Purpose:
Dose distribution characteristics for small radiation fields can be very difficult to determine. In this work a MAGIC (Methacrylic and Ascorbic acid in Gelatin Initiated by Copper) 3D polymer gel is combined with 7T micro-MR imaging for high resolution measurements of the small field (<1cm) 3D dose distributions.

Methods:
MAGIC(Gelatin 9%; Methacrylic acid 4%; CuSO4 0.1mM; Ascorbic ascid 2mM; Glucose 22%) 3D gel phantoms were irradiated with very small 6MV x-ray beams (5 x 5 mm2 and 10 x 10 mm2 square fields; 2mm diameter round field). Gel dose measurements were performed in Bruker 7T mirco-MRI and GE Signa 3T scanners and with simultaneously-obtained radiochromic films. T2 maps were acquired using a 10-echo-Multi-Spin Multi-Echo (MSME) pulse sequence on both MR scanners. Normalized 3D dose maps were calculated in Matlab.

Results:
Dose distributions determined from 30 minute scans for the 5x5 mm2 and 10x10 mm2 square fields on the 7T MR unit were superior to 3T MR unit in spatial resolution (7T: 0.156mm x 0.156mm x 1mm voxel ; 3T: 0.254mm x 0.254mm x 2mm voxel). For the very small field size (2mm diameter), the MAGIC gel with 7T MRI provided even better quality dose distribution images (1.5hour scan; spatial resolution 79um x79um x 1mm and ; 12 hour scan: spatial resolution 38um x 38um x 1mm), 3T MRI was not able to read accurate dose profile due to a low SNR in the same 1.5hour scan time.

Conclusions:
This study indicates that the MAGIC polymer gel with 7T micro-MRI for 3D dose readout can potentially be used for dosimetric characterization of very small radiation beams, including measurements for micro-beams (field size ~ 100um). Techniques and limitations for MAGIC gel dosimetry via high field MR imaging for dosimetric assessment are detailed in this work.