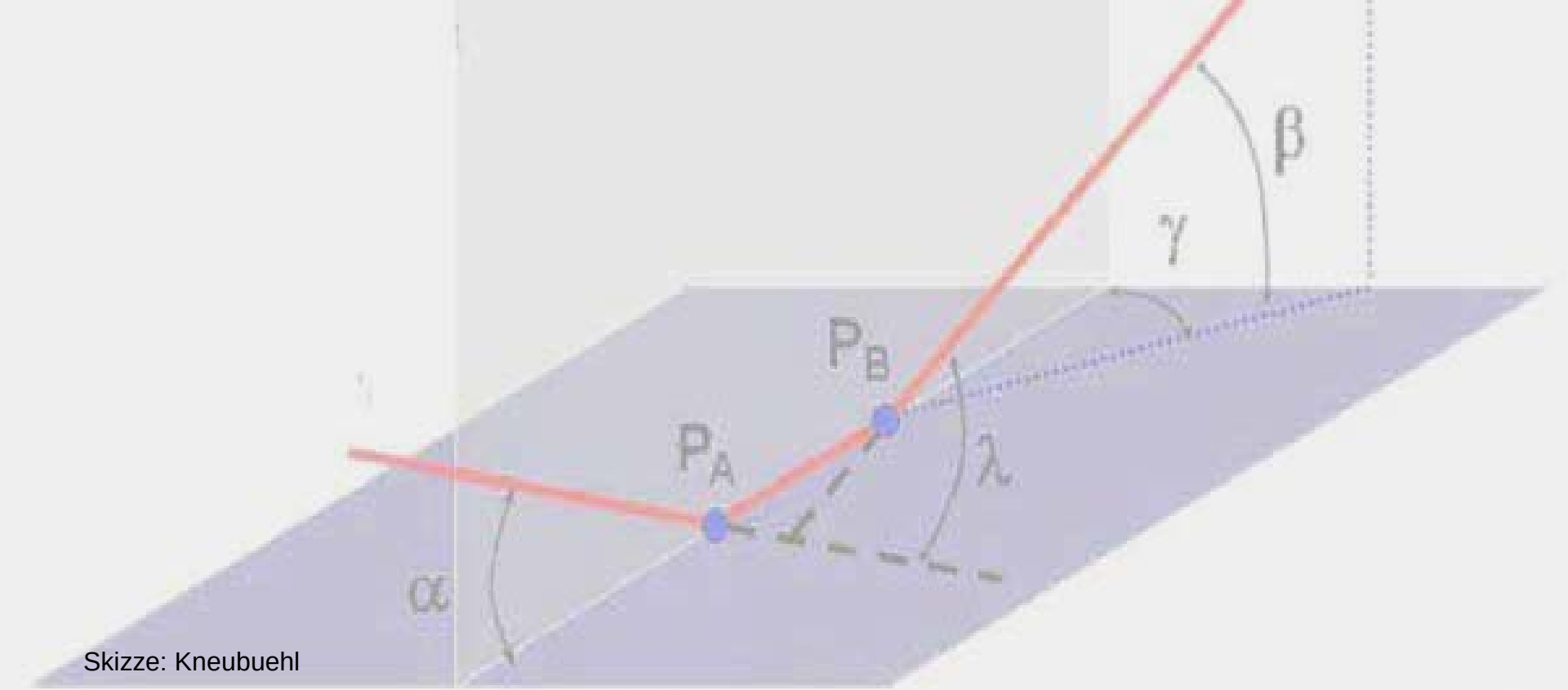


Skizze: Kneubuehl

Hunting Safety

„Rebound Behaviour of Hunting Ammunition“

(Rifle Bullets-Slugs-Shot Ammunition)

Dipl.Ing.(FH) Helmut Kinsky

Hunting accidents with lead-free solid-bullets indicate that these bullets show larger deviations than lead-containing bullets when they get in touch with obstacles.

Research Project carried out by DEVA e. V. (German Test and Research Institute for Hunting and Sporting Firearms) on behalf of BMEL (German Ministry for Agriculture):

Ascertainment of the rebound behaviour of hunting rifle bullets in different calibres and bullet constructions using lead-free and lead-containing bullets in comparison shot at different distances and media.

Ascertainment of the risk area which arises from the rebounded residual bodies of the bullets in comparison.

The evaluation of the comprehensive data material was carried out by Dr. Dr.hc. Beat Kneubuehl, Head of the Department Centre for Forensic Physics/Ballistics, Forensic Institute of the University of Bern.

Results:

There are no significant differences between the lead-free and lead-containing bullets concerning the deviation on vertical and horizontal direction.

The side angles (horizontal deviations) are on average small (< 2 degrees).

After rebounding, lead-free bullets have a significantly higher mass (on average + 36 %) and a significantly higher energy (on average + 28 %) than lead-containing bullets.

After rebounding, lead-free bullets fly significantly further than lead-containing bullets (on average 747 m lead-free, on average 516 m lead-containing).

The mass of the bullet residues after rebounding depends on the construction.

Cone Point Bullet
(lead-containg)

Barnes TSX-Bullet
(lead-free)

Large calibre lead core bullets (e. g. 9,3x74R) with thick bullet jackets hardly show any mass losses and therefore they produce larger risk areas.

In 8 out of 15 possible assessment constellations, these bullets have the wider ranges in comparison with the **lead-free** solid bullets.

In 12 out of 14 possible assessment constallations (Cal. .243 Win.), the lead-free bullets showed larger distances after rebounding.

In Cal .308 Win. they were 10 out of 17.

„Bonded“– bullets remain largely stable in mass when hitting an obstacle, therefore they behave like lead-free solid bullets (area of risk!)

The project council and the contracting authority of the research project (BLE, Federal Agency for Agriculture and Food) decided that the tests should be stopped when the bullet mass falls below 50 % of the initial mass.

Explanation: A very large number of further tests would have been the consequence, with the disadvantage that the completion date of the study would not have been met.

The consequence is that the residual bodies (< 50 %) of large-calibre bullets have not been registered. Their ranges after rebounding may, however, be larger than the ranges of smaller calibres, e. g. .243 Win., even if they keep their original mass.

Therefore, questions remain open.

Conclusion:

According to the contractual research specifications, the rebound behaviour of lead-free and lead-containing hunting rifle bullets should have been **compared**.

In this context, the aspects of hunting safety have not been sufficiently described.

Hunters must be provided with e. g. more concrete information on safety angles which need be oberved towards their hunting neighbours during driven hunts, and these informations must also be incorporated in the accident prevention regulations (UVV). The reference in the UVV „It must not be shot into a direction where somebody is threatened“, does not really help hunters any further.

Deviation Behaviour of Slugs

Examined slugs:

Lead-containing:
Brenneke classic
Winchester Super X slug
Rottweil Exact

Lead-free:
Balle blondeau
Brenneke Super Sabot (spin-stabilized)
Federal Barnes Expander Sabot (spin-stabilized)
Sauvestre Balle Fleche sans plomb

Calibre: 12/70
Shooting distance: 35 m

Target media:
bushes – tree trunk – hard soil – soft soil
stone slab

Results Slugs

The maximum deviation angles of lead-free slugs, which are produced by rebounding, show *on average* significant differences; in the maximum values, they differ only *coincidentally* from the deviation angles of lead-containing slugs.

The side angles are in all examined materials (except the tree trunk) on average small (< 10 degrees). Hitting the tree tunk, lead-containg slugs may be deviated up to 30 degrees, lead-free slugs up to approx. 15 degrees.

Rebounded slugs of a lead-free construction have a *significantly higher mass*. Concerning their *energy conservation characteristics they, however, differ only coincidentally from lead-containg slugs.*
We should therefore expect the same areas of risk for lead-containing and lead-free slugs.

Results Shot Ammunition

Examined shot ammunition:

Lead-containing:
RWS „Waidmansheil“

Lead-free:
RWS Steel Game RUAG Ammotec GmbH)
Hubertus Spezial (zinc, Lapua Schönebeck)
VIP (bismuth, Eley)
RWS Ultimate (tungsten, Ruag Ammotec GmbH)

Calibre: 12/70, shot amunition size 3,0 mm
Shooting distance: 25 m

Target media:
identical with the media for slugs

Results Shot Ammunition

Vertical angles:

If we – for every target media case - average the maximum vertical angles and take their difference to the angles of lead-containing shot, we find, in total, a larger vertical angle for lead-free shot pellets of 1.23 degrees on average.

If we consider the maximum vertical angle, this maximum is on average 5.15 degrees larger for lead-free shot pellets than for leadshot.

Results Shot Ammunition

Side angles:

On the basis of this investigation, average values as well as maximum values of the maximum side angles for lead-free shot pellets and leadshot differ significantly.
The average values of leadshot are larger than the values for lead-free shot pellets; considering the maximum values, it is just the other way round.

Results Shot Ammunition

Percental Residual Mass:

Both kinds of shot ammunitions are only coincidentally different when we consider their average mass conservation.

Considering the maximum values of the relative mass conservation, all types of lead-free shot ammunition show higher values. Statistically, there is also a significant difference.

Percental Energy Conservation:

The average values of the relative energy after rebounding only differ coincidentally.

When considering the maximum values of the relative energy conservation, there is a significant difference between lead-containg leadshot and lead-free shot ammunitions.

Results Shot Ammunition

	Pb	Fe	Zn	Bi	W
min	116	74	51	119	146
max	152	111	78	124	165

Risk Distances for shot ammunitions for all angles of impact onto target media in [m] (average values)

Results Shot Ammunition

The evaluation of the test results was made by Dr.sc.forens. Dr.med.h.c. Beat Kneubuehl, Forensic Institute of the University of Bern.

Compatibility of Firearm and Ammunition

Dipl.Ing.(FH) Helmut Kinsky

„System Compatibility“

„System compatibility“ are all effects onto a firearm‘s systen (e. g. hunting rifles) which occur while permanently shooting, without meanwhile cleaning, from barrels with groove/field or polygon profile.

These are barrel abrasions and/or barrel deposits, which can involve uncontrollable gas pressure variations, an increased strain on the lock and a widening of the grouping.

What are the effects when shooting lead-free solid bullets?

Bullet Residues in the Barrel

„Tombak“–Jacketed Bullets (copper alloys) cause depositions of the jacket material in the barrel („Barrel Fouling“).

Depending on the condition of the barrel hole, there are even stronger depositions when using lead-free solid bullets.

The depositions may have considerable negative effects on the bullet grouping and the impact position.

The narrowing decreases the barrel diameter which leads to an increase of the gas pressure up to an exceeding of the maximum permitted gas pressure. (endangering the safety!)

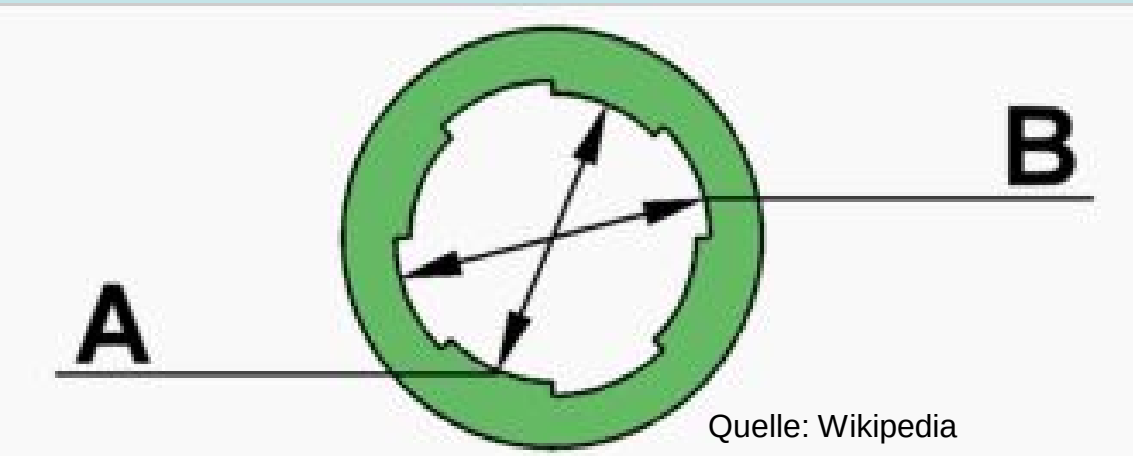
This also means an additional strain for the firearm‘s lock.

Muzzle of a Bolt Action Rifle

Bullet residues (copper) - no rust

Impact position and bullet grouping have considerably changed

Rifle barrel (cross section)

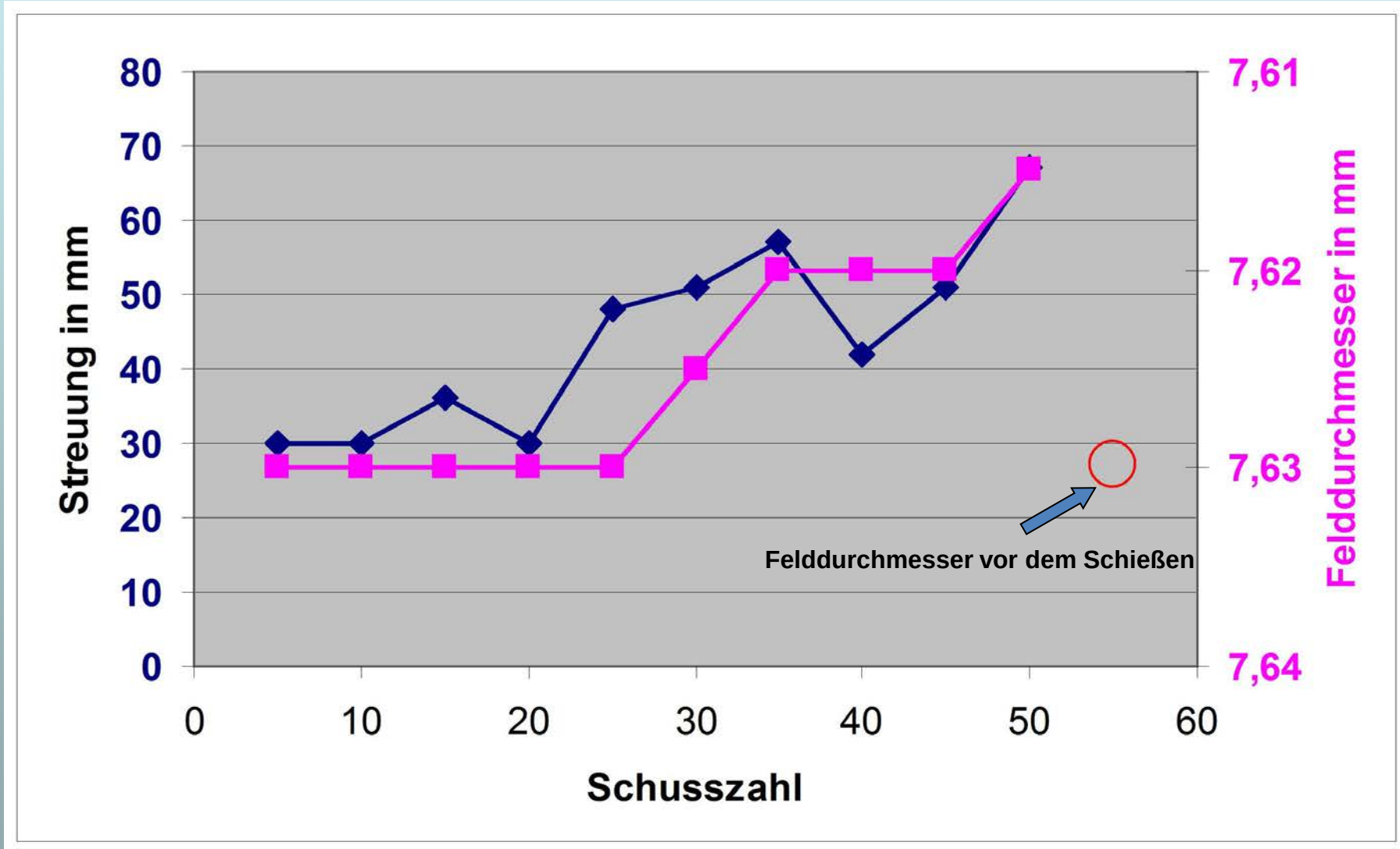


Quelle: Wikipedia

A = field diameter

B = groove diameter

Bullet grouping and field diameter of the barrel depending on the number of rounds (no cleaning of the barrel).



Bullet Grouping and Twist Rate

The twist rates for an optimal stabilization of lead-containing jacketed bullets are the results of calculations and decades of experience.

They depend on calibre and bullet mass.

For lead-free bullets, firearms should have different twist rates because the bullet masses, referring to a certain calibre, have a lower mass, as a consequence of lower material densities.

Experience shows that in many cases, lead-free bullets do not have the same shooting precision as lead-containing bullets usually have (animal protection!).

Now, the hunter has to try and find a bullet which performs the required precision from his firearm.

Service Life of Barrel and Lock System

There are no **sufficient** findings to which extent lead-free bullets negatively affect the service life of barrels and firearms systems by increased barrel wear, more barrel depositions and heavier strain on locks.

Regarding this topic, there is still a great need of examination.

Consequence:

In order to avoid bullet depositions with the shown disadvantages, it is necessary to clean the barrel regularly. The best would be to treat the barrel with an ammonia containing solution after a couple of rounds in order to remove the copper residues.

Strain onto the Slugs by Lead-free Shot Ammunition

In many European countries, the use of lead-containing leadshot is prohibited on and over waters.
Hunters have to use lead-free shot ammunition, which, due to its hardness, may cause a safety risk for hunters and firearms if no suitable precautions are taken.

This is particularly true for soft iron and tungsten shot ammunitions whose hardness is higher than 40 HV1.

For safety reasons, C.I.P. has defined regulations for the production of shot ammunition and the ballistic projectile testing.

Strain onto the Slugs by Lead-free Shot Ammunition

Specifications by the ammunition manufacturers:

For example: Lead-free shot pellets of a hardness of > 40 HV in cal. 12/70 must not exceed a diameter of 3.25 mm if they are loaded in „normal“ cartridges (gas pressure 740 bar).

In cartridges of „increased“ load (e. g. cal 12/76, gas pressure 1,050 bar), shot pellets must not exceed a diameter of 4.00 mm, irrespetive of the narrowing of the choke.

Shot pellets‘ diameters > 4.00 mm must have a choke ≤ 0.5 mm.

Firearms with an increased load must undergo additional „steelshot testings“.