https://eomys.com/produits/manatee/tutoriaux/electromagnetic-and-vibro-acoustic-simulation-of-buried-permanent-magnet/article/multi-simulation-stator-slot-skewing-effect-at-partial-load-fixed-speed

Multi-simulation: stator slot skewing effect at partial load, fixed-speed

- Products - MANATEE - Tutorials - Electromagnetic and vibro-acoustic simulation of Interior Permanent Magnet Synchronous Machine (Prius case) -

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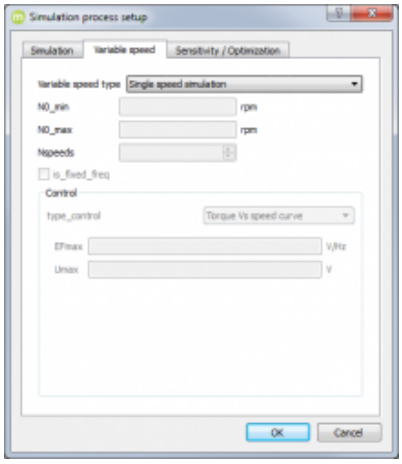
	Tutorial summary
Project name	tuto_IPMSM_08
Machine name	machine_IPMSM_A
Source project	tuto_IPMSM_06
Description	Same as tuto_IPMSM_06 but at partial load

In this example the no-load project tuto_test_IPMSM_06 is copied pasted in a new project named tuto_test_IPMSM_08 to find the optimal stator skew angle with respect to acoustic noise at partial load, fixed speed. Magnetic forces now involve both the fundamental field due to the magnets and due to the armature field.

The variable speed calculation based on spectrogram synthesization is unactivated with

```
Input.Simu.is_spectro_synthesis=0;
```



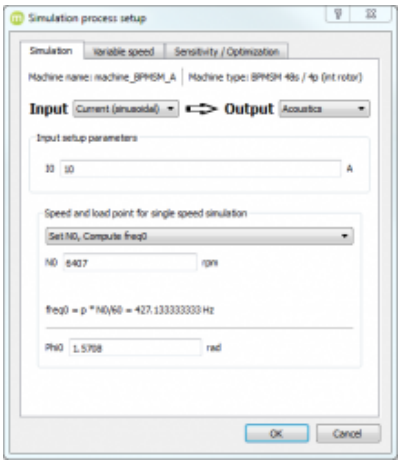
Workflow group (Variable speed tab)

The partial load is activated using

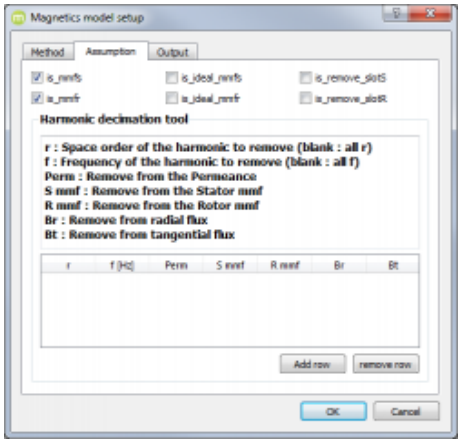
```
Input.Simu.I0 = 10;
 Input.Simu.Phi0 = pi/2;
 Input.Simu.is_fixed_load_angle =1;
 Input.Simu.is_mmfs = 1;
```

The speed is fixed at the resonance of the lamination breathing mode close to 6000 rpm:

```
Input.Simu.N0=6407;
```



Workflow group (Simulation tab)



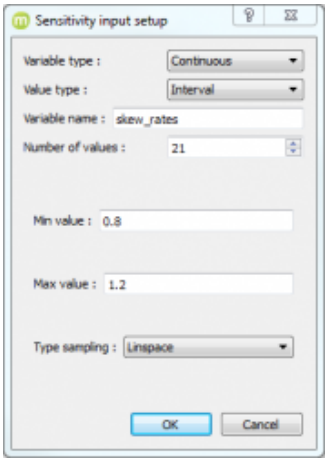
Electromagnetic group (Assumption panel)

The single input variable to be varied is the stator skew angle rate, expressed in stator slot pitch, given by

```
Input.Simu.names_var={'skew_rates'};
```

The skew rate is evenly varied from 0.8 to 1.2 stator slot pitch with 21 different values using

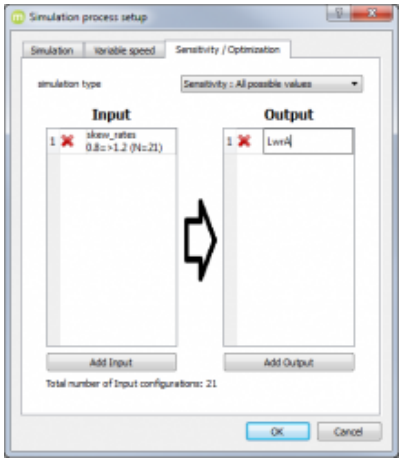
```
Input.Simu.types_var=[0]; %continuous variable
 Input.Simu.types_val=[0]; % Value defined by interval
 Input.Simu.type_sampling=[0]; % linspace sampling
 Input.Simu.bds_contvar={[0.8 1.2]}; %Values between 0.8 and 1.2
 Input.Simu.Nval_contvar=[21]; % 21 values
```



Setup of skew_rates variation

The output variable that is tracked during the sensitivity analysis is the nominal sound power level:

```
Input.Simu.names_resp={'LwrA;};
```

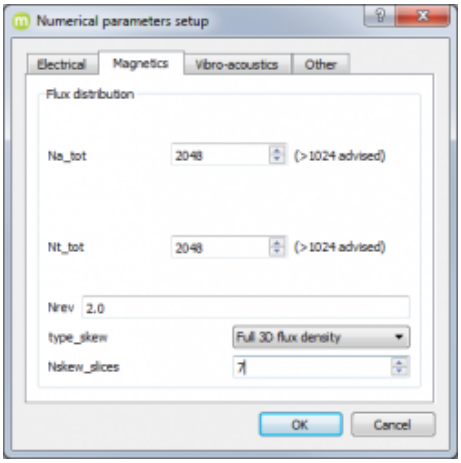


Workflow group (Sensitivity tab)

The default skew shape is linear, it is defined by the machine parameter

```
Input.Geometry.type_skew_geoS=0.
```

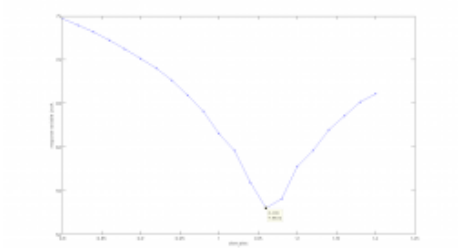
Finally the electromagnetic skewed model based on 7 slices is activated using



Numerical group (Magnetics tab)

```
Input.Simu.type_skew = 2;
 Input.Simu.Nskew_slices = 7;
```

A the end of the calculation, the noise as a function of the skew rate can be plot using plot_MS_all_resp_var



Variable speed maximum noise level as a function of stator skew rate (partial load)

One can see that the optimal skew is slightly above one stator slot pitch.

This confirms that the skew minimizing electromagneticall-excited acoustic noise and vibration is not necessarily one slot pitch.

MANATEE simulation software allows to find the best skew value depending on the force waves responsible for NVH and on the load state of the machine.