Purpose
The purpose of this study was to identify MR sequences that are best suited for 3D reconstruction of permanent implant seed cloud as well as shape and volume of the implanted prostate. The end-point is to accurately compute the post-implant DVH in order to assess permanent prostate implants quality.

Introduction
Accurate source localisation is important for a good post-implant dosimetric evaluation of the brachytherapy used to treat patients with prostate cancer [1-3]. Since it is difficult to outline the prostate accurately on CT images, it has been suggested that MRI should be used to visualise both the seeds and the prostate [4,5]. However, to date, it was not clear that MR can actually provide accurate source localisation and prostate contouring simultaneously.

Methods
For this pilot study, a Signa Horizon 1.5T MRI unit [6] has been used with various MR pulses sequences to image the implanted prostate of three patients mainly along axial but also sagittal and coronal directions. Because MR is relatively expensive and/or some patients can quickly get uncomfortable, resulting in a degradation of image quality, we sought for sequences reasonably short but still sufficiently good to provide accurate prostate and seeds visualisation.

Results
The pelvic coil was used and four families of pulse sequence parameters proved to be of interest, namely a proton density (PD) fast-spin-echo (FSE), a T2 FSE (T2) with or without fat saturation, a gradient echo (GE) and finally a variable echo with 4 echoes (VE4E). Each sequence shared the following: field-of-view = 18cm, slice thickness = 3.0mm with a spacing of 0.5mm, readout bandwidth = 16kHz, 256x192 matrix, number of excitations (NEX) = 4. Specifically, TR = 3000-3566ms, TE = 14-30ms/Ef for PD; TR = 4000-4466, TE = 98/Ef for T2; TR = 600, TE = 15 for GE; TR = 4266, TE = 40, 80, 120, 160 for VE4E with NEX = 1.5. Acquisition time was less than 12 minutes in all case but VE4E, for which it was 21 minutes. PD proves to be the best scheme to accurately identify seeds and still offer a fair/good visualisation of the prostate in most cases for most slices. Both T2 offer the best prostate visualisation with relatively well contrasted border but a poor seeds representation. GE provides a clear but very coarse visualisation of seeds with fair prostate. VE4E is very interesting since the first echo (40ms) gives a good visualisation of seeds (as for PD) and the second or third echo reveals a clear prostate contour (as for T2, see Fig. 1a,b). A phantom has been build to verify that a geometrically known structure of radioactive seeds immersed in water is adequately imaged by retained MRI sequences. The figure 1c shows this structure made of 4mm diameter straws within which 16 seeds of length 4.5mm are easily discriminated, particularly the two ones that are located leftmost along the topmost sagittal straw which are located 2.5mm apart.

Discussion
MRI sequences have been identified to obtained accurate representation of permanent implants treated prostate. In particular, the variable echo with 4 echoes sequence (VE4E) allows for accurate imaging of both the prostate and the seeds simultaneously. Axial sequences follow the orientation of the prostate and thus provide optimal prostate contours. However, coronal sequences, which have been shown superior to sagittal ones in our study, could be performed to precise seeds localisation along the axial direction and to refine contours around base and apex of the prostate. Moreover, one axial VE4E exam should be sufficient to contour the prostate and to localise most of the seeds accurately.