# 1.10 Risk management

There are several risks that could jeopardize the success of the calorimeter subproject. The risks as well as potential mitigation strategies are described below.

There is a risk that we cannot develop in time UV extended solid state photo-detectors that are blind to solar wavelength. As shown in this chapter, our *alternative* candidate to LYSO, the BaF2, has a long component produced at 310 nm. Without the development of these new photo-sensors, the rate capability of the calorimeter might be compromised. To mitigate this risk, the work on solar blind photo-detector is currently underway at Caltech, JPL and RMD. In the mean time, there is a method to directly reduce the production of the BaF2 long component by doping with La the crystal itself. Interactions with the vendors are started to improve on this side. If all of these mitigations fail, before the final technical review and the start of the pre-production series, a cheaper although less performance alternative will be followed. As reported in sec. XXX, a parallel R&D program has begun to study the feasibility of using CsI(pure) crystals with large area SiPM read-out. In this case, a complete demonstration of timing and radiation hardness capability has to be delivered in a timed fashion.

There are radiation hardness problems mainly concerning the photo-sensors. Neutrons incident on the APDs or SiPMs could increase the dark current and deteriorate the calorimeter’s performance. The usage of the disk geometry greatly reduced this problem with respect to the vane geometry. Indeed, the main neutron flux estimated by the simulation in the disk readout-area is of xx 109 n1MeVeq/cm2 , a factor 3-4 better than in the vane case. This neutron flux is still on the safe side for the discussed readout options. Moreover, the photo-sensors will be connected through *bridge-resistors* to their external shielding so that, usage of proper metallic cooling fingers, attached to the main cooling system can be used to cool them down (up to 0°C) and increase their radiation hardness. Moreover, in case of a large background dose, the pileup in the main cluster could become very important depending upon the timing characteristics of the selected crystals. Pulse shape analysis is the first mitigation used. If the situation becomes un-tolerable, the most important mitigation will be to improve the neutron shielding inside the DS.

Finally, there is a serious risk of INFN not committing on the calorimeter construction by CD-2. Reasons are due to existence of many competing projects that can somehow reduce the possibility of funding this project. The number of INFN physicists participating to Mu2e can instead limit the quantity of funds that INFN is willing to commit. Calorimeters are, by their nature, expensive devices thus challenging the standard Euro/FTE used in INFN. From the practical point of view, some delay on the decision can be tolerated due to the existence of a parallel path of approval that is well underway. In the work case scenario, of INFN dropping from the calorimeter construction, the mitigation will be to reduce the construction to 1 Disk only or fill a reduced area of the detector loosing a 35% relative acceptance. In this way, the risk will be minimized from the economical point of view and will correspond to O(1 M$).

# 1.11 Value management

Value management for the calorimeter will consist of a careful examination and validation of detector requirements coupled with an alternative analysis of engineering and design choices with special attention to cost.

Independently from the final crystal choice, the option of using large area SiPM is becoming more attractive due to low light yield of the crystals under consideration and to the fact that, nowadays, most of the producers are pushing to have blue or UV extended devices working for application in other fields, such as astro-particle. First results obtained with the CsI(pure) crystal, where SiPM matching the emission spectra were already available, are really encouraging. As shown in sec.xx, the inherent gain and lower noise of SiPMs might allow for a simpler design of the front end electronics, reducing the HV needs and simplify the amplifier design. The basic layout of the FEE chain will be kept unchanged but there will be: i) no need to have a DC-DC converter working in B-Field and ii) the amplifier gain request should be dropped considerably. Moreover, another cost effective possibility is that of selecting a SiPM in a firm smaller than Hamamatsu, .. and reduce the per unit cost considerably.