Suppressor-Compatible Hypersonic Discarding Sabot Ammunition

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Structure:

i. *Motivation*

ii. *BASS Basics – Aeromechanics, Kinematics*

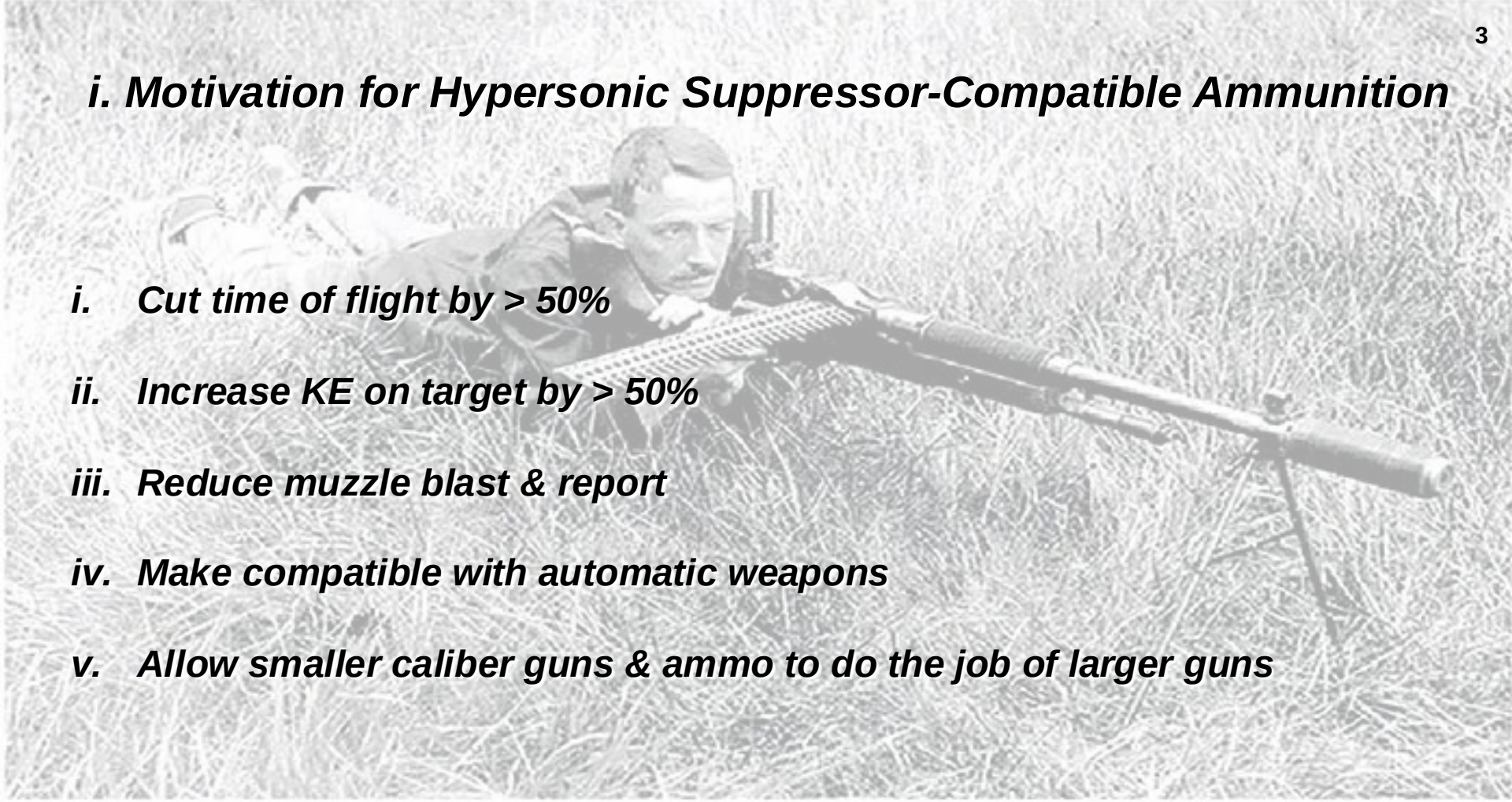
iii. *Design Philosophy & Configurations*

iv. *Basic Physics*

v. *General Performance*

vi. *Intellectual Property Filings, Claims & Status*

i. Motivation for Hypersonic Suppressor-Compatible Ammunition



i. Cut time of flight by > 50%

ii. Increase KE on target by > 50%

iii. Reduce muzzle blast & report

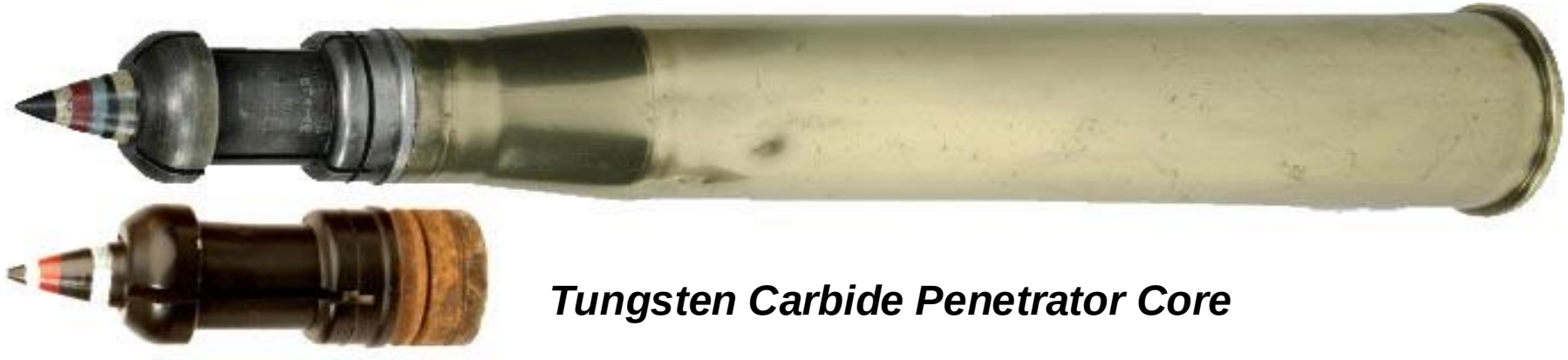
iv. Make compatible with automatic weapons

v. Allow smaller caliber guns & ammo to do the job of larger guns

ii. Ballistic Aeromechanically Stable Sabot (BASS) Ammunition

British QF 6-Pounder Antitank Gun 1944

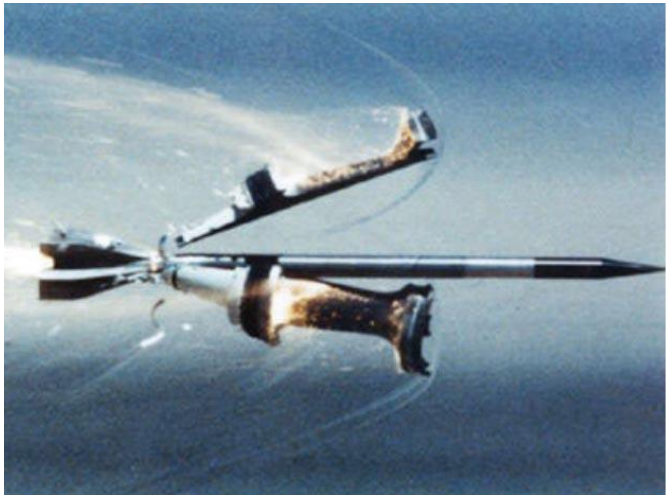
Armor-Piercing Discarding Sabot (APDS Round)

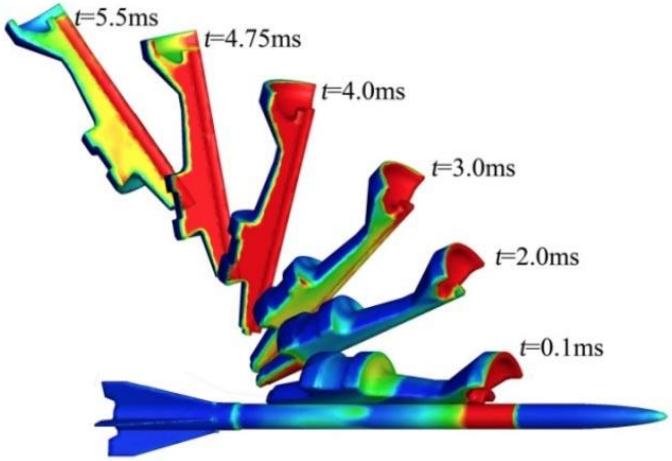


Tungsten Carbide Penetrator Core

Problems with Aircraft & Sabots

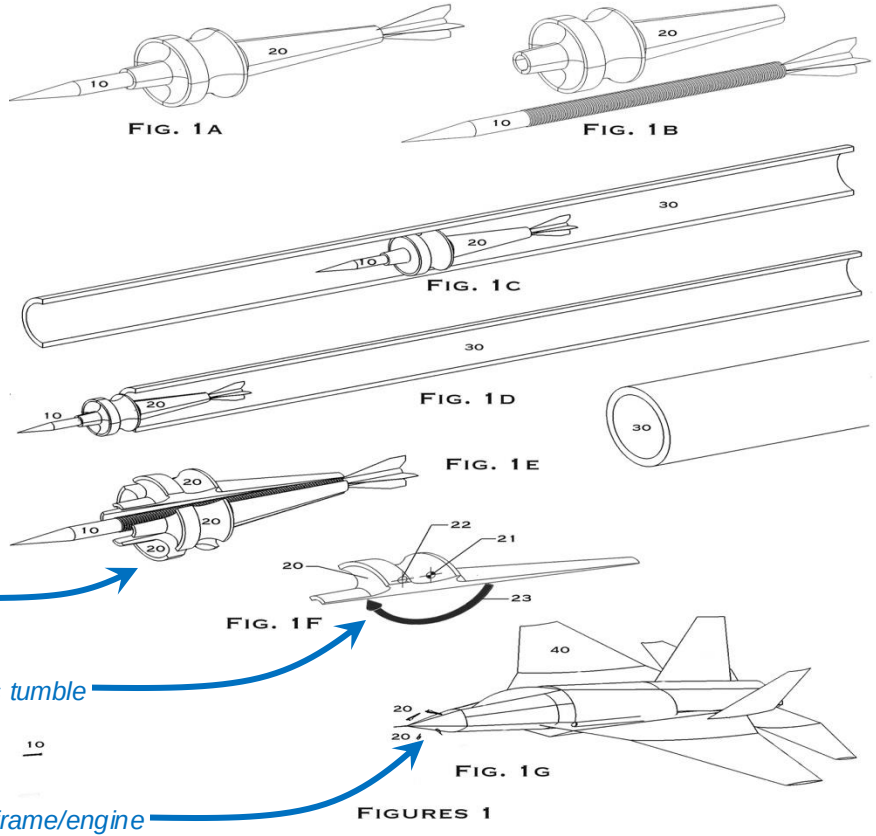
Conventional Discarding Sabot: Aeromechanically unstable by necessity...





ii. Ballistic Aeromechanically Stable Sabot (BASS) Round Basics

BASS Rounds Originally Designed for Aerial Gunnery:



Conventional sabot pieces are designed to be aeromechanically unstable, by necessity, to separate from projectile

Aeromechanically unstable sabot pieces tumble

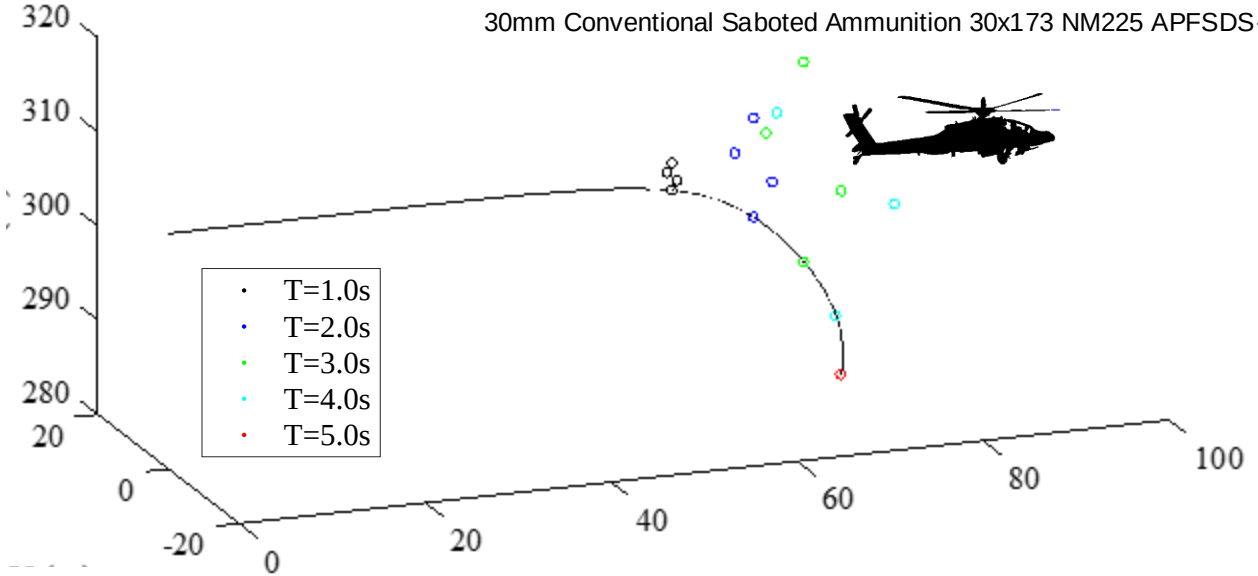
...and strike airframe/engine

Image Source: PCT/IB2020/053899

ii. Ballistic Aeromechanically Stable Sabot (BASS) Round Basics

The Great Show Stopper for conventional sabots:

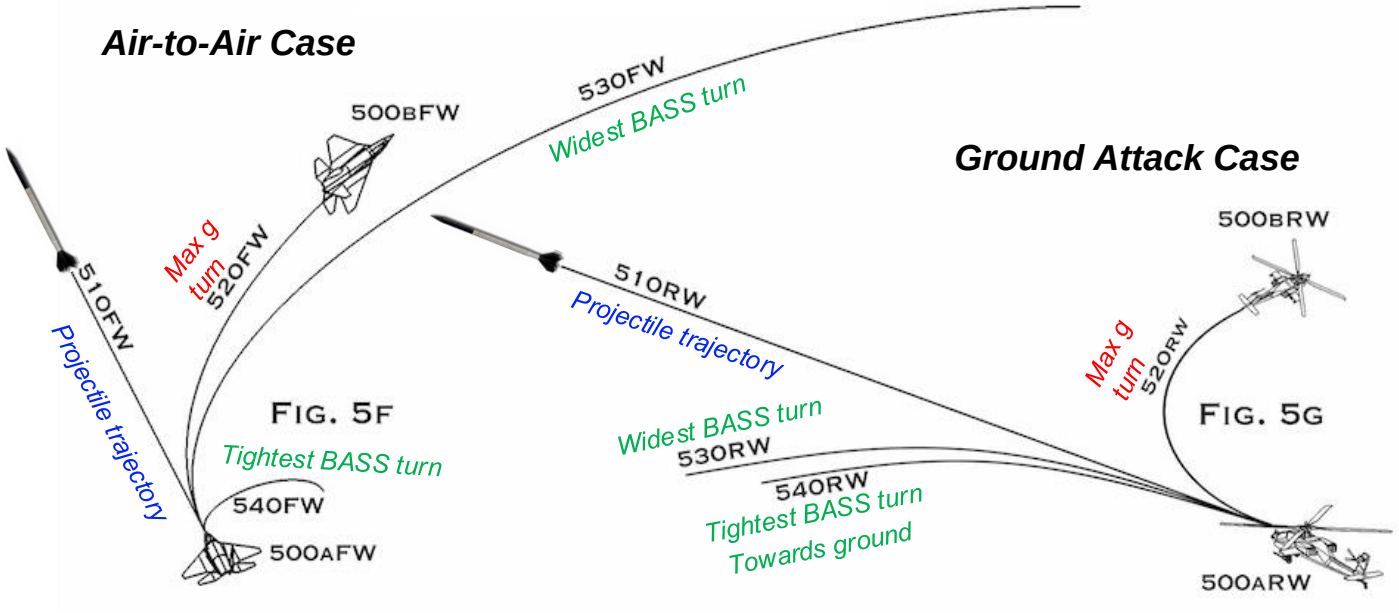
Flight Safety



ii. Ballistic Aeromechanically Stable Sabot (BASS) Round Basics

Aeromechanics, Kinematics

BASS Rounds: Design the Sabot to clear the launching aircraft



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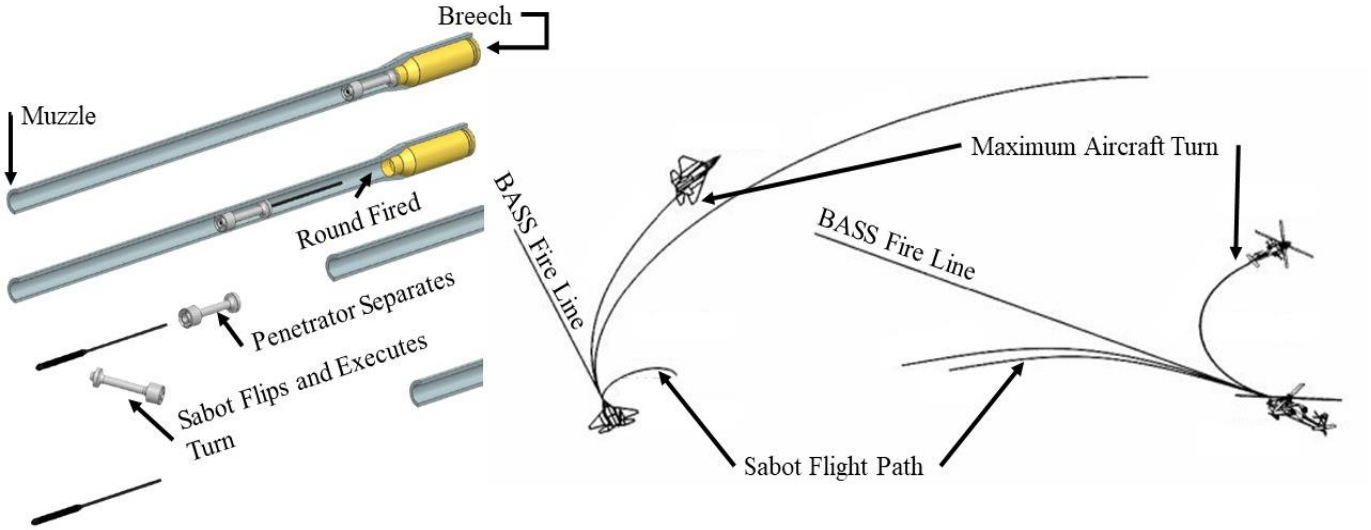

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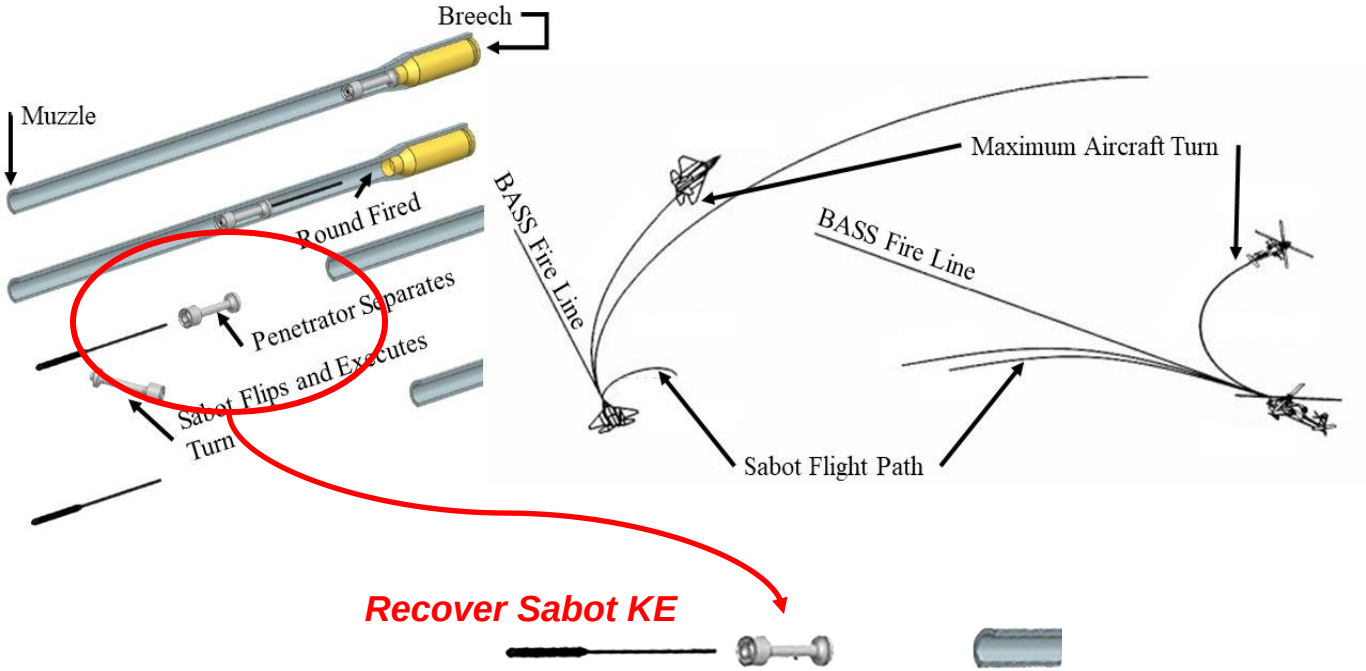


iii. Suppressor-Compatible BASS Design Philosophy

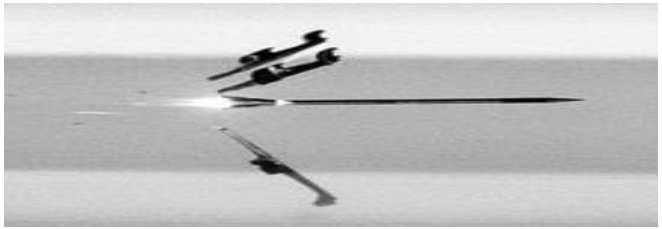
1. Use BASS to Increase projectile V_{flt} & KE at range;

2. Use monolithic nature of sabot to safely transit suppressor.

Problems with Suppressors and Sabots

Complicated baffles, wipers and chambers inside many many (many) suppressors

Pieces of conventional sabots would instantly jam inside conventional suppressors



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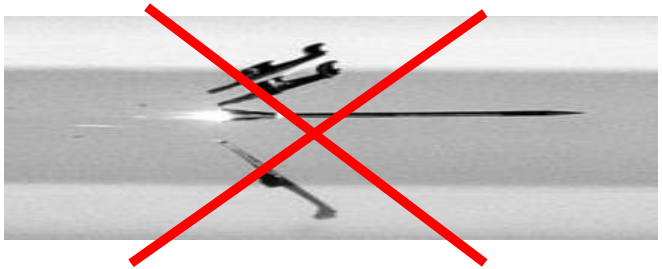
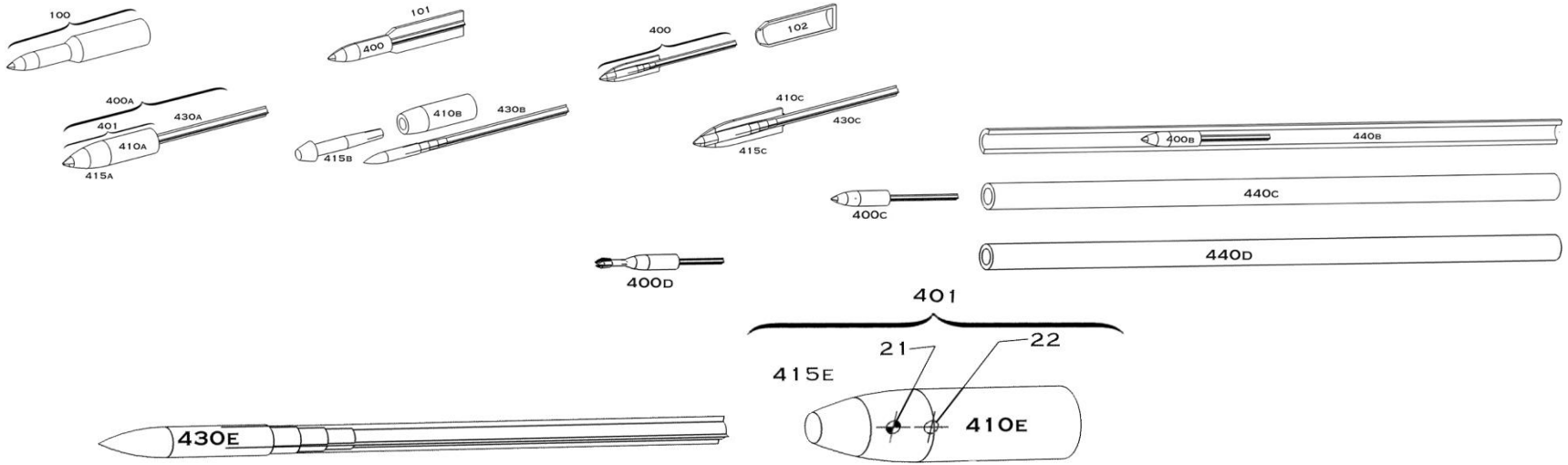


iii. BASS Design Philosophy

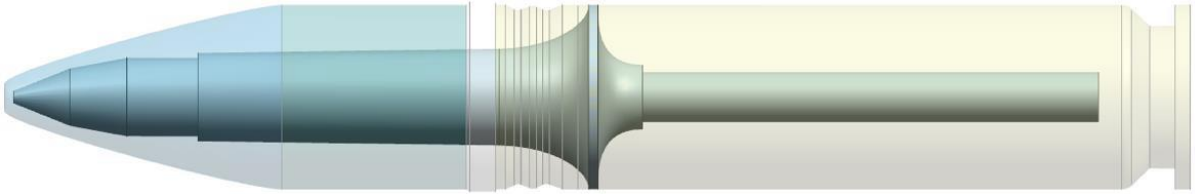
- *Monolithic sabot that shoots flechette out, but stays in one piece*
- *Prescribe high l/d, smooth bore guns w/traveling charge for hypersonic Vm*
- *Cut drag by order of magnitude by discarding sabot*
- *Trade combined sabot & flechette mass for speed*
- *Recover sabot KE after muzzle exit*



iii. BASS Design Philosophy

Today's "Advanced" 30mm Aerial Gunnery Round

BASS Round: Sub-caliber flechette goes into powder, seated in sabot

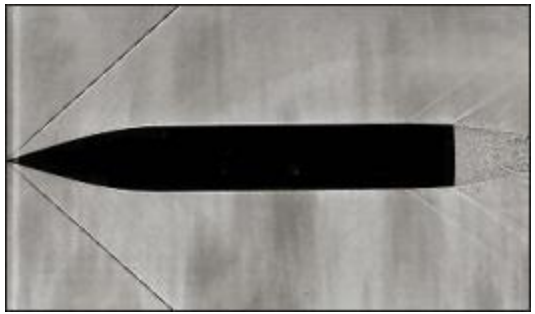


Freeflight Aeromechanics

Modeling, Analysis & Testing

Experimental Validation:

• Wind tunnel verification of preferred BASS sabot geometry center of pressure and aerodynamic center location with angle of attack changes.



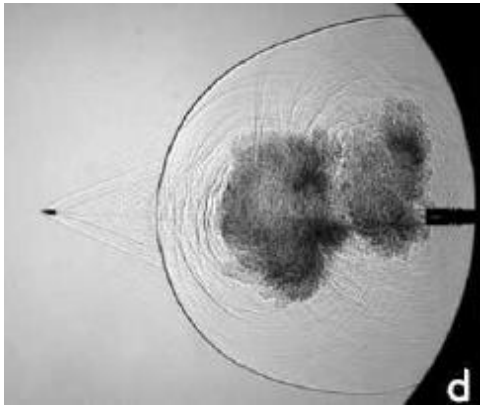
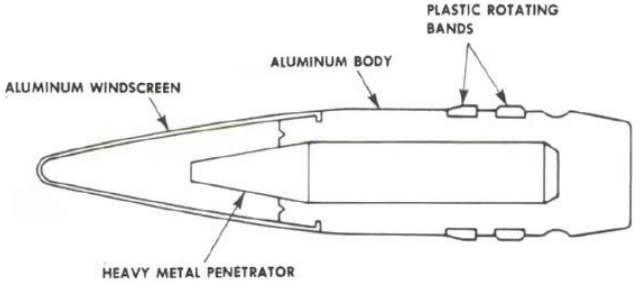


Image Sources:
https://nuclearprojects.com/blog/schlieren-flow-visualization/
https://www.researchgate.net/figure/Focused-shadowgrams-of-223-automatic-rifle-fire-a-sharply-focused-b-defocused-1m_fig3_226053639

iii. BASS Design Philosophy

Today's Premier API Aerial Gunnery Round

PGU-14



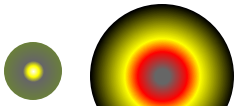
BASS 2081 Flechette/penetrator

iii. BASS Design Philosophy

Projectile Aeromechanics & CEP Fundamentals

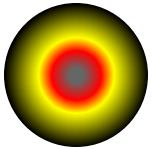
Flechette

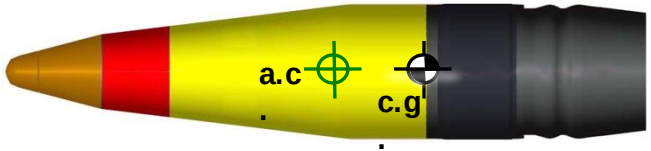
X-Sectional Area of PGU-14 >> Flechette



PGU-xx

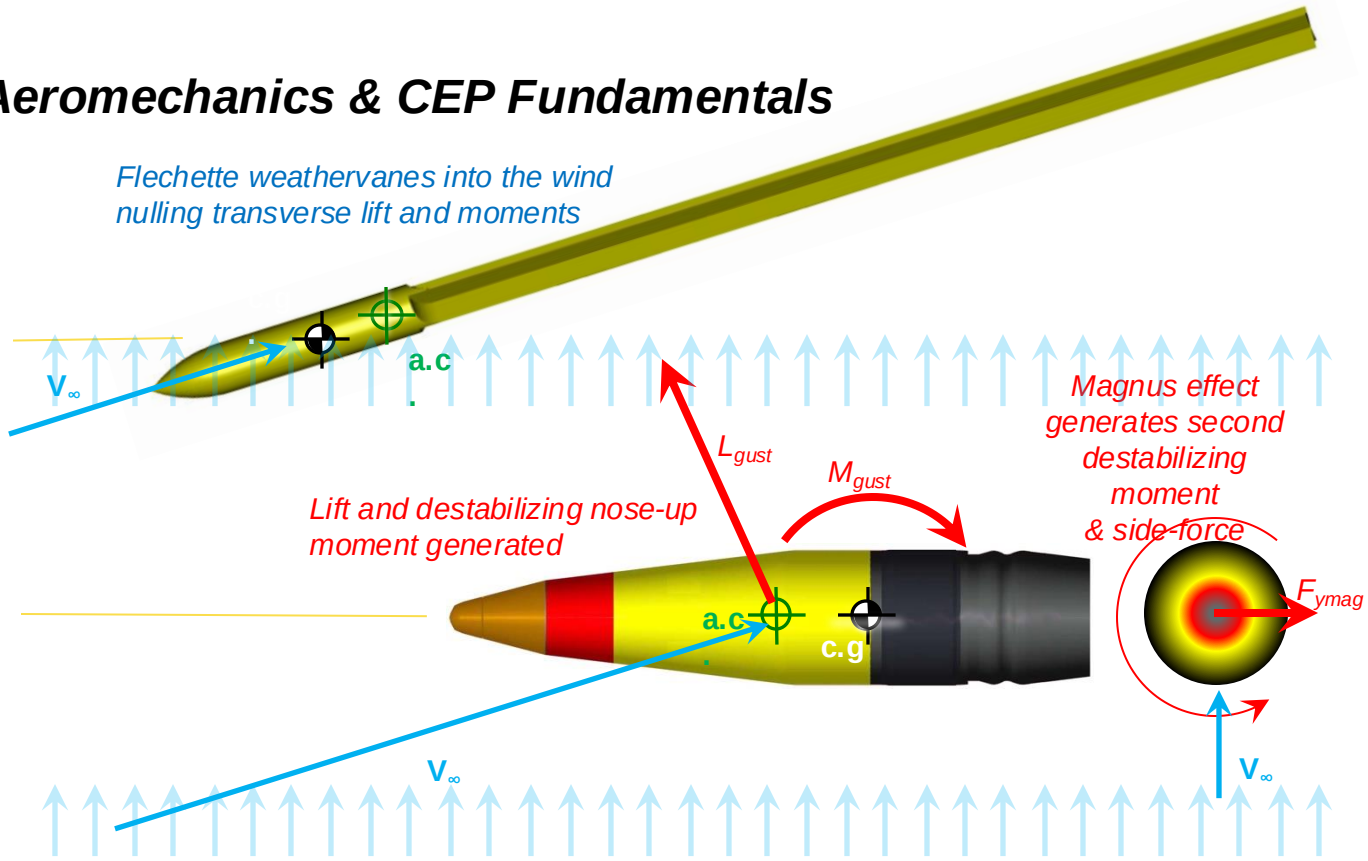
Supersonic Drag ~ proportional to X-Sectional Area, $Drag_{PGU14}$ >> $D_{Flechette}$





iii. BASS Design Philosophy

Projectile Aeromechanics & CEP Fundamentals

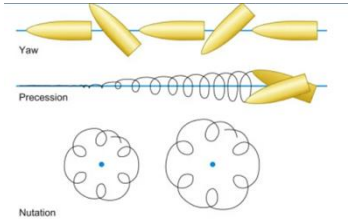


iii. BASS Design Philosophy

Projectile Aeromechanics & CEP Fundamentals

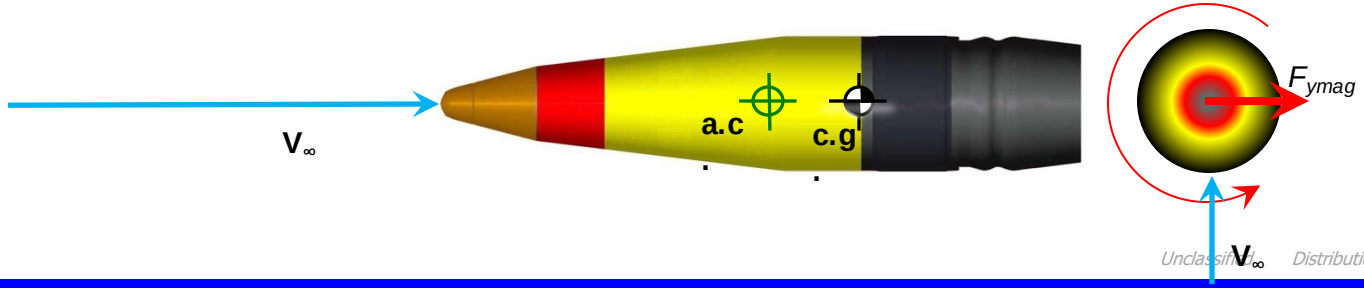
Flechette

Flechette returned to steady-state flight close to original flight path (maintaining very small CEP)



PGU-xx

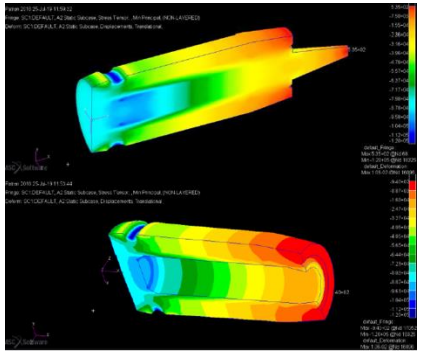
CEP greately increased due to steady-state and dynamic effects

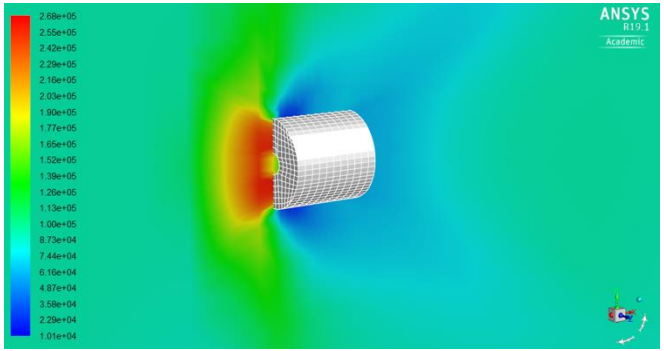


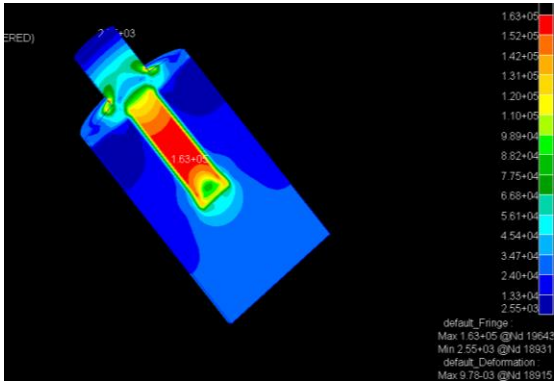
iv. BASS Round Physics & Modeling

Aeromechanics, Kinematics

- *Conceived & reduced to practice 2016 – Present*
- *Modeled in CFD, FEM, DATCOM & PRODAS*
- *Tested on Shock Table, Supersonic Wind Tunnel, Range*
- *>12 rounds fired, currently @ TRL-5*







v. BASS Round Performance

Modeling, Analysis & Testing

Experimental Validation:

- Full scale range testing of preferred BASS configuration w/muzzle exit dynamics;
- Structural verification of BASS components via soft catch.

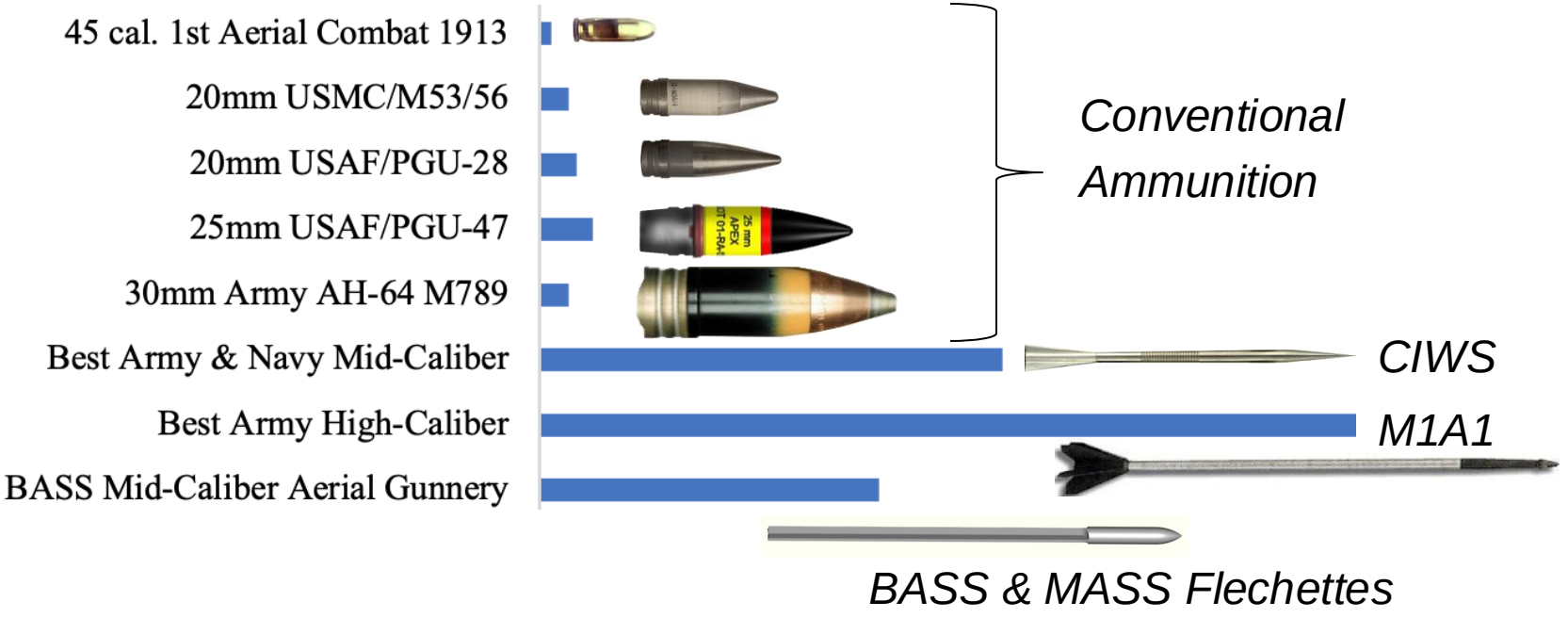
v. BASS Round Performance

Range Shots

Video Source: Schumacher, L. N., "BASS Medium Caliber System Modeling: Proof-of-Concept and the Future of Aerial Gunnery with Advanced Munitions," public Ph.D. Dissertation Defense, 29 June 2020, The University of Kansas Aerospace Engineering Department, Lawrence, Kansas.

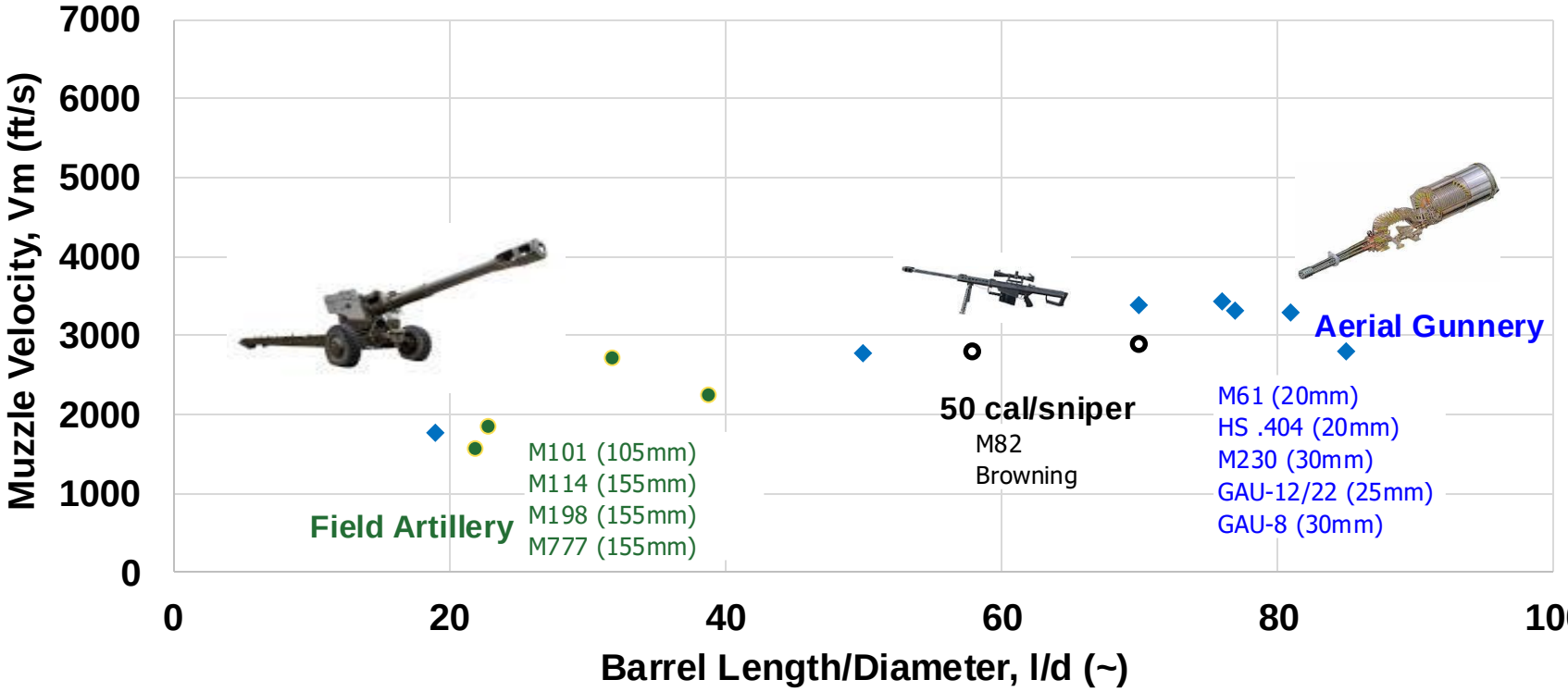
v. BASS Round Performance

Relative Ballistic Coefficients



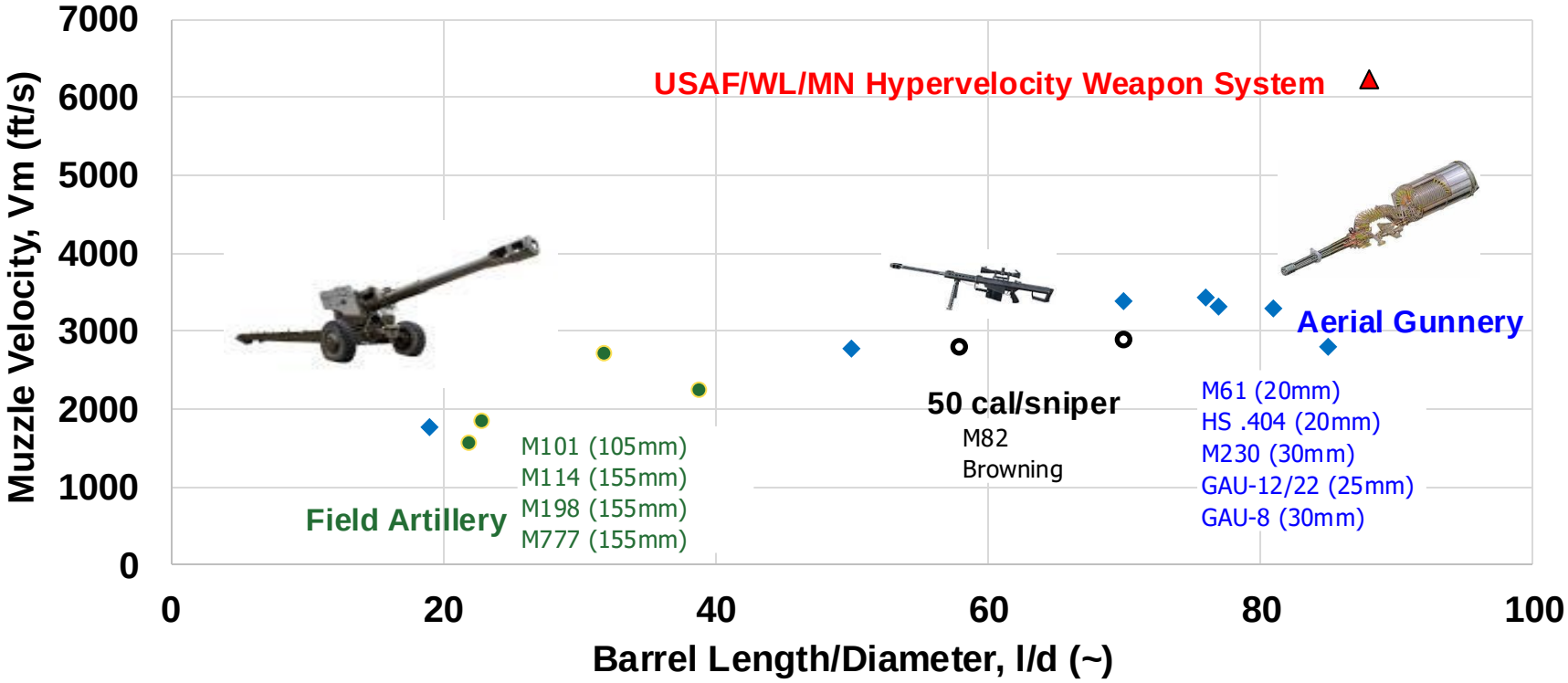
v. BASS Round Performance

How to get to hypersonic speeds with conventional gunnery…



v. BASS Round Performance

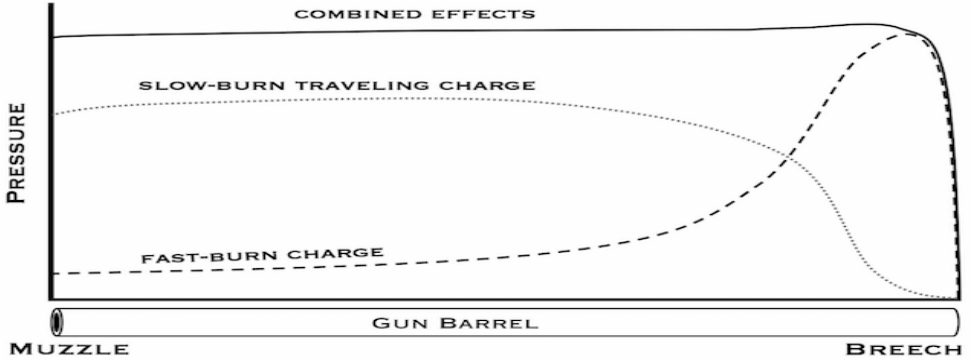
Look to history

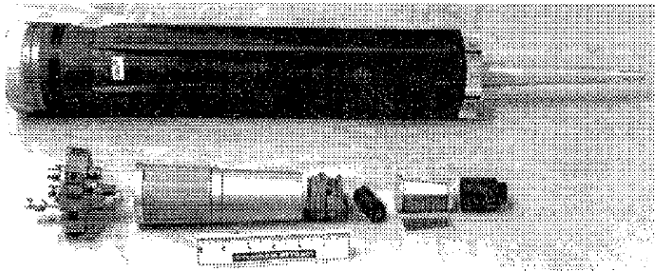


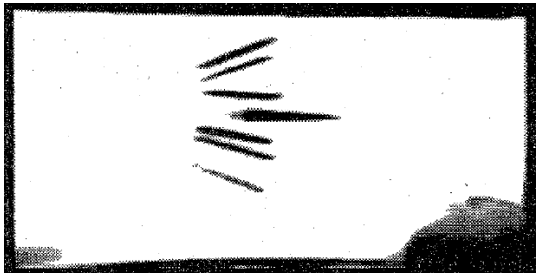
v. BASS Round Performance

Hypervelocity Weapon System (HWVS) AFRL/MN Eglin AFB

- **Muzzle Mach ~ 6 – 8**
- **Enabling technologies:**
  - -High l/d barrel
  - -Sabot
  - -Traveling Charge

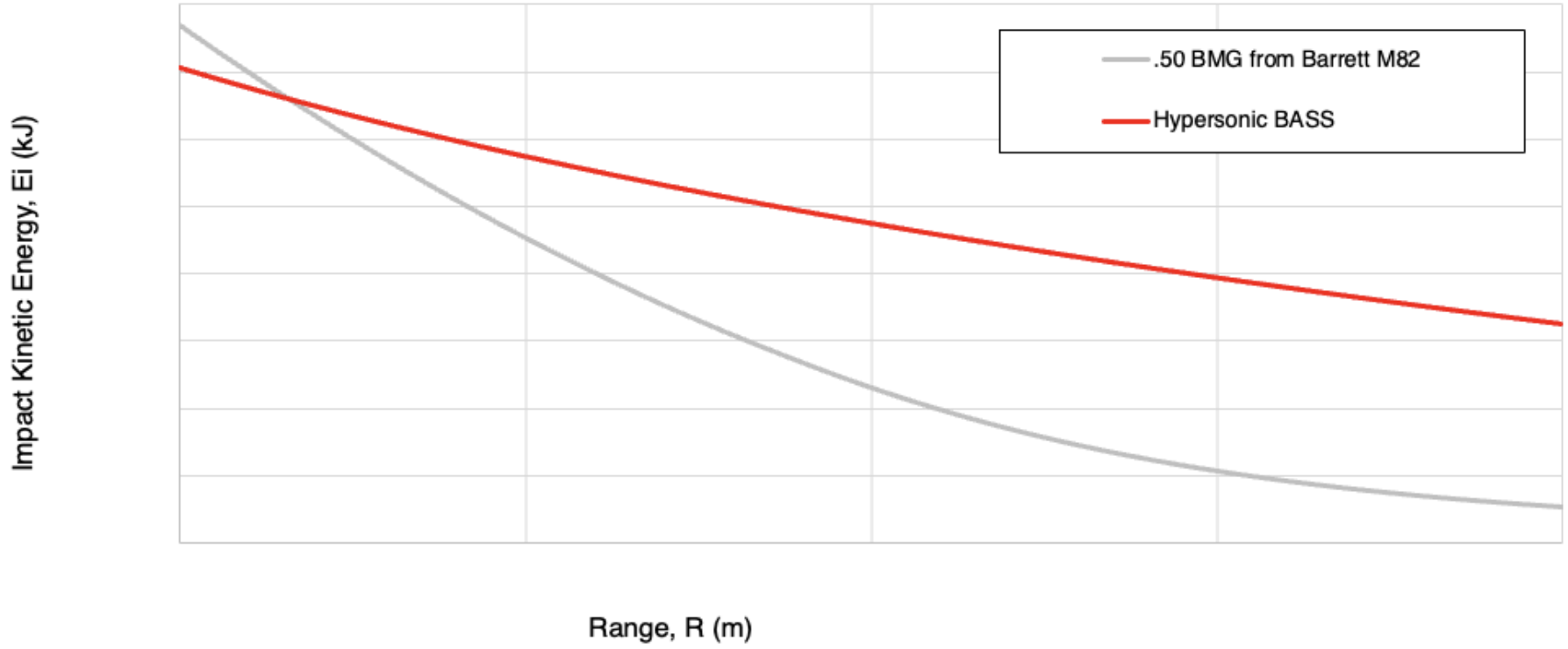






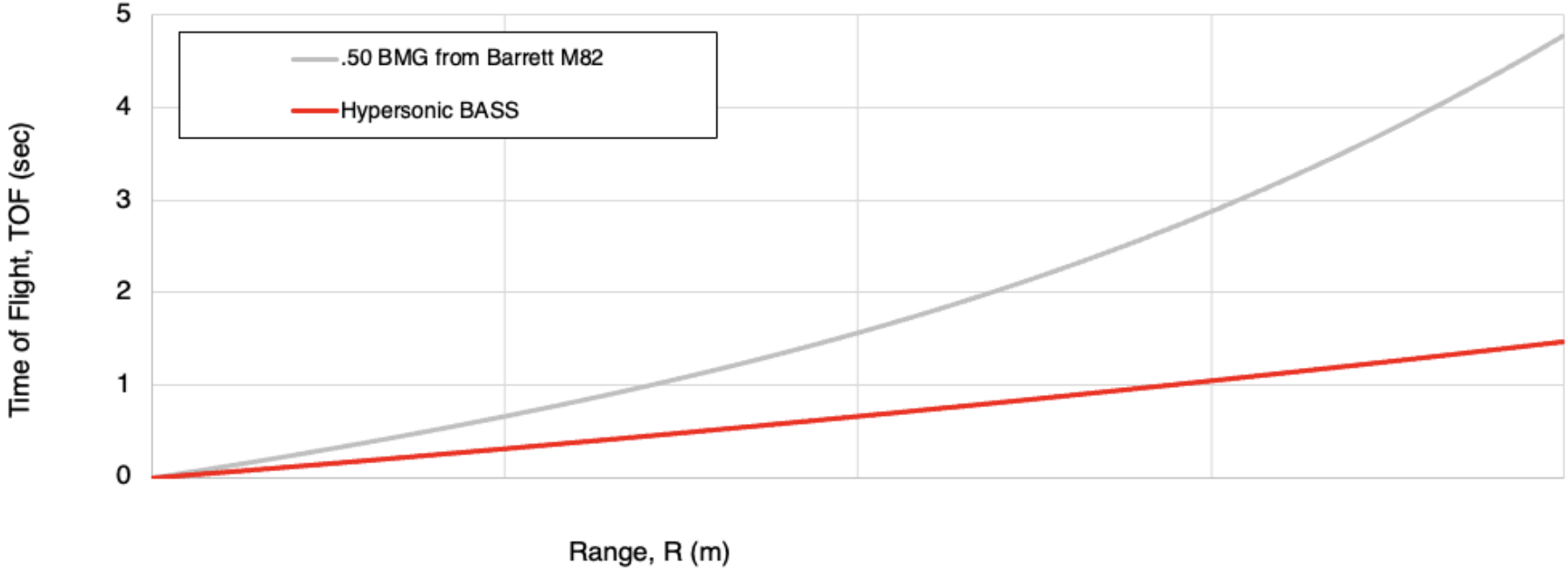
v. BASS Round Performance

Hypersonic BASS Rounds Maintain KE with Range



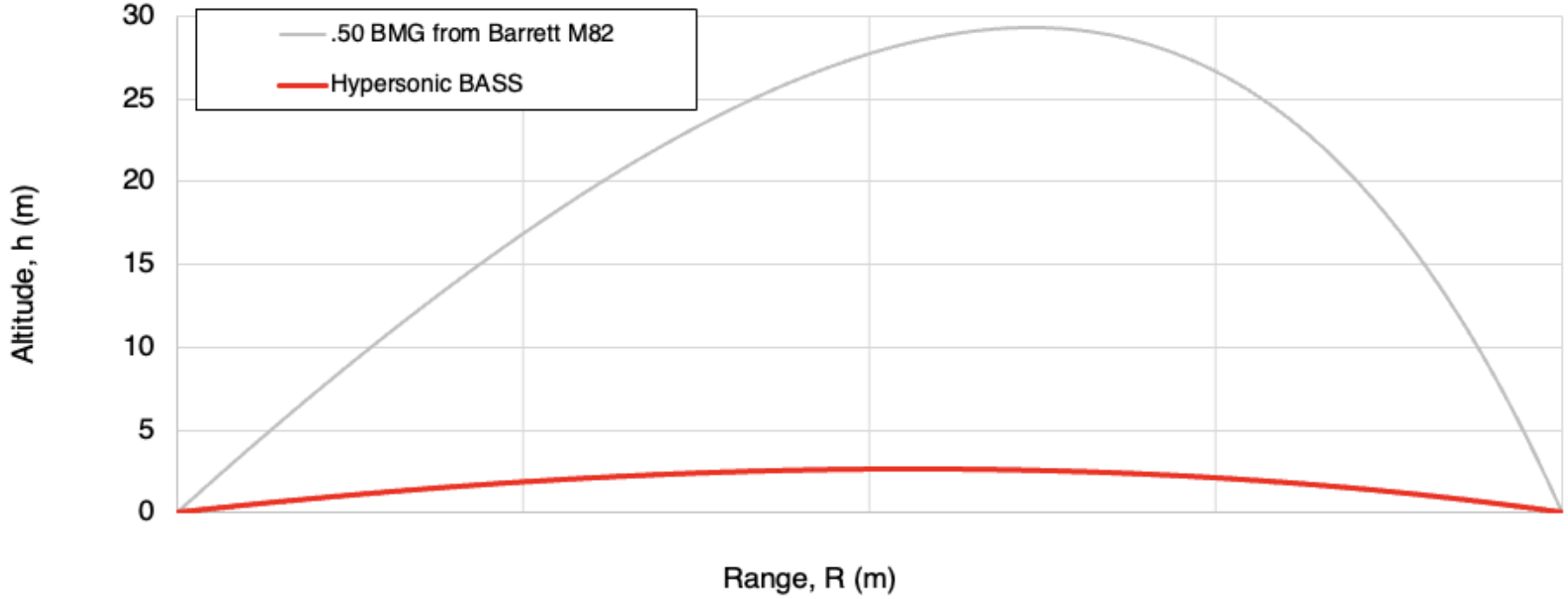
v. BASS Round Performance

Dramatic Reductions in Times of Flight



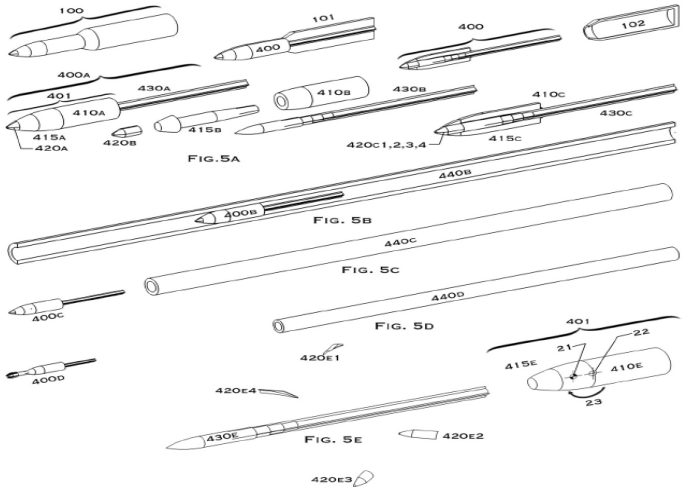
v. BASS Round Performance

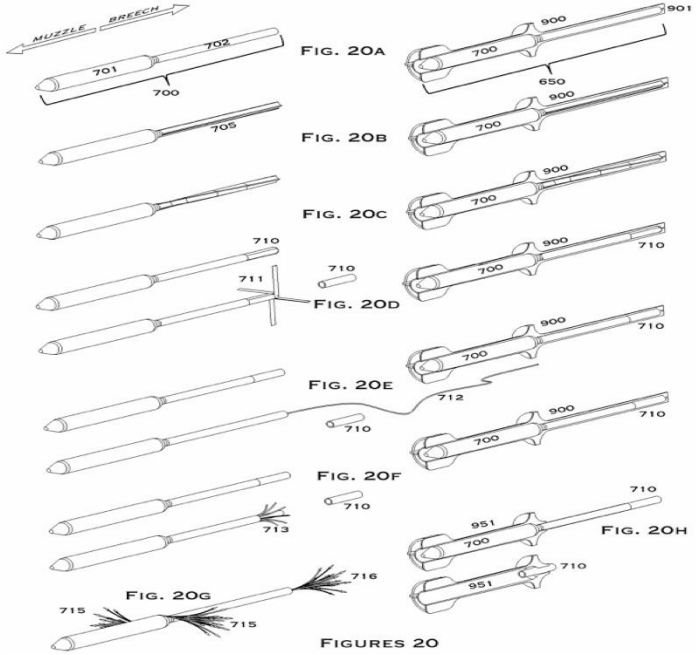
Much Flatter Fire



v. BASS IP Status

- **Strong, Broad US Patents Filed 2019, 2020**
- **Fed. Government Approved the Concept for Export & Exported**
- **Patents filed: US, Europe, Germany, Norway, Australia, UK, Netherlands, France, Belgium, Italy, Spain, Japan, Korea, Singapore**





US Patent 11,852,447 Issued 26 December 2023

Licensed to Watson Aerospace and Defense

Provisional Patent Application 62/839,551 26 April 2019 priority date


Questions?