Purpose:
Small field dosimetry is challenging that impacts patient specific QA in proton beam therapy due to detector size, aperture scattering and disequilibrium. Therefore, it is urgent to develop an accurate and efficient method to quantify the uncertainty of 3D dosimetry of small fields. This study investigated the feasibility of using a new formula PRESAGE® for 3D dosimetry of small irregular field in proton therapy.

Methods:
Three cylindrical shape PRESAGE® dosimeters (10 cm or 4 cm in diameter, 6 cm in length) of a new formula ($C_{304}H_{510}N_{20}O_{71}SBr$) were irradiated with three irregular patient fields (field size 2-4 cm) either with or without range compensators, respectively. A proton range 6 cm with three different SOBP widths were used. To test the sensitivity of the dosimeter, three different dose levels, 150, 300, and 500 cGy were delivered. Uniform scanning proton beams with energy stacking were used for beam delivery. Three corresponding treatment plans created on the CMS XiO treatment planning system using pencil beam algorithm were compared with the experimental results in the form of relative dose distributions, including isodose plots, dose profiles and gamma index maps.

Results:
Transverse dose profile comparison showed spatial agreement within 1-2 mm. The measured depth dose results showed a sharper distal fall off compared to the calculations with negligible quenching effect (< 5%). Most differences were observed in the high dose gradient region (field edges and distal end). Majority of the data points in the target region passed the 3% dose difference and 3 mm DTA gamma analysis.

Conclusions:
Good agreement was observed between planned and measured 3D dose distributions. Overall, the new formula PRESAGE® dosimeter was found to be suitable for verifying the 3D dose distribution for small irregular fields in proton therapy with single shot irradiation.