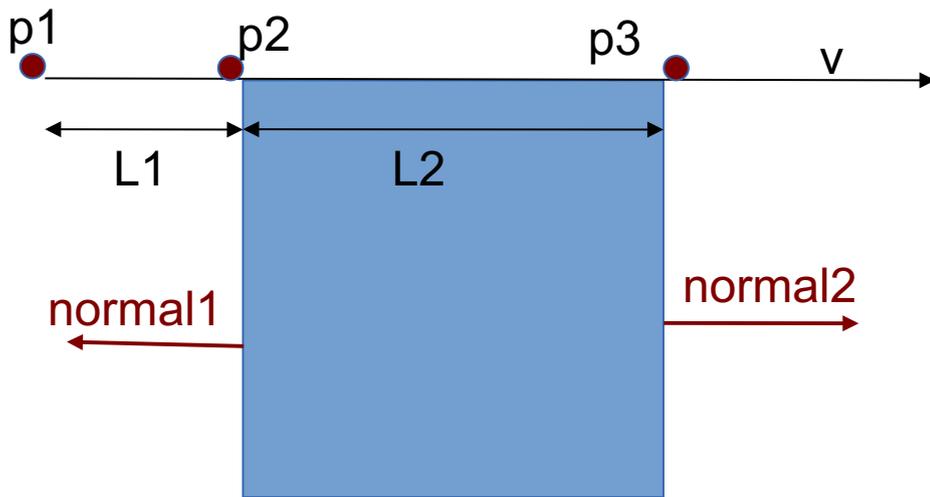


# Shape Conventions

*Distance & Safety*

# Convex shape with flat surfaces, conventions for 'scratching' directions

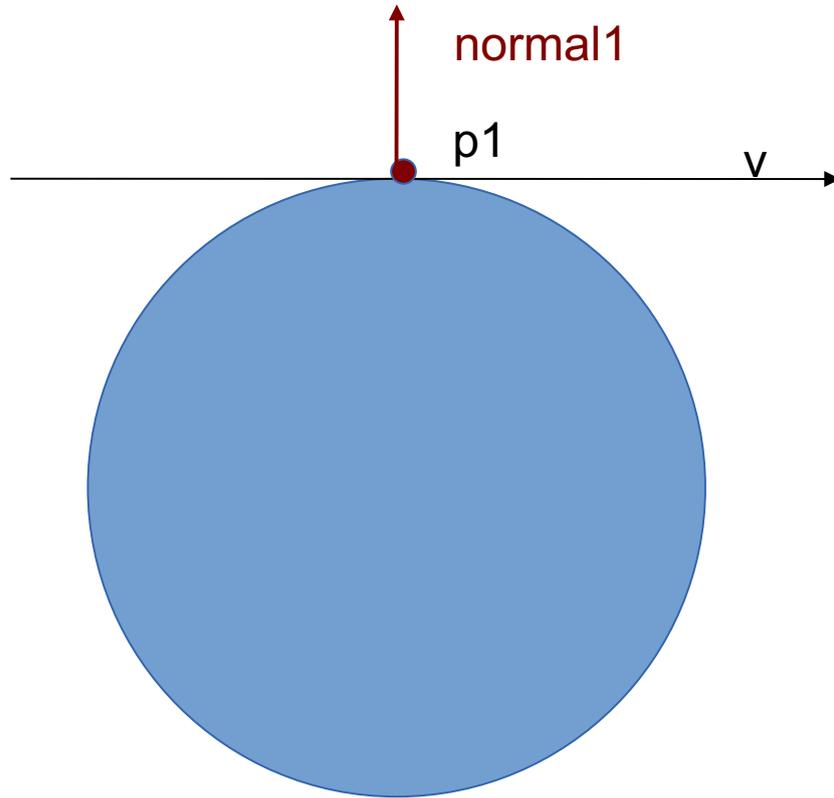


p1 : DistanceToIn(p1,v) = L1

p2 : DistanceToIn (p2,v) = 0, (normal1,v) < 0  
DistanceToOut(p2,v) = L2, (normal1,v) < 0

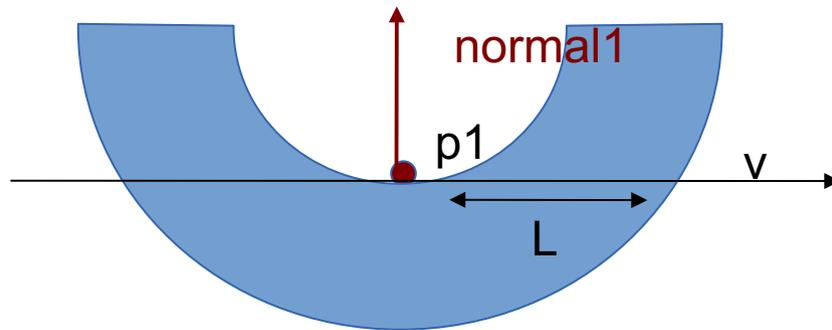
p3 : DistanceToIn (p3,v) = Infinity, (normal2,v) > 0  
DistanceToOut(p3,v) = 0, (normal2,v) > 0

# Convex shape with curved surfaces, conventions for 'scratching' directions



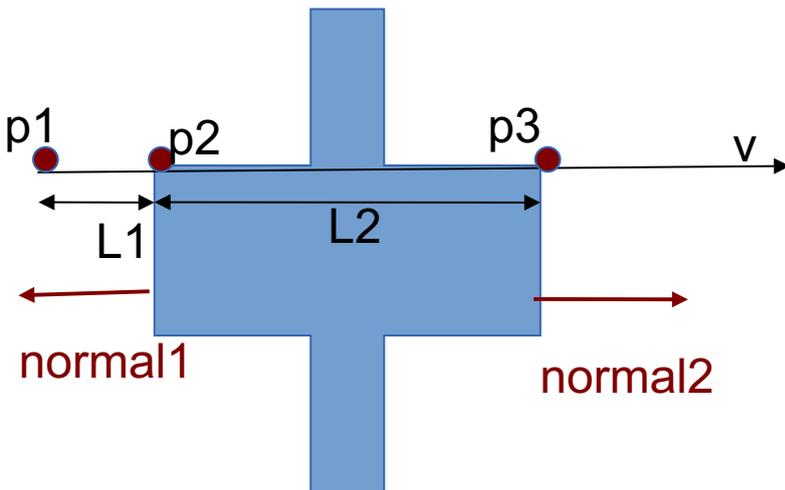
$p1$  : DistanceToIn ( $p1, v$ ) = Infinity, ( $normal1, v$ ) = 0  
DistanceToOut( $p1, v$ ) = 0, ( $normal1, v$ ) = 0

## Concave shape with curved surfaces, 'scratching' directions



P1 : DistanceToIn (p1,v) = 0, (normal1,v) = 0  
 DistanceToOut(p1,v) = L, (normal1,v) = 0

## Concave shape with flat surfaces, 'scratching' directions

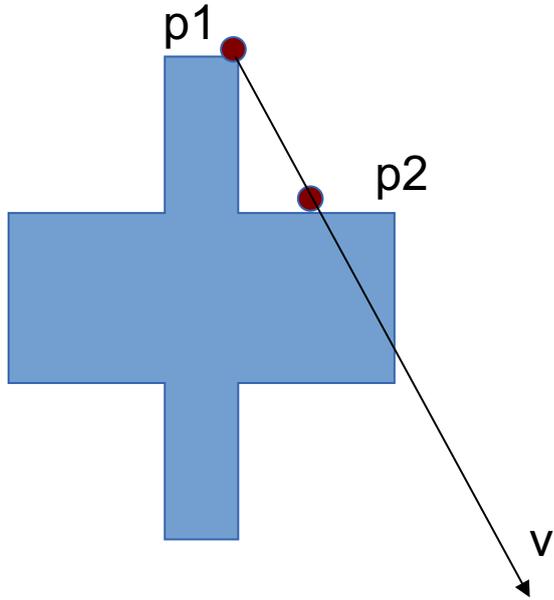


p1 : DistanceToIn(p1,v) = L1, not Infinity

p2 : DistanceToIn (p2,v) = 0, (normal1,v) < 0  
 DistanceToOut(p2,v) = L2, (normal1,v) < 0

p3 : DistanceToIn (p3,v) = Infinity, (normal2,v) > 0  
 DistanceToOut(p3,v) = 0, (normal2,v) > 0

## Concave shapes , 'reentering' directions



p1 :  $\text{DistanceToIn}(p1, v) = L1$ , not Infinity

# Conventions. DistanceToIn(p,v)

DistanceToIn(p,v) return the exact distance (double) to the surface of the shape for given point p and direction v. Normal is pointing outwards shape.

	Geant4	USolids	VecGeom	ROOT
Point p is <b>Outside</b> No intersection Between shape and ray(p+v*t)	Infinity	Infinity	Infinity	Infinity
Point p is <b>Outside</b> Intersection Between shape and ray(p+v*t)	Distance	Distance	Distance	Distance
Point p is <b>on Surface</b>	0, if 'entering shape', normal.dot(v) < 0 for convex shapes  <b>Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape', normal.dot(v) &gt;= 0 for convex shapes</b>	0, if 'entering shape', normal.dot(v) < 0 for convex shapes  <b>Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape' normal.dot(v) &gt;= 0, for convex shapes</b>	<b>Distance</b> , if 'entering shape'  <b>Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape'</b>	0, if 'entering shape', normal.dot(v) < 0 for convex shapes  <b>Infinity for convex shapes or Distance to next Intersection for concave shapes, if 'leaving shape', normal.dot(v) &gt;= 0 for convex shapes</b>
Point p is <b>Inside</b> "Wrong side"	Undefined or 0	0	Negative number	Negative number or 0
If Distance(p,v)<halfTolerance	0	0	Distance	

# Conventions. *DistanceToOut(p,v)*

*DistanceToOut(p,v)* return the exact distance (double) to the surface of the shape for given point *p* and direction *v*. Normal is pointing outwards shape.

	Geant4	USolids	VecGeom	ROOT
Point <i>p</i> is <b>Inside</b> No intersection Between shape and ray( <i>p+v*t</i> ), “wrong result”	Infinity, as default value	Infinity, as default value	Infinity, as default value	Infinity, as default value
Point <i>p</i> is <b>Inside</b> Intersection Between shape and ray( <i>p+v*t</i> )	Distance	Distance	Distance	Distance
Point <i>p</i> is <b>on Surface</b>	<b>0</b> , if 'leaving' shape, $\text{normal.dot}(v) \geq 0$ for convex shape <b>DistanceTo next boundary</b> , if 'entering' shape, $\text{normal.dot}(v) < 0$ for convex shape	<b>0</b> , if 'leaving' shape, $\text{normal.dot}(v) \geq 0$ , for convex shape <b>DistanceTo next boundary</b> , if 'entering' shape, $\text{normal.dot}(v) < 0$ for convex shaper	<b>Distance</b> , if 'leaving shape' <b>DistanceTo next boundary</b> , if 'entering shape'	<b>0</b> , if 'leaving' shape, $\text{normal.dot}(v) \geq 0$ for convex shape <b>DistanceTo next boundary</b> , if 'entering' shape, $\text{normal.dot}(v) < 0$ for convex shape
Point <i>p</i> is <b>Outside</b> “Wrong side”	Undefined or 0	0	Negative number	Negative number or 0
If $\text{Distance}(p,v) < \text{halfTolerance}$	0	0	Distance	

# Conventions. *SafetyFromOutside(p)*

SafetyFromOutside estimates isotropic distance to the surface of the shape from Outside. This must be either accurate or an underestimate.

	Geant4	USolids	VecGeom	ROOT
Point p is <b>Outside</b>	Safety	Safety	Safety	Safety
Point p is <b>on Surface</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Point p is <b>Inside</b> "Wrong side"	0	0	Negative number	Negative number or 0

# Conventions. *SafetyFromInside(p)*

*SafetyFromInside(p)* estimates isotropic distance to the surface of the shape from Inside point p. This must be either accurate or an underestimate.

	Geant4	USolids	VecGeom	ROOT
Point p is <b>Inside</b>	Safety	Safety	Safety	Safety
Point p is <b>on Surface</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Point p is <b>Outside</b> "Wrong side"	0	0	Negative number	Negative number or 0