Summary
The LHC collimation system is crucial for safe and reliable operation. Standard collimator set-up is performed by observing beam losses. The procedure is lengthy (~18h shift time per ring) and can only be performed with special low intensity fills. For a drastic reduction of setup time the next generation of the LHC collimators will be equipped with button beam position monitors (BPMs) embedded into the collimator jaws.

Motivations
• Non-invasive and more accurate method.
• Allow continuous monitoring of beam offsets.
• Increased passive machine protection as collimators can follow slow orbit drifts.
• Add more flexibility for local orbit changes.

Components

Button

• Accurate Mechanics
• Low capacitance.
• Sensitivity.
• Robustness against LHC beam.

Implementation in Jaws

• Integration of buttons in a BPM demonstrator based on a modified version of phase I collimator.
  Detail A: Center pair of buttons. Detail B: Button in each of the shape adapters (tapering).
• Protection of the button from accidental beam impact.
• Preserve machine impedance.

Cables & Feedthroughs

• RF SiO2 Coaxial cables
• Temperature & Radiation handling.
• Delay matched.
• Stable phase.

Measurements

From Laboratory …

Test bench.
• S11 in Time Domain.
• Button frequency response

Wire measurements on the test bench:
• We checked position linearity, buttons sensitivity, characteristic impedance vs jaws aperture with a synthetic pulse.
• Comparison with simulation models.

… to the SPS Machine

SPS slot 51939
response to a LHC type bunch of some 1.7e10 protons.
Linearity error shifting the jaw gap center

Experiments on the SPS machine with beam:
• We were able to measure up to 10um steps and reproducible position.
• No noise on the BPM buttons when making losses by scraping away a large part of the beam (max. losses per step ~ 1e10p)

Conclusions
• The wire test bench is a good tool for measuring the transfer characteristics of buttons. The central pair of buttons proved to be inefficient for small apertures and this kind of configuration will not be kept.
• Embedded BPM will be an advanced feature of next generation collimators. We should be able to center the jaws with a resolution below 1 um even with the jaws fully open.

Future Work
• Integration into Tertiary, Dispersion Suppressor and Phase II collimators series.
• Start in production for first installation of TCTP in LHC during next long shutdown.