CFS consideration on the Main Dump and around

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Design of Main Dump and around

- **Main Dump**
  - **Shielding for rock and groundwater**
  - **Dump hall design**
  - **Decommissioning issues**

- **Around**
  - **Muon Wall**
  - **Positron Tune-up Dump**
  - **Photon Dump** **(undulator positron source)**

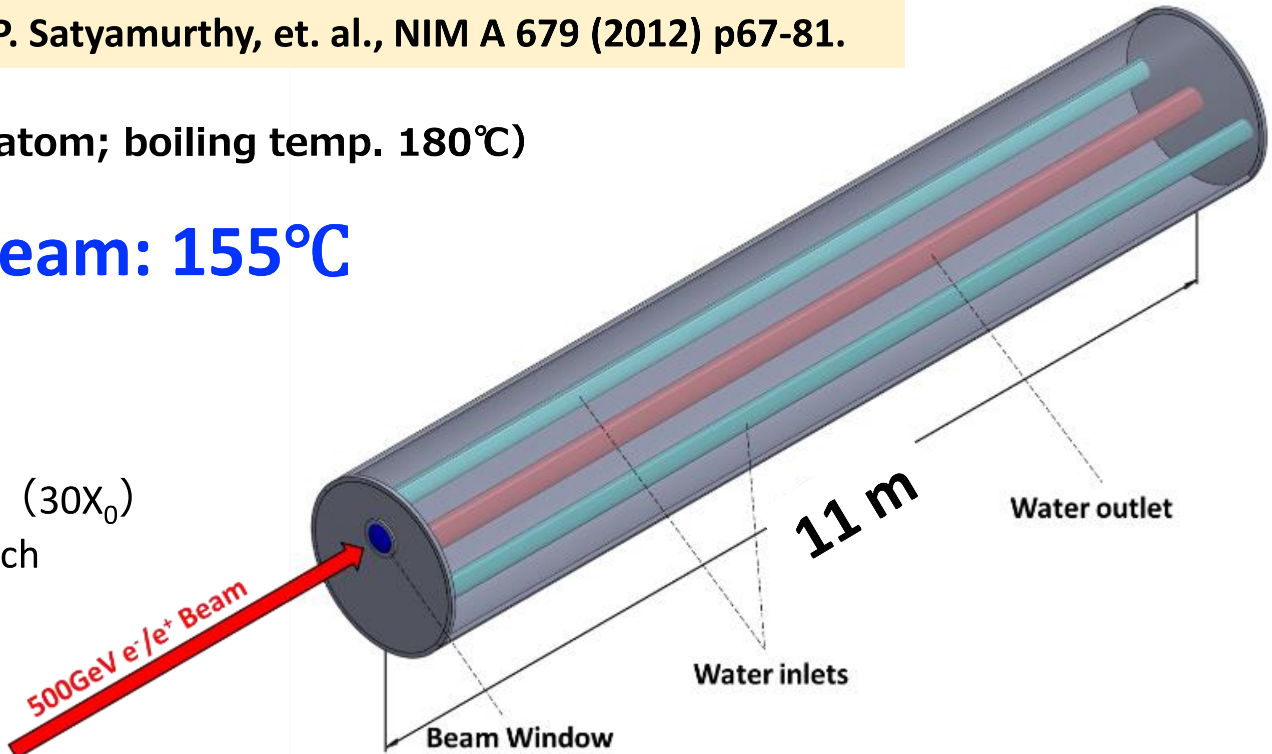
Main beam dump

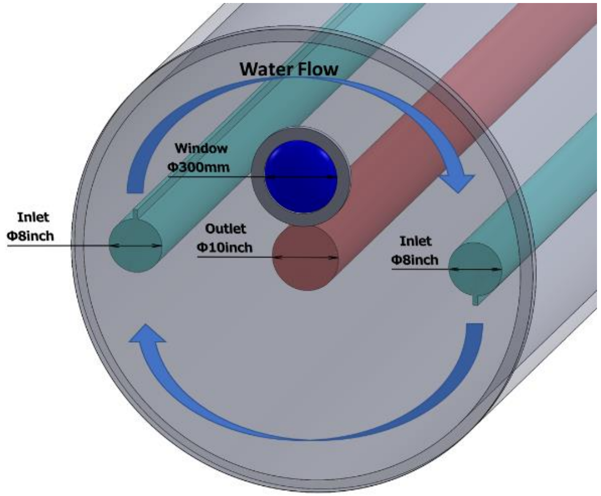
P. Satyamurthy, et. al., NIM A 679 (2012) p67-81.

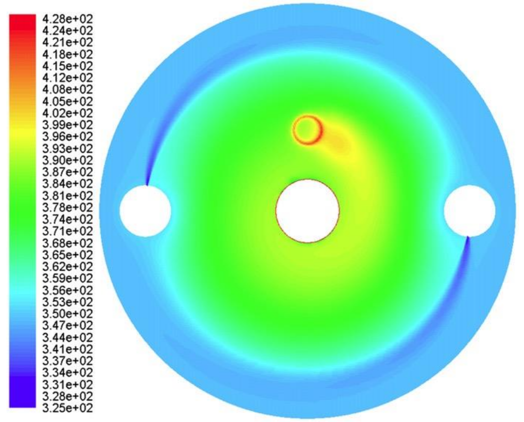
Water dump (10 atom; boiling temp. 180℃)

Peak temp. by beam: 155°C

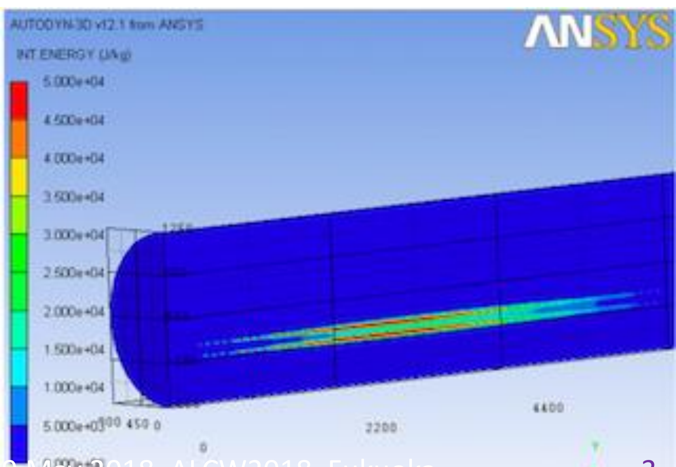
- Water flow: **2.17m/s**
- Inlet temp.: **50°C**
- Diam. 1.8m、length 11m（$30X_0$）
- SUS 316LN, thickness 2 inch
- End plate: SUS t7.5cm





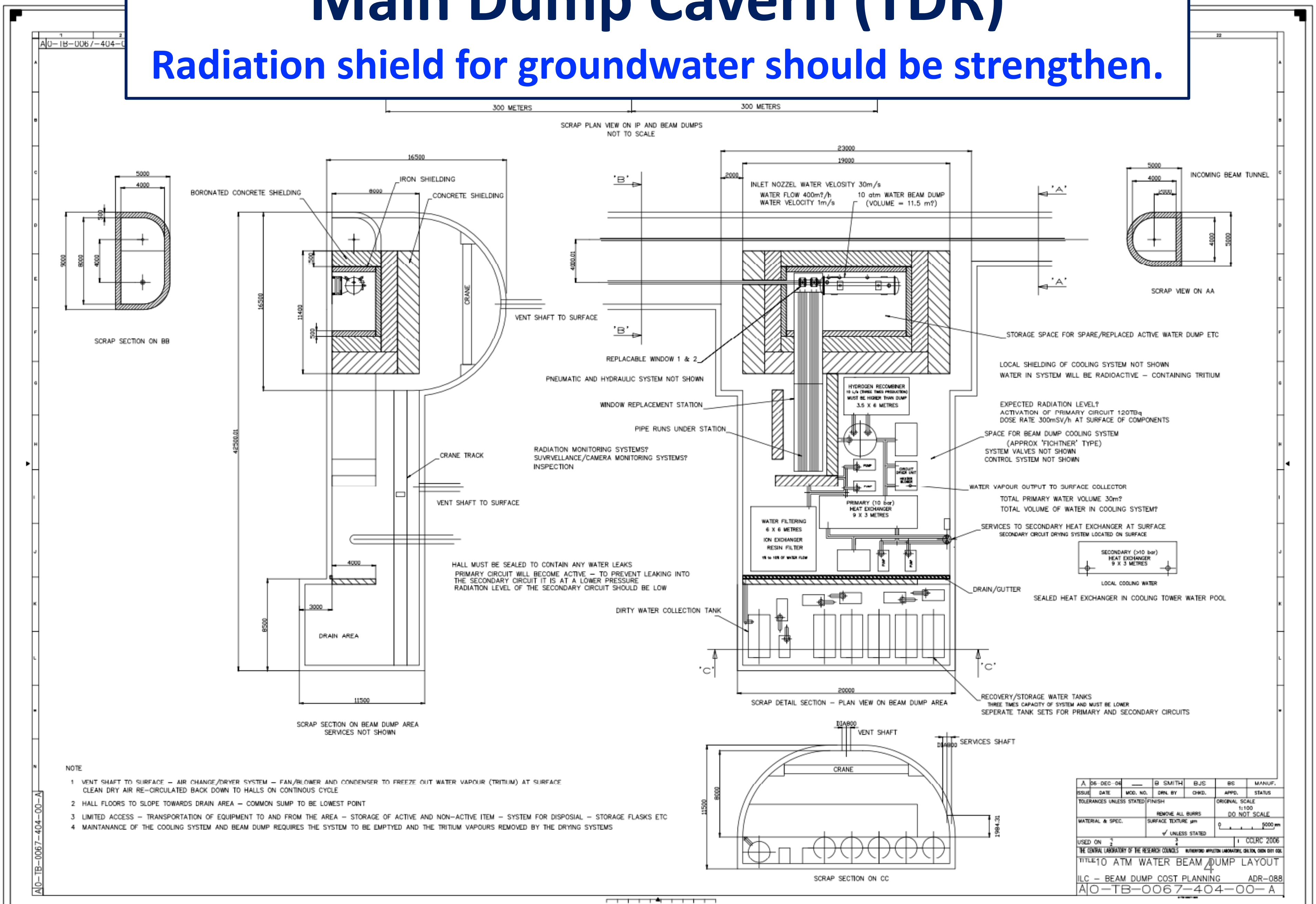


Temp. profile at Z=290cm



Main Dump Cavern (TDR)

Radiation shield for groundwater should be strengthen.

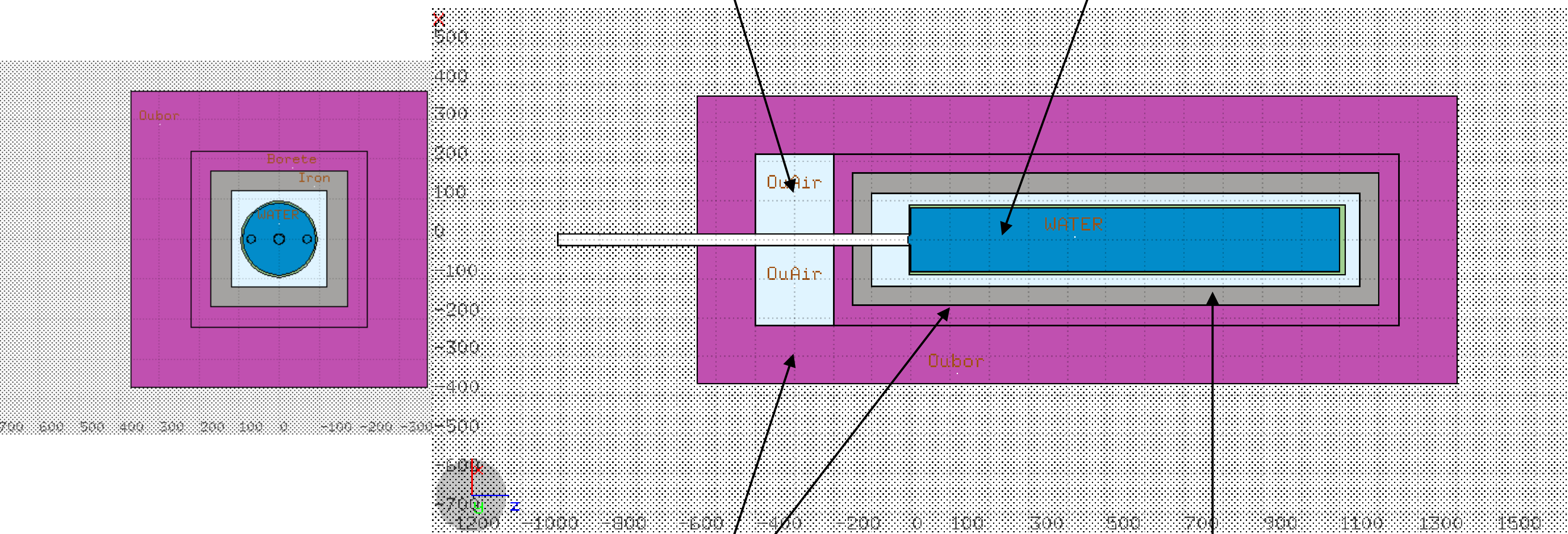


Beam dump materials in FLUKA simulation

Dummy room for window exchange in simulation

Water vessel

SUS: diam. 1.8m, thick. 5cm



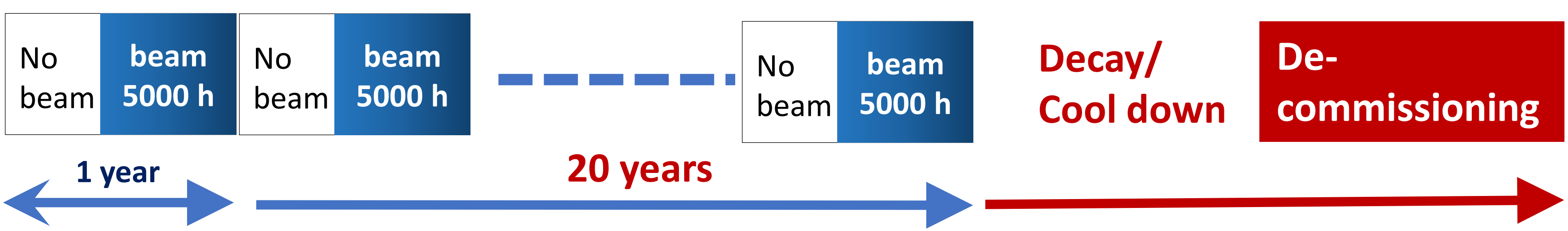
Boron Concrete:

50cm+150cm = 2m

Iron shield: 50cm

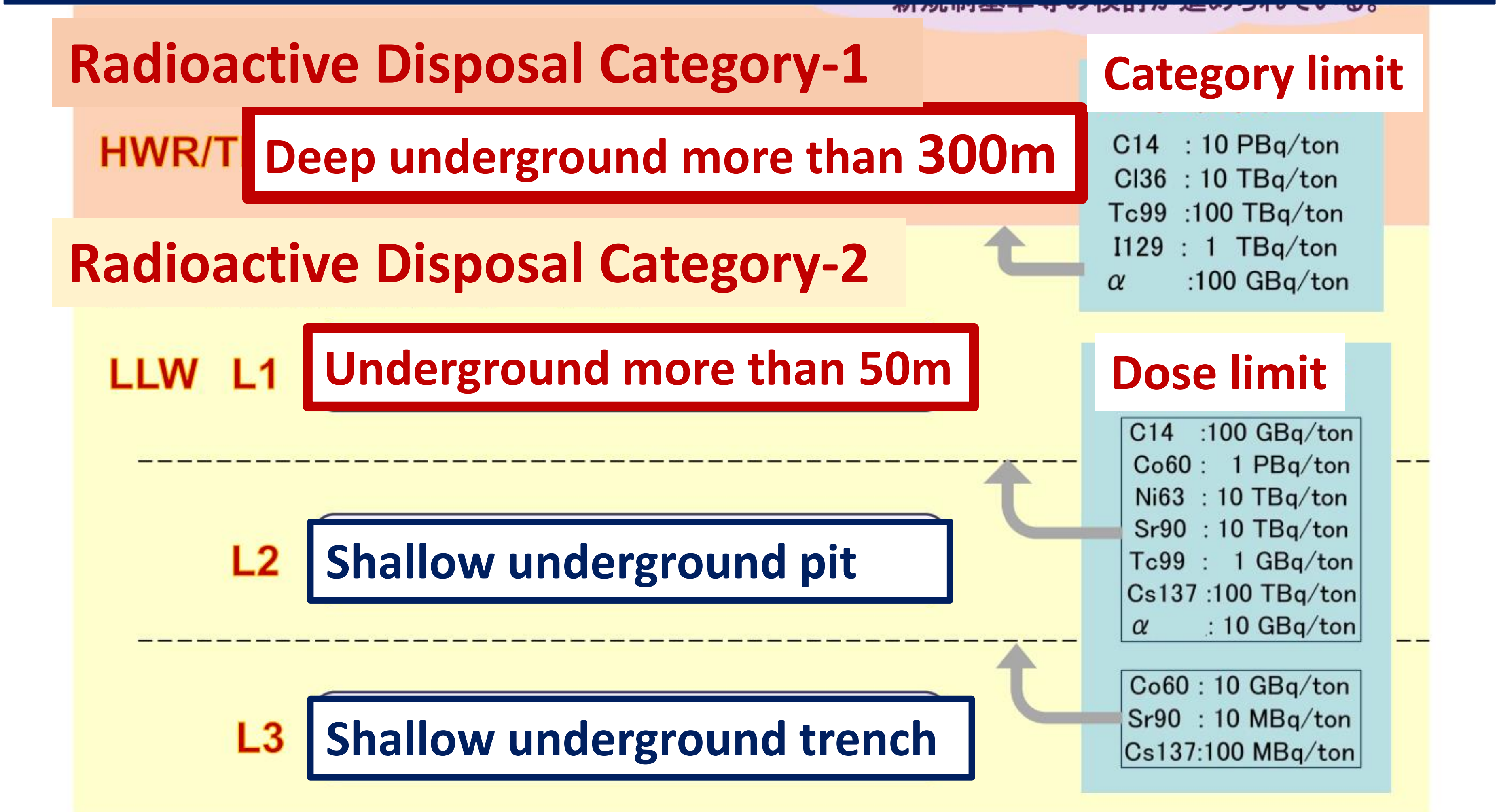
Radioactivity Estimation for Decommissioning

- **Decommissioning is one of the questions by MEXT and the TDR validation committee.**
- **Main beam dump will be the most activated device and concerns the level in the case of underground disposal.**
- **The estimation had been done by FLUKA Monte Carlo simulation.**
  - assume a maximum intense beam
  - accumulation and decay in 20 years operation



Law in Japan: Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors

Regulations Concerning the Activities of Radioactive Waste Disposal and Storage



＊核原料物質、核燃料物質及び原子炉の規制に関する法律

＊2017年度原産会員フォーラム - 廃棄物の処理･処分に係る課題
公益財団法人 原子力バックエンド推進センター (RANDEC)澁 谷　進

Radioactive nucleus generated by main dump

A lot of radioactive nucleus are generated in the material of dump and its shields.

- **^{60}Co is a target to evaluate**
  - because of the effectiveness (energy, lifetime).
  - **Most of ^{60}Co is generated from the contamination of ^{59}Co (stable) in the materials.**
    - **SUS**: 10~**100ppm → use 100ppm for FLUKA**
    - Others: 10~50ppm

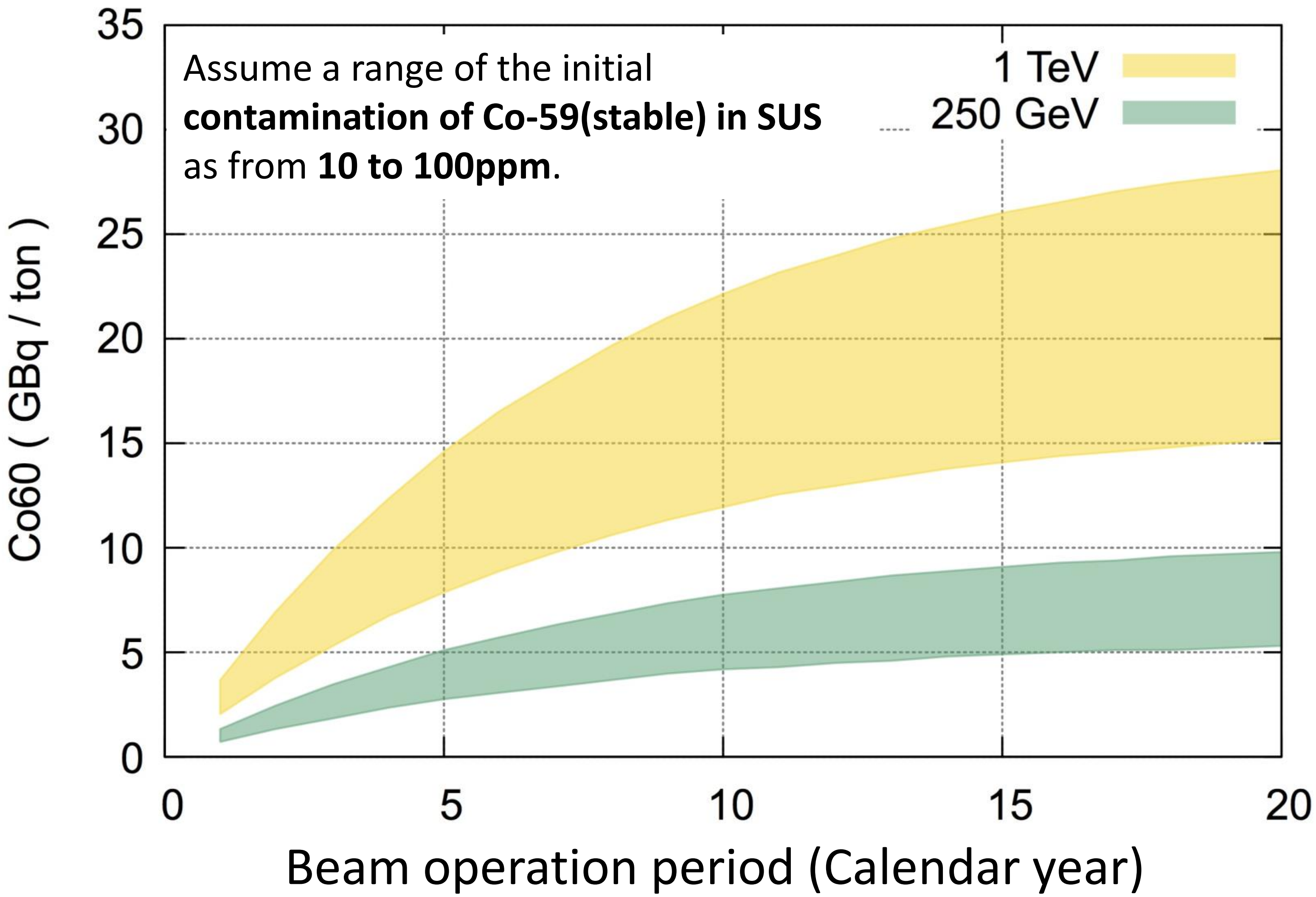
- **Results of simulation**

All activated material of dump will be ranked to the easier disposal such as in a shallow trench.

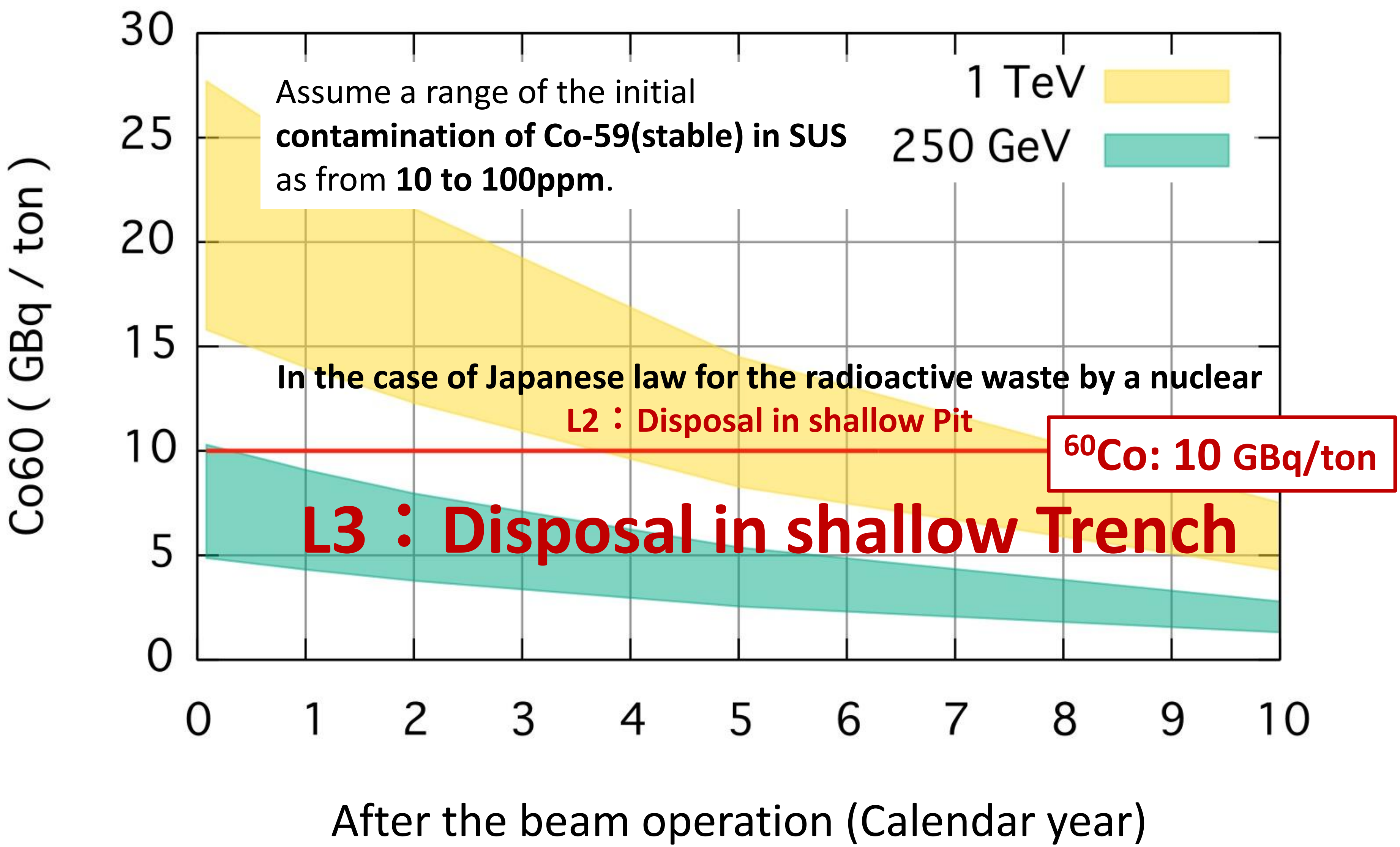
It is not like a show stopper.

Build up of the activated Co-60 in the water vessel

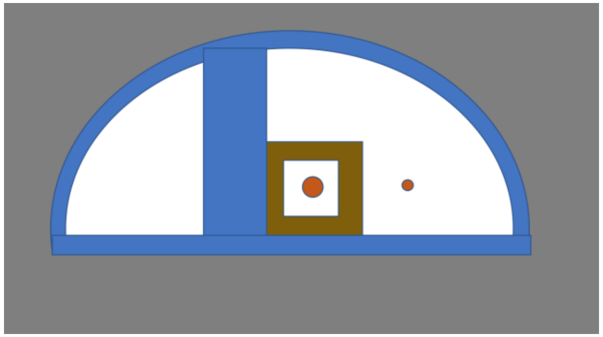
Water vessel is the highest activated material.



Decay of the activated Co-60 in the water vessel



Radiation control for the underground environment



Local Shielding
is required for the higher radiation sources.
It is not only for workers but also for the outside of 30 cm concrete of the tunnel wall as a public environment.

- **Activation of Rock and Groundwater should be lower than the authorized level.**
- **A guideline have been established for J-PARC.**

5 mSv/h (neutron) when Beam ON

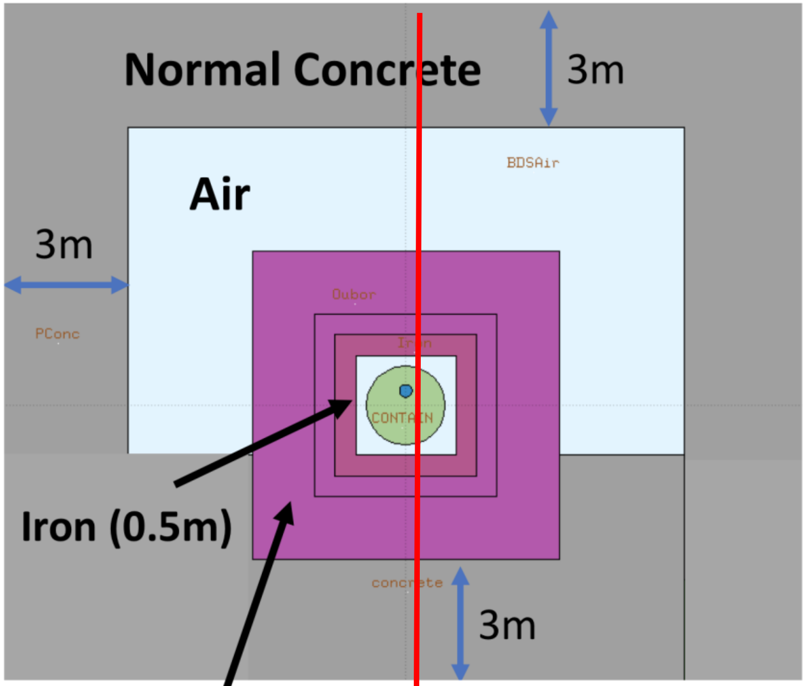
- **Neutron is dominant component especially for the transverse radiation** from a high power absorber even for electron machine.
- **The guideline for ILC have to be established as soon as possible, anyway.**

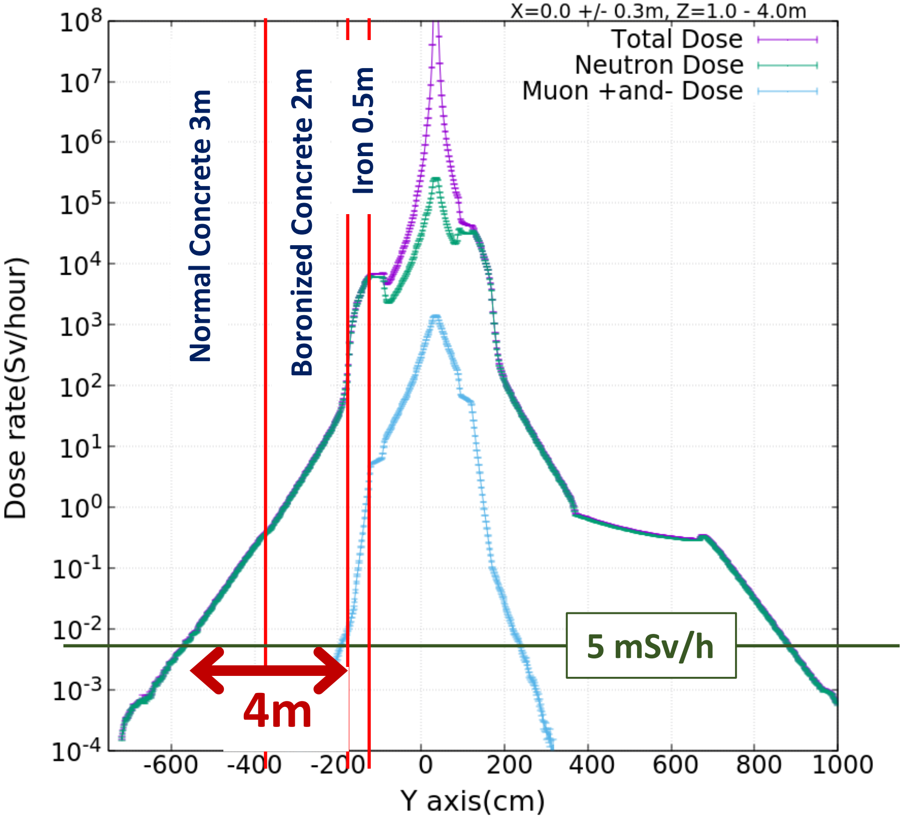
Radiation dose from Main Dump

- **Beam for simulation**
  → **1 TeV, 14 MW**
- **Dump design with 20% margin**
  → 17 MW

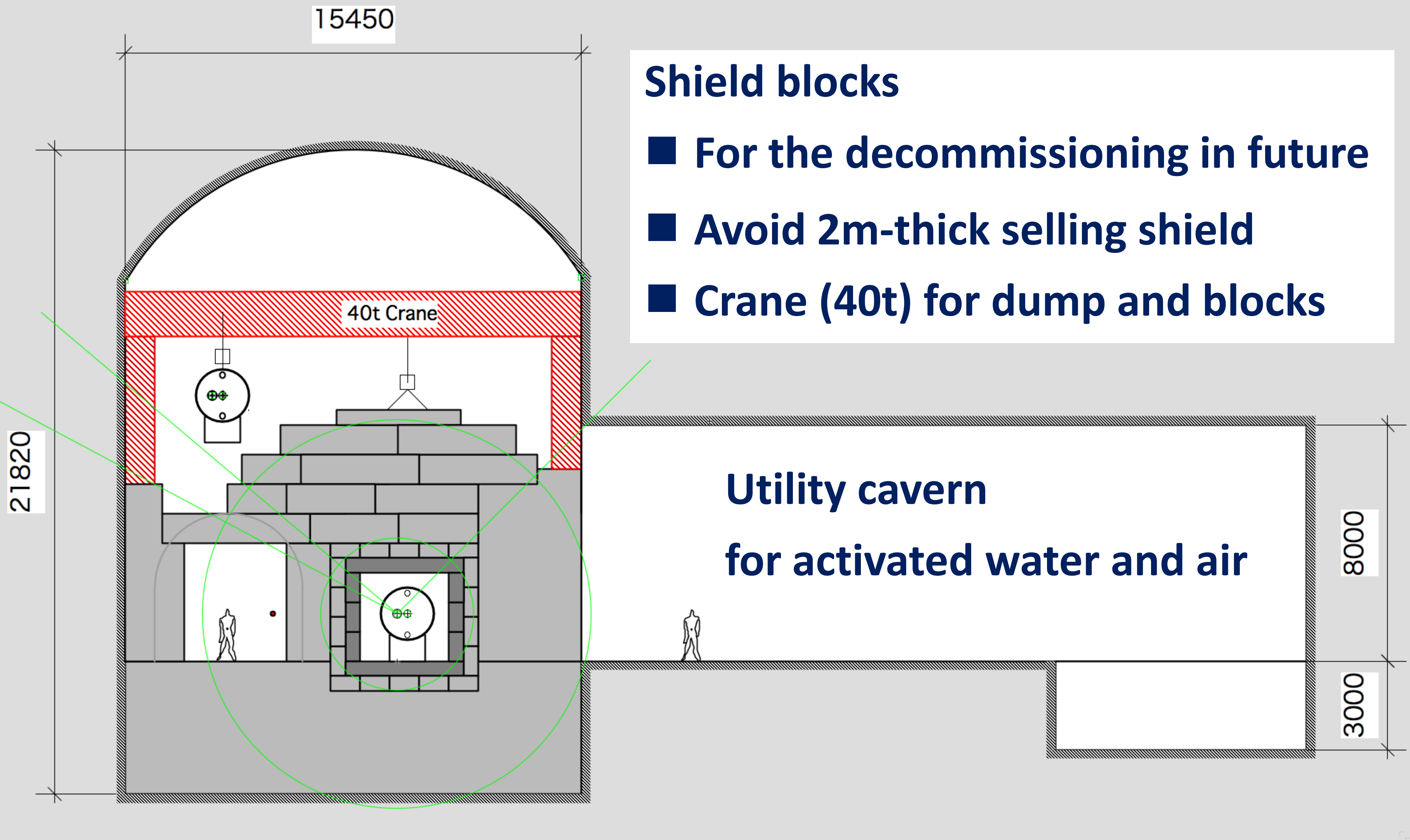
Iron Shield 0.5 m
and
(Boronized) Concrete 4 m

Geometry used for FLUKA Study





Main Dump Cavern



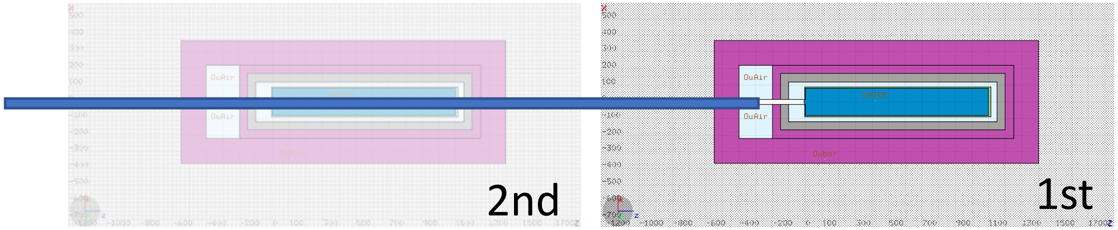
Shield blocks

- For the decommissioning in future
- Avoid 2m-thick selling shield
- Crane (40t) for dump and blocks

2nd Main Dump

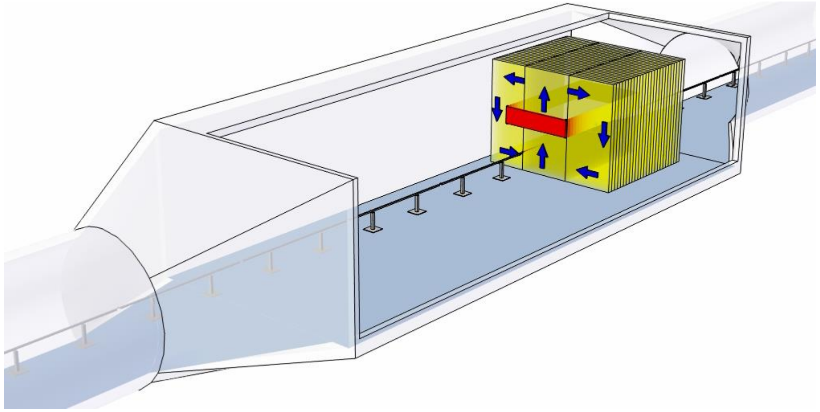
For the serious failure of the highly activated main dump,
2nd dump has been suggested.

- **avoid too-long years shutdown** due to a heavy activation.
- Put **on the same beamline** because of the MW beamstrahlung will come from IP.
- Installation will be done when required.
- **Concrete shields for groundwater have to be constructed with tunnel, especially for bottom and side.**
- Utilities can be switched from 1st dump.



Muon Wall

- Starting by **5m-thick muon wall** then extend **up to 19m** in future.
- Location was 350m from IP, just behind the main dump shield.
- Some discussions on the muon background for **ILC250 seems suggesting no need of the muon wall.**
- No installation first, but need a space for future?



Photon Dump from Undulator

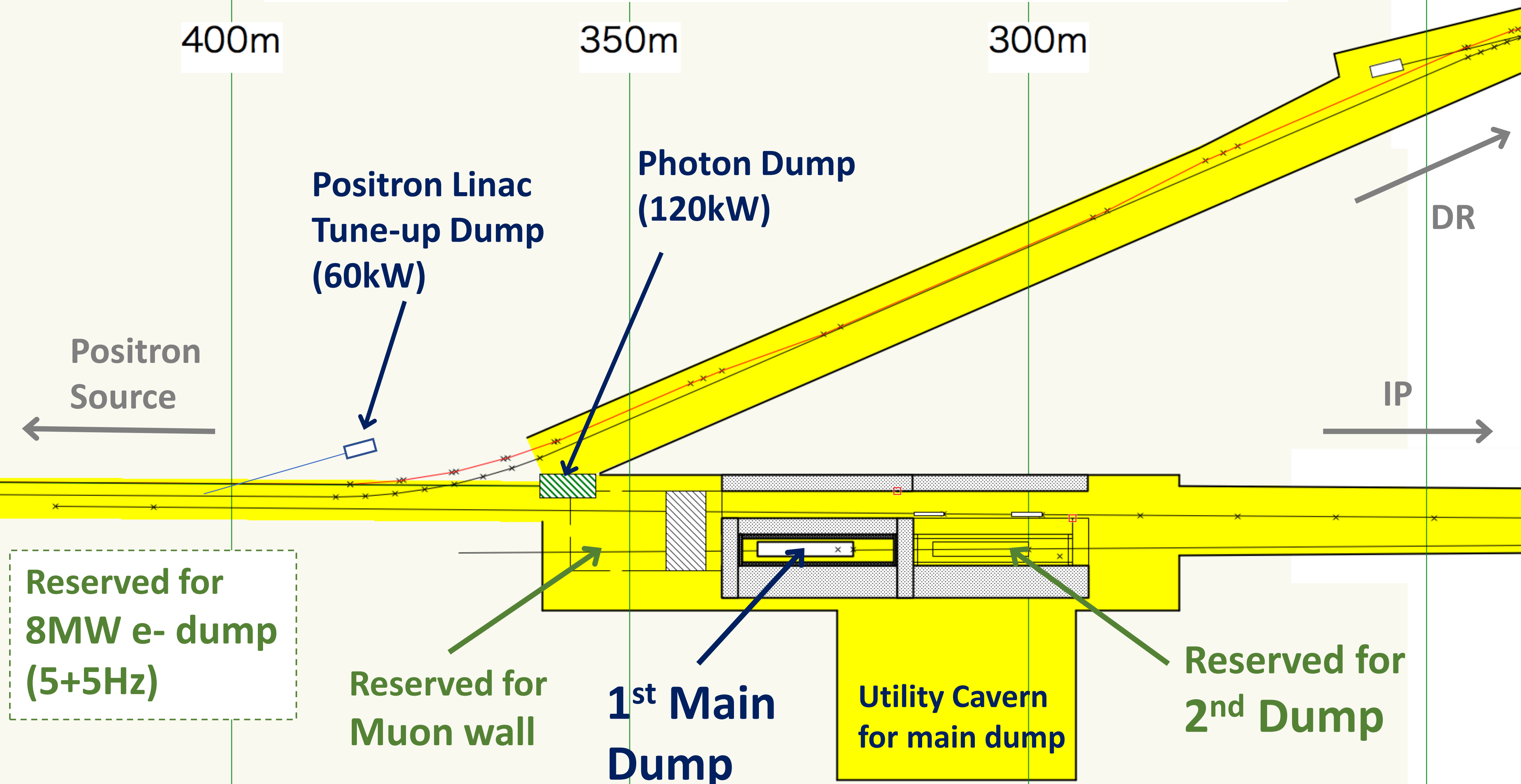
- TDR photon dump will not work then alternative ideas have been proposed.
- **One of them is a Graphite dump with 2km photon line.**
- **It will be near the main dump room and in the same accelerator tunnel (on the line 1.6m from BDS).**
- It needs a space to exchange an activated graphite dump.
  - The dump with shield will be 2m(W) X 1m(H) X 7m(L).
  - Working space should be proposed by positron group.
  - Beamline layout should be re-optimized.

e- dump for 5+5Hz option

- Beam power for this dump will be **8 MW** at maximum, then it will be **a copy of 17 MW Main Dump**.
- Same scenario of the measure for failure will bring the **2nd dump**.
- Cooling water system can be shared with the main dump.
- It will be located somewhere in BDS region.
- **Then it will be better to joint a cavern following main dump and muon wall.**
- No installation at first, but need radiation-shield walls both for bottom and side.

Summary: Main Beam Dump and Around

Time for the CFS engineering design is limited.
Fix beamlines, location and size of systems!



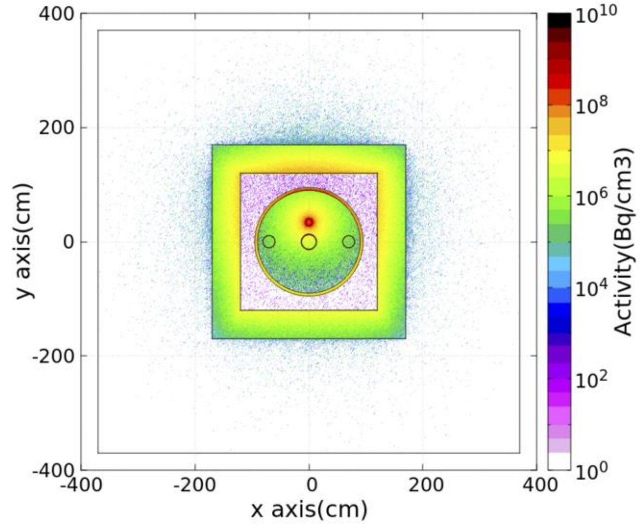
Where the 2nd-loop water come from?

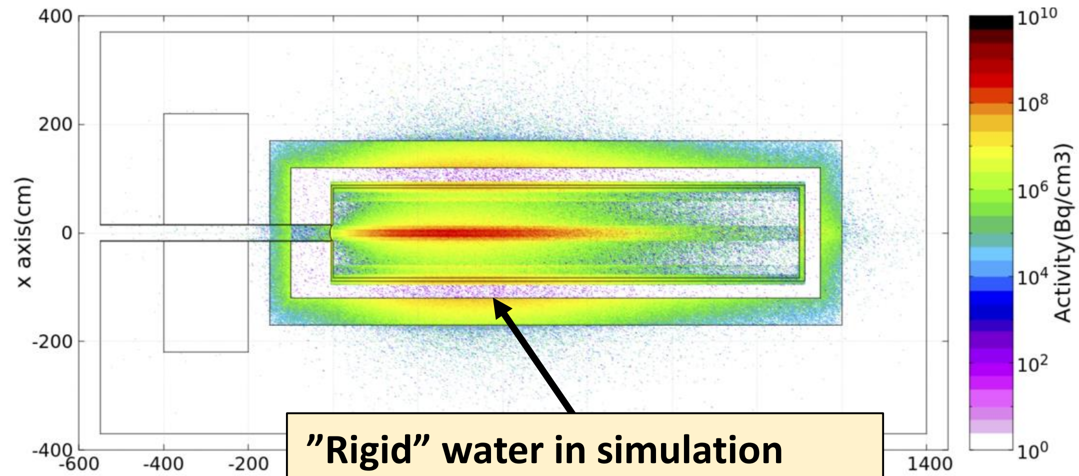
Backup slides

Beam Power at Main Dump

	TDR			ILC250	
		Lum. upgrade	Energy upgrade		Lum. upgrade
Beam Energy (GeV)	**250**	**250**	**500**	**125**	**125**
Rep. rate (Hz)	5	5	4	5	5
bunch per pulse	1312	2625	2450	1312	2625
bunch spacing (nsec)	554	366	366	554	366
pulse length (msec)	0.727	0.961	0.897	0.727	0.961
particles per bunch	$2x10^{10}$ (3.2nC)	$2x10^{10}$ (3.2nC)	$1.74x10^{10}$ (2.79nC)	$2x10^{10}$ (3.2nC)	$2x10^{10}$ (3.2nC)
bunch charge (μC)	4.20	8.41	6.83	4.20	8.41
bunch current (mA)	5.78	8.75	7.61	5.78	8.75
pulse energy (MJ)	1.05	2.10	3.41	0.53	1.05
Power (MW)	**5.25**	**10.5**	**13.7**	**2.6**	**5.3**
with 20% margin			**17.0**	**3.1**	**6.3**

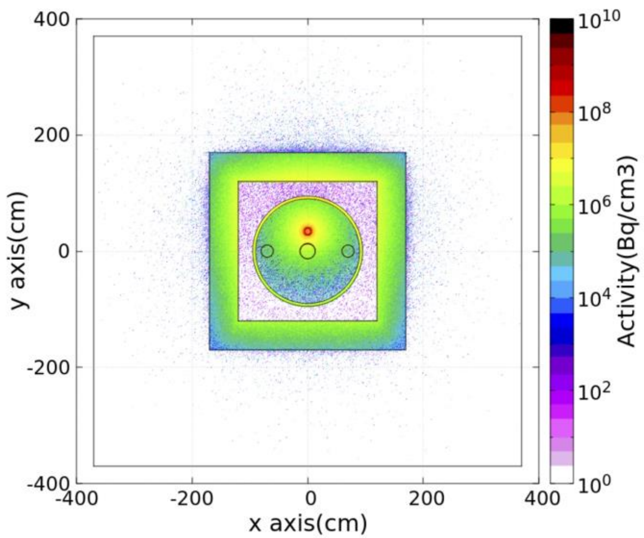
Activation after 20-years operation (1TeV)

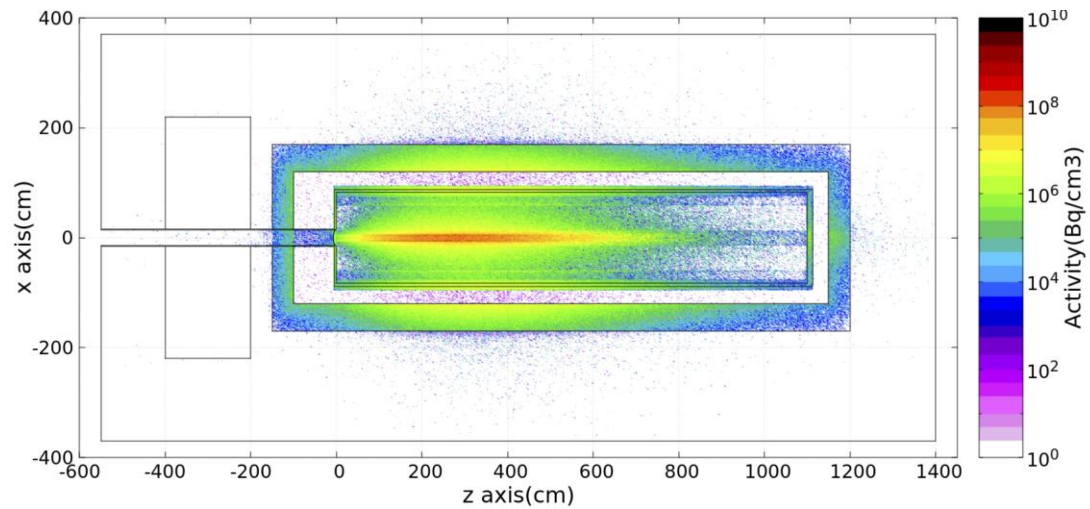




"Rigid" water in simulation
i.e.; generated H3 and Be7.

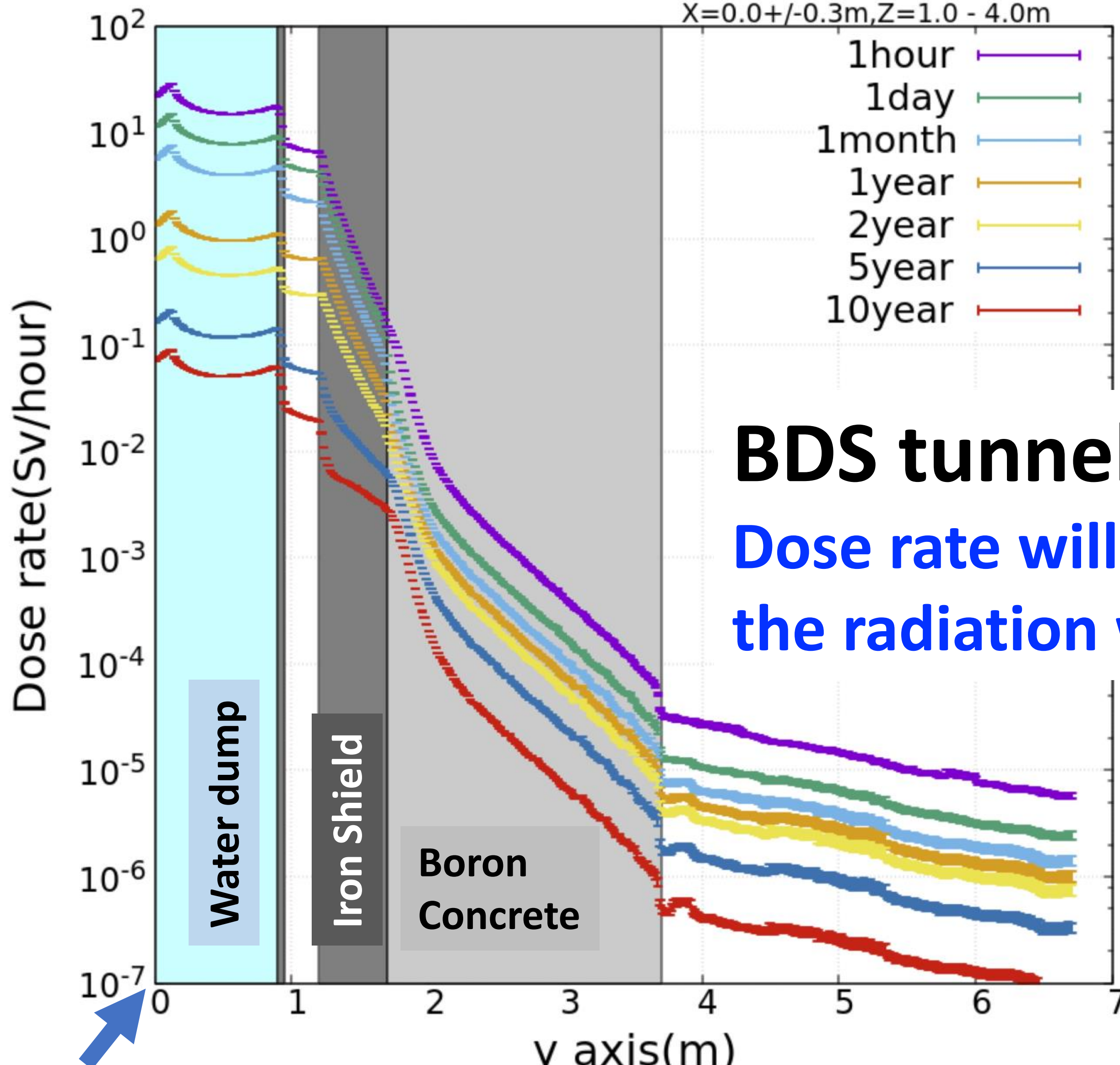
1 month





5 years

Dose rate by residual activation: 1 TeV, 20 years



BDS tunnel

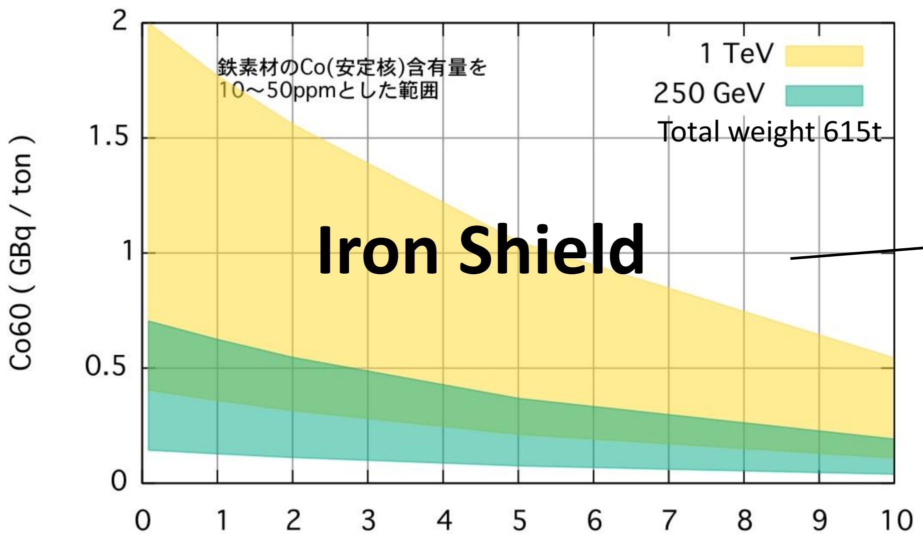
Dose rate will be OK for the radiation workers.

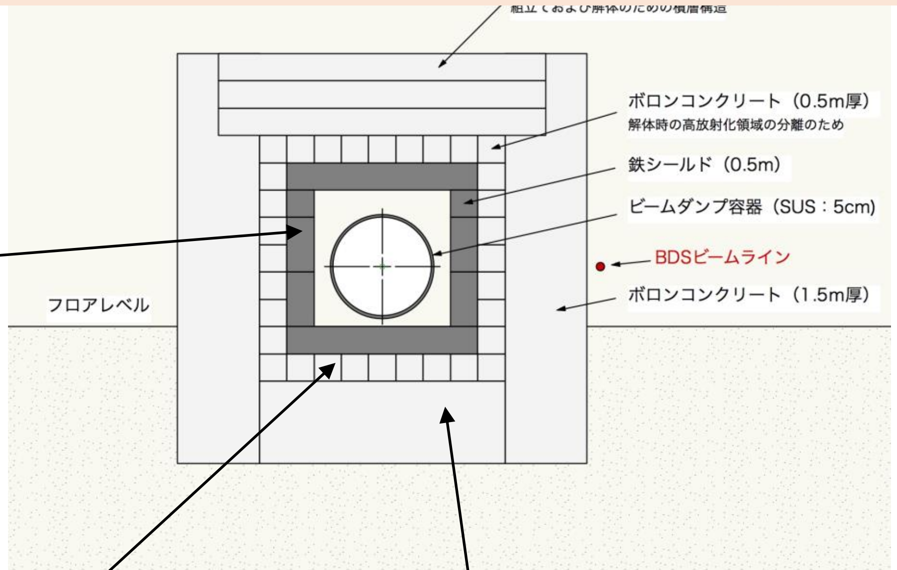
Center of the beam dump

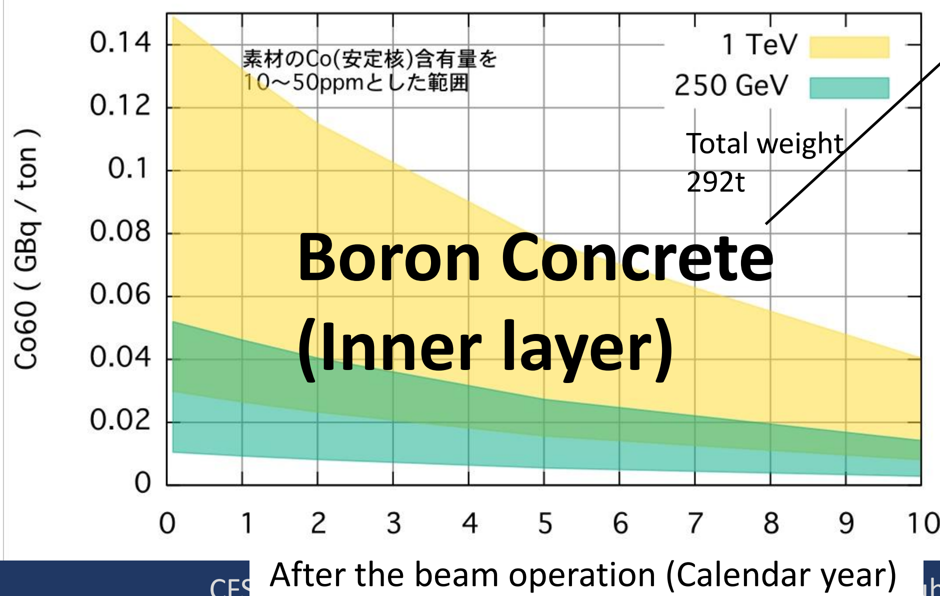
Shield blocks will be categorized in a group of a disposal in trench (L3)

It can be reused and minimized the amount of disposal.

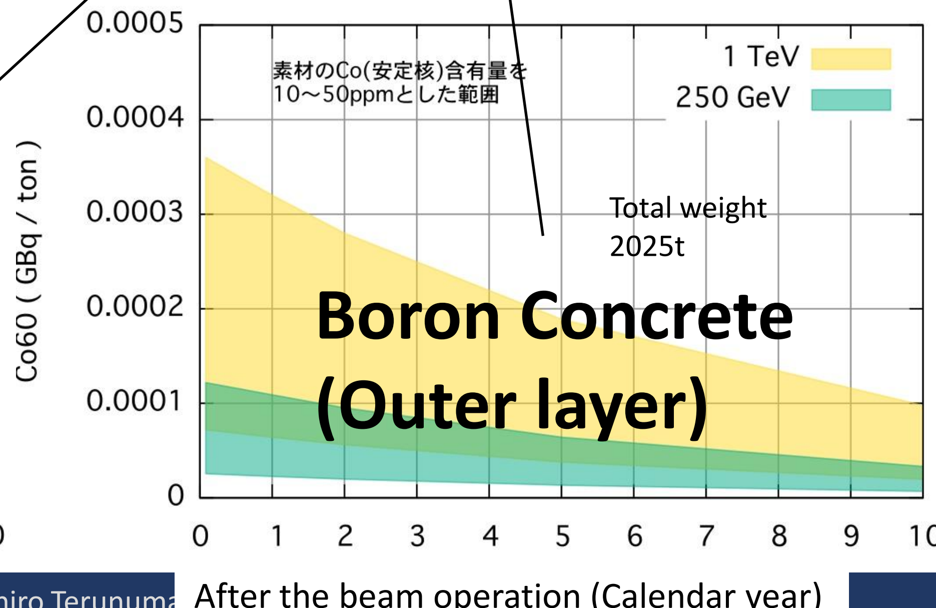
鉄遮蔽体(50cm)のCo





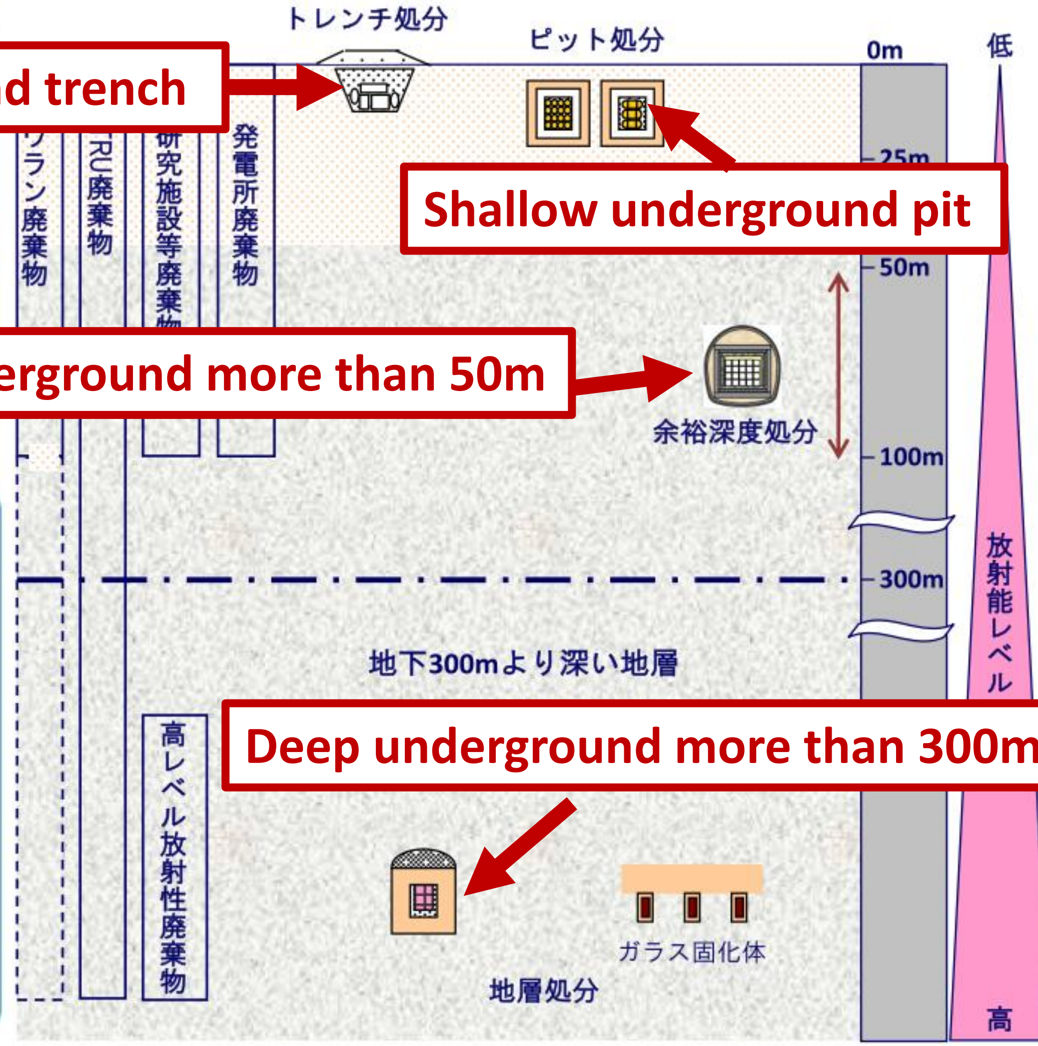


ボロンコンクリート外側遮蔽体のCo60総量の推移



放射性廃棄物処分の深度の相違

放射性廃棄物の処分方法は、深さや放
射性物質の濃[illegible]
アの違いによ[illegible]



第一種廃棄物埋設

- **地層処分**
  地下300mより深い地層中に処分（最終[illegible]

第二種廃棄物埋設

- **余裕深度処分**
  一般的な地下利用に対して十分余裕を持った深度（地下50m以上の深度）への処分
- **浅地中ピット処分**
  コンクリートピットを設けた浅地中（地下50m未満）への処分
- **浅地中トレンチ処分**
  人工構築物を設けない浅地中（地下50m未満）埋設処分

【出典】新計画策定会議(第18回)資料

＊余裕深度処分に対する安全規制の概要 第6回埋設処分技術ワーキンググループ:平成23年1月19日
放射性廃棄物規制課 原子力安全・保安院