Formal Specification of a Submarine-Oval Simulonic Craft with HO/INC, Dual MEA Strips, and a 12-SFG Toroidal Ring

Hrishi Mukherjee

Simulonic Draft Specification

Abstract

We define a submarine-like (elongated oval) spacecraft as a smooth body of revolution in a body-fixed frame. We formally place: (i) a Harmonic Oscillator (HO) at the anterior nose tip, (ii) an Inertial Null Core (INC) at the posterior tail region, (iii) two dorsal Membrane Emitter Array (MEA) strips (anterior and posterior) positioned on either side of a midship toroidal ring, and (iv) a toroidal ring around the craft midsection carrying twelve Simulonic Field Generators (SFGs) evenly spaced in azimuth. A minimal diagrammatic blueprint is included.

Keywords: Simulonic Craft, Harmonic Oscillator, Inertial Null Core, Membrane Emitter Arrays, Toroidal Ring, Simulonic Field Generators

1. Body-Fixed Frame and Hull Geometry

Let the spacecraft body-fixed frame be

$$\mathcal{F}_b = \{O; \hat{\mathbf{x}}, \hat{\mathbf{y}}, \hat{\mathbf{z}}\},$$

where $\hat{\mathbf{x}}$ is longitudinal (nose→tail), $\hat{\mathbf{y}}$ starboard, and $\hat{\mathbf{z}}$ dorsal.

Let the craft length be $L > 0$, with nose tip at $x = 0$ and tail tip at $x = L$. Define cylindrical radius about $\hat{\mathbf{x}}$:

$$\rho(x, y, z) = \sqrt{y^2 + z^2}.$$

1.1. Elongated oval (submarine-like) hull

Define the hull as a body of revolution with radius profile $r(x)$:

$$\boxed{\mathcal{H} = \left\{(x, y, z) : 0 \le x \le L, \;\; y^2 + z^2 \le r(x)^2\right\}.} \tag{1}$$

A smooth "oval" profile vanishing at both tips:

$$\boxed{r(x) = R_{\max} \, \sin\!\left(\pi \frac{x}{L}\right), \qquad 0 \le x \le L,} \tag{2}$$

so $r(0) = r(L) = 0$ and $r(L/2) = R_{\max}$.

The hull surface is

$$\partial\mathcal{H} = \{(x, y, z) : y^2 + z^2 = r(x)^2, \; 0 \le x \le L\}.$$

2. Principal Stations and Component Placement

Define the midship (ring) station

$$\boxed{x_c := L/2.} \tag{3}$$

2.1. Harmonic Oscillator (HO) at the anterior tip

Place the HO on the longitudinal axis near the nose:

$$\boxed{\mathbf{p}_{\text{HO}} = (x_{\text{HO}}, 0, 0), \quad x_{\text{HO}} = \varepsilon_{\text{HO}} L, \;\; 0 < \varepsilon_{\text{HO}} \ll 1.} \tag{4}$$

Define the HO as an embedded ellipsoid volume:

$$\boxed{\mathcal{V}_{\text{HO}} = \left\{\mathbf{x} : \; (\mathbf{x} - \mathbf{p}_{\text{HO}})^\top \operatorname{diag}(a_{\text{HO}}^{-2}, b_{\text{HO}}^{-2}, b_{\text{HO}}^{-2})(\mathbf{x} - \mathbf{p}_{\text{HO}}) \le 1\right\}.} \tag{5}$$

2.2. Inertial Null Core (INC) at the posterior end

Place the INC on-axis near the tail:

$$\boxed{\mathbf{p}_{\text{INC}} = (x_{\text{INC}}, 0, 0), \quad x_{\text{INC}} = (1 - \varepsilon_{\text{INC}})L, \;\; 0 < \varepsilon_{\text{INC}} \ll 1.} \tag{6}$$

Define the INC as an embedded ellipsoid volume:

$$\boxed{\mathcal{V}_{\text{INC}} = \left\{\mathbf{x} : \; (\mathbf{x} - \mathbf{p}_{\text{INC}})^\top \operatorname{diag}(a_{\text{INC}}^{-2}, b_{\text{INC}}^{-2}, b_{\text{INC}}^{-2})(\mathbf{x} - \mathbf{p}_{\text{INC}}) \le 1\right\}.} \tag{7}$$

3. Toroidal Ring and 12 Simulonic Field Generators (SFGs)

Let R_c be the hull radius at the ring station:

$$\boxed{R_c := r(x_c) = R_{\max}.}$$

Let $r_t \ll R_c$ be the torus tube radius.

3.1. Toroidal ring around the midship circumference

Define the torus (around the $\hat{\mathbf{x}}$ axis) centered at $x = x_c$:

$$\boxed{\mathcal{T} = \left\{(x, y, z) : (x - x_c)^2 + \left(\sqrt{y^2 + z^2} - R_c\right)^2 \le r_t^2\right\}.} \tag{8}$$

3.2. Twelve SFG modules uniformly distributed in azimuth

Let $N = 12$ and define azimuth angles:

$$\boxed{\theta_k = \frac{2\pi k}{12}, \quad k = 0, 1, \ldots, 11.} \tag{9}$$

Let the ring centerline (major circle) be

$$\mathbf{p}_{\text{ring}}(\theta) = (x_c,\ R_c \cos\theta,\ R_c \sin\theta).$$

Define each SFG center:

$$\boxed{\mathbf{p}_{\text{SFG},k} = \mathbf{p}_{\text{ring}}(\theta_k).} \tag{10}$$

Radial unit vector at θ_k:

$$\hat{\mathbf{r}}_k = (0, \cos\theta_k, \sin\theta_k).$$

Model each SFG as a small cylinder (length ℓ_s, radius r_s) oriented radially:

$$\boxed{\mathcal{V}_{\text{SFG},k} = \left\{ \mathbf{x} :\ \left\| \left(\mathbf{I} - \hat{\mathbf{r}}_k \hat{\mathbf{r}}_k^\top\right)(\mathbf{x} - \mathbf{p}_{\text{SFG},k}) \right\| \le r_s,\ \left| \hat{\mathbf{r}}_k^\top (\mathbf{x} - \mathbf{p}_{\text{SFG},k}) \right| \le \frac{\ell_s}{2} \right\}.} \tag{11}$$

The full SFG assembly is

$$\boxed{\mathcal{SFG} = \bigcup_{k=0}^{11} \mathcal{V}_{\text{SFG},k}.}$$

4. Dual Dorsal MEA Strips (Anterior and Posterior)

Parameterize the hull surface by (x, ϕ):

$$\mathbf{s}(x, \phi) = (x,\ r(x)\cos\phi,\ r(x)\sin\phi),$$

where $\phi = \pi/2$ is dorsal (top: $z > 0$). Let $\Delta\phi$ be the dorsal half-width.

Choose anterior and posterior axial intervals:

$$0 < x_{A1} < x_{A2} < x_c, \qquad x_c < x_{P1} < x_{P2} < L.$$

Define the anterior MEA strip:

$$\boxed{\text{MEA}_A = \left\{ \mathbf{s}(x, \phi) : x \in [x_{A1}, x_{A2}],\ \phi \in \left[\frac{\pi}{2} - \Delta\phi, \frac{\pi}{2} + \Delta\phi\right] \right\}.} \tag{12}$$

Define the posterior MEA strip:

$$\boxed{\text{MEA}_P = \left\{ \mathbf{s}(x, \phi) : x \in [x_{P1}, x_{P2}],\ \phi \in \left[\frac{\pi}{2} - \Delta\phi, \frac{\pi}{2} + \Delta\phi\right] \right\}.} \tag{13}$$

Total MEA system:

$$\boxed{\text{MEA} = \text{MEA}_A \cup \text{MEA}_P.}$$

5. Assembly Constraints

$$\boxed{\mathcal{V}_{\text{HO}} \subset \mathcal{H}, \qquad \mathcal{V}_{\text{INC}} \subset \mathcal{H}} \tag{14}$$

$$\boxed{\mathcal{T} \subset \mathcal{N}(\partial\mathcal{H}) \text{ near } x = x_c} \tag{15}$$

$$\boxed{\mathcal{V}_{\text{SFG},k} \subset \mathcal{N}(\mathcal{T}),\ \forall k} \tag{16}$$

$$\boxed{\text{MEA}_A \subset \partial\mathcal{H}, \quad \text{MEA}_P \subset \partial\mathcal{H}} \tag{17}$$

where $\mathcal{N}(\cdot)$ denotes a thin neighborhood (mounting layer).

5.1. One-line Simulonic craft definition

$$\boxed{\mathcal{C} = \left(\mathcal{H},\ \mathcal{V}_{\text{HO}},\ \mathcal{V}_{\text{INC}},\ \mathcal{T},\ \{\mathcal{V}_{\text{SFG},k}\}_{k=0}^{11},\ \text{MEA}_A,\ \text{MEA}_P\right).}$$

6. Blueprint Diagram (Top and Side Views)

7. Parameter Table (Implementation Handles)

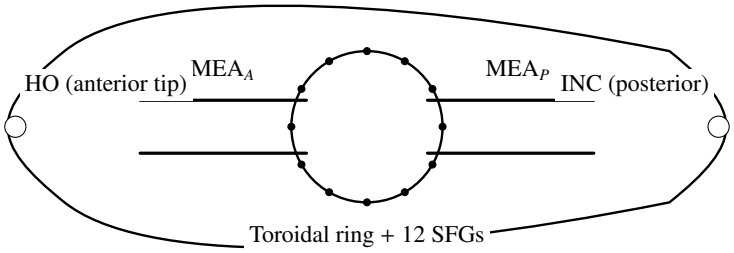
Table 1: Primary geometric and placement parameters.

Symbol	Meaning
L	craft length (nose tip $x = 0$ to tail tip $x = L$)
$R_{\max}$	max hull radius at midship ($x = L/2$)
x_c	ring station (default $L/2$)
r_t	torus tube radius (ring thickness)
Γ	(optional) circulation magnitude if coupling to vortex model
ε_{HO}	nose offset fraction for HO placement
ε_{INC}	tail offset fraction for INC placement
$[x_{A1}, x_{A2}]$	anterior MEA axial extent (must satisfy $x_{A2} < x_c$)
$[x_{P1}, x_{P2}]$	posterior MEA axial extent (must satisfy $x_{P1} > x_c$)
$\Delta\phi$	dorsal MEA half-width in azimuth about $\phi = \pi/2$
ℓ_s, r_s	SFG cylinder length and radius (module envelope)

8. Closing Simulonic Statement

This specification fixes *(i)* hull as $\mathcal{H}$, *(ii)* HO as $\mathcal{V}_{\text{HO}}$ at the nose, *(iii)* INC as $\mathcal{V}_{\text{INC}}$ at the tail, *(iv)* two dorsal MEA strips $\text{MEA}_A, \text{MEA}_P$ straddling the midship station, and *(v)* a midship toroidal ring $\mathcal{T}$ carrying twelve uniformly spaced SFG modules $\{\mathcal{V}_{\text{SFG},k}\}_{k=0}^{11}$. All elements are constrained to be embedded in/on the hull as stated in Section 6.

Top view (dorsal): elongated hull, midship toroidal ring with 12 SFGs, two MEA strips



Side view: HO at nose, INC at tail, MEA strips on dorsal surface, ring at midship

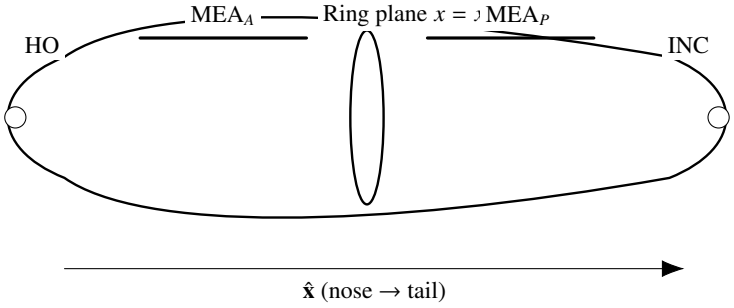


Figure 1: Minimal Simulonic blueprint diagram (top and side views). The craft is an elongated oval hull; HO sits at the anterior tip, INC at the posterior; two dorsal MEA strips sit fore and aft of the midship toroidal ring; the ring carries 12 SFG modules uniformly spaced in azimuth.