INTRODUCTION
Recently the use of imageless computer-assisted navigation (CAS) for total knee arthroplasty (TKA) has demonstrated encouraging results in both accuracy and repeatability. The use of CAS in TKA may increase surgical time required to intra-operatively register the patient. More recently, patient specific instrumentation systems utilizing pre-operative imaging techniques are entering the marketplace to potentially improve the accuracy and repeatability of TKA procedures with the potential benefit of decreased operative time. Some patient specific instrumentation systems require pre-operative magnetic resonance imaging (MRI) scans of the patient’s knee anatomy and an additional long-standing radiograph; the long-standing radiograph is required to identify the mechanical axis references of the limb.

A MRI protocol was developed to eliminate the need for the long-standing radiograph overlayed on a solid model of the knee to identify the mechanical reference lines. We propose to use a software model using only MRI scans to digitally obtain the knee alignment angles necessary for total knee arthroplasty. The purpose of this study was to verify the accuracy and repeatability of measurements obtained from this MRI procedure and the use of the associated software (Stryker Orthopaedics, Alameda, CA).

METHODS
Test Subjects
Institutional Review Board approval was obtained for this study. Testing was performed on 15 consenting normal healthy adult subjects (n=30 knee specimens), indiscriminate of gender or age. Radiographic measurements were performed independently by four segmentation specialists.

Radiographic Procedure
Long leg standing digital radiograph were performed in an anterior/posterior alignment, presenting the limb in a coronal plane orientation. The limb was aligned so the patient’s second metatarsal point was aligned with the x-ray source. Additionally, the subject’s foot positioning was specified as a comfortable stance within the width allotted in the imaging equipment. Using the radiograph, the centers of the femoral head, distal femur, proximal tibia and talus were identified by the specialists. An on-screen goniometer was used to measure the femoral-tibial angle, the femoral varus/valgus angle, and the tibial varus/valgus angle.

MRI Procedure
Imaging was performed to generate a multi-slice high resolution scan of the knee with the use of a knee-coil and a scout single-slice low-resolution scan of the hip, knee and ankle performed with a full body coil. Medical image visualization and segmentation software (Stryker Orthopaedics, Alameda, CA) was used to digitally identify landmarks, orient the scans and perform final measurements as described below.

First, landmarks were identified on the scout scan, including the center point of the femoral head, distal femur, proximal tibia and talus. These points were then used to establish the three mechanical axis reference lines: the Mechanical Axis Reference Line (MA), established by connecting the center point of the femoral head to that of the talus, the Femoral Mechanical Axis Reference Line (MAF), established by connecting the center point of the femoral head to that of the distal femur and the Tibial Mechanical Axis Reference Line (MAT), established by connecting the center point of the proximal tibia to that of the talus. A group of six (6) identical landmarks were digitally located on the scout and knee-coil scans. The scout image then underwent a coordinate transformation to align it to the knee coil scan. This was done in order to map the reference lines on the knee-coil scan. Then, computer planning models were developed for the femur and the tibia and then virtually aligned in the coronal plane to a simulated weight-bearing position, or the HKA standard position (Fig 1a). All reference axes were translated onto the HKA standard position. Finally, the three knee alignment parameters measured manually on the radiograph were then digitally measured from this position (Figure 1a and 1c).