3D Target Simulations with Front Tracking/Ghost Fluid Method

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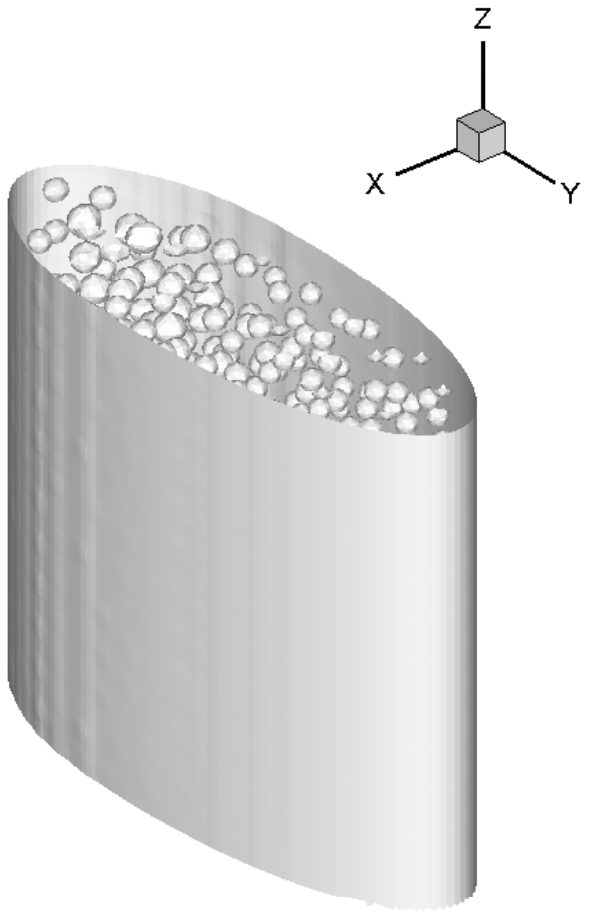
Setup of the 3D Simulations

- Numerical method: The jet interface and cavitation bubbles are tracked by the front tracking method. Fluid solver is coupled with ghost fluid method.
- Parameters: Length = 2cm
  - Elliptic jet: Major radius = 0.8cm
  - Minor radius = 0.3cm
- Striganov's Energy deposition calculation for 14Gev, 10T proton beam is used. The peak pressure is 12,050 bar.

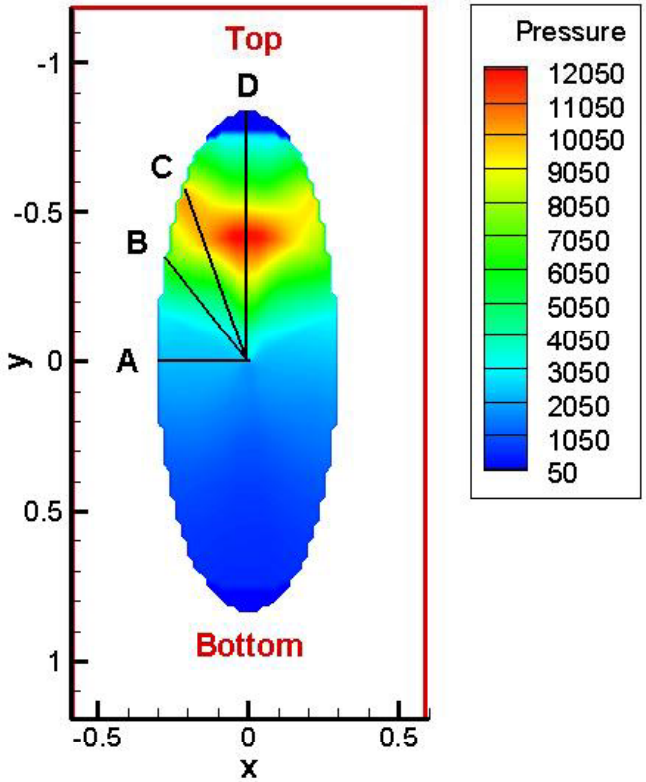
Setup of the 3D Simulations

- Evolution of the jet surface and cavitation bubbles for B=5T



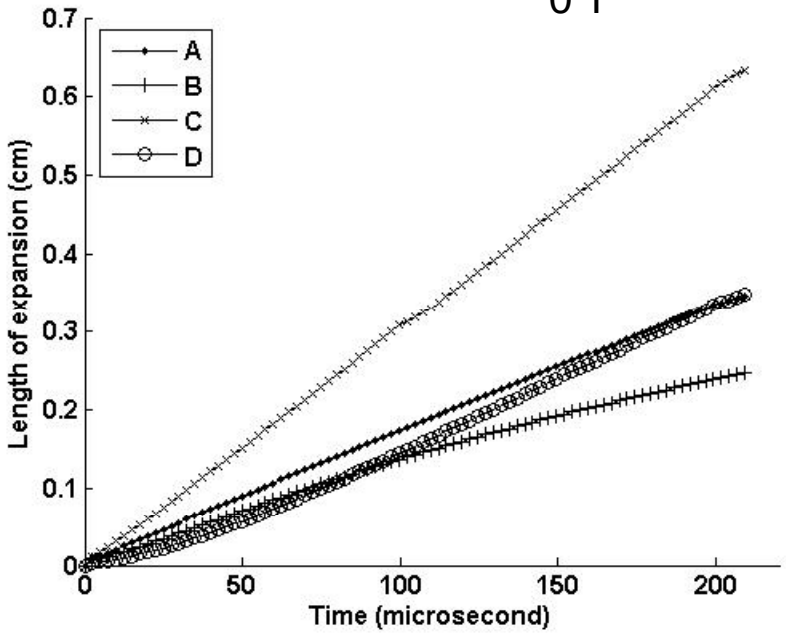
Calculating filament length

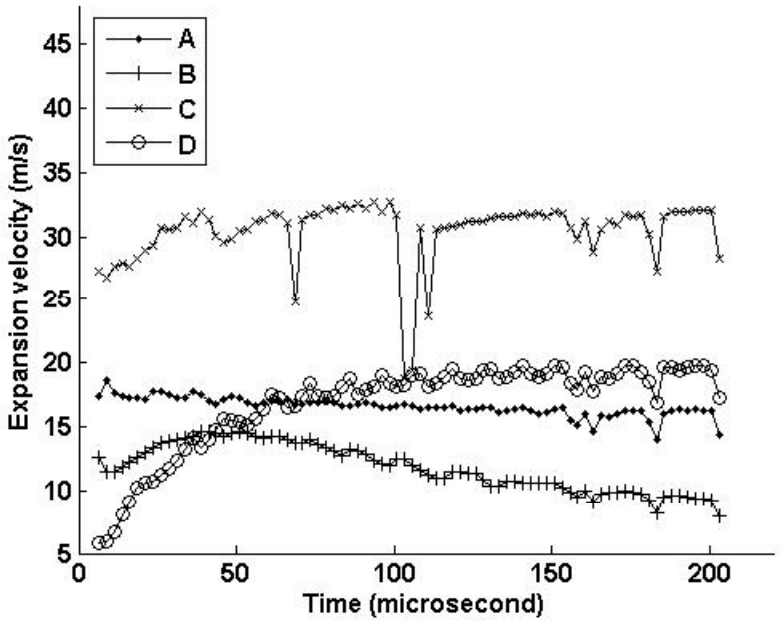
- To obtain the expansion velocity along the jet surface, we evaluate the expansion length in 4 typical positions.



No magnetic field

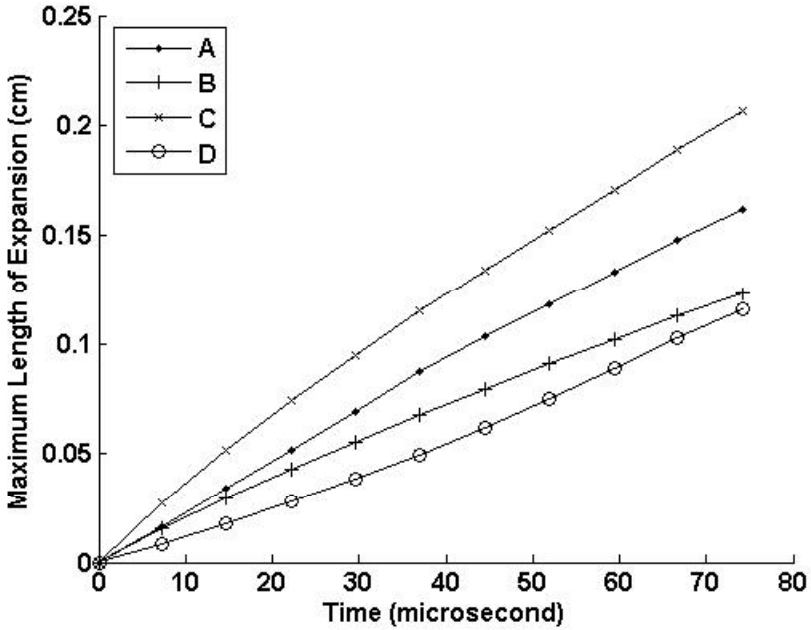
0 T

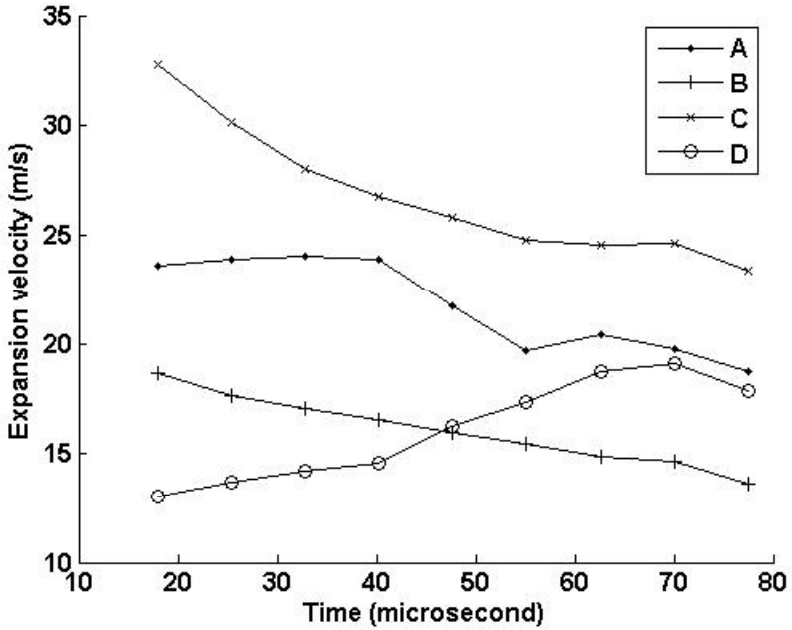




B=5T

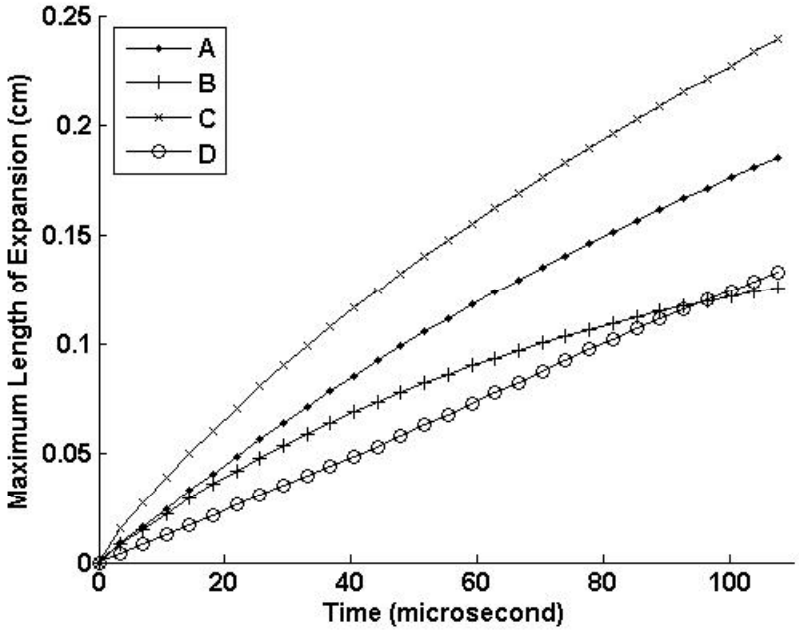
5 T

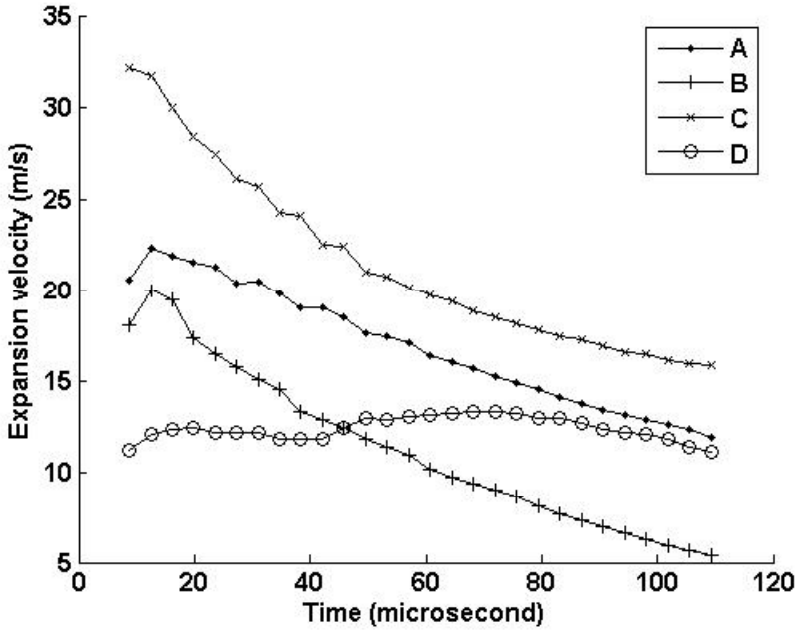

Maximum Length of Expansion (cm)
Time (microsecond)
A
B
C
D
0
0.05
0.1
0.15
0.2
0.25
0
10
20
30
40
50
60
70
80


Expansion velocity (m/s)
Time (microsecond)
A
B
C
D
10
15
20
25
30
35
10
20
30
40
50
60
70
80

B=10T

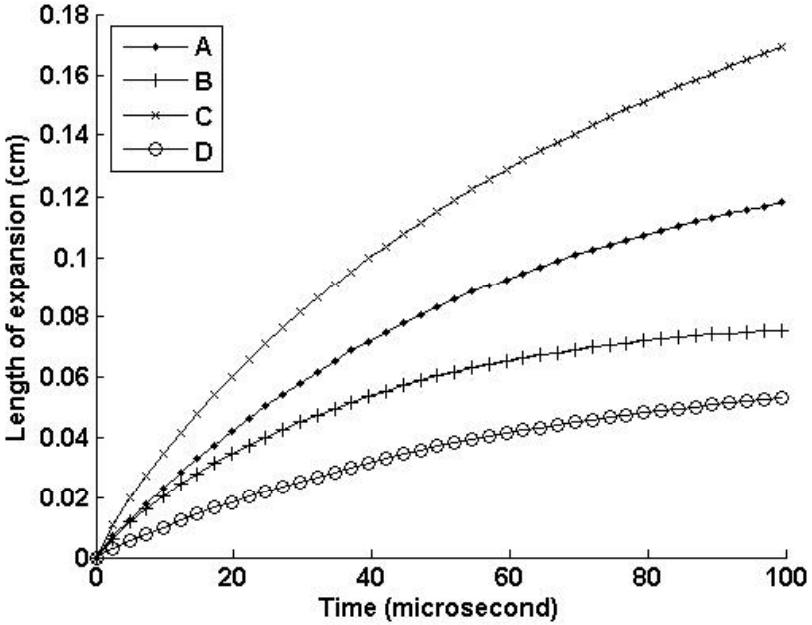
10 T

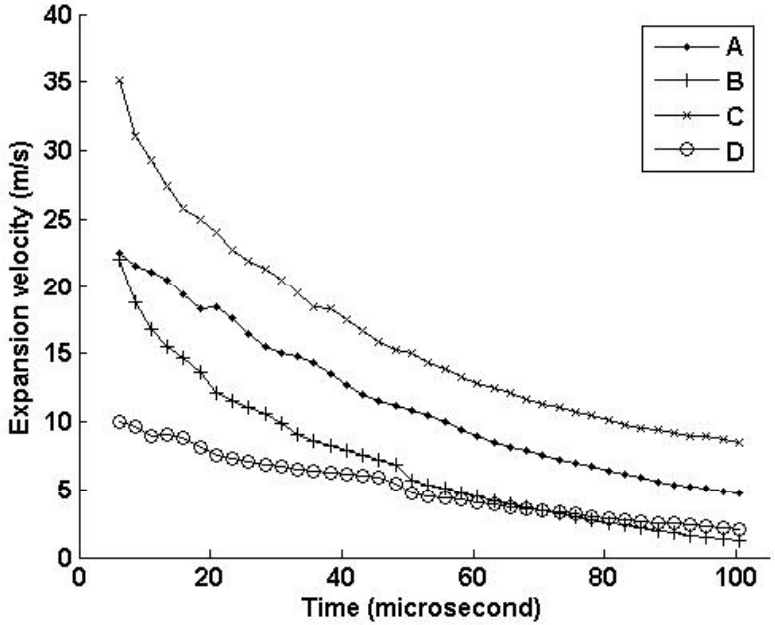

Maximum Length of Expansion (cm)
Time (microsecond)
A
B
C
D
0
0.05
0.1
0.15
0.2
0.25
0
20
40
60
80
100


Expansion velocity (m/s)
Time (microsecond)
A
B
C
D
5
10
15
20
25
30
35
0
20
40
60
80
100
120

B=15T

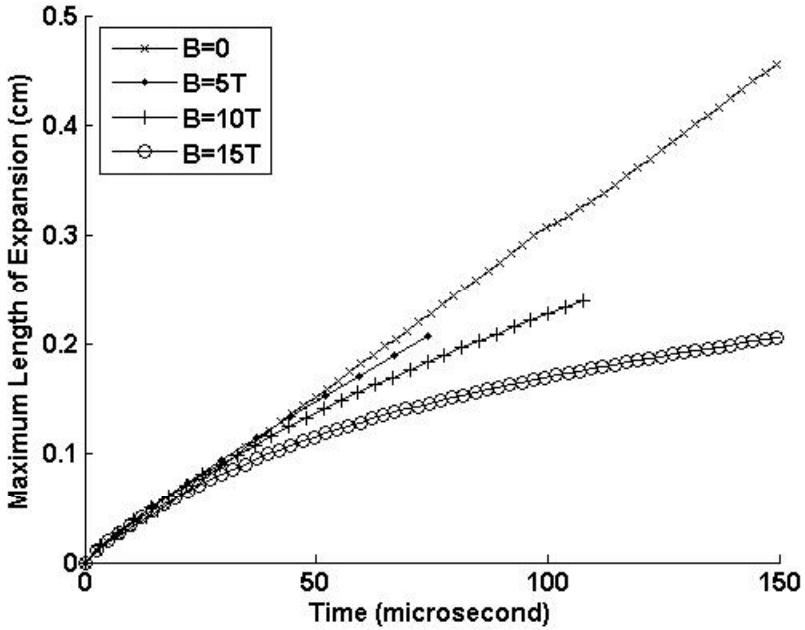
15 T

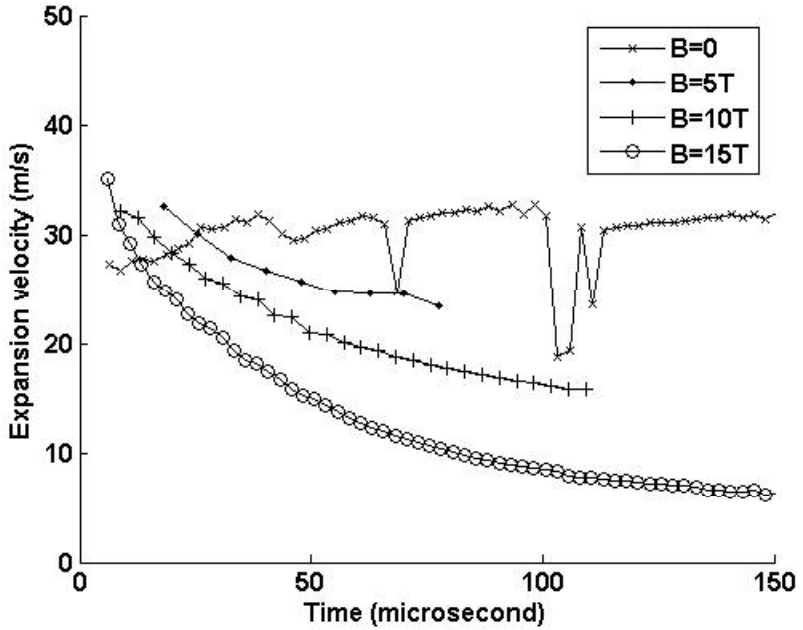

Length of expansion (cm)
Time (microsecond)
A
B
C
D
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0
20
40
60
80
100


Expansion velocity (m/s)
Time (microsecond)
A
B
C
D
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100

Summary

Position C





Conclusions

- Front tracking/Ghost fluid method is developed. Compared with the previous method, the new method has less numerical diffusion and gives reasonable expansion velocity.
- Different positions on the jet surface have different expansion velocity. The expansion velocity depends on the distance from the center of the energy deposition.
- The velocities of expansion along the major axis of the ellipse are 20, 20, 15, 4 m/s for B=0,5,10,15T cases.
- The delay for filaments is not noticed. There can be some unknown physical effects.