RADSYNCH 2023

ESRF, 30 May – 2 June 2023

Decommissioning of the ESRF storage ring

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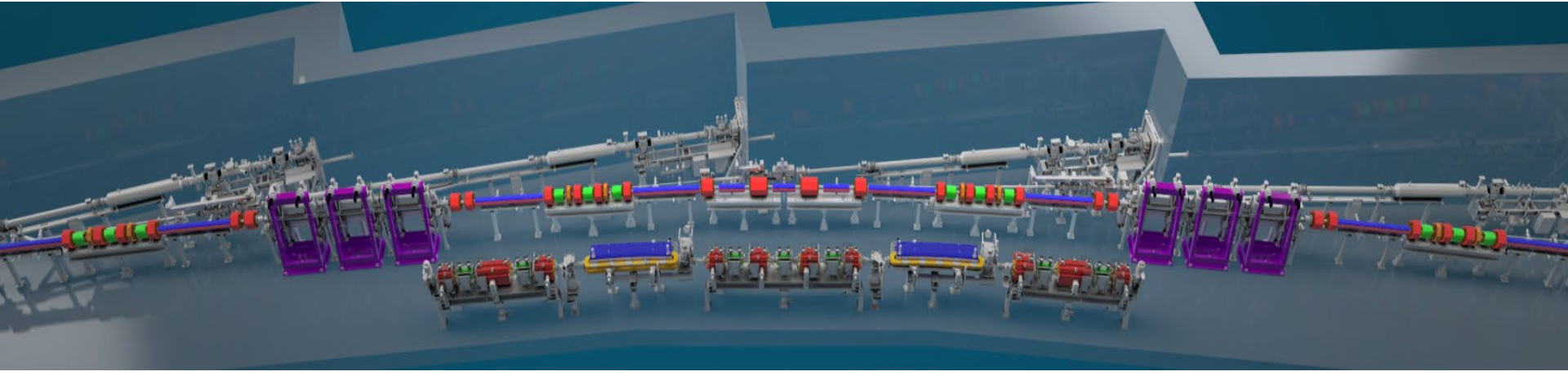
ESRF | The European Synchrotron

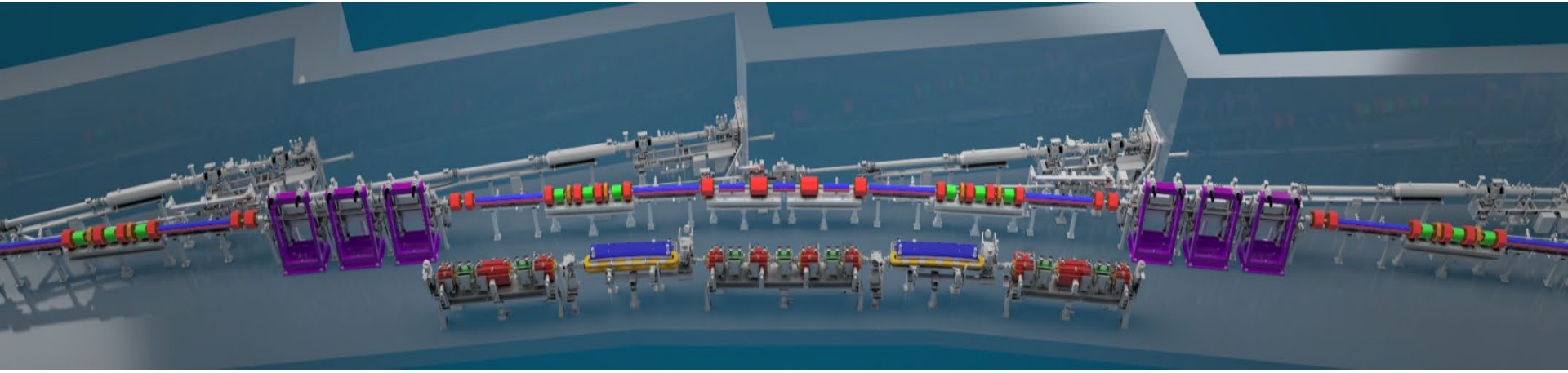
DECOMMISSIONING OF THE ESRF STORAGE RING

1. Decommissioning of old storage ring
2. Update of waste management program: procedures for handling activated components during EBS operation



Replacement of storage ring:

- All accelerator components, except ID vessel and IDs and last module of front ends.
- Cable trays and cables.
- Piping.



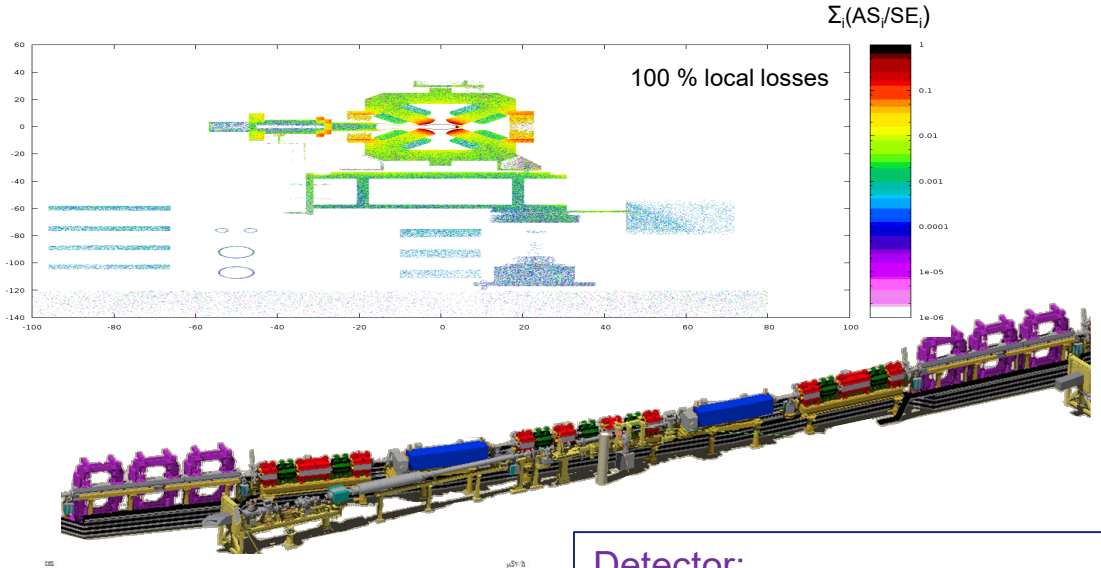
Recall:

After several years of discussion, the proposal from ESRF for the classification of the dismantled storage ring components as non-activated waste was accepted by the French Nuclear Safety Authority.

The valorisation of these components as non-activated waste was possible after detailed radiation measurements of all individual elements.

Detailed FLUKA study:
Only a limited number of elements (injection zone + scrapers) should be considered as activated.

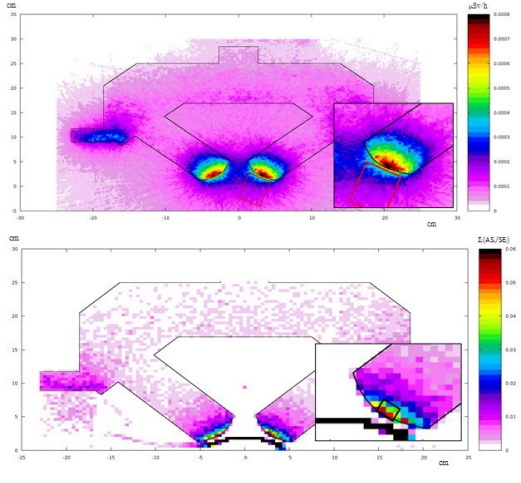
→ **Radioactive zoning**
  → All special elements, considered as spare parts.



Surface dose measurements (indistinguishable form background)

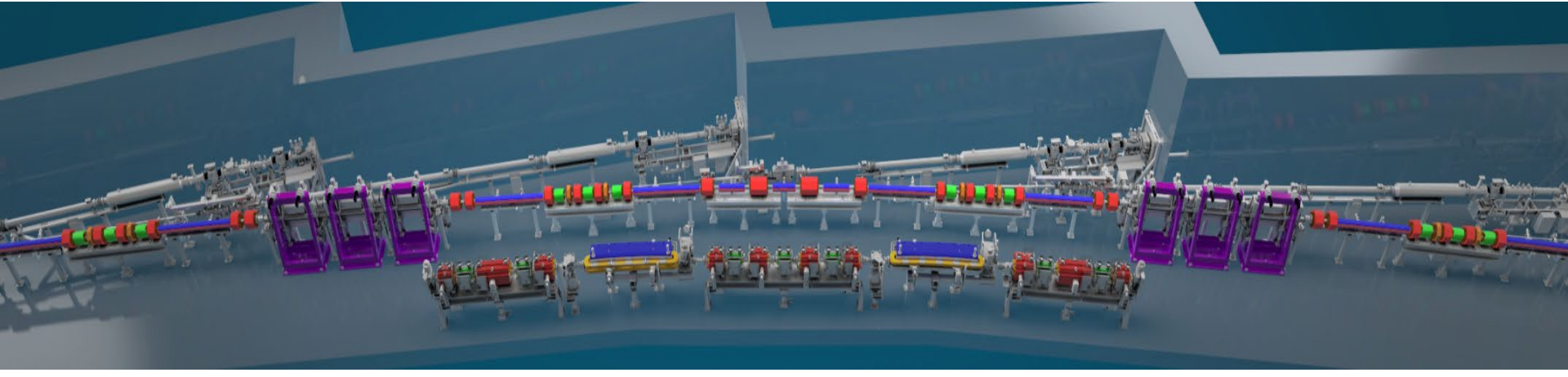
$$\sum_{all\ isotopes} \frac{AS_i}{SE_i} \leq 1$$

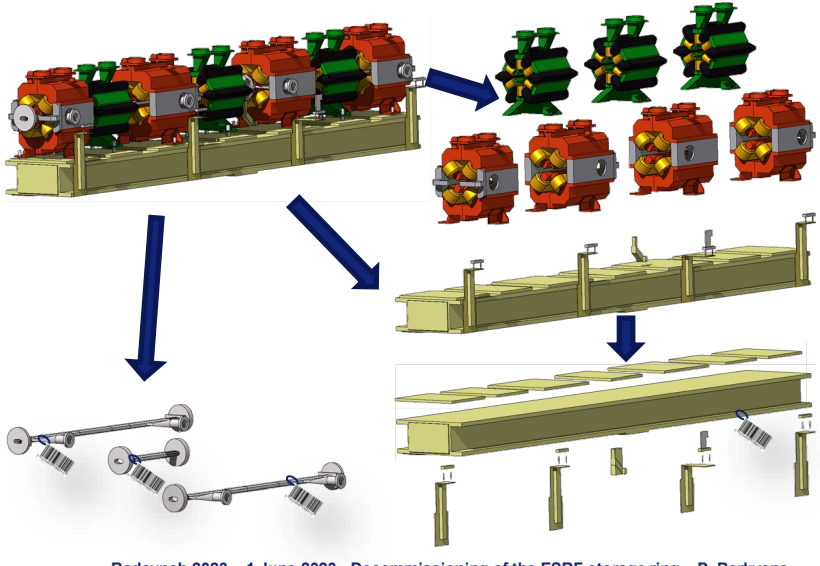
guaranteed for 1 cm^3 hotspots.

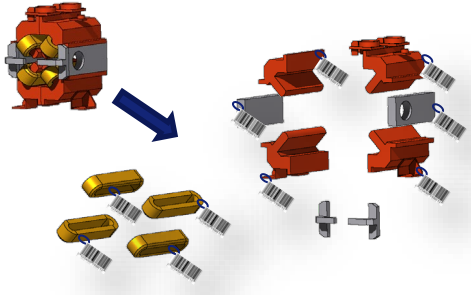


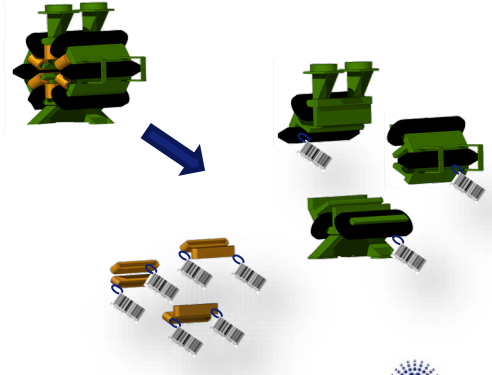
Detector:
FHZ 503E
(3” × 3” NaI(Tl) scintillator)

10 – 15 nSv/h background
$\beta = \alpha = 1.\ 10^{-4}$
Decision threshold: 1.5 nSv/h
Detection limit: 3 nSv/h





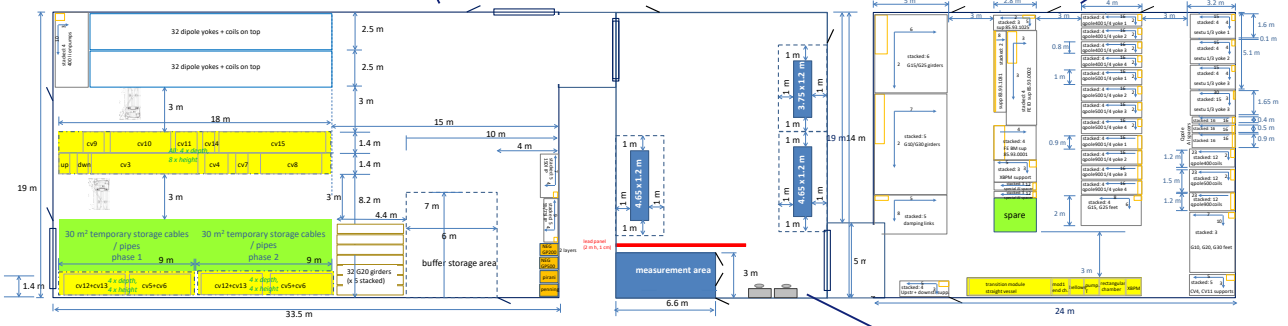




DECOMMISSIONING OF OLD STORAGE RING

ESRF13

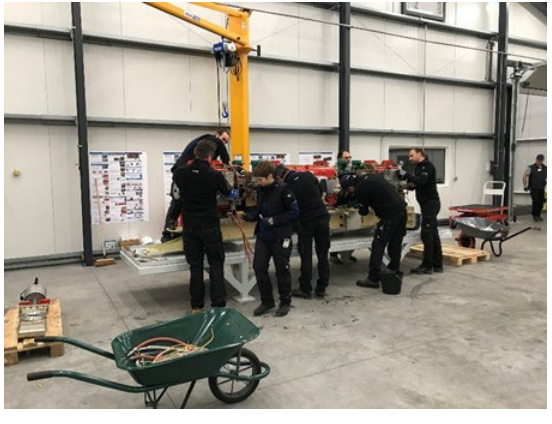
ESRF11



ESRF12

Total surface: 1500 m²

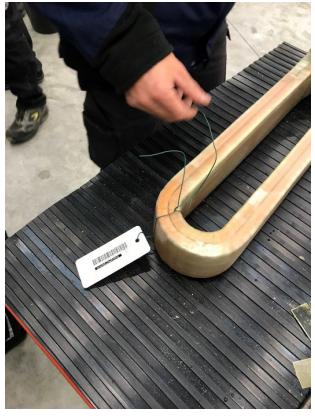
DECOMMISSIONING OF OLD STORAGE RING

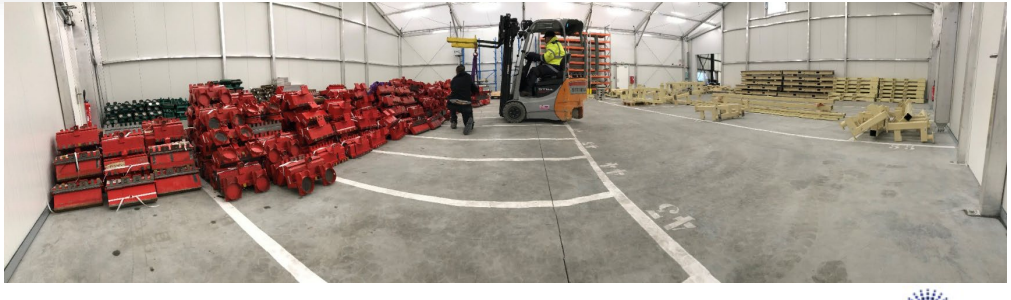


Quadrupole / sextupole girder

Disassembly procedure for G30 girder

Putting barcodes on individual components





Part of quadrupole yokes to ESRF11

DECOMMISSIONING OF OLD STORAGE RING

Disassembled storage ring components, April 2019

Robotised measurements of accelerator components in the ESRF-12 building

DECOMMISSIONING OF OLD STORAGE RING

Detailed measurement protocols archived

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+-----------------------------------------------------------------------------------------------------------+
| Compte rendu de mesure de classification radiologique dans le cadre du démantèlement de l'anneau de stockage |
+-----------------------------------------------------------------------------------------------------------+

                      ------------    CHAMBRES A VIDE    ------------

                                              Référence: ESRF/SG/RP/CR/decomm1/vacves/2022-1fr, 07/01/2022

+-----------------------------------------------------+
| Mesures effectuées par : P. Berkvens / P. Colomp    |
| Date des mesures : 05/07/2022                       |
+-----------------------------------------------------+

Note: les différentes mesures correspondent au protocole pour les chambres à vide,
      comme décrit dans la section 5.1.2.2 de la référence ESRF/SG/RP/ASN/rapport/decomm1/2016-fr.

+--------------------------+
|+------------------------+|
|| mesure de bruit de fond ||
|+------------------------+|
+--------------------------+
      1 - 2022_07_05_09-43-48 : 54.21200
      2 - 2022_07_05_09-43-49 : 52.61850
      3 - 2022_07_05_09-43-50 : 52.64630
      4 - 2022_07_05_09-43-51 : 55.43870
      5 - 2022_07_05_09-43-52 : 52.59530
      6 - 2022_07_05_09-43-53 : 55.82820
      7 - 2022_07_05_09-43-54 : 56.53180
      8 - 2022_07_05_09-43-55 : 53.50080
      9 - 2022_07_05_09-43-56 : 56.91370
     10 - 2022_07_05_09-43-57 : 57.02560
     11 - 2022_07_05_09-43-58 : 57.14700
     12 - 2022_07_05_09-43-59 : 53.71930
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+---------------------------------------+
|+-------------------------------------+|
|| référence chambre :    CELL24-CV11-11 ||
|+-------------------------------------+|
+---------------------------------------+

    mesure 1
    ------------------------
     1 - 2022_07_05_09-58-45 : 54.95860
     2 - 2022_07_05_09-58-46 : 59.65770
     3 - 2022_07_05_09-58-47 : 58.26540
     4 - 2022_07_05_09-58-48 : 56.48300
     5 - 2022_07_05_09-58-49 : 58.33730
     6 - 2022_07_05_09-58-50 : 57.76500
     7 - 2022_07_05_09-58-51 : 51.97150
     8 - 2022_07_05_09-58-52 : 50.34140
     9 - 2022_07_05_09-58-53 : 58.24470
    10 - 2022_07_05_09-58-54 : 54.16670
    11 - 2022_07_05_09-58-55 : 56.70060
    12 - 2022_07_05_09-58-56 : 51.36340
    13 - 2022_07_05_09-58-57 : 54.67730
    14 - 2022_07_05_09-58-58 : 53.13520
    15 - 2022_07_05_09-58-59 : 56.85650
    16 - 2022_07_05_09-59-00 : 59.32610
    17 - 2022_07_05_09-59-01 : 52.43810
    18 - 2022_07_05_09-59-02 : 54.05490
    19 - 2022_07_05_09-59-03 : 49.98090
    20 - 2022_07_05_09-59-04 : 59.32460
    21 - 2022_07_05_09-59-05 : 55.65970
    22 - 2022_07_05_09-59-06 : 51.73390
    23 - 2022_07_05_09-59-07 : 58.13090
    24 - 2022_07_05_09-59-08 : 55.39430
    25 - 2022_07_05_09-59-09 : 57.39440
```

```
mesure 51 brute : cps moyennés sur 1 minute : 55.73359
mesure 51 nette : cps moyennés sur 1 minute : 0.98395
mesure 51 nette / seuil de décision : 0.19

mesure 52 brute : cps moyennés sur 1 minute : 54.86700
mesure 52 nette : cps moyennés sur 1 minute : 0.11737
mesure 52 nette / seuil de décision : 0.02

mesure 53 brute : cps moyennés sur 1 minute : 54.41125
mesure 53 nette : cps moyennés sur 1 minute : -0.33839
mesure 53 nette / seuil de décision : -0.07

mesure 54 brute : cps moyennés sur 1 minute : 54.44268
mesure 54 nette : cps moyennés sur 1 minute : -0.30696
mesure 54 nette / seuil de décision : -0.06

mesure 55 brute : cps moyennés sur 1 minute : 54.58148
mesure 55 nette : cps moyennés sur 1 minute : -0.16816
mesure 55 nette / seuil de décision : -0.03


+-----------------------------------------------------------------------------------------+
| Classification radiologique du composant retenue selon résultats des mesures : non-activée |
+-----------------------------------------------------------------------------------------+
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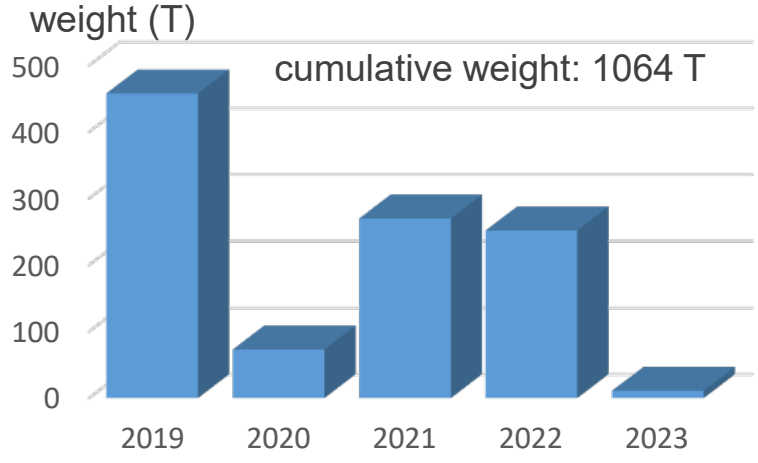
DECOMMISSIONING OF OLD STORAGE RING

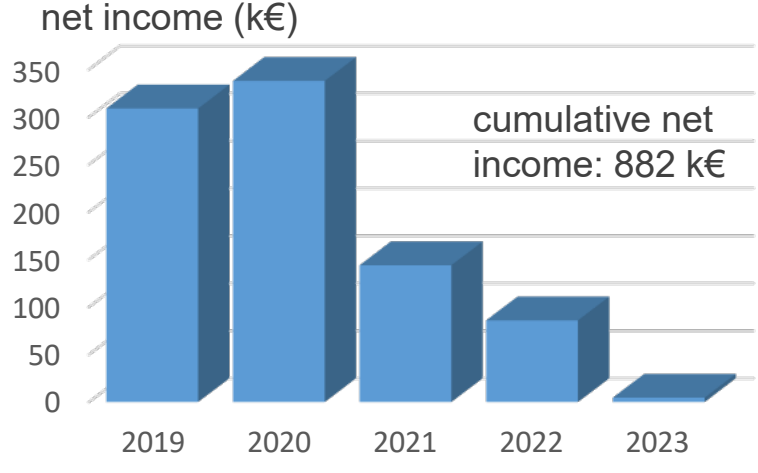
All components taken out of the tunnel during the long shutdown have been measured (end 2022).

None of the scanned components showed any measureable level of activation.

More than 1000 tons of metal have been evacuated so far.

The corresponding cumulative net income from the valorisation of this waste is 882 k€.





ESRF-13 building, October 2022:
Only ID vacuum vessels are left to be measured.

DECOMMISSIONING OF OLD STORAGE RING

Throughout the lifetime of the old storage ring, a large number of components were taken out of the tunnel and were stored on site.

All these components are measured and disposed of using the same protocols.

ESRF-12 building, October 2022:
part of the storage ring components that were accumulated over the 30 years of operation of the old storage ring.

UPDATE OF WASTE MANAGEMENT PLAN

Request from French Nuclear Safety Authority (ASN):

Provide activation calculations for all accelerators to update the ESRF waste management plan.

The results are used to define waste management zoning in the tunnels and define corresponding procedures to be followed for the verification of the non-activation of accelerator components taken out of the tunnel (simple measurements using hand-held monitors or measurements using ESRF-12 robot).

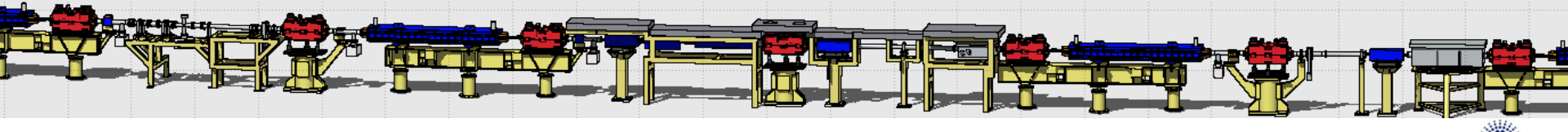
The procedures do not cover the final decommissioning of the accelerators.

Already done:

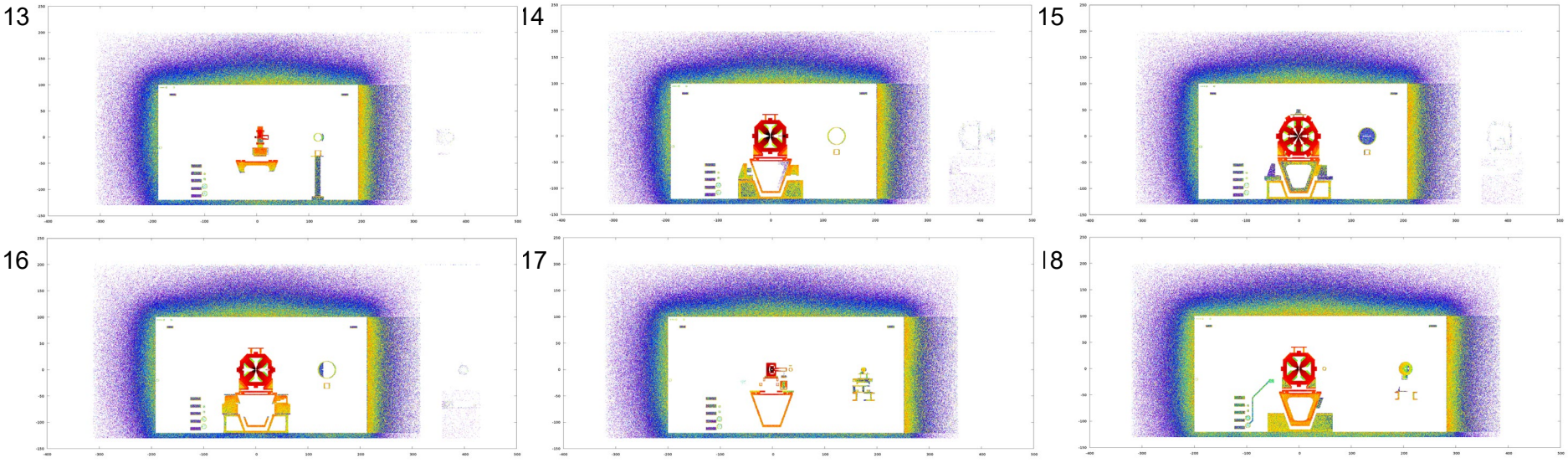
- Storage ring
- Booster, standard cells and extraction zone

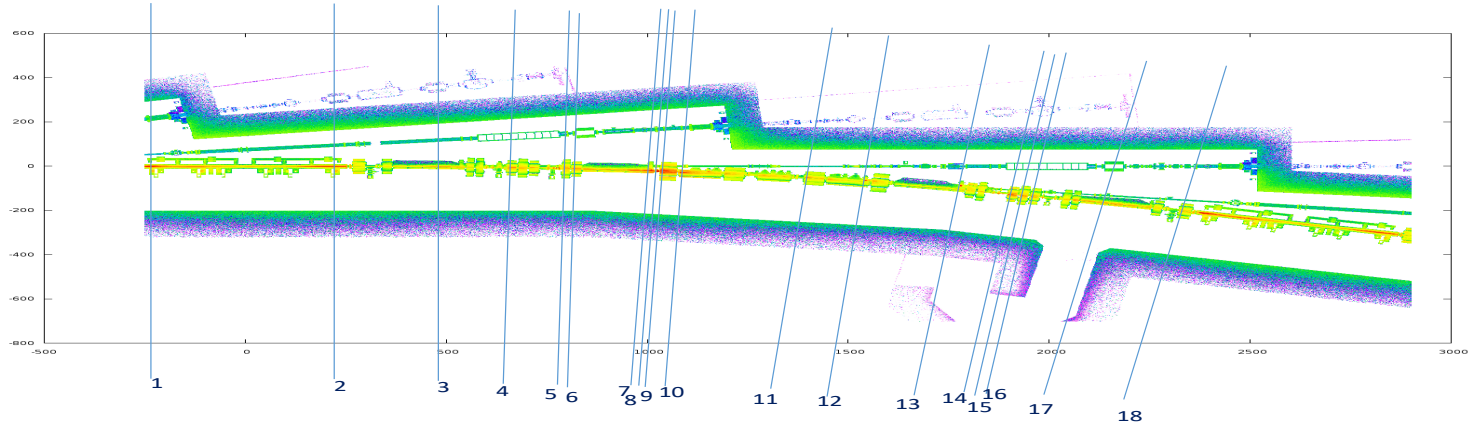
To be done:

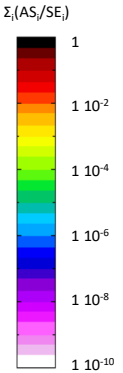
- Booster injection zone
- Linac
- Transfer lines



UPDATE OF WASTE MANAGEMENT PLAN: STORAGE RING

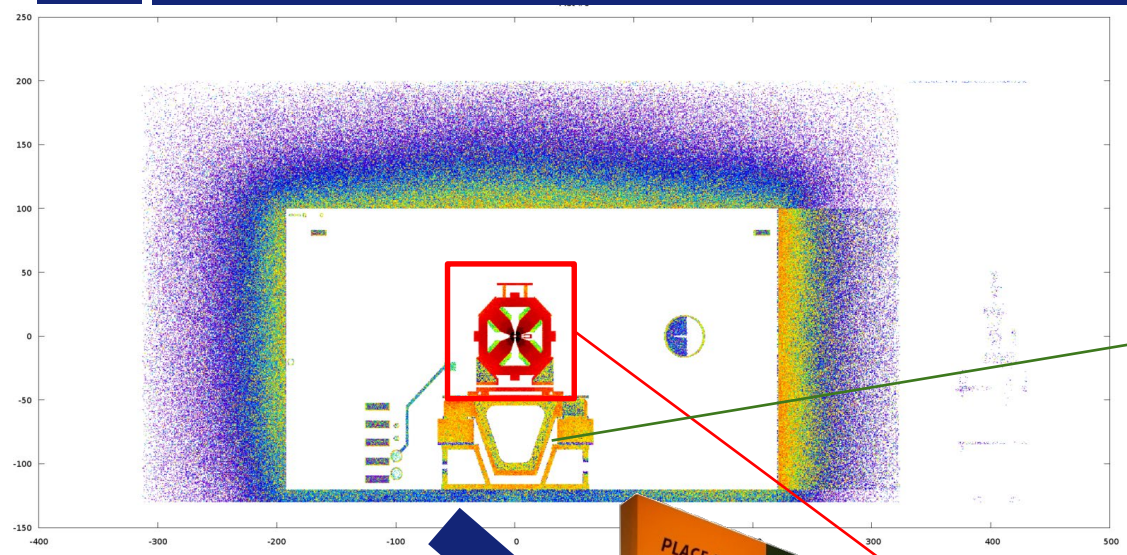






1.2 mC/year – 20 years

UPDATE OF WASTE MANAGEMENT PLAN: STORAGE RING



$\Sigma_i(AS_i/SE_i)$

1

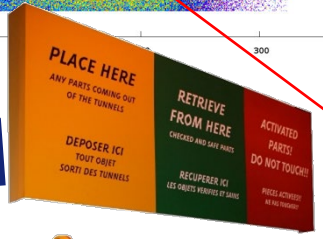
$1\ 10^{-2}$

$1\ 10^{-4}$

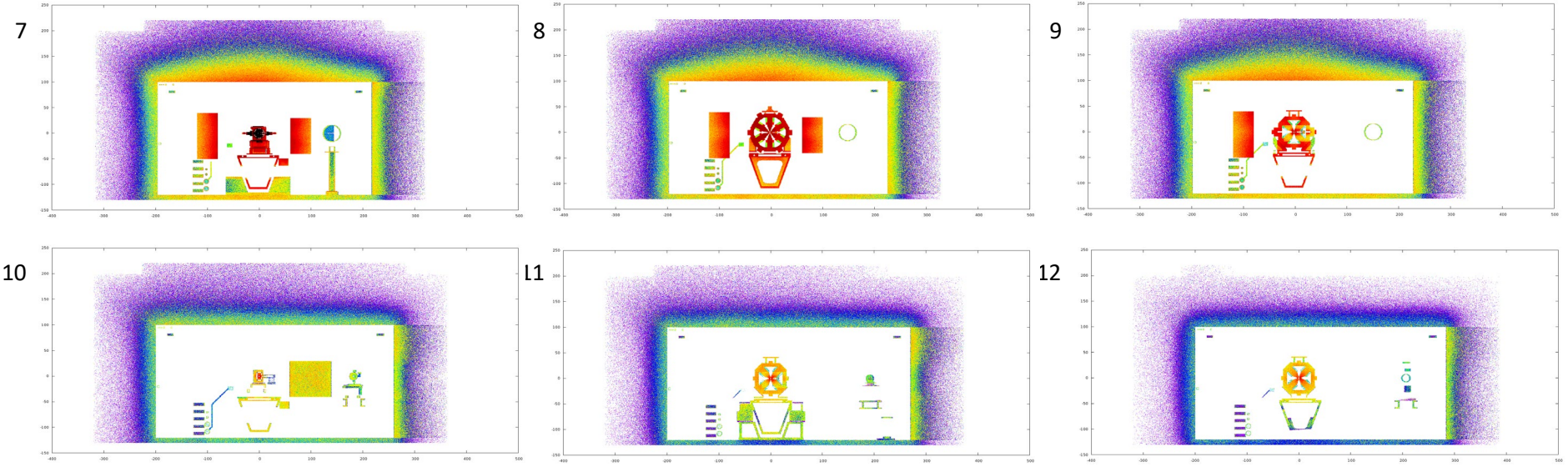
$1\ 10^{-6}$

$1\ 10^{-8}$

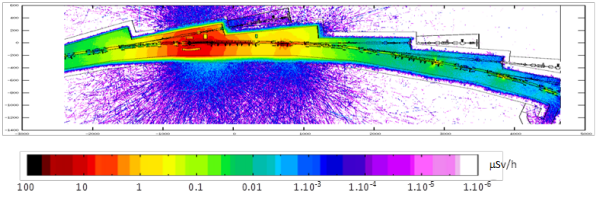
$1\ 10^{-10}$



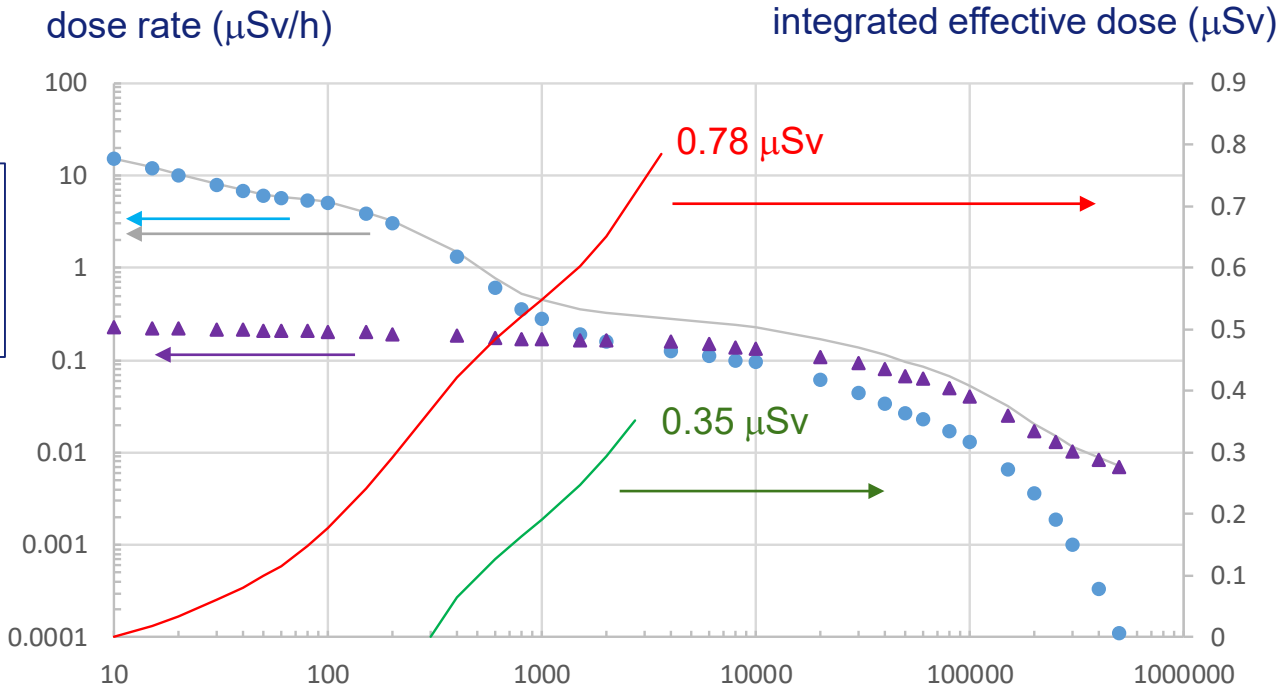
UPDATE OF WASTE MANAGEMENT PLAN: STORAGE RING



UPDATE OF WASTE MANAGEMENT PLAN: STORAGE RING



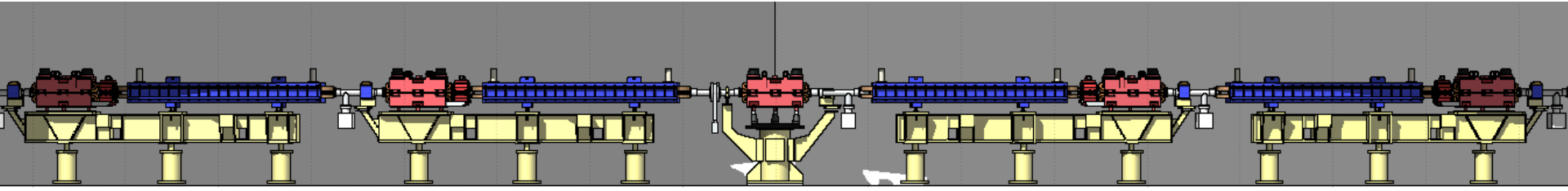
French law: radiation area if effective dose **> 80 µSv** per month



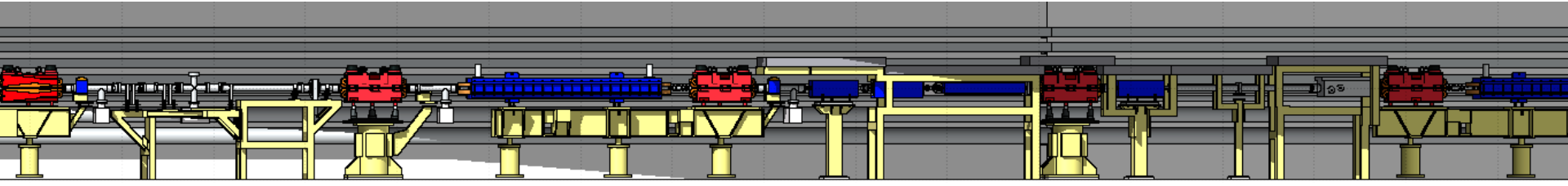
forced entry: 0.78 µSv in one h → repeat every two hours, 200 h /month → **78 µSv per month**
"normal" entry: 0.35 µSv in 45 minutes → repeat every hour, 200 h /month → **70 µSv per month**
20 days next to collimator (1 month shutdown) → **< 6 µSv**

Maximum dose, under completely unrealistic conditions < 80 mSv / month → no need for a radiation area.

UPDATE OF WASTE MANAGEMENT PLAN: BOOSTER



booster standard cell



booster extraction area and stripline area

UPDATE OF WASTE MANAGEMENT PLAN: BOOSTER

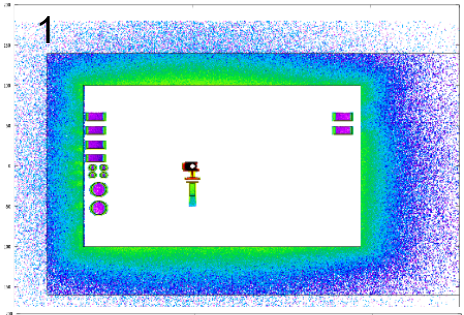
Annual beam loss assumptions in booster

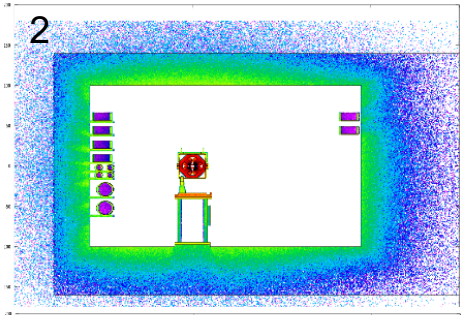
(recall: maximum annual injected charge in storage ring: 1.2 mC

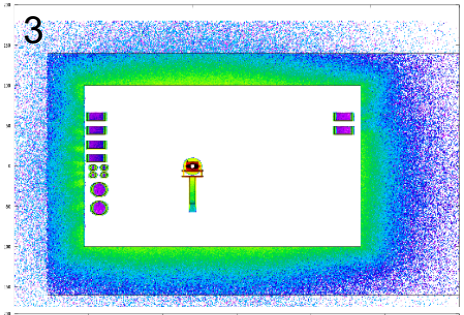
	Injection in storage ring	R&D booster	Total
Injection (200 MeV)	2.9 mC	2 mC	4.9 mC
Extraction (6 GeV)	0.4 mC	-	0.4 mC
Scraper (1 GeV)	0.1 mC	0.3 mC	0.4 mC
Scraper (6 GeV)	0.1 mC	0.3 mC	0.4 mC
Striplines (1 GeV)	-	0.3 mC	0.3 mC
Elsewhere in booster (1 GeV)	0.1 mC	0.3 mC	0.4 mC
Total	3.6 mC	3.2 mC	6.8 mC

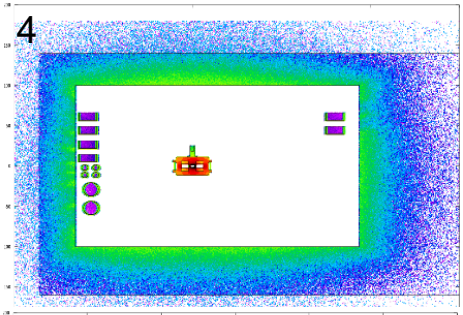
For activation measurements we assume 0.4 mC lost in a single cell.

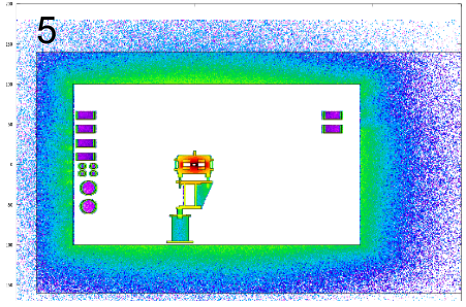
UPDATE OF WASTE MANAGEMENT PLAN: BOOSTER

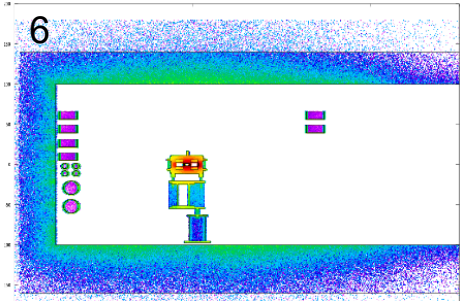


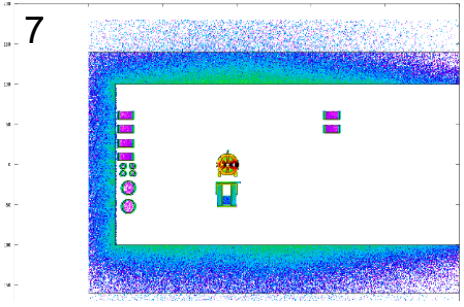


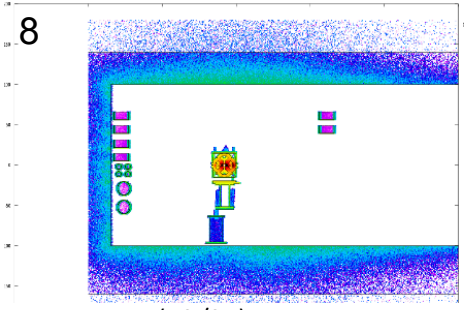


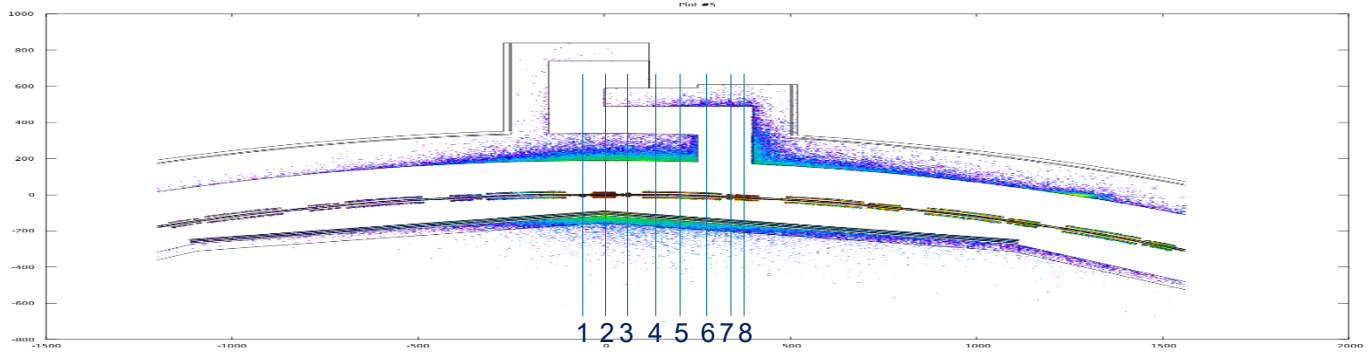




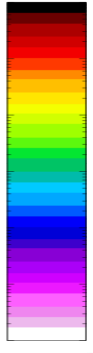




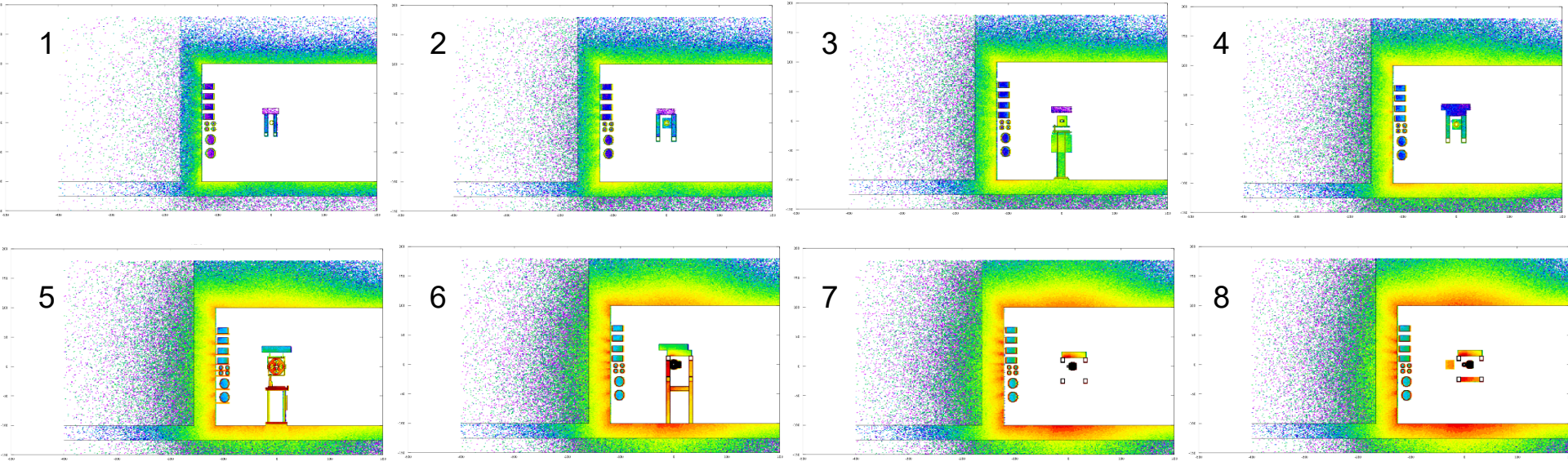


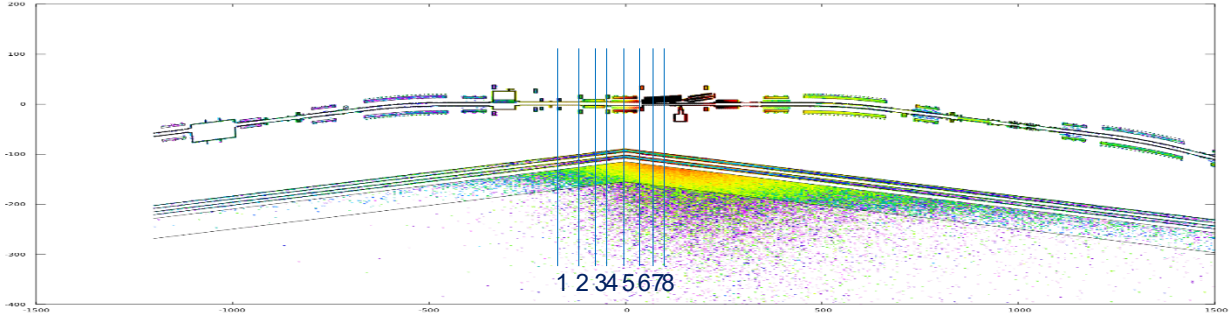


$\Sigma_i(AS_i/SE_i)$



UPDATE OF WASTE MANAGEMENT PLAN: BOOSTER





$\Sigma_i(AS_i/SE_i)$

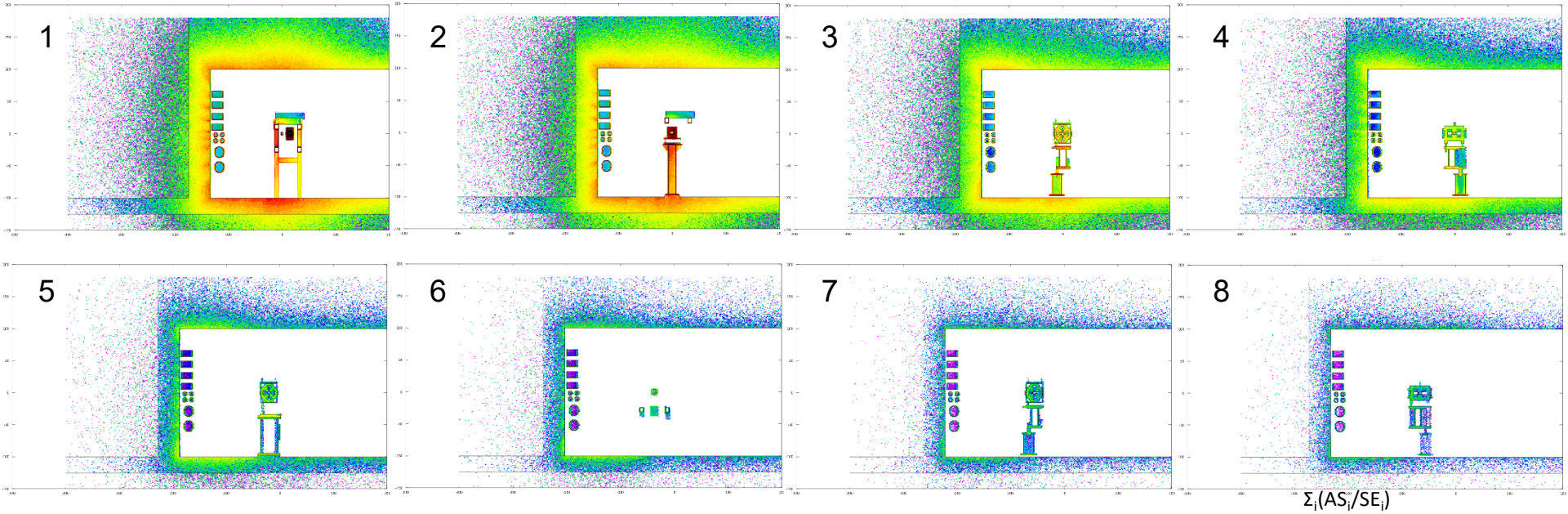
1

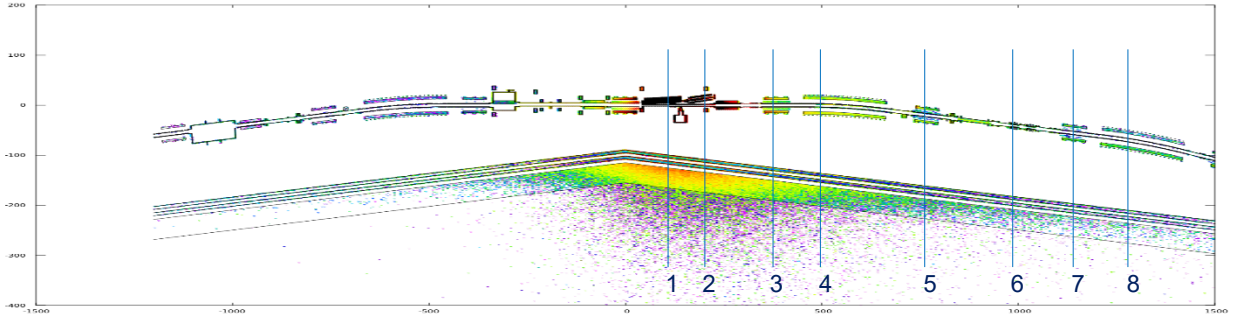
$1\ 10^{-2}$

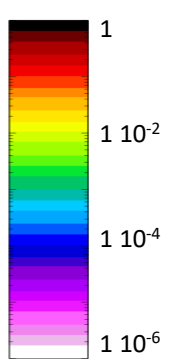
$1\ 10^{-4}$

$1\ 10^{-6}$

UPDATE OF WASTE MANAGEMENT PLAN: BOOSTER







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