Description of the J7 "Plunging Stripping Foil"
27Oct09 Leif Ahrens

Players and contributors (probably a subset):
Kip Gardner
Peter Thieberger
Dave Gassner
George Mahler
(Haixin Huang and Woody Glenn)
(Pablo Rosas and Ioannis Marneris)
() = helping define the baseline

For the 2010 RHIC gold run we plan to commission a more efficient mechanism for dumping the gold beam when it is being accelerated in the AGS but not being extracted out of the AGS. The plunging stripping foil to be located at the J7 straight section in the AGS ring is the additional piece of ring equipment to make this method of dumping possible. Descriptions of the present (without the plunging target) dumping procedure, the enchanced procedure and the machinery to be added are gived as is a short motivation for this effort.

During the last gold run (dAu run 2008) the AGS ring vacuum degraded several times due to the gold beam dumping strategy being employed. After each vacuum failure work was necessary in the AGS ring to recover the required good vacuum. In particular, several five-foot straight section vacuum pipes had to be replaced. The dumping stradegy itself evolved during the run, and indeed for most of the last half of the run the beam was not dumped in the AGS at all, but when necessary was extracted to dump into the flange at the end of the W line in AtR. During a series of studies during the latter half of that 2008 run, the quality of the internal dumping was improved - judging from the loss patterns around the J10 dump - by beefing up the power supply - changing a tap - used to create the bump that drives the beam into the dump, by allowing that bump mechanism to dominate the dumping (instead of partially relying on the behavior of the AGS main magnet function as it prepares to reduce the AGS field at the end of the flattop), and by inserting the J10 dump absorber a bit closer to the curculating beam. Several hours of high intensity internal dumping at the end of the run resulted in no vacuum problems.

The starting plan for the 2010 gold run is to return to internal dumping in the final configuration present at the end of the 2008 run. This setup is quite similar to the modes used in all earlier gold runs except that the relative loss patterns around the J10 dump are somewhat improved when compared to the past, primarily due to the stronger dump bump.

At bit more background to the problem: Dumping the gold beam results in a loss pattern with larger peaks away from the dump absorber itself than is seen for similar dumping of the proton beam. The dumping of the gold beam is explained to be problematic because the circulating ions carry two electrons. Any gentle interaction can loose these electrons and produce a secondary gold beam with a 2.5% low rigidity (a huge "kick"). Then this beam can find a spot to hit - perhaps because of the evolution of the machine optics at that time in the acceleration cycle - with high transverse density. The gold ion's high charge then causes the extreme local heating that can create holes in the vacuum pipe. Beam dumping using the present bump dump results in beam - dump interactions only on very near the surface of the J10 absorber - the surface parallel to the beam.

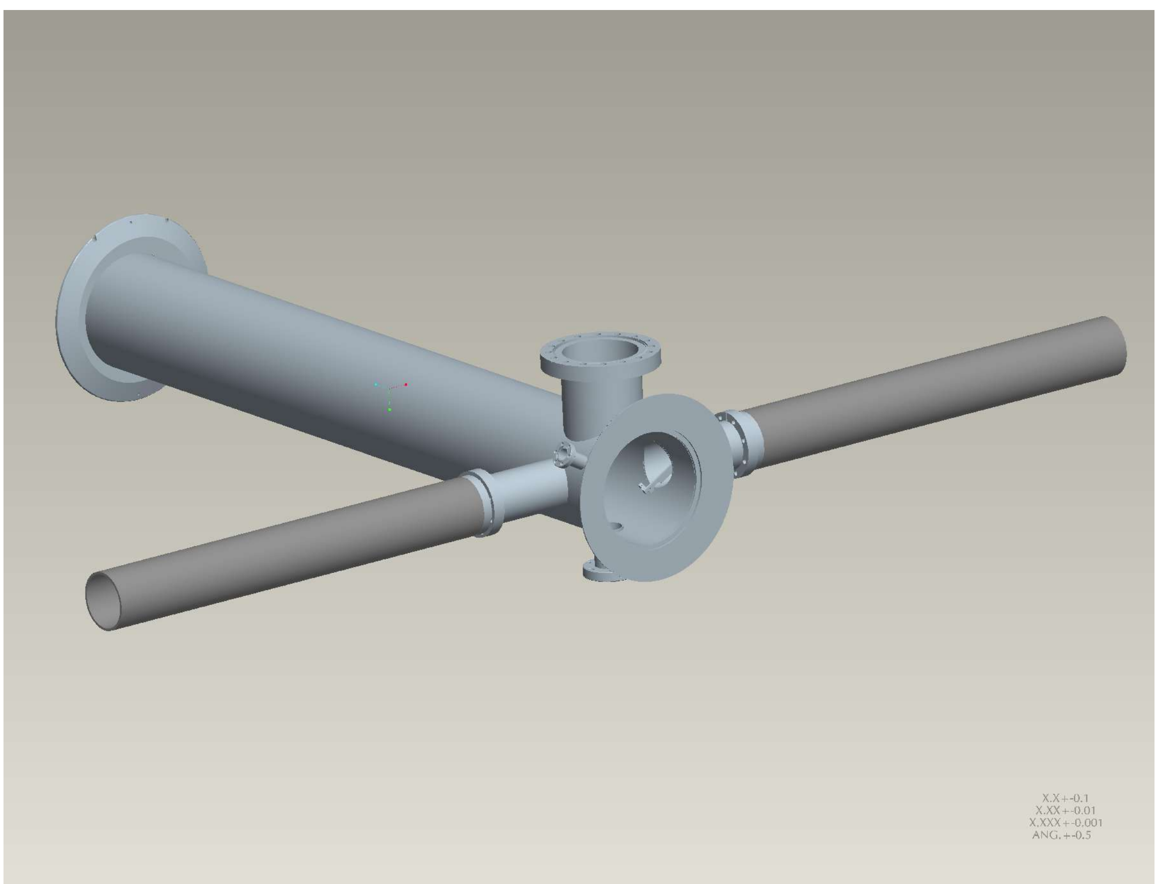
This same stripping possibility and the associated large rigidity change is to be used in the new stripping system being described here to force the gold beam deeper into the J10 dump. At the start of the run, the beam dumping will be set up in the normal internal fashion as described above. The bump dump rise time is slow enough (~ 100ms) to allow a reasonable window during which the next step can be taken. This step is to plunge the J7 stripping foil through the circulating beam. The motion of the foil is perpendicular to the beam motion axis. The beam moves along the z axis. The foil is in the x-y plane. The tungsten foil has a width from the beam's point of view of 1 mil (= .0254 mm). As the edge of this foil crosses the beam, any ion hitting the foil will lose its two electrons and on the same turn will hit the J10 dump absorber. The location of the target in the ring, namely at J7, is chosen such that this will happen (see next figure). The stripped beam will hit the dump absorber at a steeper angle than with the bump-only dumping. Indeed the beam can be put into the upstream face of the dump. The plunging foil crosses the beam (~ 2mm beam half width) in a few milliseconds. The foil flies first and fast from inside the beam aperturn across the beam. Then the foil is pulled back more slowly (the beam is gone), pausing for a moment in the center of the beam pipe before going back to its starting position inside of the beam aperture to await the next beam cycle.

The above figure and caption is from a set of evolving notes created by Kip Gardner dealing with the new system. These notes as they exist 30Oct09 are attached. Here is shown a simulation of the trajectory modifications (red lines) due to the plunging stripping foil (hitting the beam at ~ 627 meters (S) in the figure). The gold beam moves from left to right. Its trajectory is wiggly due to the dump bump. The purple lines describe particles at the edges of the beam transverse aperture. The J10 dump absorber is indicated by the blue outline at 637 - 638 meters (S). The beam goes into the upstream face of the dump absorber. The amplitude of the dump bump at the moment of plunging determines where on the absorber the beam lands. The loss pattern as reported by the normal ags loss monitor system should give a good indication of the required bump amplitude at plunge time.

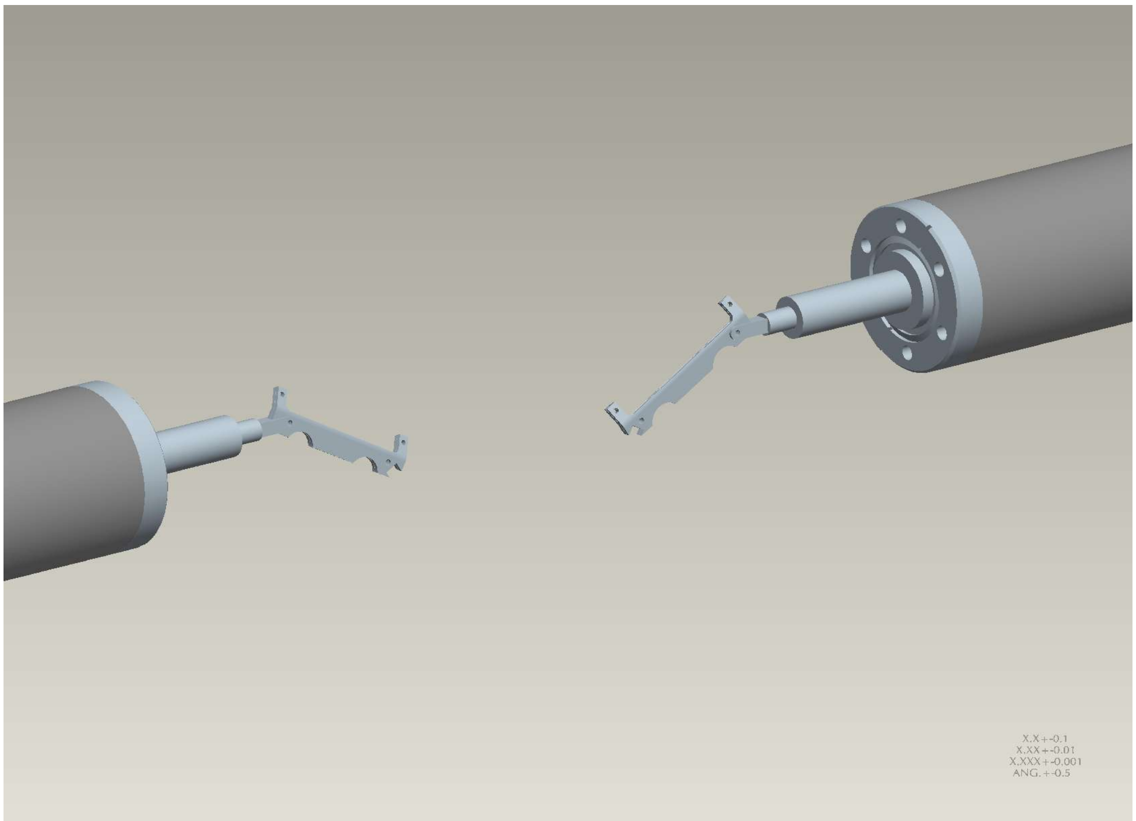
The machinery used to cause the rapid and large (5 inch travel) motion of the foil is the same as has been used for many years for the AGS jump targets. The machinery has recently been run (at the F5 location in the AGS ring) constantly at the normal ags repetition rate for several days with a motion program similar to the one required here. That exercise was successful and allowed a better understanding of cooling requirements for the jumping or plunging mechanism. The plunging and stripping will be observed using a camera viewing from above the plunger. The evolution of the stripping edge will be visible each cycle on the return pause. Loss monitors will monitor the loss pattern.

A major issue is the instantanious heating of the foil. (The average heating corresponds to 100mW). The edge of the foil lies in the x-y plane (beam traveling along z) but the edge itself at a given time is not described by a line at constant x. Rather it is tilted in the x-y plane so that these is some spread along the foil of the interaction point as the target plunges through the beam. The edge is also slightly folded parallel with its interacting edge to allow edge inspection using a camera viewing from above.

The 1 mil tungsten foil will cause nuclear interactions with ~ 0.1% of the beam. (Peter Thieberger - enlightened back of envelope calculation).



Sketch of the new J7 vacuum pipe. Did I mention…there are actually two plunging stripping foils, one coming from the inside of the ring and the other from the outside. We will use only one of these at any time, the second is brought to life (maybe it has been commissioned) only after the first one dies gracefully. The beam is going nearly into the page, along the axis of the big pipe. The top flange is a viewing port. The foils come in along the two little pipes.



And next a drawing of both of the plunging stripping foil drives. The foils are missing, but attach along the top edges of the mechanism.