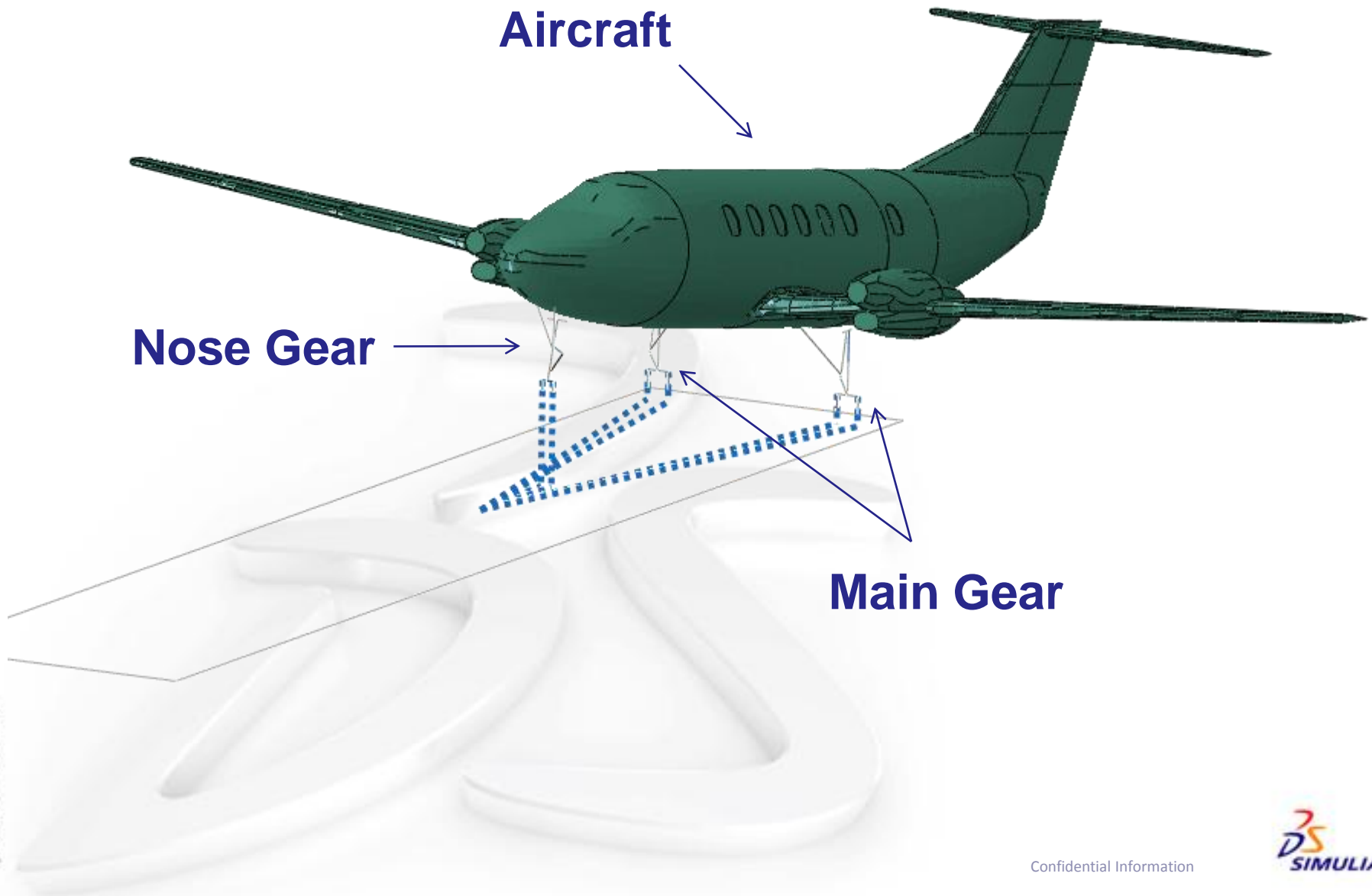


# Landing Gear Model Plug-in

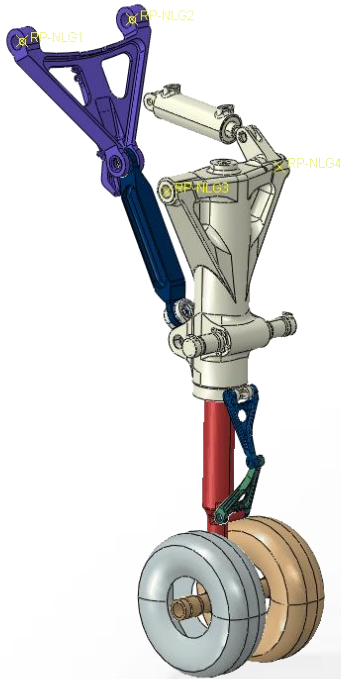


# Landing Gear Model



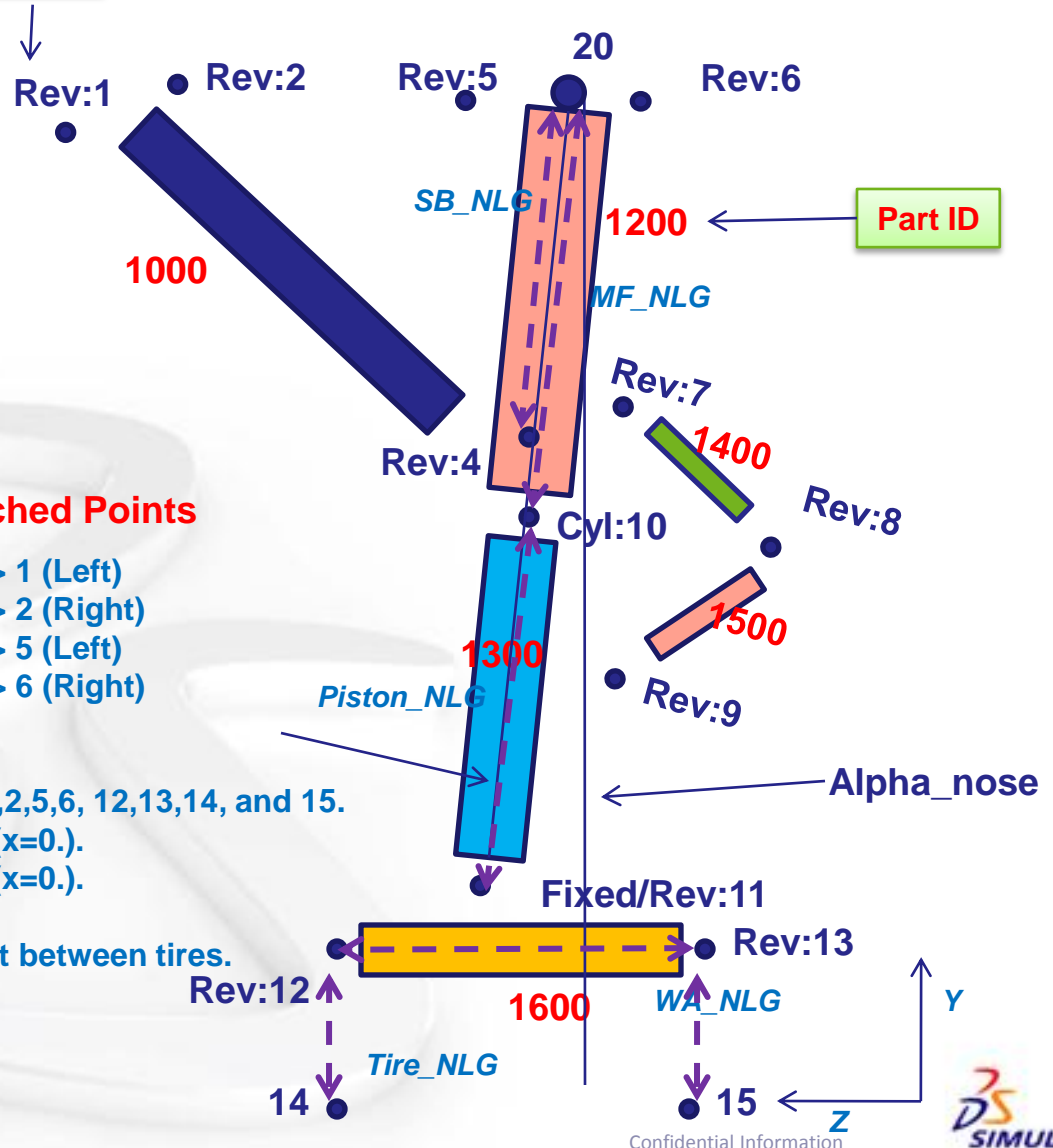
# Schematic Model: Nose Gear

**“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)

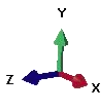
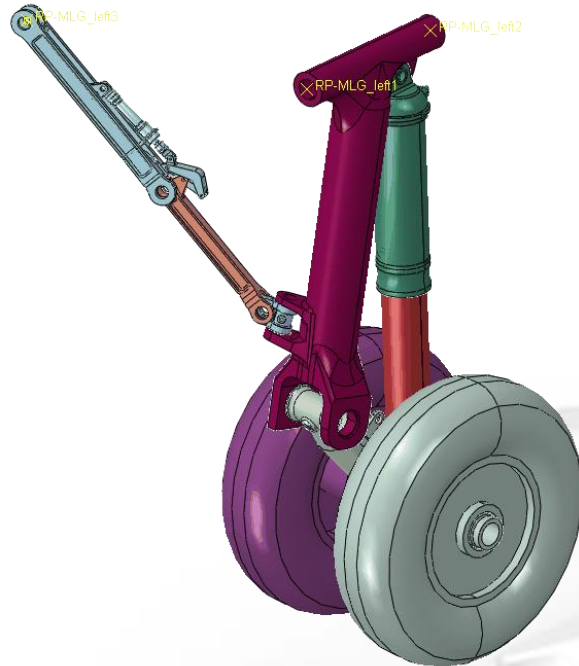


## Assumption:

- 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"**

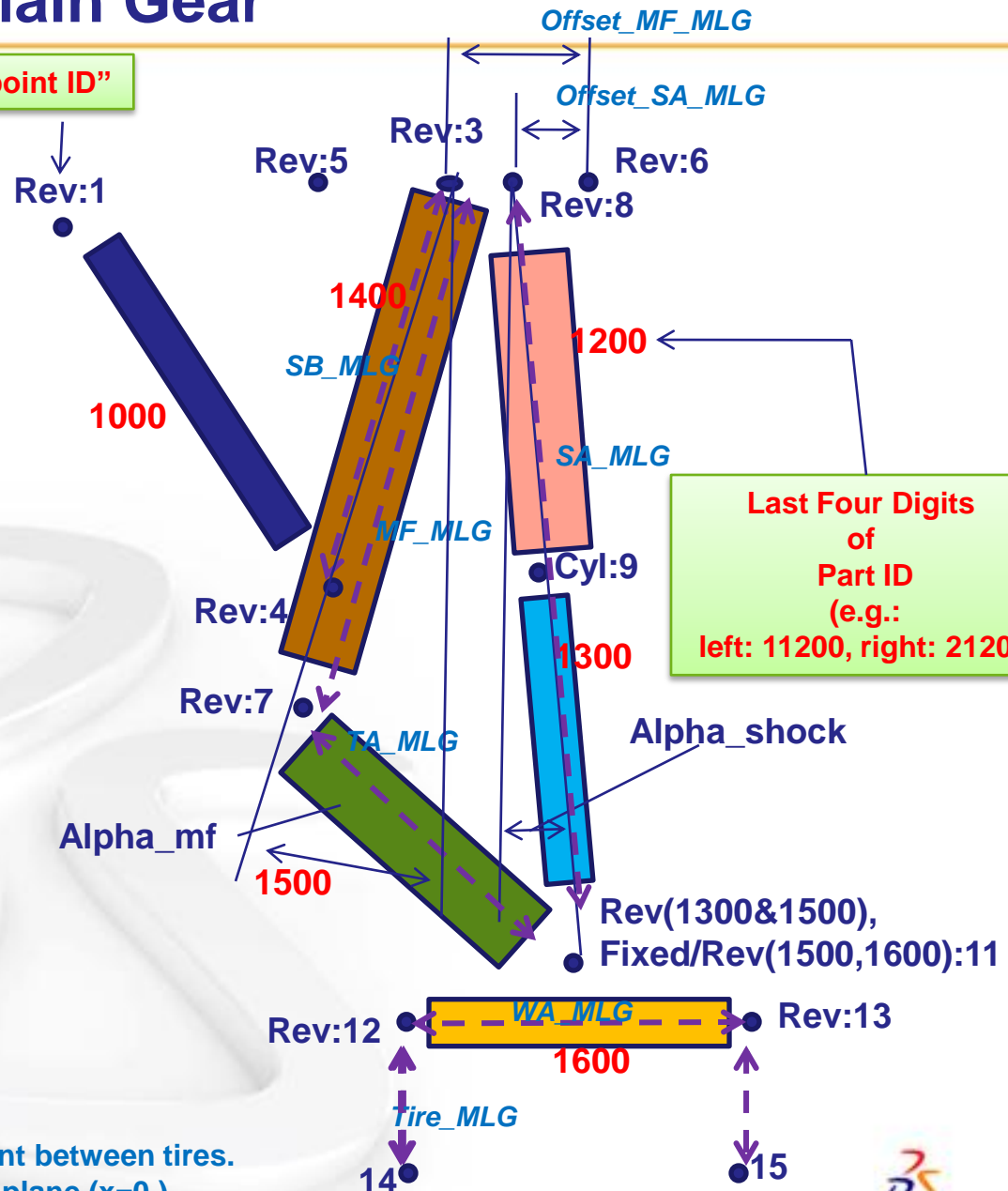


## Aircraft Attached Points

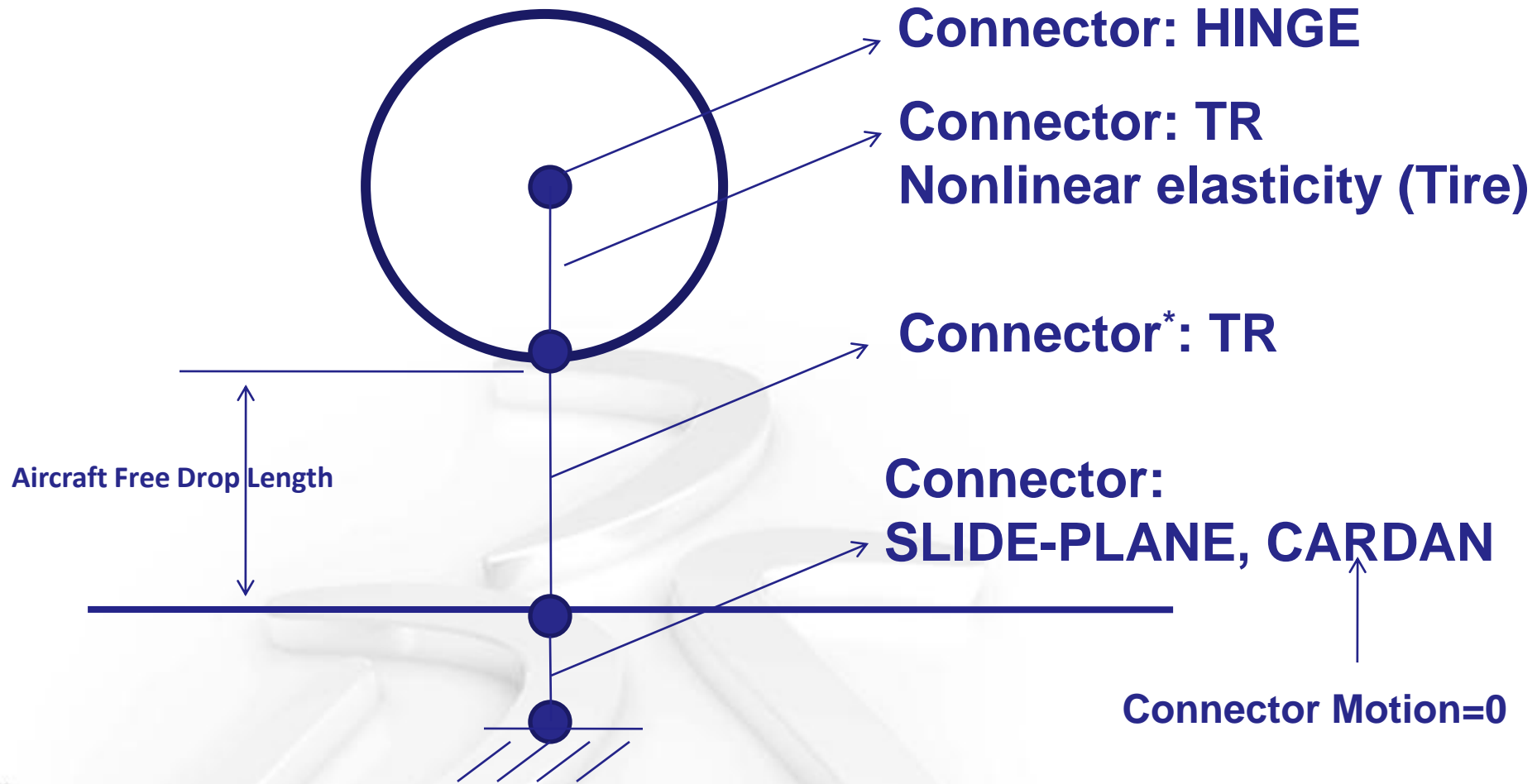
RP-MLG\_left1 => 5  
RP-MLG\_left2 => 6  
RP-MLG\_left3 => 1

## 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”

Confidential Information

# 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

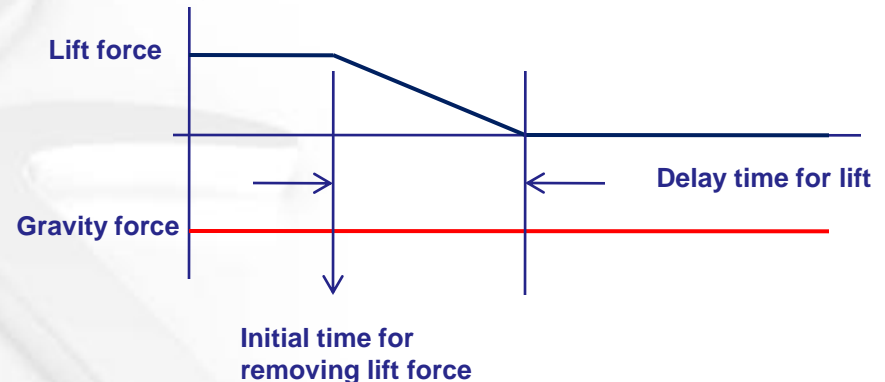
Field Output Number

**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)

SB\_NLG  MF\_NLG  Piston\_NLG  WA\_NLG  Tire\_NLG

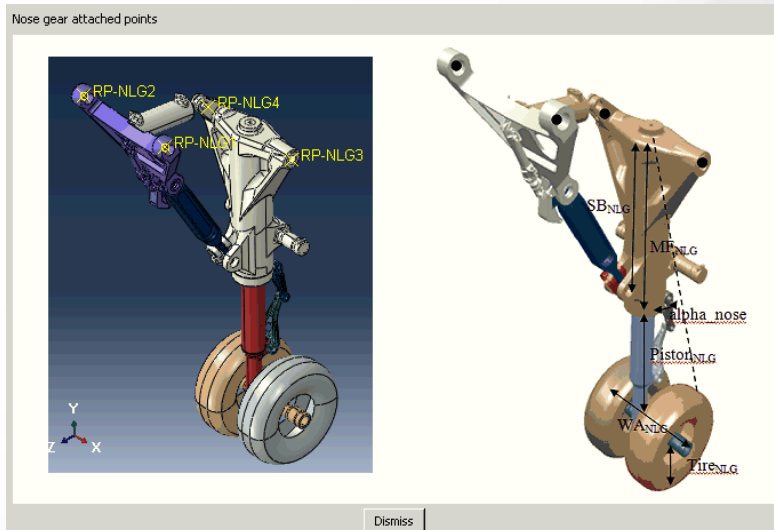
S.A. Stroke  Tire\_Damping\_Coeff

Spring Data File  Damper Data File  Tire Data File

**NLG Mass and Inertia**

FB mass	<input type="text" value="0.001"/>	MF mass	<input type="text" value="0.003"/>	piston mass	<input type="text" value="0.003"/>
TP mass	<input type="text" value="0.001"/>	TB mass	<input type="text" value="0.001"/>	WA mass	<input type="text" value="0.001"/>
Wheel mass	<input type="text" value="0.1"/>				
FB Ixx	<input type="text" value="10000"/>	FB Iyy	<input type="text" value="10000"/>	FB Izz	<input type="text" value="2000"/>
MF Ixx	<input type="text" value="600"/>	MF Iyy	<input type="text" value="600"/>	MF Izz	<input type="text" value="80"/>
Piston Ixx	<input type="text" value="40"/>	Piston Iyy	<input type="text" value="40"/>	Piston Izz	<input type="text" value="0.1"/>
TP Ixx	<input type="text" value="0.1"/>	TP Iyy	<input type="text" value="0.1"/>	TP Izz	<input type="text" value="0.001"/>
TB Ixx	<input type="text" value="0.1"/>	TB Iyy	<input type="text" value="0.1"/>	TB Izz	<input type="text" value="0.001"/>
WA Ixx	<input type="text" value="2"/>	WA Iyy	<input type="text" value="2"/>	WA Izz	<input type="text" value="0.02"/>
Wheel Ixx	<input type="text" value="3000"/>	Wheel Iyy	<input type="text" value="3000"/>	Wheel Izz	<input type="text" value="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:

**Reference Aircraft Attached Points (mm)**

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

**MLG Modeling Parameters**

ALPHA_mf (deg)	4	ALPHA_shock (deg)	9		
SB_MLG	880	MF_MLG	950	TA_MLG	460
WA_MLG	480	Tire_MLG	370	Offset_SA_MLG	146
S.A. Stroke	360	Tire_Damping_Coeff	10	Offset_MF_MLG	270

Spring Data File spring\_main.prc Damper Data File damper\_main.p Tire Data File tire\_main.prope

**MLG Mass and Inertia**

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
TA Ixx	7	TA Iyy	7	TA Izz	0.04	SAT Ixx	200	SAT Iyy	200
SAB Ixx	40	SAB Iyy	40	SAB Izz	0.07	WA Ixx	20	WA Iyy	20
Wheel Ixx	80000	Wheel Iyy	80000	Wheel Izz	40000	WA Izz	0.05		

- **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)

