Introduction to dump issues

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This session...

- Introduction to the dump issues (Appleby, 5’)
- Summary of dump studies at KEK (Sugahara, 20’)
- A water dump for the ILC (Walz, 30’)
- Agreement in prewritten summary (Markiewicz, 5’)

This talk: Issues of dumps and a brief summary of the talk by Michael Schmitz of DESY at the BDIR meeting in London in June.
### Baseline configuration document

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Main beam dumps based on water vortex scheme rated for 18MW beam. Common e+ and g dump for 20mrad, separate g dump for 2mrad. Separate beam dumps rated for full power for all beamlines (total six beam dumps). Undisrupted beam size increased by distance.</td>
<td>Prototype and tests of beam dump window? Gas dump prototype?</td>
<td>Elliptical wide window. Gas beam dump (1km of Ar in Fe). Beam sweeping and/or graphite rod to increase undisrupted beam size.</td>
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**6 18MW dumps!!!**
**Introduction**

- **Thermal and Mechanical Issues**
  - heating and heat extraction
  - stresses and pressure

- **Radiochemical Aspects**
  - radiolysis, dissociation

- **Radiological Issues**
  - handling of induced radioactivity
  - shielding of direct radiation

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**Beam to be dumped (TESLA 800 parameters)**

- $E_0=400\text{GeV}$, $N_t=6.84\times10^{13}\text{e-}$, $T_t\approx1\text{ms}$, $\nu_{\text{rep}}=4\text{Hz}$
  - pulsed power source
  - $W_t=4.4\text{MJ}$ per train
  - $P_{\text{ave}}=17.5\text{MW}$ in average

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**Diagram:**

- **Beam Sweeping**
- **Window**
- **Absorber**

- **Distribution of Beam on Absorber**
  - intra bunch train (fast sweep)
  - average power (slow sweep)

- **Repetition time** $1/\nu_{\text{rep}}$
Solid Dump: Heat Extraction

C-based absorber embedded in Cu

- capture 400 GeV shower ⇒ longitudinal: ≈5m, transversal: 1R_m(C)+3R_m(Cu)=7cm+5cm
- $E_0=400\text{GeV}$, $P_{\text{ave}}=17.5\text{MW}$ ⇔ $I_{\text{ave}}=44\mu\text{A}$ ⇒ $(dP/dz)_{\text{max}}\approx 75\text{kW/cm}$! How to get rid of?

Heat extraction by transverse heat conduction and sweeping

\[ \alpha_{\text{tot}} \approx 0.12\text{W/(cm}^2\cdot\text{K)} \text{ and } (dP/dz)_{\text{max}} = \alpha_{\text{tot}} \cdot w \cdot (\Delta T_{\text{eq}})_{\text{max}} \]

allow $(\Delta T_{\text{eq}})_{\text{max}} \leq 400\text{K}$ (prevent oxidation of C)

⇒ $w \approx 20\text{cm} / (\text{kW/cm}) \cdot (dP/dz)_{\text{max}}$

Discussion

- huge and heavy absorber
- huge vacuum system
- complicated slow beam sweeping

⇒ C-Cu Approach not suitable

only reasonable for $(dP/dz)_{\text{max}} \approx \text{kW/cm} ⇔ P_{\text{ave}} \approx 100\text{kW level}$
Water Dump: Overall Scheme

- normal cooling water
- exhaust / chimney?
- sand
- enclosure
- water-system
- basin
- emergency/comm. beam tilted ≈15mrad
- water-dump vessel
- dump shielding
- spent beam, tilted ≈15mrad
Gas Dump: First Thoughts

One atomic noble gas core (Ar, Xe) is surrounded by solid material (Fe)

- gas core acts as scattering target (only small amount of energy deposition) and distributes energy longitudinally over ~1km into surrounding material → low energy densities, no sweeping, small spot size possible, no radiolysis
- surrounding material takes main part of energy
  \[ Z > 20 \rightarrow \text{reduced tritium production} \]

Basic Idea

Energy density (1 electron 400GeV), \( \frac{dE}{dV} \ [\text{GeV/cm}^3] \)

First Attempt (not optimized)

- water, 4cm
- Fe, 52cm thick
- Ar core, ∅ 8cm @ normal conditions

[Diagram showing energy density with r-bin=1cm, z-bin=10m]
### Comparative Summary

<table>
<thead>
<tr>
<th>Graphite-Copper Dump</th>
<th>Water Dump</th>
<th>Noble Gas Dump</th>
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<tbody>
<tr>
<td>2m x 2m, 5m long</td>
<td>Ø1.5m, 10m long</td>
<td>Ø1.2m, 1km long (extra? tunnel)</td>
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<tr>
<td>heat conductivity &amp; immense slow sweep</td>
<td>adequate water flow no slow sweep</td>
<td>heat conductivity no slow sweep</td>
</tr>
<tr>
<td>radiation degradation of heat conductivity of graphite?</td>
<td>explosive radiolysis gases in a highly activated system</td>
<td>no dissociation of one atomic gas</td>
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<td>cyclic stress in C tolerable</td>
<td>transient pressure in water</td>
<td>gas buffers transient expansion</td>
</tr>
<tr>
<td>window Ø2m unless not put upstream of sweeping</td>
<td>vac./water window Ø20cm challenging design</td>
<td>vacuum/gas window Ø8cm design ~exists</td>
</tr>
<tr>
<td>need increased spot size (fast sweep) to limit energy density</td>
<td>applicable for smaller spot sizes and therefore as ( \gamma/\gamma )-dump</td>
<td></td>
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<tr>
<td>total tritium inventory ( \approx 300 )TBq ( \approx 30% ) in water, rest in C-Cu</td>
<td>tritium inventory factor 10 less and 98% bound in a solid</td>
<td></td>
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<tr>
<td>maintenance complicated</td>
<td>easier maintenance</td>
<td>activation of 1km tunnel</td>
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<td>high activated components, dismantling costs not negligible</td>
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**Technically not practicable for high power applications**

**Principally feasible, but inherent risks will make it difficult to „sell“ it as reliable, safe and robust.**

**Attractive new idea, which should be investigated in more detail.**