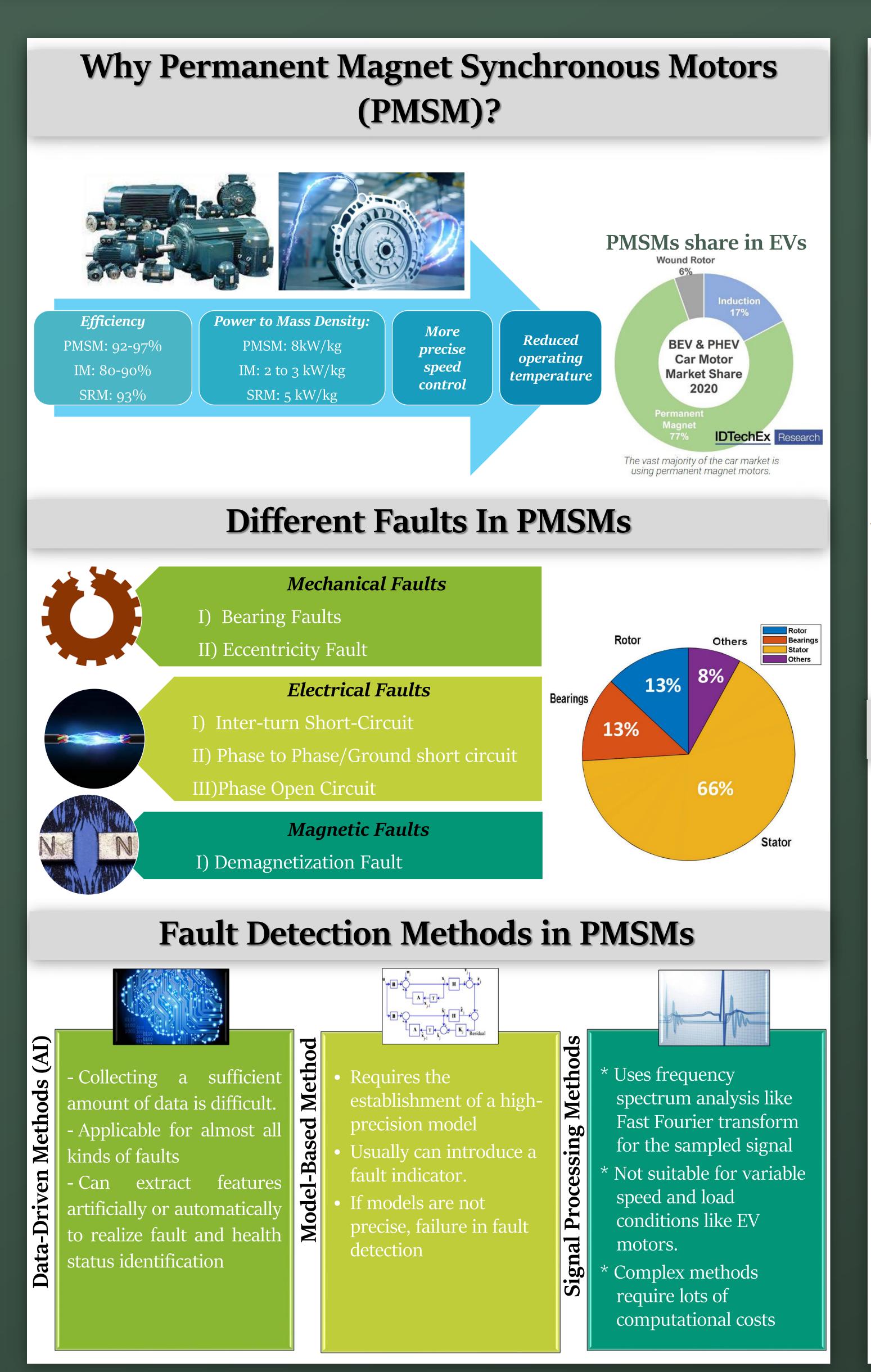
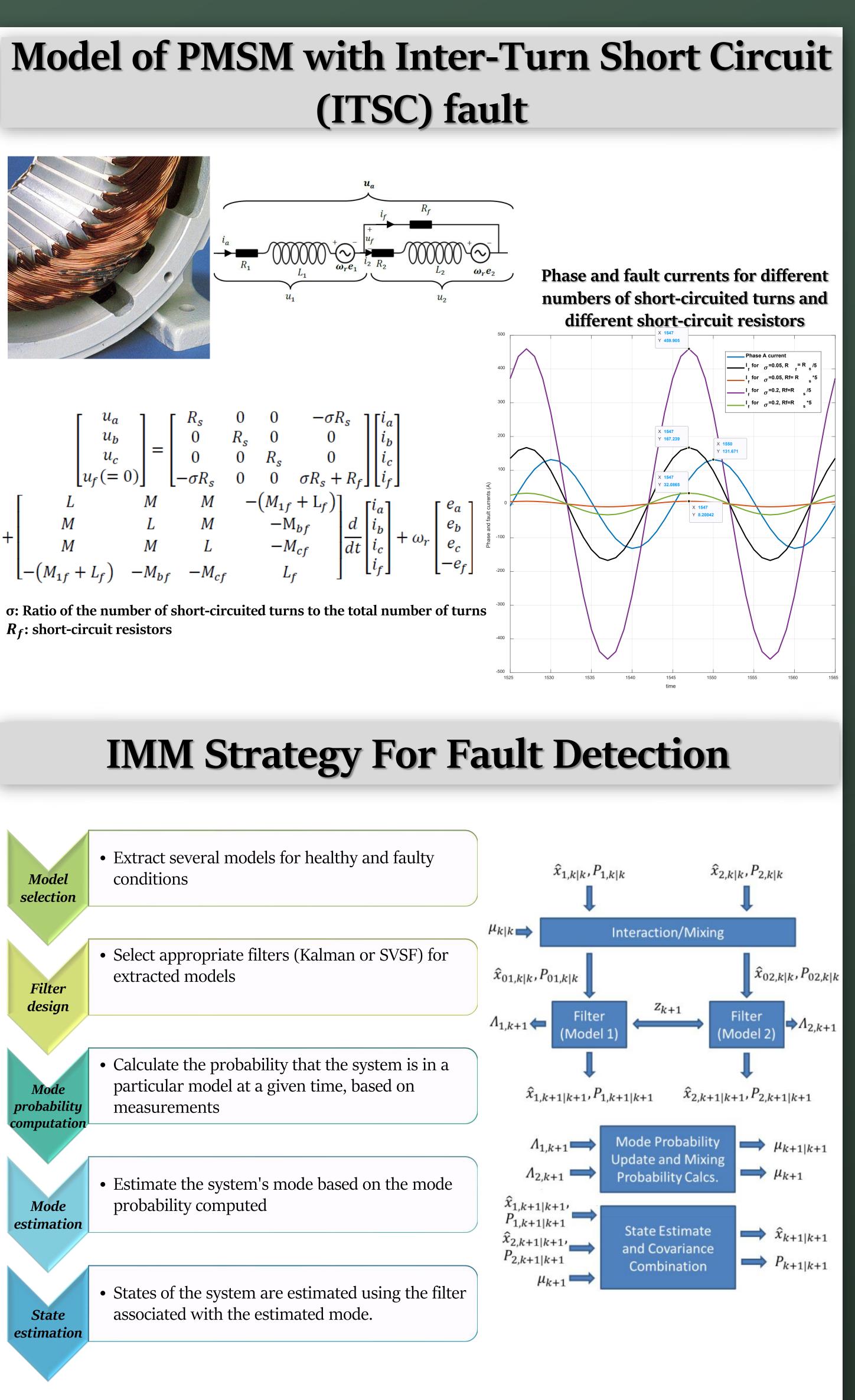
Fault Detection of PMSMs using IMM Strategy

Centre for Mechatronics and Hybrid Technology Mechanical Engineering McMaster University

Ehsan Majma (Supervisors: Dr. Habibi & Dr. Deshpande)

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Parameter and state estimation simultaneously

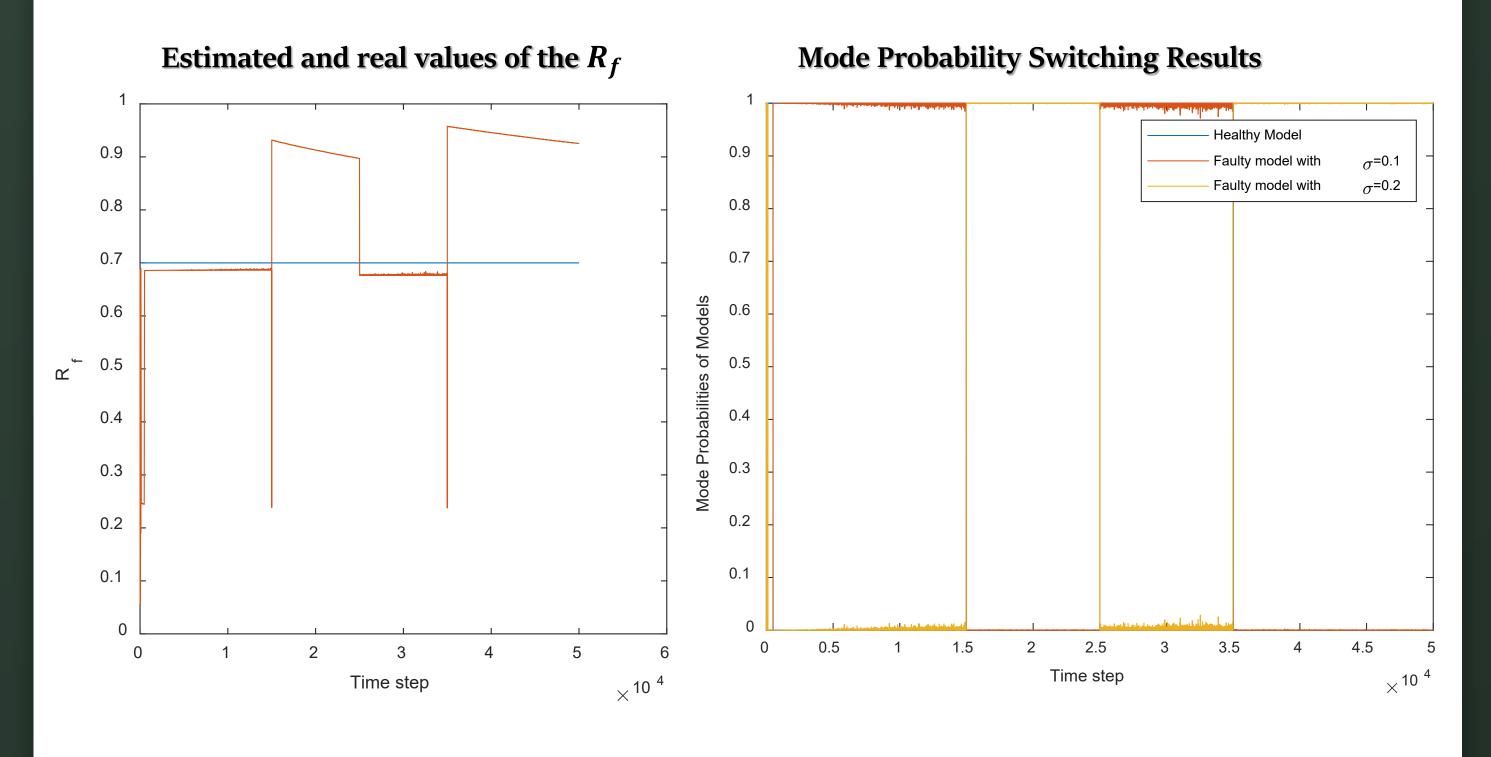
Some parameters in the model are unknown when a fault happens. These parameters need to be estimated with the states of the system at the same time. Equations of the system can be rewritten as:

$$\begin{cases} \dot{X}_{e}(t) = \begin{bmatrix} \dot{X}(t) \\ \dot{\lambda}(t) \end{bmatrix} = \begin{bmatrix} A(\lambda(t)) & 0 \\ 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} X(t) \\ \lambda(t) \end{bmatrix} + \begin{bmatrix} B(\lambda(t)) \\ 0 \end{bmatrix} \cdot U(t) + \begin{bmatrix} W_{X}(t) \\ W_{\lambda}(t) \end{bmatrix} \\ Y(t) = C(\lambda(t)) \cdot X(t) + D(\lambda(t)) \cdot U(t) + V(t) \end{cases}$$

To estimate one or several parameters (λ) of the model

Simulation Results

Three models for fault detection are considered. One for the electric motor in healthy condition and two for faulty conditions with different fault severity. Process or real system has a fault with different severity and switches between different fault severity conditions at sample times equal to 200, 1500, 2500, and 3500. corresponding Extended Kalman Filter (EKF) is designed and used for each one of these models. As presented in the following figures, Interactive Multiple Model (IMM) is able to detect the fault occurrence in a reasonable number of time steps.



The results of the IMM-Kalman filtering need to be compared with IMM-Smooth-Variable Structure Filter (SVSF) since that method is more robust to uncertainty in the models.

Also, all results need to be evaluated using a real PMSM setup which provides access to the middle point of the winding and enables emulating ITSC fault by using an external resistor.











