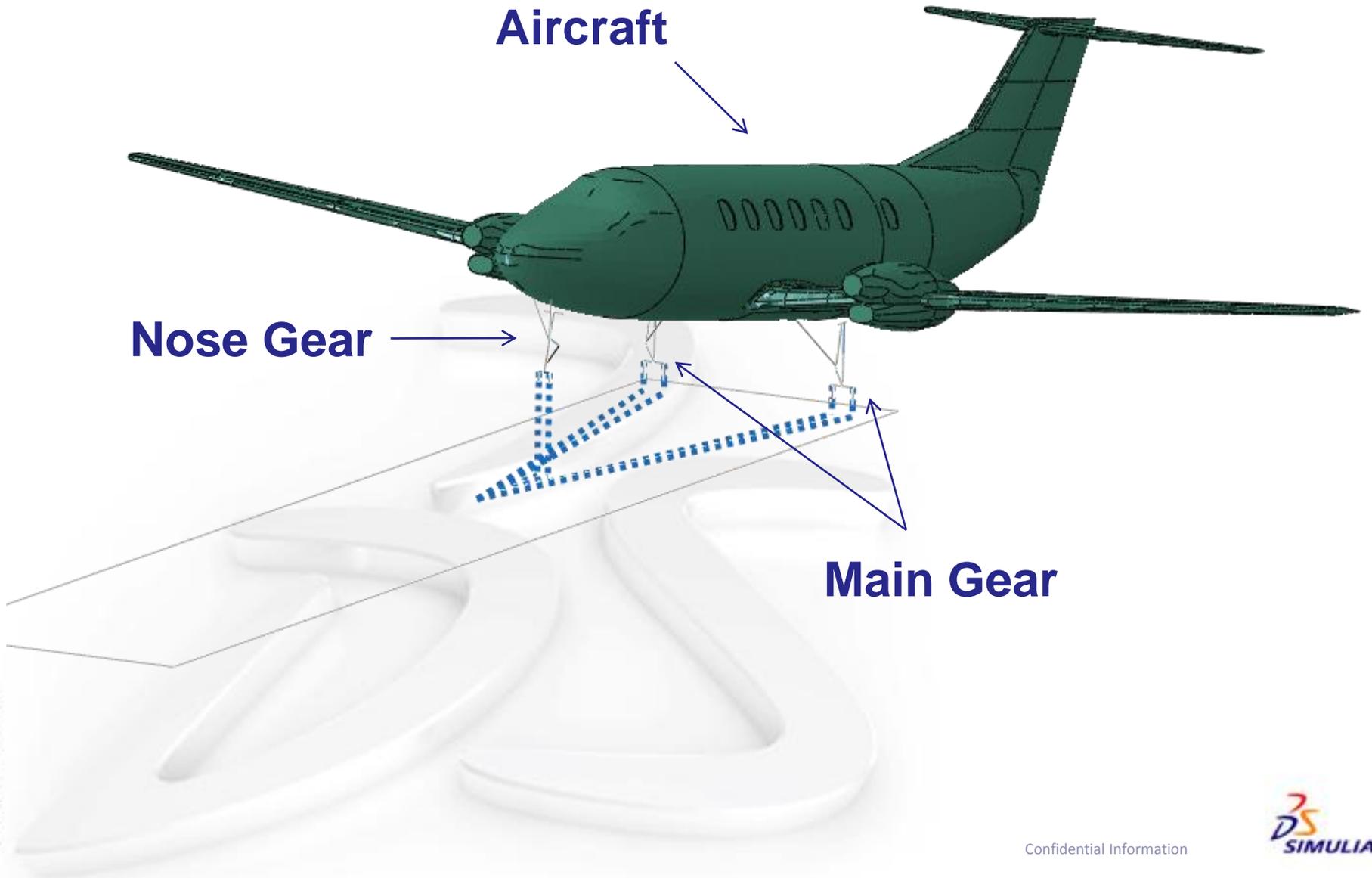


# Landing Gear Model Plug-in

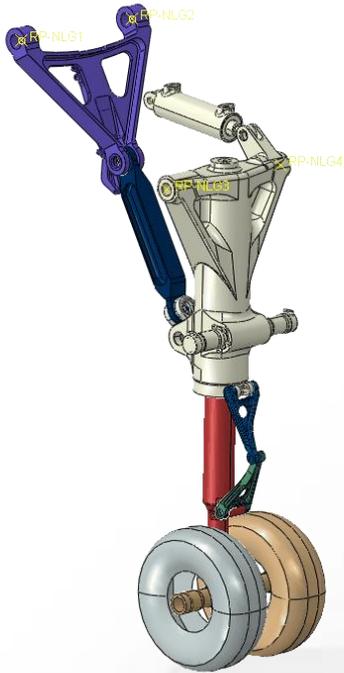


# Landing Gear Model



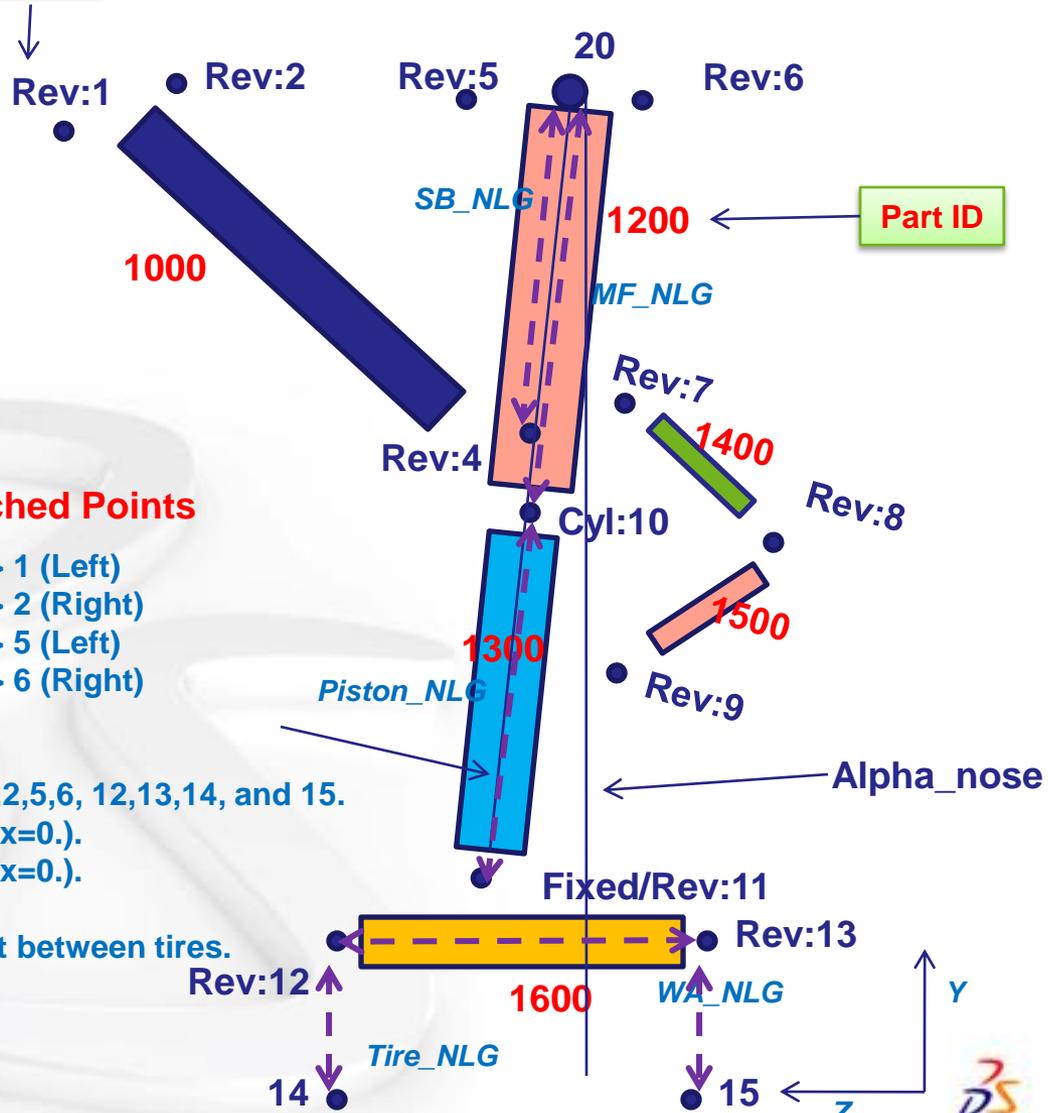
# Schematic Model: Nose Gear

**“Joint Type”: “Last digit of reference point ID”**



**Aircraft Attached Points**

- RP-NLG1 => 1 (Left)
- RP-NLG2 => 2 (Right)
- RP-NLG3 => 5 (Left)
- RP-NLG4 => 6 (Right)



**Assumption:**

- Every points lies in the YZ plane except for 1,2,5,6, 12,13,14, and 15.
- Points 1 and 2 are symmetric w.r.t. YZ plane (x=0.).
- Points 5 and 6 are symmetric w.r.t. YZ plane (x=0.).
- Points 20,4,10, and 11 are on the same line.
- The bottom point at shock is the middle point between tires.

# Schematic Model: Main Gear

**“Joint Type” : “Last Digit of Reference point ID”**

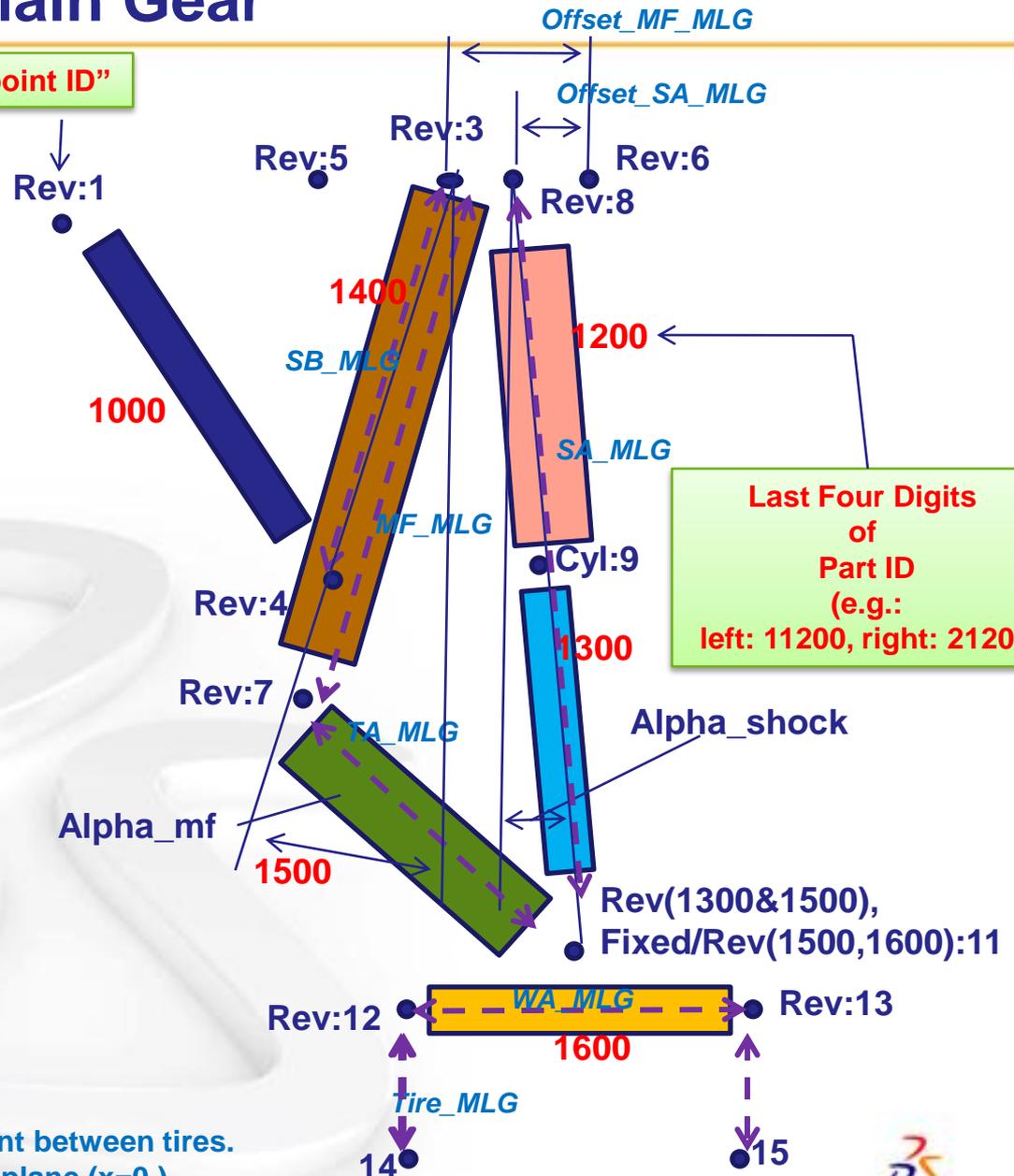


## Aircraft Attached Points

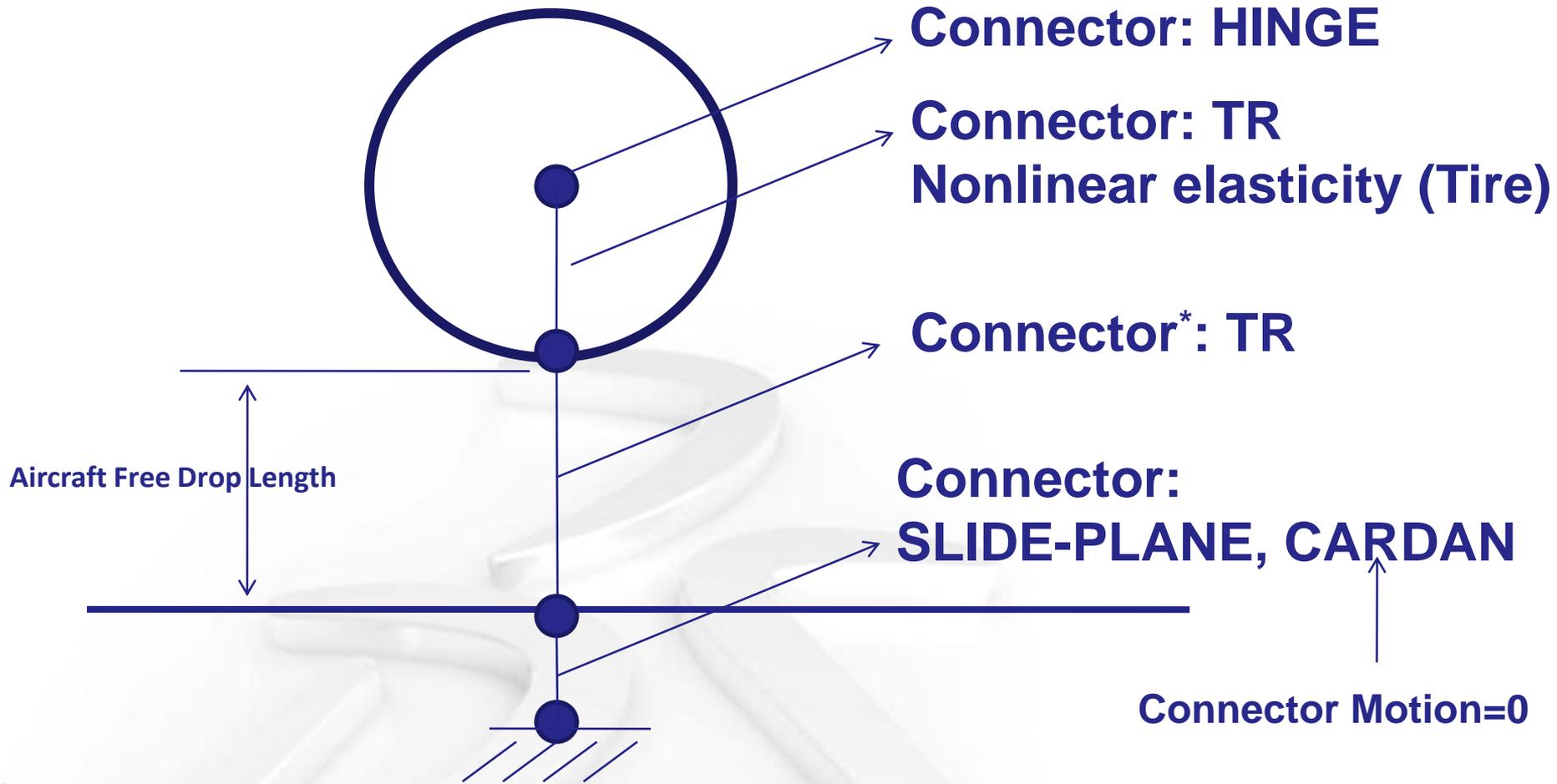
- RP-MLG\_left1 => 5
- RP-MLG\_left2 => 6
- RP-MLG\_left3 => 1

## Assumption:

- Points 5,3,8 and 6 are on the same line.
- Points 3, 4 and 7 are on the same line.
- The bottom point at shock is the middle point between tires.
- Left and right MLGs are symmetric w.r.t. YZ plane (x=0.).
- The axis of orientation of 1 is in the ZX plane.



# Schematic Model: Tire and Ground



\* The working length is defined by “\*Connector Stop”.

\*\* The working length of the tire is also defined by “\*Connector Stop”

# Approximate Mass and Inertia of NLG

- The total aircraft mass: 22.65 ton

		Mass	Ixx	Iyy	Izz
NLG	Folding Braces	1.00E-03	1.00E+04	1.00E+04	2.00E+03
	MF	3.00E-03	6.00E+02	6.00E+02	80
	piston	3.00E-03	40	40	1.00E-01
	torque link Top	1.00E-03	0.1	0.1	1.00E-03
	torque link Bot	1.00E-03	0.1	0.1	1.00E-03
	WA	1.00E-03	2	2	2.00E-02
	Wheel	1.00E-01	3000	3000	1000
MLG	Folding Braces	6.00E-03	1000	1000	2
	MF	6.00E-03	5000	5000	100
	TA	5.00E-03	7	7	4.00E-02
	SA Top	1.00E-03	200	200	1
	SA Bot	1.00E-03	40	40	7.00E-02
	WA	1.00E-03	20	20	5.00E-02
	Wheel	1.00E-01	8.00E+04	8.00E+04	4.00E+04
Aircraft	Body	22	65.e6	100.e6	100.e6
Total Mass (considering 2 MLGs and a pair of tires)		22.65	N/A		

- Every node in A/Explicit needs mass/inertia.

- We define relatively small mass/inertia for this.
  - Mass = 1.e-7, inertia = 1.e-7

# Analysis Parameter Tab

**Analysis Parameters** | Nose Gear | Main Gear

**Aircraft Condition**

Pitch Angle (deg)  Downward Initial Velocity  Forward Initial Velocity

Gravity

CG X  CG Y  CG Z

**Analysis Condition**

Time Constant for Landing  Delay Time for Lift

Time Step  End Time

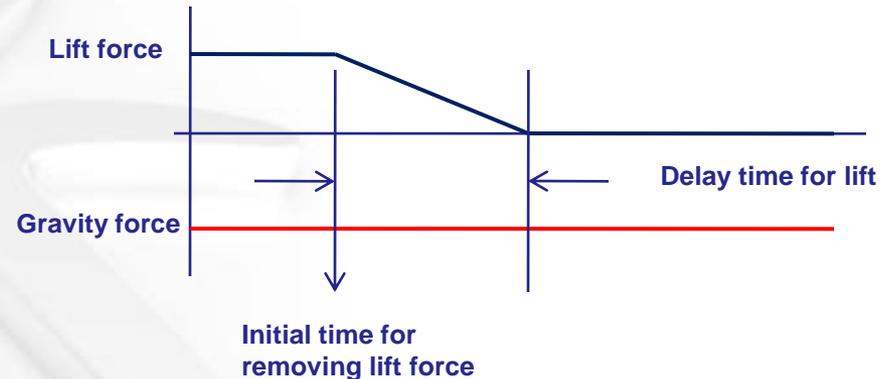
Field Output Number

**Aircraft Mass and Inertia**

Airplane Mass

Airplane Ixx  Airplane Iyy  Airplane Izz

- **Pitch Angle:** pitch angle of the aircraft (deg)
- **Downward Initial Velocity:** initial velocity of the aircraft to the center of the earth
- **Forward Initial Velocity:** initial velocity of the aircraft in forward direction
- **Gravity:** the acceleration of the gravity ( $\text{mm/s}^2$ )
- **CG X,Y,Z:** the coordinate of CG of the aircraft
- **Time constant for landing:** Initial time for removing lift force= 1./ “time constant for landing”
- **Delay time for lift:**



- **Time step, end time:** time step and end time in A/explicit
- **Field Output number:** number of field output
- **Airplane mass and inertia**

# Nose Gear Tab

Analysis Parameters | **Nose Gear** | Main Gear

Diagram:

**Reference Aircraft Attached Points**

RP-NLG1 X	222.75	RP-NLG1 Y	-756	RP-NLG1 Z	-2552
RP-NLG2 X	-222.75	RP-NLG2 Y	-756	RP-NLG2 Z	-2552
RP-NLG3 X	230.5	RP-NLG3 Y	-1115	RP-NLG3 Z	-3145
RP-NLG4 X	-230.5	RP-NLG4 Y	-1115	RP-NLG4 Z	-3145

**NLG Modeling Parameters**

ALPHA\_nose (deg) 7.5

SB\_NLG 600 MF\_NLG 690 Piston\_NLG 550 WA\_NLG 240 Tire\_NLG 212

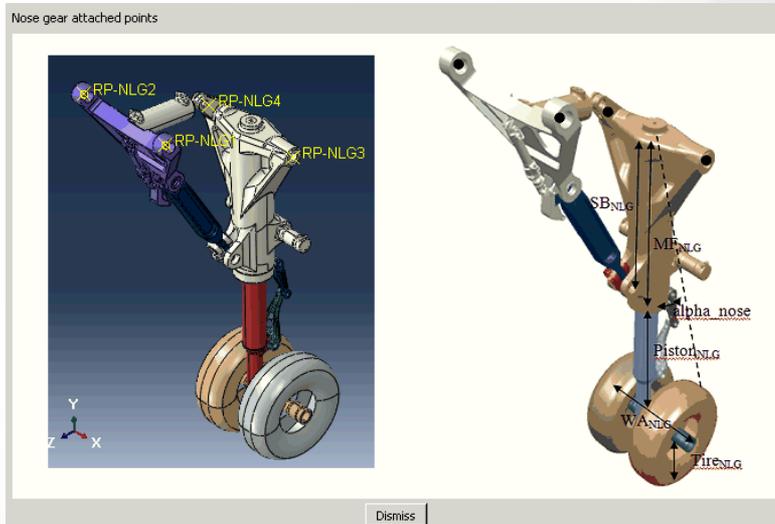
S.A. Stroke 300 Tire\_Damping\_Coeff 10

Spring Data File spring\_nose.prc Damper Data File damper\_nose.p Tire Data File tire\_nose.pro

**NLG Mass and Inertia**

FB mass	0.001	MF mass	0.003	piston mass	0.003						
TP mass	0.001	TB mass	0.001	WA mass	0.001	Wheel mass	0.1				
FB Ixx	10000	FB Iyy	10000	FB Izz	2000	MF Ixx	600	MF Iyy	600	MF Izz	80
Piston Ixx	40	Piston Iyy	40	Piston Izz	0.1	TP Ixx	0.1	TP Iyy	0.1	TP Izz	0.001
TB Ixx	0.1	TB Iyy	0.1	TB Izz	0.001	WA Ixx	2	WA Iyy	2	WA Izz	0.02
Wheel Ixx	3000	Wheel Iyy	3000	Wheel Izz	1000						

- **RP-NLG1, 2, 3, 4:** The coordinate of the reference points in nose gear system. (please see the slide 3)
- **NLG modeling parameter:** relative length for nose gear system. (please see the slide 3)
- **Spring data file, damper data file, tire data file:** nonlinear spring (spring force is function of relative displacement(stroke), nonlinear damper (damping force is function of relative displacement(stroke) and relative velocity), and nonlinear tire stiffness (tire spring force is function of relative displacement (tire deflection))
  - Spring data file format: force, relative displacement
  - Damper data file format: force, relative velocity, relative displacement
  - Tire data file format: force, relative displacement



- **NLG mass and inertia:** please see the slide 3
  - FB: folding brace: Part 1000
  - MF: main fitting: Part 1200
  - Piston: piston: Part 1300
  - TP: Part 1400
  - TB: Part 1500
  - WA: wheel axle: Part 1600
  - Wheel: wheel: Part 1700 and Part 1800 (these are not shown in slide 3)

# Main Gear Tab

Analysis Parameters			Nose Gear			Main Gear					
Diagram:											
<b>Reference Aircraft Attached Points (mm)</b>											
RP-MLG1 X	2169	RP-MLG1 Y	-1074	RP-MLG1 Z	-11567						
RP-MLG2 X	2233	RP-MLG2 Y	-1136	RP-MLG2 Z	-11065						
RP-MLG3 X	1429	RP-MLG3 Y	-1136	RP-MLG3 Z	-10806						
<b>MLG Modeling Parameters</b>											
ALPHA_mf (deg)	4	ALPHA_shock (deg)	9								
SB_MLG	880	MF_MLG	950	TA_MLG	460	SAB_MLG	1330				
WA_MLG	480	Tire_MLG	370	Offset_SA_MLG	146	Offset_MF_MLG	270				
S.A. Stroke	360	Tire_Damping_Coeff	10								
Spring Data File	spring_main.prc	Damper Data File	damper_main.p	Tire Data File	tire_main.prope						
<b>MLG Mass and Inertia</b>											
FB mass	0.006	MF mass	0.006	TA mass	0.005	SAT mass	0.001	SAB mass	0.001		
WA mass	0.001	Wheel mass	0.1								
FB Ixx	1000	FB Iyy	1000	FB Izz	2	MF Ixx	5000	MF Iyy	5000	MF Izz	100
TA Ixx	7	TA Iyy	7	TA Izz	0.04	SAT Ixx	200	SAT Iyy	200	SAT Izz	1
SAB Ixx	40	SAB Iyy	40	SAB Izz	0.07	WA Ixx	20	WA Iyy	20	WA Izz	0.05
Wheel Ixx	80000	Wheel Iyy	80000	Wheel Izz	40000						

- **RP-MLG1, 2, 3:** The coordinate of the reference points in main gear system. (please see the slide 4)
- **MLG modeling parameter:** relative length for nose gear system. (please see the slide 4)
- **Spring data file, damper data file, tire data file:** nonlinear spring (spring force is function of relative displacement(stroke), nonlinear damper (damping force is function of relative displacement(stroke) and relative velocity), and nonlinear tire stiffness (tire spring force is function of relative displacement (tire deflection))
  - Spring data file format: force, relative displacement
  - Damper data file format: force, relative velocity, relative displacement
  - Tire data file format: force, relative displacement

- **MLG mass and inertia: please see the slide 4**

- FB: folding brace: Part 1000
- MF: main fitting: Part 1400
- TA: tailing arm: Part 1500
- SAT: Upper Shock Absorber: Part 1200
- SAB: Lower Shock Absorber: Part 1300
- WA: wheel axle: Part 1600
- Wheel: wheel: Part 1700 and Part 1800 (these are not shown in slide 4)

