Dumps and shielding walls needed for Operations, Commissioning, and Availability

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Introduction

This is a first draft and has only been discussed with a few people. We are now putting it out to a wide audience for comment. If you see something you don't like, please don't get mad, just explain what is wrong (with the contents of this memo, not with the author).

This is an attempt to put in one place all the information regarding the need for dumps and shielding walls. After it has been discussed with many groups and suitably modified, it would be reformatted to become a section in the Operations and Reliability chapter of the BCD and also in the area sections of the BCD. Note that the Operations and Reliability chapter already spells out the principle that people should be allowed in one part of the accelerator while beam is in another, it does not give specific details. Here we are trying to flesh out those details, both from the viewpoint of availability, and from operations and MPS. Many of these dumps are already mentioned in the area sections of the BCD and some, but not all of them, have been discussed with area leaders. The intention of this memo is to solicit extra input on these matters and then to rapidly settle on the list of dumps.

Much of the logic and some of the words in this note come from an email that Marc Ross sent to the BDS group on 11/29/05.

The next section gives a table of the dump locations and power requirements. The one after that gives more detailed motivation for these requirements.

Dump and shield wall locations

Location	Power	Power (kW)	Wall, dump, or both	# of dumps	Reason	Comment
At ~100 MeV in e- injector between warm and cold RF, downstream of the diagnostics	100 MeV, 5 Hz, 3000/train	4.8	dump	1	Allow proper tuning and bunching before injection into the 5 GeV SC linac.	
Between 5 GeV e- and e+ linacs and DRs	5 GeV, 5 Hz, 100/train	8	both	2	Keep injector tuned after DR beam abort and while repairs are done in the DR	Might be acceptable to stop beam after bunching at about 100 MeV. Perhaps since for commissioning it will be possible to go from 5 GeV injector into RTML, the dump at the front of the RTML could be used for this. This would only work if the bypass is pulsed.
DR beam abort dump	5 GeV, 0.01 Hz, 3000/train	0.5	Dump	2	Needed to protect the DR if something breaks or the beam goes unstable	Could be same as the beginning of RTML dump if kickers could be made to extract all bunches in a single turn
In DRX or RTML, just downstream of the first multi-wire emittance measuring section, but upstream of the compressors	5 GeV, 5 Hz, 3000/train	240	both	2	Allow DR to run full blast when people are in the linac tunnel or when there is a downstream MPS trip	Can probably be a couple of gates instead of a shielding wall as there may well be a bend between this dump and the main linac tunnel or a km of linac tunnel may provide sufficient separation.

Location	Power	Power (kW)	Wall, dump, or both	# of dumps	Reason	Comment
						There is some flexibility as to which dump in RTML is full power. At present, PT prefers it be the one after BC2. **To be discussed.**
Between BC1 and BC2	5 GeV, 5 Hz, 100/train	8	dump	2	Allow tuneup of BC1 with no beam going further	Do beam loading concerns require >1/train
Between BC2 and main linac	15 GeV, 5 Hz, 100/train	24	both	2	Allow tuneup of BC2 with no beam going further. Allow repairs in main linac while keeping DR and BC tuned	Could be 2 gates and 1 km of space instead of thick shielding wall.
Every km along linac	Up to 250 GeV, 0.1 Hz, 3/train	0.2	Dump	40	Dump following bunches if the pilot bunch doesn't make it to the IP.	These dumps could possibly be small and consumable. The are in the ACD and may only be necessary if we cannot convince ourselves that a fault which makes the beam exit the linac cannot be so small as to drill a hole
Beginning of Undulator Chicane	150 GeV, 5 Hz, 100/train	240	dump	1	Needed to tune beam (especially energy) before letting it through the full chicane and undulator)	
End of Undulator Chicane	150 GeV, 5 Hz, 3000/train	7,200	Dump	1	Needed to keep e+ normal conducting sections hot when there is an MPS trip further downstream.	Could choose to omit this one while making the one at the beginning of the BDS full power.
Beginning of each	500 GeV,	800	both	2	Needed to tune up linac before	Note this is NOT a full power dump.

Location	Power	Power (kW)	Wall, dump, or both	# of dumps	Reason	Comment
BDS	5 Hz, 100/train				letting beam into the BDS.	
End of each BDS extraction line	500 GeV, 5 Hz, 3000/train	24,000	dump	4	The main dumps after the beams collide.	2 dumps if 1 IP, 4 if 2.
After capture section of e+ source	114 MeV, 5Hz, 3000/train	5.5	Dump	2	The unwanted electrons hit these targets	2 targets (one running, one hot spare).
Gamma ray dump	0-40 MeV, 5 Hz, 3000/train	1.9	dump	1	Dump for the undulator gamma rays that did not interact in the target.	
Between warm and cold acceleration of e+	400 MeV, 5 Hz, 3000/train	19.2	Dump	1	Full power dump used to keep e+ target and capture warm when people are in the linac tunnel	
After capture section of e+ keep-alive source	114 MeV, 5 Hz, 3000/train	5.5	Dump	1	The unwanted electrons hit this target. Note the bunch intensity may be lower than the normal beam	
Between warm and cold acceleration of keep alive source	400 MeV, 5 Hz, 3000/train	19.2	Dump	1	Used to keep keep alive target and capture warm when its beam not going to the DR. Note the bunch intensity may be lower than the normal beam.	

Operability concerns

During operations, there are likely to be frequent MPS trips. The recovery from these should be as rapid as possible. To support this, beam should be kept as normal as reasonably possible in the areas upstream of the MPS trips.

The DRs and e+ source have significant heating effects. The beam heating primarily effects the alignment in the DR and the phase in the e+ capture system. While every effort should be taken to minimize the effects of this heating, experience on many accelerators tells us that keeping the beam intensity constant is important to maintain a steady well tuned beam. This is the main reason full power dumps are included downstream of the DRs and e+ source. While it is clear that when there is an e- linac MPS trip that there will be no e+ produced or in the e+ DR, it is still worthwhile to have a near instantaneous recovery time for MPS trips further down stream. Note that in the SLC, the vast majority of MPS trips came from backgrounds being too high in the detector. If ILC is similar, then rapid recovery from this type of trip is more important than from other types.

Note that when there is an MPS trip, rather than keeping the beams in the DRs, they are extracted and re-injected at 5 Hz. This avoids problems with the short lifetime in the DR causing the first pulse-train to have low intensities. It also keeps the injector and DR extraction systems running during the MPS trip.

Designing most of the dumps to take only 100 bunches/train comes from the assumption that we will not have a great deal of trouble with beam loading and other multi-bunch problems when going from 100 bunches to 3000 bunches per train. **This assumption needs to be discussed as I'm not sure it is valid.** Note that 100 bunches is chosen rather than 1 so that various intra-train feedbacks, LLRF, and long range wakes can come to equilibrium.

Most of the dumps are specified to take 5 Hz, even if only 100 bunches per train. This avoids thermal changes in klystrons and modulators and is a high enough rate for beam feedbacks and manual tuning.

Availability Concerns

The availability simulation assumed that when something was broken in a region that there could still be beam in the upstream regions. It assumed this even if people had to enter the accelerator tunnel to perform the repair. The availability would have been 1.7% less without this assumption. The rows of the table where both a dump and a shielding wall are specified come from this requirement. Note that the shielding wall doesn't necessarily have to be thick enough to allow beam on one side and people immediately downstream. Some hundreds of meters of tunnel could be left between the dump and the shielding, or between the shielding and a PPS gate so that the distance is used to attenuate the radiation, not just the shielding wall. The shielding walls could be chicanes instead of solid walls so that people and equipment can pass along the tunnel. There would need to

be an airtight gate between the regions to prevent ozone and radioactive gasses from passing from the region with beam to the region with people.

PPS gates

In additions to the shielding walls, a large number of PPS gates will be needed. These gates are much cheaper as they only need to keep people from passing from one section of the accelerator to another. Their main purpose is to minimize the amount of the tunnel that must be searched after part of it has been in permitted access. It will probably be sufficient to have PPS zones split at each access shaft and midway between access shafts.