Sprint Mechanics

A QUICK START GUIDE TO INCREASING PERFORMANCE

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RUNNING MECHANICS

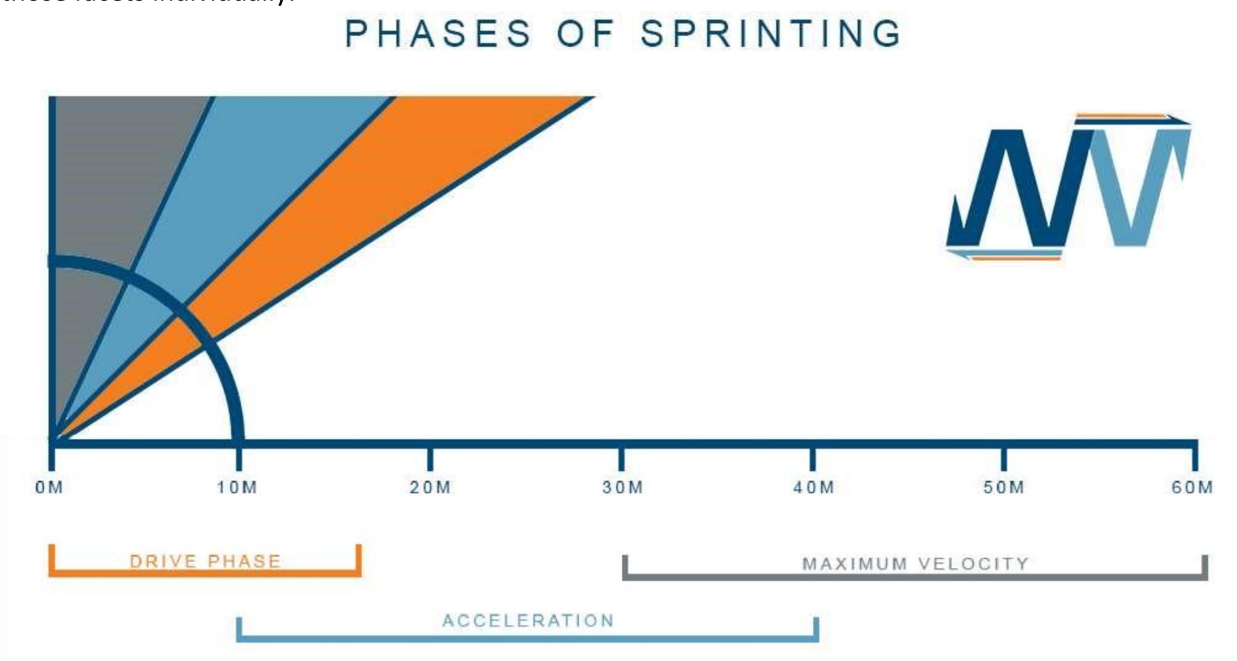
PHASES OF SPRINTING

Understanding the biomechanical properties behind running gives a better understanding to the purpose of specific drills, and how we can get the most from each phase of movement. Speed is universal in sport and as such all athletes should understand the components of running mechanics.

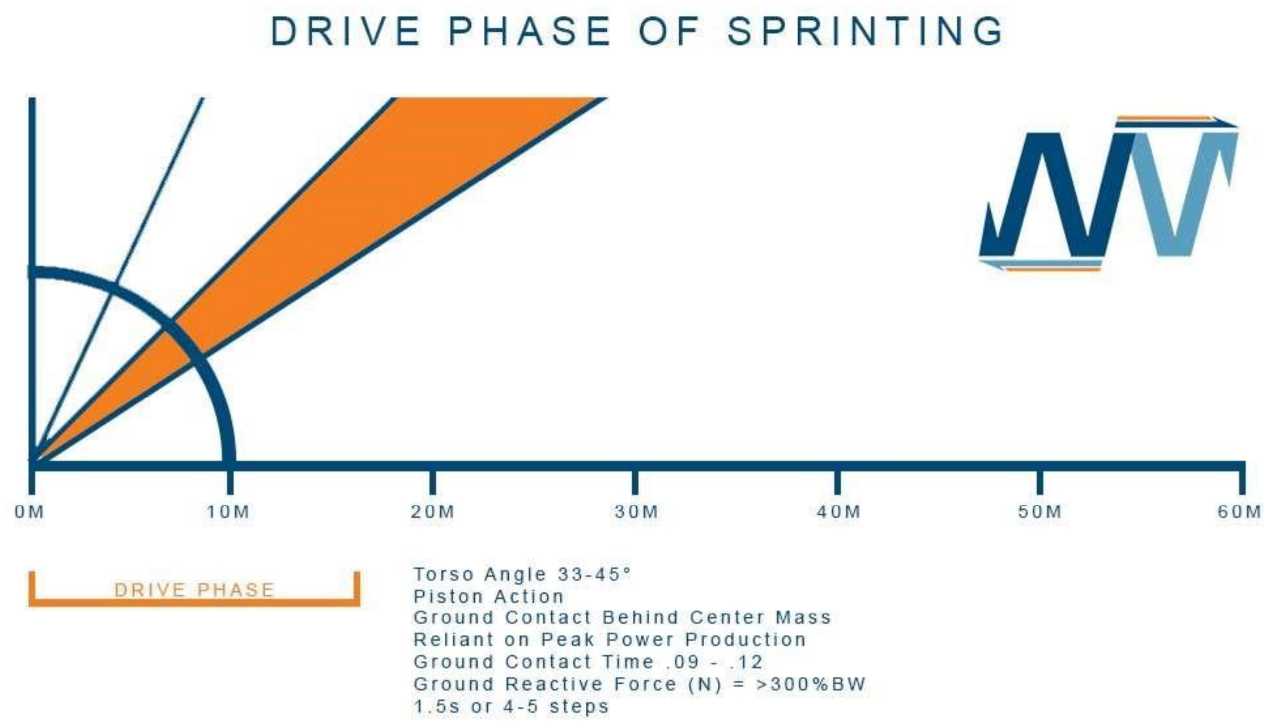
The following outlines the fundamentals of sprinting and stride development, as well as creates a structure to teach from and evaluate new techniques by before integration into the program design.

Sprinting can be broken into 4 distinct phases; Drive Phase, Acceleration, Maximum Velocity and Deceleration. We will cover the first three phases in depth, and touch on the final phase in a discussion of braking forces, and their role in sprinting.

In the advanced concepts of sprinting, there are several ways that we can identify an athlete's strengths, weaknesses, and limitations. Our goal in sprint development is to specifically identify possible deficits and implement exercises and training routines that directly affect stride length, frequency and address those facets individually.



DRIVE PHASE - THE EXPLOSIVE START



There are 3 basic starting positions in sport; The 4 point or block start, the 3-point start, and the rolling or 2-point start. For less advanced athletes the Drive Phase will consist of the first 1.5 seconds of a sprint or for elite athletes the first 4-5 steps. Regardless the type of start, they should all consist of the same fundamental principles. The Drive Phase models as follows:

Torso Angle of 33-45° - Measured in relation to the ground from the tip of the shoulder to the heel in the triple extension phase of the stride.

Piston Action - Knee height and shin angle will be mobility dependent, but the stride action and heel recovery should operate with a piston like effect with the knee ideally rising above the tip of the hip, the heel tucked to the hamstring, and the ankle dorsi flexed.

Ground Contact Behind Center Mass - As the athlete accelerates the ground contact position will move slightly forward. In the drive phase it is ideal for the athlete to contact the ground as far behind their center of mass as possible. This gives them the greatest opportunity to create a positive torso/shin angle.

Ground Contact Time of .09-.12s - Peak power production is reliant on the force component in the drive phase, this results in higher ground contact times. Reducing the ground contact times in this phase below .09s reduces the force profile to a diminishing return. The amount of force actively applied to the ground while running by elite level athletes is generally 300% bodyweight due to a number of factors ranging from the weight of gravity to the travel time of a human synapse. However, due to the role of velocity in Ground Reaction Force, as we accelerate athletes may produce more than 500% of their bodyweight in force newtons while sprinting at maximum velocity despite only applying a force of <150% bodyweight.

MOVEMENTS TO DEVELOP DRIVE PHASE

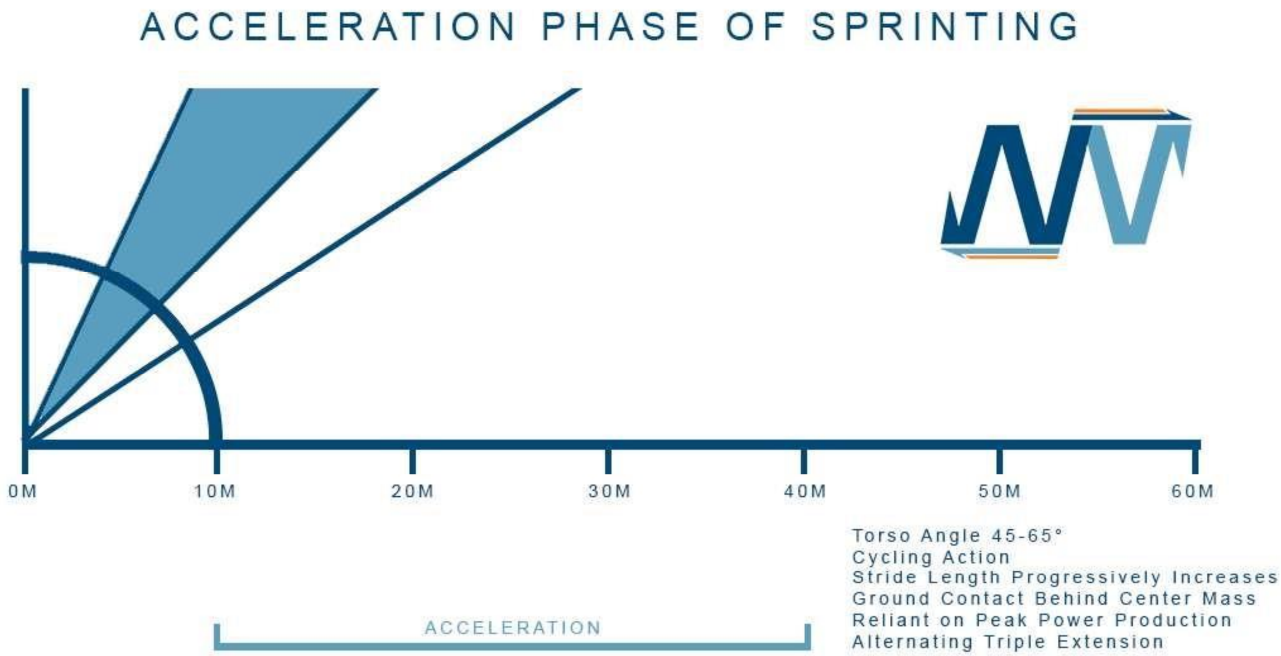
- Hex Bar Deadlifts
- Sled Pushes
- Med Ball Scoop Tosses / Athletic Cleans

RUNNING TECHNIQUES TO DEVELOP DRIVE PHASE

- Block Starts
- Wall Strides
- Banded First Step

NOTES:

ACCELERATION - BREAK-AWAY SPEED



Acceleration is the most utilized phase of sprinting in sport. In nearly all sports an athlete is executing an activity less than 40M. There are of course exceptions, but field and court sports live and die in acceleration. Acceleration models as follows:

Torso Angle of 45-65° - Measured in relation to the ground from the tip of the shoulder to the heel in the triple extension phase of the stride.

Piston/Cycling Action Transition - As the stride lengthens and the athlete comes upright, there is a controlled transition from the sharper tighter piston action to a cycling action in the recovery of the heel.

Ground Contact Behind Center Mass - As the athlete accelerates the ground contact position will move slightly forward. In the Acceleration Phase it is critical that the athlete recovers the stride in a position to the rear of the hip. Once the ground contact moves directly under the athlete, they are no longer able to accelerate. The goal is to allow them the greatest opportunity to accelerate as long as possible before they stabilize at maximum velocity.

Peak Power Dependent - The Acceleration Phase is still peak power dependent. By keeping this in mind, through simple evaluations we can identify that athletes that are not producing large amounts of peak for in a stationary position, are very likely not producing large amounts of peak power in triple extension.

MOVEMENTS TO DEVELOP ACCELERATION PHASE

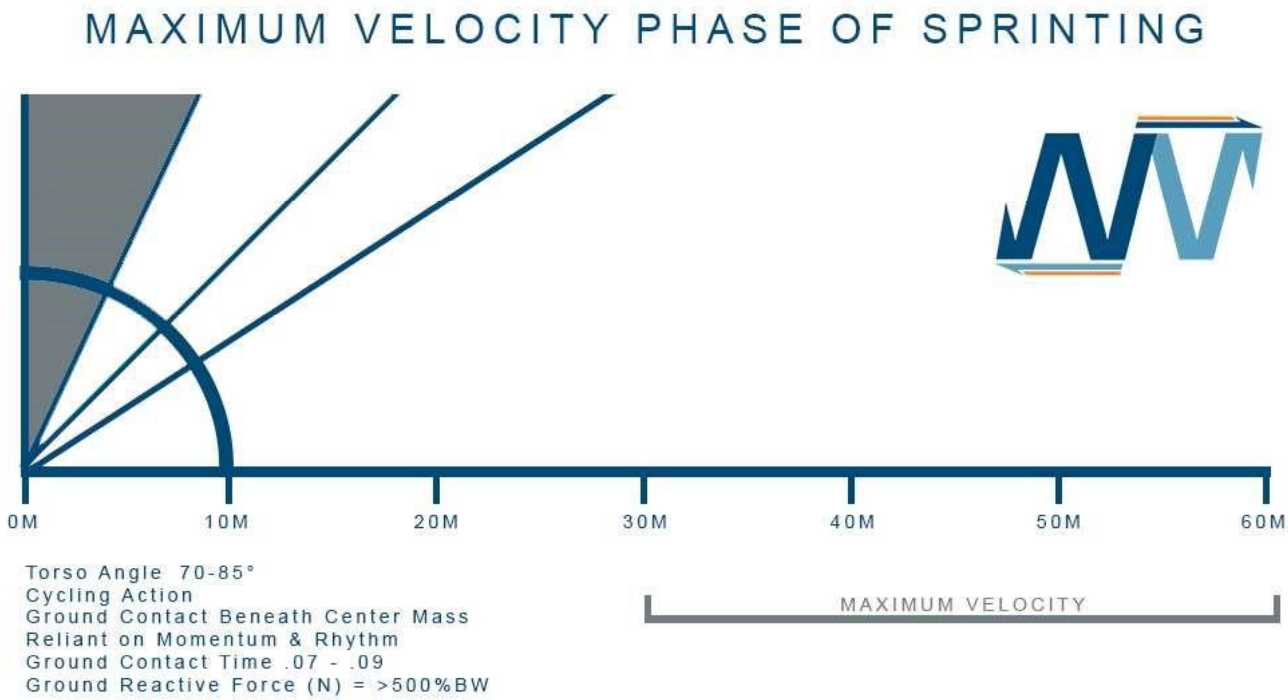
- Hex Bar Deadlifts
- Split Landmine Presses
- Keiser Air Runner

RUNNING TECHNIQUES TO DEVELOP ACCELERATION PHASE

- Hill Sprints
- Resisted March / Resisted Sprints
- Bounding

NOTES:

MAXIMUM VELOCITY PHASE - CLOSING SPEED



The Maximum Velocity Phase or interchangeably referred to as Absolute Speed Phase of sprinting is the least utilized and most dependent upon stride consistency and technique. In ideal circumstances maximum velocity is sustainable for up to 30M but can be as short as a single stride. Maximum Velocity models as follows:

Torso Angle of 70-85° - Measured in relation to the ground from the tip of the shoulder to the heel in the triple extension phase of the stride.

Cycling Action - The cycling action of maximum velocity has a much lower knee height and is driven by the momentum gained in the Drive and Acceleration Phases. This is sustained by creating a consistent rhythm to sustain the maximum benefits of momentum.

Ground Contact Beneath Center Mass - At Maximum Velocity the ground contact position is most efficient directly under the center of mass as opposed to the drive phase where it is ideal for the athlete to contact the ground as far behind their center of mass as possible. This gives them the greatest opportunity to create a positive torso/shin angle.

Ground Contact Time of .07-.09 - The term “maximum velocity” is best illustrated when we look at Ground Reaction Force equations in this phase. The reduced Ground Contact Time and change in the Resultant Force Angle restricts the athlete’s ability to project force to the ground, leaving the resulting forward movement heavily reliant on the velocity component of Ground Reaction Force. Various controlled studies reflect a 50% reduction in the force transferred to the ground from the Drive Phase to the Maximum Velocity Phase. Despite this, the added velocity results in a Ground Reactive Force more than 1.5x higher, displaying the high reliance of reactive strength in this phase of sprinting.

MOVEMENTS TO DEVELOP MAXIMUM VELOCITY PHASE

- Pogo Jumps
- Single Leg Squats
- Rack Pulls

RUNNING TECHNIQUES TO DEVELOP MAXIMUM VELOCITY

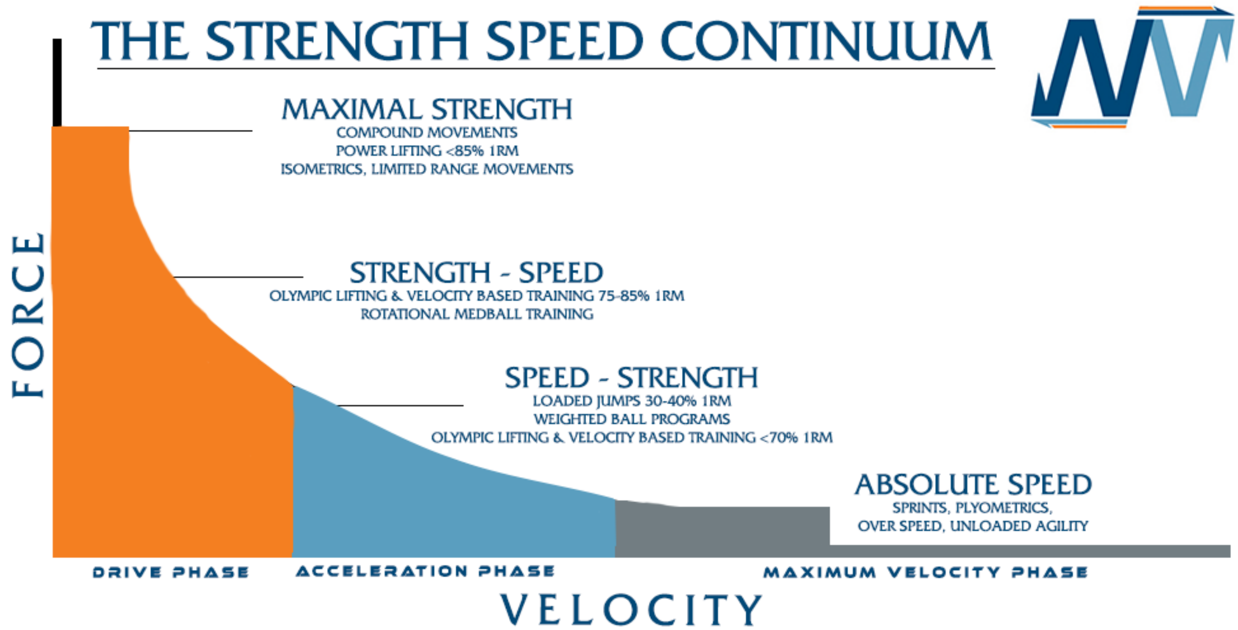
- Pony Drill
- A-Skips
- Overspeed

NOTES:

ADVANCED SPRINTING CONCEPTS

STRENGTH SPEED CONTINUUM FOR SPRINT DEVELOPMENT

To optimize training, integrating movements that consider the Strength Speed Continuum and reflect athlete needs is essential. A complete training program should keep athletes active through the entirety of the Strength Speed Continuum, but at the highest levels or sport, focus specifically on deficiencies. Each aspect of the Strength Speed Continuum offers specific benefit, the following graphic can be used as a roadmap to program modification as required to maintain athletic and neuromuscular development.



OPTIMIZING SPRINT MECHANICS

ARM SWING

The arm works as a cantilever, balancing the body when you are in double float (when both feet are off the ground). The purpose of the rear arm is to counter the rotation of the knee drive, while the forward swing is providing a small amount of lift and governing the tempo. Arm swing can be inhibited by several factors, but most commonly poor shoulder mobility, causing efficiency issues in equilateral stride length, imbalance in counter rotation, and foot strike position. Identifying shoulder mobility, or the lack of, can be the simplest correction to make for athletes.

Most commonly the hands will be clenched into a fist, or the hand will be balled in some fashion. Experience notes that pressure at the hands will often lead to tension in the shoulder, limiting the shoulder and arms ability to move freely around the torso. It is common to see a mild ulnar rotation in the backswing, in ideal circumstances this is a component that we should seek to eliminate.

Arm swing will vary from athlete to athlete but should be fluid and comfortable delivering optimal biomechanics and transfer of force.

STRIDE LENGTH AT MAX VELOCITY

Trochanter length is a necessary factor to be aware of to assess an athlete's stride length as it specifically relates to the individual athlete. Without knowing the trochanter length, and its specific values as it pertains to sprinting ability, it is impossible to effectively troubleshoot advanced athletes. Measured in centimeters from the top of the greater trochanter to the ground in bare feet. Once we have this information, we can calculate optimal stride length with the values below:

MAX V Females: 2.35 x Troch Length

MAX V Males: 2.43 x Troch Length

ESTABLISHING STRIDE FREQUENCY

The standard protocol for testing stride length and stride frequency is with a 30 meter run-in, to 30 meters flying at top speed. Ideally the 30m should be broken up into 3 - 10m segments, each individually timed.

Using the fastest 10m segment calculate the Stride Frequency by counting the number of strides (from toe off on one leg to touchdown of the opposite leg) for 5 strides or through the entirety of the 10m segment.

To establish Stride Length the calculation is as follows:

Max V/SF = SL

We can compare these to our normative data on Stride Length (as per studies by Levtshenko, Tabatshnik, et. al) to establish stride efficiency.

TARGET STRIDE LENGTH AND STRIDE FREQUENCY VALUES
FOR OBTAINING DESIRED MAXIMUM VELOCITIES

Velocity in Meters Per Second \ Stride Frequency in Strides Per Second	5.25	5.20	5.10	5.00	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00
12.00	2.28	2.30	2.35	2.40	2.45	2.50	2.55	2.60	2.66	2.72	2.79	2.85		
11.75	2.24	2.25	2.30	2.35	2.39	2.45	2.50	2.55	2.61	2.67	2.73	2.79	2.86	
11.50	2.19	2.21	2.25	2.30	2.34	2.40	2.44	2.50	2.55	2.61	2.67	2.74	2.80	2.87
11.25	2.14	2.16	2.20	2.25	2.29	2.34	2.39	2.44	2.50	2.55	2.62	2.68	2.74	2.81
11.00	2.09	2.11	2.15	2.20	2.24	2.29	2.34	2.39	2.44	2.50	2.56	2.62	2.68	2.75
10.75	2.05	2.06	2.10	2.15	2.19	2.24	2.28	2.33	2.38	2.44	2.50	2.56	2.62	2.69
10.50	2.00	2.01	2.05	2.10	2.14	2.19	2.23	2.28	2.33	2.38	2.44	2.50	2.56	2.63
10.25	1.95	1.97	2.00	2.05	2.09	2.14	2.18	2.22	2.27	2.32	2.38	2.44	2.50	2.56
10.00	1.90	1.92	1.96	2.00	2.04	2.08	2.12	2.17	2.22	2.27	2.33	2.38	2.44	2.50
9.75	1.86	1.87	1.91	1.95	1.98	2.03	2.07	2.11	2.16	2.21	2.27	2.32	2.37	2.44
9.50	1.81	1.82	1.86	1.90	1.93	1.98	2.02	2.06	2.11	2.15	2.21	2.26	2.31	2.38
9.25	1.76	1.77	1.81	1.85	1.88	1.93	1.96	2.01	2.05	2.10	2.15	2.20	2.25	2.31
9.00	1.71	1.73	1.76	1.80	1.83	1.86	1.91	1.95	2.00	2.04	2.09	2.14	2.19	2.25
8.75	1.66	1.68	1.71	1.75	1.78	1.82	1.86	1.90	1.94	1.98	2.03	2.08	2.13	2.18
8.50	1.61	1.63	1.66	1.70	1.73	1.77	1.80	1.84	1.88	1.93	1.97	2.02	2.07	2.12
8.25	1.57	1.58	1.61	1.65	1.68	1.71	1.75	1.79	1.83	1.87	1.91	1.96	2.01	2.06
8.00	1.52	1.53	1.56	1.60	1.63	1.66	1.70	1.74	1.77	1.81	1.86	1.90	1.95	2.00
7.75	1.46	1.49	1.51	1.55	1.58	1.61	1.64	1.68	1.72	1.76	1.80	1.84	1.89	1.93
7.50	1.42	1.44	1.47	1.50	1.53	1.56	1.59	1.63	1.66	1.70	1.74	1.78	1.82	1.87