Discussion: 3 D Hg Jet Simulation

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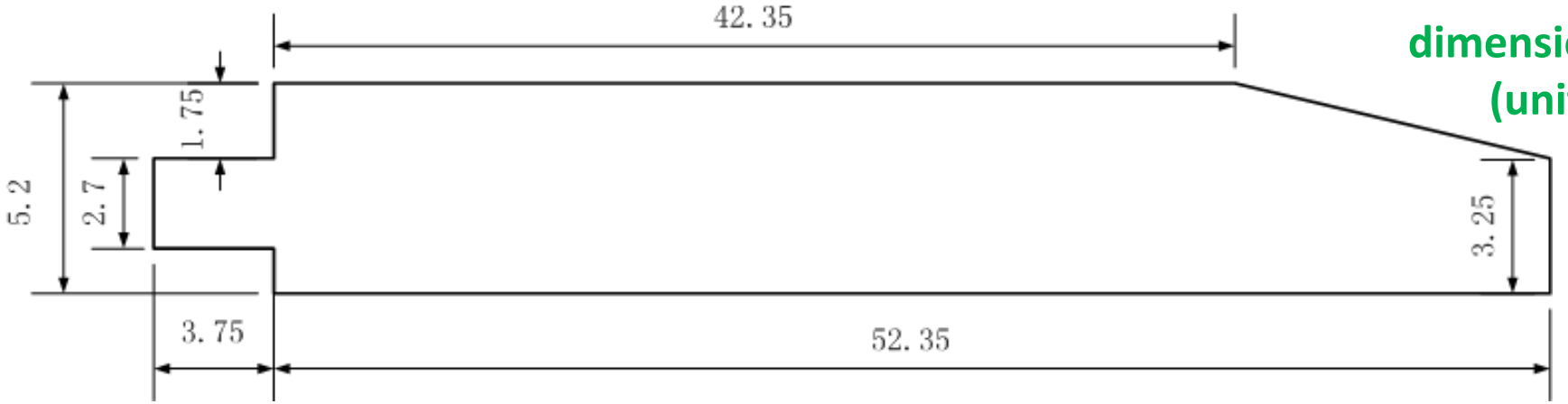
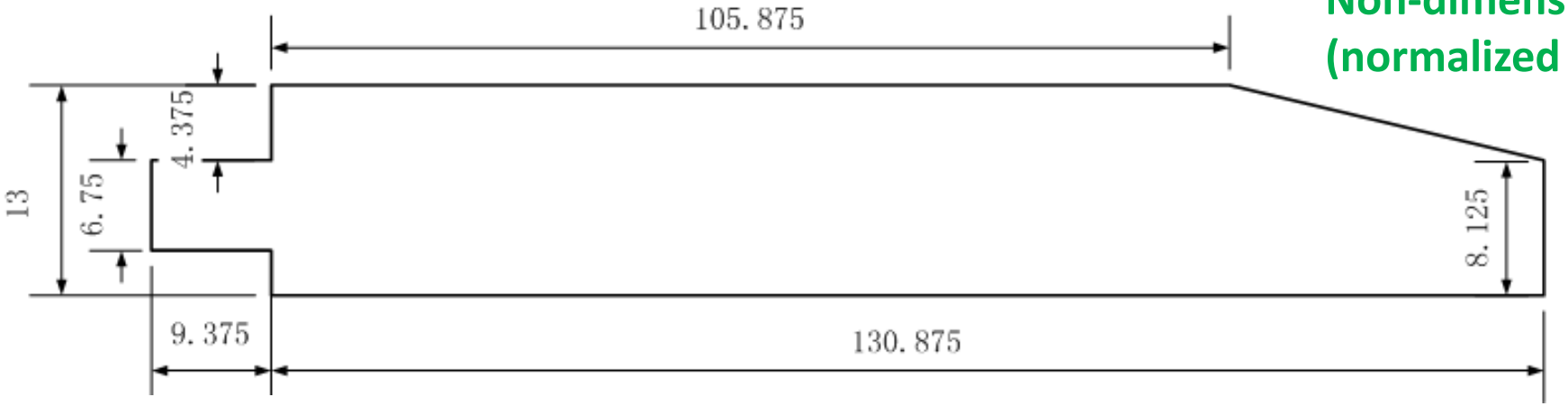
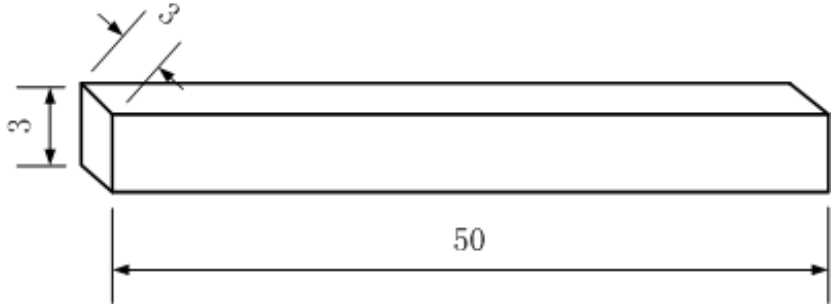
Simplification Of The 3D Hg Jet



dimensional model
(unit: inch)

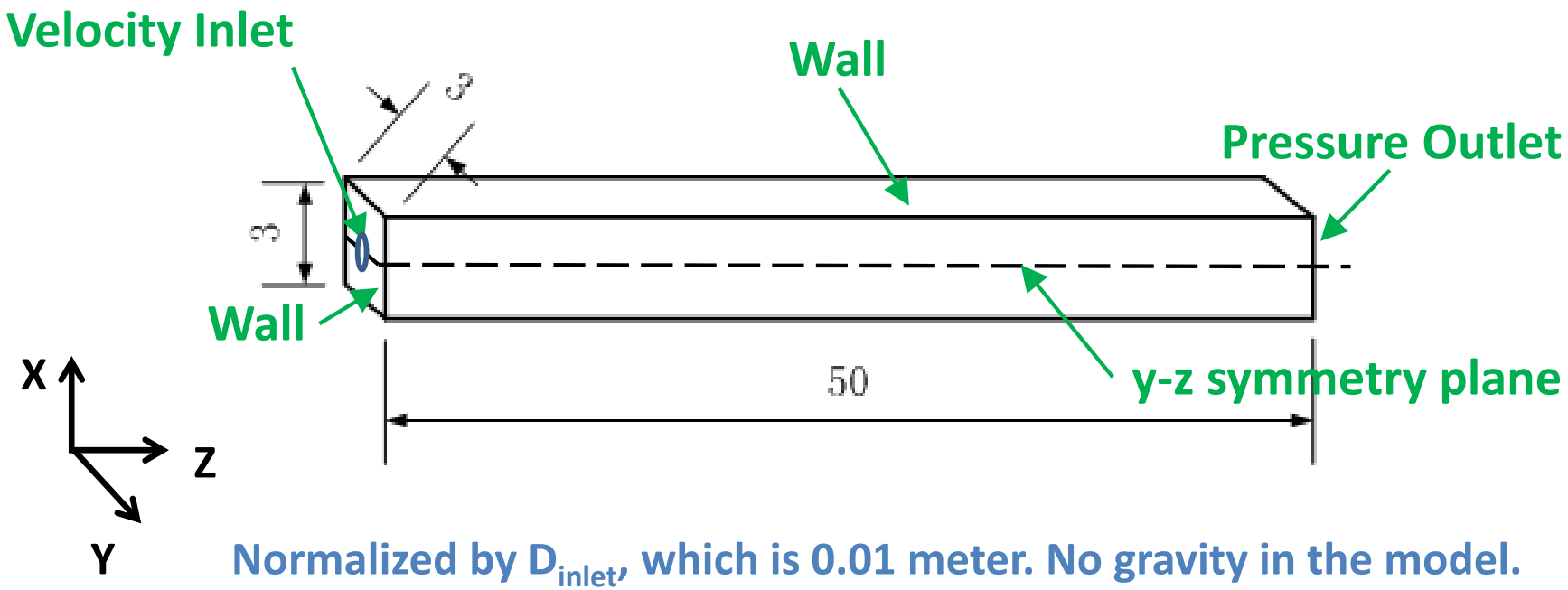


Non-dimensional model
(normalized by $D_{jet\ exit}$)



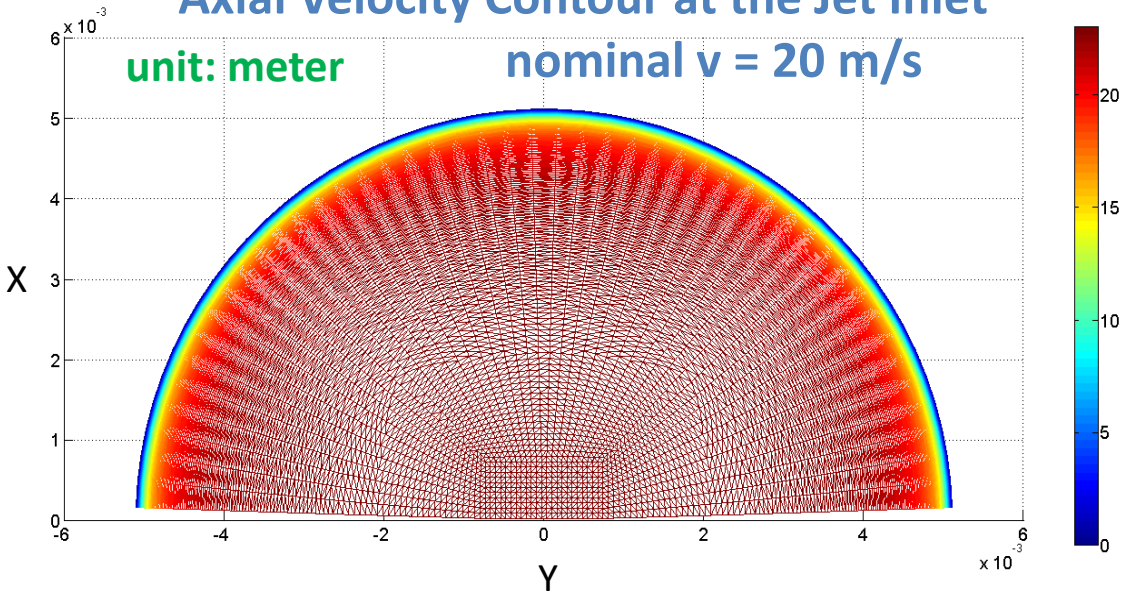
Simplified model
(normalized by $D_{jet\ exit}$)

Boundary Conditions



Normalized by D_{inlet}, which is 0.01 meter. No gravity in the model.

Axial Velocity Contour at the Jet Inlet



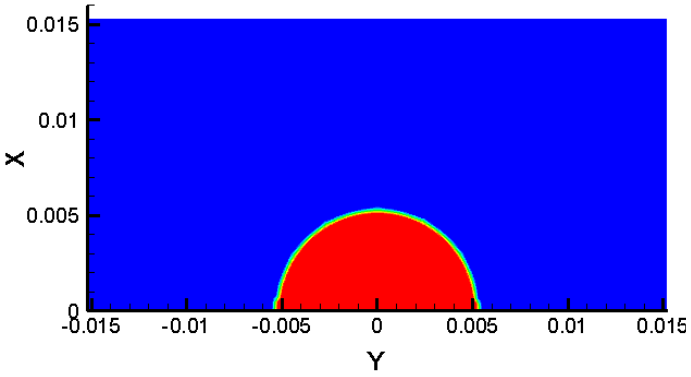
pipe simulation

u = **U** + sqrt(2**k**/3),
where **k** = ½((u')^2+(v')^2+(w')^2)

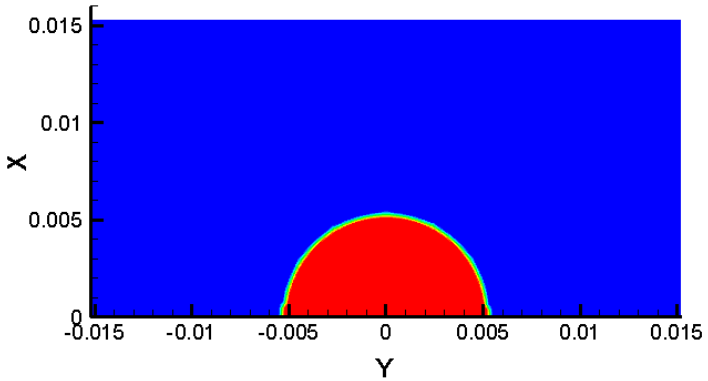
Input at velocity inlet from pipe-flow study without weld, and without bend.
Mesh: 14M, ⇒ 1 week per 1 velocity flow thru (25 ms).

Results of α_{Hg} at t = 0.2 μs (one time step)

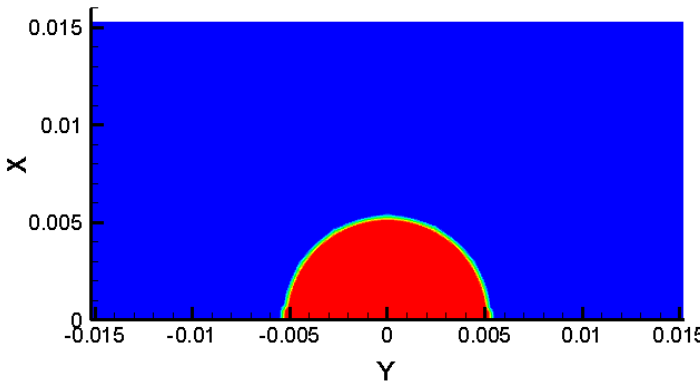
z = 0 cm



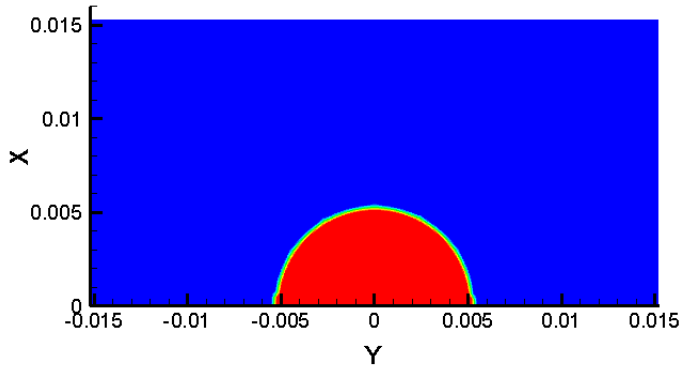
z = 1 cm



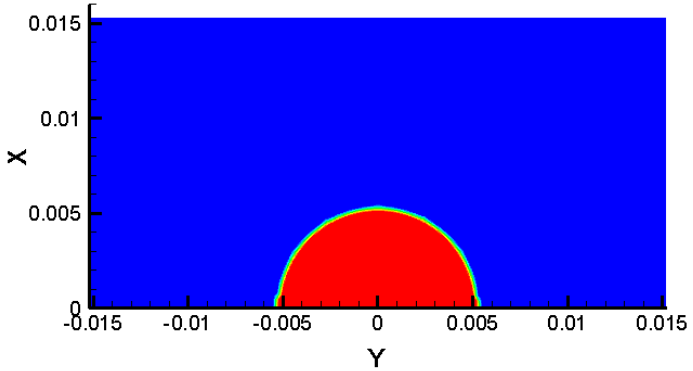
z = 5 cm



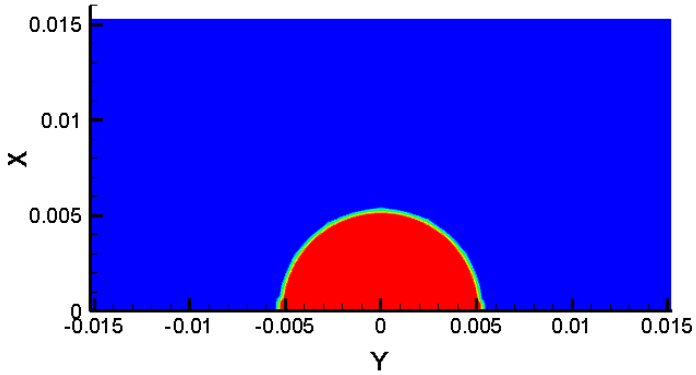
z = 10 cm



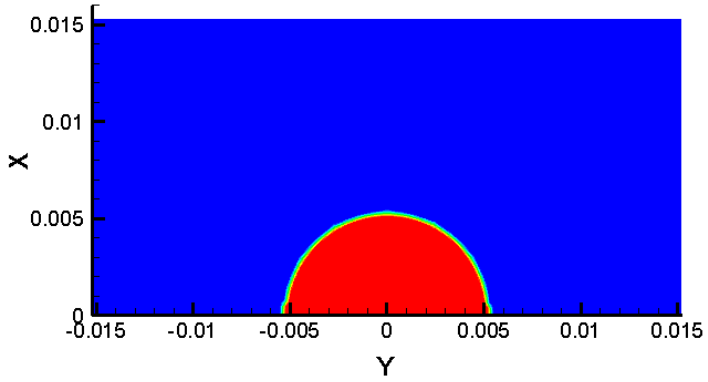
z = 15 cm



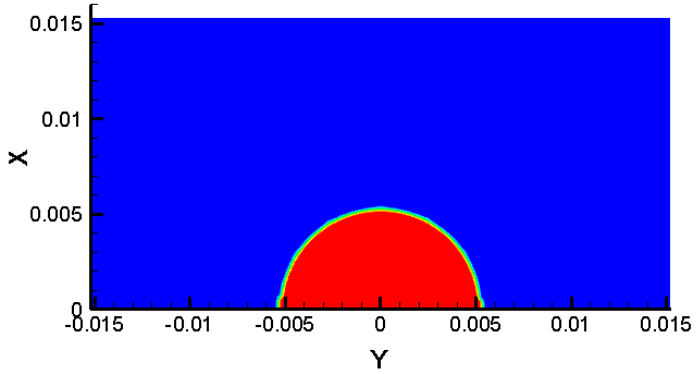
z = 20 cm

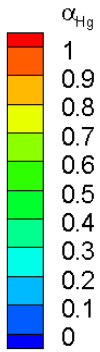


z = 30 cm



z = 45 cm

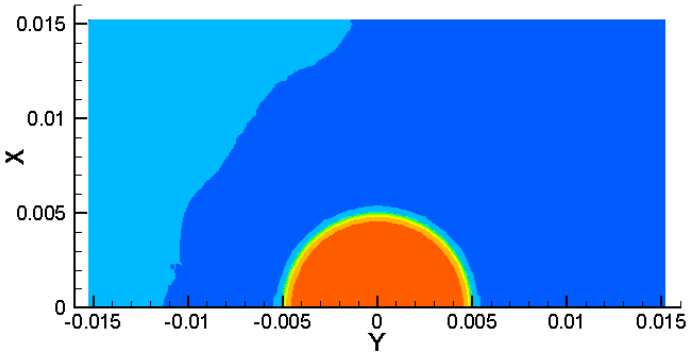




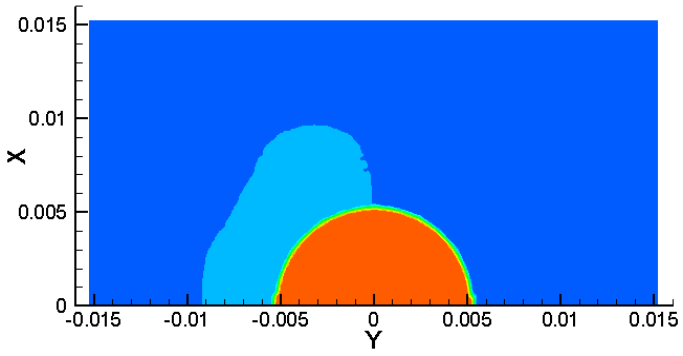
α_{Hg} = volume fraction of mercury

Results of u_z at t = 0.2 μs (one time step)

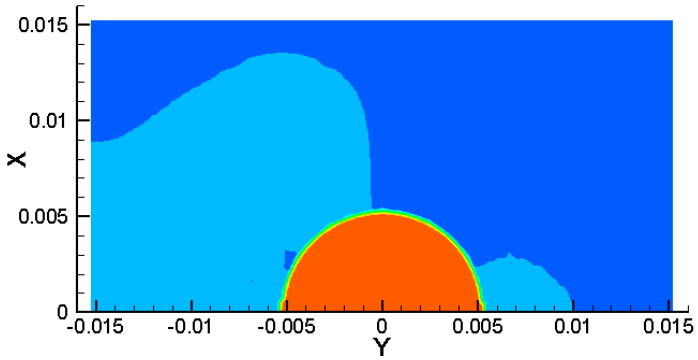
z = 0 cm



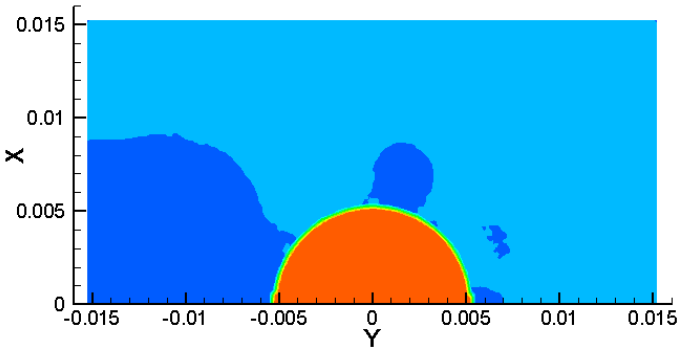
z = 1 cm



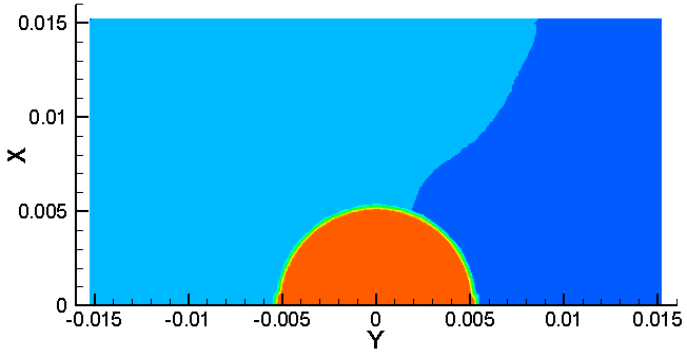
z = 5 cm



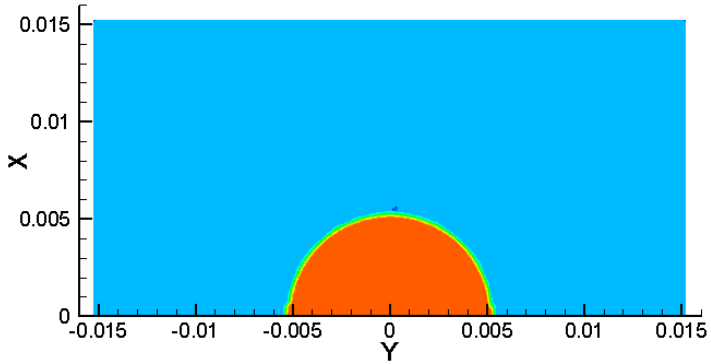
z = 10 cm



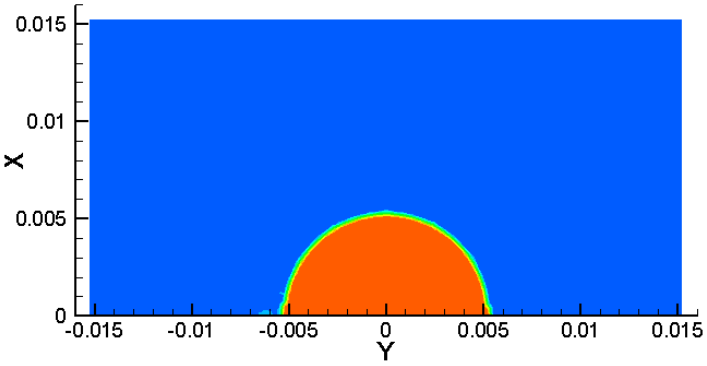
z = 15 cm



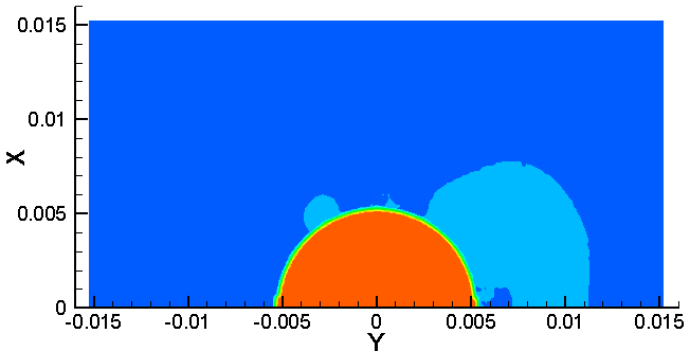
z = 20 cm



z = 30 cm



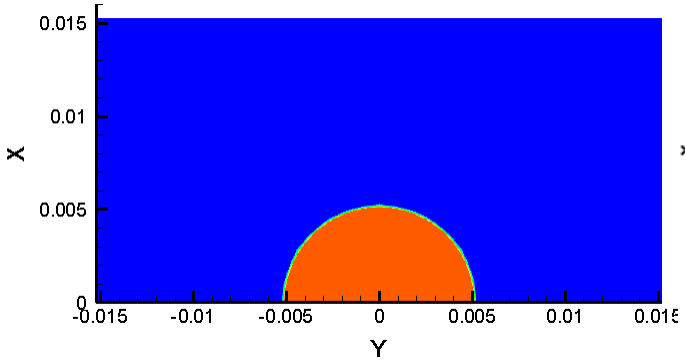
z = 45 cm



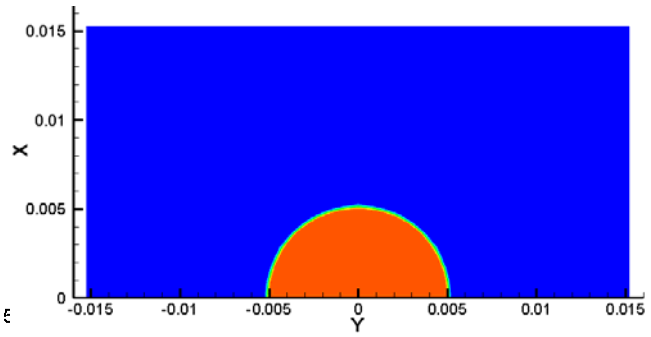
u_z = z component of velocity

Results of α_{Hg} at t = 14.4 ms

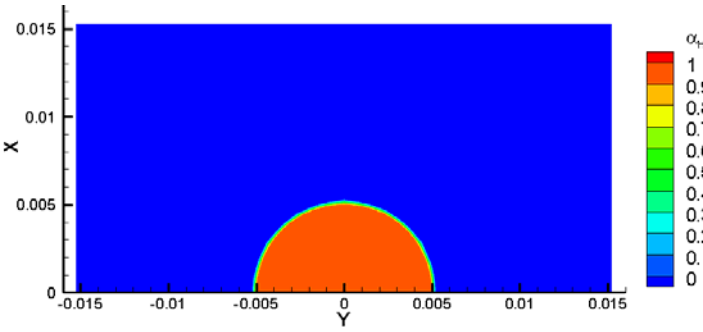
z = 0 cm



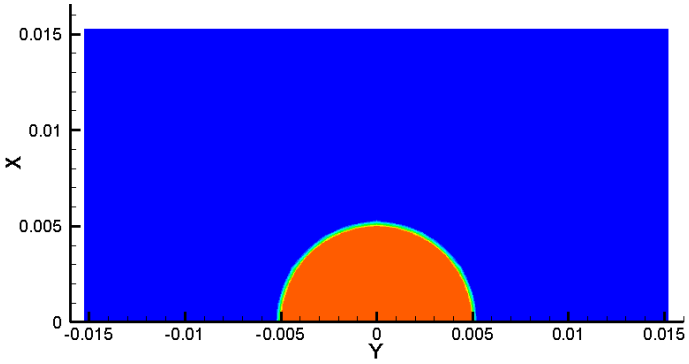
z = 1 cm



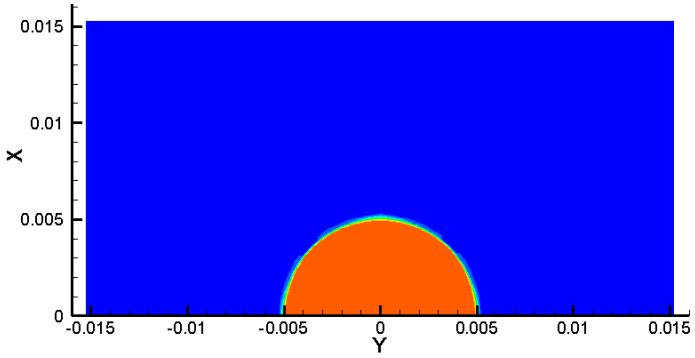
z = 5 cm



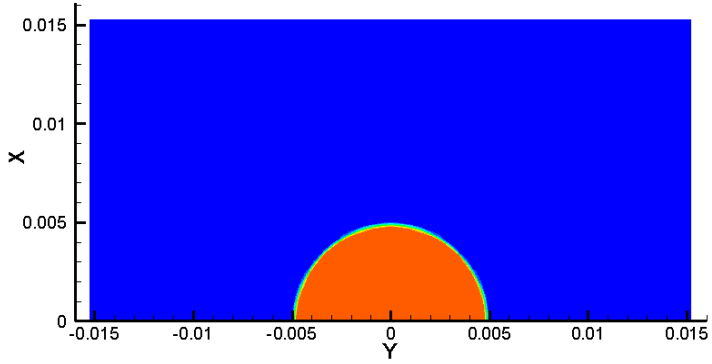
z = 10 cm



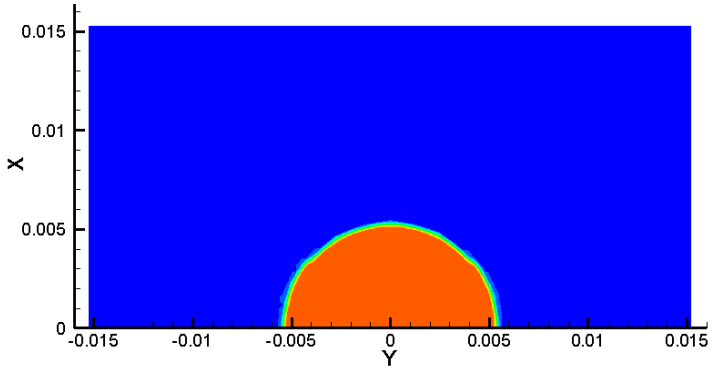
z = 15 cm



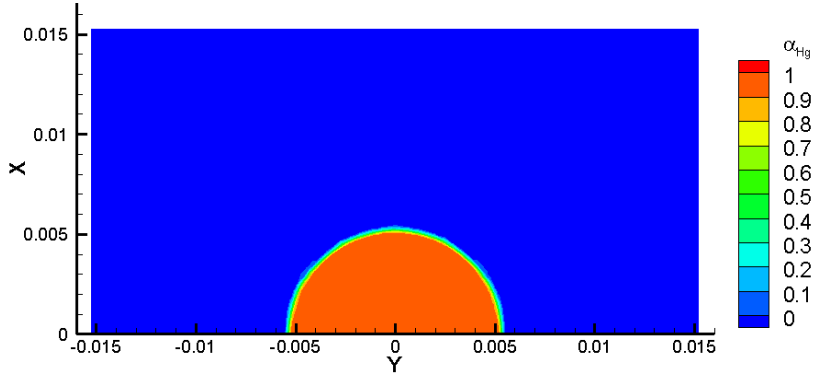
z = 20 cm



z = 30 cm



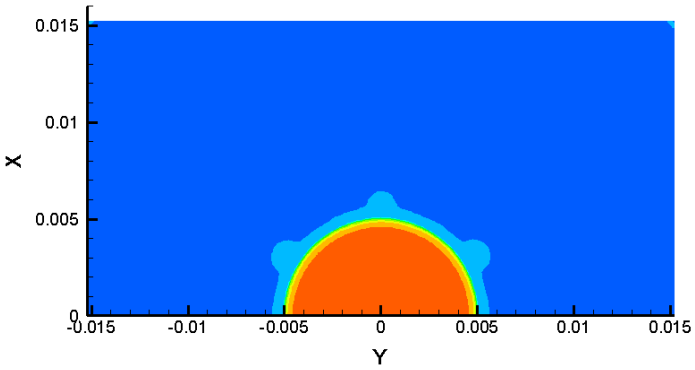
z = 45 cm



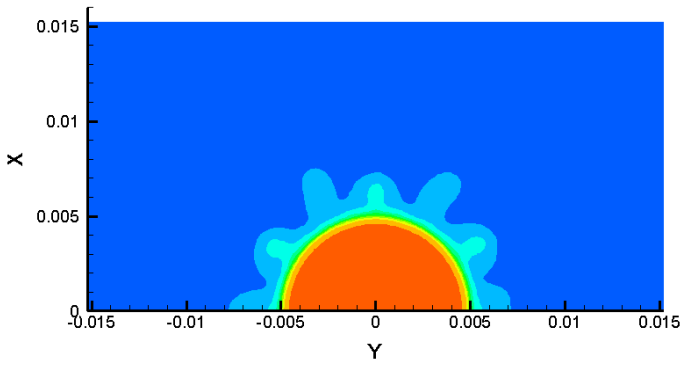
One flow-thru time = 25 ms

Results of u_z at t = 14.4 ms

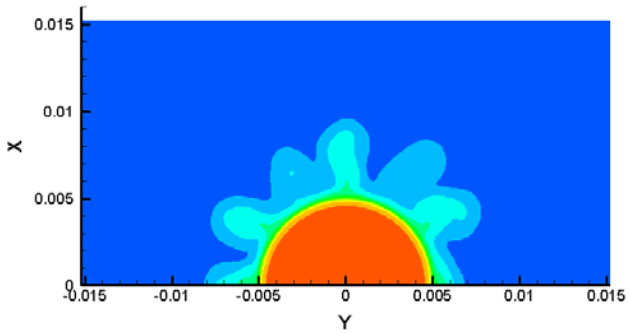
z= 0 cm



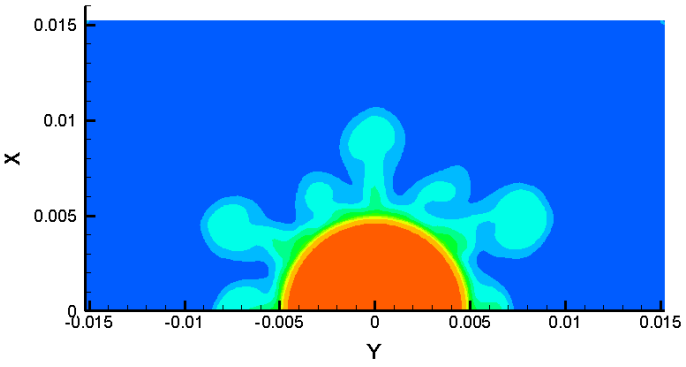
z = 1 cm



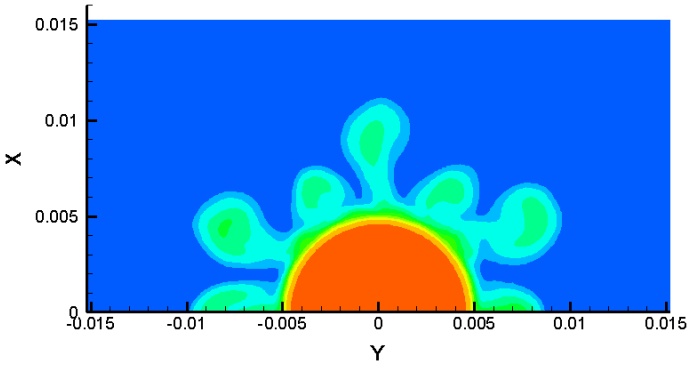
z = 5 cm



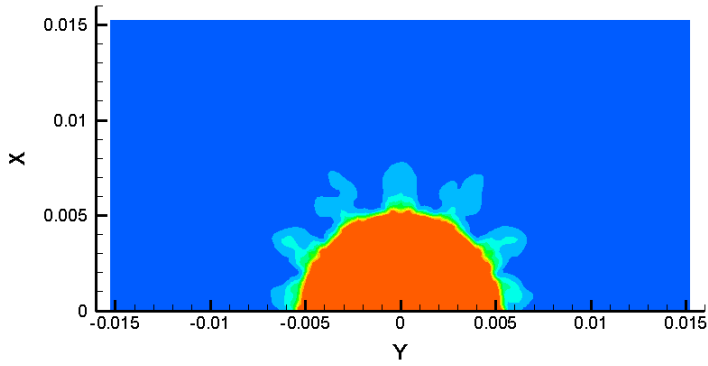
z = 10 cm



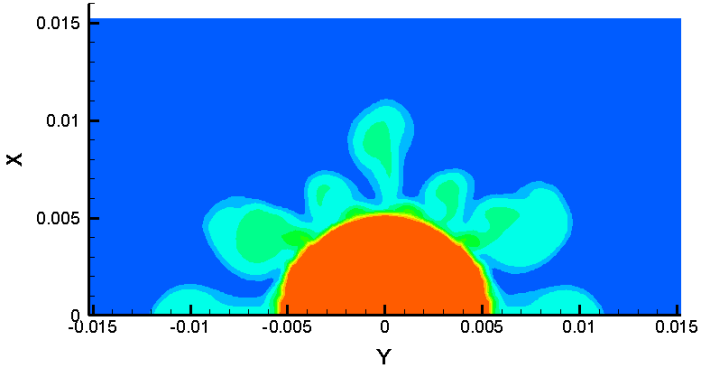
z = 15 cm



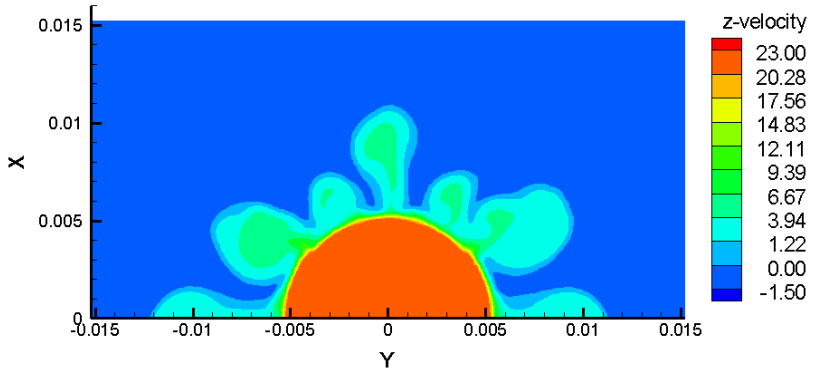
z = 20 cm



z = 30 cm



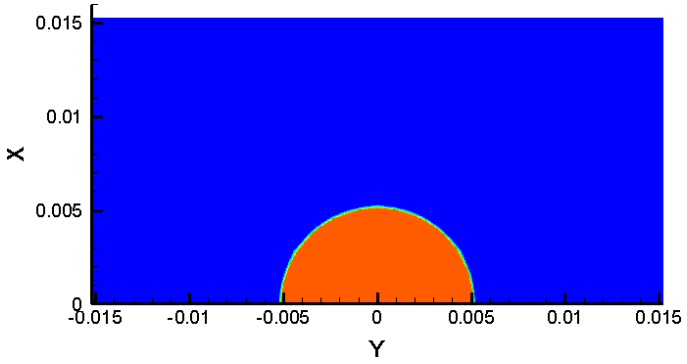
z = 45 cm



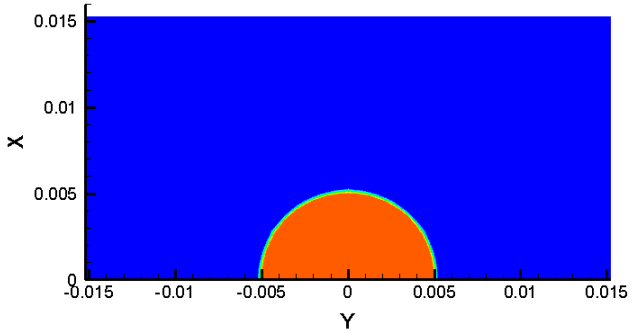
Fingers have u_z ~ 8m/s and u_r ~ 1/3 m/s.
The Hg density in the fingers is very small.
These may be just transient effects.

Results of α_{Hg} at t = 26.4 ms

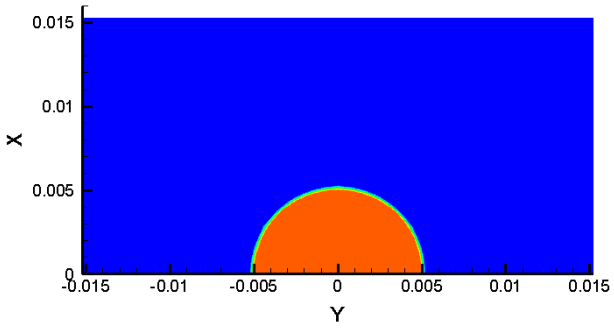
z = 0 cm



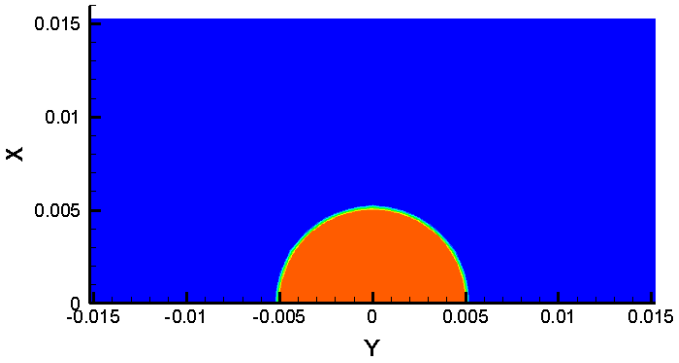
z = 1 cm



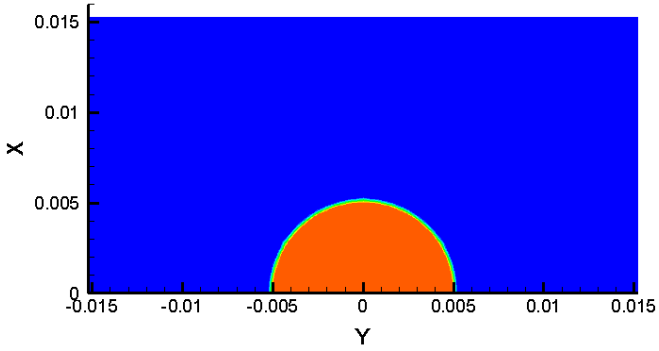
z = 5 cm



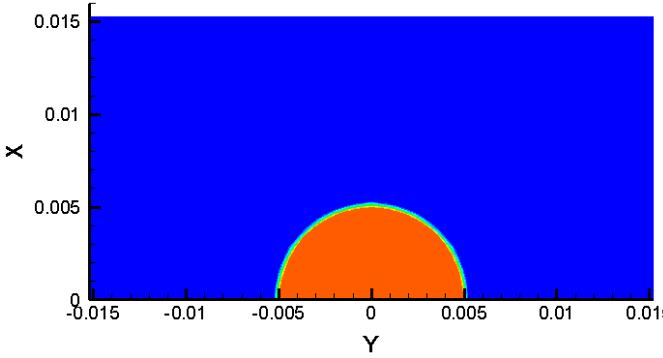
z = 10 cm



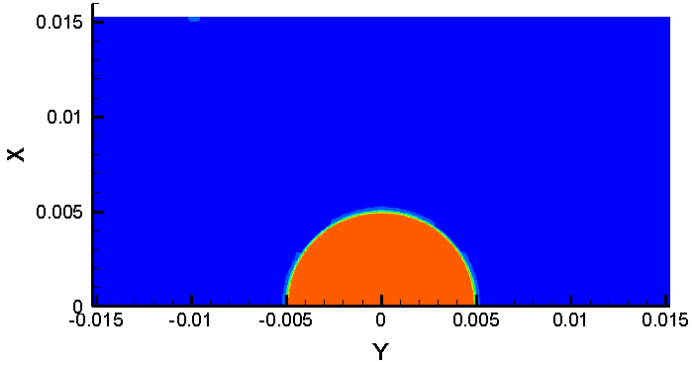
z = 15 cm



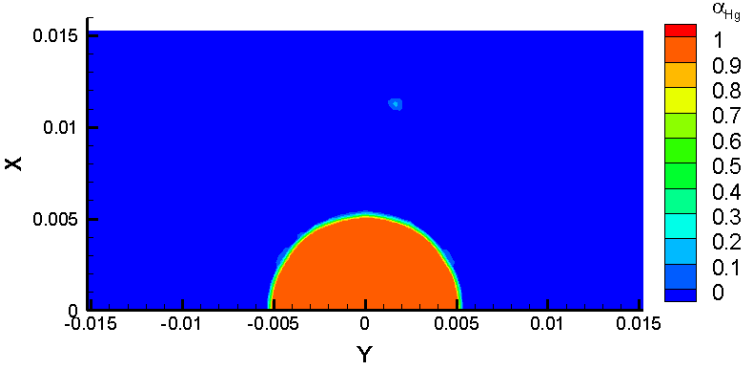
z = 20 cm



z = 30 cm

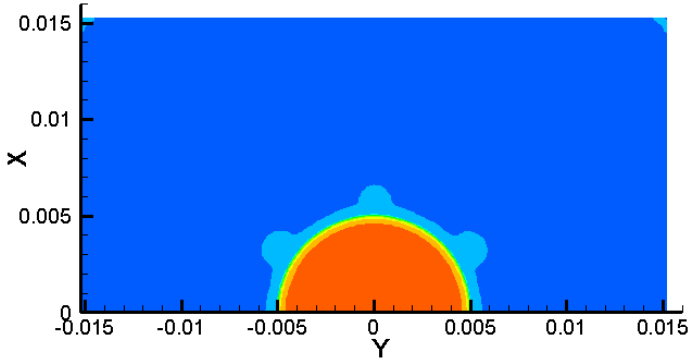


z = 45 cm

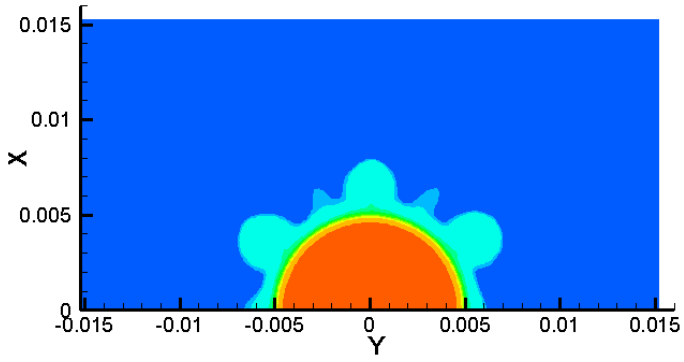


Results of u_z at t = 26.4 ms

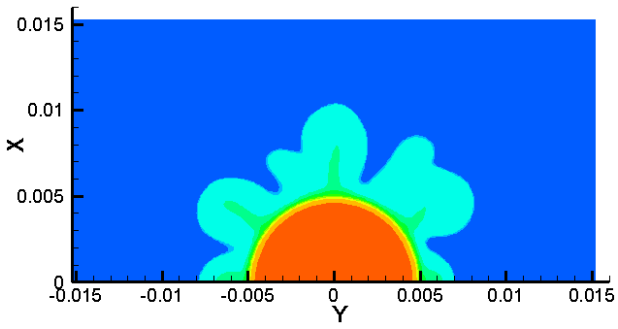
z = 0 cm



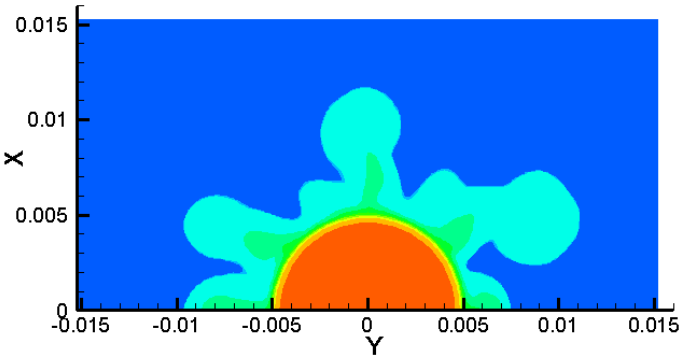
z = 1 cm



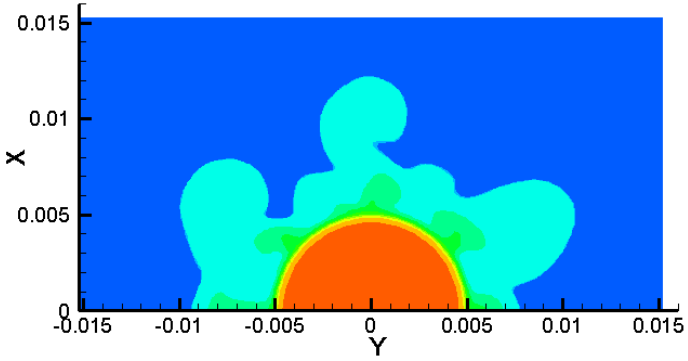
z = 5 cm



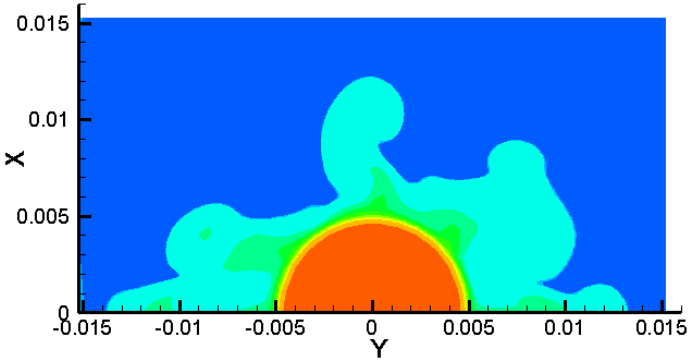
z = 10 cm



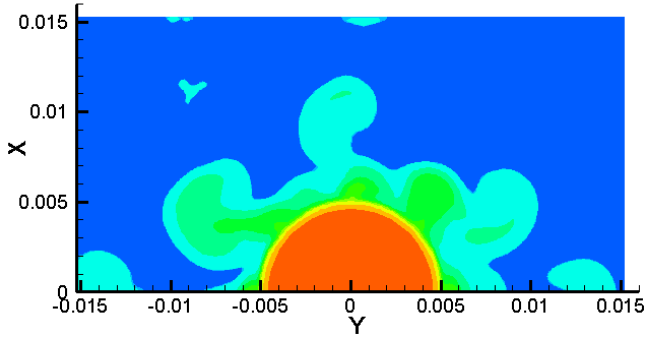
z = 15 cm



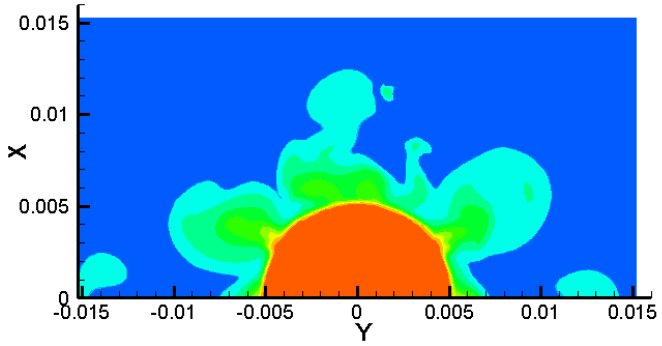
z = 20 cm

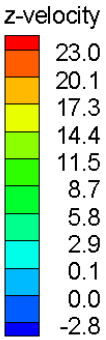


z = 30 cm



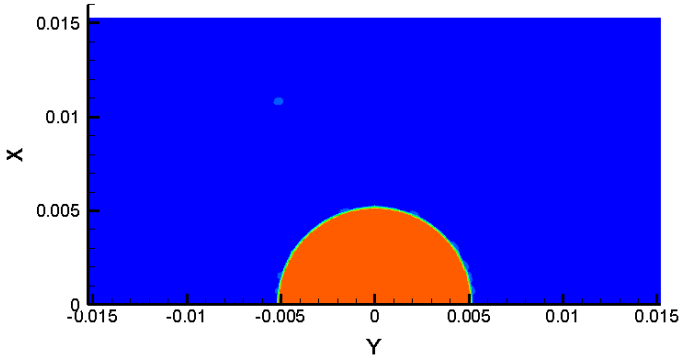
z = 45 cm



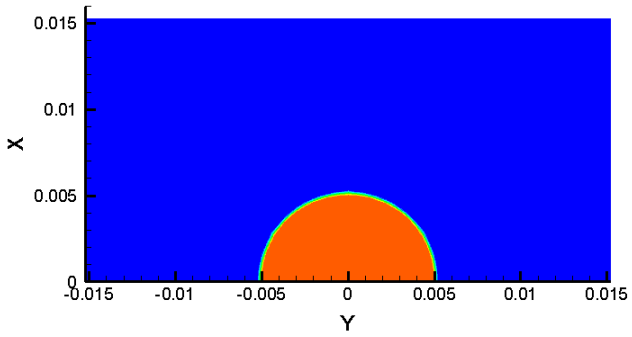


Results of α_{Hg} at t = 44.4 ms

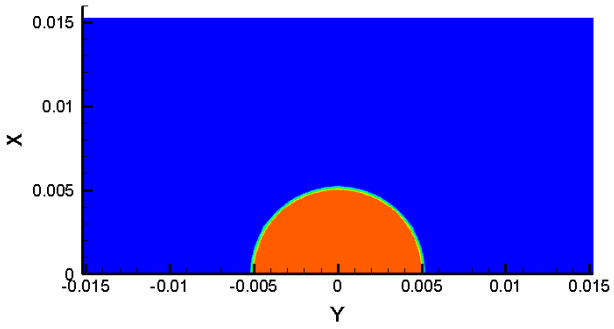
z = 0 cm



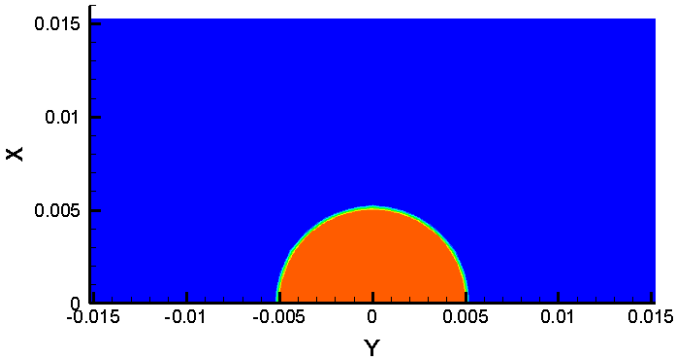
z = 1 cm



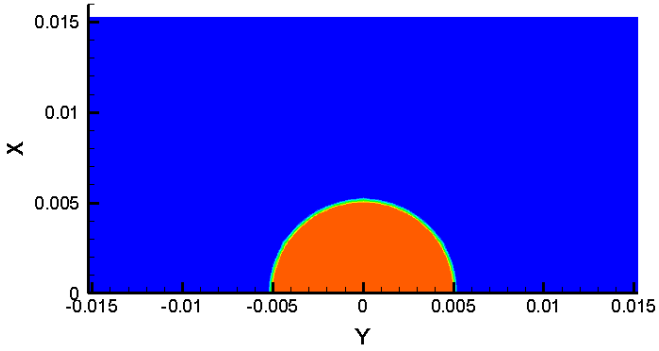
z = 5 cm



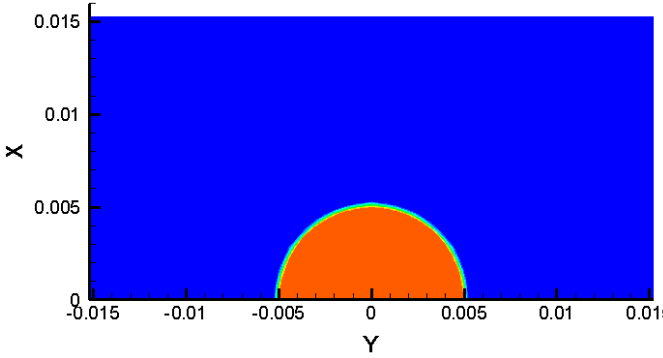
z = 10 cm



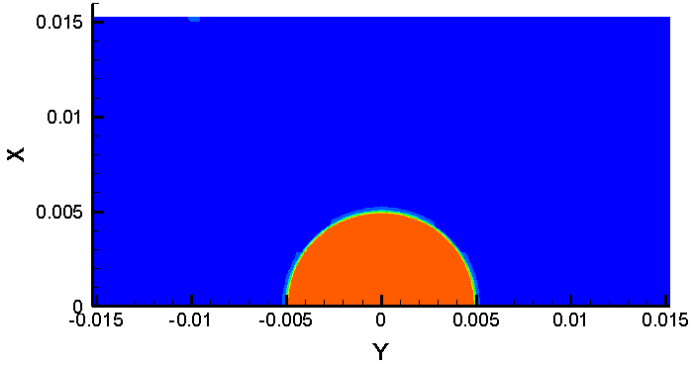
z = 15 cm



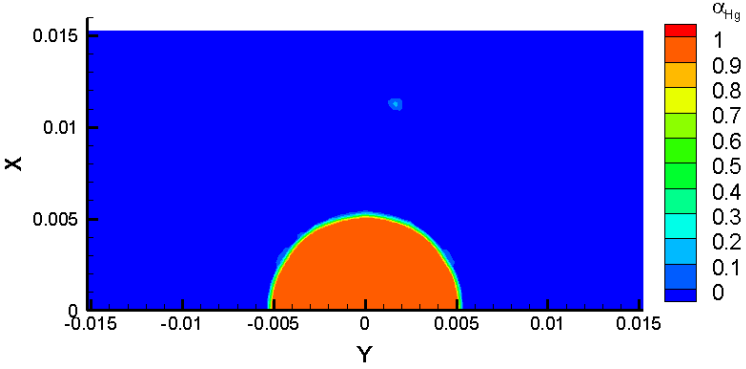
z = 20 cm



z = 30 cm

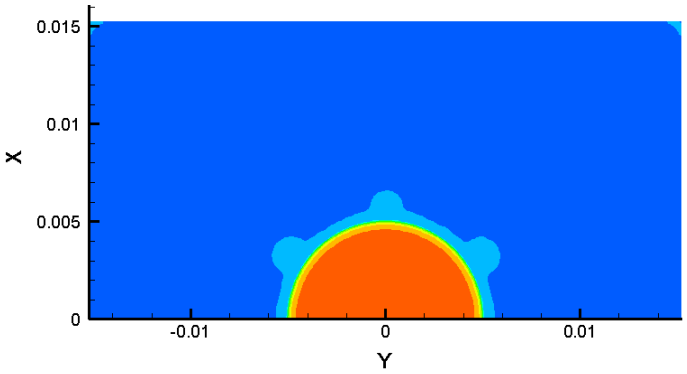


z = 45 cm

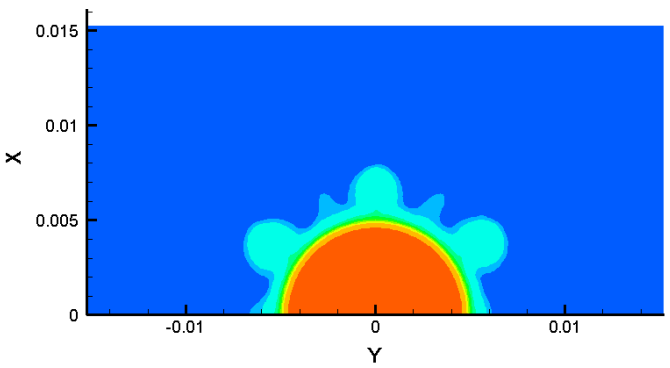


Results of u_z at t = 44.4 ms

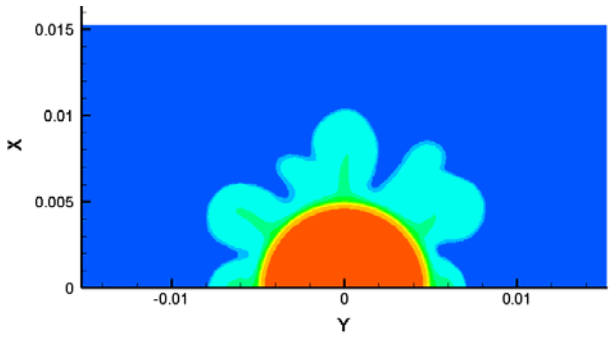
z = 0 cm



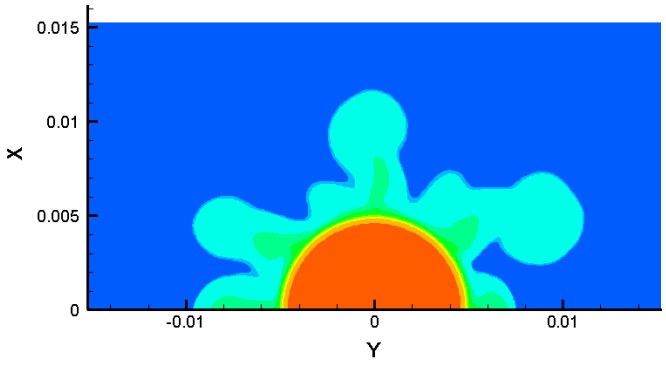
z = 1 cm



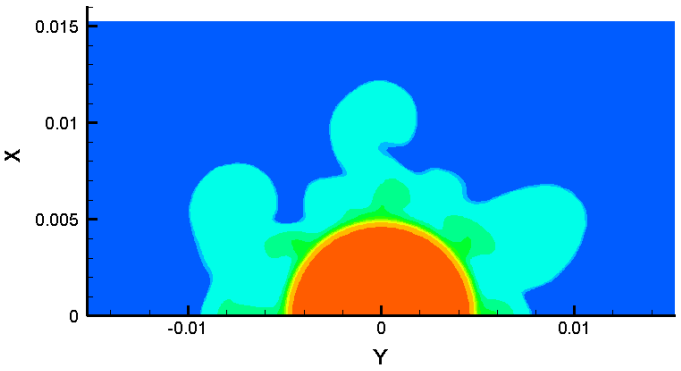
z = 5 cm



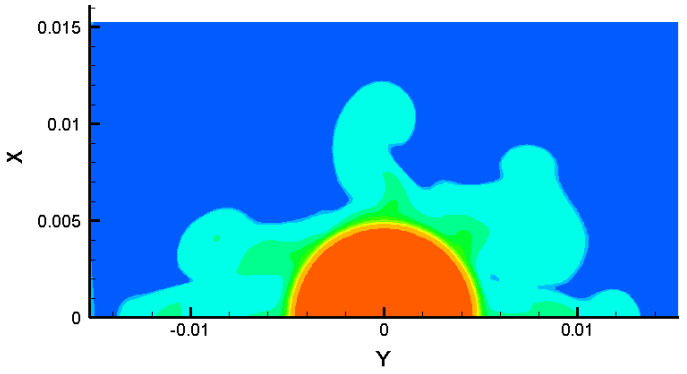
z = 10 cm



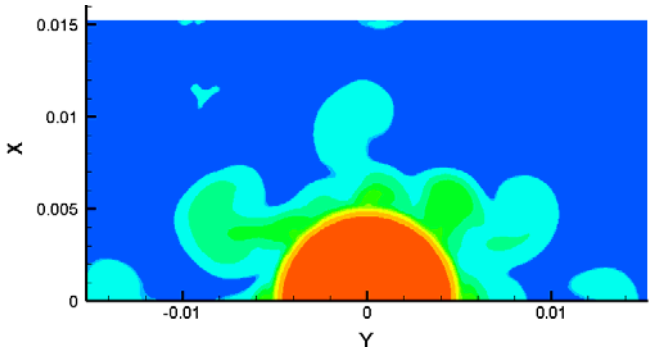
z = 15 cm



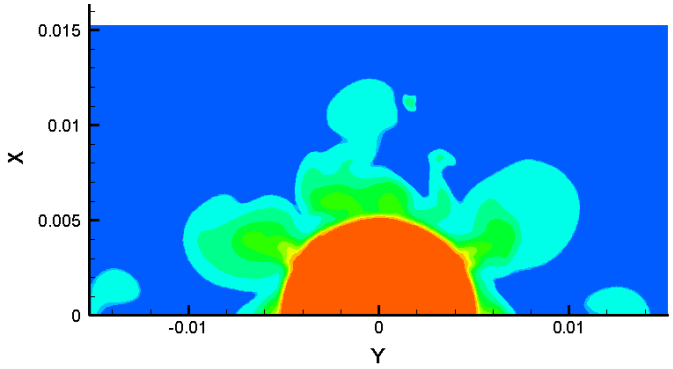
z = 20 cm

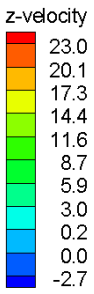


z = 30 cm



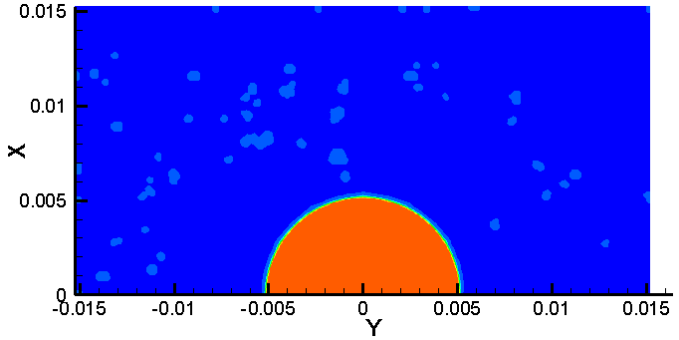
z = 45 cm



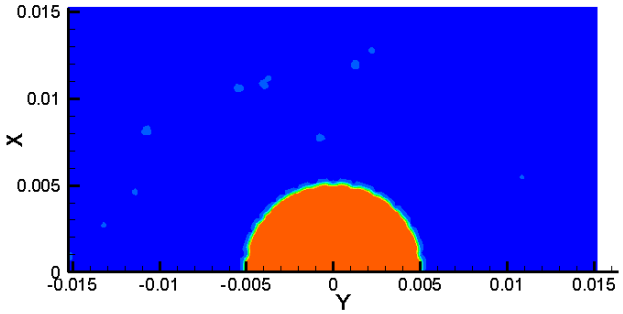


Results of α_{Hg} at t = 83.4 ms

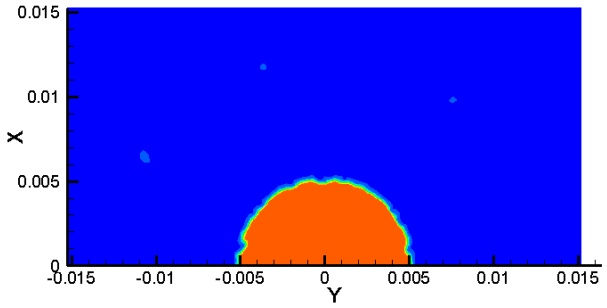
z = 0 cm



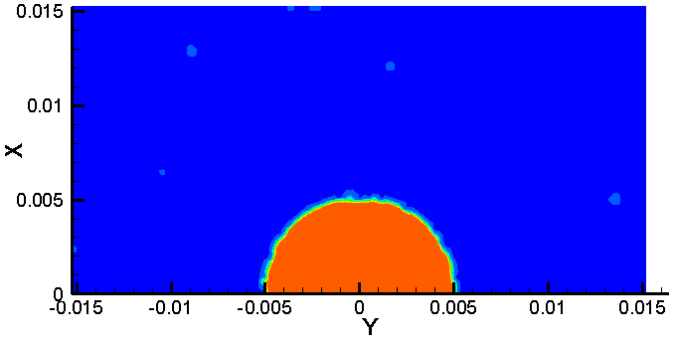
z = 1 cm



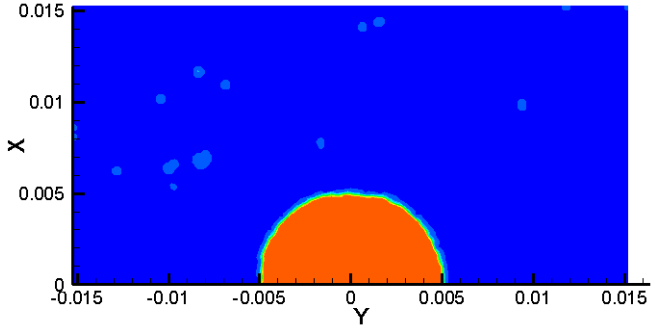
z = 5 cm



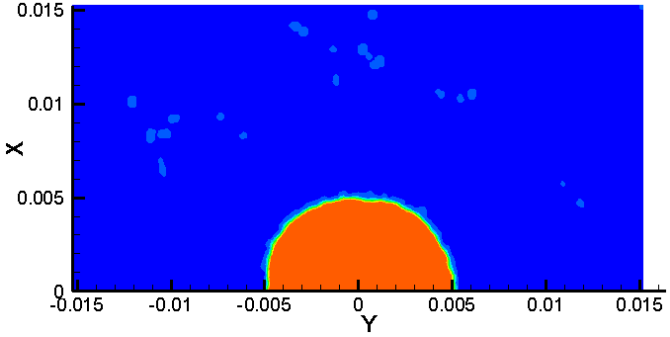
z = 10 cm



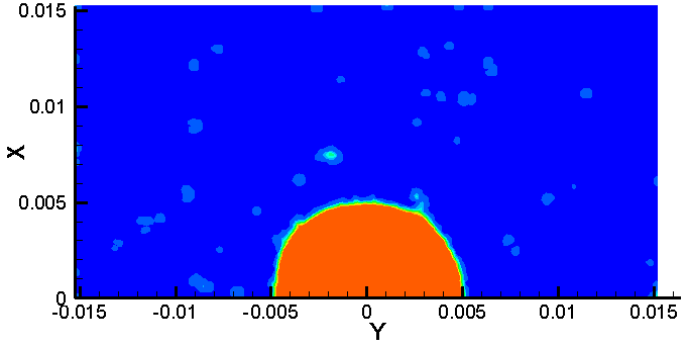
z = 15 cm



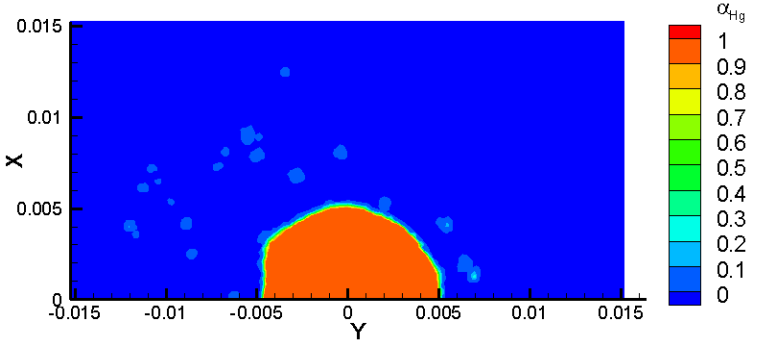
z = 20 cm



z = 30 cm

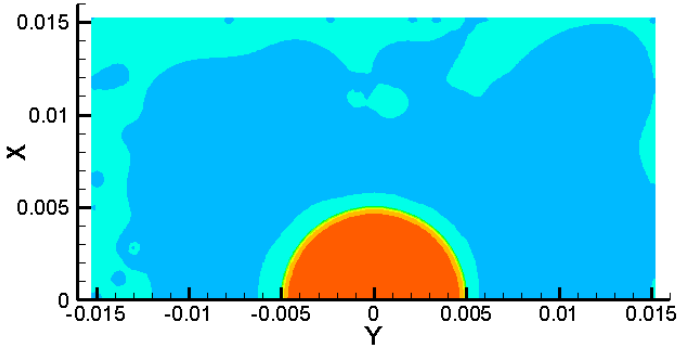


z = 45 cm

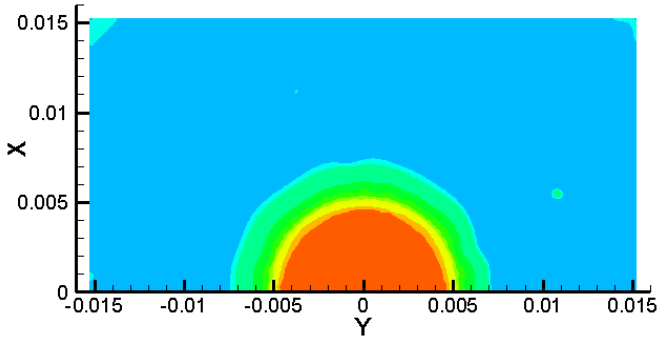


Results of u_z at t = 83.4 ms

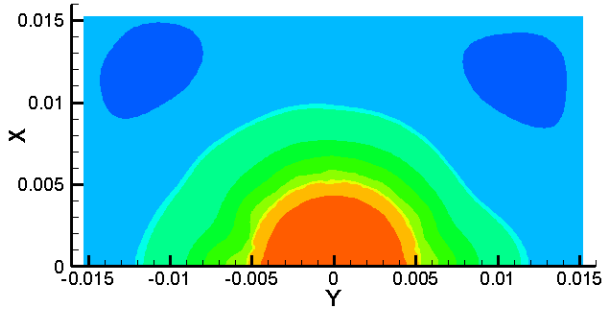
z = 0 cm



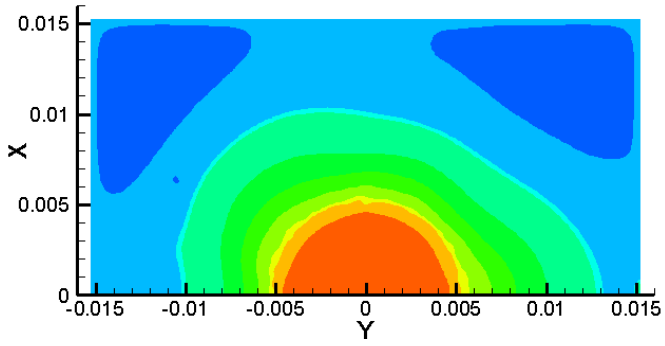
z = 1 cm



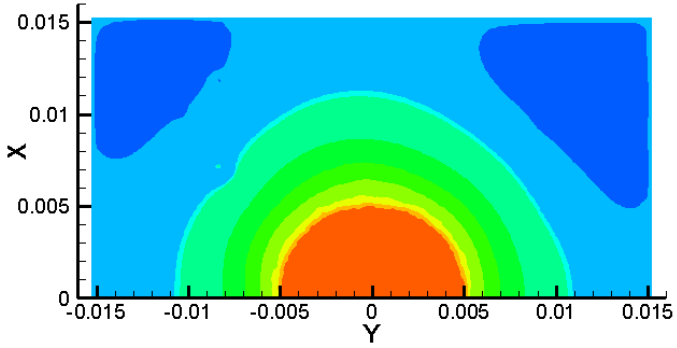
z = 5 cm



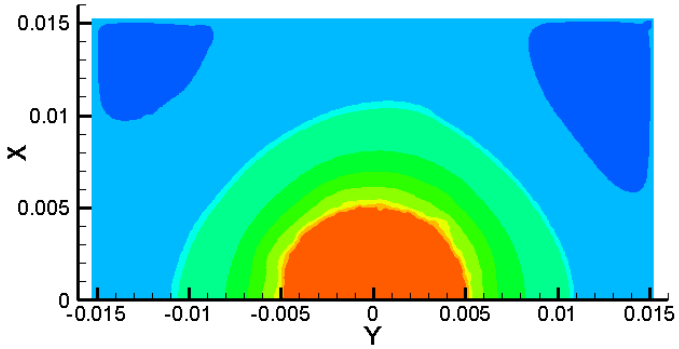
z = 10 cm



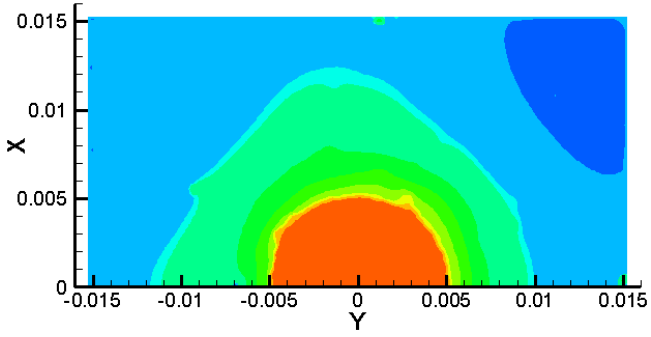
z = 15 cm



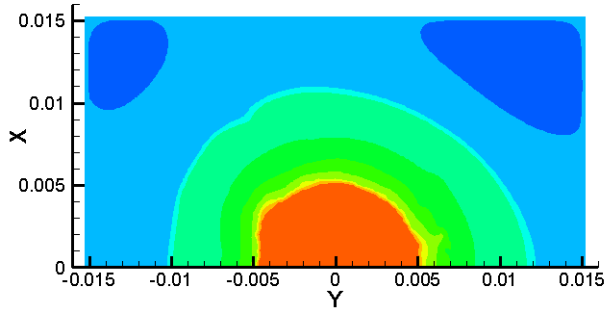
z = 20 cm

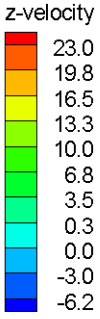


z = 30 cm



z = 45 cm





Core of jet is distorted at large z, and may be surrounded by a halo (without the fingers seen earlier).