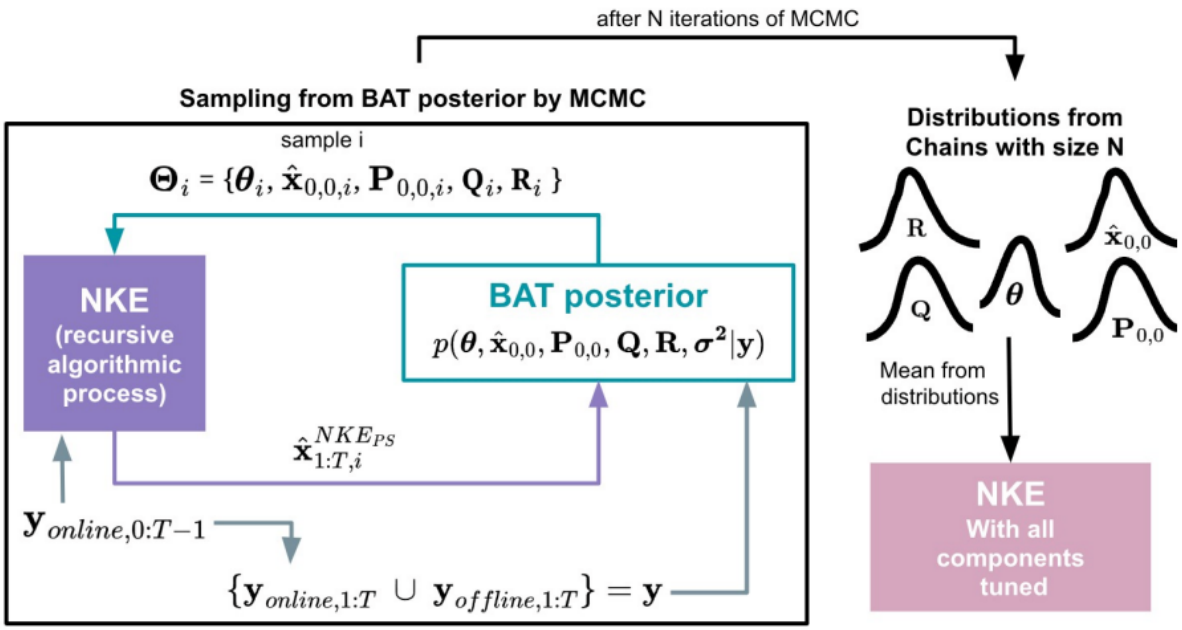

Figure 1. BAT: Batch Bayesian Auto-Tuning for Nonlinear Kalman Estimators. BAT posterior of $\boldsymbol{\theta}, \hat{\mathbf{x}}_{0,0}, \mathbf{P}_{0,0}, \mathbf{Q}, \mathbf{R}$) given $\mathbf{y}$ is defined outside of NKE recursive algorithm that after complete T steps produce a set of predicted mean of states variables $\hat{\mathbf{x}}_{1:T,i}^{NKE_{PS}} = [\hat{\mathbf{x}}_{1,i}^{NKE_{PS}}, ..., \hat{\mathbf{x}}_{T,i}^{NKE_{PS}}]$. $\mathbf{y}$ represent a full set of measured data of all state variables of the system composed of online measurements $\mathbf{y}_{online,1:T}$ (used to generate innovation errors) and offline measurements $\mathbf{y}_{offline,1:T}$ of other state variables. Since $\mathbf{y}$ can be described by a measurement model (Equation 4) outside of the NKE, it is possible to define the BAT likelihood (Equation 7) and priors to obtain the BAT posterior (Equation 8). Then, samples can be extracted by MCMC methods, and after N iterations of MCMC, the mean/mode values can be extracted from the obtained distribution of $\boldsymbol{\theta}, \hat{\mathbf{x}}_{0,0}, \mathbf{P}_{0,0}, \mathbf{Q}, \mathbf{R}$ to tune all NKE components. It is important to that the NKE loop start from update step then the first measurement is included in $\mathbf{y}_{online,0:T-1}$, but not in $\mathbf{y}_{online,1:T}$.