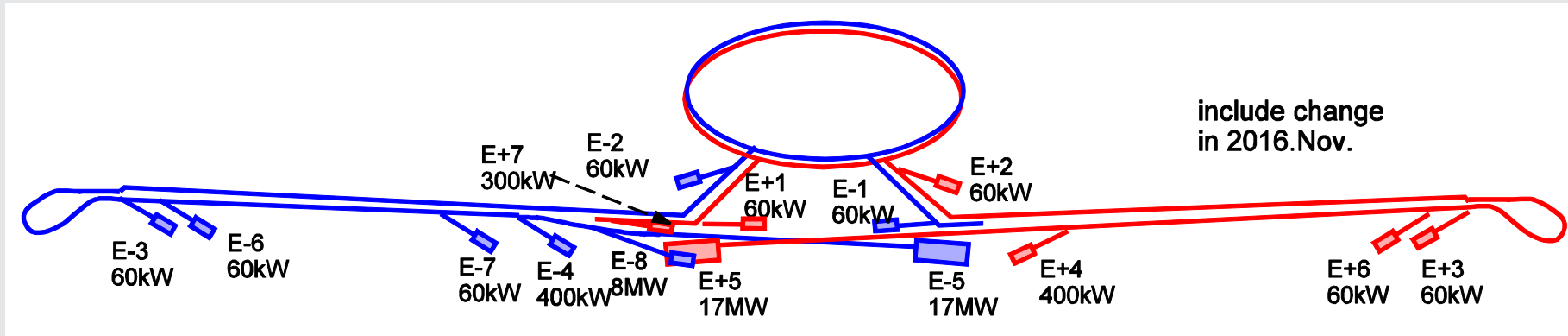


# IDT-WG2 Dump

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



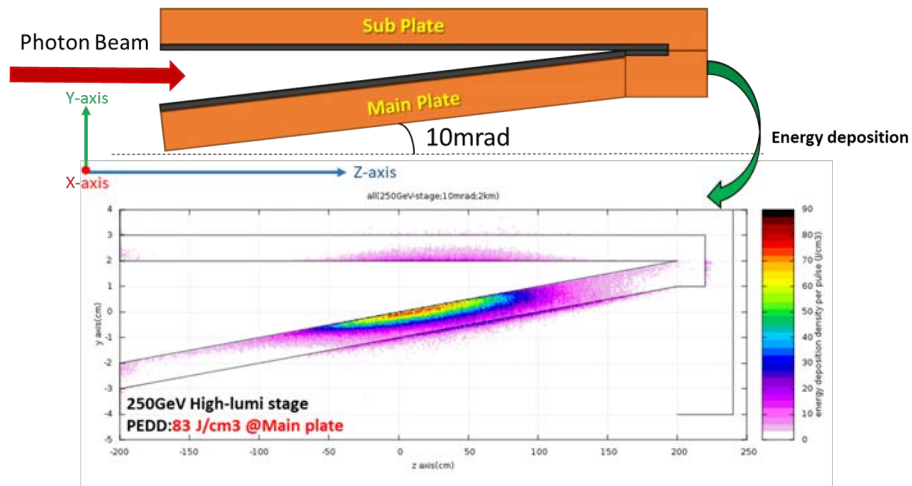
Dump	Max. Power	Num	Examples (design)	
Tune-up	60 kW	9	LCLS-II (120kW)	If rastering → 250kW
Tune-up ML	400 kW	2	XFEL (300kW)	
Undulator photon	300 kW	1	-none-	Conceptual designs (graphite at 2km, water)
<b>Main dump</b>	<b>17 MW (1TeV)</b>	<b>2</b>	<b>SLAC (2.2MW), JLAB (1MW)</b>	<b>Water dump; 0.75,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

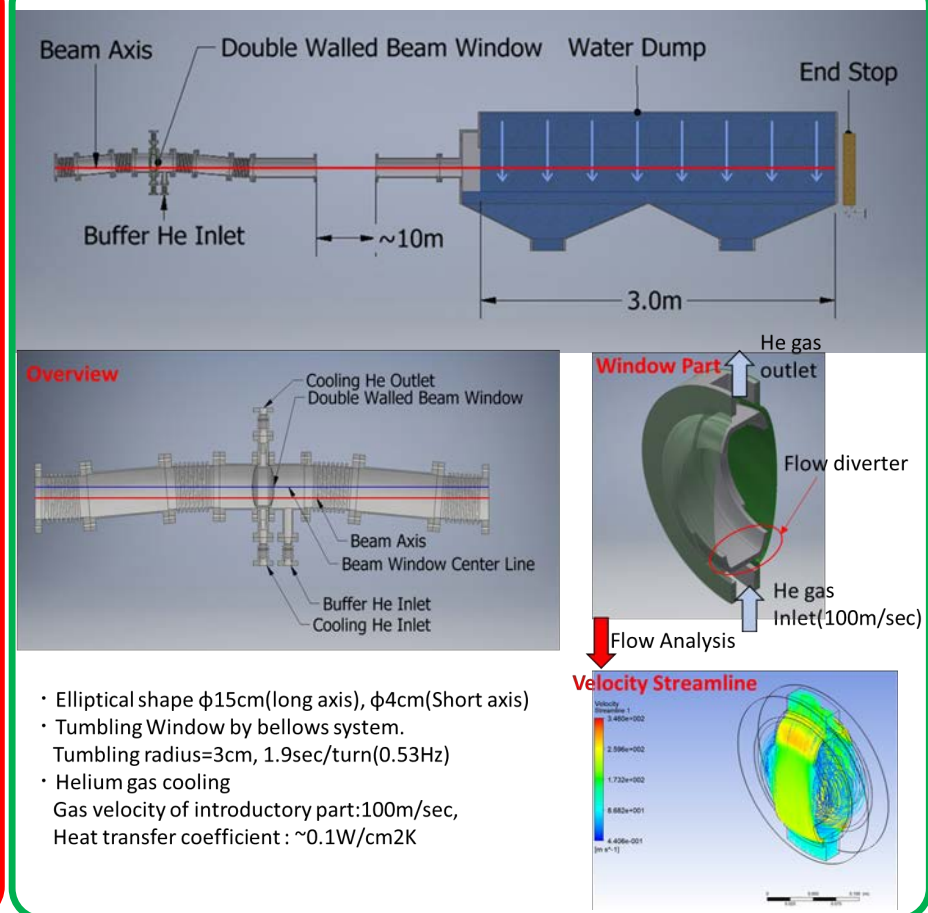
# Photon Beam Dump (Graphite or Water, type C)

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°C(887K) @ Main plate**  
**143°C(416K) @ Sub plate**

Water Curtain dump & tumbling beam window\*

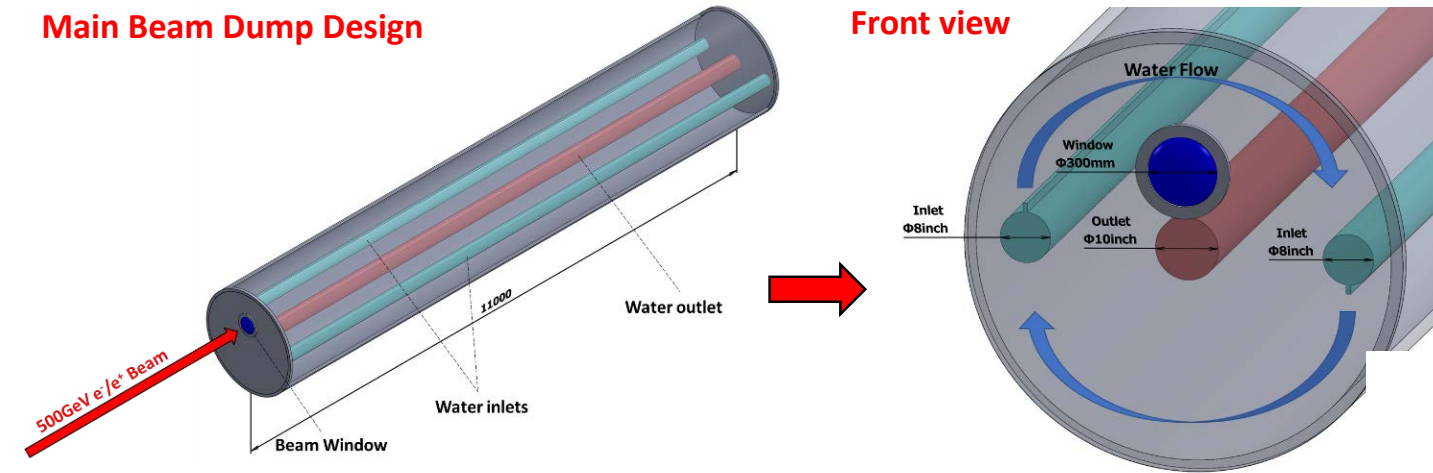


- Elliptical shape  $\phi 15\text{cm}$ (long axis),  $\phi 4\text{cm}$ (Short axis)
- Tumbling Window by bellows system.  
Tumbling radius=3cm, 1.9sec/turn(0.53Hz)
- Helium gas cooling  
Gas velocity of introductory part:100m/sec,  
Heat transfer coefficient :  $\sim 0.1\text{W}/\text{cm}^2\text{K}$

- 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



### 【Beam Power @ 1TeV Beam operation】

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

### 【Base Design\*】

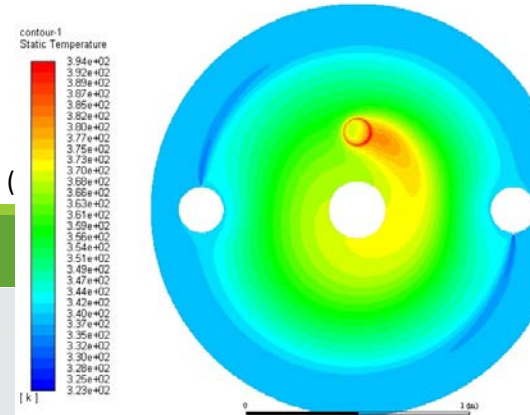
- **Water power absorber** and **forced convection** to extract the heat.
  - \* Water is compressed **1 MPa** ⇒ **boiling temp 180°C**
  - \* Vortex water flow ⇒ Mass flow rate : **104.5kg/s** each inlet, flow velocity **2.17m/s**
- **1mm thick** Beam Window made of **Ti-6Al-4V**.
  - \* Base design of ILC Main Beam Dump : P. Satyamurthy, et.al., NIM A 679 (

# 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)



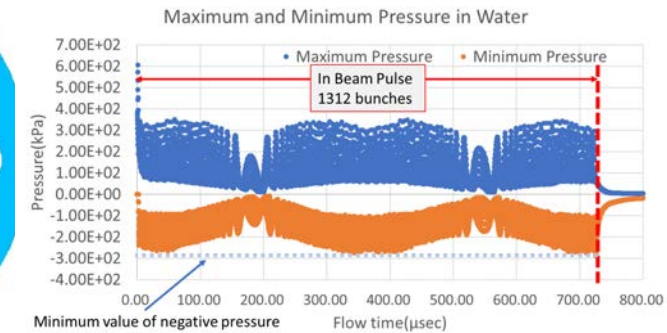
【Max Temperature】

250GeV-nominal : 68°C , 1TeV : 121°C

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

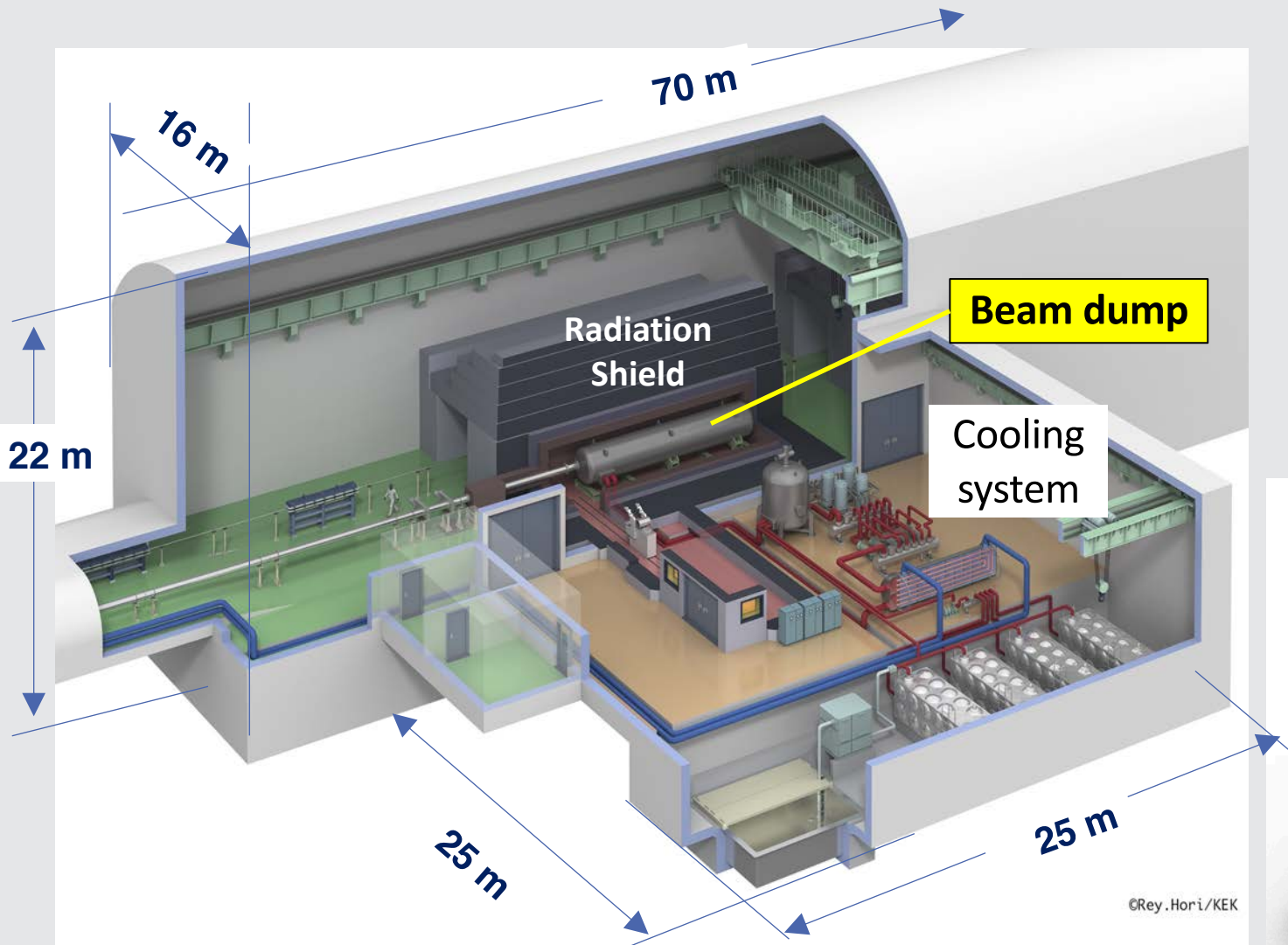
### Pressure wave simulation

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

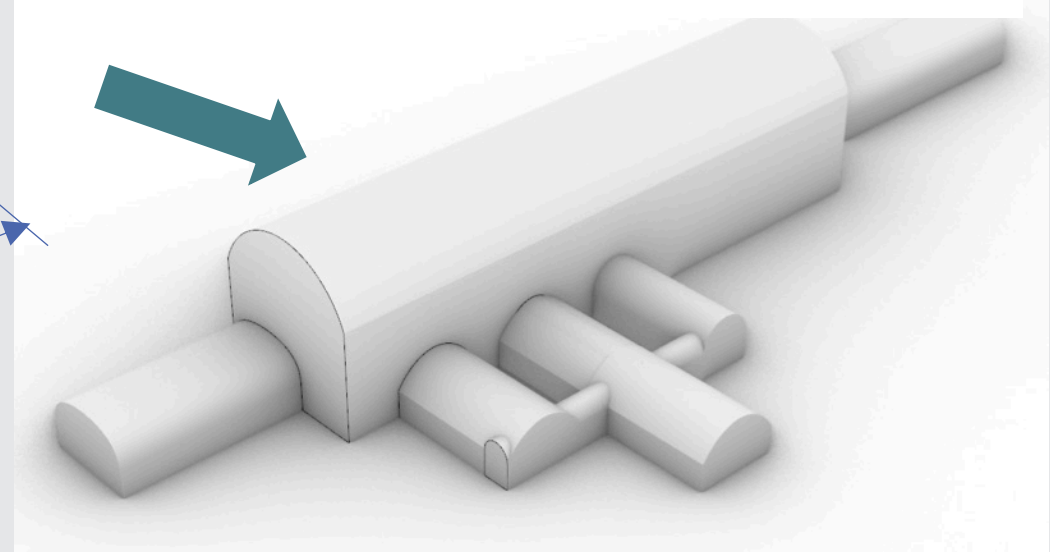


Highest Pressure : 6.2 bar , **Lowest Pressure : -2.8bar**

# 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