Pneumatic Tennis Ball Antenna Launching

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www.qsl.net/wb6zqz/antlaunching.html

This Presentation

- Material: 50+ slides and a short video
- Handout sheet has web URLs, etc
- This presentation available online
  - Courtesy of QSL.net (www.qsl.net/wb6zqz)
- Interrupt with questions that are of interest to everyone, due to time constraints please take offline those that are lengthy or not of general interest

Purpose of Antenna Launching

- To Install Antennae in Trees
  - For Emergency Communications,
  - Field Day,
  - Portable Field Ops (QRP/QRO),
  - Home station operations...
- To do so Safely and Effectively

Audience Survey

- How many folks have used:
  - Slingshots to put up Antenna Lines?
  - Hand Throwing?
  - Fishing Pole (Casting)?
  - Bow and Arrow?
  - Combustion Launcher? (Potato cannon)
  - Compressed Air Launcher?

Systems we used Previously

- Archery
- Slingshots
- Fishing Pole (Casting)
- Throwing a rock, stick, ball, water bottle …
- Climbing trees
- Poles, Towers, (guyed), etc
- Helium Balloons, Kites, Other

Concern over Safety Issues

- Loose or Misdirected Projectile
- Rebounding/Deflected Projectile
- Projectile Retrieval
  - Stuck projectile left behind (to fall later...)
- Skinned arms, knuckles
- Falling from tree, branches falling, ...
- Falling Towers, poles, etc

How to Increase Safety?

- Use a Tower Trailer?
- Keep both feet on the Ground
- Use a Large and Soft Projectile
- Keep the velocity low (k.e. = $\frac{1}{2}mv^2$)

- What about a Tennis Ball?

Launching Requirements

- Launch a Tennis Ball
  - Towing a line up to 150+ feet in height
  - With enough weight to draw line down
- Accurately, and with Height Control
- Portable enough to take to field
- Fairly Quiet, No Combustion
- Simple enough for anyone to use

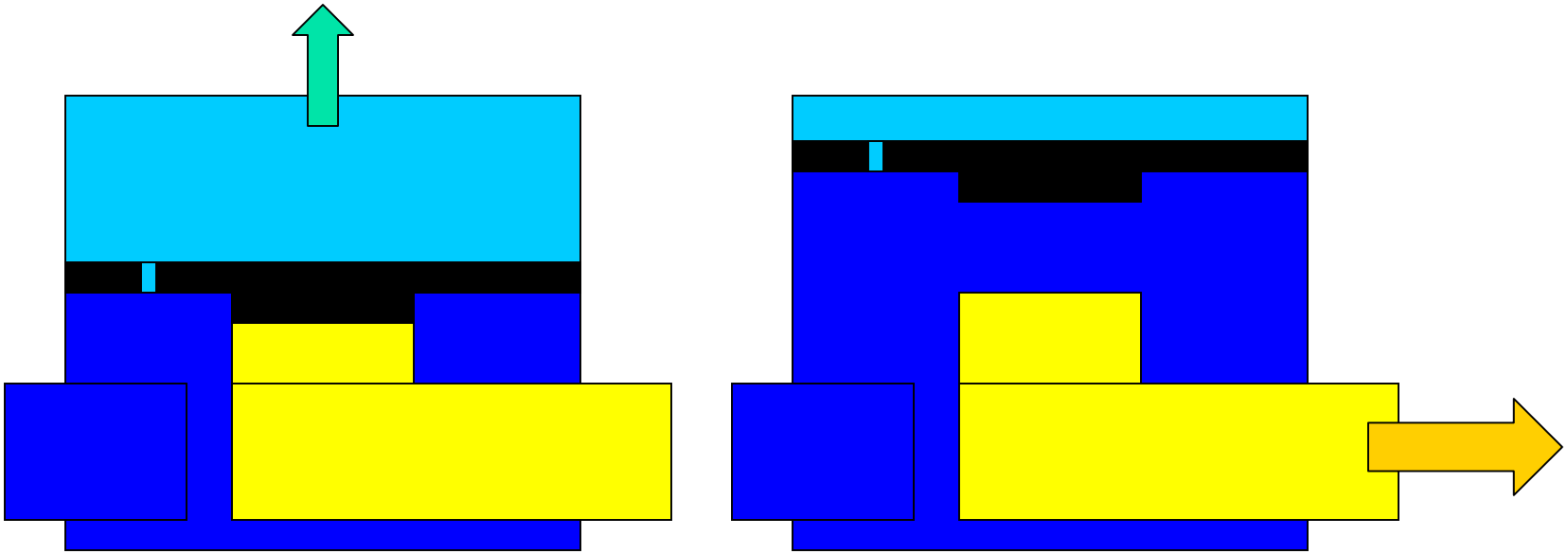
Selected Launcher Design

- Tennis Ball projectile
- Compressed Air (or CO_2) powered
- System consisting of Pressure Chamber, (Sprinkler) Valve & Barrel
- Fishing reel to feed line
- Built from Pressure Rated PVC
  - available, low-cost, easy to work with

How the Launcher Works

- Pressure chamber holds 25-70 psi air
- Valve holds the air back, when triggered releases it in a few milliseconds
- Air flows rapidly into barrel
- Pressure in the barrel accelerates Tennis Ball

Pilot Valve Operation



Launching Process

- Attach line to tennis ball, push into barrel
- Choose tree, line path and landing zone
- Ascertain height, choose pressure
- Pressurize & Launch
- Get ball down
- Attach, pull back nylon Mason Twine
- Pull up Antenna or heavier Line ...

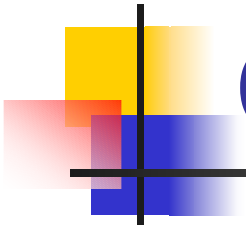
PVC Pressure Safety Concerns

- Not Recommended for Compressed Gas
  - Breakage while under pressure may lead to high velocity PVC shrapnel
  - Do not break while under pressure!
- Loses strength at low and high temperatures
- Consider Other Materials?
  - Copper, Aluminum, Brass, etc

G2 Launcher (June 2002)

Initial Field Testing

- Eric's G2 Launcher used Field Day 2002
  - Dual sprinkler valves, 500 cubic inch chamber
  - Four foot barrel of 2.5" PVC sch 40 pipe
  - 25 pounds of PVC (all schedule 40 pressure rated)
  - Achieved 13-14 seconds air-time
    - Untethered unweighted Tennis Ball! (about 400 FPS)
- Issues
  - More velocity/height/size/weight than Required...
  - Standard Tennis Ball too light to pull line down



Computer Modelling

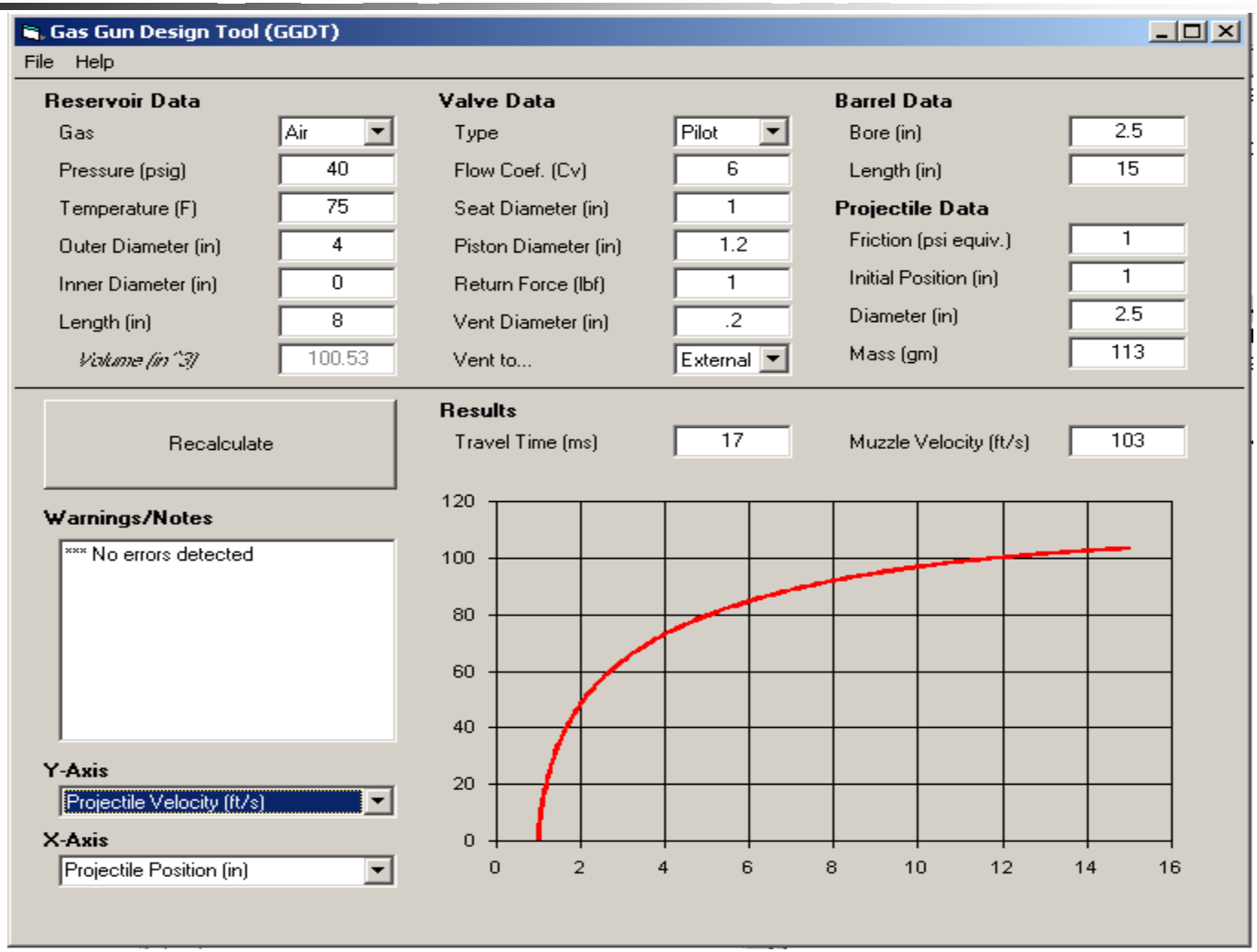
- SCFM = 16 * Cv * sqrt((P1^2-P2^2)/T)
  - (If P2 < 0.53 * P1 then P2 = 0.53 * P1: Mach)
  - PV = nRT, f = ma, etc
- Compressed Air Launcher Modeler (CALM)
  - Python, source code visible
- Gas Gun Design Tool (GGDT)
  - Visual Basic, not source visible
- (URLs on the handout/slide near end)

CALM Example

CSV-19 Cv 5.0 Ballwt 4.0 oz

chp	fps	ms	xbp	xcp	ht	tofl
30	79	20	0.2	21	76	4.4
40	105	17	1.3	30	117	5.4
50	123	15	2.5	39	146	6.0
60	138	14	3.7	48	168	6.5
70	151	13	4.8	57	188	6.9
80	162	13	5.9	66	205	7.2

GGDT Example (CSV19)



Tennis Ball Weight

- Regulation 2 oz Tennis Ball
  - Is a bit light to pull line down
- 4 ounces produces highest trajectory
  - Improved energy transfer and efficiency
  - Is usually enough to pull line down
- Up to 8 ounces has been used successfully
  - 8 oz really comes down firmly, be careful!
- 4-5 ounces generally best overall
- Add 11 pennies per ounce (22 cents = 4 oz)

Tennis Ball Velocity

- Velocity to reach 150 feet height
  - Is less than a fast Tennis Serve
  - 220 fps ~ 280 ft height (regulation 2 oz ball)
- Higher velocities
  - Not required for most antenna work
- With 4 oz ball
  - Improved coupling to launch energy
  - 140 fps yields about 170 ft height

Launcher Refinement

- Reduce size with adequate performance
  - U37A -> DU36C Evolution (electric to pneum.)
  - QE28 ¾" Quick Exhaust Valve based
  - Eric's Trident – very light pressure chamber
- Alan's new Requirement –Tote-Sized (19")
  - QE19 – Quick Exhaust Valve shortened
  - DV19 – Dual Sprinkler Valve model
  - DFTV19 – Darn Fast Turbo Valve model
  - CSV19 – Compact Sprinkler Valve model

U37A Launcher (37” electric)

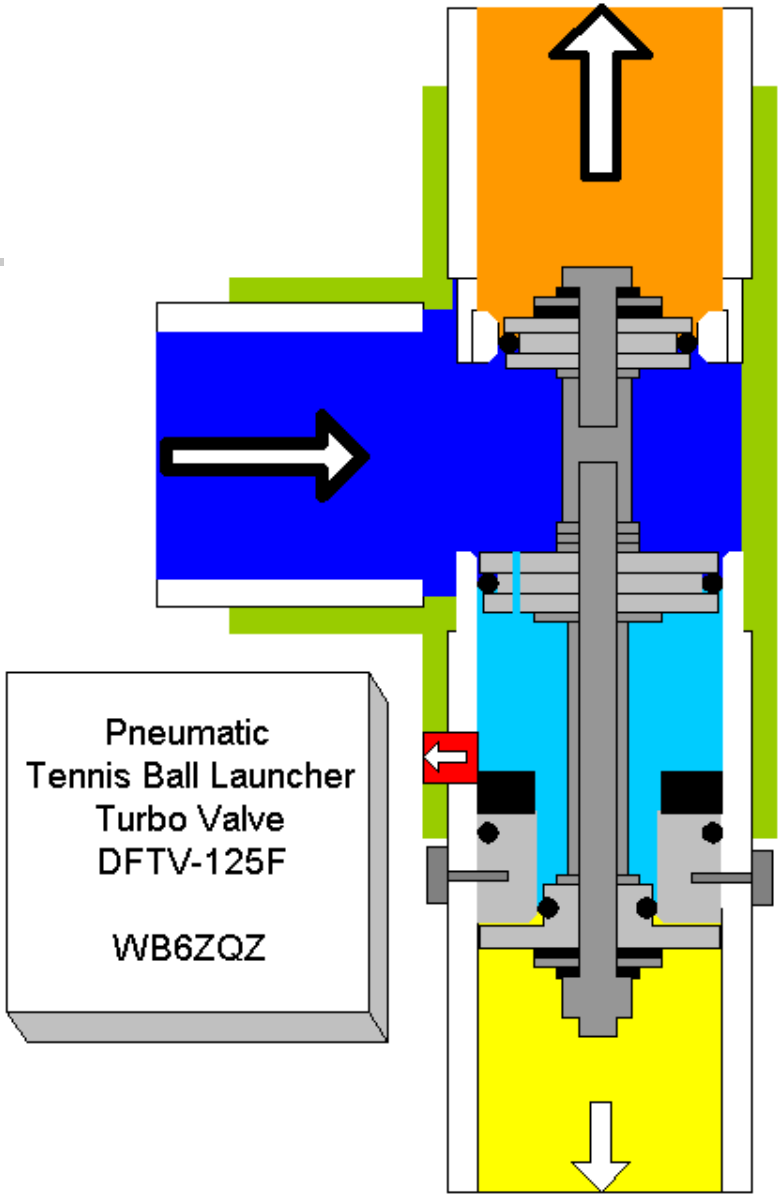
Trident Launcher (lightest)

QE19 Launcher (smallest)

DV19 Launcher (high perf.)

DFTV19 Internals

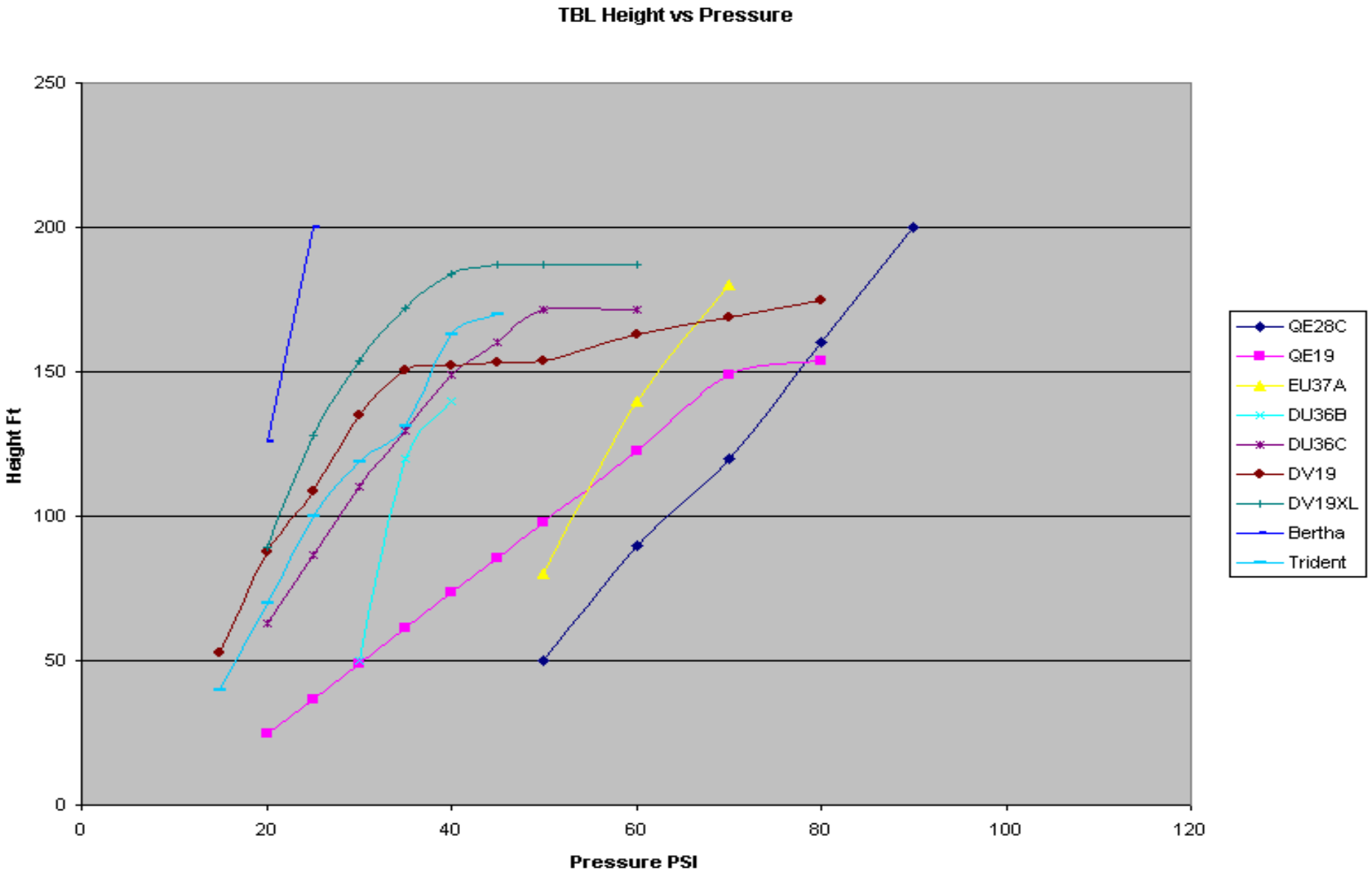
- Extremely Fast
- High Flow
- Small
- Lightweight
- Valve Speed Independent of Trigger Flow



DFTV19 Launcher (high, light)

CSV19 Launcher (simple)

Antenna Launcher Performance



Reel Choices

- Fishing Reels
  - Spinning type (preferred)
  - Closed face Spin-Cast
- Saunder's Zip Reel
  - Designed for Archery Bowfishing
  - Excellent feed
  - 21" per wrap, can feed small wire directly

Saunders Zip Reel on Coupler

Launching Line

- Monofilament, 10-30 lb test
  - low cost, stretches, best on small reels
- Dacron kite line, 25-50 lb test
  - low cost (twisted ok, braided is better)
  - works but line drag limits height, not robust
- Synthetic fishing/kite lines, 35-50 lb test
  - Extremely thin and tough, 20% higher traj.
  - Spectra, Gorilla line, Fireline, Spyderwire, etc
- USE GLOVES, don’t wrap fingers!

Tennis Ball Preparation

- Preparing Tennis Ball
  - Slit with utility knife
  - Insert pennies for weight, 11 per oz
  - Use leather needle to thread heavy line for loop
  - Hot melt glue to reseal slit
- Attachment Double Loop
  - Controlling where the line will break
  - Short dual loop section of weaker line (mono)
  - 10-20 pound test

Secondary Lines

- Nylon Mason Twine
  - Various commercial and homemade spools
  - Adequate to support most wire antennas
- Tertiary Lines
  - Required for heavier antennas
  - Dacron cord, nylon/poly line, etc

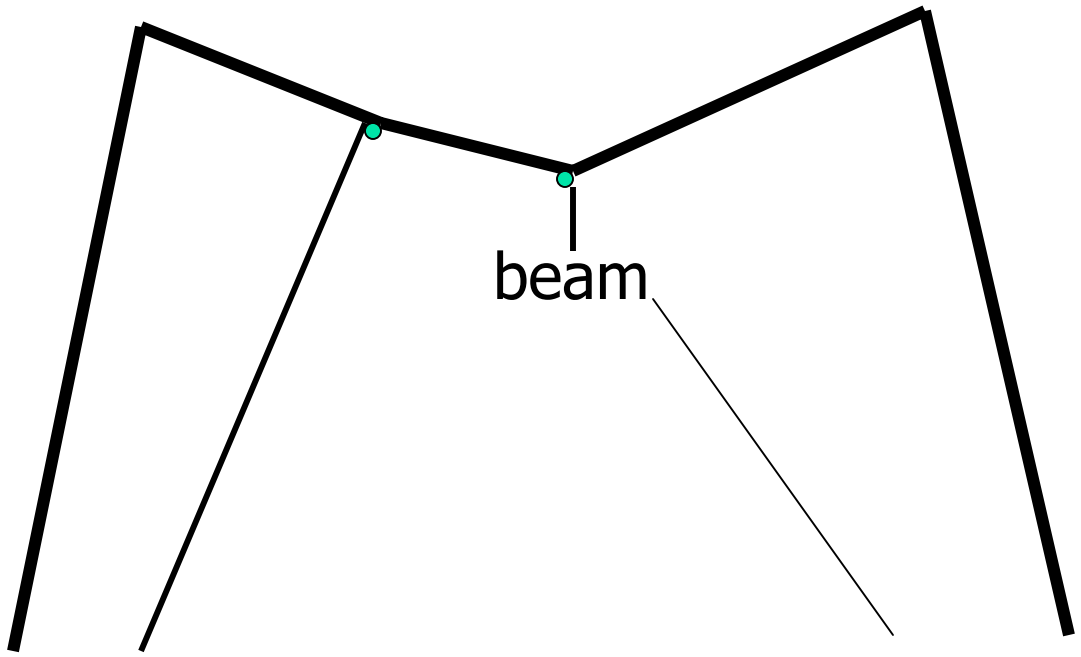
Antennas

- Dipoles, Vees
- Inverted L longwire
- Vertical Dipole, Sloper, J pole
- Vertical w/ Radials
- Suspending Beam Antennas
- Vee Beam
- Many Others

Inverted L Longwire

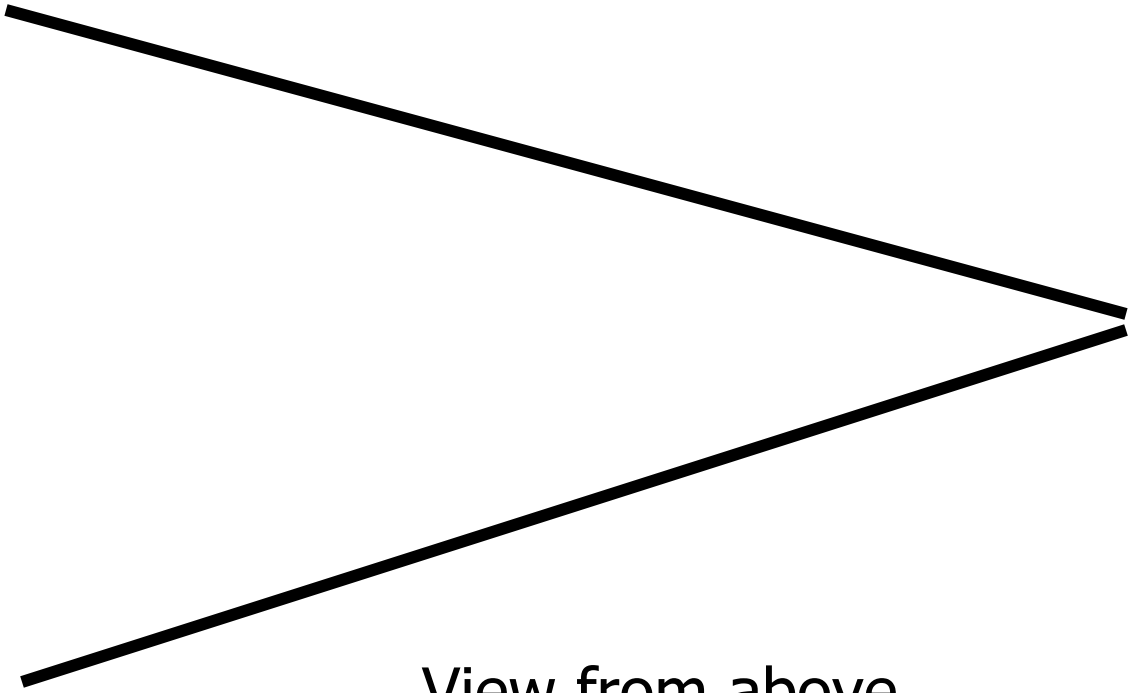
- One Launch over several trees
- Quick to deploy
- Counterpoise elevated or on the ground
- Trees not shown for clarity

Suspending a Beam



Field Day Beam/inverted Vee

Vee Beam



View from above

Pressurizing

- 25 to 70 psi required
- Foot or Hand Pumps work
- Bicycle Pumps also work
- 12VDC Pumps (& Battery)
- Portable Jump Start Box (Battery & Compressor)
- Small AC Compressors (& Generator)
- CO_2 Systems

Portable Jump-Start Box

CO_2 Systems

- Portable, quick, quiet, convenient
  - Pressurize just before use, right at launch location
  - Minimize time the launcher is pressurized
- One ounce of Liquid CO_2
  - Yields about two to four launches (100-150')
- Liquid CO_2 800-1000 psi depending on temp
  - Quality pressure regulator required
- Safety Issues
  - High pressure & cold dangerous to PVC
  - Periodic recertification required on pressure vessels

Paintball CO_2 System

- Paintball bottles, 8-24 ounces of CO_2
  - Refills $2-5, approx 10 cents per launch
  - 12 oz = approx 30 launches (<3 lb total wt)
- Regulator
  - Palmer Tire Stabilizer
    - Available with tire fill fitting, ready to go
  - www.palmer-pursuit.com

Paintball CO_2 System

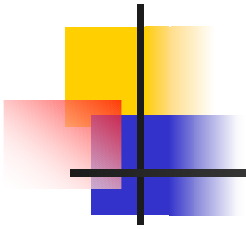
palmer-pursuit.com

RV/4WD CO_2 Tire Filling System

- Large capacity, more utility
  - High flow rate, will run air tools!
- Heavier, larger, higher initial cost
- www.rvpowershot.com
- Refills $12-15 per 5-20 lb CO_2
- Launches about 2 cents each

RV PowerShot CO_2 System

RVPowershot.com

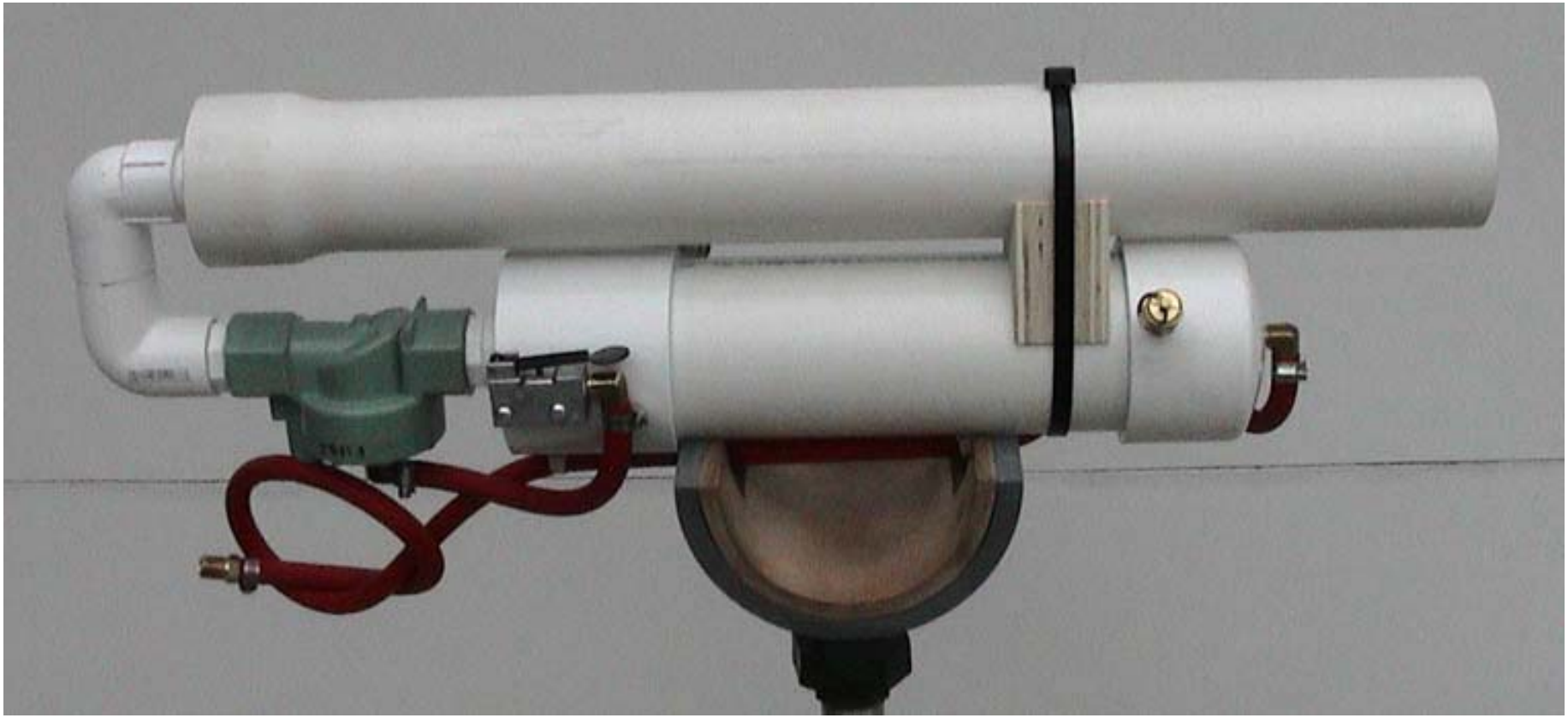


Procuring a Launcher

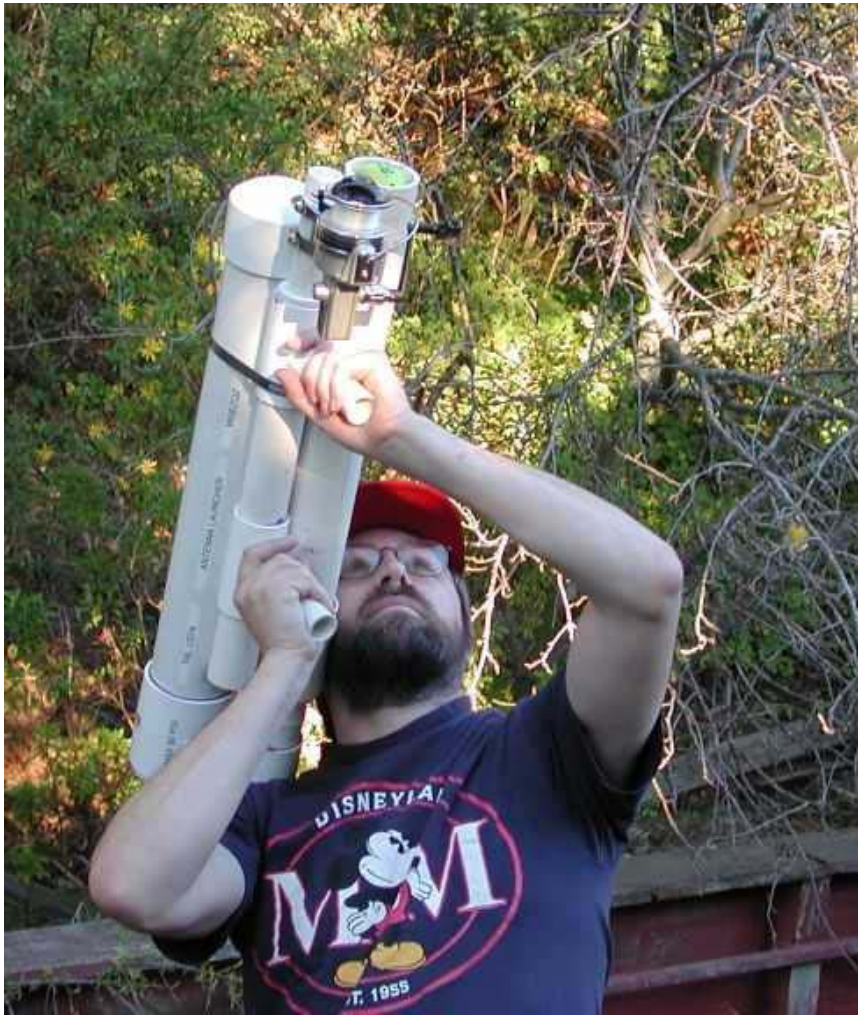
- Build One
  - Many plans on the web (see handout)
  - Size, Performance, Difficulty, Tools, Cost
  - Kits – excellent group project
- Commercially Built
  - Joel at www.spudtech.com

Commercial Launcher

www.spudtech.com TB500LP



Launch Videos



Legal Issues

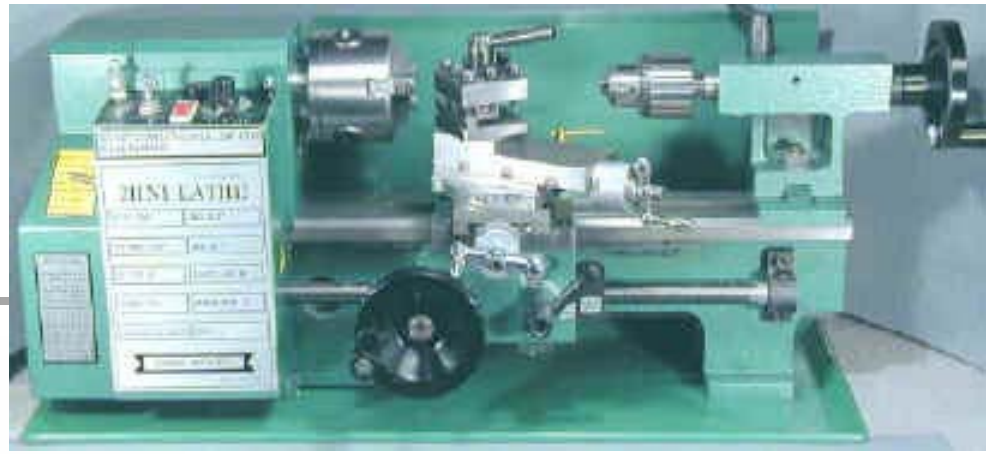
- Pneumatics are NOT firearms (BATF)
  - And are generally not regulated
- Archery and Slingshots
  - Are generally not legal to use inside city limits
- Check your local regulations

- Use care and common sense

Working with PVC

- Wood or metalworking tools work on PVC
  - Sharp cutters, Carbide is best, avoid melting
- Hacksaw, File, Sandpaper, Drill, Tap
- PVC Purple Primer & Cement, Epoxy
- Drill Press, Power Saw, Belt/disc Sander
- Advanced tools - Mini-Lathe/Mill
  - Useful for many Ham radio projects

Mini-Lathe
Mini-Mill



Mini-Lathe.com

Grizzly.com

HarborFreight.com

Making a PVC Joint

- Preparing
  - Use new materials; Clean & dry
- Priming
  - Use purple primer!
- Cementing
  - Assembly (quarter turn, seat and hold 1 min)
- Drying time 24 hours before pressure!

Pressure Testing & Safety

- Fill chamber with water, then pressurize
  - Or wrap with heavy blankets and test
- Test to 125% of operating pressure
- Re-test periodically (perhaps annually)
- Destroy any PVC launcher that has flaws
  - Cracks, etc
- Avoid dropping PVC or leaving in the sun
- Do not operate PVC launcher in low or high temperatures

Additional Information Sources

- www.qsl.net/wb6zqz/antlaunching.html
- www.qsl.net/wd6cmu
- www.spudtech.com
- www.rvpowershot.com
- www.palmer-pursuit.com
- www.mini-lathe.com
- www.grizzly.com
- www.harborfreight.com
- www1.iwvisp.com/thehalls/ggdt/main.html

CSV19 Mini-Kit

- The CSV19 Mini Kit contains the “hard” parts that are machined & fitted:
  - Pressure Chamber End Cap (4”) w/ lathe bored hole & matching 1” pipe
  - Barrel End Cap (2.5”) w/ lathe bored hole & fitted 1.25” elbow
  - 1.25” to 1” bushing, shortened
  - 1” Rainbird flat-top valve modified for pneumatic operation
  - The remainder of the parts can be purchased at a local hardware store
- Kits available from WB6ZQZ at qsl.net

Any Questions?