# Mu2e Electrostatic Septa (ESS) specifications

The following terms are used below:

**Frame** - the C-shaped frame carrying the septum plane (foils or wires). Frame is grounded.

**Cathode** – the flat electrode facing the septum plane and forming the electric field. The high negative voltage is applied to the cathode.

**Stand-offs** – the isolated structures that hold and position the cathode.

**Feedthough** – the structure that penetrates the vessel and brings the HV connection from outside the vessel to the cathode.

**Baffles** – shielding screens separating the cathode from the foil anchoring and removal mechanism area.

1. The total active length of two septa is 3m.
2. Septa frames have equal lengths for ESS1 and ESS2.
3. ESS1 accommodates 50 cm for the diffuser in front of the foil septum. This space is reserved on the same frame that is holding foils for the ESS1. The active length of the ESS1 is 125cm and active length of ESS2 is 175cm, which equates to their cathode lengths. Very small deviations may be allowed in favor of #5.
4. It is recognized that the foil area is longer than the active length, therefore the total length of the frame is little longer than 175cm.
5. Vacuum vessels for ESS1 and ESS2 are fully interchangeable. Same frame that houses the diffuser in ESS1 can be used in the ESS2.
6. Septa frames have symmetrical design against 180° rotation around the perpendicular to the frame line in the horizontal plane.
7. The septum plane (knife) is made of W/25%Re alloy foil strips of 1mm width and 25u thickness.
8. The spacing between the foils is 2.6mm center-to-center. This is determined from the 3D FEA electrostatic modeling in ANSYS with requirement that the gap field does not penetrate into the region of the dense proton circulating beam in the presence of reasonable clearing field.
9. The apparent (effective) thickness of the foil plane should be about or better than 50u. This includes both foil and frame non-flatness.
10. Tension on the foils should be sufficient to satisfy condition #9 and is not desirable to be higher than the tensile strength of the foils after recrystallization.
11. The foil assembly design should allow replacing a single foil in a fully assembled septum.
12. The foil assembly design should prevent a broken foil from touching the cathode. This is facilitated by the spring removal mechanism that is capable of fast removing the foil residuals on both sides and at the full length of the foil.
13. Septum design should include the baffles.
14. Septum design and assembly (including but not limited to: parts fabrication and finishing process, choice of materials, UH vacuum class conditions of assembly, cable connections, feedthroughs design, proper field shielding, choice of the powers supply) – should provide stable operation in good vacuum without beam up to 150kV voltage on the cathode.
15. Conditioning process should be established to achieve reliable HV operation without damage to the septum parts.
16. The present understanding is that choice of Titanium as the cathode material offers certain advantages in terms of vacuum discharge stability at high voltage. Titanium is presently the preferred choice.
17. The nominal distance between the circulating beam position and the foil plane is 12mm. However it is very likely that optics at the extraction location will be optimized so that beta-function will grow substantially. In this case the design should anticipate changing the position of the foil plane with respect to the central orbit by as much as 0.5”.
18. The nominal distance between the foil plane and the cathode is 10mm. There should be additional regulation room for increasing this distance by 0.5”. (Note that if #17 is realized with moving the frame independently on the cathode, these two add up to additional cathode moving freedom of 1”).
19. Residual activation after beam operation on the septa parts is a serious issue for their maintenance. To reduce it, the vessel and its flanges, the frame, cathode and other most bulky parts should most preferably made of low-Z materials.
20. Septa vessels shall have alignment monuments on them and the frame inside shall be aligned with them. This allows septa installation as close as possible to the calculated position. Additional alignment during the beam commissioning will be necessary. The vessels shall allow independent horizontal movement on both ends with remote control and remote displacement measurement. The control and measurement precision needs to be better than 0.002”. The range of remote position control on both sides is at least ±5mm.
21. The motion system should limit the backlash to within the allowed precision.
22. The flange connection of the vessels to the beam pipe should be designed to allow the quick disconnect with minimum exposure of the mechanical personnel to activated parts of the beam line.
23. The septa, in particular the ESS1 should be installed as close as possible to the Q203 focusing quad in the Delivery Ring. The current space allowance is 0.415m distance between the end of the frame and the steel face of the Q203.
24. Good vacuum is very important for the ESS stable operation. Local vacuum system should be designed aimed to reach the level of 1e-9torr in the foils septum area.