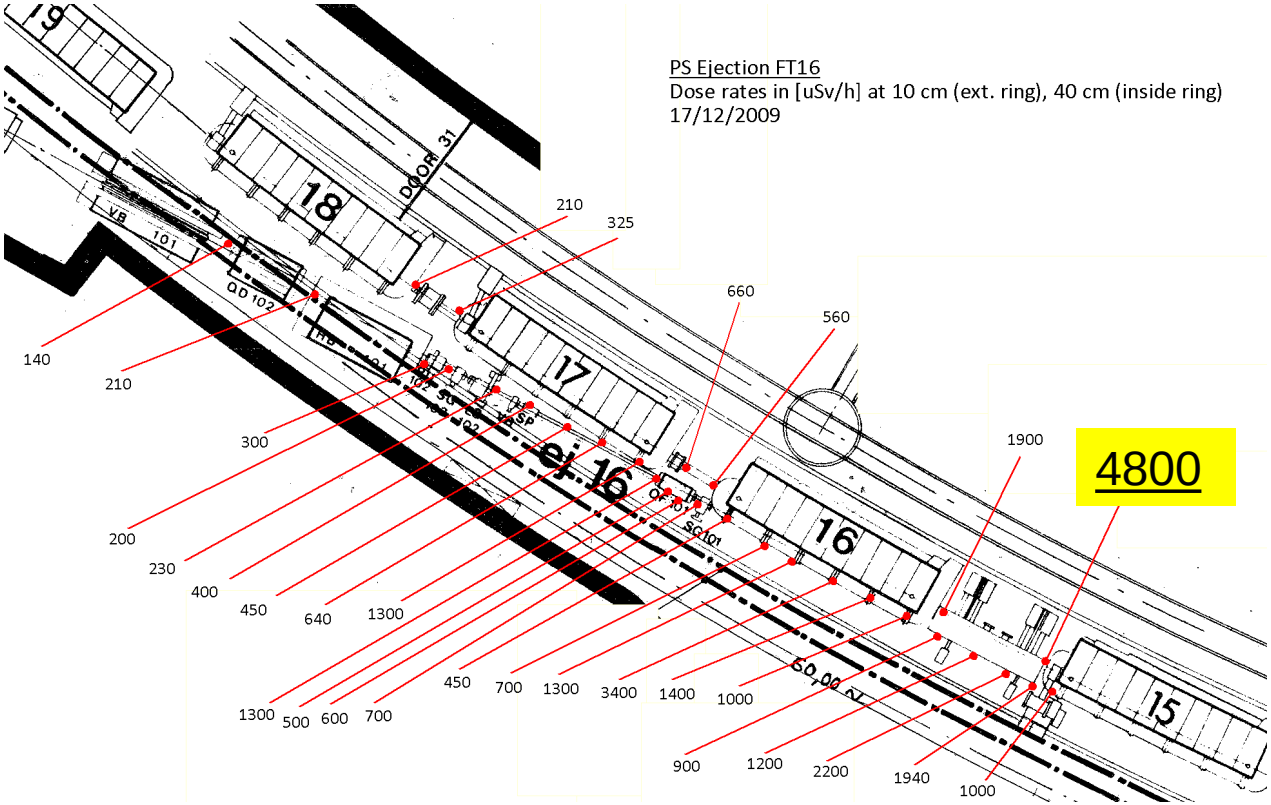
(Beam)
Impact of MTE on the PS septa



J. Borburgh
With input from S. Damjanovic, M. Hourican and S. Gilardoni

SMH16 – too radioactive with MTE

The replacement of Continuous Transfer (CT) by Multi-Turn Extraction (MTE) has reduced the absolute beam losses in the PS from about 8% down to 2%, half of which is localized in septum SMH16. However, the level of 1% is still too high (estimated for CT: 0.1-0.5 %).



Measured residual DoseEq rates 40 days after operation with MTE at a beam intensity of 10^{13}p/s and beam losses of ~1% in the SS16 (M.Widorski, 17/12/09)

Residual Dose Eq. Rate of about 5 mSv/h in the region of septum SMH16

Status for septum SMH16

SMH16.1; not operational, very radioactive to renovate

- 4 years run (2006-2009), 14×10^6 pulses (now considered as max. lifetime)
- still 1 mSv/h at 40cm January 2011;
- stored in PS tunnel since 2010

SMH16.2; operational in PS

- run 2010: 7.5×10^6 pulses
- run 2011 →August: ~6×10^6 pulses → needs to be replaced at end of 2011 run

SMH16.3; Newly built operational spare

No operational spare SMH16 as from 2012!

→ additional spare to be built in any scenario

Spare SMH16: 365 kCHF + 0.6 MY

So let's be careful with SMH16

From BBC2 'Top Gear end of year special' , 2009
Jeremy Clarkson driving through Bolivia

Extraction variants and consequences

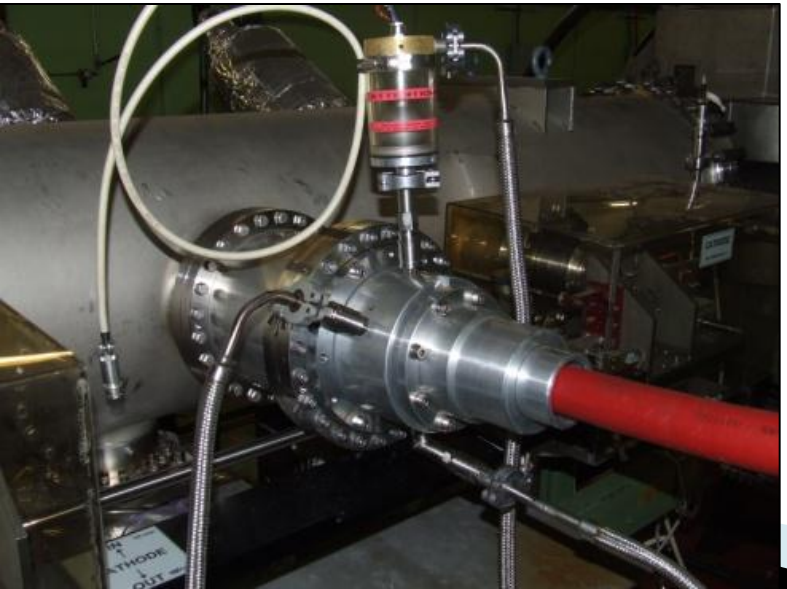
- **CT:**
  - SEH31→ beam slicing septum highly radioactive; PS machine activation spread around circumference
- **MTE**
  - SMH 16 → Too radioactive to work on after use with MTE (debunched beam swept across blade)
  - Possible mitigation:
    - Spoiler → radiation remains close to maintenance intensive object
    - Thinner septum 16
    - MTE –CT hybrid
    - Dummy septum (ss15)

Septum SEH31

Present status:
SEH31.1: installed in PS (2010+2011)
SEH31.2: removed from PS January 2010, under nitrogen, in radioactive storage cooling down before renovation (2mSv/h at 40 cm).
SEH31.3: removed from PS after accident: diffuser wires broken. Renovated in 2011.

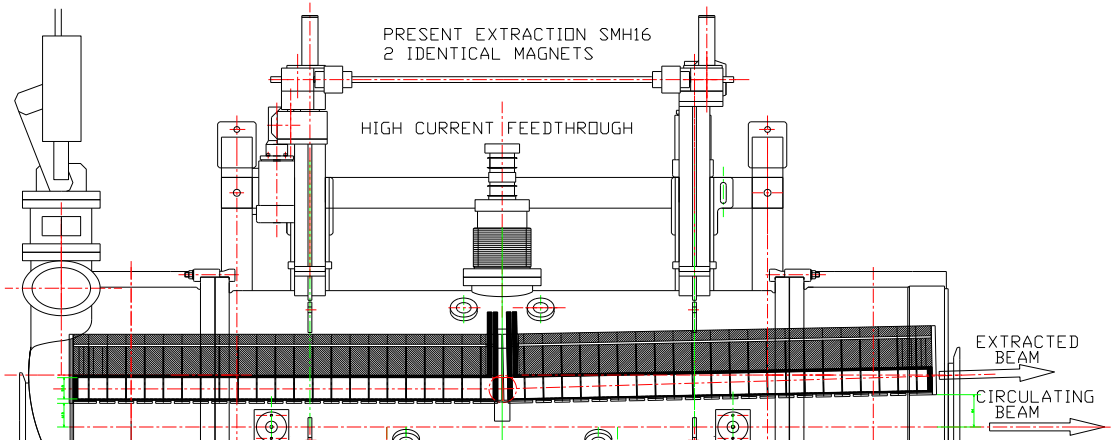
If SEH 31 is to be retained >2013:
Modification of 3M Fluorinert insulation regeneration station to SEH23 (eradication of oil insulation in HV feedthroughs).

Spare SEH31 + oil eradication: 25 kCHF + 0.4 MY, ongoing.

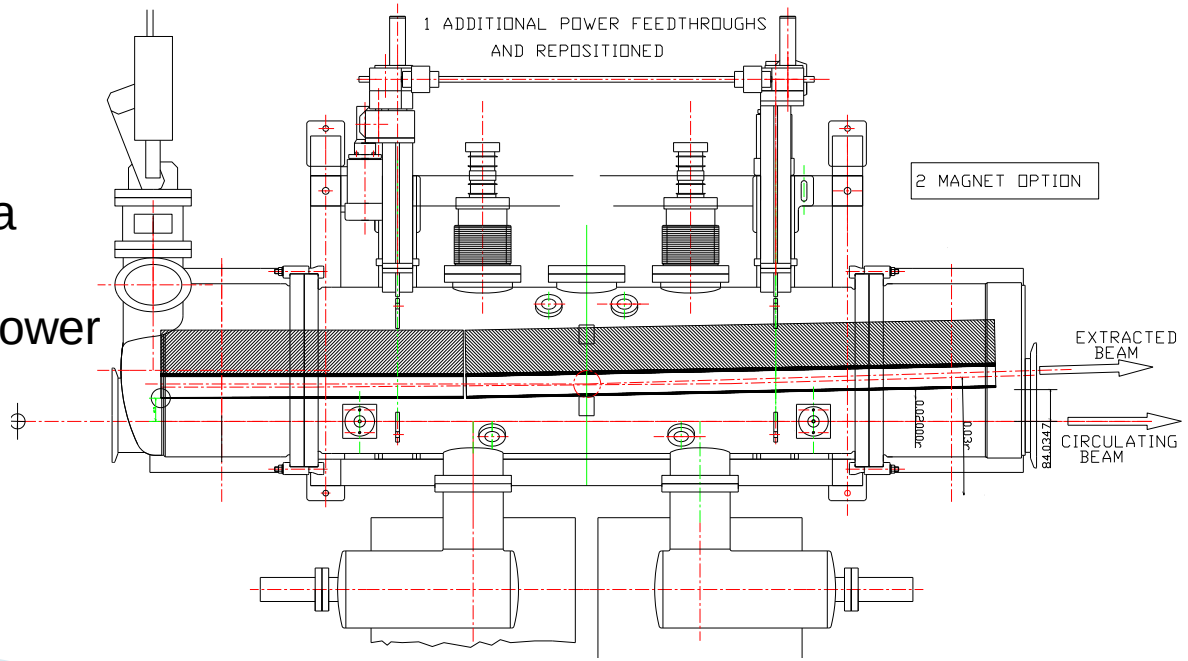


Thinner septum SMH16

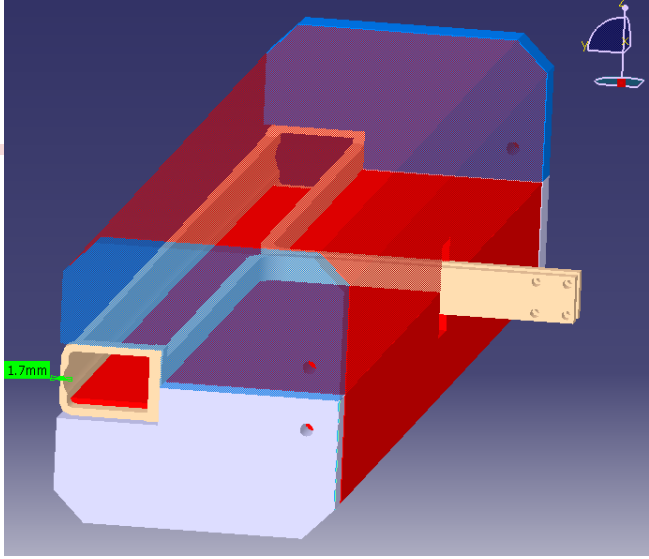
Present SMH16
- 2 magnets in series
- 3 mm thick septum
- 29 kA peak current



Thin SMH16
- 2 separate magnets
- 1.7 and 5 mm thin septa
- 21.5 and 35 kA
- Needs 2 independent power supplies



Thinner SMH16



- Advantages:
  - Losses on the septum blade ~linear with reduction in septum thickness (1.7/3).
  - Compatible with existing SMH16, except for power supplies and connections.
- Outstanding issues:
  - Impact on shift of deflection point to be studied.
  - Septum of demanding characteristics, using new techniques → requires R&D and an extensive prototyping phase.
  - Increased operational risk w.r.t. present septum.

Thinner septum 16: 1 MCHF (excluding power supplies) + 3 MY, not foreseen in MTP

MTE-CT hybrid

Requires:

all MTE elements,

+ electrostatic septum SEH31

+ KFA 21 with inverted polarity

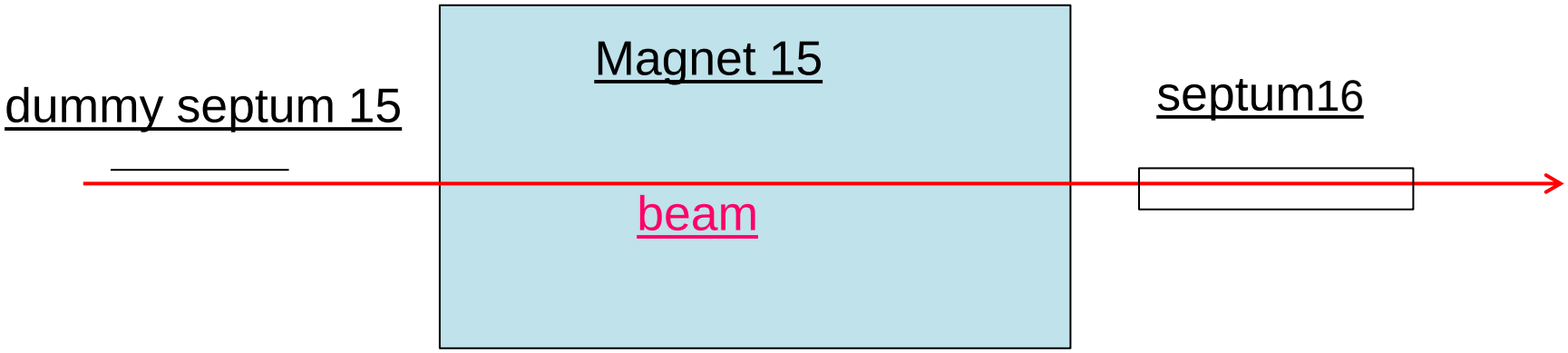
- BFA9-21 Staircase (assuming KFA21 and BFA21P provide enough strength to jump septum SEH31)

Tested in 2011 during an MD and test will be continued in a MD planned for October 2011.

Spare SEH31 + oil eradication: 25 kCHF + 0.4 MY, ongoing.

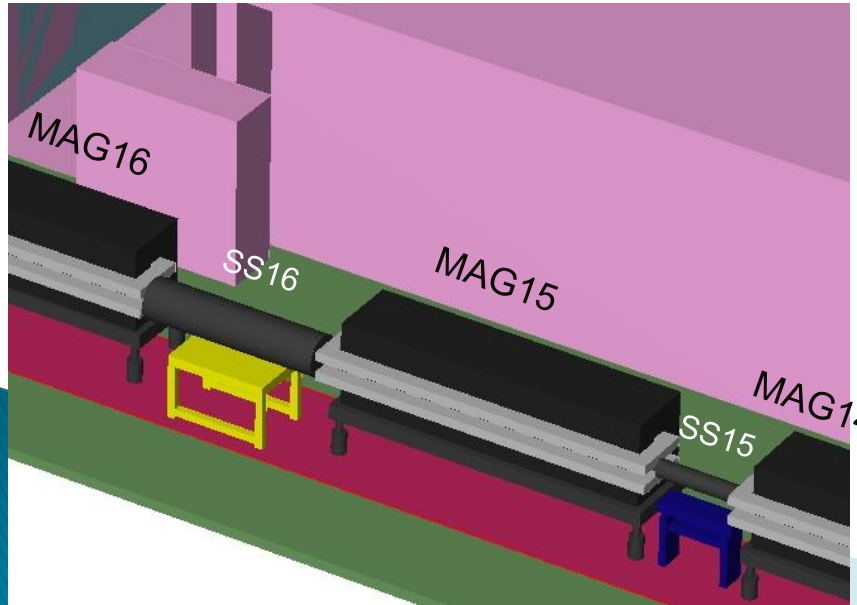
A method for reducing the radiation field around SMH16 keeping MTE

Installation of a dummy septum blade inside the straight section SS15, shadowing the blade in the true septum SMH16 inside the SS16.



Assess the benefits of the new proposal by comparative FLUKA simulations of the radiation field in the region of SS16 by beam losses in the dummy septum 15 and in septum 16

PS Straight Section 15

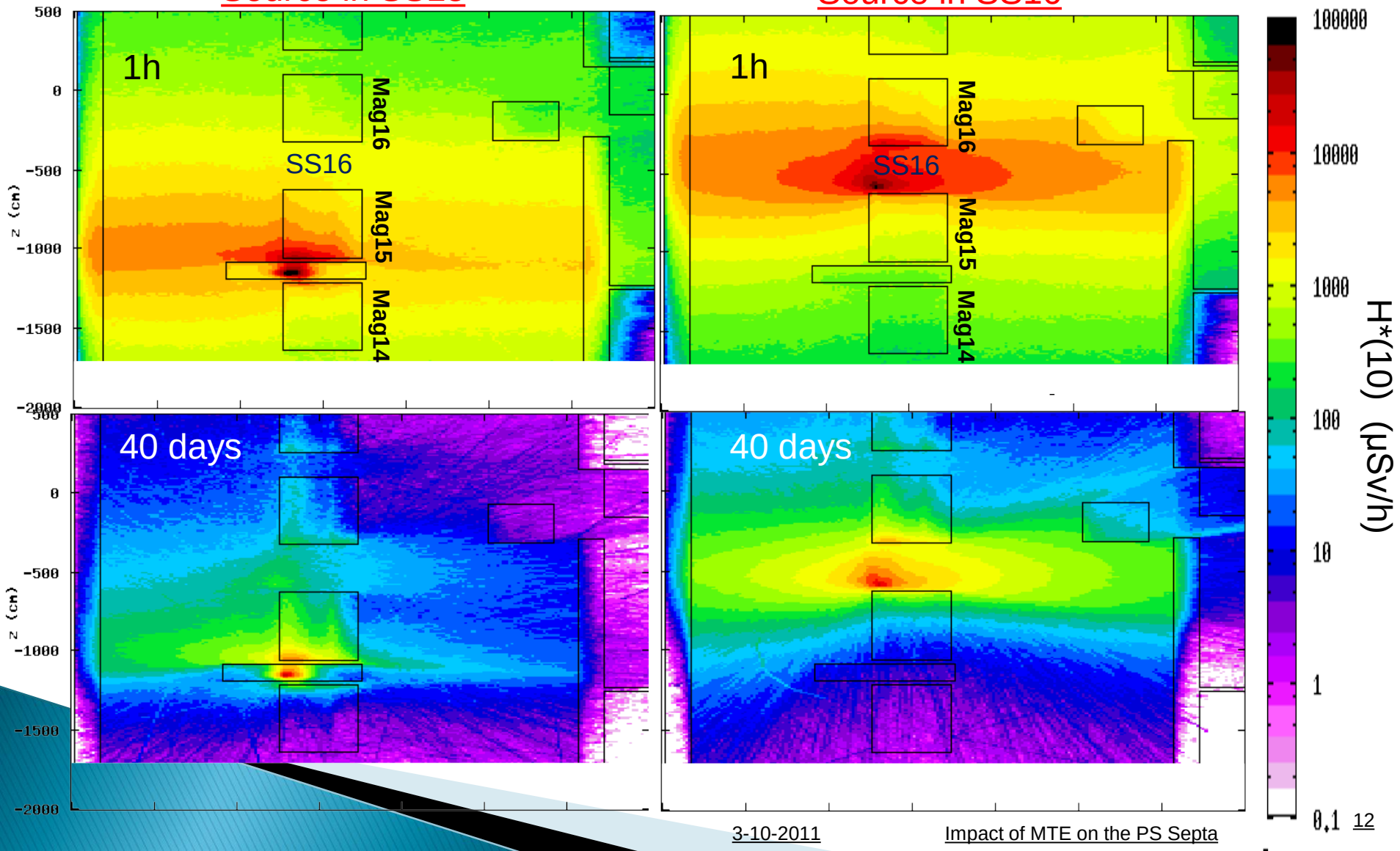


Present situation:
dipole and quadrupole magnets inside the SS15

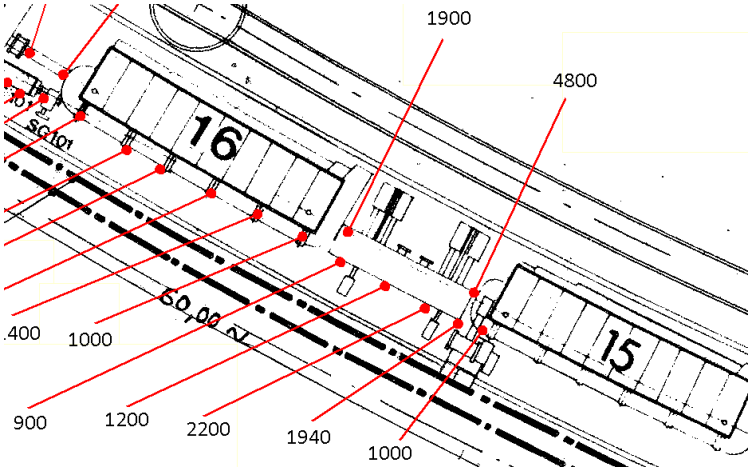
Proposed situation:

1. Magnets (re)moved,
2. Additional shielding of the vacuum chamber (radius 10cm, thickness 6mm, stainless steel)
3. Dummy septum -- a 40 cm long blade installed under vacuum (material choice W or Cu studied)
4. SS15 with dummy septum 15 inside surrounded by shielding material (concrete, iron, marble, borated polyethylene studied)

Residual Ambient DoseEq Rate (μSv/h) after cooling periods of 1h/40 days

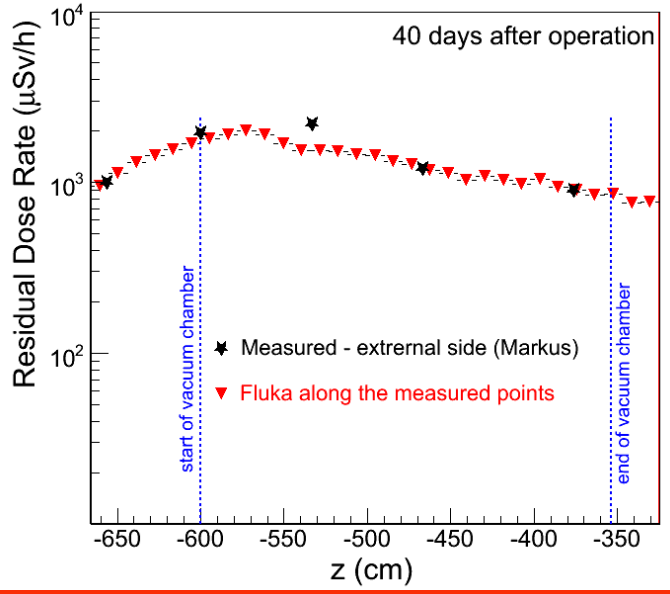


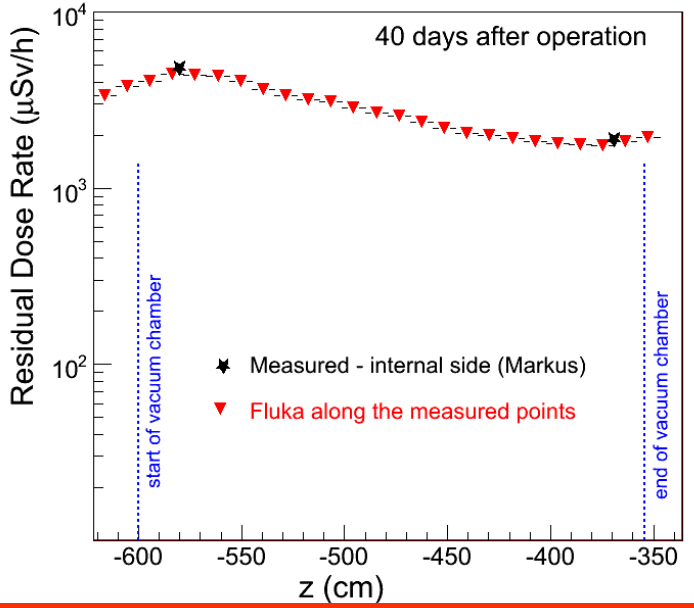
Validation of FLUKA with measured activation



Measured residual DoseEq rates after 40 days of operation at the beam intensity of 10^{13}p/s and beam losses of ~1% (10^{11} lost p/s) in the SS16 (M.Widorski 17/12/09)

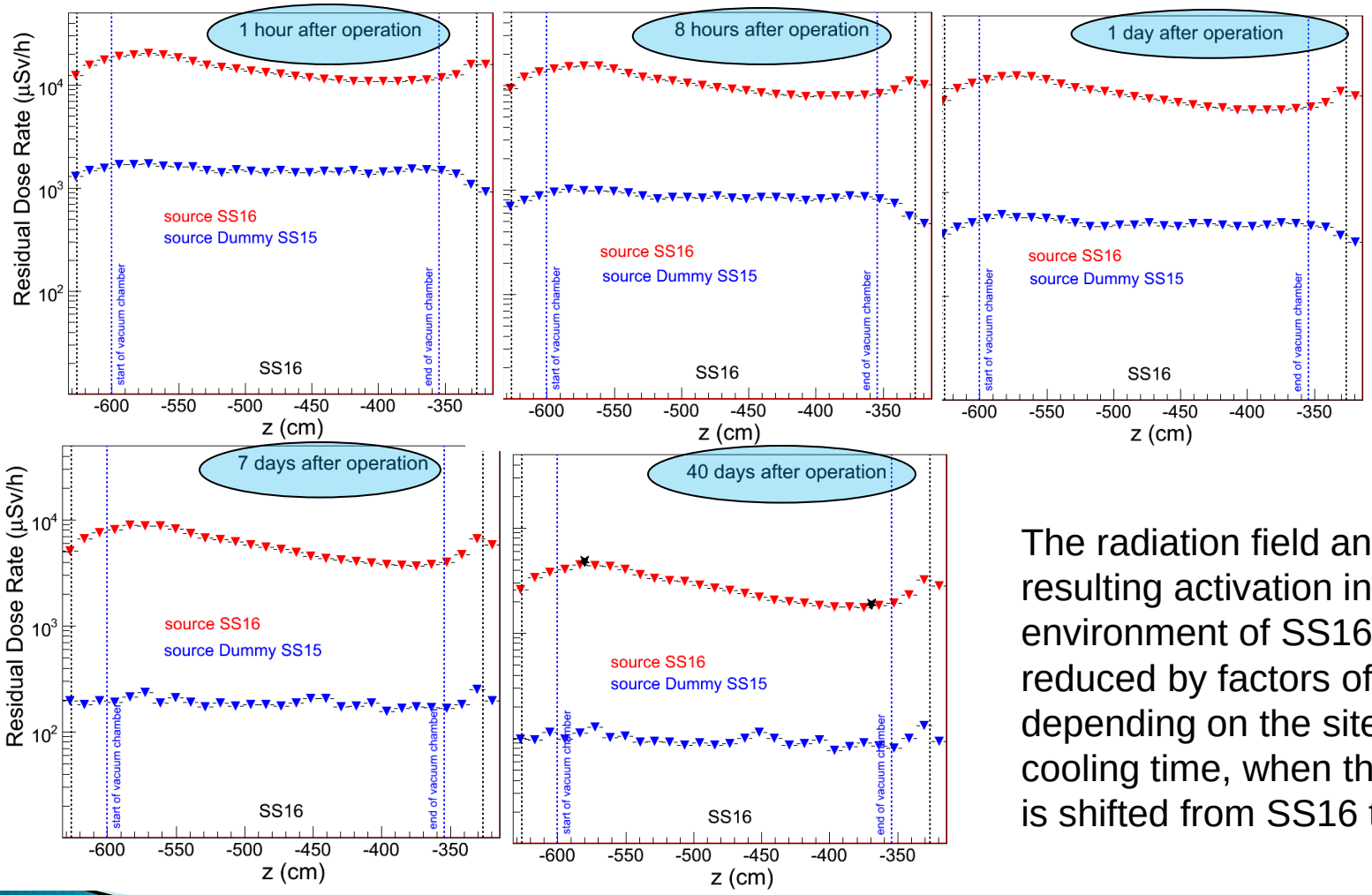
Simulated Residual DoseEq Rates along the measured points in the region of SS16





Since the measured residual dose-eq rate is described in absolute terms, all results can be interpreted also in absolute and not only in relative terms.

Comparison of Residual Ambient DoseEq Rates in SS16 induced by beam losses in the dummy septum15 or in SMH16



The radiation field and the resulting activation in the whole environment of SS16 can be reduced by factors of 10 to 40 depending on the site and the cooling time, when the beam loss is shifted from SS16 to SS15.

Effects of possible errors, misalignments, tolerances still to be studied.

Advantages by shifting the beam loss from SS16 to SS15

The FLUKA model was benchmarked by simulating the present situation. Subsequent calculations with the model demonstrated that a dummy septum in ss 15 will be effective.

The radiation field and resulting activation in the whole environment of SS16 can be reduced by factors of 10-40.

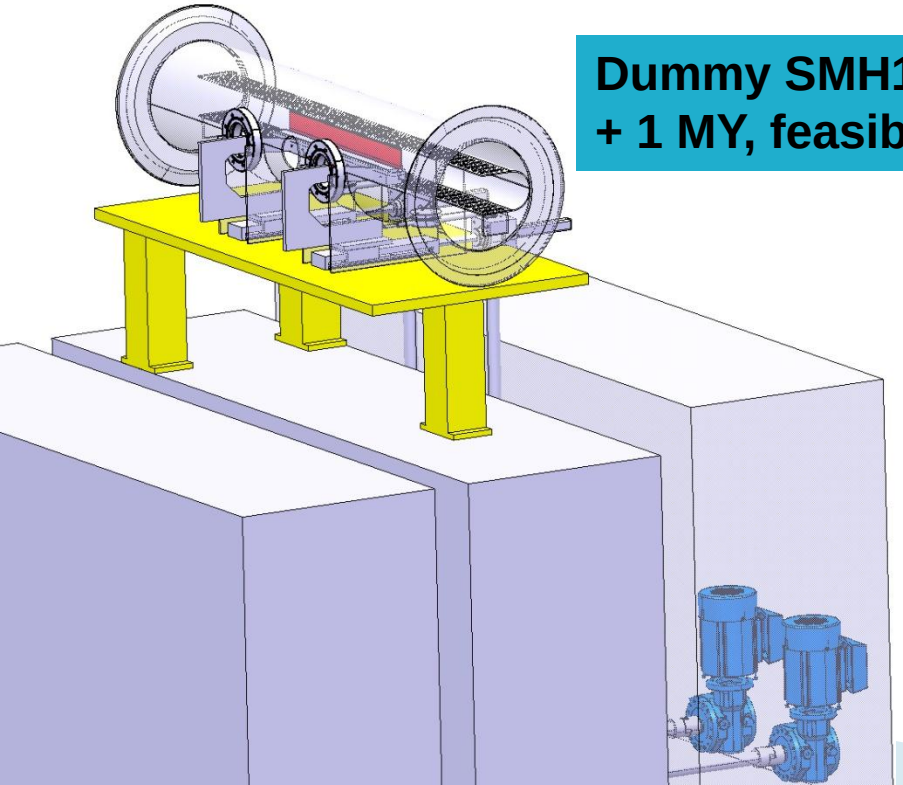
Additionally:

- the stray radiation on top of the PS complex (10 m above the SS15 and SS16) presently reaching up to 300 μSv/h can be reduced by a factor of 3 (thanks to addition of shielding around the dummy septum 15).

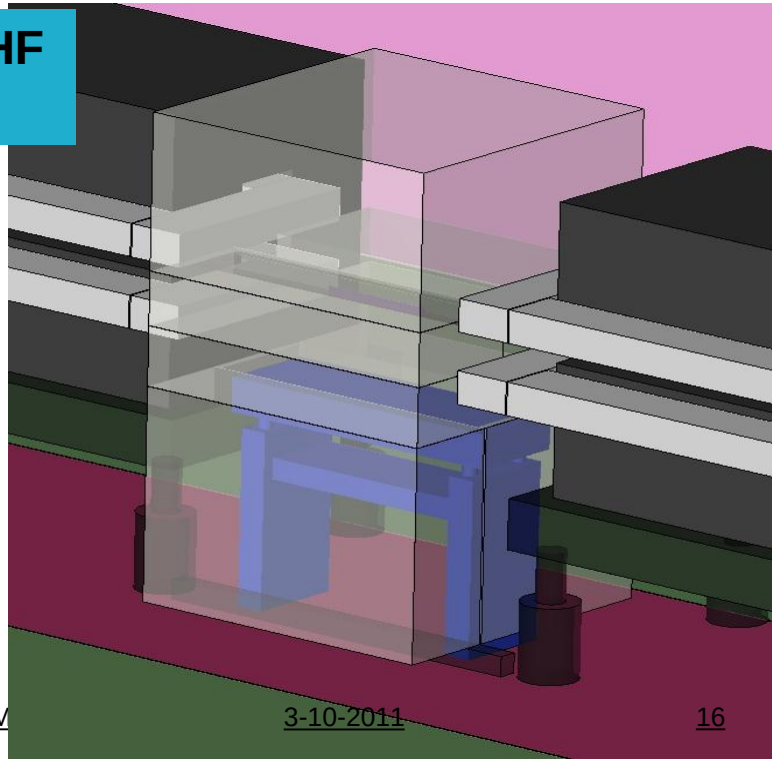
- the stray radiation at the D122.bis door presently measured to be 100 μSv/h can be reduced by a factor of 5.

Mechanical concept

- Based on TPSG6 (SPS)
- Radial remote displacement system (position and angle)
- Cooling foreseen, but not mandatory
- Shielding with (removable) concrete blocks



Dummy SMH15: 250 kCHF + 1 MY, feasible for LS1



MTE septa resource requirements

Scenario and option	Resources kCHF	MY	Feasibility
CT only	390	1.0	LS1
MTE only	365	0.6	LS1
CT-MTE Hybrid	390	1.0	LS1
Thinner septum	1000*	3.0	$\geq$ 2016
Dummy Septum	250	1.0	LS1
Faster kicker	-	-	n.a.
Stronger kicker	-	-	n.a.

* Excl. power supplies

Conclusions

- Desperate need for additional spare septum 16.
- Definitive decision whether the CT equipment (SEH31) is to be retained after 2013 is needed before end of 2011 at latest.
- Thinner septum SMH16 yields little gain (< factor 2) in activation with increased risks related to the use of new technology. Does not seem a realistic alternative.
- Dummy septum in ss15 can reduce activation of the region of septum 16 with a factor 10-40. Resource requirement (P) acceptable for section.