

Déformation de la valve Aortique: première approche mécanique

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But

- Construire un modèle numérique.
- Évaluer la déformation de la valve, étudier les déplacements sous chargement.
- Modélisation de la valve sous 2 logiciels, de conception et de calcul.

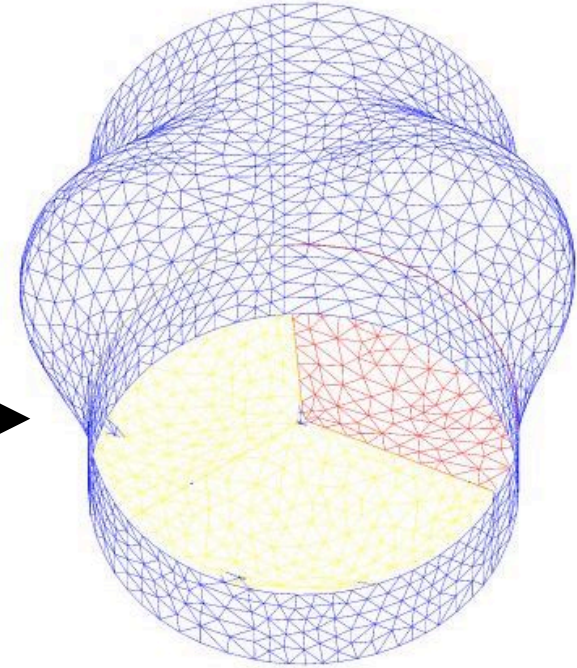
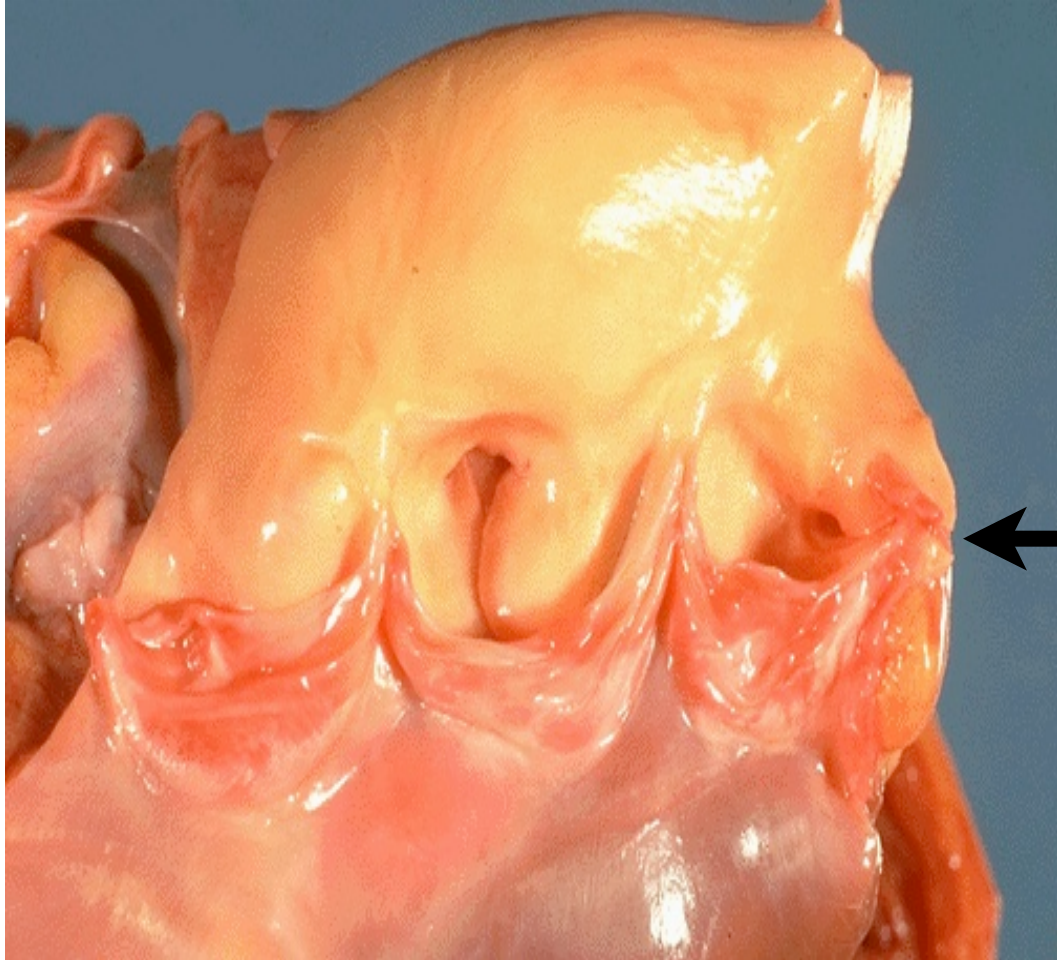
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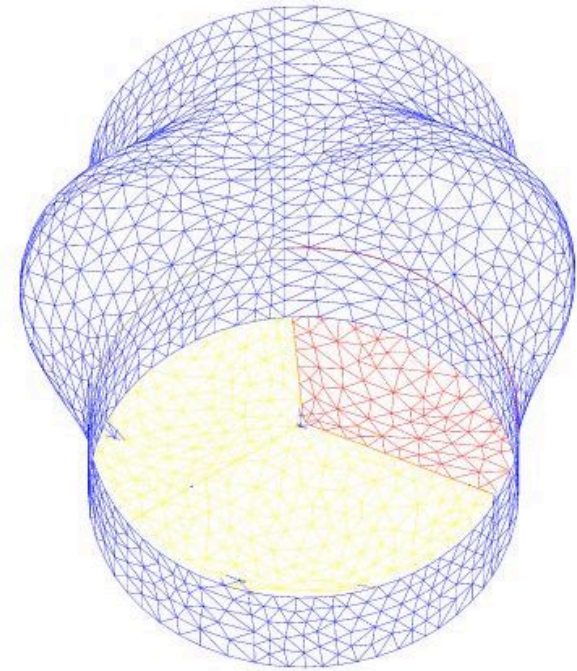
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Castem 3M & Catia V5

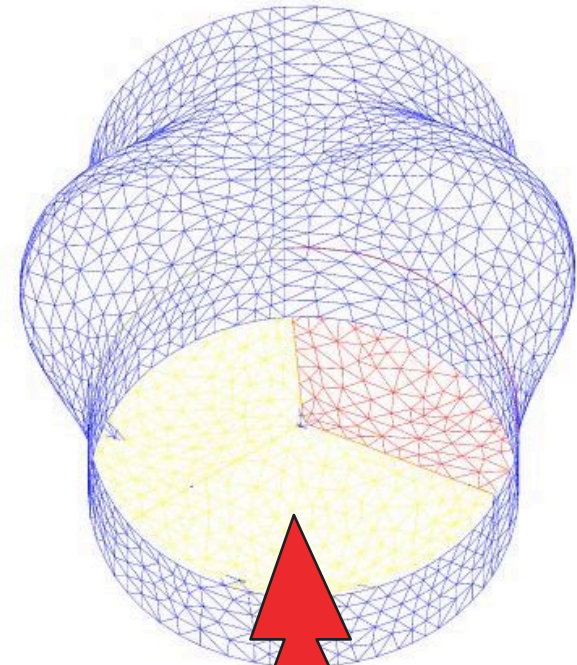
POUR L'INSTANT PAS DE FLUIDE!



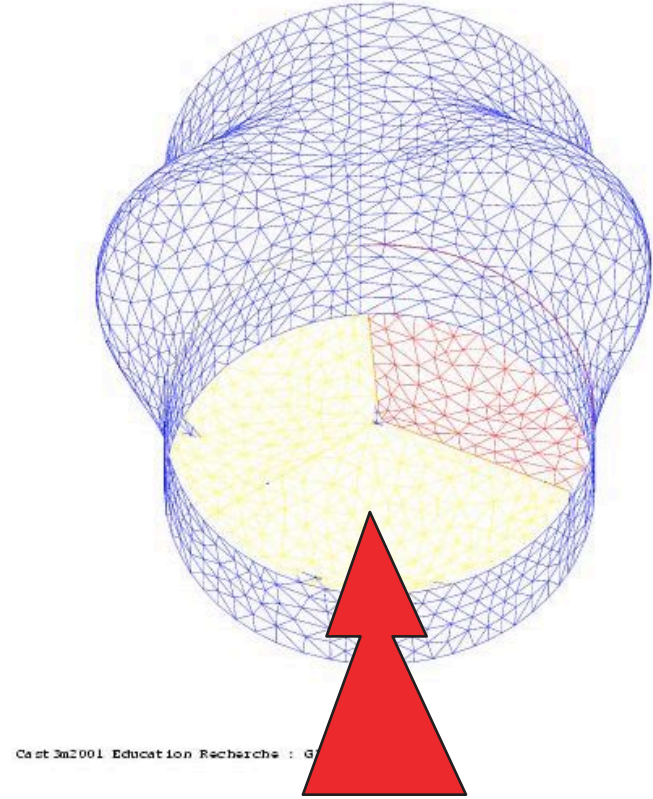
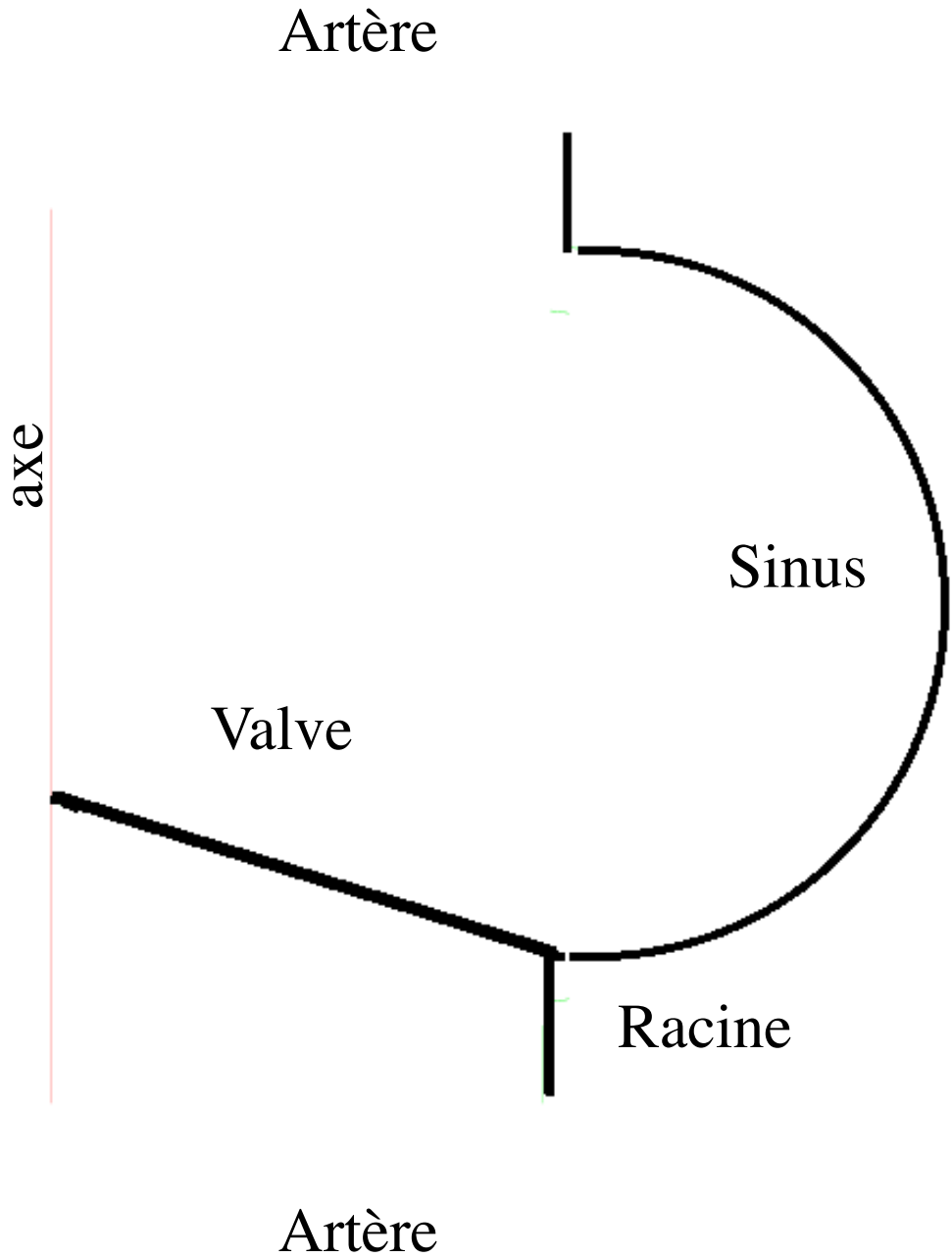


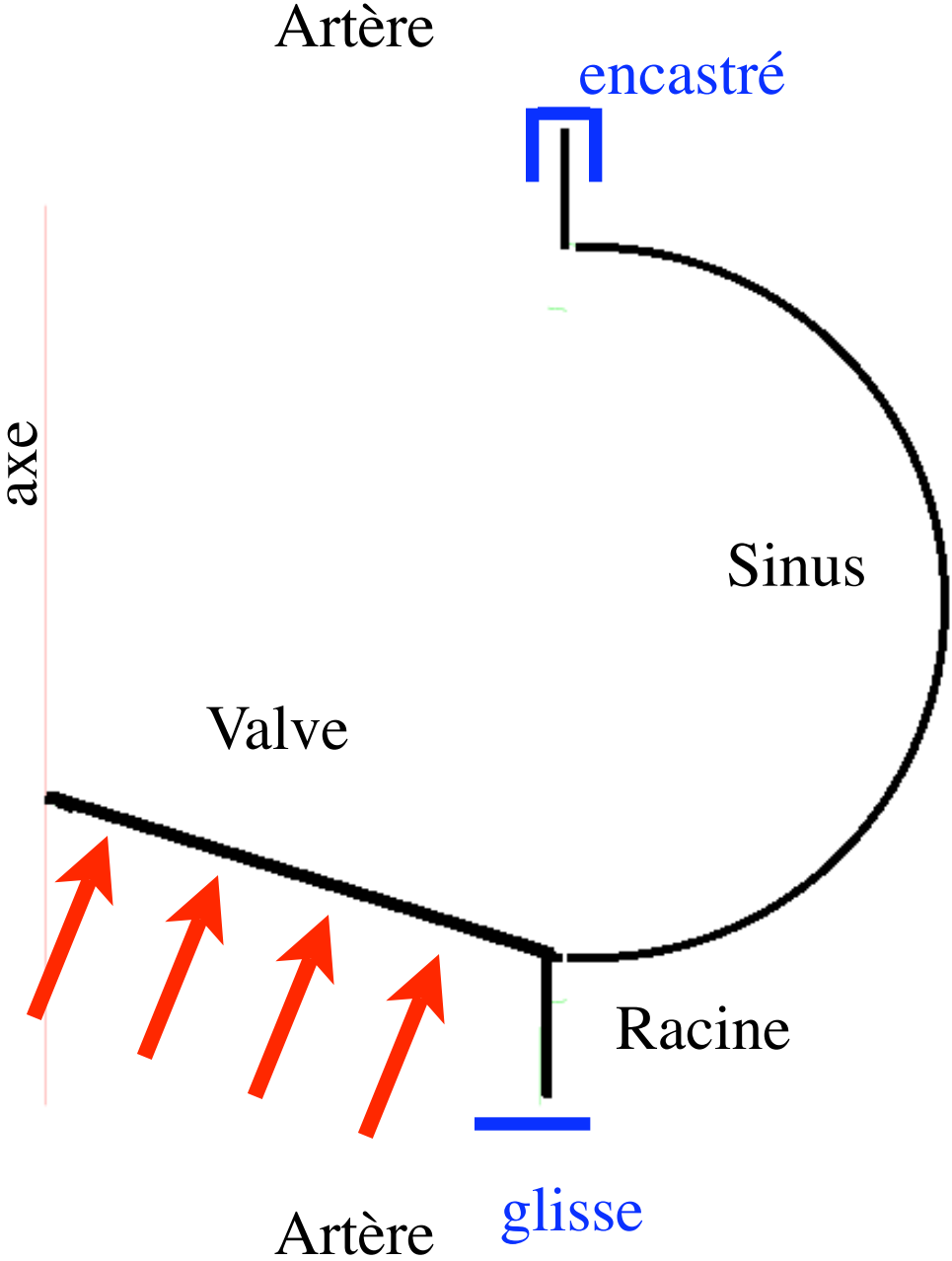


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Propriétés Mécaniques

Propriété	Feuillet	Mur aortique
Épaisseur (mm)	0,500	1,000
Comportement	Isotrope	Isotrope
M. Young (MPa)	0,900	6,000
Coef de Poisson	0,450	0,450

Propriétés Mécaniques

Propriété	Valve aortique	Racine aortique
Ecir (KPa)	200,000	334,000
Erad (KPa)	200,000	-
Elong (KPa)	-	350,000
Nu	0,450	0,450

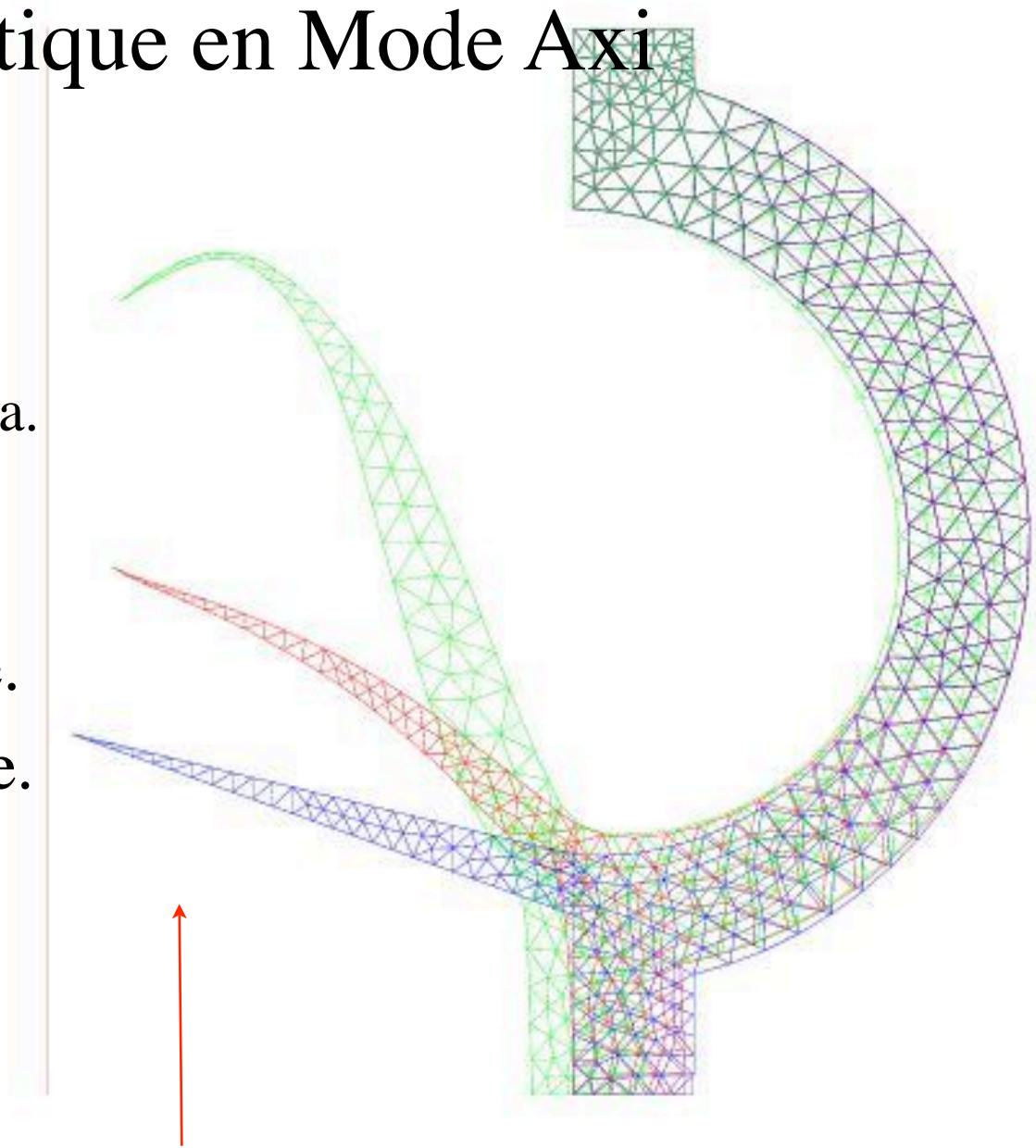
Calcul sous Castem

Imposition d'un chargement (pression) et on fait varier:

- Les formes géométriques des sinus aortiques:
Forme circulaire et forme exponentielle.
- Les propriétés mécaniques.
- Les modèles: Solide et Coque en mode:
 - Plan (éléments linéaires quadratiques) et
 - Axisymétrique.

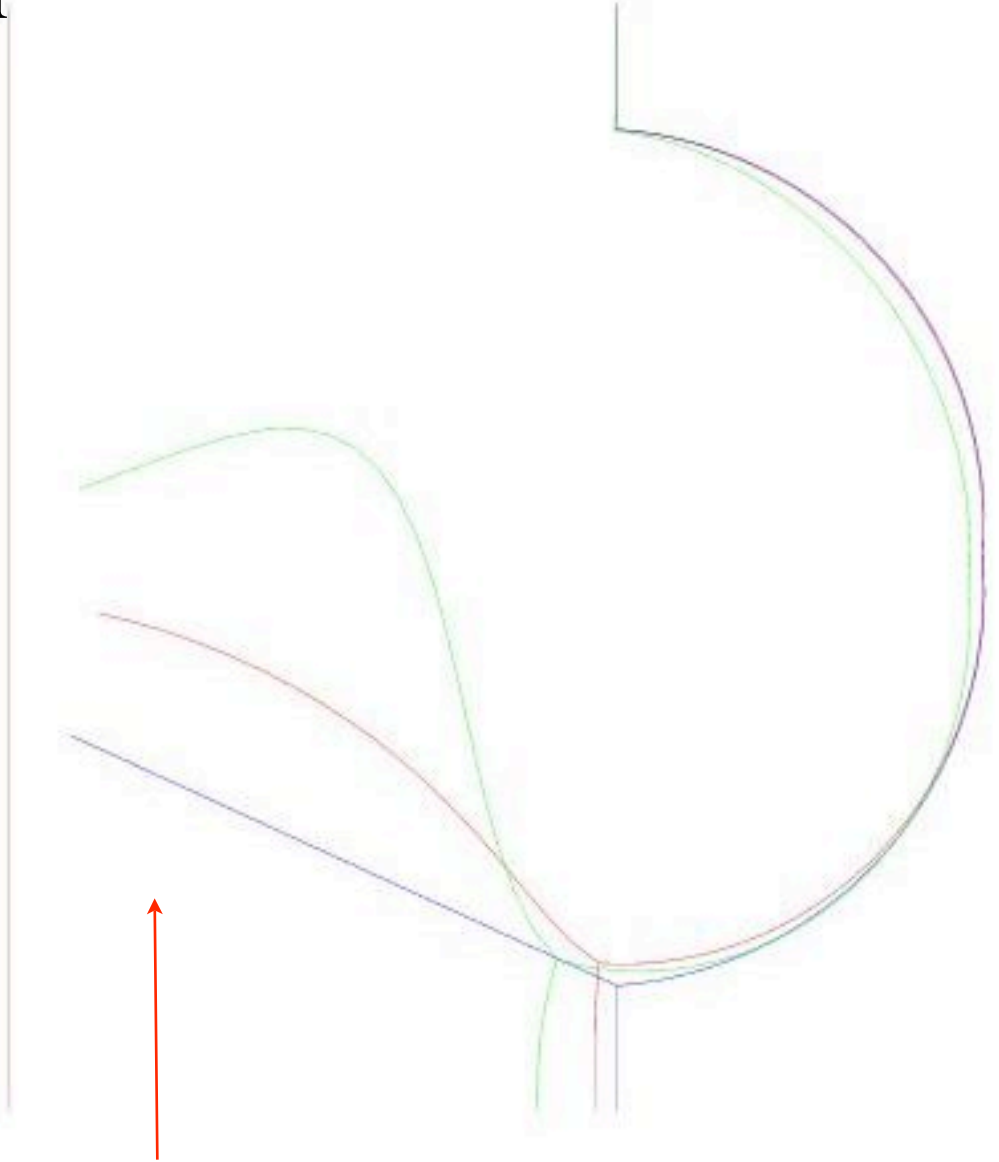
Modèle élastique en Mode Axi

- 2 matériaux utilisés:
- $E_1 = 0,9\text{MPa}$, $E_2 = 0,2\text{MPa}$.
- $\nu = 0,45$ et $\Delta P = 10500\text{Pa}$ (79mmHg).
- En bleu: valve fermée.
- En rouge: non-linéaire.
- En vert: linéaire.



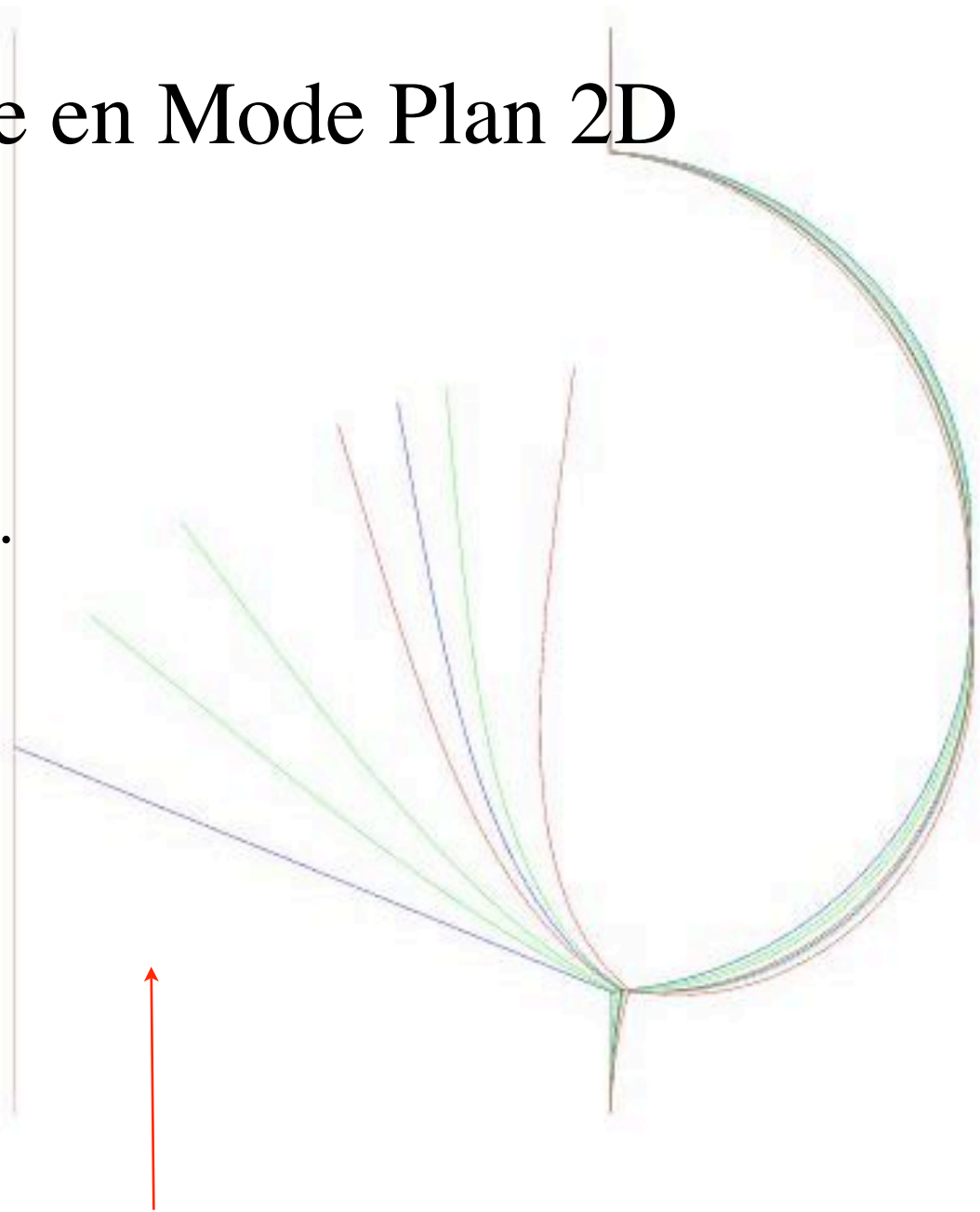
Modèle Coque en Mode Axi

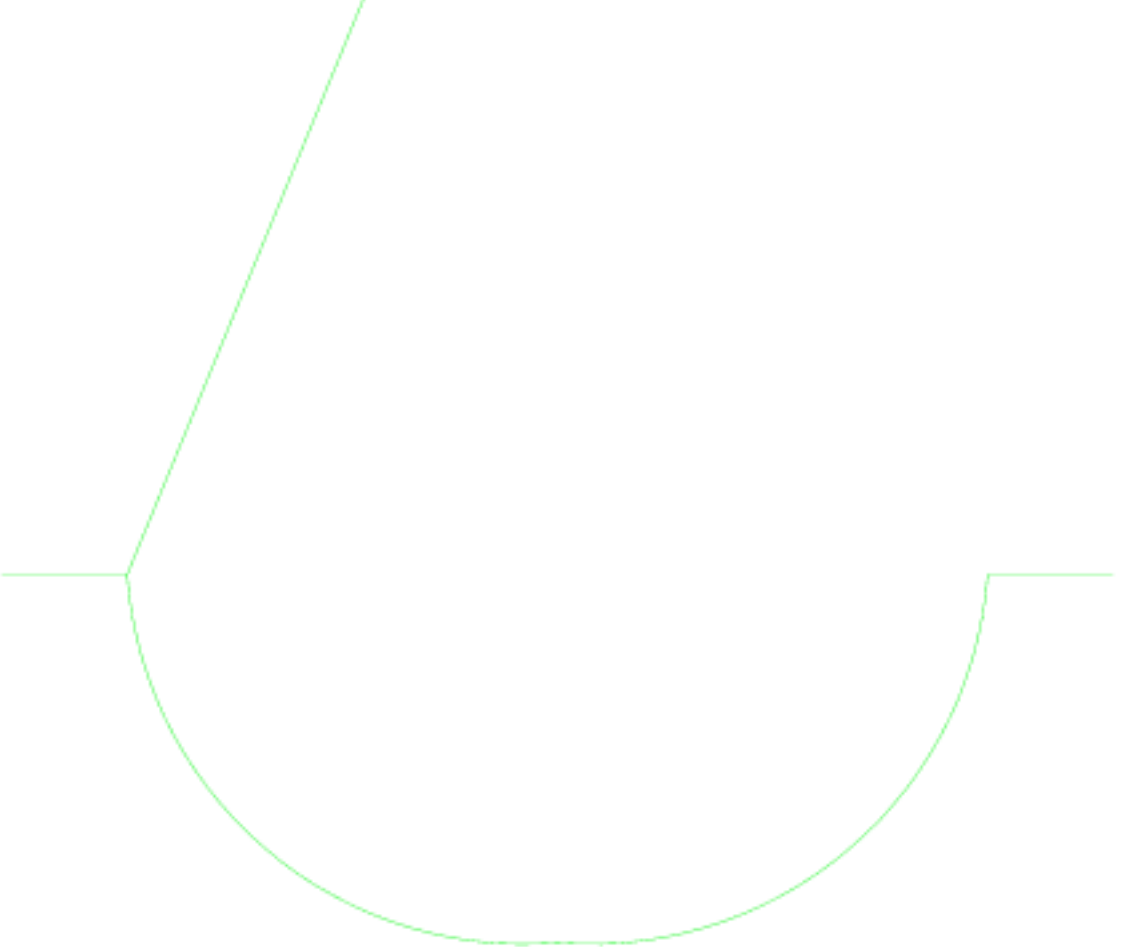
- $E = 0,9\text{MPa}$.
- $e=0,5\text{mm}$ pour les feuillets.
- $\nu = 0,45$ et $\Delta P = 10500\text{Pa}$.
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- En bleu: valve fermée.
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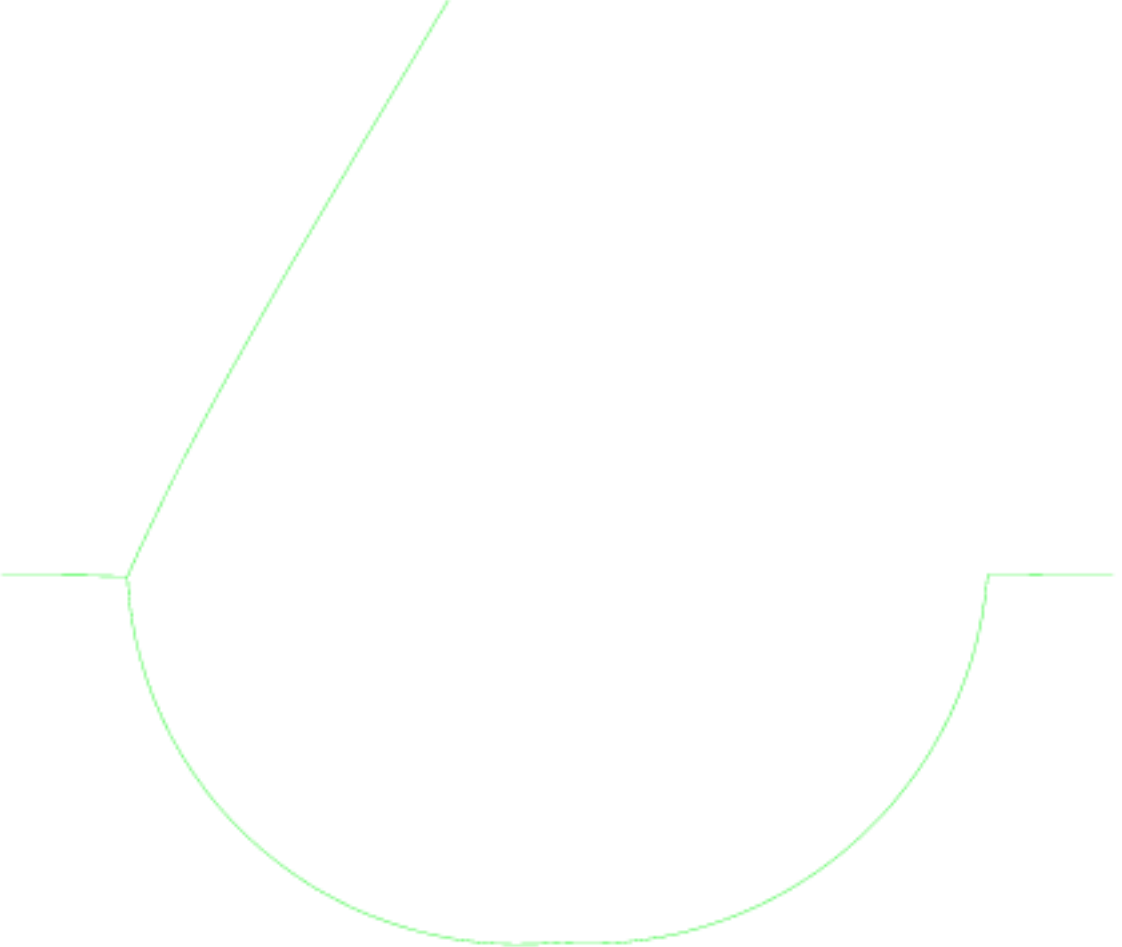
Modèle Coque en Mode Plan 2D

- Forme géométrique des sinus aortique: circulaire.
- 2 matériaux utilisés:
 $E1=0,9\text{MPa}$ et $E2=0,2\text{MPa}$.
- $\nu=0,45$.
- $t = 0:0.05:1$.



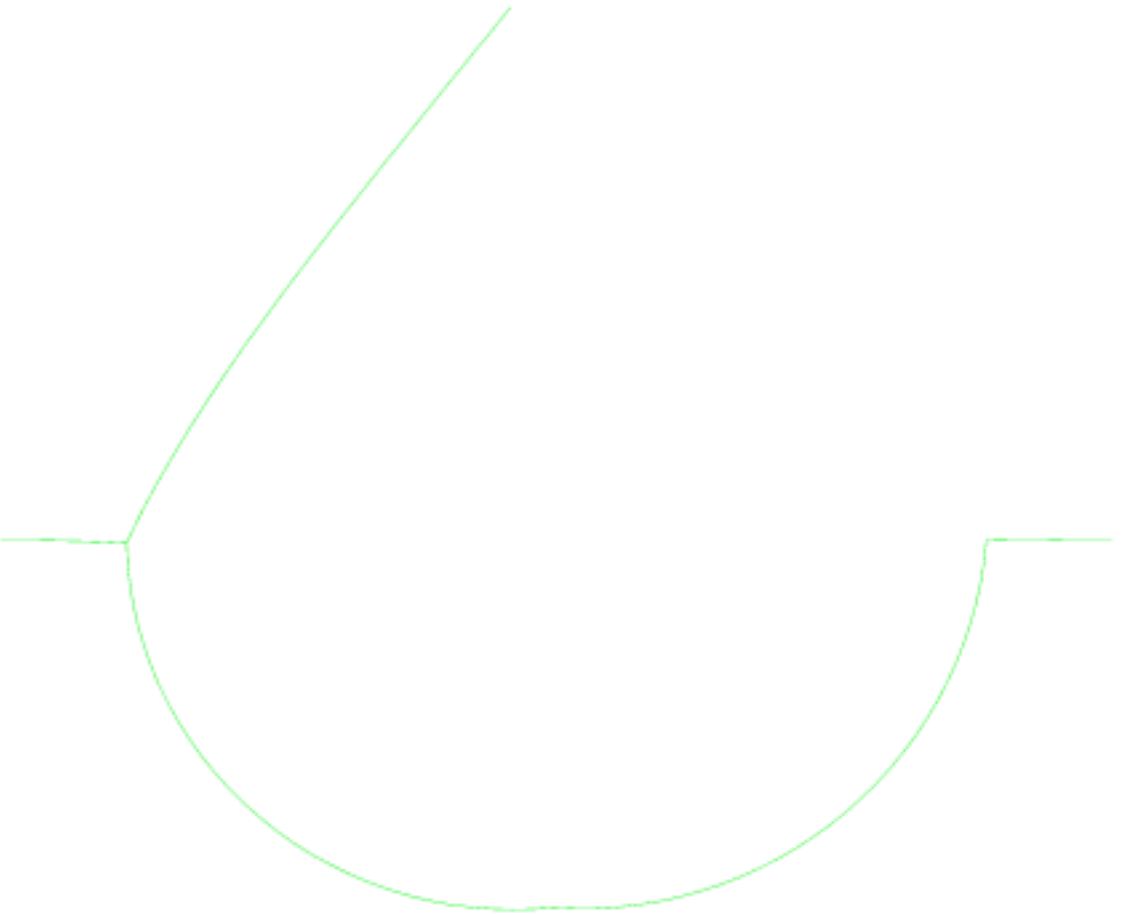


Education Recherche : maillage de la sphere



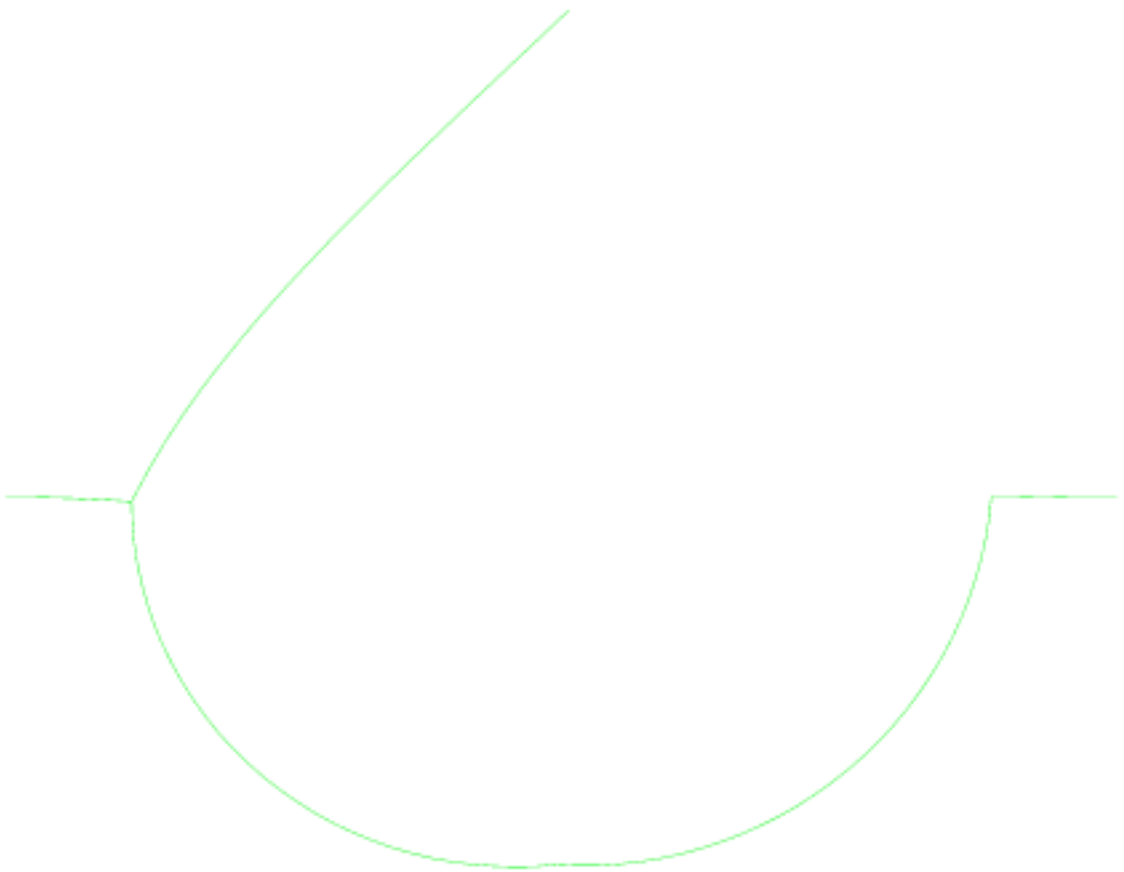
Educational Research : mallege de la sphere





Education Recherche : maillage de la sphere

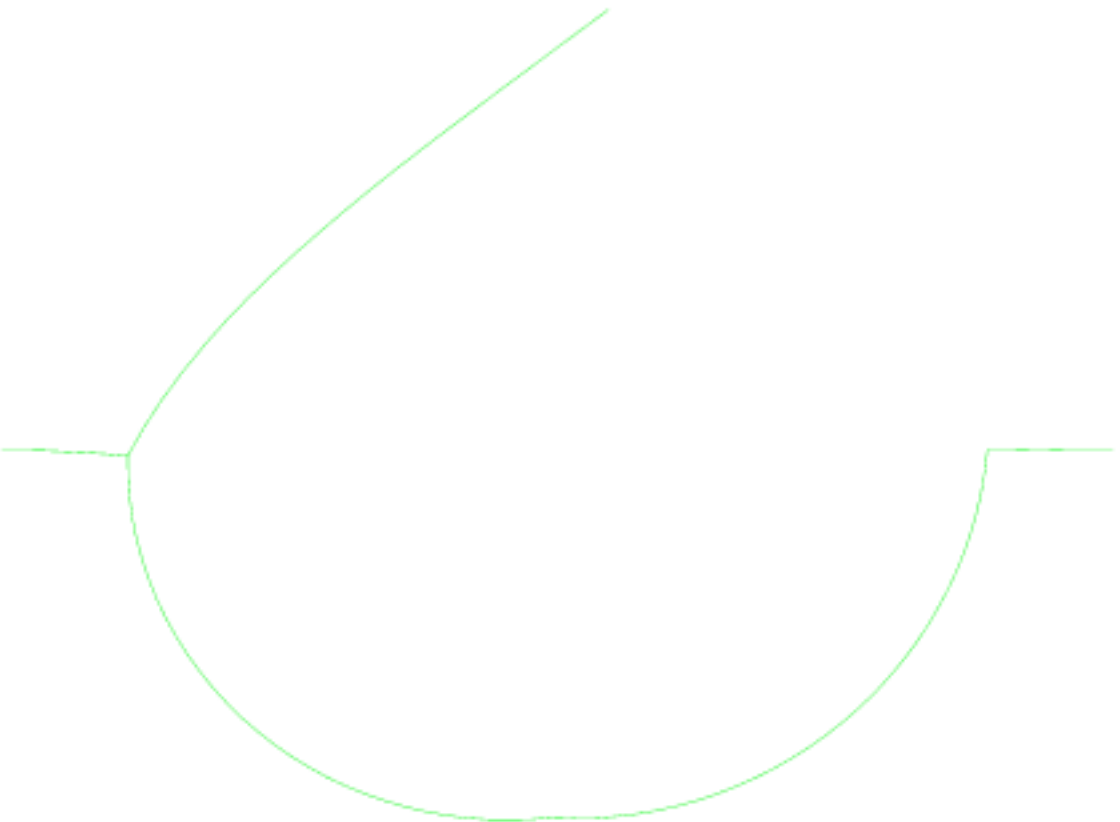


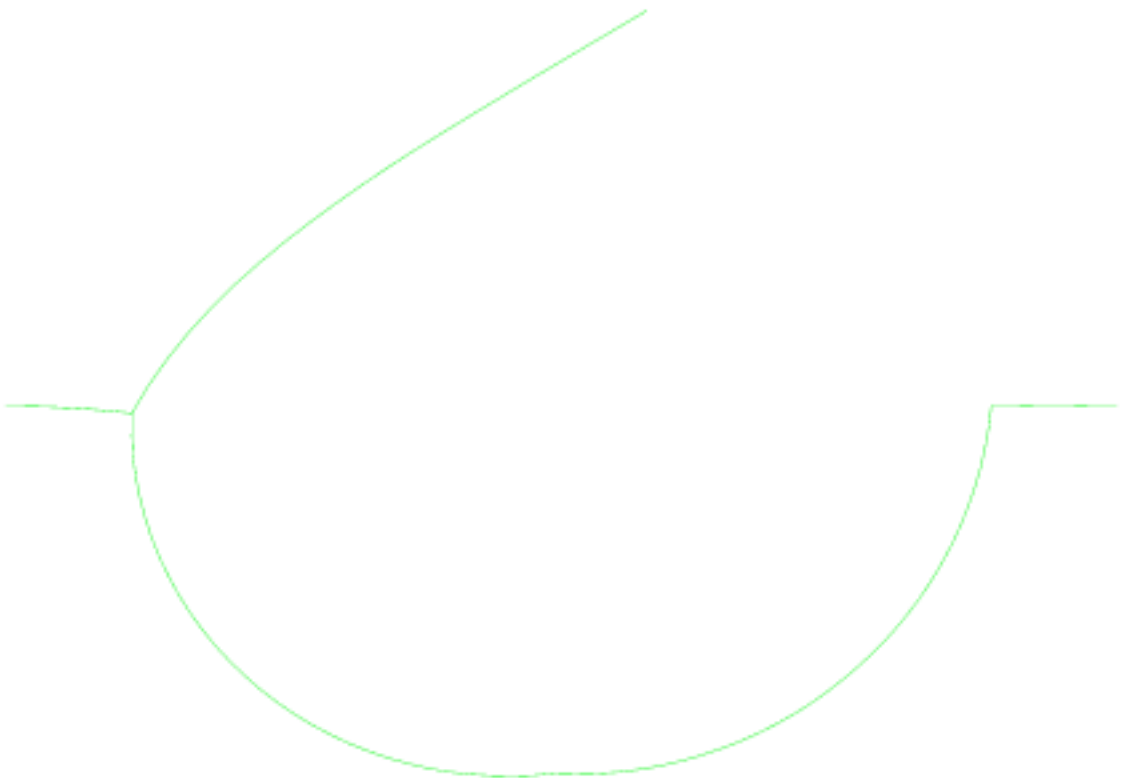


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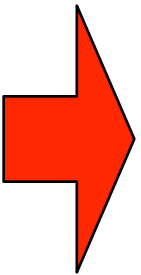


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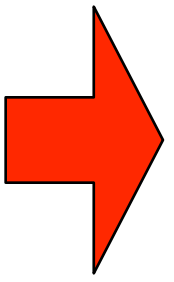


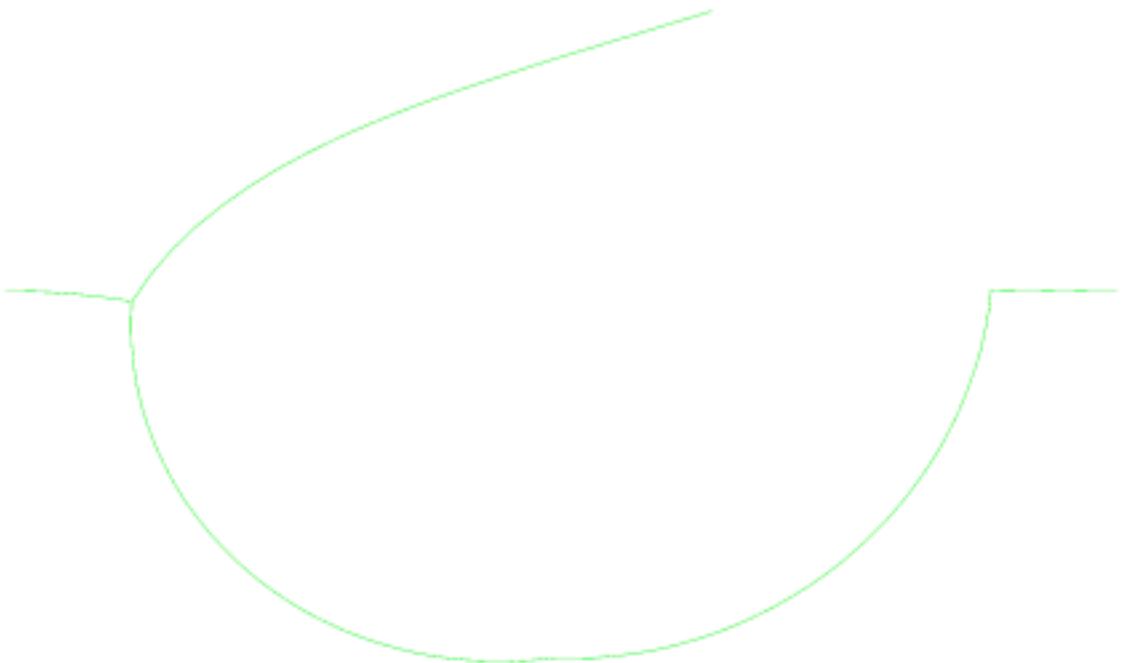
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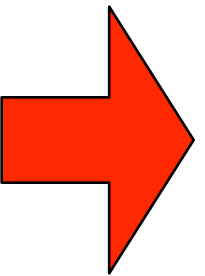


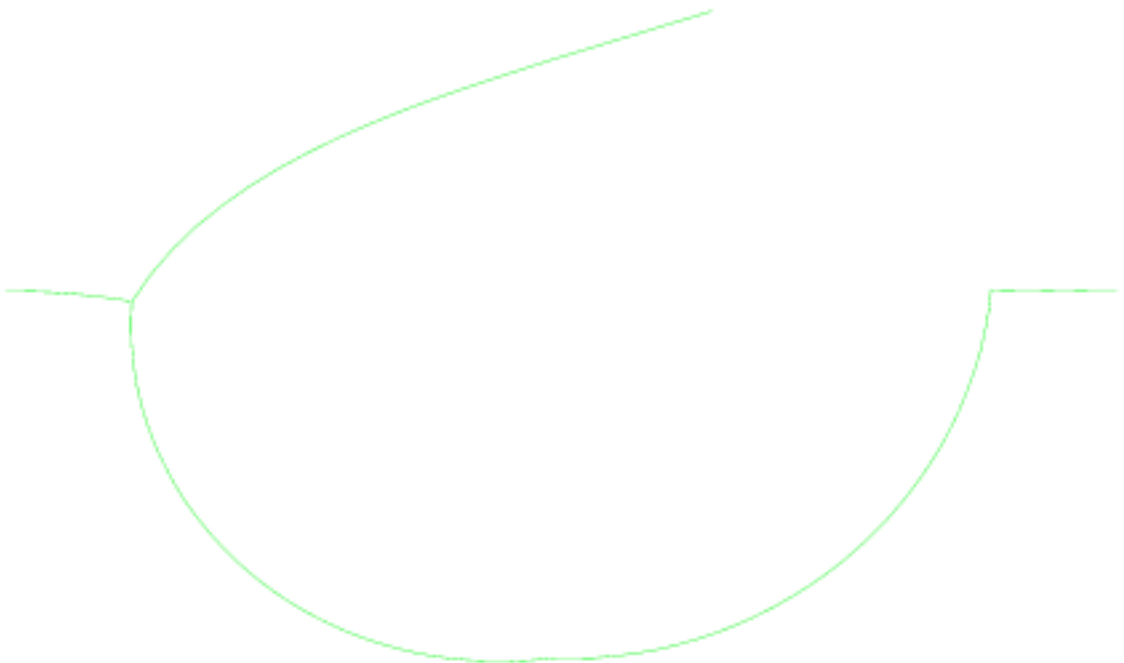
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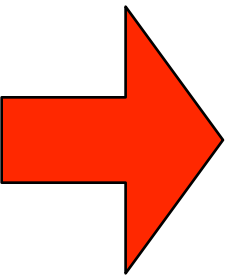


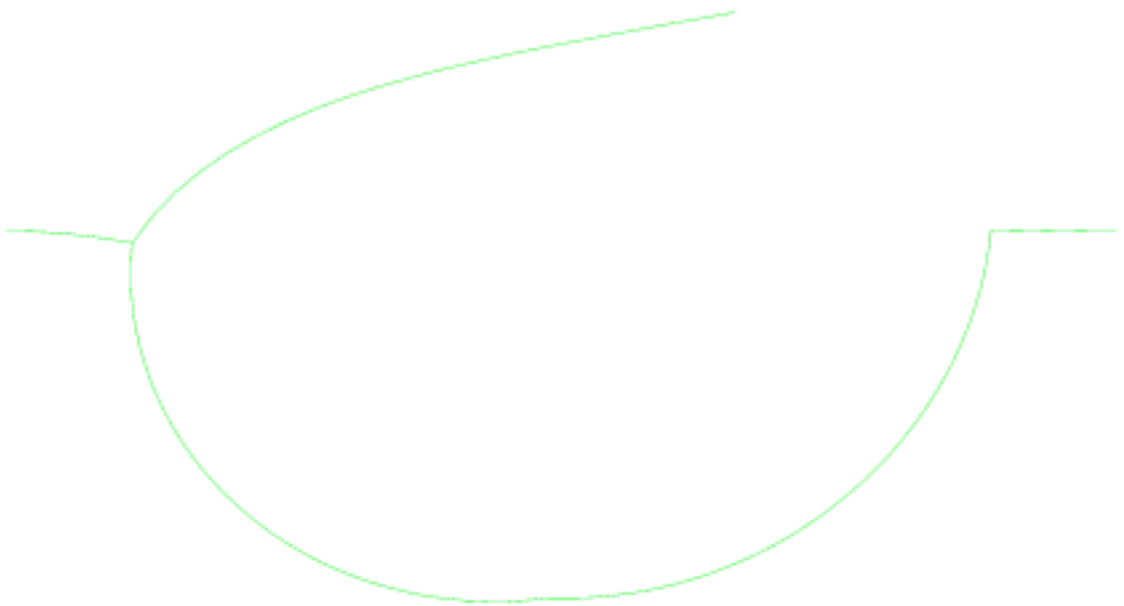
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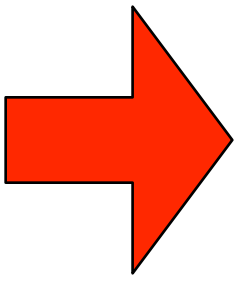


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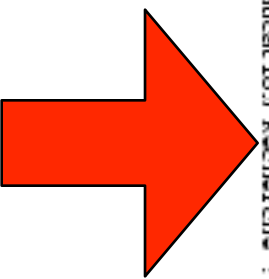
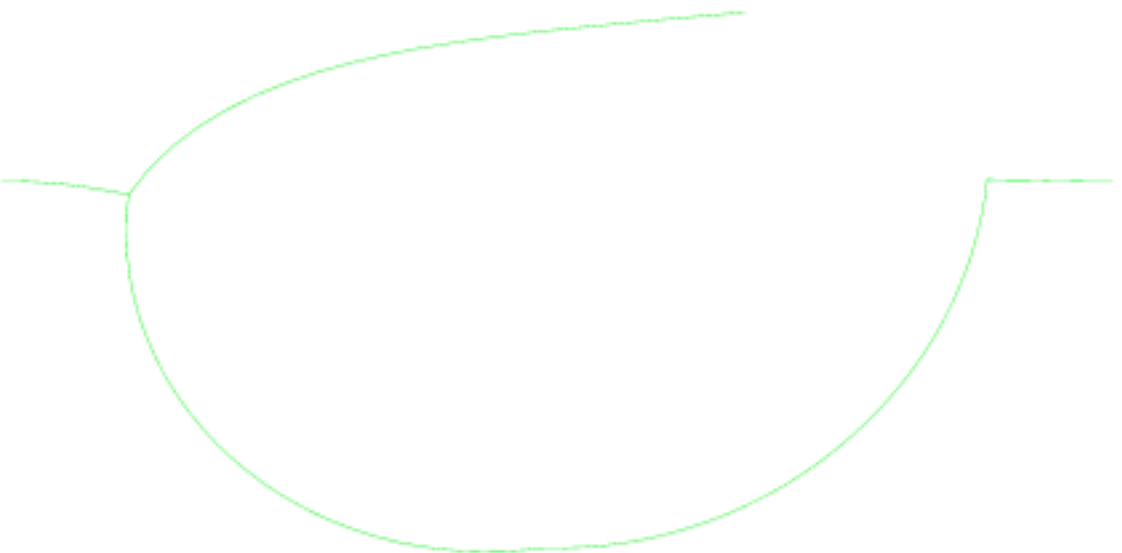


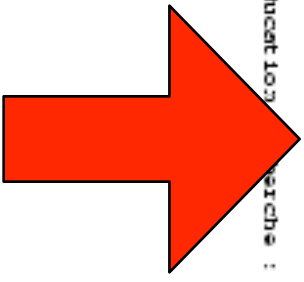
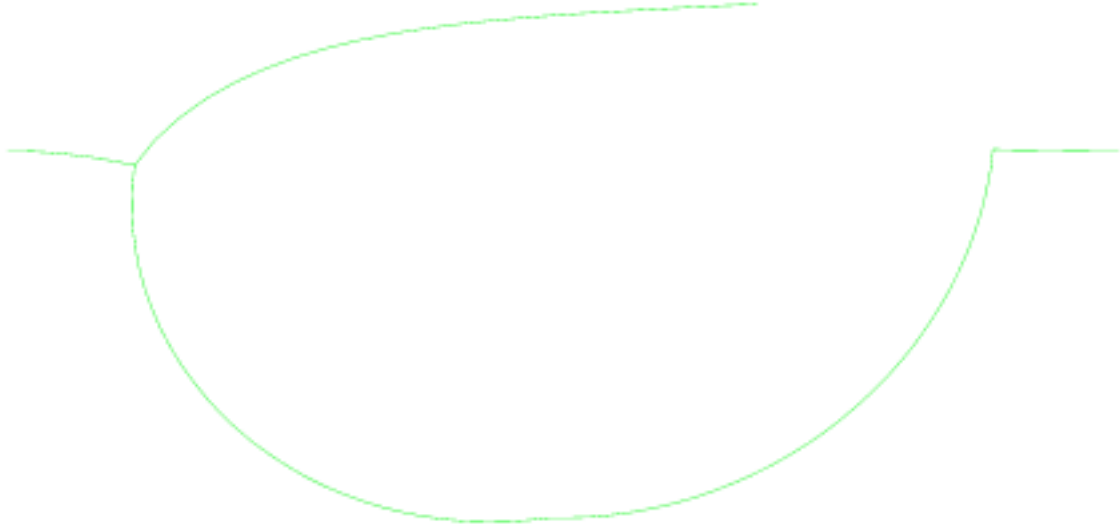


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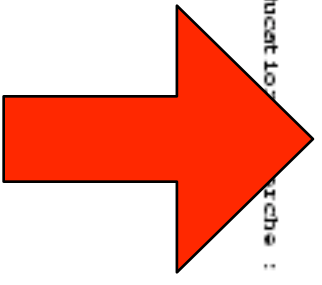
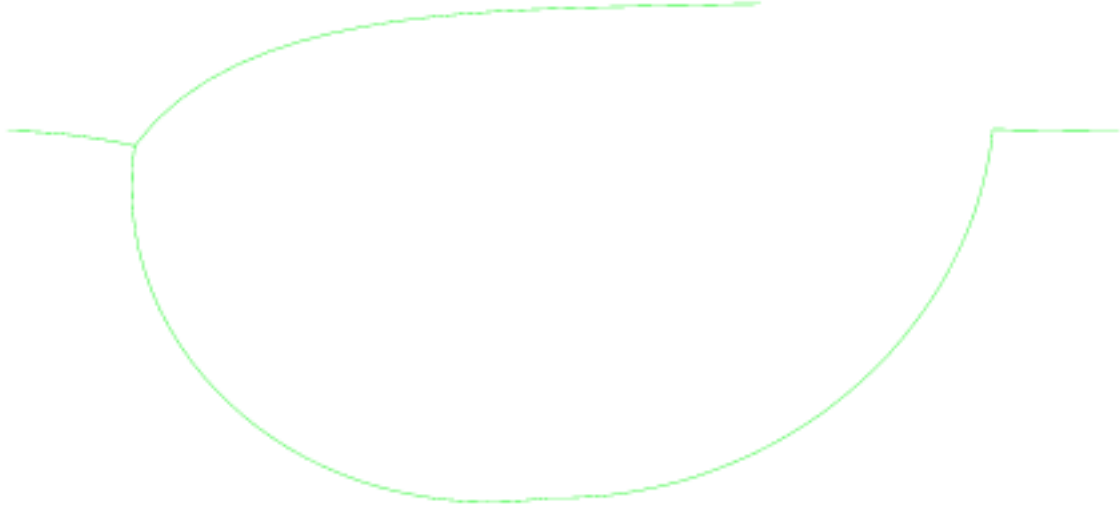


Educational Research : mapping de la sphere

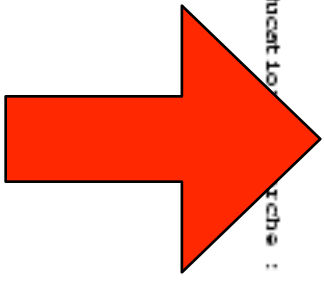
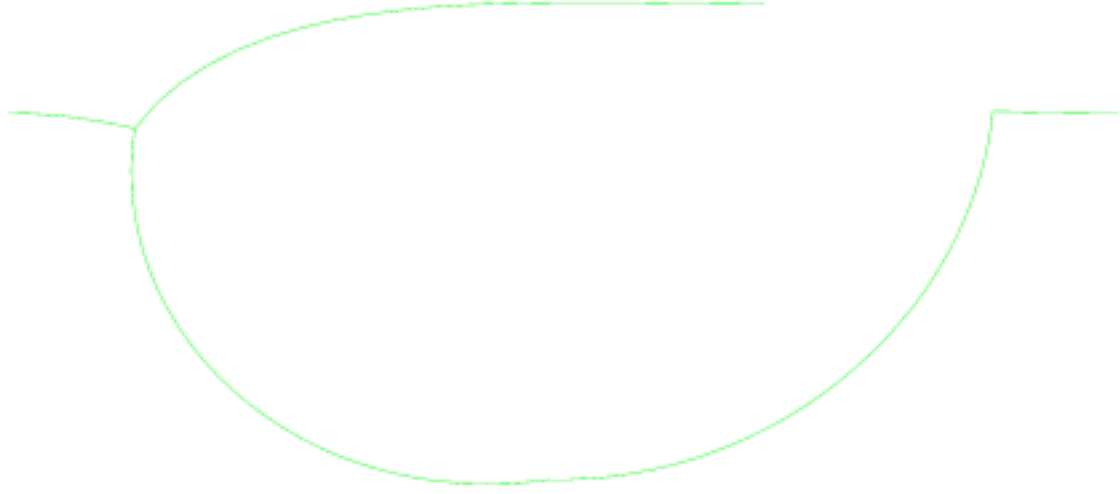




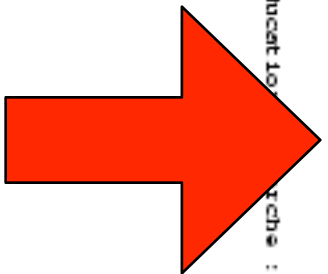
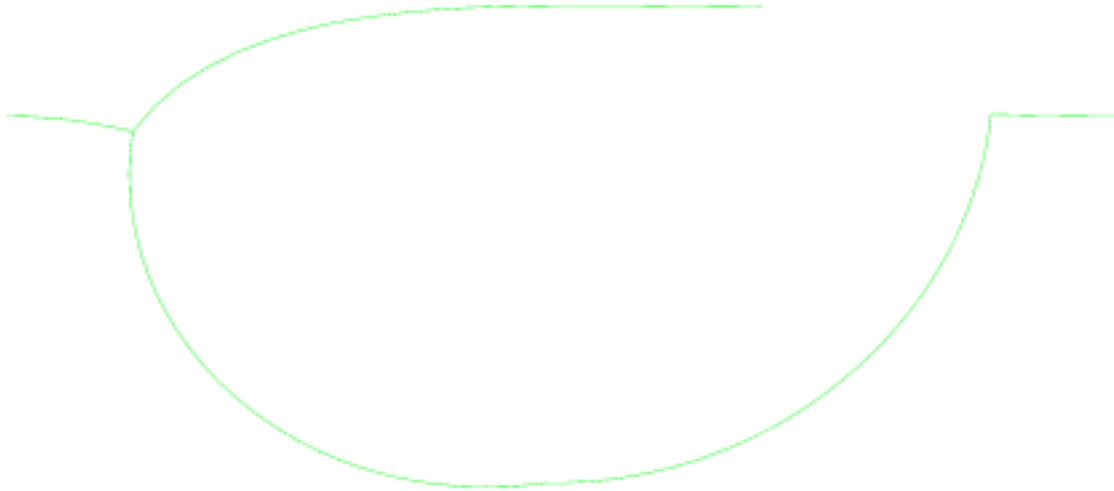
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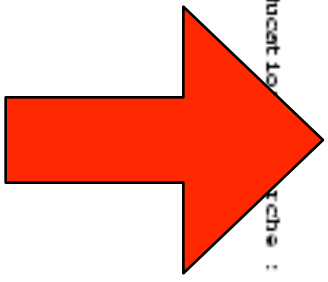
Educational Research : mapping de la sphere

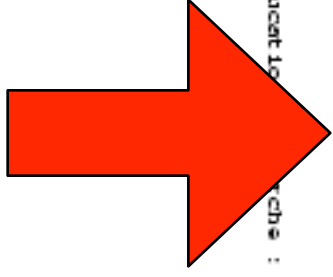
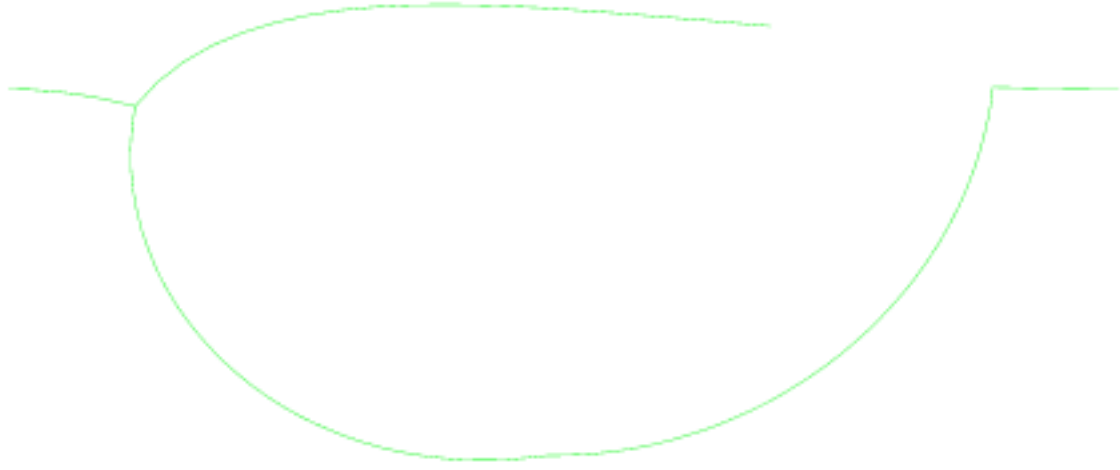


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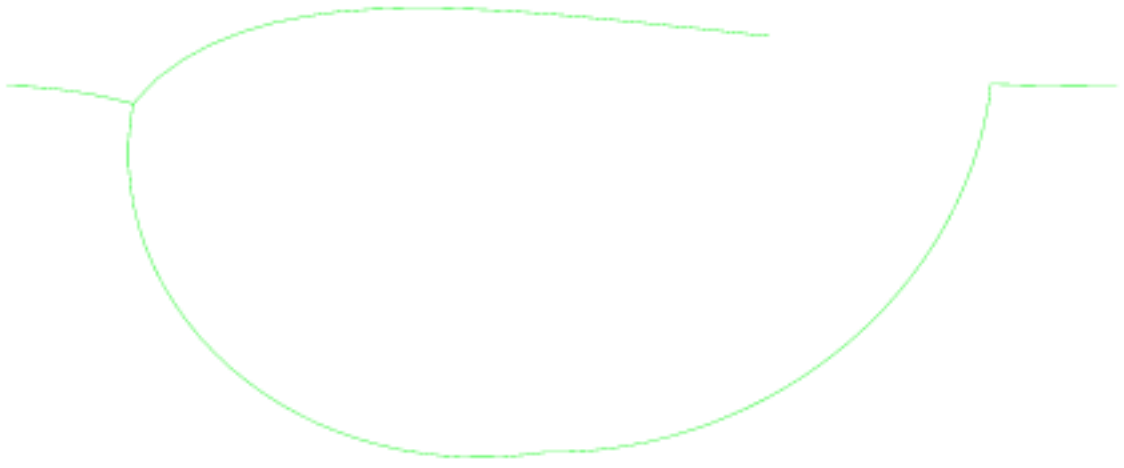
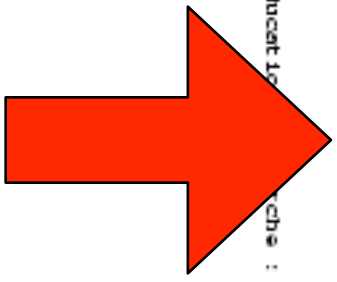


Educational Technology : malleage de la sphere

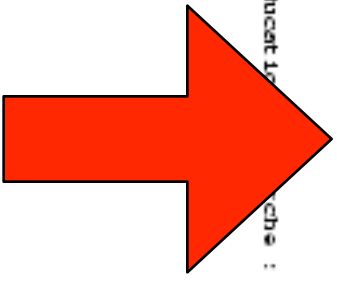
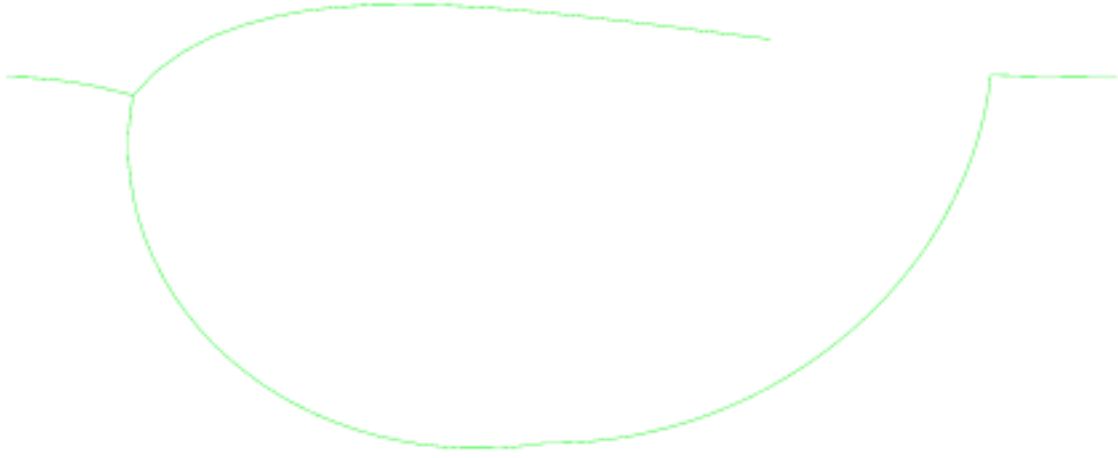




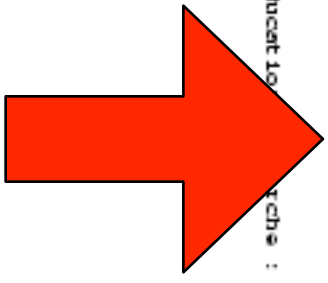
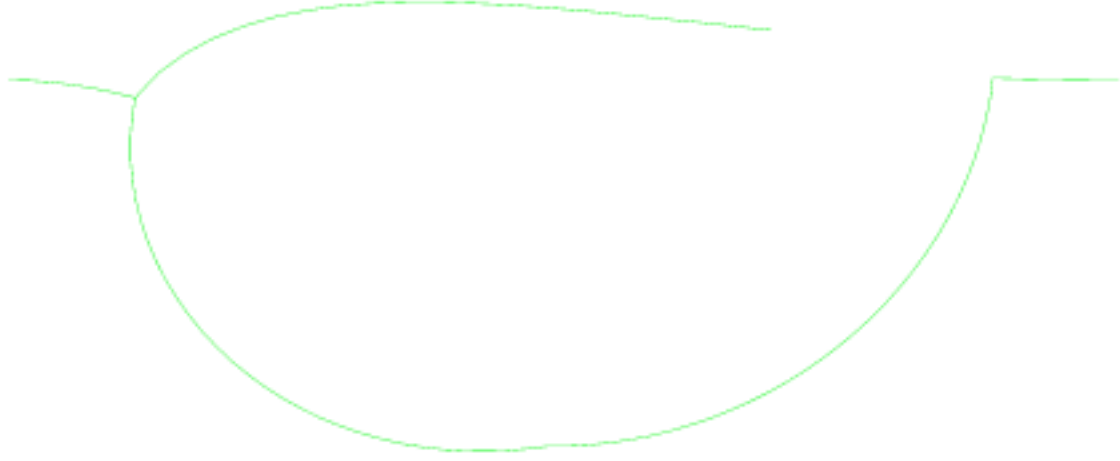
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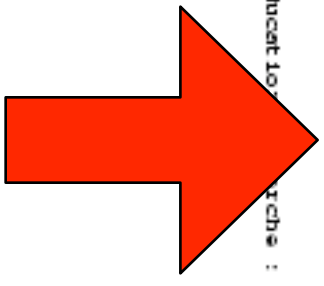
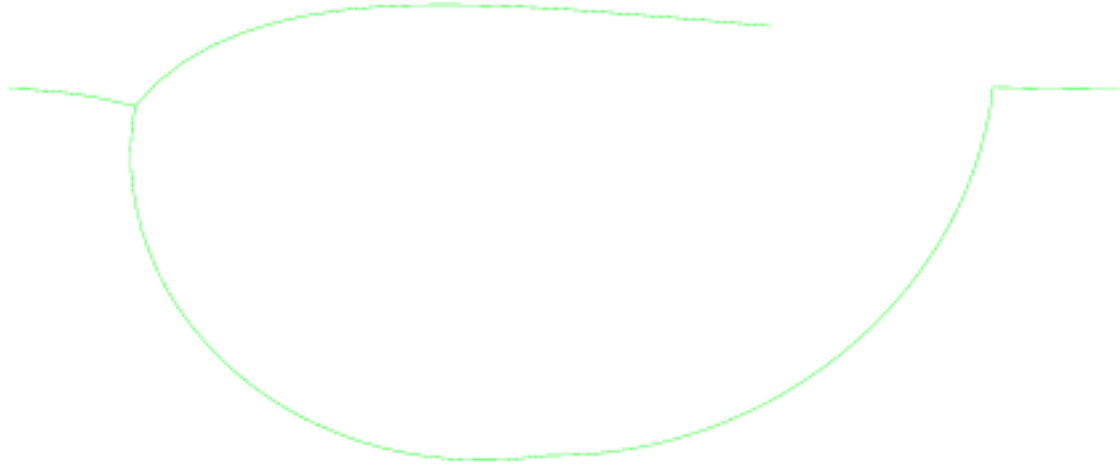
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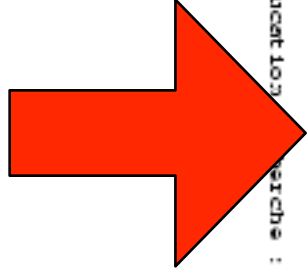
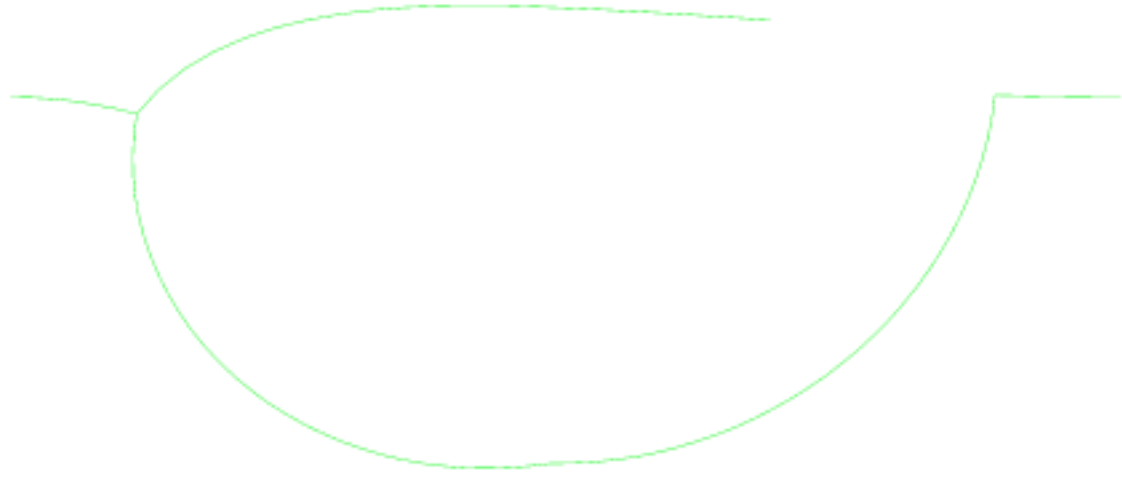


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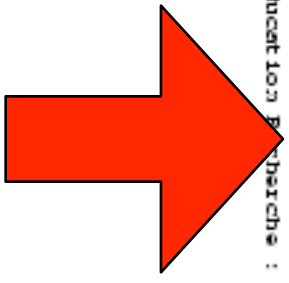
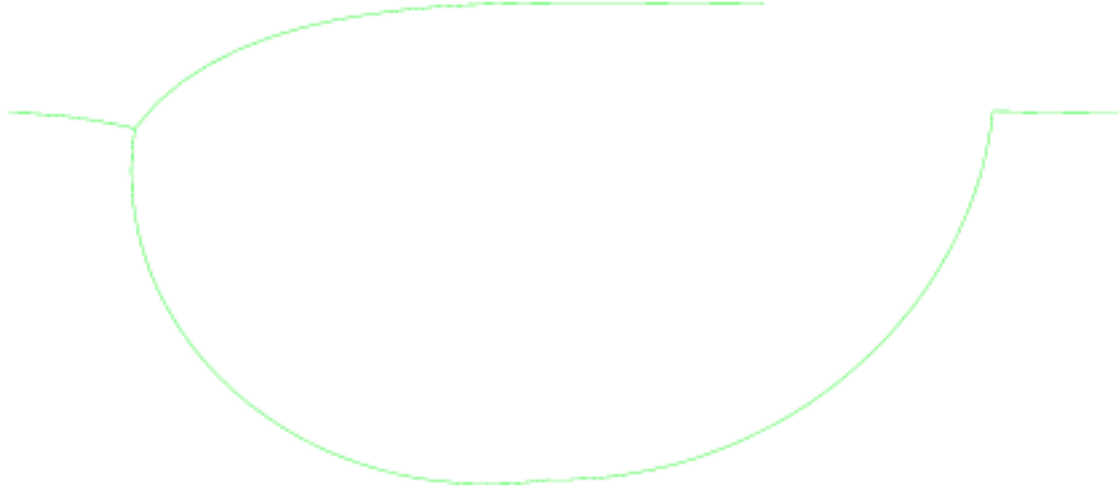


Educational Research : mapping de la sphere

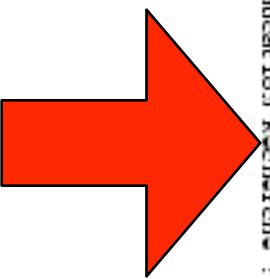
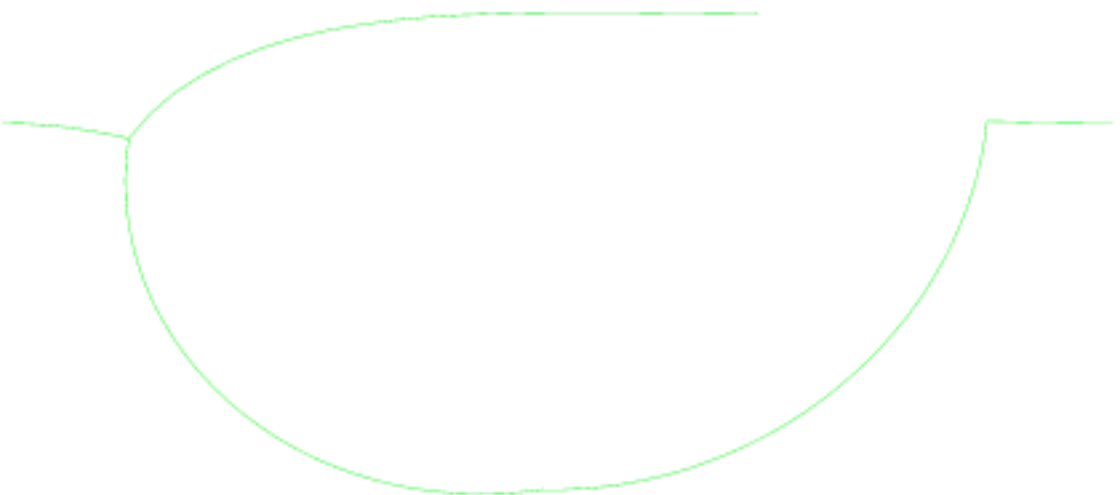


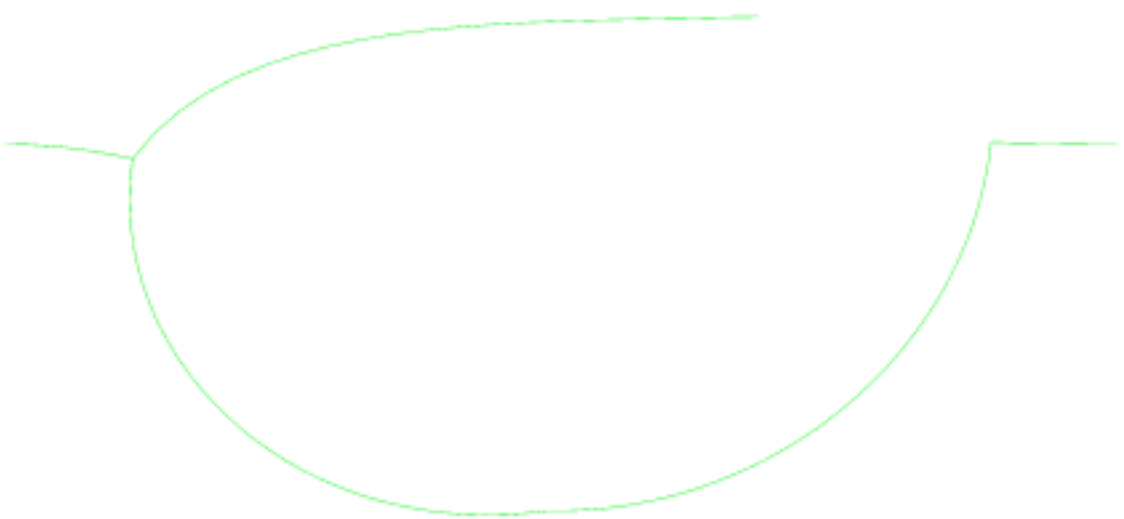


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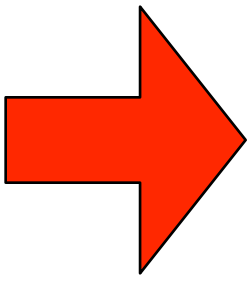


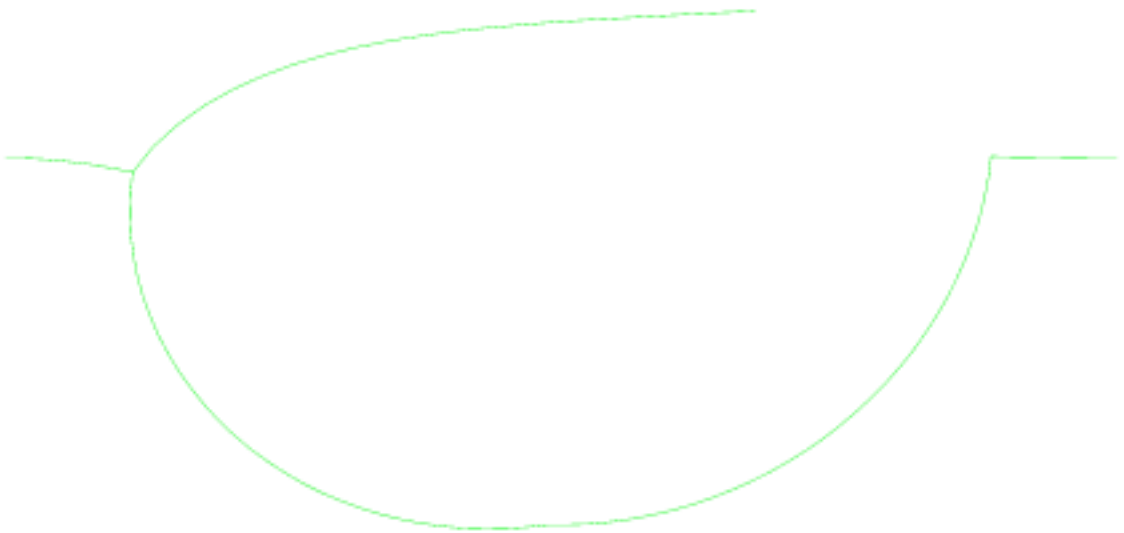
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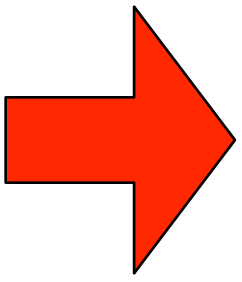


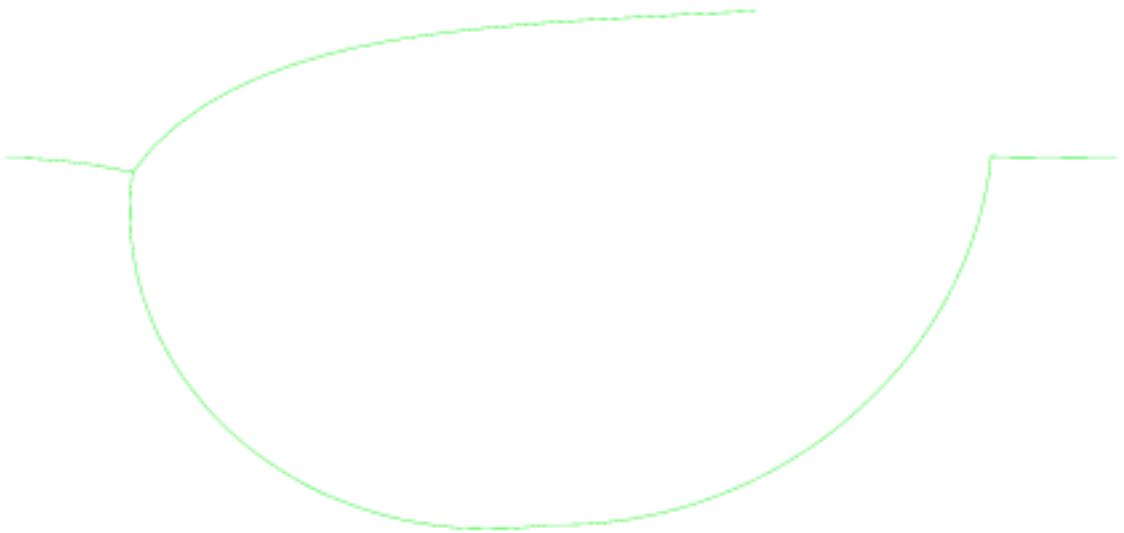
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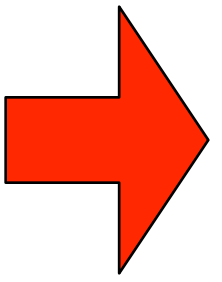


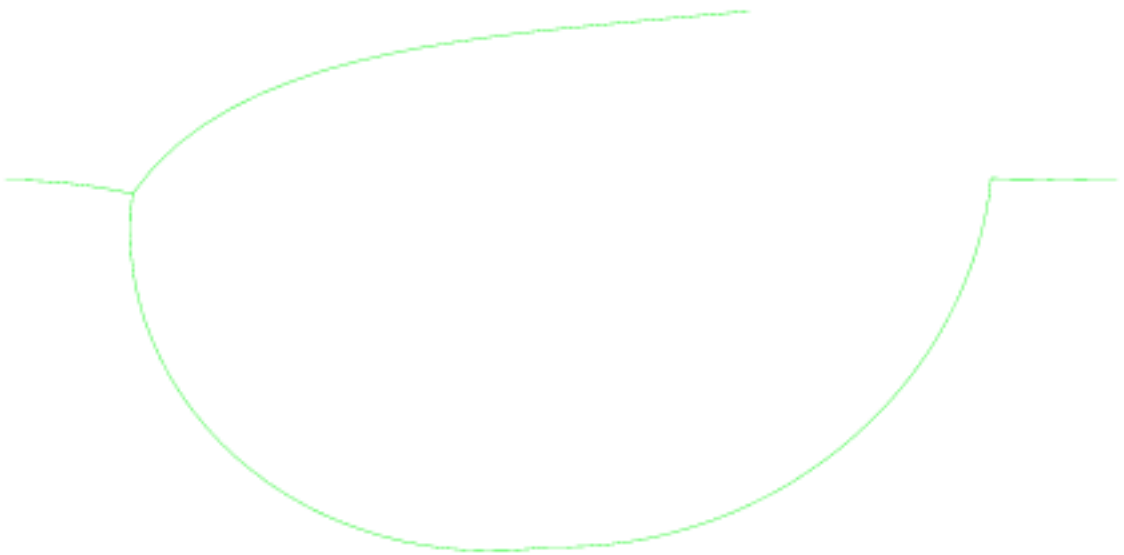
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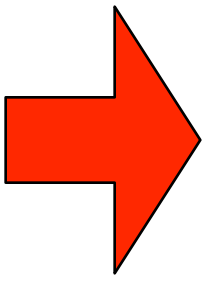


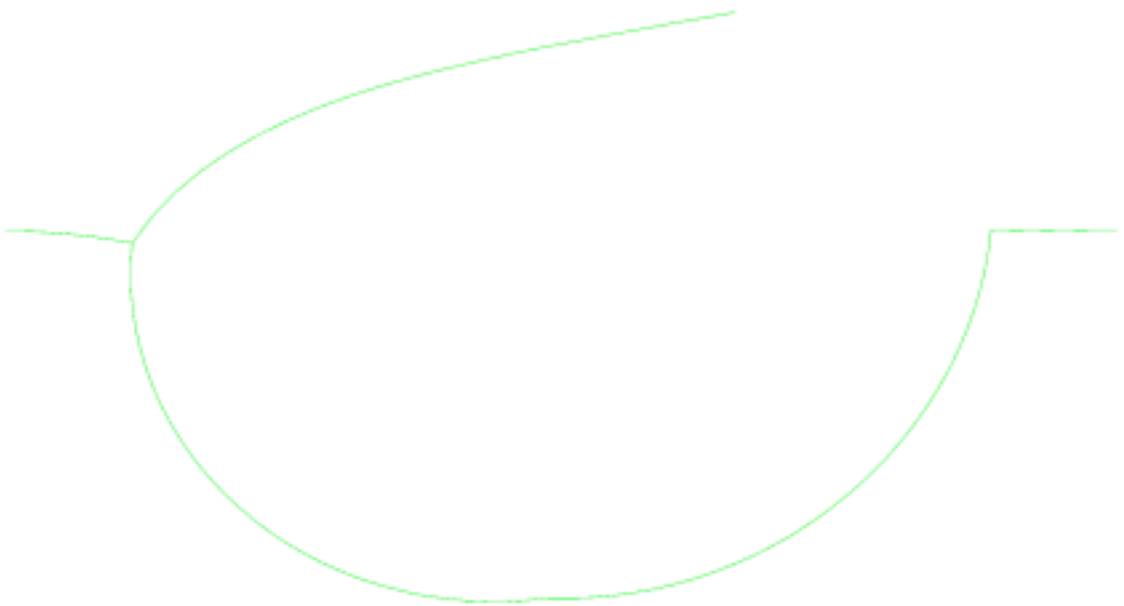
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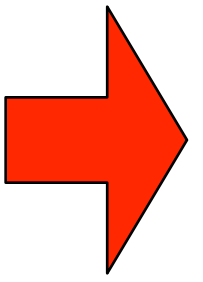


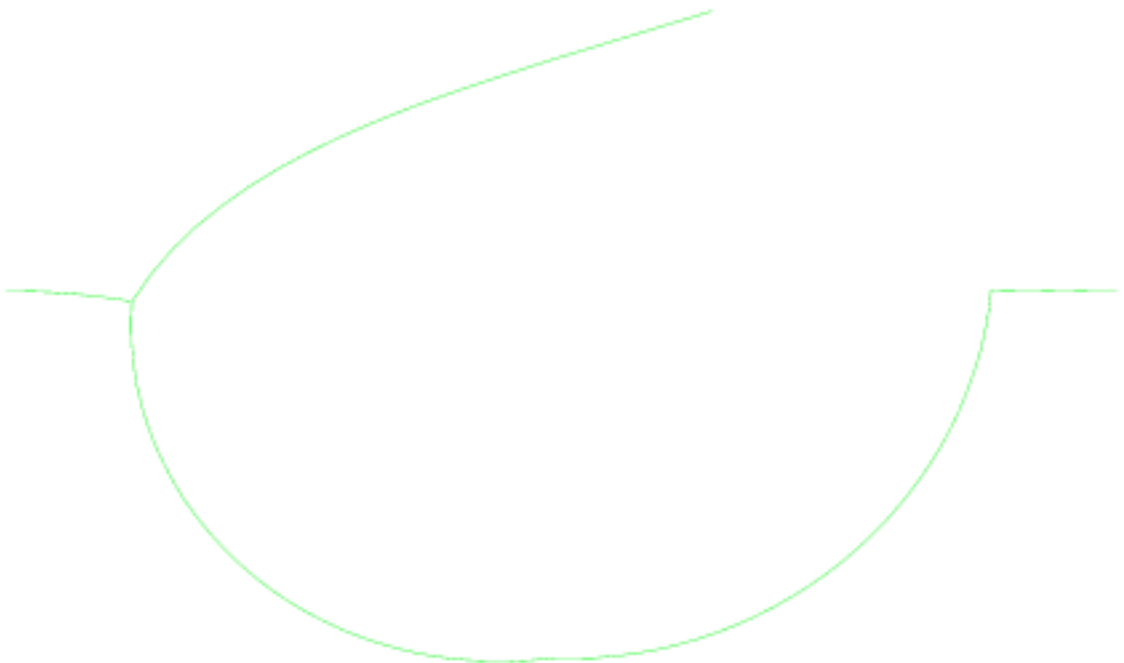
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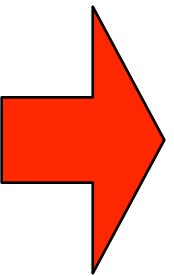


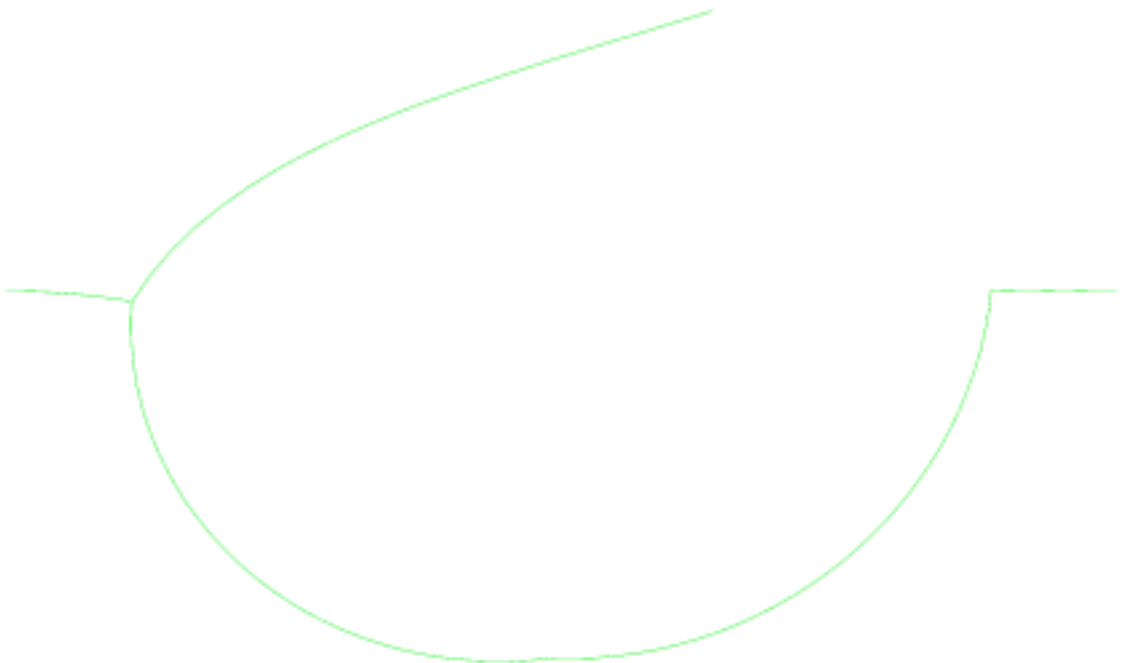
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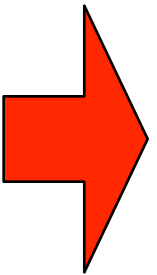


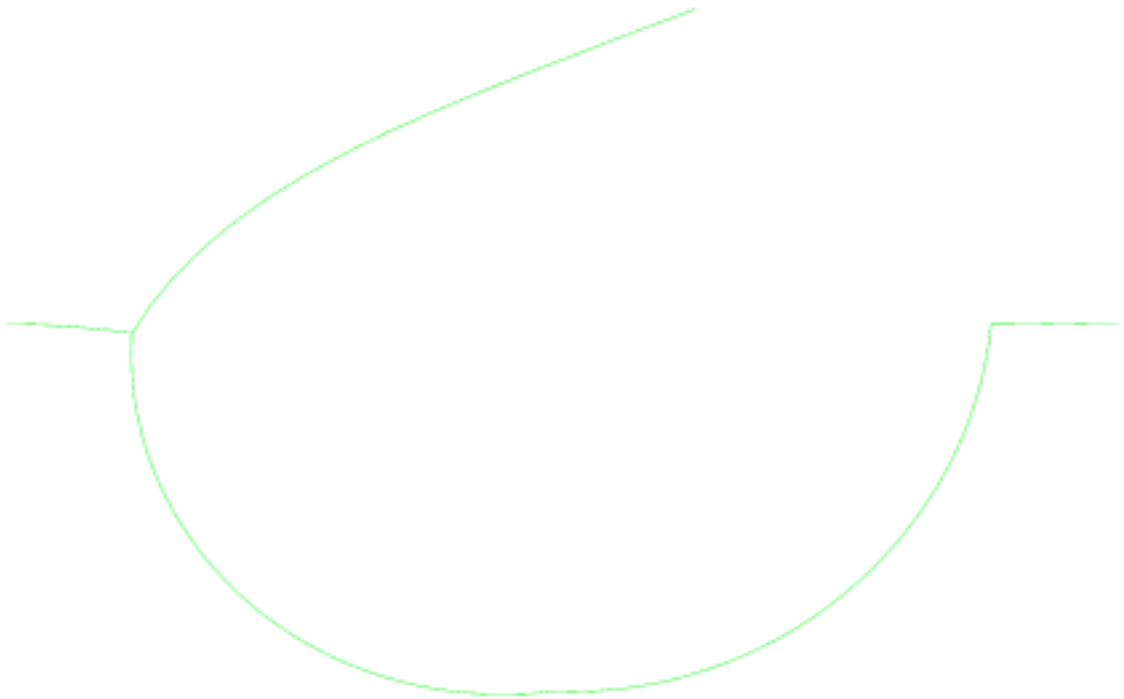
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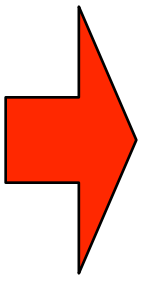


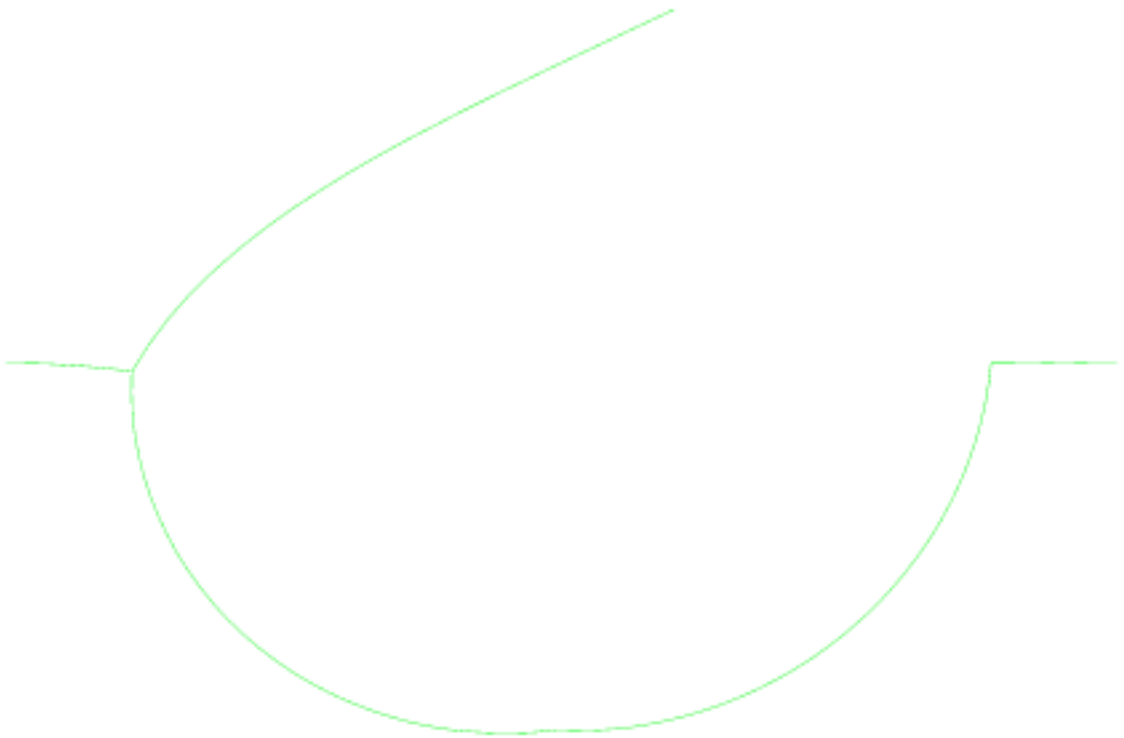
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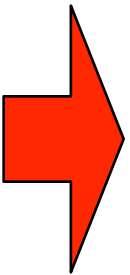


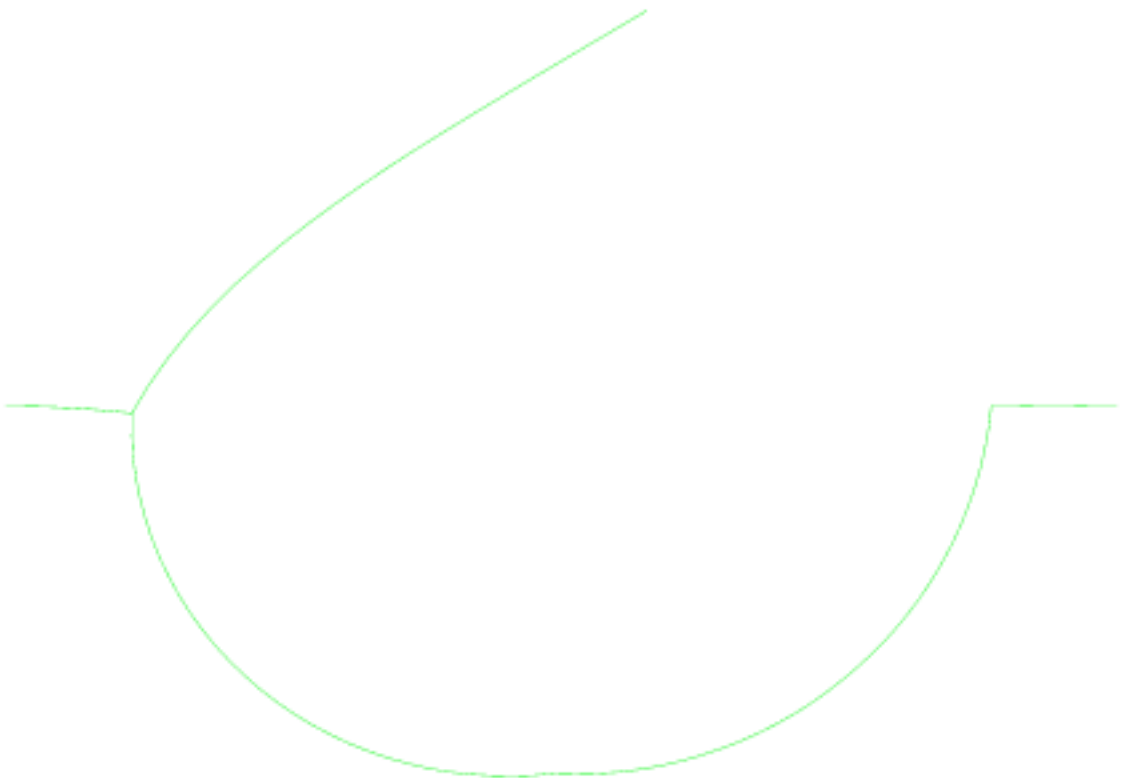
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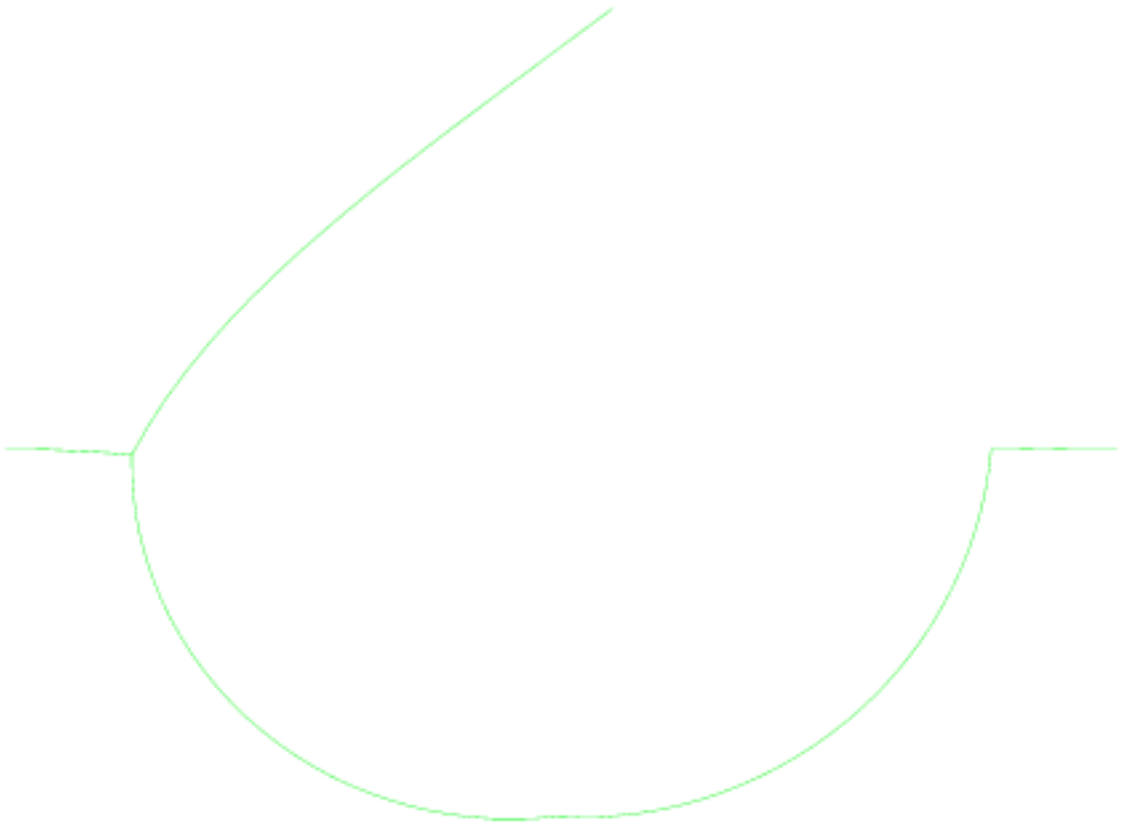
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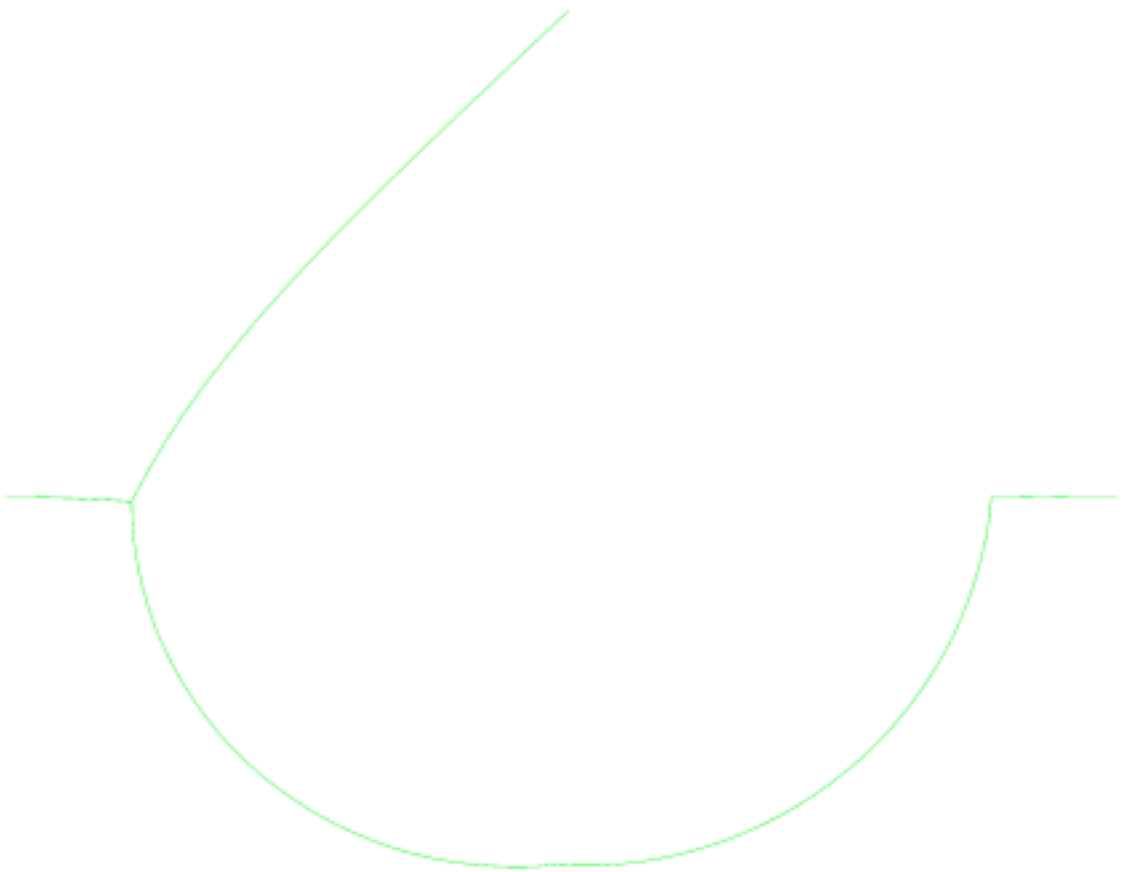
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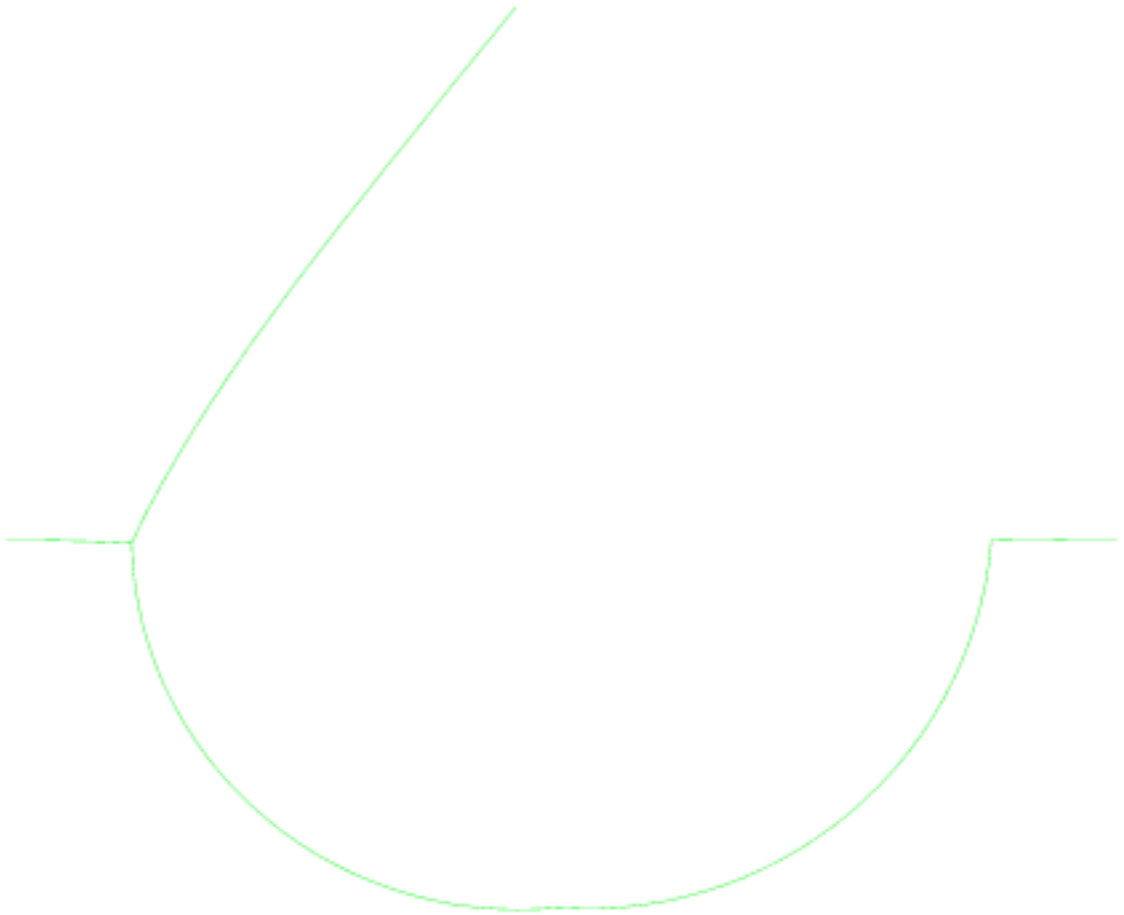
Education Recherche : maillage de la sphere





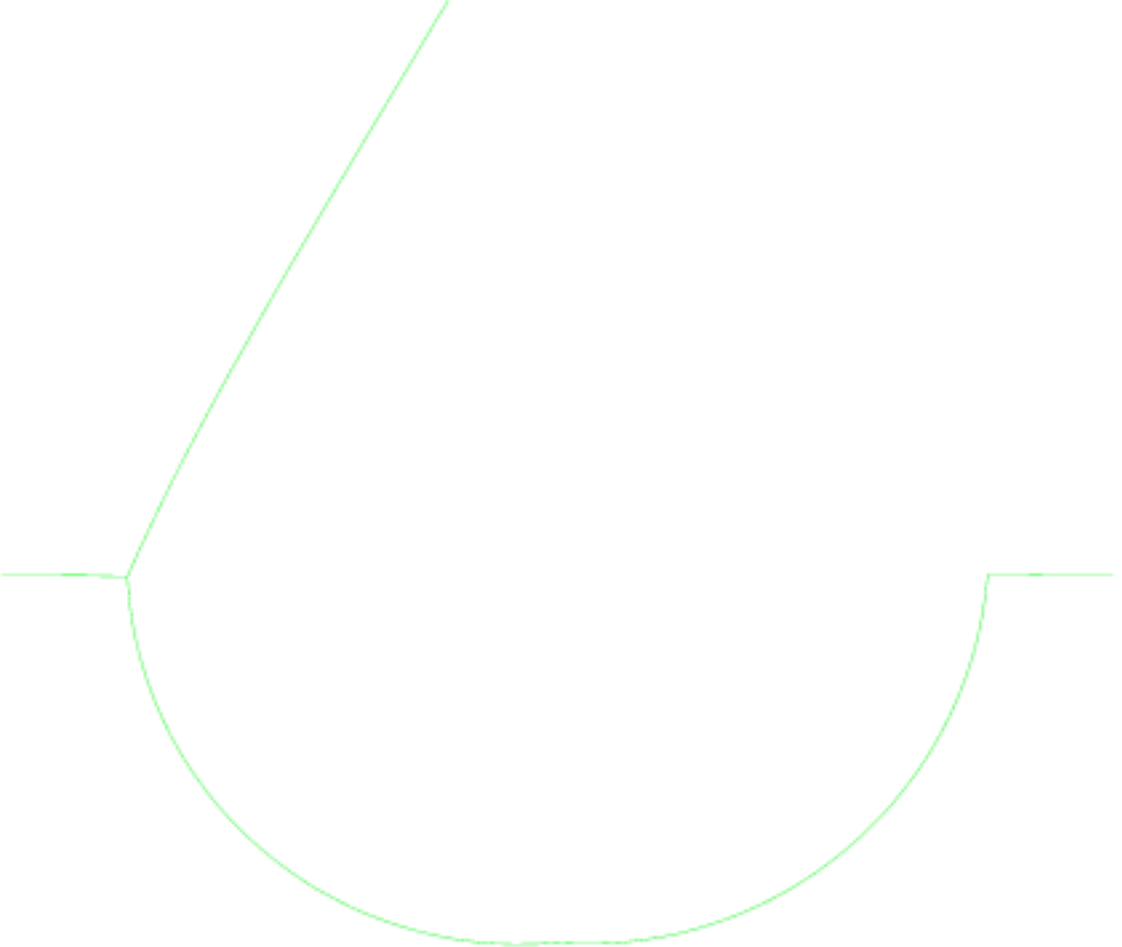
Educational Recherche : maillage de la sphere





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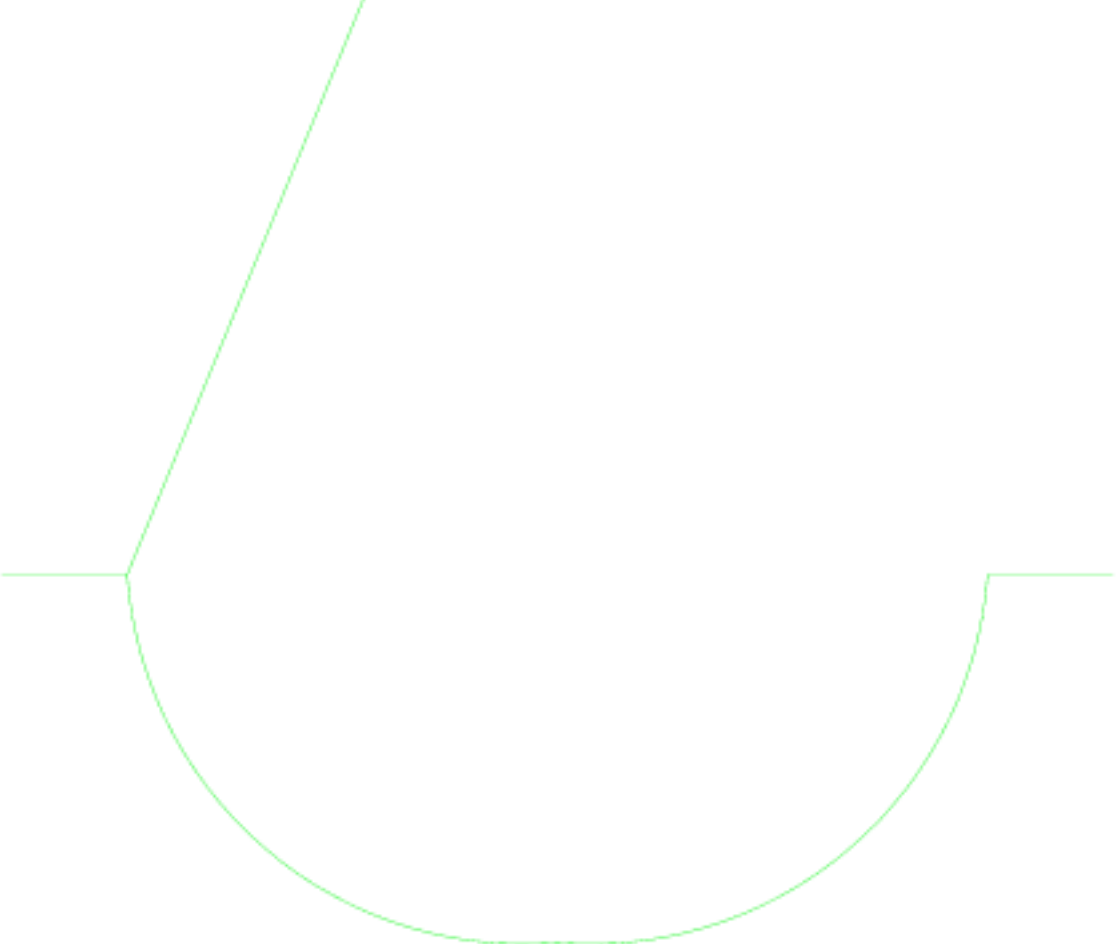


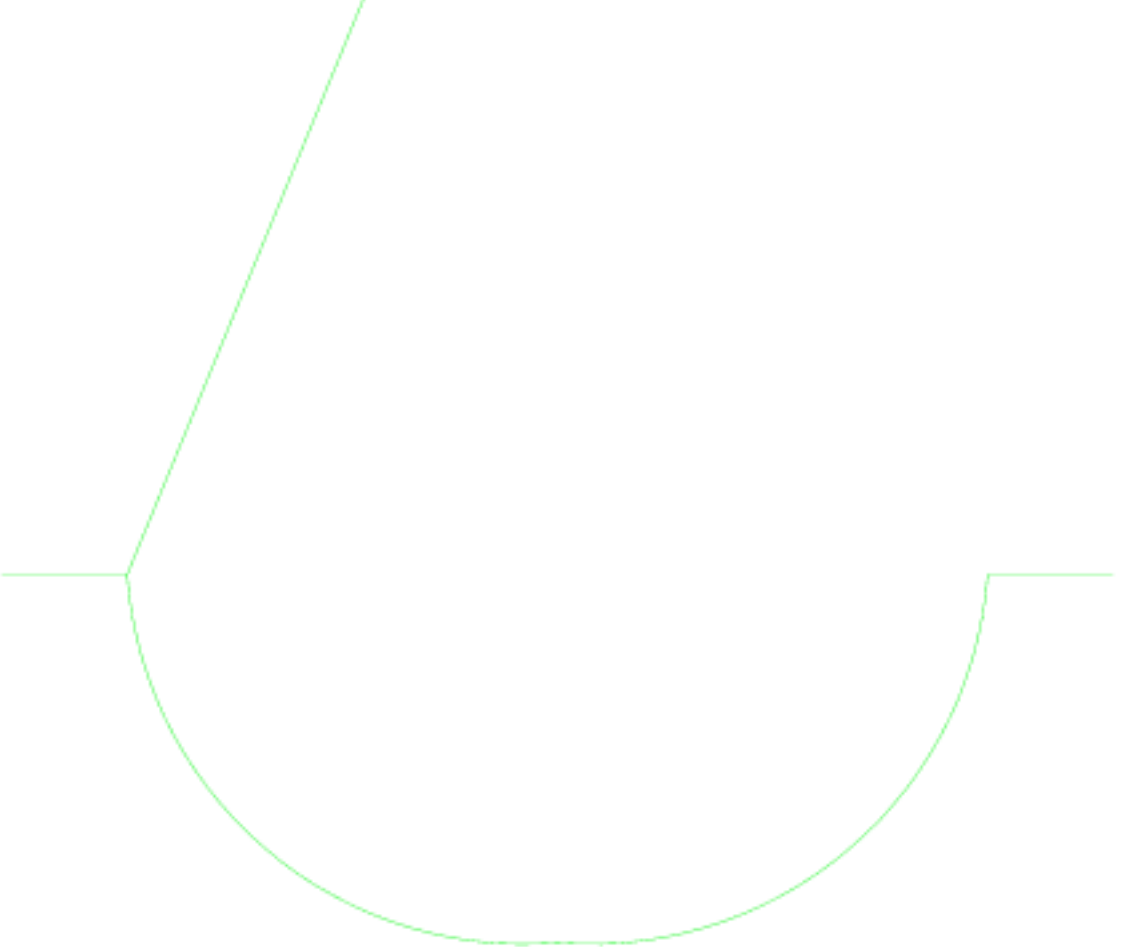


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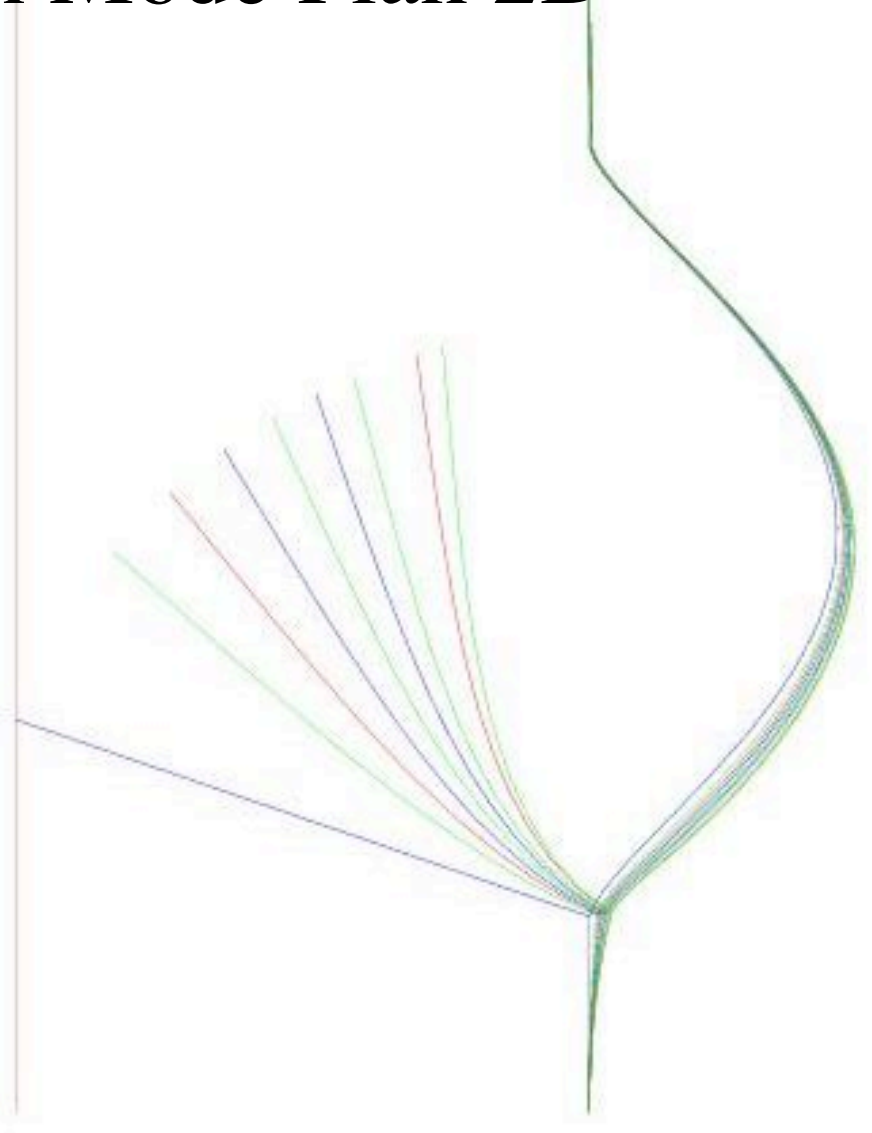




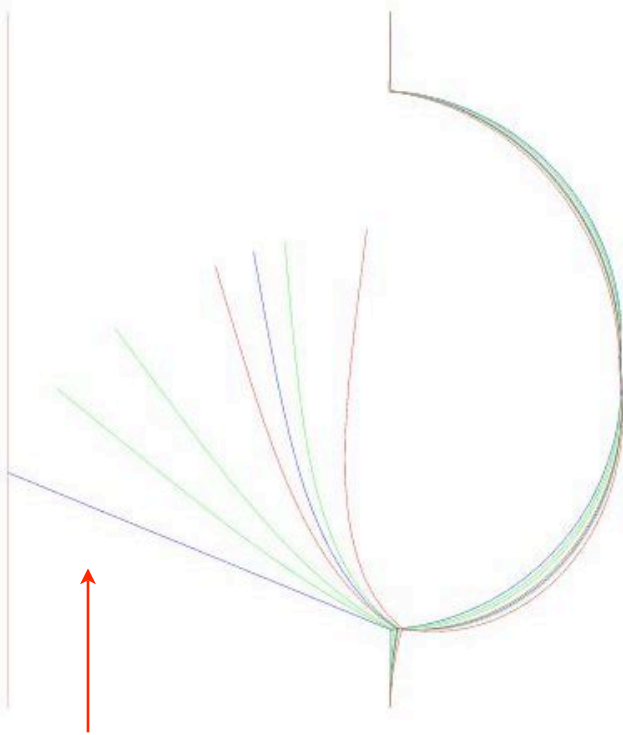
Education Recherche : maillage de la sphere

Modèle Coque en Mode Plan 2D

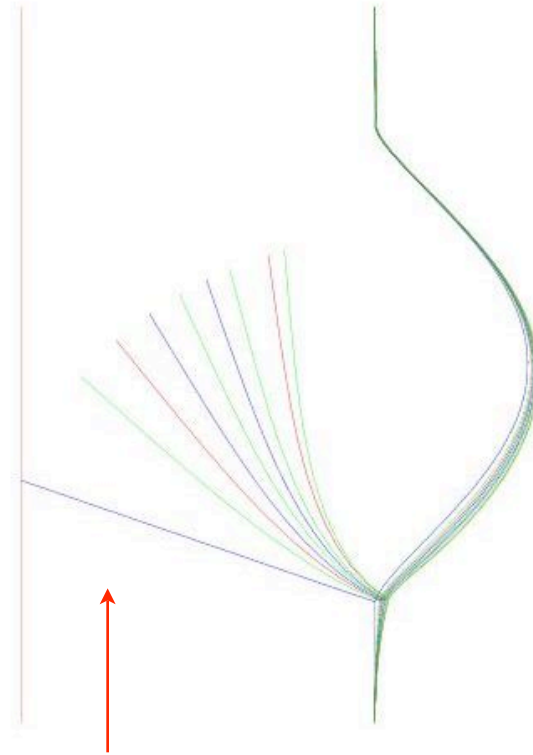
- Forme géométrique des sinus: exponentielle (ovale).
- 2 matériaux utilisés:
 $E1=0,9\text{MPa}$ et $E2=0,2\text{MPa}$.
- $\nu=0,45$.
- $t = 0:0.05:1$.



Forme du sinus



Contaminé - Fonction - Réparation - à l'air - l'âge de la spirale

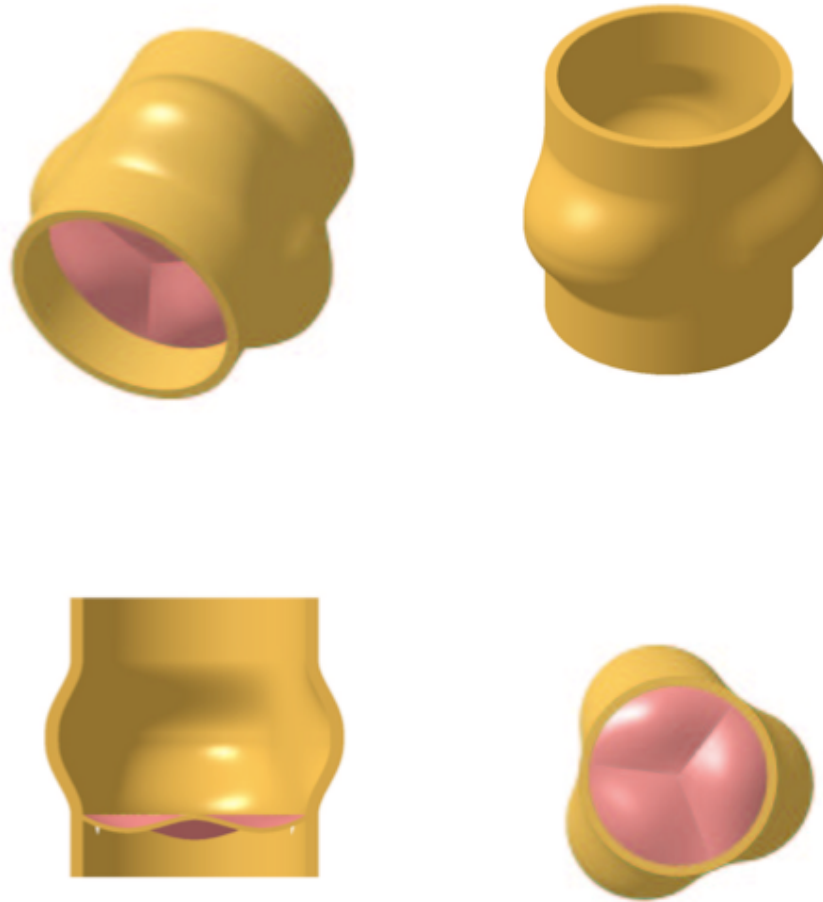


Contaminé - Fonction - Réparation - à l'âge - avec un changement

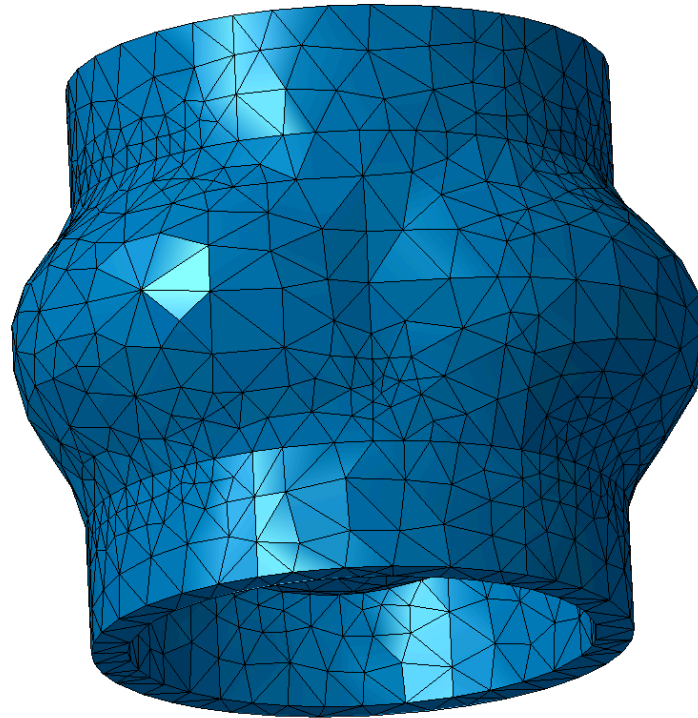
Conclusion du 2D/Axi

- La forme géométrique des sinus peut influencer sur l'ouverture de la valve aortique.
- La valve s'ouvre plus facilement en 2D plan.

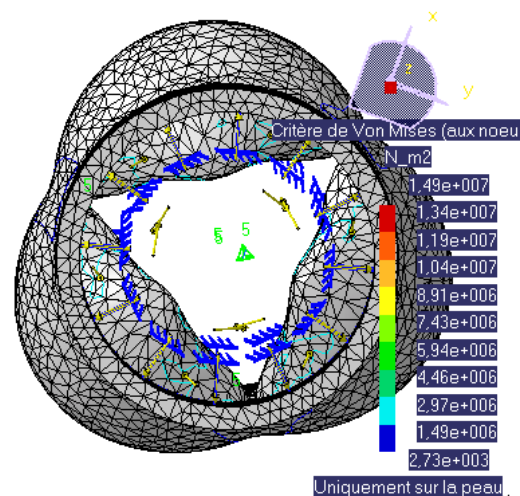
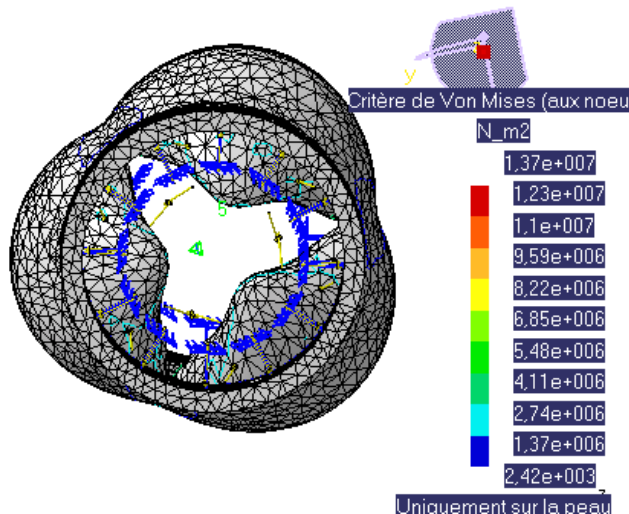
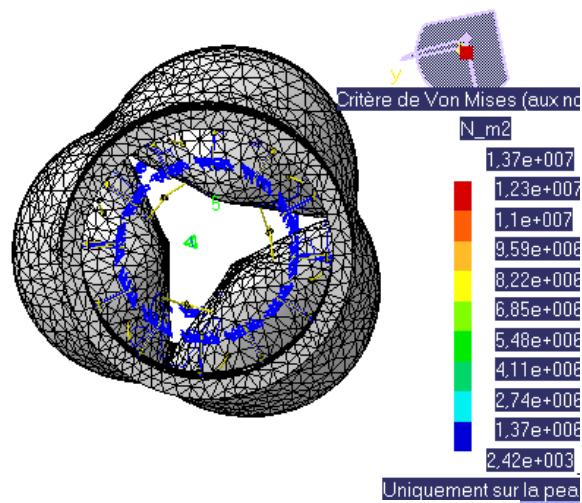
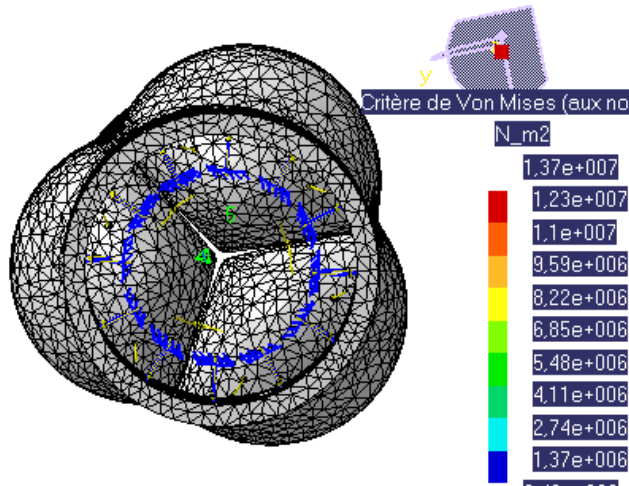
Vue 3D: Catia V5



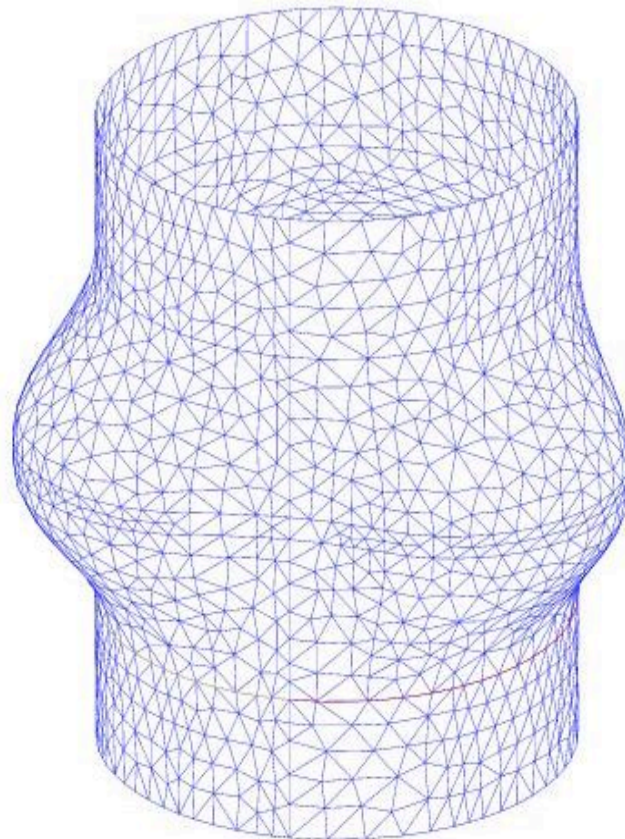
Maillage sous Catia



Maillage et déformation linéaires sous Catia V5

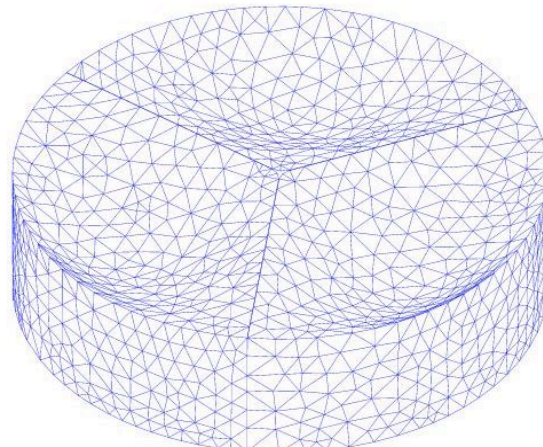


Maillage sous Catia V5 avec un calcul grands déplacements sous Castem 3M

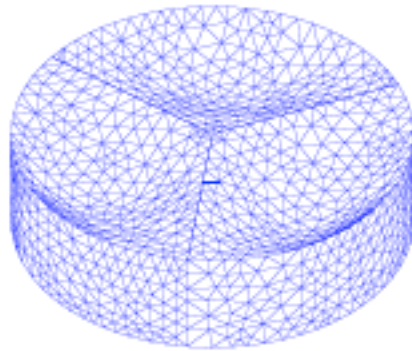


Maillage sous Catia V5 avec un calcul grands déplacements sous Castem 3M

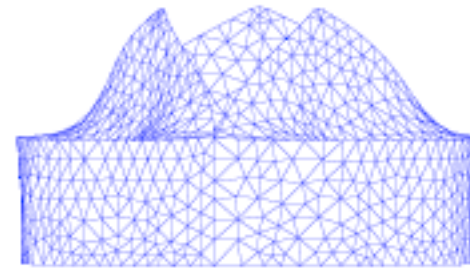
- partie inférieure de la valve (racine aortique et feuillets)
- Éléments DKT



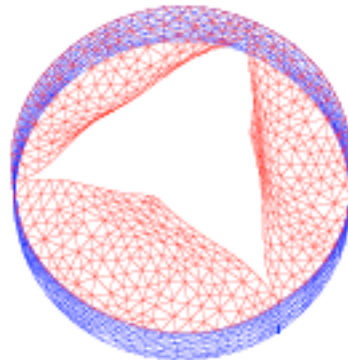
Maillage sous Catia V5 avec un calcul grands déplacements sous Castem 3M



CATIA V5 - Éléments - Éléments - Éléments



CATIA V5 - Éléments - Éléments - Éléments



CATIA V5 - Éléments - Éléments - Éléments

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conclusion

- une première analyse mécanique
- calculs 2D/Axi avec CASTEM, élastique / coque
 - influence sur l'ouverture
 - influence de la forme des sinus
 - influence des grands déplacements, rigidification
- calculs 3D
 - linéaires avec CATIA
 - non linéaires avec CASTEM:
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Mieux évaluer la pression!

etc.

