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The CMS phase-1 pixel detector - experience and lessons learned from 2 years of operation

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In 2017, CMS has installed a new pixel detector with 124M channels that features full 4-hit coverage in the tracking volume and is capable to withstand instantaneous luminosities of $2 \cdot 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ and beyond. By now the detector has been successfully operated for two years in p-p and heavy ion collisions. Besides many improvements of the DAQ system, the detector monitoring capabilities, and silicon property prediction, very valuable experience has been collected in running a detector with DCDC powering and CO2 cooling, which are both new core technologies for most of the upcoming detector upgrades at LHC experiments. During the long shut down of LHC from 2019 to 2021 the CMS pixel detector will be extracted and the modules of the inner most layer that suffered the most from radiation damage will be replaced. At that occasion a better read out chip as well as a new token bit manager chip will be used for these modules that fixes problems observed during operation.
This talk will give an overview of the different improvements that have been made and the challenges that have been faced in the last two years. A special focus will be put on the lessons learned in the light of the design of future detectors. Finally, the planned work on the CMS pixel detector during the LHC shutdown will be outlined.

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