

## Pre-Review: PIP-I+ Booster Collimator

Date and time: Tuesday, 11/15/2017 at 1:00 pm

Place: Dungeon

Reviewers:

W. Pellico, N. Mokhov, CY Tan and C. Bhat,

Preliminary agenda: Presentations

- 1) Valery Kapin: Booster Collimation Upgrade Plans for PIP-I+ –design proposals "Booster Collimation Upgrade Plans" Beams Document 5930-v1
- 2) Vladimir Sidorov: New BOOSTER Collimation System– Feasibility of the different designs using CAD, "New BOOSTER Collimation System Conceptual design" Beams Document 5927-v1
- 3) Discussion

**VKapin presented a talk on his 2015-2017 work on 2-stage collimation System for the Booster.**

1. The list of relevant reports and talks on the recent works have been presented. Starting from an introduction to the Booster layout he pointed out that the available physical aperture from the F (vertical aperture of 1.64"), D (vertical aperture of 2.25") dipole magnets, RF (2.25" dia) – are limiting apertures (~4.5 beam sigma). He also showed the lattice where one expects aperture restrictions in the Booster. Gave an overview on the original design efforts on 2-stage collimators (2SC) in 2004 (A. Drozhdin), 2011 design optimization effort (again by A. Drozhdin) and simulated loss distributions of halo protons around the Booster with primary and secondary collimators. VK discussed reasons for low collimation efficiency of previous 2SC system – one reason is non-optimal phase locations of the secondary collimators. Showed 1-foot Residual Radiation Data of 03/31/2017 in the Booster. Pointed that high radiation regions are injection, extraction, collimation and notching areas in the ring. The observation is every pair of RF stations acts as a sequence of aperture restrictions for the beam even in the presence of the existing single-stage (1SC) collimator system. The data also suggests that a considerable part of the beam halo cannot be removed with the current 1SC collimators – beam traverses till it hits the RF aperture.
2. Next he talked about the present collimators system at L06-L07 designed by Bartoszek Eng. Commented that with the existing 1SC collimator system we have seen reduced activation around the ring by 40-50%. However, an increased activation is seen at injection (possibly due to increase in intensity, increase in beam rep-rate – Chandra's comment) and at and downstream of collimators. He suggested that this issue calls for a new 2SC system aimed to reduce a residual radiation around collimators and to intercept halo particles before the beam goes through the RF cavities.

3. Subsequently, he showed layout of simulated new 2SC with thick foil and some results from the MADX+MARS 2SC with thick foil simulations. Simulation results support a new 2SC system designed as a ~ 4m long well-shielded collimation unit containing 2 (H&V) primary collimators and 2 (H&V) secondary collimators. Such 2SC unit can be installed within one Long Sections of the ring e.g., at L08, L09 or L10 locations. He also told that some-what similar 2SC units are in use at RCS of RAL.
4. Finally, talked about the possible solutions based on the new 2SC unit. Suggested a plan in three stages. 1<sup>st</sup> stage– 2SC unit in L08 region. If this is successful, 2<sup>nd</sup> stage should be followed – 2<sup>nd</sup> 2SC unit in L09. If these are successful then replace collimators in L06 and L07 by two 2SC units. The plan also outlined a list of necessary design works and numerical simulations. He showed three schematic pictures for distinctive designs for the 2SC and had a short discussion on each design.

Noted points: All simulations are carried out at 400 MeV. Minimal thickness for the foil~1cm.

BP: Commented that the simulations are like that for a transfer line. Most likely that may be ok.

Valery' response: First time he did simulations for the entire Booster ring. But he strongly argued that simulations for the entire ring is not necessary in this case. The Booster collimator can be treated as a local loss points and all the losses will be in the first pass if designed correctly.

N.M.: In the case of collimator like this one must look at 1) residual activation, 2) ground water activation and 3) air borne activation.

**VSidorov presented preliminary results from his efforts on 2SC** for the Booster for all three different designs mentioned by VKapin, with illustrations and details for every component of the collimator and with CAD drawings. Beautiful presentation!

N.M.: Suggested that Air gap inside a collimator should be avoided mainly to avoid any production of tritium and its contamination. So 3<sup>rd</sup> design of 2SC is not acceptable.

BP: A cavity like structure with big vertical aperture should be avoided in a ring.

BP: The current model for the 2SC doe not have much shielding from below.

VS's Responses: This is currently a preliminary design of the 2SC. In the final drawing we provide enough shielding from all 3-sides. One side the Booster wall will not allow us to add any further shielding.

Summary/Conclusions: Department will choose for one of the three designs which is most suitable for Booster Accelerator. The decision will be made after the next review with outside reviewers.