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XM-80 GRENADE POINT BURST REFERENCE AND CASING EXPANSION INVESTIGATIONS

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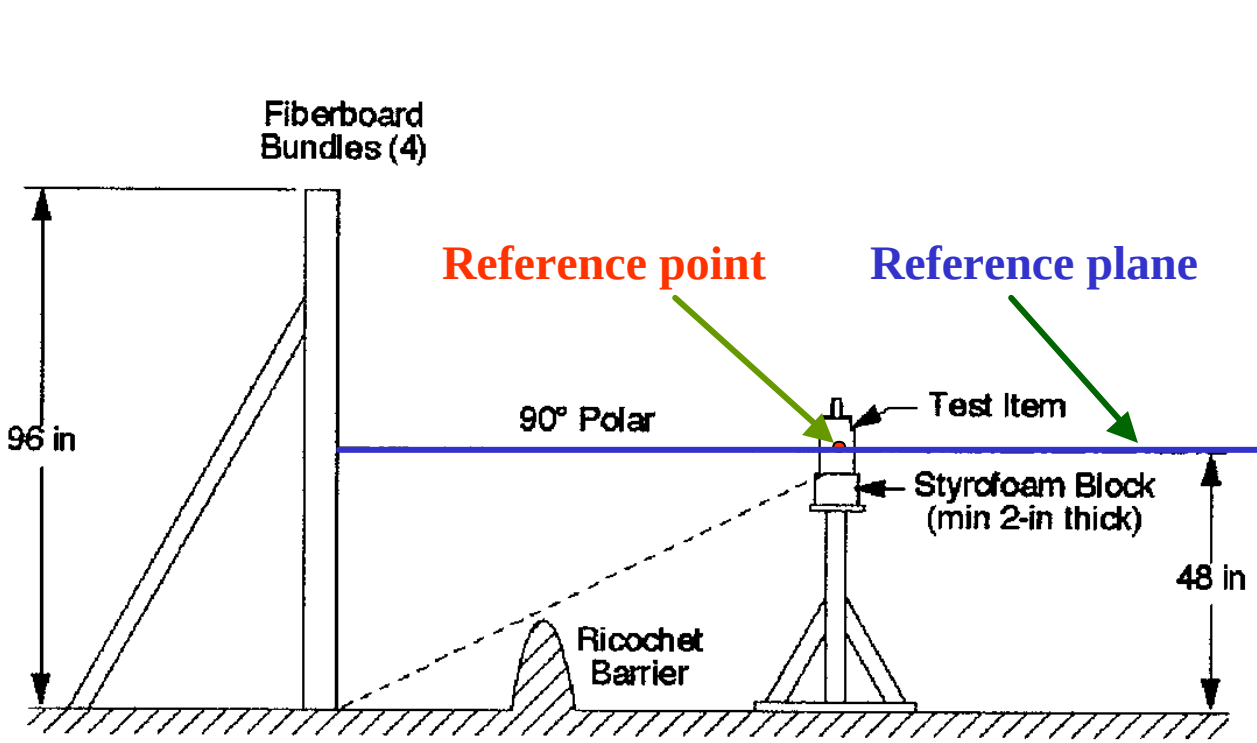
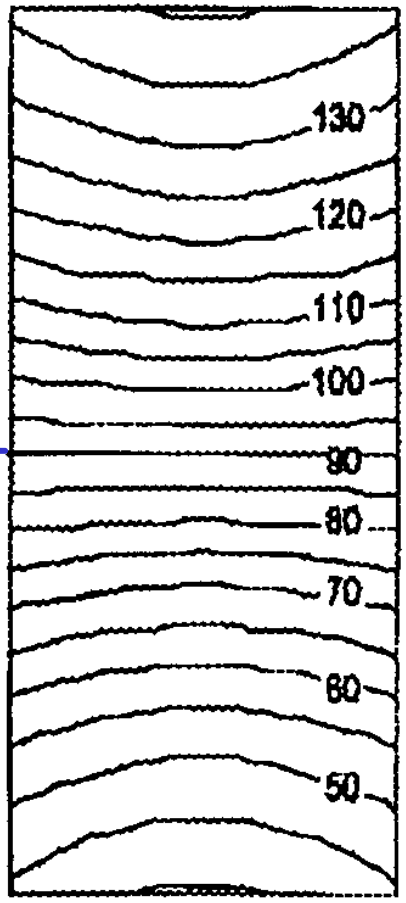
Outline

- *Objectives*
- *Background*
- *Phase I & II Experiments*
- *Observations*
- *Conclusions*

Background
Example of Arena Testing



Elevation View

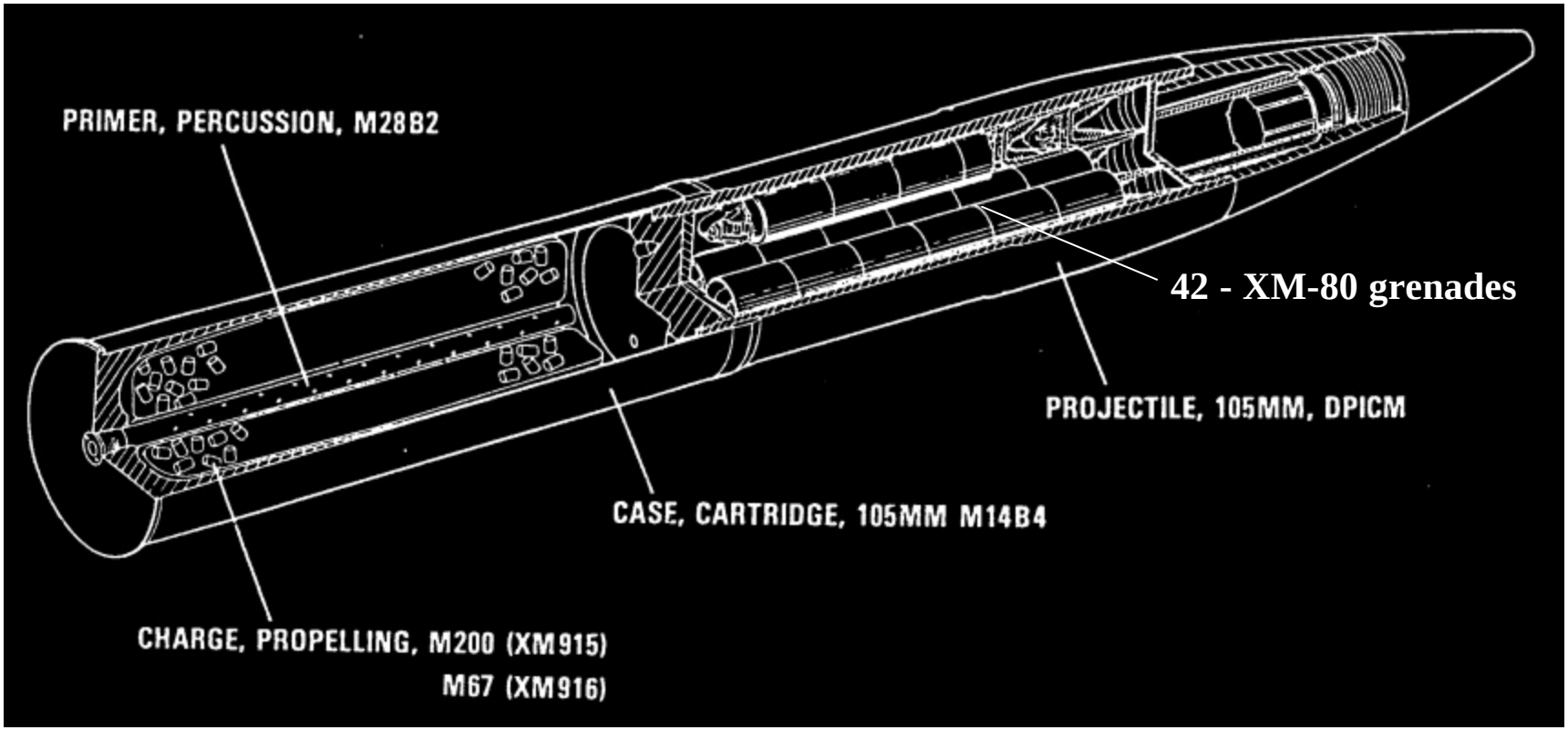


Collection Panel

All angles on collection panel are measured from reference point

Background (cont.)

CARTRIDGE, 105mm, DPICM, XM915/XM916



Keith E. Van Biert, "Development of the 105mm XM915/XM916 Projectiles,Design, Testing and Analysis", ARFSD-TR-91021, August 1991.

DPICM – Dual Purpose Improved Conventional Munition

Objectives

- **PHASE I:**

  Validate a "reference plane" and a "reference origin" establishing a standard operating procedure for XM-80 grenade arena testing

  Observe XM-80 grenade shell expansion

- **PHASE II:**

  Observe the grenade shell expansion, section of fragments and individual fragment for orientation

Experimental Approach

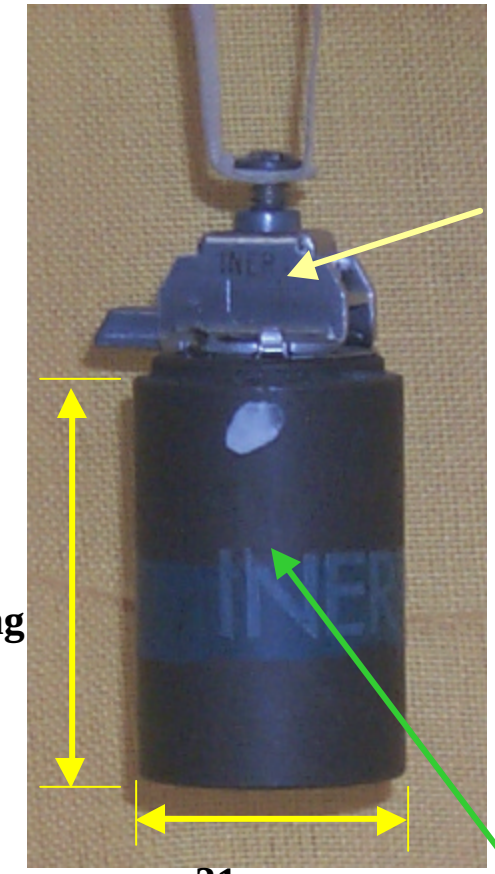
- **PHASE I**

  Use radiographic diagnostics to establish the fragmenting XM-80 grenade reference plane with respect to the horizontal plane

- **PHASE II**

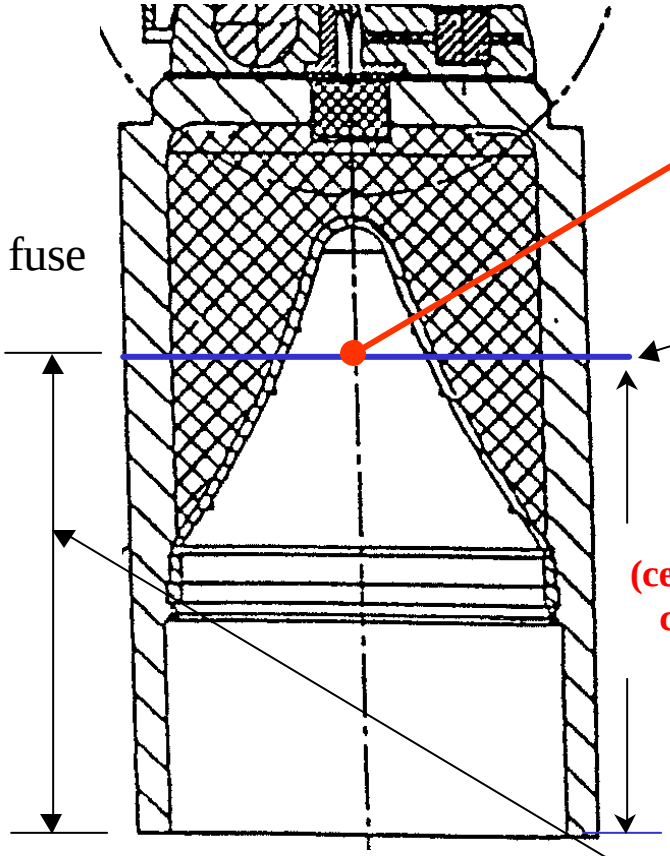
  Use radiographic system and unique shielding method to observe selected portion of the XM-80 fragment expansion

XM-80 Grenade



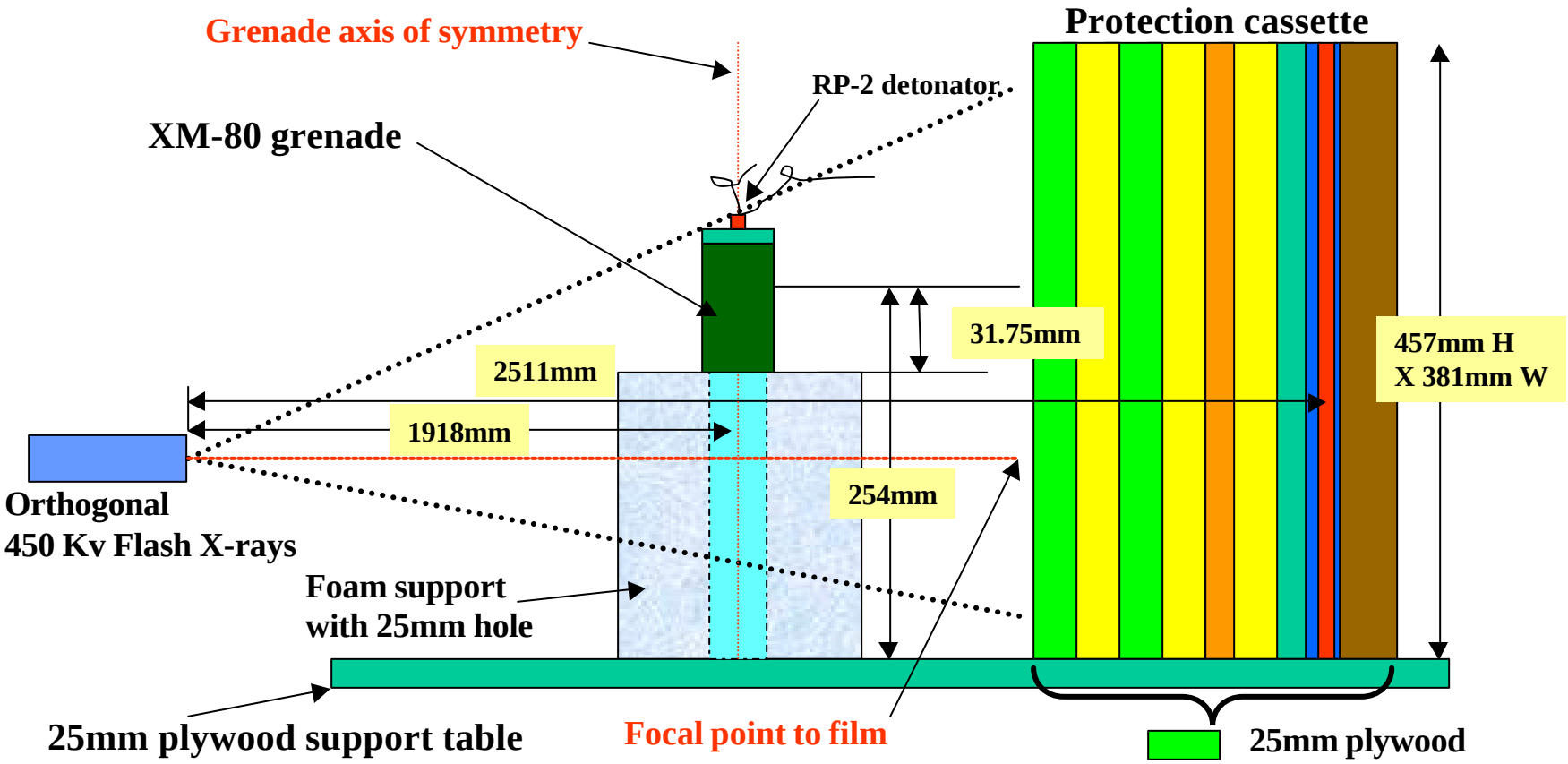
46mm stacking height

31mm



Nominal dimensions

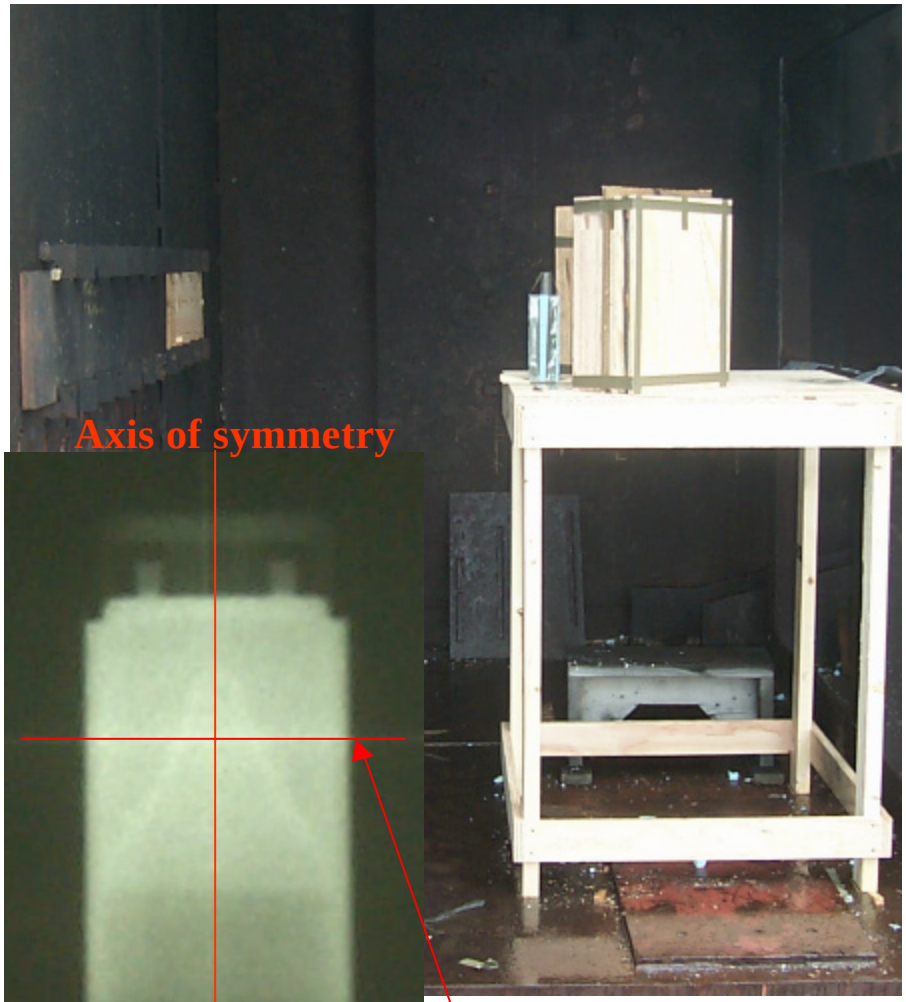
Phase I Experimental Arrangement



Side View

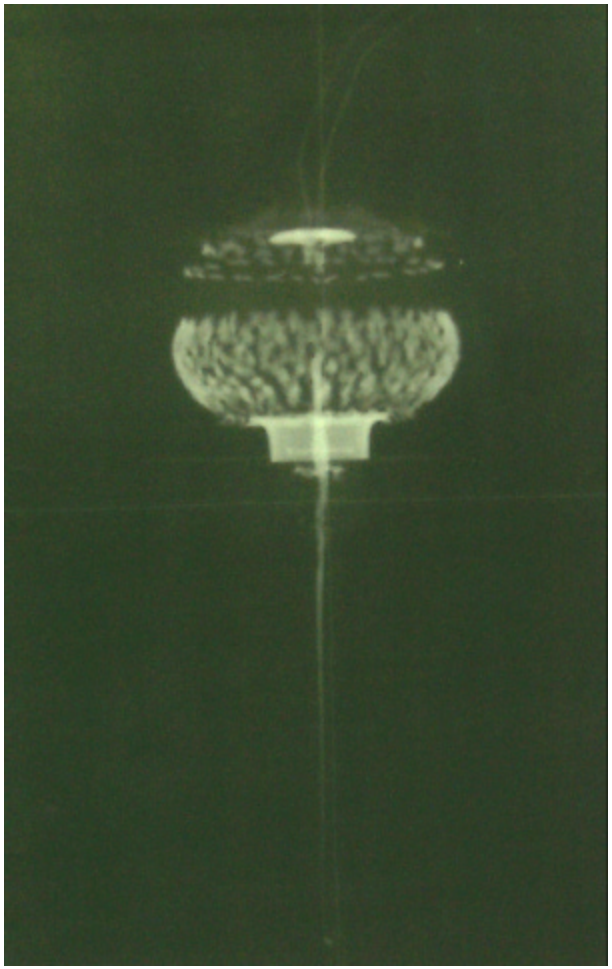
Not to scale with nominal dimensions

Phase I Experimental Arrangement

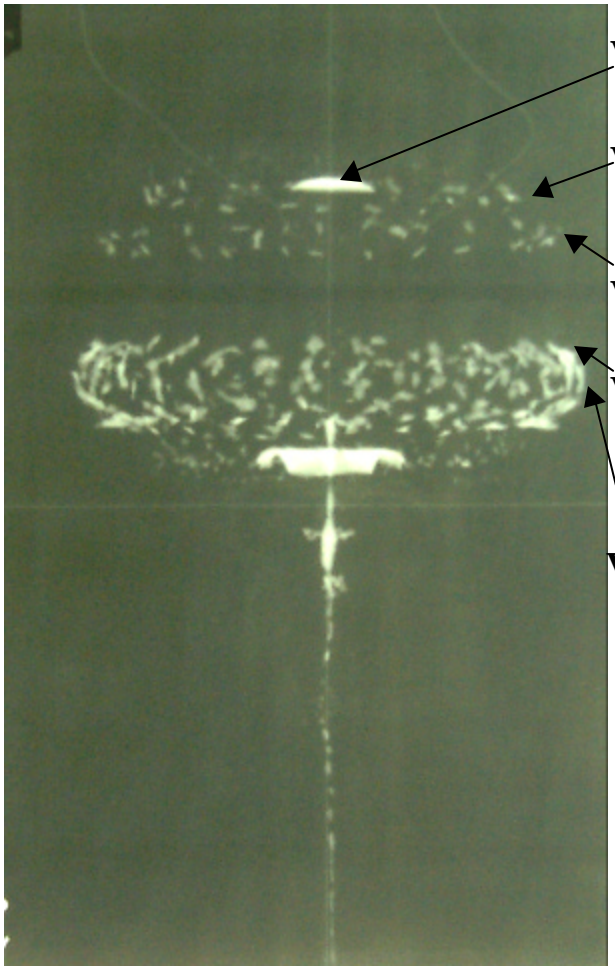


XM – 80 Shell Expansion

Rd 412



T_1 = 30 μs



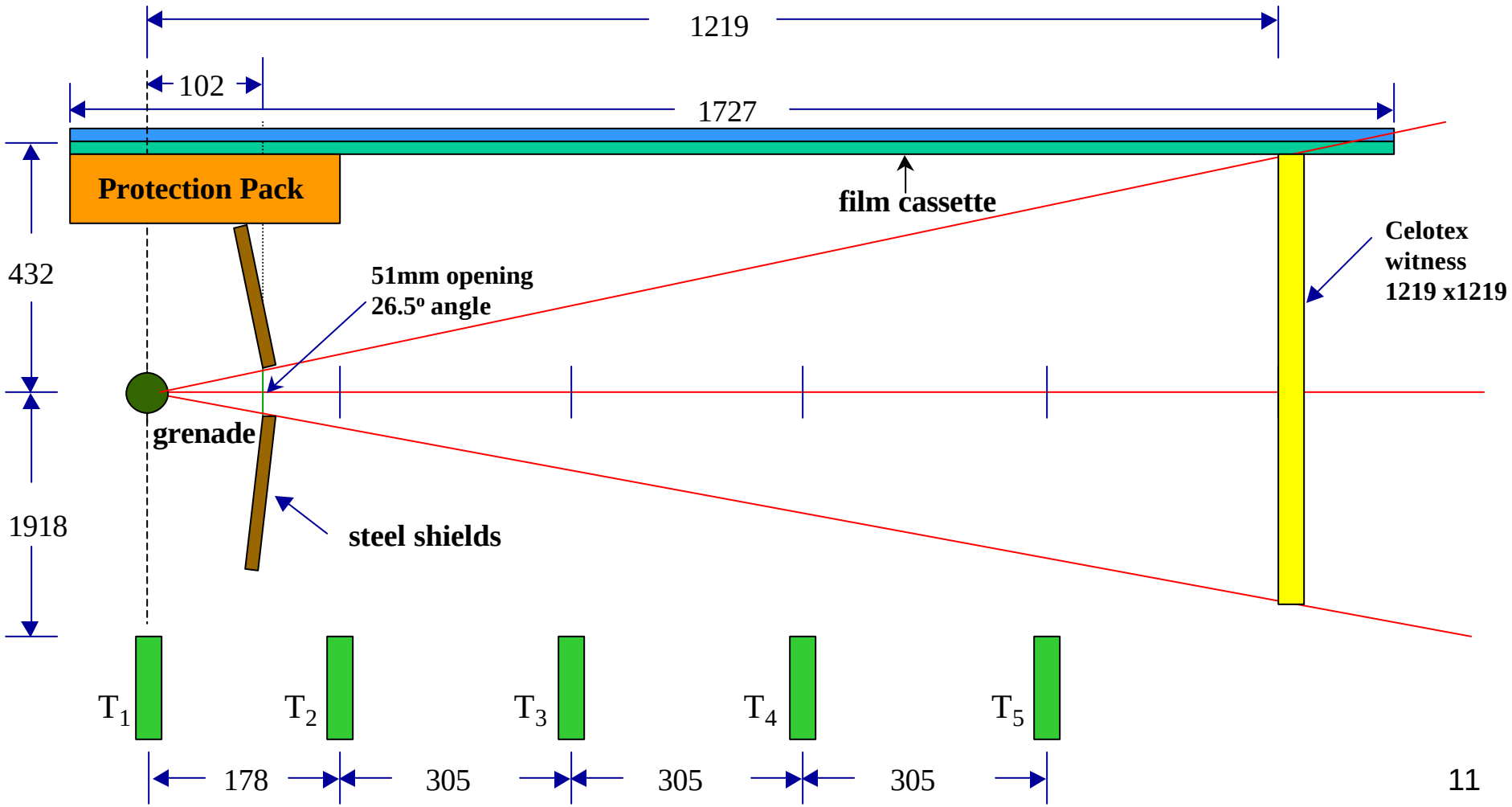
T_2 = 60 μs

Phase II
Experimental Arrangement

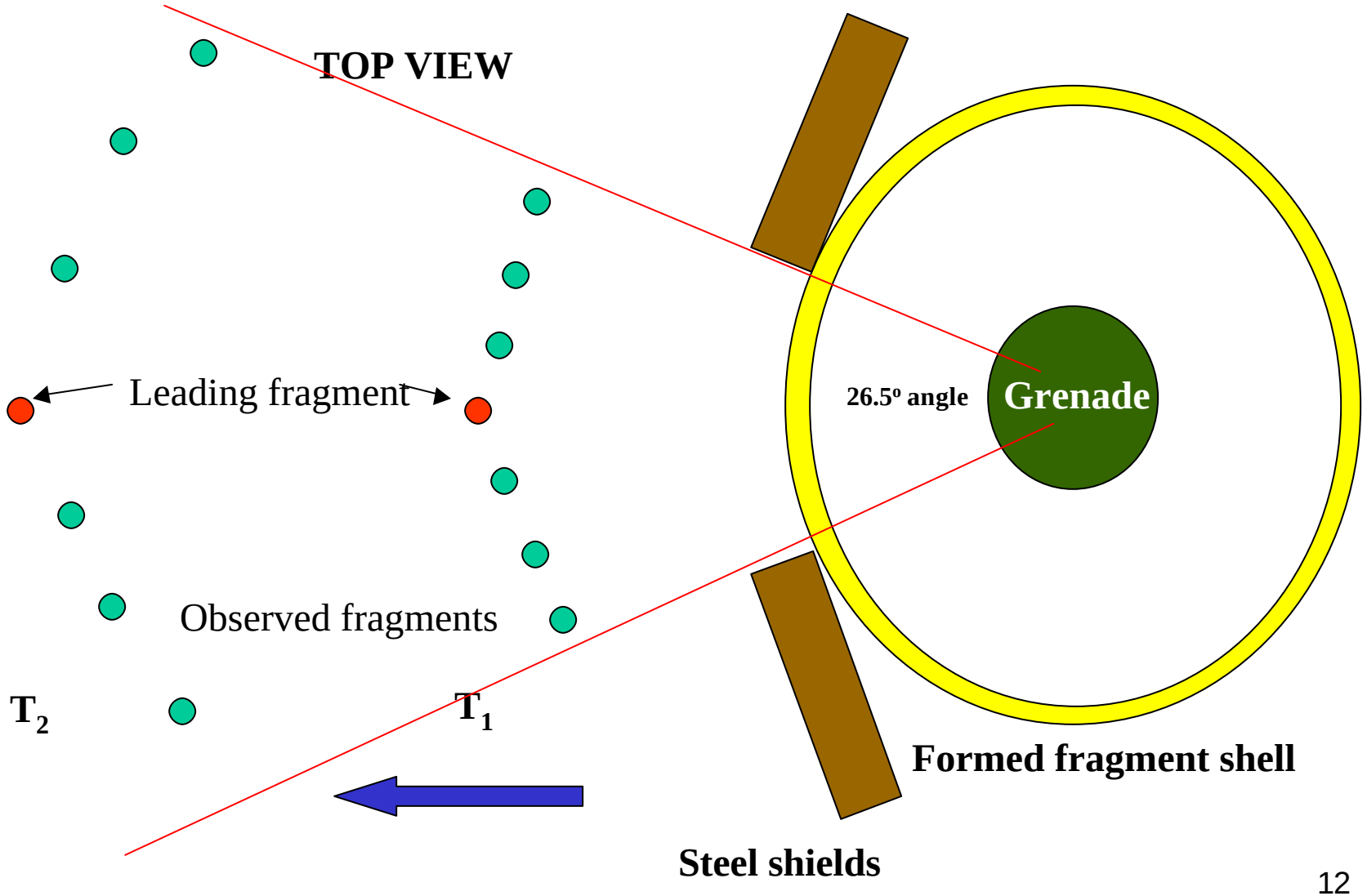
Overhead View

Not to scale / nominal measurements (mm)

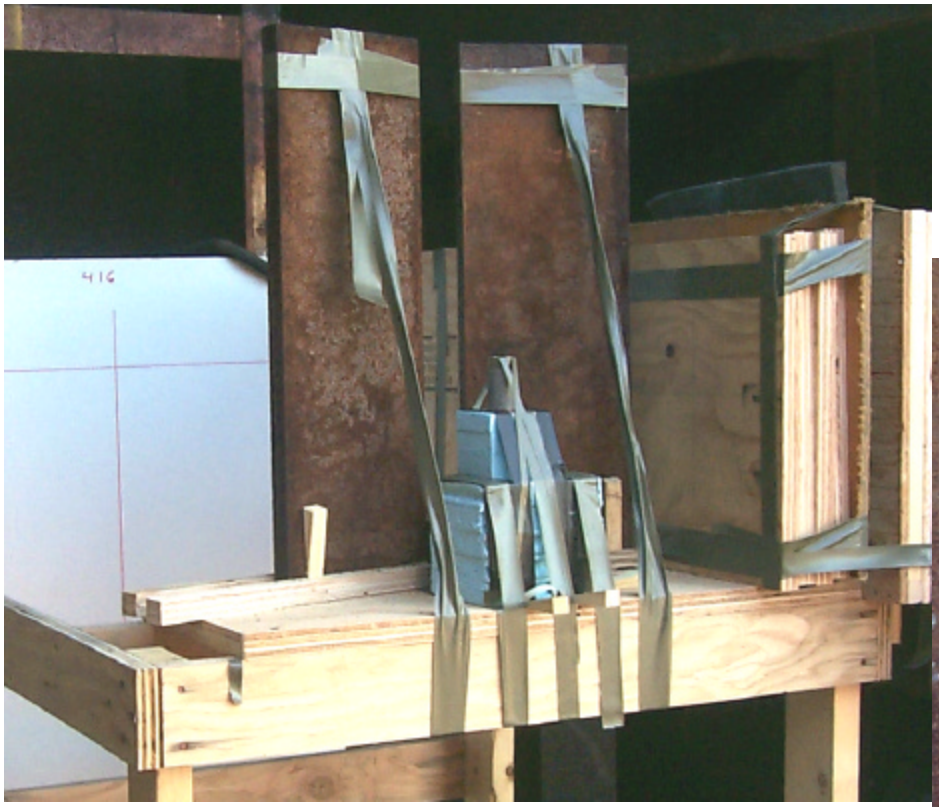
Top view



Formed Fragment Observations

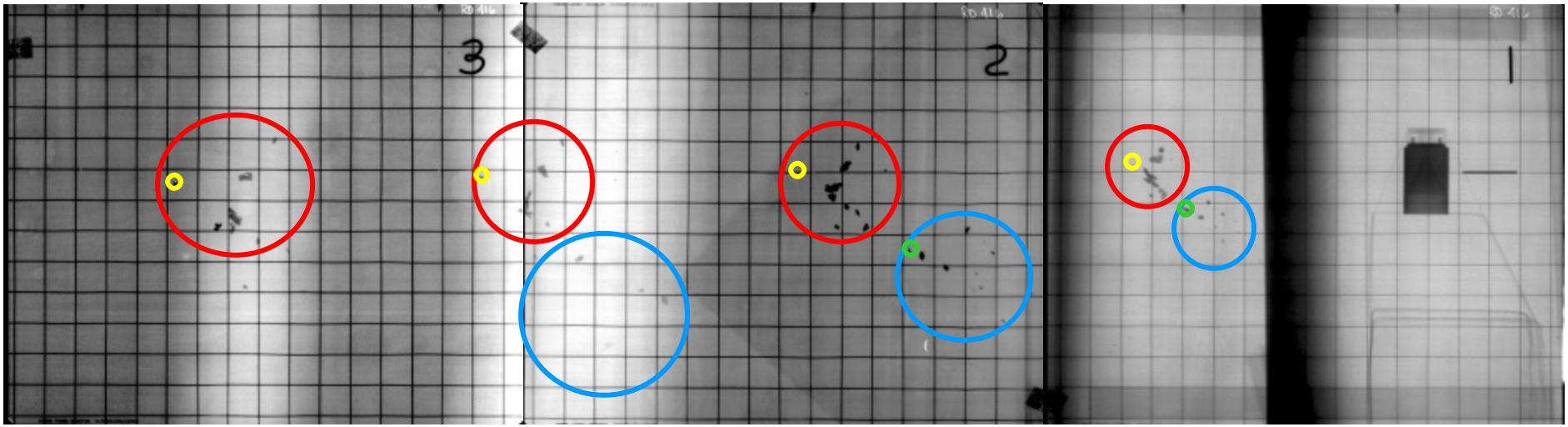


Experiment Arrangement & Post-mortem



Radiographic Observations

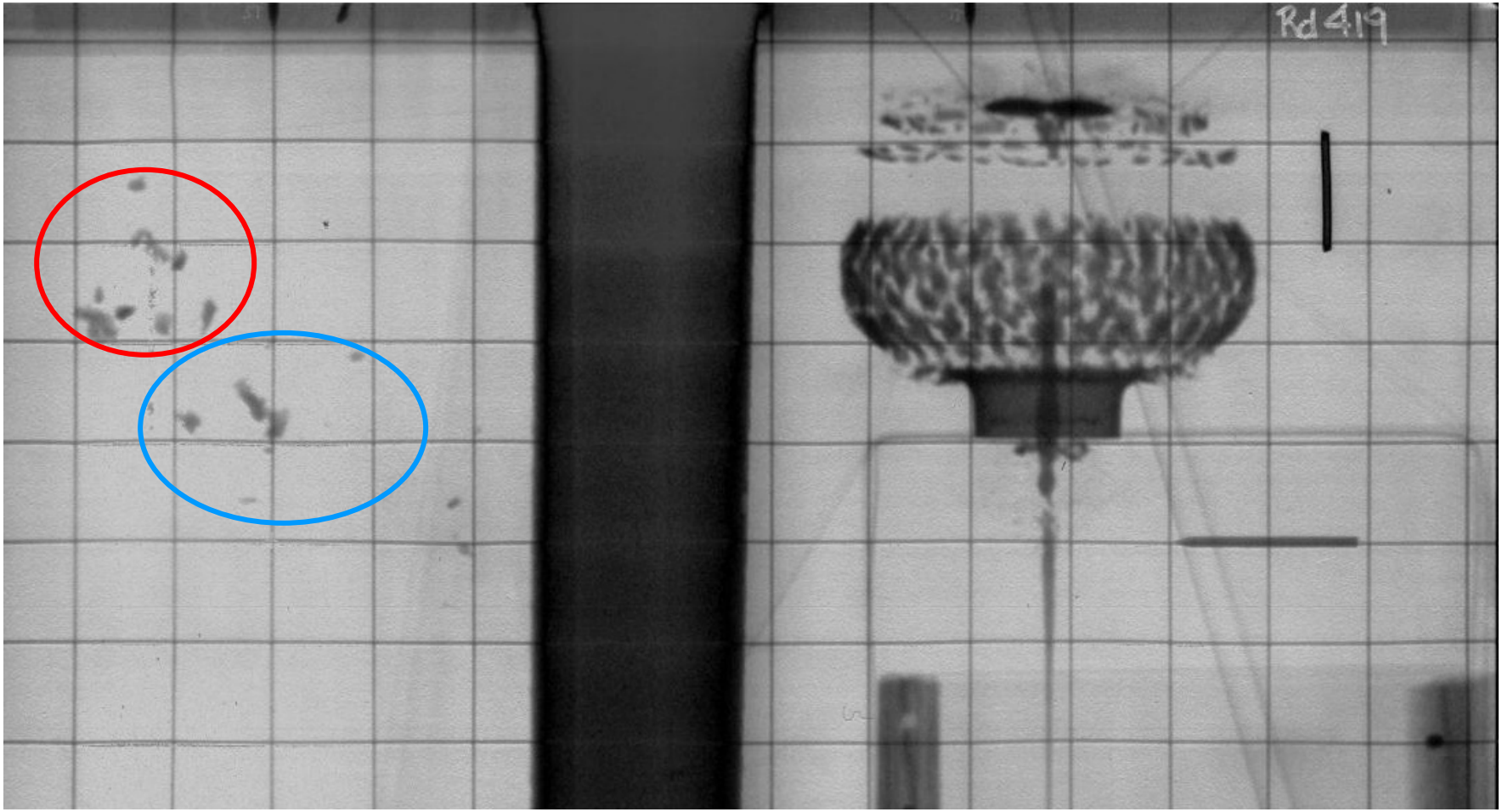
Composite Image Rd 416



T_5 = 888ms T_4 =654ms T_3 = 420ms T_2 = 186 ms T_1 = 0 ms

Group 1 Group 2 Frag 1 Frag 2

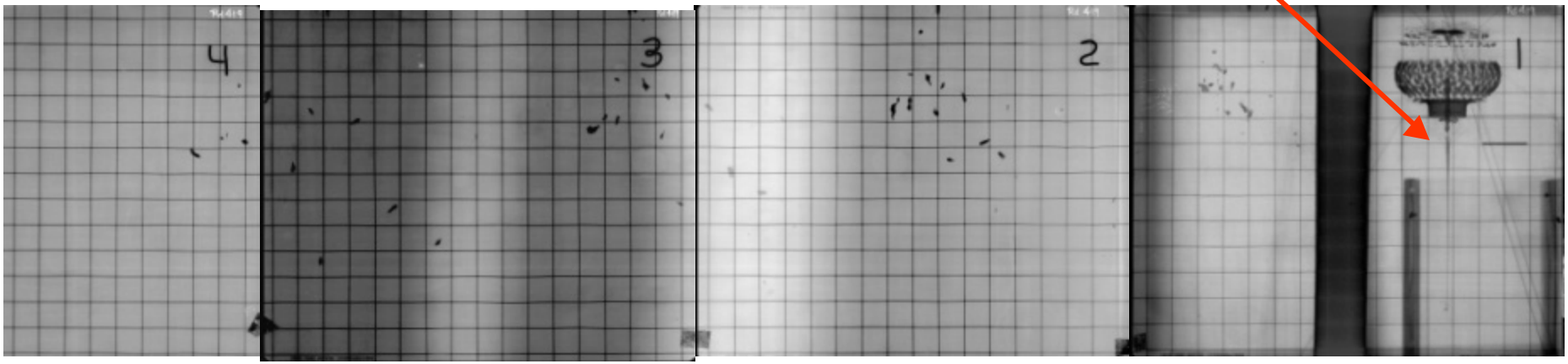
Majority of Fragment Groupings



Group 1 Group 2

Radiographic Observations

Composite Image Rd 419

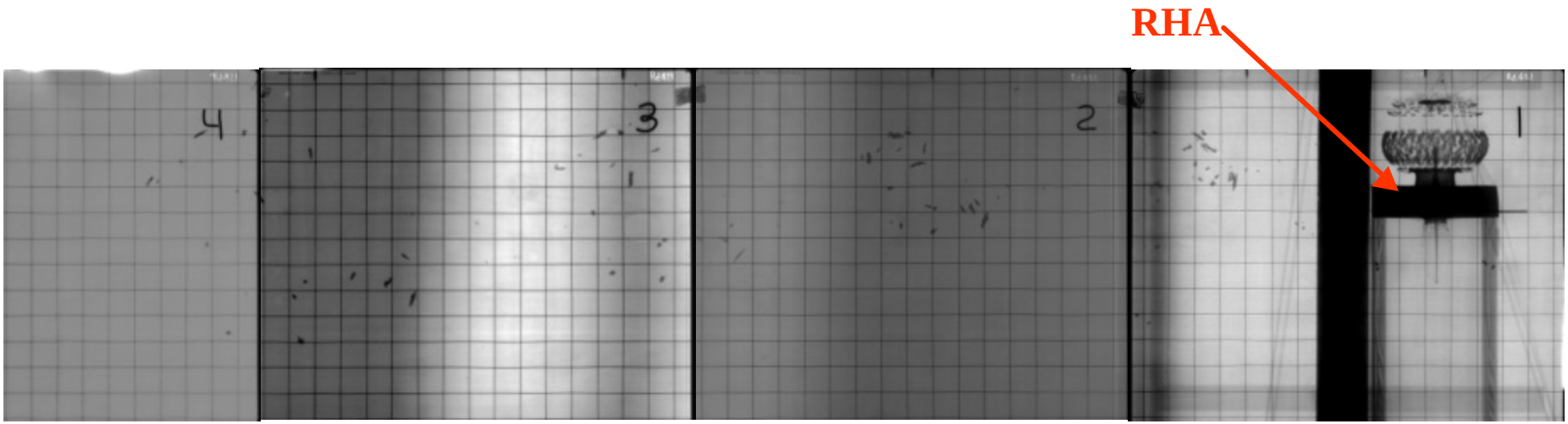


T_5 = 1021ms T_4 = 694ms T_3 = 440ms T_2 = 186ms T_1 = 30ms

Grenade supported on 50.8mm Styrofoam
25.4mm grid

Radiographic Observations

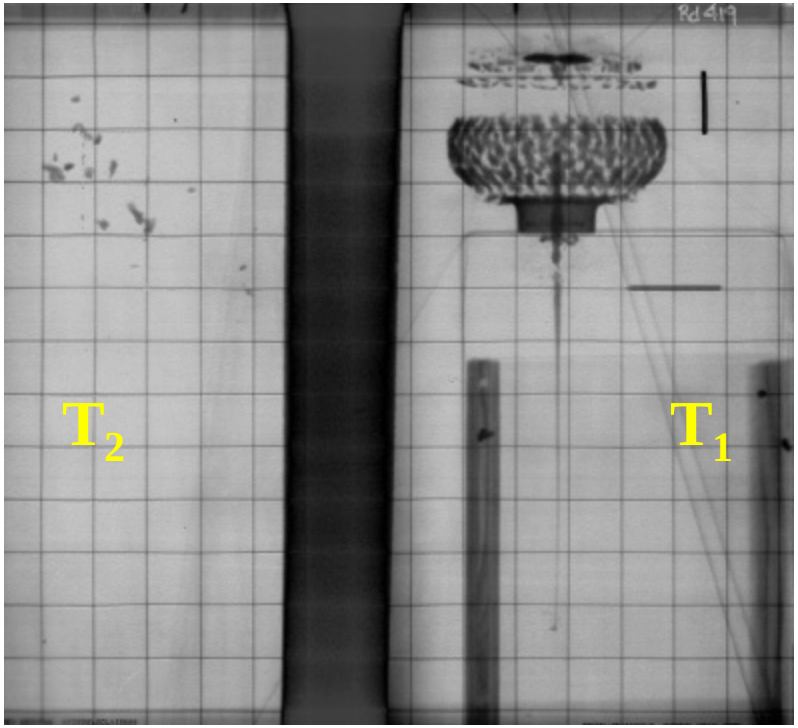
Composite Image Rd 421



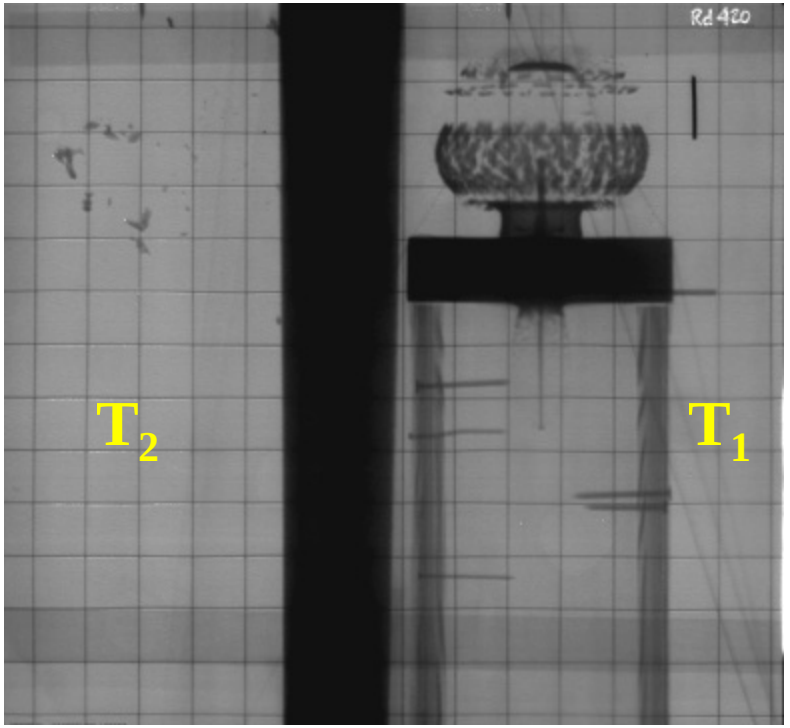
T_5 = 1022 ms T_4 = 695 ms T_3 = 440ms T_2 = 186 ms T_1 = 30 ms

Grenade supported on 25.4mm RHA
25.4mm grid

Grenade Support
Foam vs Steel



Grenade supported on 50.8mm Styrofoam



Grenade supported on 25.4mm RHA

T_1 = 30ms

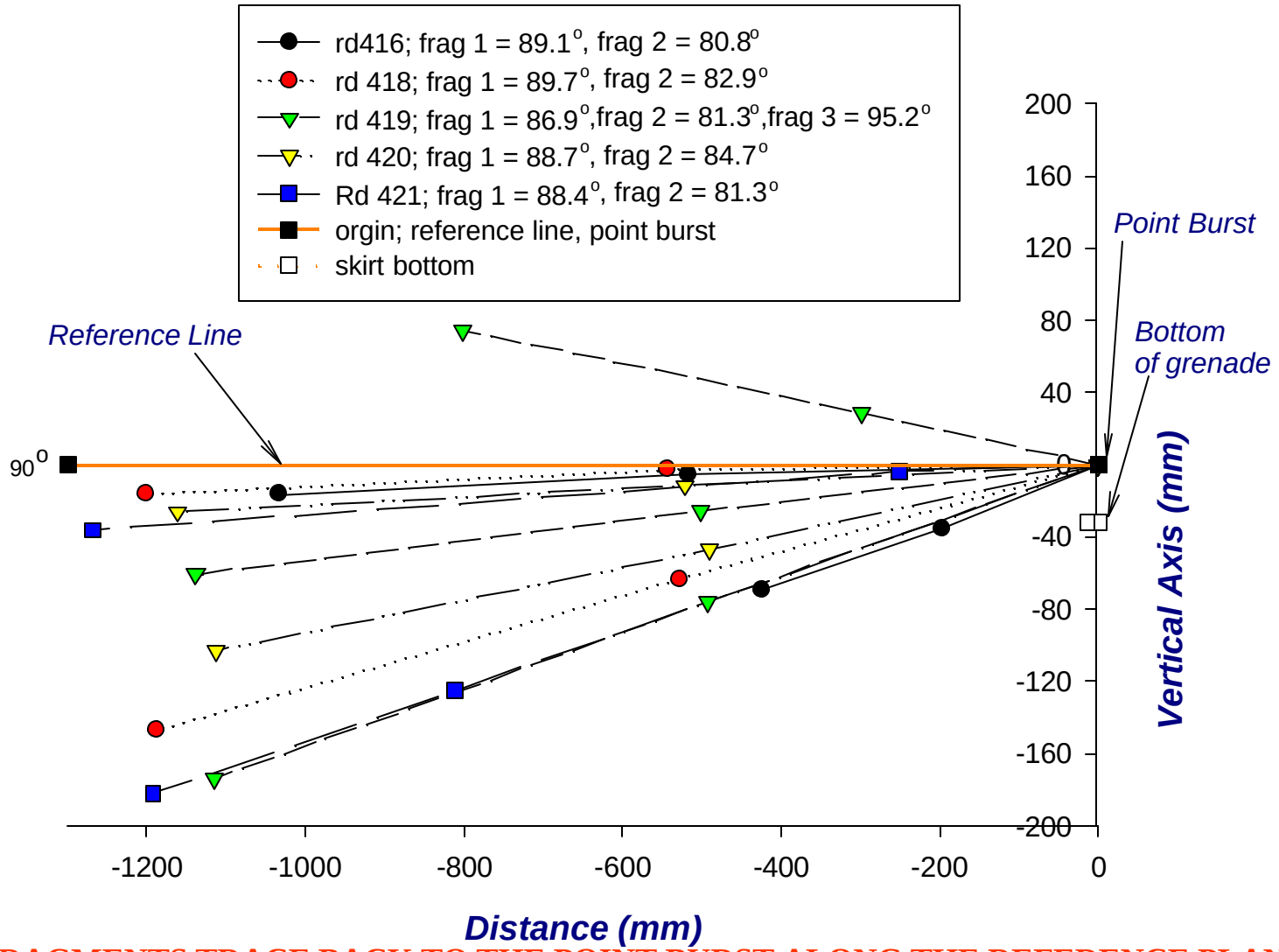
T_2 = 186ms

25.4mm grid

Fragment Speed and Orientation

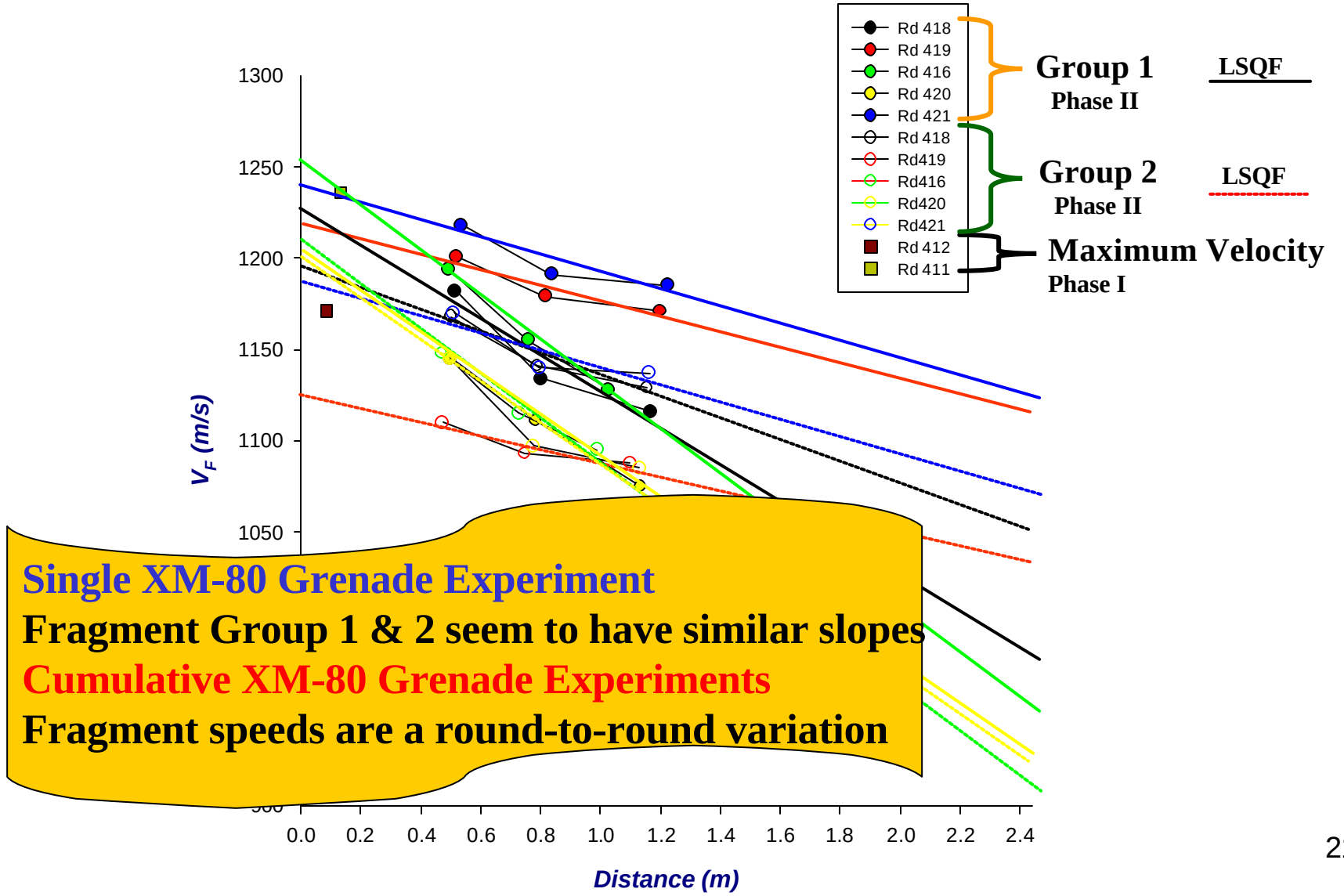
Rd No.		*Distance from Reference Point (RF) (m)*			*Maximum Speed (m/s)*			*Orientation Angle from RF (degrees)*
411(casing)		0.1312	-	-	1236	-	-	-
412(casing)		0.0857	-	-	1171	-	-	-
416	Frag 1	0.4919	0.7587	1.0278	1194	1155	1128	89.1
	Frag 2	0.4697	0.7273	0.9884	1148	1115	1095	80.8
418	Frag 1	0.5139	0.8029	1.1660	1182	1132	1116	89.7
	Frag 2	0.5014	0.7889	1.1550	1168	1141	1129	82.9
419	Frag 1	0.5186	0.8173	1.1990	1201	1179	1171	86.9
	Frag 2	0.4733	0.7464	1.0994	1110	1093	1088	81.3
420	Frag 1	0.4993	0.7826	1.1340	1145	1111	1075	88.7
	Frag 2	0.4966	0.7764	1.1310	1145	1097	1085	84.7
421	Frag 1	0.5349	0.8383	1.2255	1218	1191	1185	88.4
	Frag 2	0.5087	0.7957	1.1627	1170	1140	1137	81.3

Cumulative Measured Fragment Orientation



ALL FRAGMENTS TRACE BACK TO THE POINT BURST ALONG THE REFERENCE PLANE (LINE)

Maximum Fragment Velocity as a Function of Distance



Single XM-80 Grenade Experiment

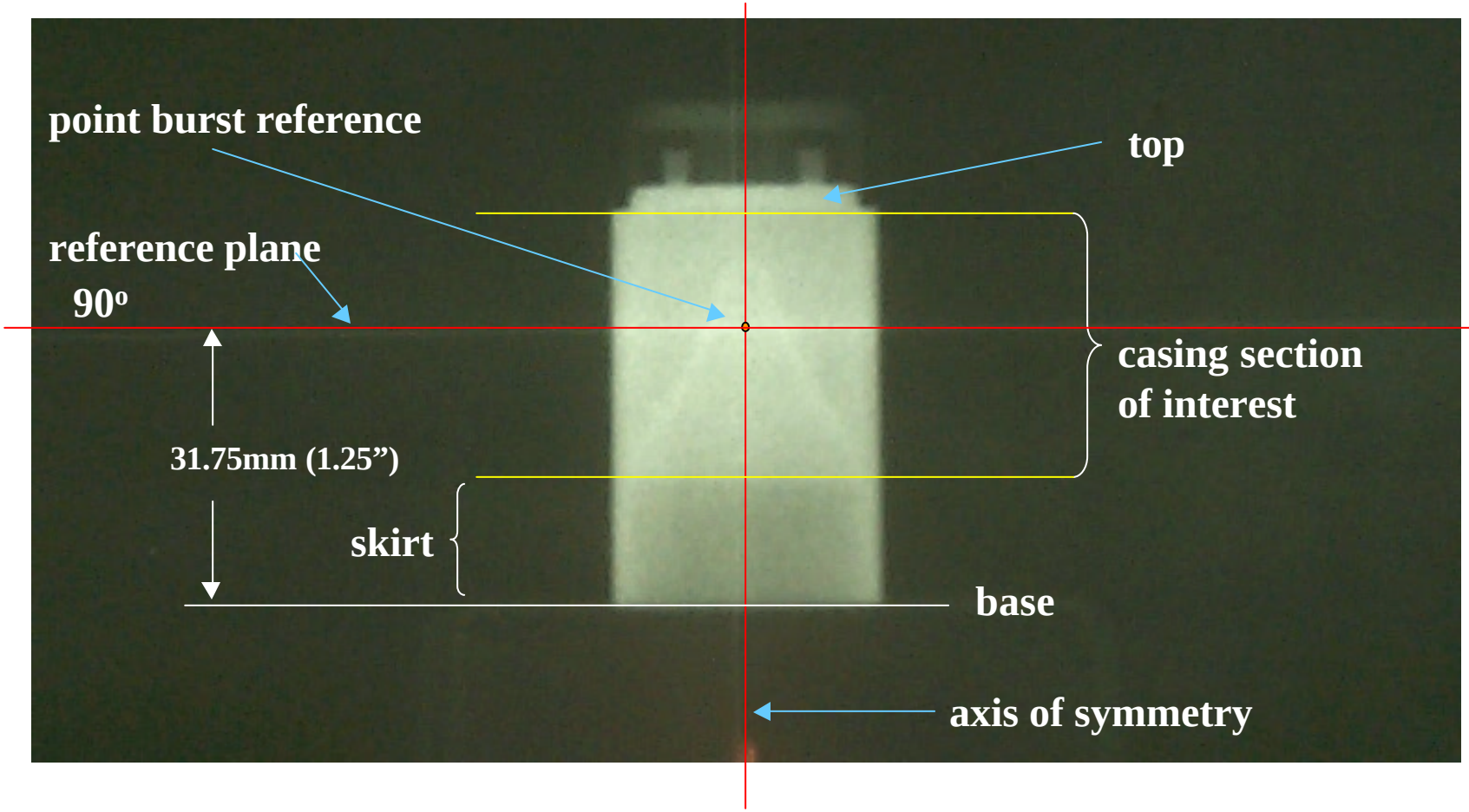
Fragment Group 1 & 2 seem to have similar slopes

Cumulative XM-80 Grenade Experiments

Fragment speeds are a round-to-round variation

Summary

Grenade at T = 0 ms



Conclusion

Phase I (Establish a Reference Line and Point)

- **Reference plane** is 31.75mm (1.25”) from the bottom of grenades’ skirt
- **Point burst reference** is located at the intersection of the reference plane and the axis of symmetry

Phase II (Observe Grenade Expansion)

- Grenade’s shell expansion is similar when supported by foam or steel
- Fragmentation is separated into 2 major groups
  - Group 1 is directed at 85^{o} to 90^{o}
  - Group 2 is directed at 80^{o} to 85^{o} due to the tapering of explosive / Taylor angle
- Minimum number of fragments are directed at 90^{o} to 95^{o}, due to corner effects