

Exercises: Particle Detectors WS 2016/17
Prof. Dr. Ulrich Landgraf, Dr. Susanne Kühn
Problem Set No. 11

**Solutions have to be handed in by Wednesday 3pm, 8.2.2017 in letter box
no. 3, in the ground floor of Gustav-Mie building!**

1. Design of a particle physics detector

Design a detector with the goal of measuring two categories of beauty hadron decays:

- (a) $B_s \rightarrow \mu^+ \mu^-$ is a rare decay and is very sensitive to physics beyond the Standard Model.
- (b) With the two decays $B^0 \rightarrow \pi^+ \pi^-$ and $B_s^0 \rightarrow K^+ K^-$ time dependant CP asymmetries are studied. They provide important measurements for the determination of Cabibbo-Kobayashi-Maskawa angles.

The detector is to be built into the beam line of a proton-proton collider. In high energy proton-proton collisions the production of hadrons strongly peaks at low angles to the incident beams, hence it is sufficient to instrument an angle of ~ 0.8 radian, centered on the beam line and on one side only (similar to a fixed target experiment). The detector should measure charged particles with momenta from a few hundred MeV to about 80 GeV, in particular being able to distinguish charged hadrons starting from momenta around 1-2 GeV. The detector needs to be able to perform lifetime measurements and provide flavour tagging. While meeting the design goals try to be realistic and cost efficient.

- (a) Make a sketch with annotations, describe the characteristics and dimensions of sub-detectors and components and justify your choices.
- (b) Provide some information about the expected performance of the subdetectors in terms of efficiency and resolution.

Note: This exercise counts as 4 points. Up to 8 points can be earned, allowing to 'recover' points missed on previous problem sets.

[4+4* points]