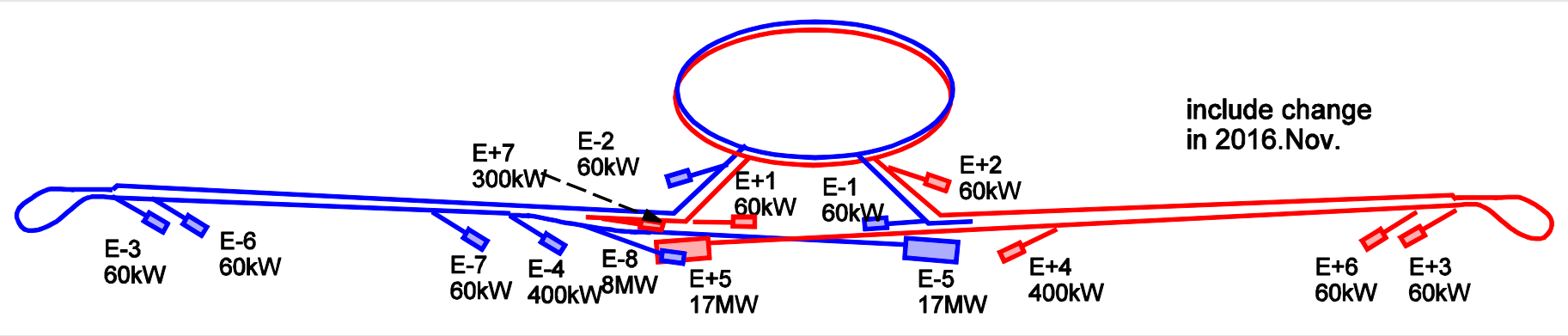
IDT-WG2 Dump

2020/10/13 Nobuhiro Terunuma, KEK

Charges of sub-group

- C1: Technical preparation (remaining topics) at Pre-lab
- C2: Preparation for mass production at Pre-lab
  - It is out of the scope for beam dump … max 9 units for 60kW tune-up dump
- C3: Possible schedule at Pre-lab
- C4: International sharing candidates of these activities



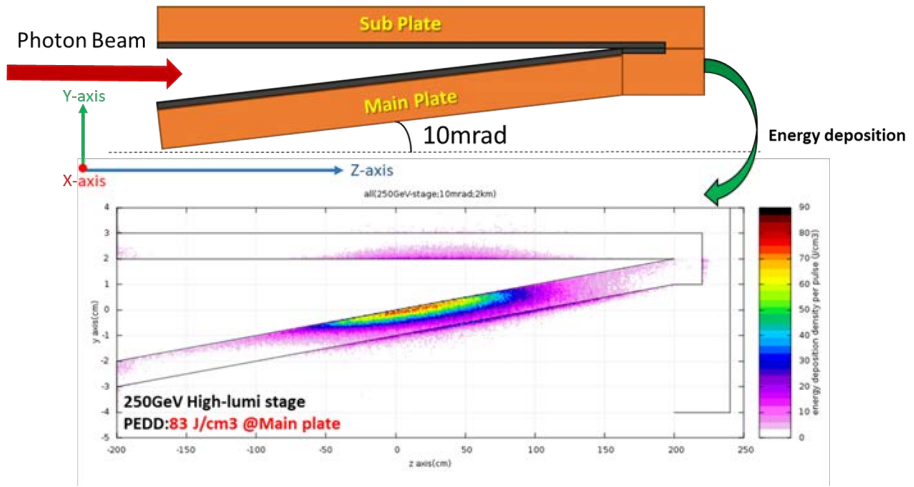
Dump	Max. Power	Num	Examples (design)	
Tune-up	60 kW	9	LCLS-II (120kW)	If rastering → 250kW
Tune-up ML	400 kW	2	XFEL (300kW)	
Undulator photon	**300 kW**	**1**	**-none-**	**Conceptual designs (graphite at 2km, water)**
Main dump	**17 MW (1TeV)**	**2**	**SLAC (2.2MW), JLAB (1MW)**	**Water dump; 0.75, 0.9MW operated**
Undulator 5+5Hz	8 MW	1	*Same as main dump*	*Same as main dump*

■ 17 MW main dump and 8 MW(5+5 Hz) dump

- Basic design as **water dump** has been established. (TDR) 14MW+20%margin
- need technical design for **window and its remote exchange, activated water circulation system, radiation safety and CFS.**

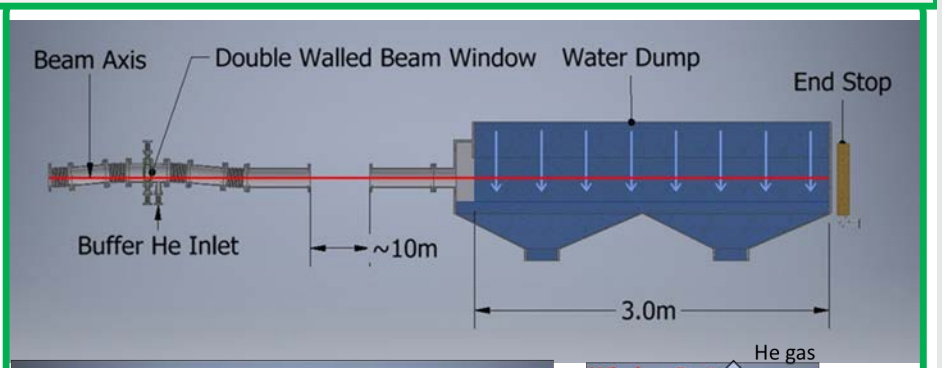
Photon Beam Dump (Graphite or Water, type C)

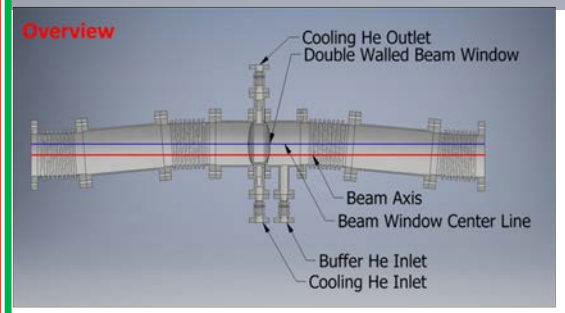
Tilted Graphite dump(no need beam window)*

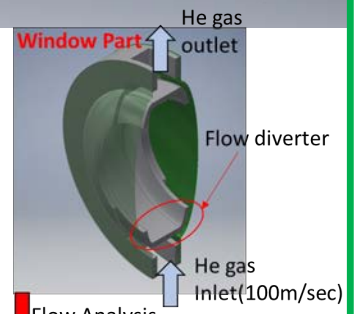


- **Increasing the effective beam size by making beam incident on tilted graphite.**
- **Max temp for 250GeV-High lumi stage**
  - **614℃(887K) @ Main plate**
  - **143℃(416K) @ Sub plate**

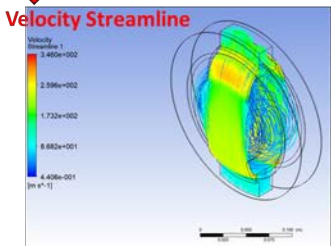
Water Curtain dump & tumbling beam window*







Flow Analysis



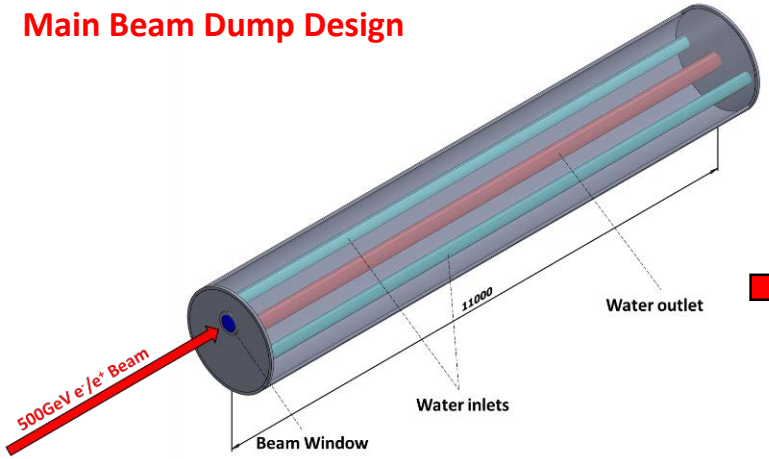
- Elliptical shape ϕ15cm(long axis), ϕ4cm(Short axis)
- Tumbling Window by bellows system.
  Tumbling radius=3cm, 1.9sec/turn(0.53Hz)
- Helium gas cooling
  Gas velocity of introductory part:100m/sec,
  Heat transfer coefficient : ~0.1W/cm2K

- We have 2 design candidates. Water Curtain and Graphite design.
- Basic thermal analysis was already done. Next issue will be how we can make the robust system with industrial technology.

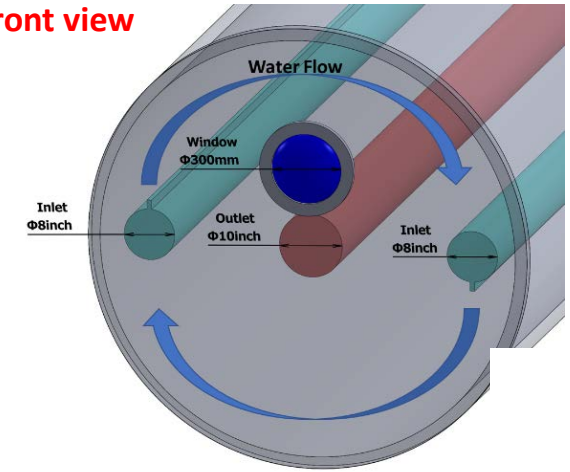
* Photon Dump Design and R&D plan :Y. Morikawa,POSIPOL2018,

Main Beam Dump (Water , type D&E)

Main Beam Dump Design



Front view



【Beam Power @ 1TeV Beam operation】

・500GeV × 2.79nC × 2450Bunches × 4pulses/sec : **13.7MW** + **20% safety margin** ≒ **17MW**

【Base Design*】

・**Water power absorber** and **forced convection** to extract the heat.

* Water is compressed **1 MPa** ⇒ **boiling temp 180℃**

* Vortex water flow ⇒ Mass flow rate : **104.5kg/s** each inlet, flow velocity **2.17m/s**

・**1mm thick** Beam Window made of **Ti-6Al-4V**.

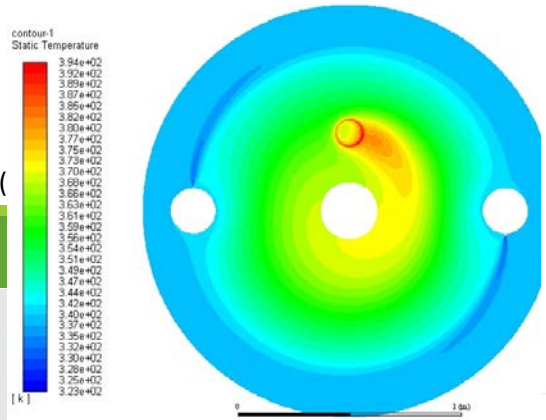
* Base design of ILC Main Beam Dump : P. Satyamurthy, et.al., NIM A 679 (

Yu Morikawa, LCWS2019

Main Beam Dump (Water , type D&E)

Many simulations have been performed on this beam dump performance.*

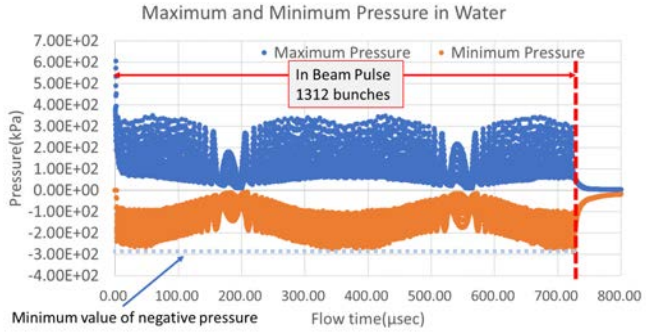
Temperature simulation
@1TeV Status (500GeV, 2450bunch/pulse, 4pulse/sec)



【Max Temperature】

250GeV-nominal : 68℃ , 1TeV : 121℃

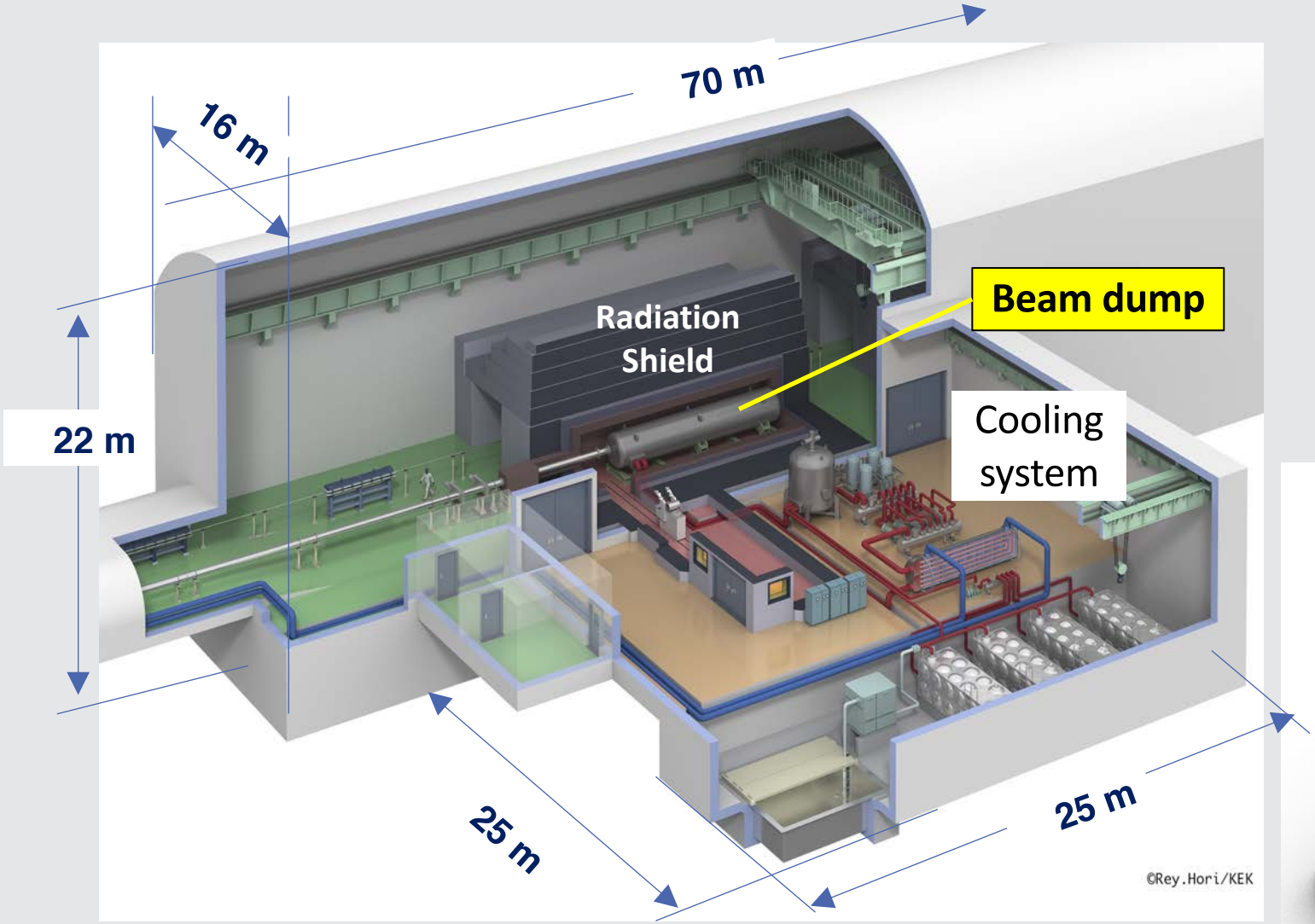
Pressure wave simulation
@250GeV-nominal(125GeV, 1312bunch/pulse, 5pulse/sec)



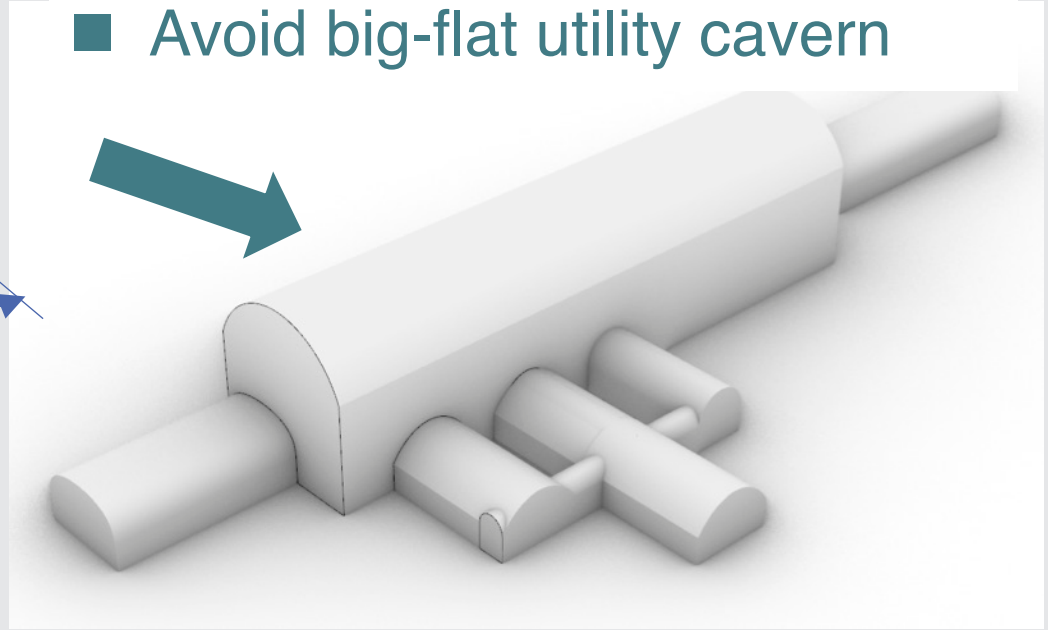
Highest Pressure : 6.2 bar , Lowest Pressure : -2.8bar

* Design check of ILC Main Beam Dump :Y. Morikawa, LCWS2018

Main beam dump



- **Big cavern to install the 5m-thick shields.**
- Water dump capable for 17MW beam power (1TeV).
- **Optimization of cavern is ongoing with Civil Team in Japan.**
- Avoid big-flat utility cavern



C1: Technical preparation (remaining topics) at Pre-lab

- Specific designs what we need to proceed
  - **300 kW photon dump**
  - **17 MW main dump**
    - Water flow system (include vortex flow in dump vessel)
    - Window sealing and remote exchange (30cm in diam., 10 atm activated water)
    - Countermeasure for failure; e.g., window, water system,…
  - **Civil and utility design under the condition of candidate site**
- Robustness test of window for 17 MW main dump
  - Prototyping of window and its attachment
  - Beam test of window material if possible

C3: Possible schedule at Pre-lab

- **A convincing main dump design with maintenance and failure scenarios should be prepared in early Pre-lab phase.**
- SCJ and MEXT panel show concerns about the safety on the main beam dump. Radioactive product is a concern by people especially in candidate site.
- The main dump window needs to be studied well, but the concern about it is not like a showstopper, but an engineering issue.
- **Prototyping of the window system** is expected in Pre-lab phase, for a better maintenance design.

C4: International sharing candidates of Pre-lab activities

- **Possible collaboration on the engineering design of dump system**
  - SLAC, JLAB … experience of the 1MW water dump
  - CERN, DESY … High power dumps
  - Spain … ESS Target (5MW), IFMIF dump (1MW)

- **Study of the window material**
  - Industry/supplier
  - possibly with RaDIATE collaboration for the high-power targets

Activity on ILC main dump

- Until the TDR, overseas researchers contributed and summarized the base design.
- After the TDR, especially in recent years, KEK has resumed the dump study to fulfill the responsibility for radiation safety by host country.
  - Member: staff of ILC accelerator and Radiation Safety
  - Studying the radiation safety over the ILC
  - Visited the dump sections at CERN, SLAC and JLAB
  - Now we start the design work with companies for the sub-system
    - Water flow system
    - Window system (sealing and remote exchange)
    - Civil and utility design under the condition of candidate site
- Willing to re-organize the international team