Abstract
Muon tomography is a relatively newly developed method to indirectly observe objects using cosmic ray muons in extreme environments or situations which we cannot observe objects directly. Our final purpose is applying muon tomography tombs in the ruin of ancient city Limyra. Here we discuss our GEANT4 Monte Carlo simulation works to simulate a small object above our detector.

Methods
Muon tomography is a method developed in 1950s. Comparing to X-ray scanning, it has two advantages. First, muon tomography can be used to make images very thick structure. Second, muon can penetrate materials like lead. Therefore, muon tomography can be used to detect volcano magma chamber and hidden voids in pyramids. A hidden void in the Great Pyramid was actually discovered recently[1].

Limyra
Limyra was a small city of Lycia, an Asian geopolitical region of the ancient Roman empire. Its ruin is located in southern part of Turkey. In rumor, the tomb of Gaius Caesar, the adopted son of Julius Caesar, is located in Limyra. The picture below shows the theater ruin in Limyra. The archeology meaning of this ruin is huge, therefore we cannot observe the tombs directly.

Our detector
Currently, Our detector was still in development. The picture on the left shows the pervious state of our detector several months ago. The detector contains four trays. Each tray consists ten 5x5x60cm³ scintillator bars. The figures below show the structure of our detector. We put two trays with a 5cm gap on the bottom. Those two trays are perpendicular to each other. The other two trays were installed about the original two trays about 40cm with the same setting.

Current Process
In our simulation, we put an small, air, iron or tungsten object above our detector, like the left figure below. The right figure below shows the structure of our simulation.

The current process of our research work is listed below. The graphs shows the x component of muon distribution at z=400cm. The red line in those graphs represents the distribution when the object is made by air. The black line represents the distribution with iron object. The green line represents the distribution with tungsten object. The left graph shows the result of the true muons( the muon tracks calculated by the recorded position and momentum data of muons passed the reference xy plane whose center is the origin point ). The right graph shows the result of the reconstructed muons(the muon tracks reconstructed by the locations of the bars with energy deposited).

The graph below shows the reconstructed muon distribution at z=600cm.

References:

Software:
• GEANT4
• Cosmic Ray Shower Library(CRY)
• CERN ROOT