Fluka simulations for DY run 2018

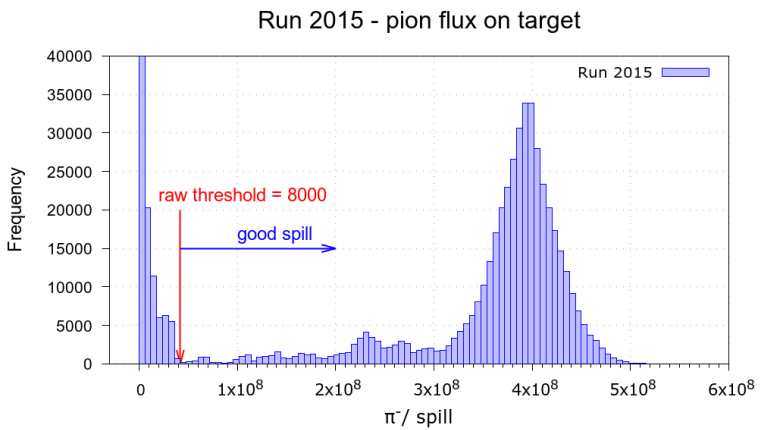
- non-derogable requests by CERN radio protection service
  - The dose integrated over the full run, measured at the CERN fence, must be below 1mSv/y
  - The dose measured alogn the Heinsenberg road, any time during the run, must be below 2.5 μSV/h
- no problem with the first request in 2015 run
- the second limit was exceeded in the 2015 run
  - therefore, we need to increase the shielding around the absorber for the next year run

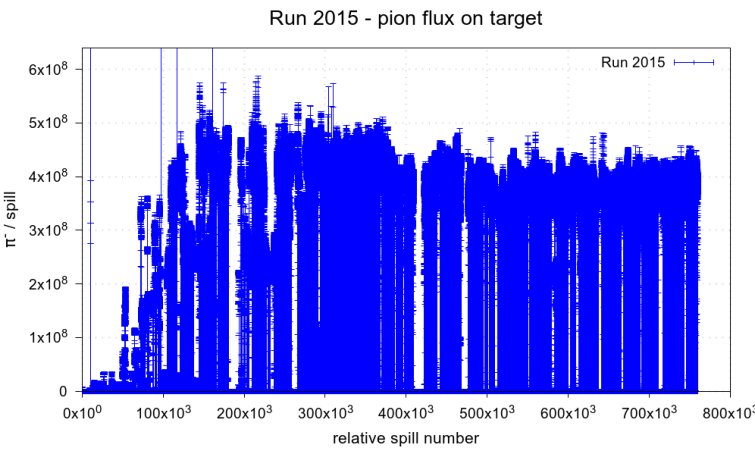
Pion flux during 2015 run

- From ION2 data (thanks to Christophe)
  - Date: 2015-04-27 08:14 to 2015-11-16 06 ; 203 days
  - Data taking 2015-07-08 09:50 to 2015-11-16 06:01 ; 116 days (without MD)
  - Number of spill and flux of pions on ION2 → see next page
  - **Mean SPS cycle: 23,07s**
  - **Mean number of spill/hour : 156** from DVCS
- RUN 2018 = RUN 2017
  - Mean SPS cycle: 24,81s
  - Mean number of spill/hour: 145,2

Pion flux calculations

- From ION2
  - Full run 2015: 2015-04-27 08:14 to 2015-11-16 06
    - Correction factor: 5300
    - Threshold for empty spill: 8000 ION2 counts
    - Total number of π during run 2015: 1,67415x10^{14} (include empty spill)
    - **Total number of π during run 2015: 1,66492x10^{14} (without empty spill)**
    - Total number of spill during run 2015: 759855
    - Number of good spill: 461337
    - Number of π/spill (good spill) : 3,61663x10^{8} (mean over the full run)
    - Number of π/spill (good spill in data taking) for Phys. data: 3,86x10^{8}





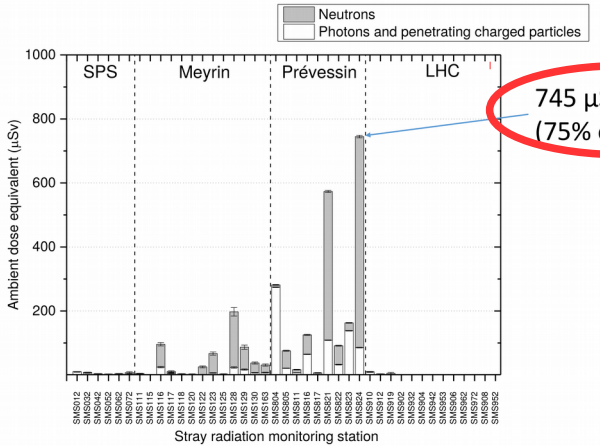
Fluka parameters

- Beam: π^-
- Momentum: 190 GeV/c; Δp = 12 GeV/c
- Shape X = Y = gaussian; FWHM = 2.5 GeV/c
- Divergence: $\Delta\phi$ = gaussian; FWHM = 1 mrad
- Solenoid dipole, SM1, SM2 included
- Default: PRECISIO
- EMF OFF **(with EMF ON, systematic error +4%)**
- DOSE-EQ conversion: EWTMP
- Last improvements
  - The entrance cicane/door is described correctly
  - The building 891 is included, walls 5mm iron
  - Simulations of the Dose (in Gy/y) for run 2015 in the zone upstream the cicane/door, where there is the electronics of PT superconducting magnet

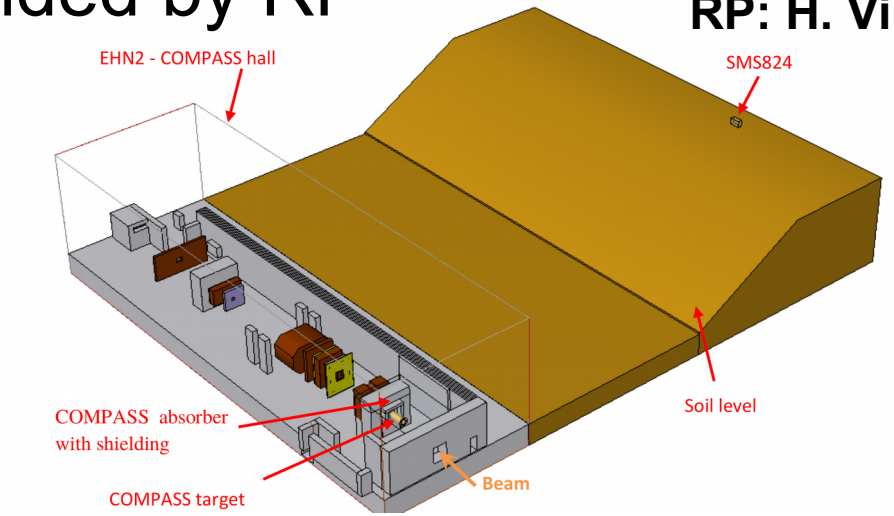
Environment radiation monitor

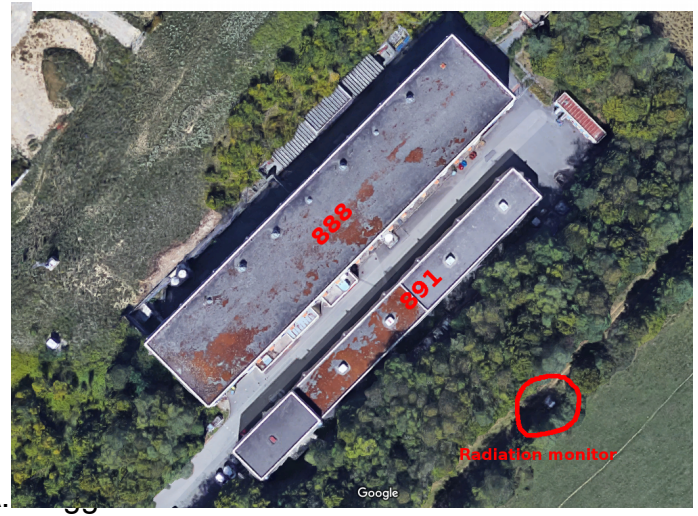
fluka geometry extended by RP

RP: H. Vincke

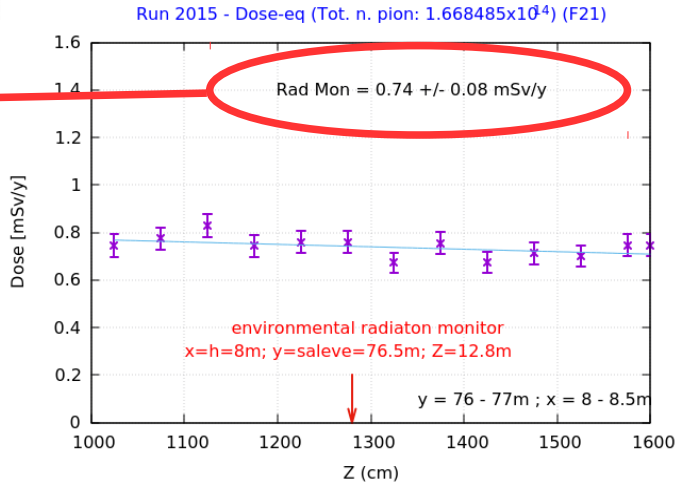


745 µSv (in 2015)
(75% of the limit)





<1%



RUN 2018 - environment monitor

- Total number of days : 217 (+7% of run 2015)
  - Commissioning: 30d; half intensity (was 87d in 2015)
  - Data taking: 187
- Mean SPS cycle (same as run 2017): 24,81s, 145,1 spill/h
  - 3482 spill/d
  - SPS efficiency 75% (MD included)
    - was 71% during run 2017 and 61% during run 2015)
  - Number of good spill ~ 2600 spill/d
  - Mean π^-/spill: $3.9*10^8$
  - Total number of π in run 2018
    - $30 \times (2600 \times 3{,}9\times10^8 \times 0.5) + 187 \times (2600 \times 3{,}9\times10^8) =$ **$2{,}05\times10^{14}$**
  - Run 2015: **$1{,}67\times10^{14}$**
  - Run2018/run2015 → **+ 23%**

SPS cycle - dose x hour

- Run 2015
  - From DVCS
    - Mean over full run: 2,60057845392 min^{-1}
      - SPS cycle : 23.072 s ; 156 spill/h
    - Mean over data taking: 2,64548974643 min^{-1}
      - SPS cycle : 22,680 s ; 158.73 spill/h
- Run 2017
  - From DVCS
    - Mean over the full run 2017: 2.41827002488 min^{-1}
      - SPS cycle : 24,811 s ; 145,1 spill/h
  - From Jens Barth report
    - Shorter SPS cycle : 18s ; 200 spill/h

156 spill/h

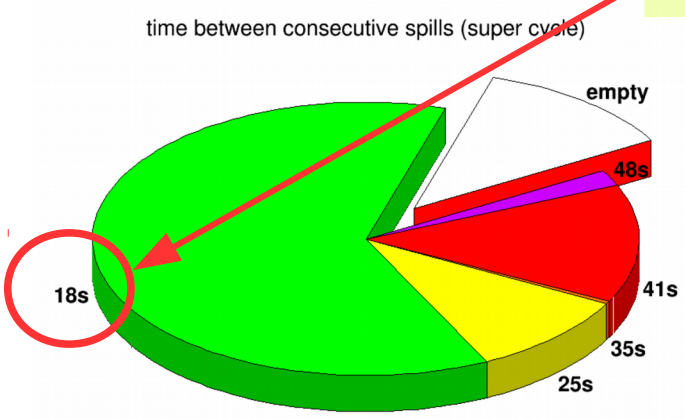
145 spill/h

200 spill/h

In order to safe, the number of pion

3.9×10^8 π/spill x 200 spill/h

78×10^9 π/h



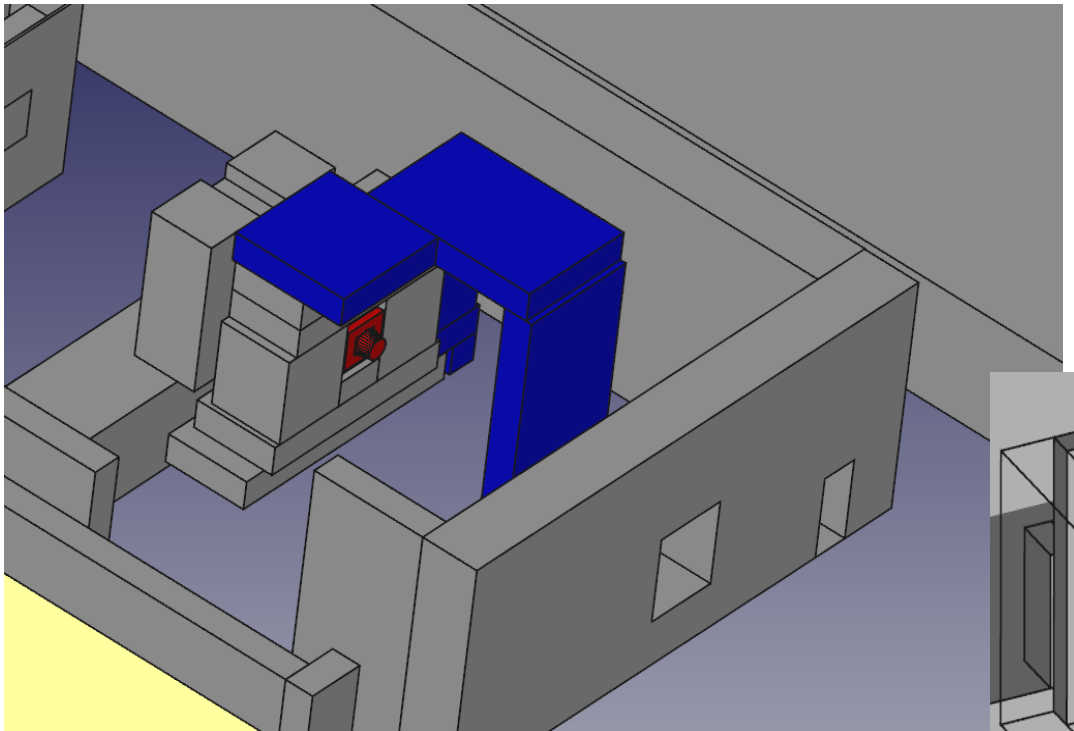
empty spills: 12%

super cycle efficiency: 77%

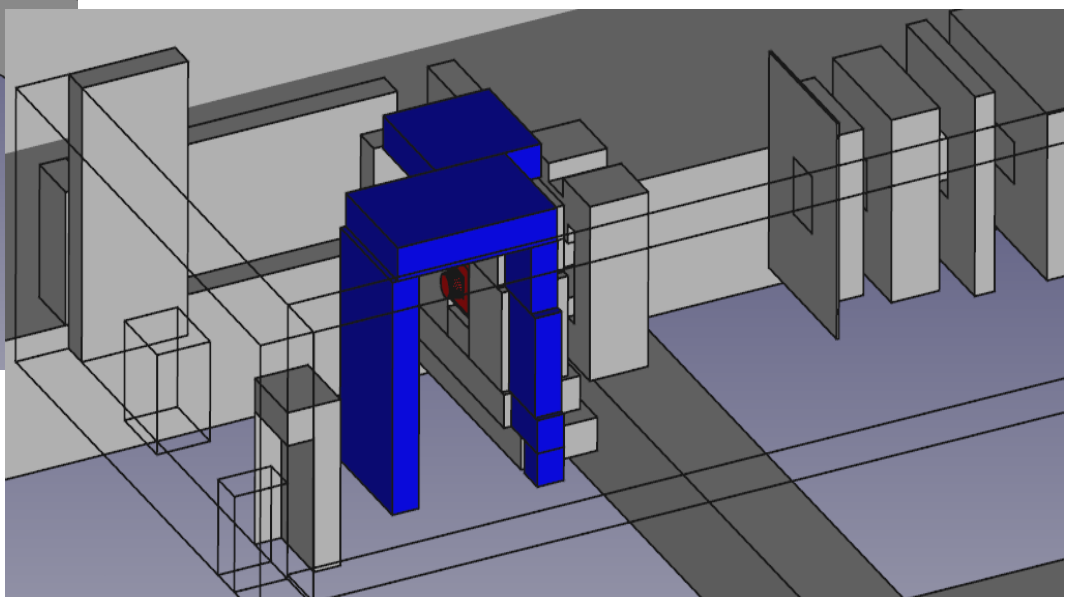
(compared to ideal super cycle 18s)

in average 1 spill each 23 s

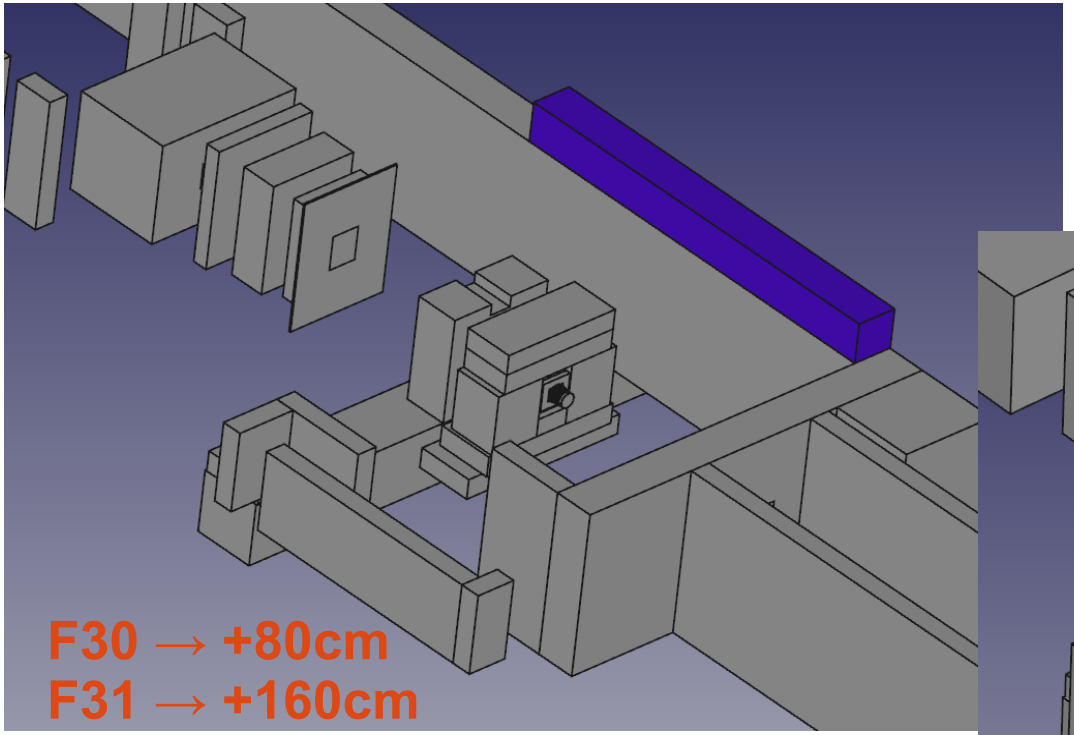
Umbrella shield



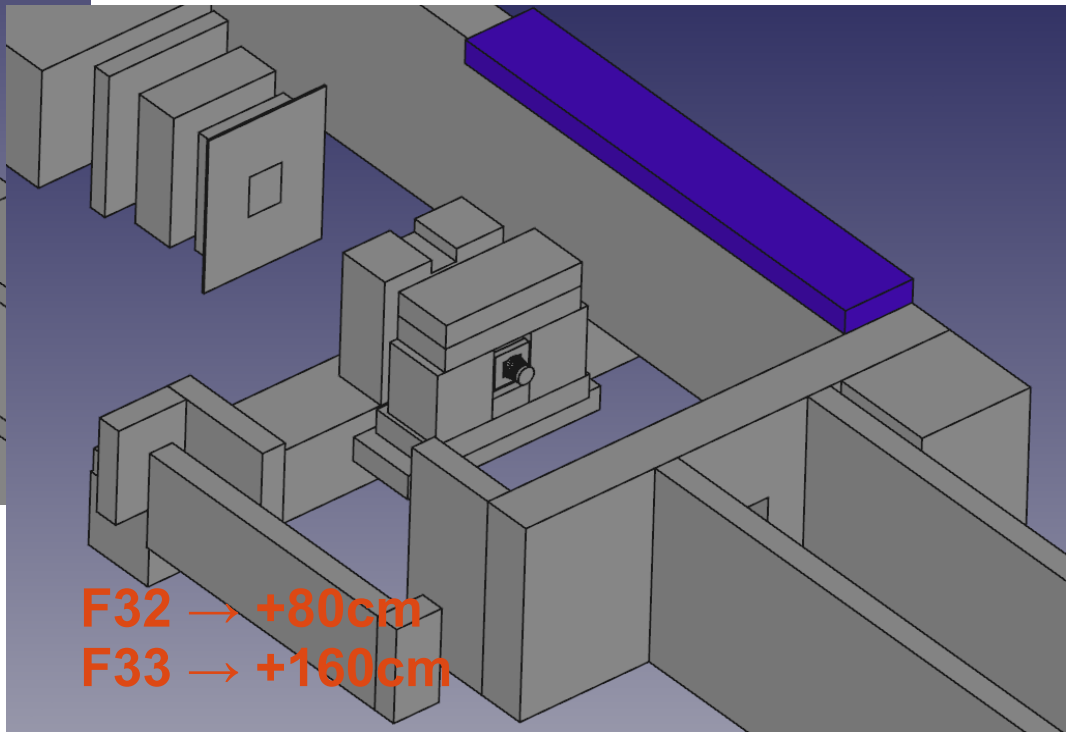
- Only concrete blocks
- Roof extended upstream
- “umbrella” on the side of PT target



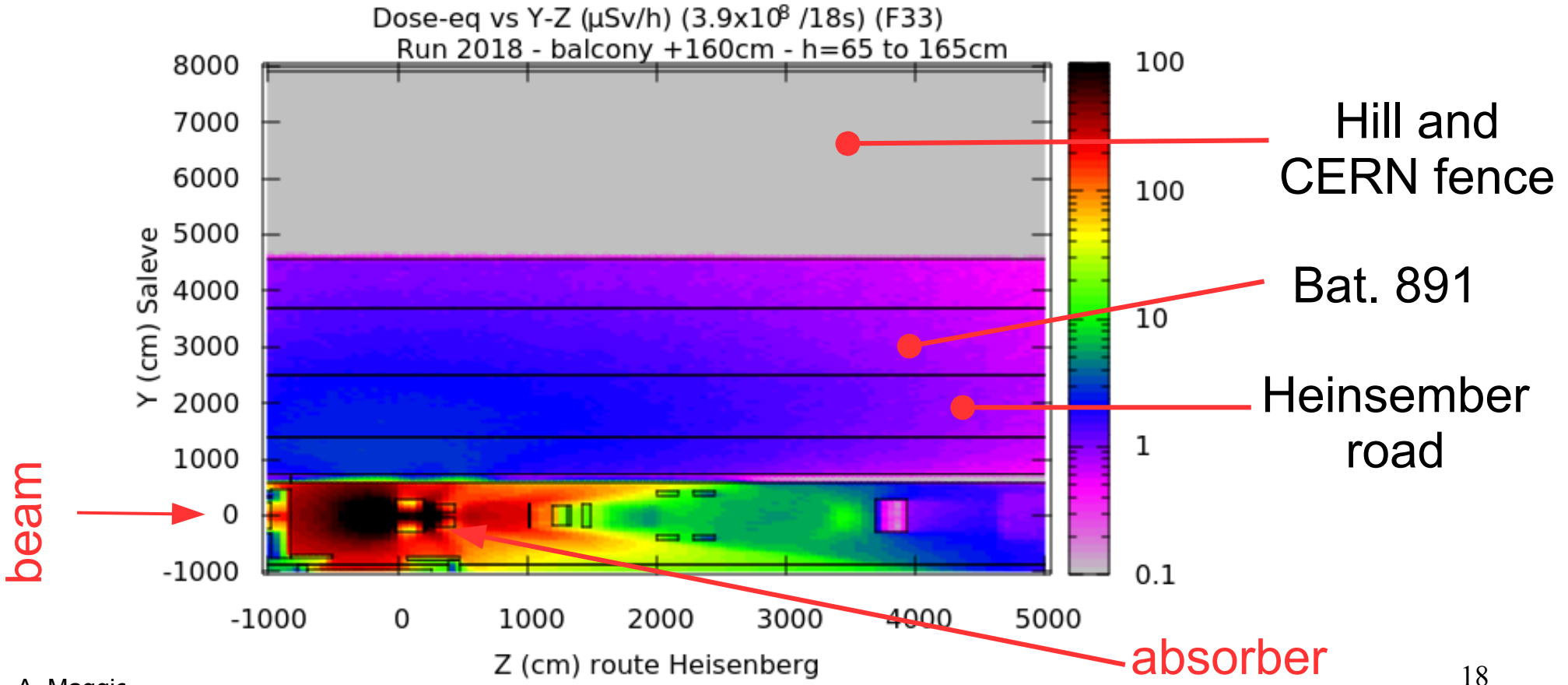
Increased height and Sticked out



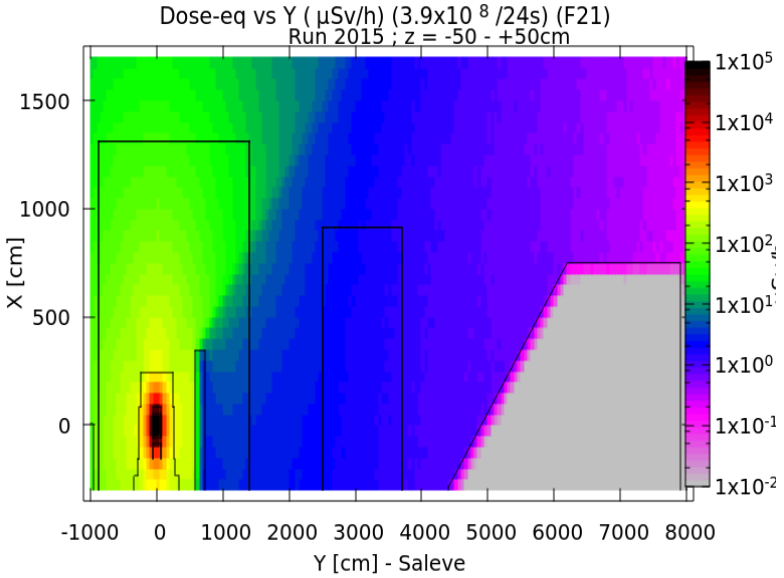
L_z = 16m



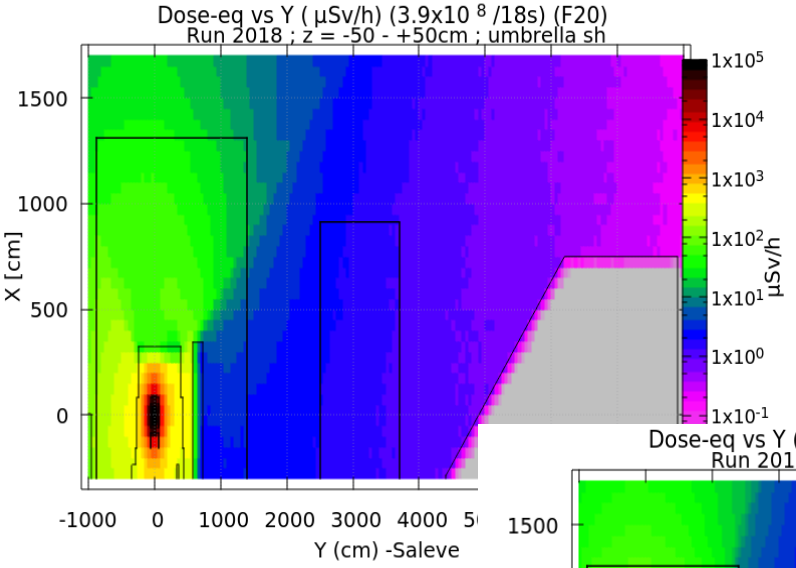
Dose vs road an Saleve



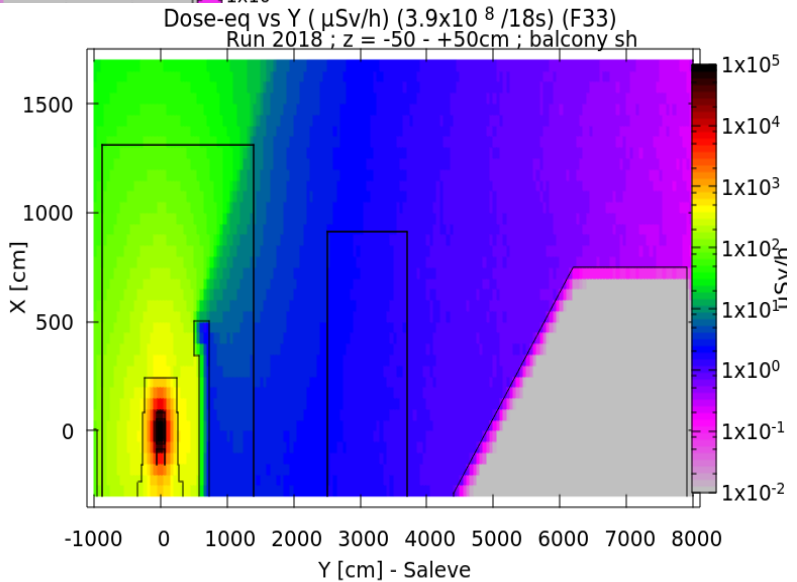
Dose vs Y, Saleve direction



RUN 2015



RUN 2018
Umbrella sh

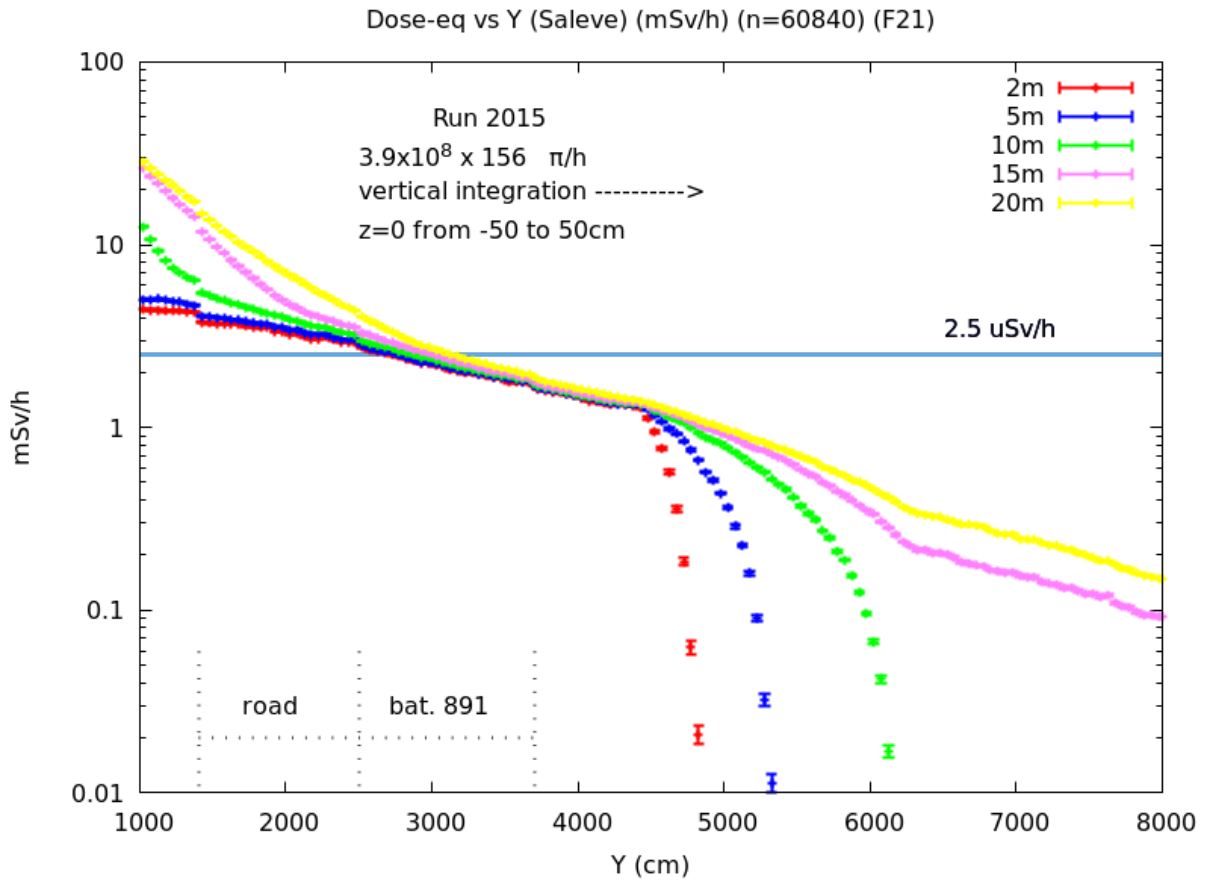


RUN 2018
Balcony sh

Z = -50 -+50cm

Dose on the road, up to CERN fence, Saleve direction

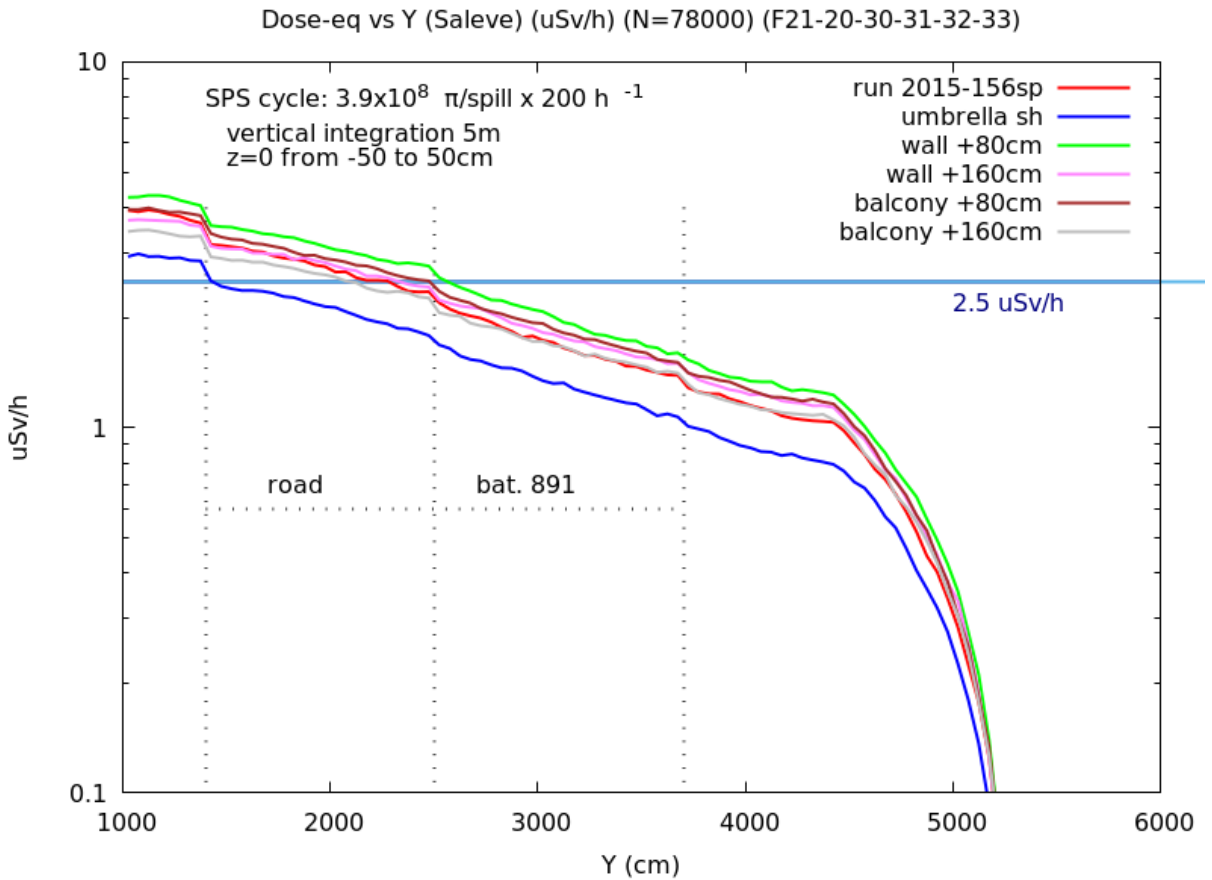
RUN 2015

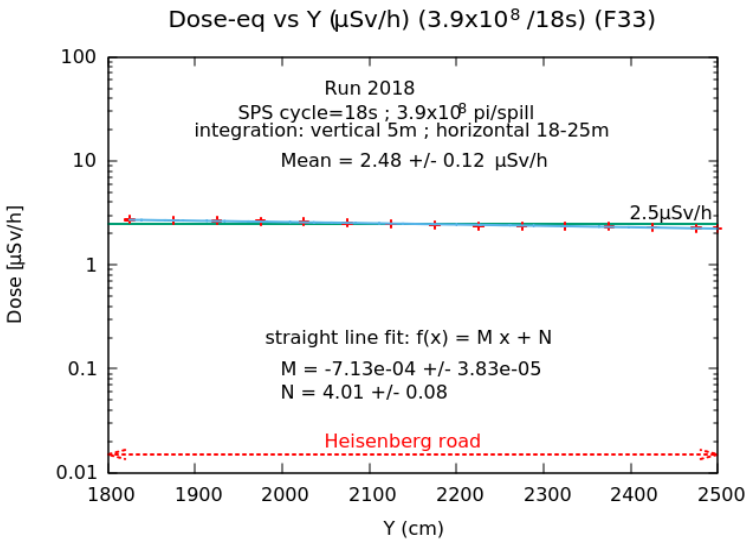


Dose on the road, up to CERN fence, Saleve direction

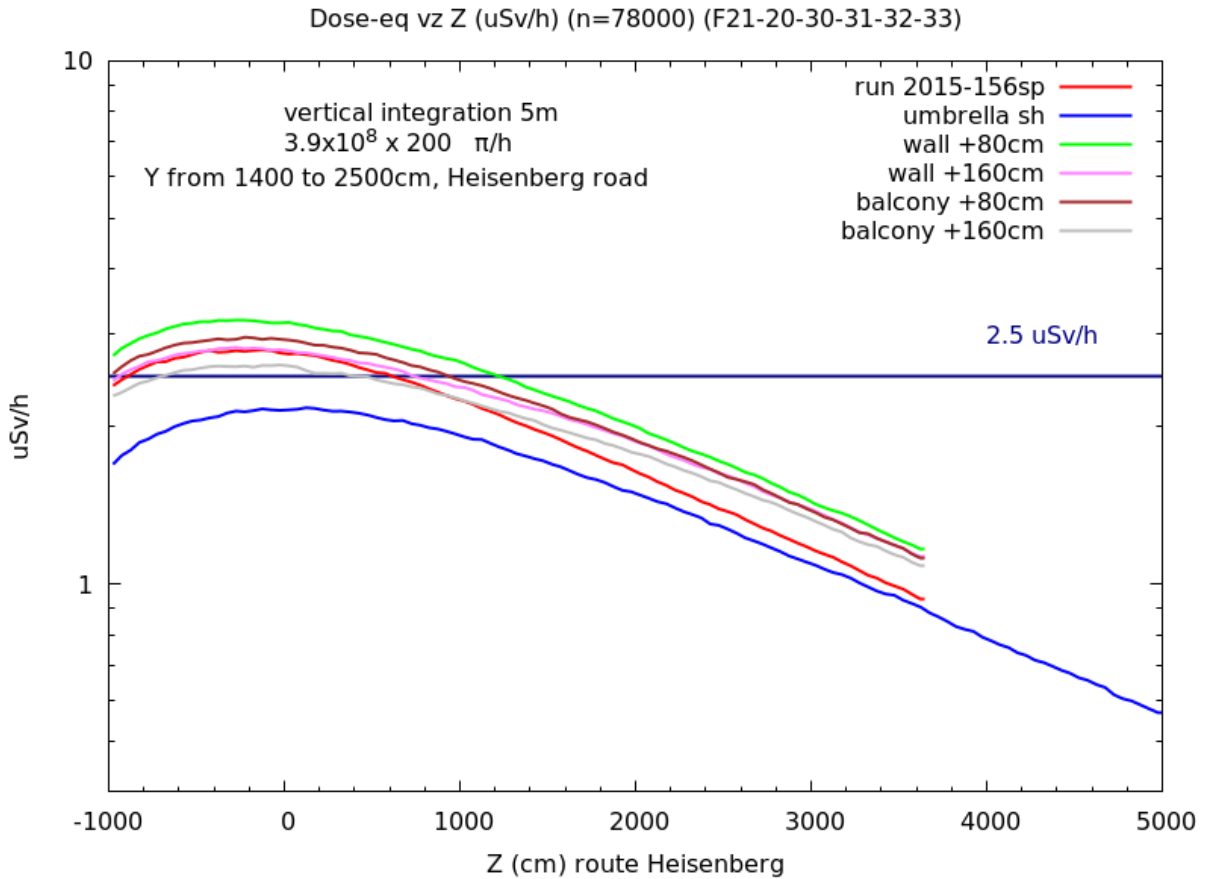
RUN 2018

3.9×10^8 π/spill
200 spill/h





Dose on the Heisenberg road mean over 11m



RUN 2018

3.9×10^8 π/spill

150 spill/h

Dose on 888 DAQ and environment rad mon

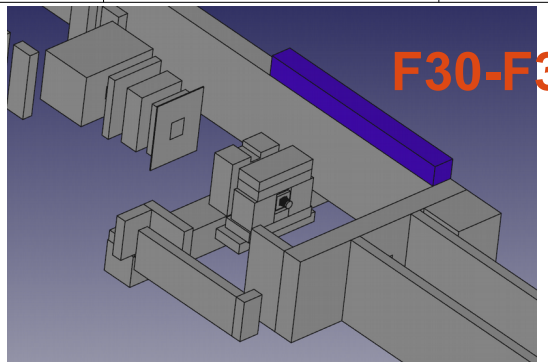
+4% systematic

configuration	environment monitor (mSv/y)	888 DAQ (µSv/h)	Heisenberg road Vert=5m ; Hor=18-25m (µSv/h)	note: no vertex det. secondary target Z=-20cm
F21	0,72 ± 0,09	3,29 ± 0,01	2,59 ± 0,09	Run 2015 (156 spill / h)
F20	0,55 ± 0,06	2,97± 0,02	2,16 ± 0,16	Run 2015 + umbrella shield
F30	0,85 ± 0,10	3,67 ± 0,01	2,99 ± 0,09	wall height + 80cm
F31	0,75 ± 0,11	3,23 ± 0,02	2,66 ± 0,07	wall height + 160cm
F32	0,79 ± 0,15	3,40 ± 0,02	2,75 ± 0,17	wall height + 80cm–balcony
F33	0,76 ± 0,05	2,97 ± 0,02	2,48 ± 0,12	wall height + 160cm–balcony

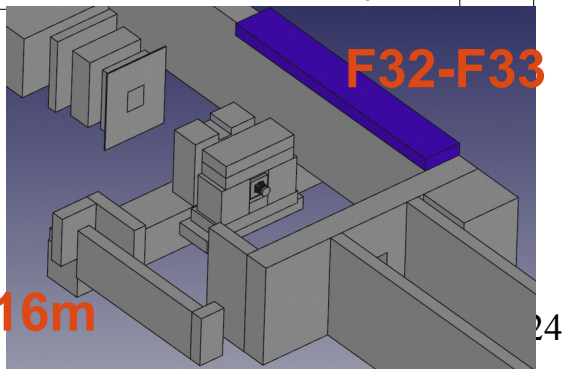
200 spill / h

2.05×10^{14} π/y

1.66×10^{14} π/y

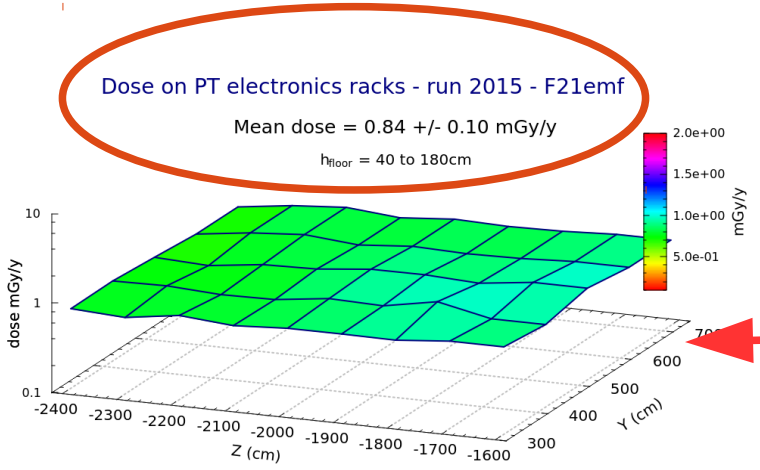


L_z = 16m

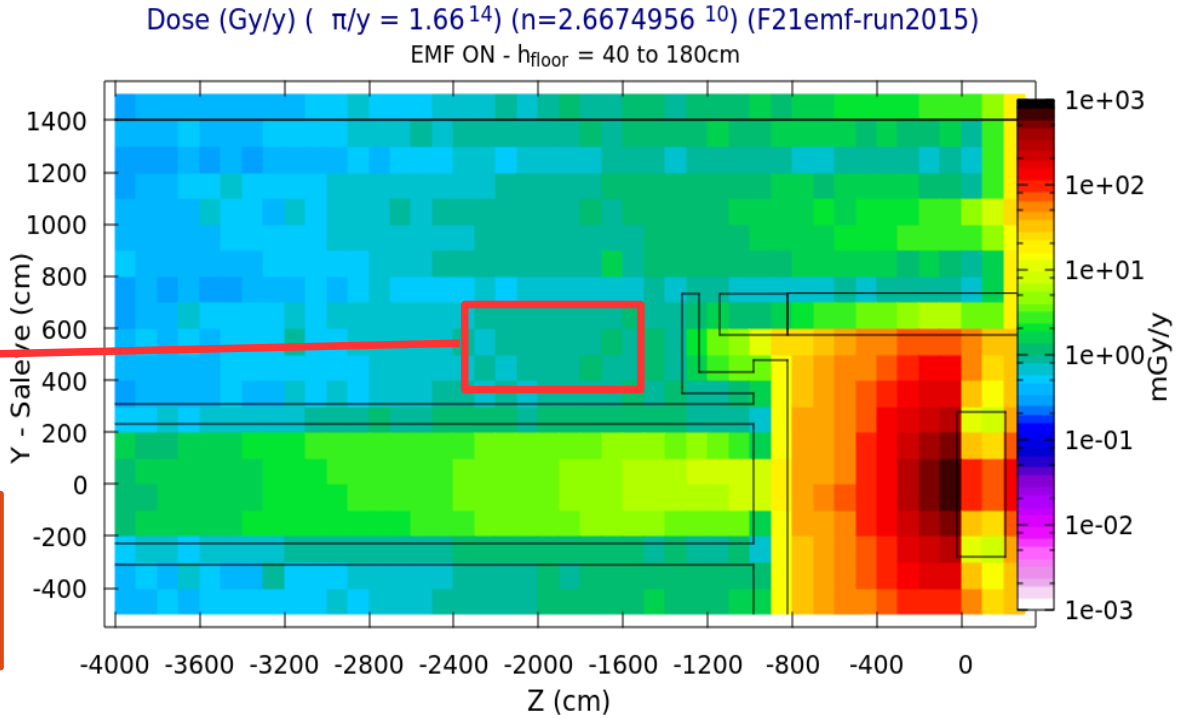


Dose on PT solenoid electronics during the run 2015

ONLY regular beam can be simulated,
no beam spike, no magnet or quadrupole failure,
no bit flip, no computer or FPGA registers glitch etc.



Very far from radiation electronics damages - 1MGy



Summary of Blue Waters usage

	Time/pr [s]	Number of config.	Number of primary	Total time [h]	Time/node [h]
EMF ON	35,41	10	$11{,}354 \times 10^6$	111671,70	3489,74
EMF OFF	3,34	44	$114{,}792 \times 10^6$	106573,93	3330,74
Total		54	$126{,}146 \times 10^6$	218245,63	6820,18

underestimated: some configuration was simulated twice with marginal changes and the output was rewritten

Conclusions

- The fuka simulations are in excellent agreement with the environment dose measured at CERN fence for run 2015 when the π integrated flux is evaluated correctly
- A cross-check has been done by Radioprotection group. Very good agreement has been found.
- Environmet dose,
  - It was below the limit, 1 mSv/y, also in 2015
  - It will be same in 2018, also with 20% more beam, using sticked out shielding, h=160cm
- Dose on 888 DAQ
  - Is almost independent from position and material of secondary target with umbrella shielding
- Dose on Heinsemberg road
  - The dose is evaluated in the worse and safe conditions. In this condition
  - The “umbrella” shielding fulfill the RP request
  - The 160cm sticked shielding out shielding is at the limit but fulfil the RP request
- Dose on PT magnet electonics racks
  - The dose due to regular beam, integrated on full run 2015 has been simulated
  - No relevant dose has been found, as well as the dose on PT target

Acknowledgments

- this work has been possible thanks to the help and suggestions of many people:
  - Christophe for the 2015 data of beam intensity and Flavio for Cedars position
  - Caroline, Marco, Riccardo for the help to compile and run fluka on Blue Waters.
  - Catarina, Alain, Michela and Bakur for sugestions and ideas
  - Gherard ad Vladimir for the suggestions on feasible shielding
- Thanks to everybody and …..

HAVE A SMOOTH AND PRODUCTIVE DY RUN 2018