Clinical use of the software for the automation of treatment field parameters verification prior to radiation delivery

**Introduction**
Verification of treatment field parameters by therapists take place prior to every or first fraction. Such verification or field timeout should be completely independent from record-and-verify system. It is performed manually by therapists via reading treatment parameters from linac screen and comparing them to treatment plan. Treatment plan data is, typically, read from a printout, a write-up from the printout, or an electronic printout.

Field timeout is an important safety step. It is required by The Joint Commission and performed in many centers in the United States.

We evaluate the software allowing automation of field timeout for the clinical use.

**Methods**
Treatment field timeout involves three steps: (1) extraction information from the plan printout, (2) extraction information from the linac screen and (3) comparison of the extracted information. These steps are elucidated below:

1. Plan printouts from Eclipse treatment planning system (Varian Medical Systems, Palo Alto, CA) are stored in a PDF format. Information in these PDFs is stored in form of text rather than as images, and, therefore, is easily extracted.
2. Information from the linac’s screen is extracted using video signal splitter and VGA2USB converter (Epiphan Systems, Ottawa, CA). Acquired image farther requires character recognition. For Varian linacs (pre TrueBeam models), position of the symbols to be recognized does not change, thus, allowing the following, rather simple recognition process:
   - For each region of interest (ROI) in the image:
     - (a) Convert ROI image into binary
     - (b) Find a set of connected clusters of foreground pixels
     - (c) For each candidate symbol in a ROI, find the best matching template among the templates of possible symbols in this ROI. For some ROI, there might be no candidate symbols, i.e. the value of the parameter in this ROI is actually empty.
   Step (b) is done using Connected Component Labeling and similarity measure for step (c) is sum of the absolute differences between the image (binary) and template.
3. A user friendly program is developed using Java. It outputs parameters extracted at the steps (1) and (2) to the user (e.g. radiation therapist) and alerts him/her about a mismatch. All beam data are displayed side by side on the screen. The color coding is used to reflect clinic specific tolerance levels, green for exact match, red for unacceptable discrepancy, and yellow for small differences. All field verifications can be recorded to a log file, for periodic review. The program also outputs auxiliary information, e.g. bolus, which is not well alerted by or can be omitted in the record and verify system.

**Results**
The software has friendly user interface and is easily included in clinical work flow. Therapist find it intuitive and easy to use. With the error rate in our clinics being extremely low, we don’t have data yet to claim that automated timeout provides higher safety than manual; however, it definitely cuts timeout time to 2-3sec per fields versus 10sec, if done manually.

**Discussion**
Field timeout automation is practicable and fits well into clinical workflow. It improves patient throughput and is expected to improve patient safety.

In the current workflow PDFs are uploaded during second check. We believe that it may be more practical to upload plans after planning is complete and verify during physics second check.