

THE BIOMECHANICS OF THROWING DISCUS

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Discus Throw

- Three-dimensional complex movement
- Aerodynamic effect on official distance
- Many debates about the techniques in coaching literature
- Limited biomechanical studies
- More things we don't know than things we know

USATF Discus Throw Database

- 3-D biomechanical data of over 300 trials from
 - 1990 Goodwill Games
 - 1990 Olympic Festivals
 - 2001 New Zealand Open
 - 1996 to 2006 USATF Outdoor National Championships and Olympic Team Trials

Discus Throwing Technique



Full Wind-up

Unwind



Right Foot
Takeoff

Single
Support
on the
Back



Left Foot
Takeoff

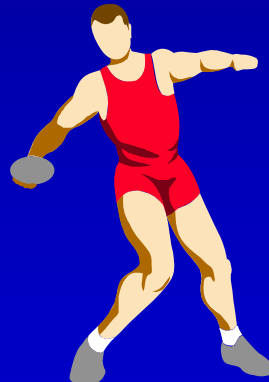
Flight



Flight

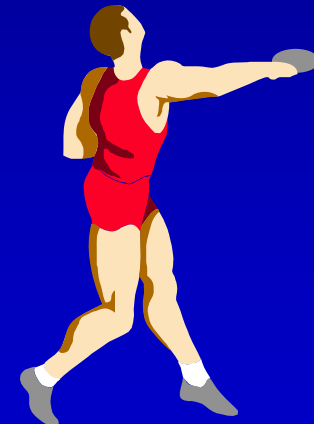
Right Foot
Touchdown

Single
Support
in the
Middle



Power
Position

Delivery

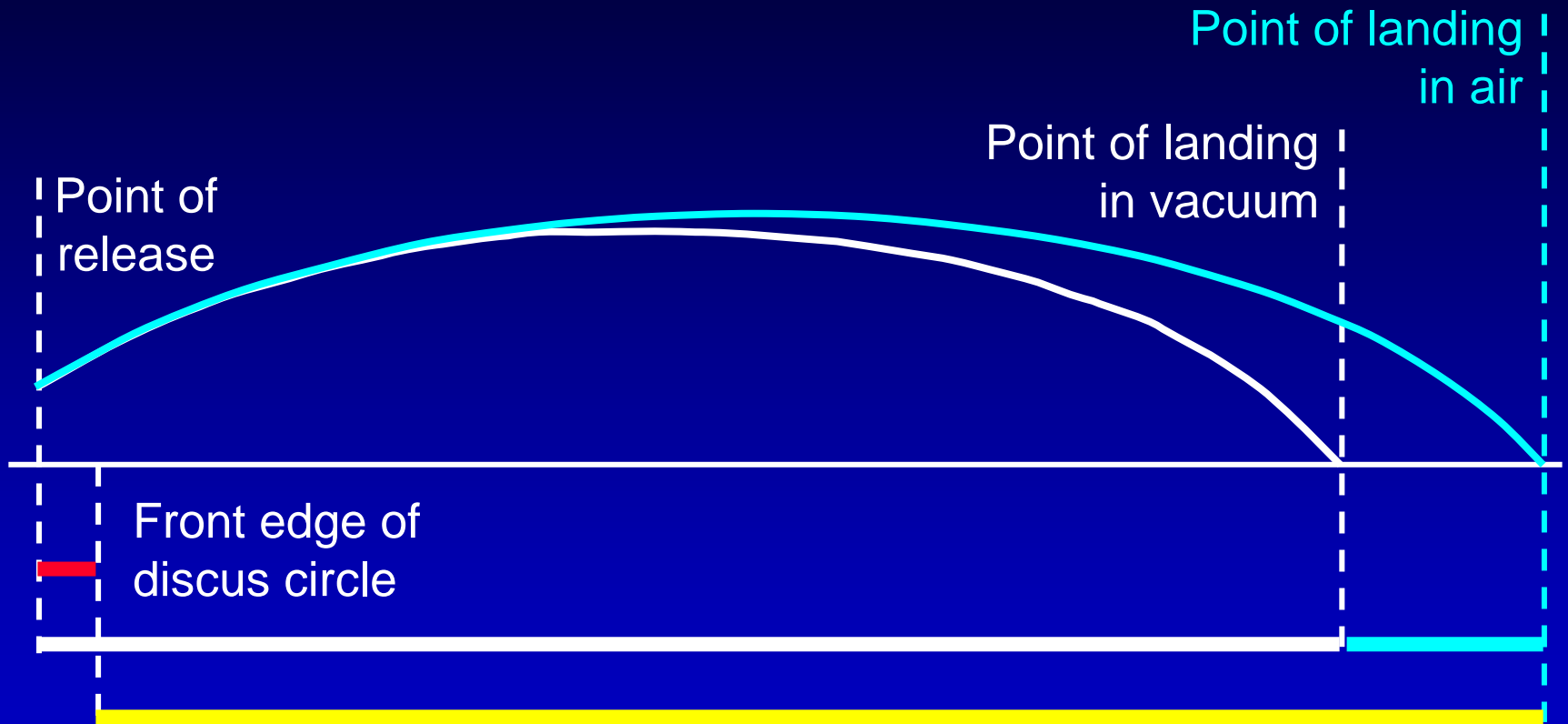


Release

Official Distance of Discus Throw

- Official distance of discus throw
 - Distance lost at the release
 - Vacuum flight distance
 - Aerodynamic distance

Partition of Official Distance



Distance lost at release

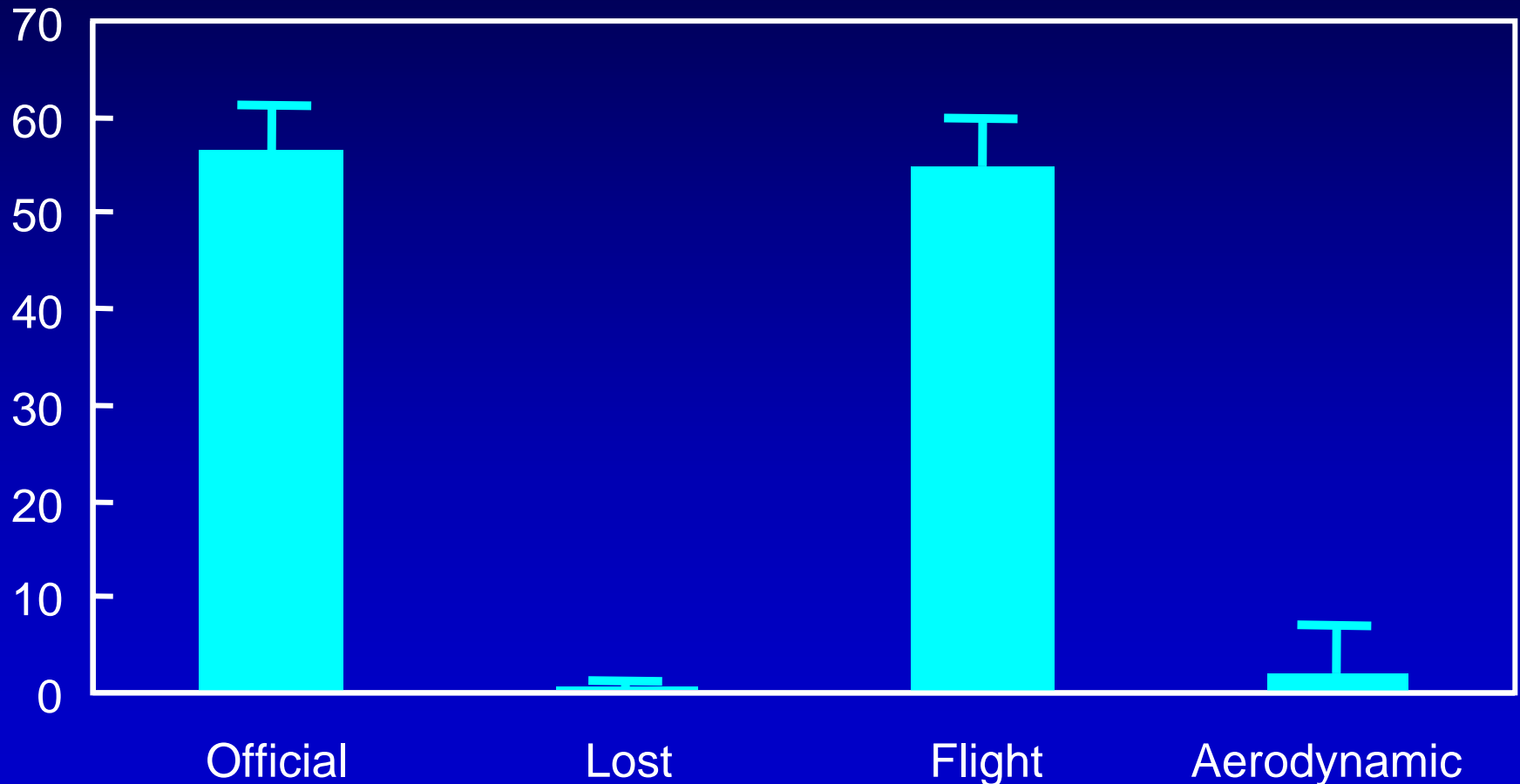
Vacuum flight distance

Aerodynamic distance

Official distance

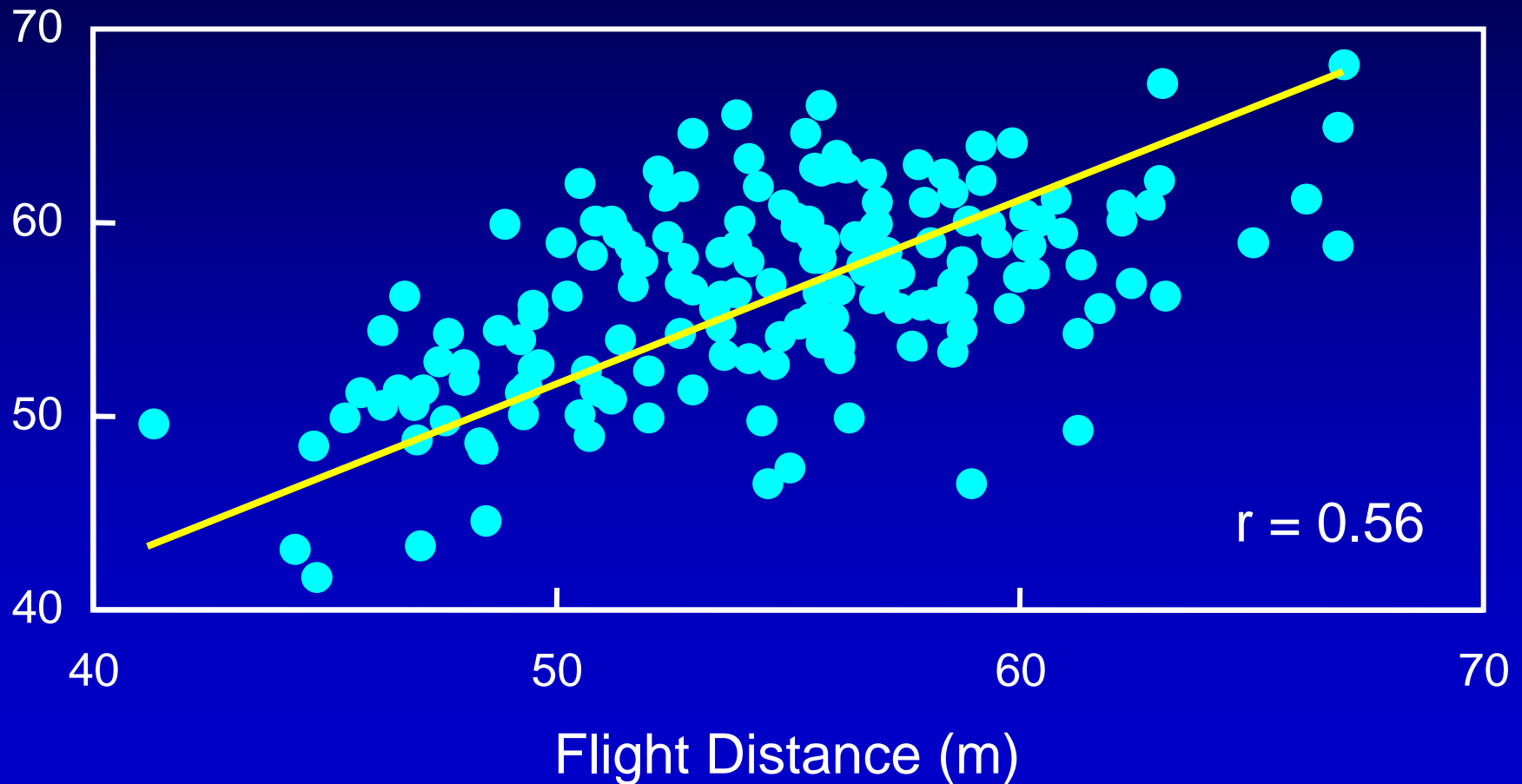
Partition of Official Distance

Partial Distance (m)



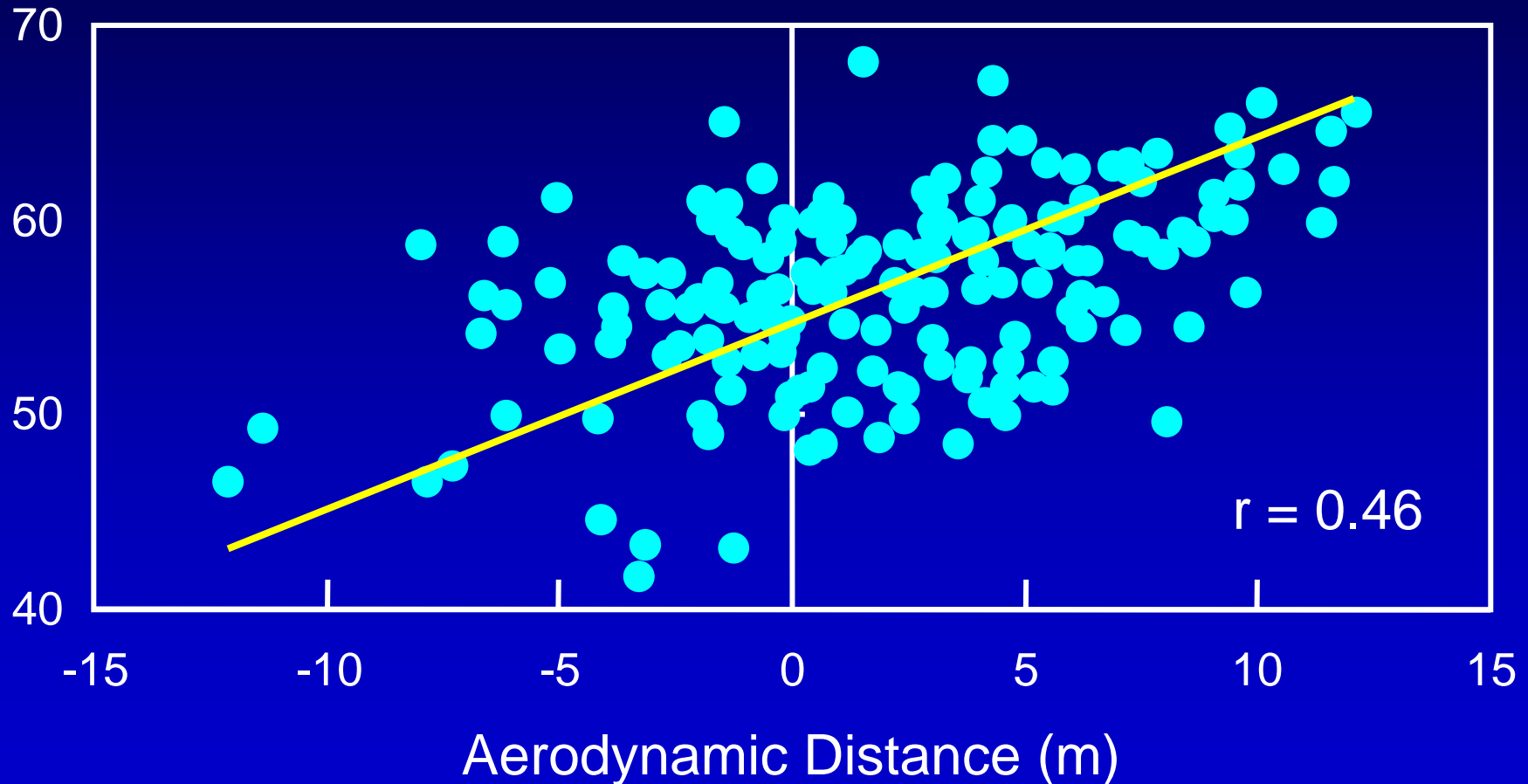
Effect of Vacuum Flight Distance

Official Distance (m)



Effect of Aerodynamic Distance

Official Distance (m)



Vacuum Flight Distance

- Major component of the official distance
- Mainly determined by release speed
- A reflection of throwing ability

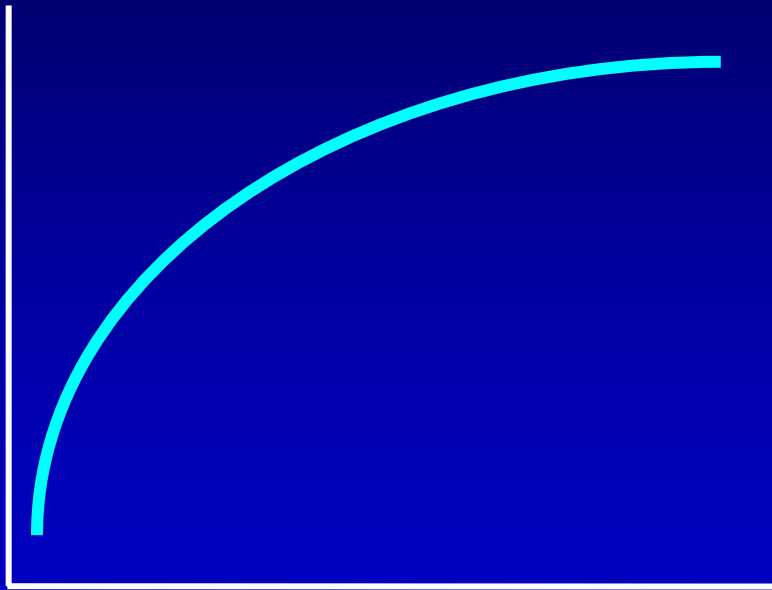
How to Maximize Release Speed

- Appropriate temporal rhythm
- Large hip-shoulder separations
- Large shoulder-arm separations
- Powerful left leg block with full hip and knee extensions
- Appropriate ground contact

Temporal Rhythm

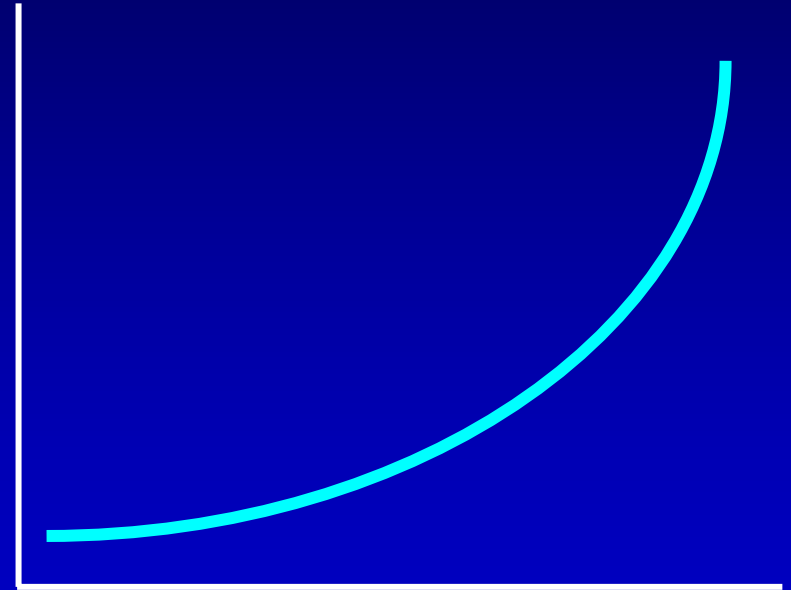
Acceleration Patterns

Speed (m/s)



Time (sec)

Speed (m/s)



Time (sec)

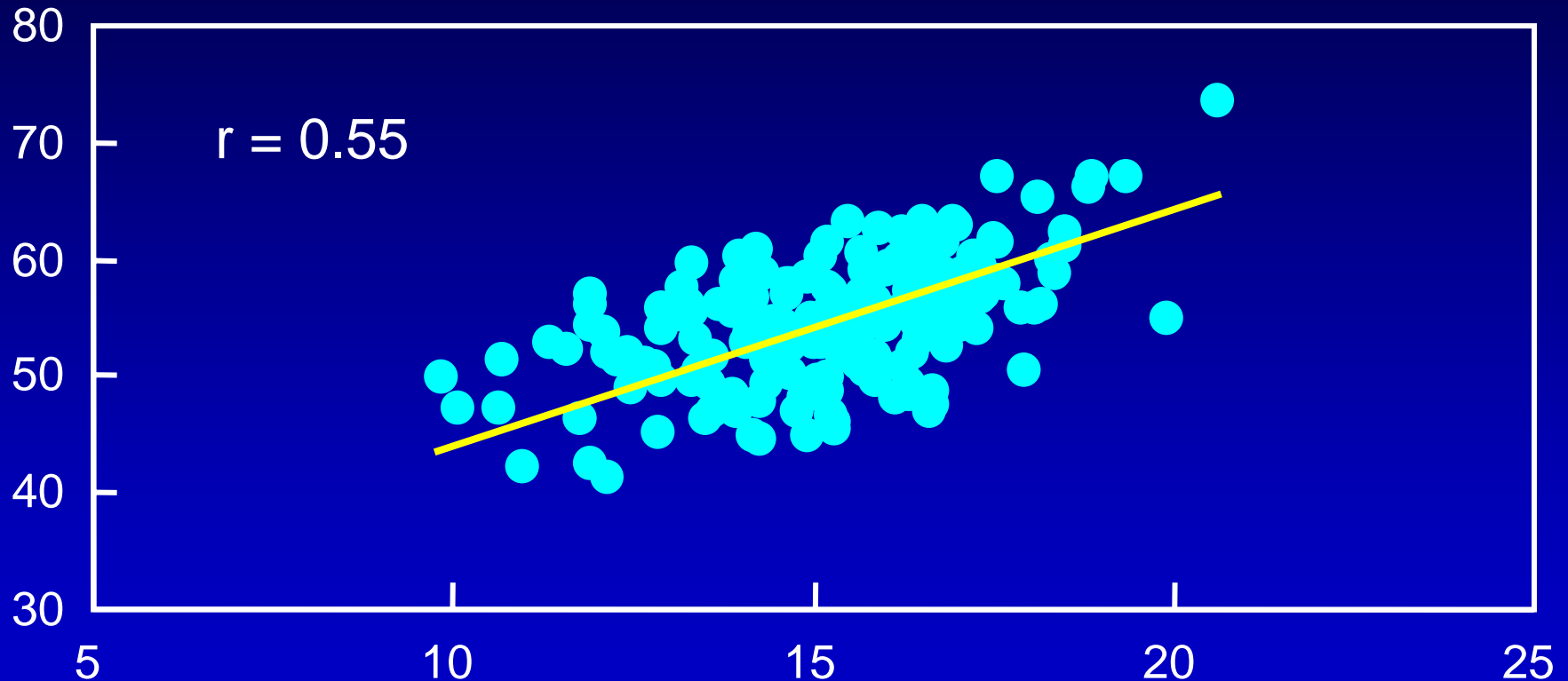
Gain in Speed during Delivery

Gain in Discus Speed (m/s)



Gain in Speed during Delivery

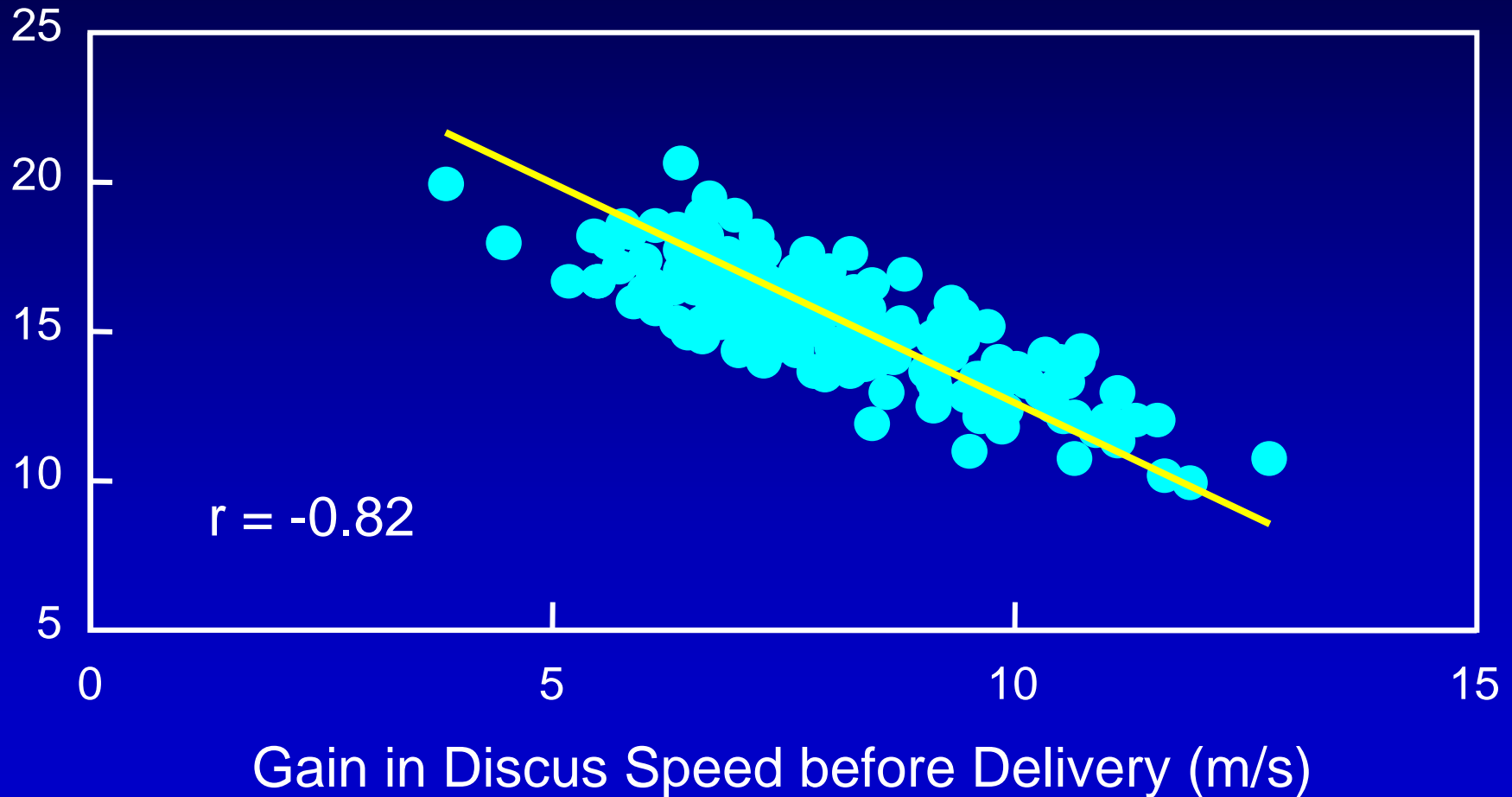
Flight Distance (m)



Gain in Discus Speed during Delivery (m/s)

Gain in Speed during Delivery

Gain in Discus Speed during Delivery (m/s)



Temporal Rhythm

- Slow Unwind
- Start acceleration from flight
- Quick left foot landing to form the power position
- Full acceleration during the delivery

Optimum Temporal Rhythm

- Unwind > 0.6 sec
- 0.45 sec $<$ Single support on the back $<$ 0.55 sec
- 0.08 sec $<$ Flight $<$ 0.12 sec
- 0.17 sec $<$ Single support in the middle $<$ 0.22 sec
- Delivery = 0.15 sec

Temporal Rhythm

- Consequences of quick unwind
 - Difficulty to control upper body movements after flight
 - Poor hip-shoulder and shoulder-arm separations after the flight
 - Difficulty to gain speed during delivery

Temporal Rhythm

- Duration of flight is not the shorter the better
- Optimum duration of flight
 - Increase hip-shoulder and shoulder-arm separations
 - Get appropriate body position to start the single support in the middle to minimize the loss in momentum before the power position

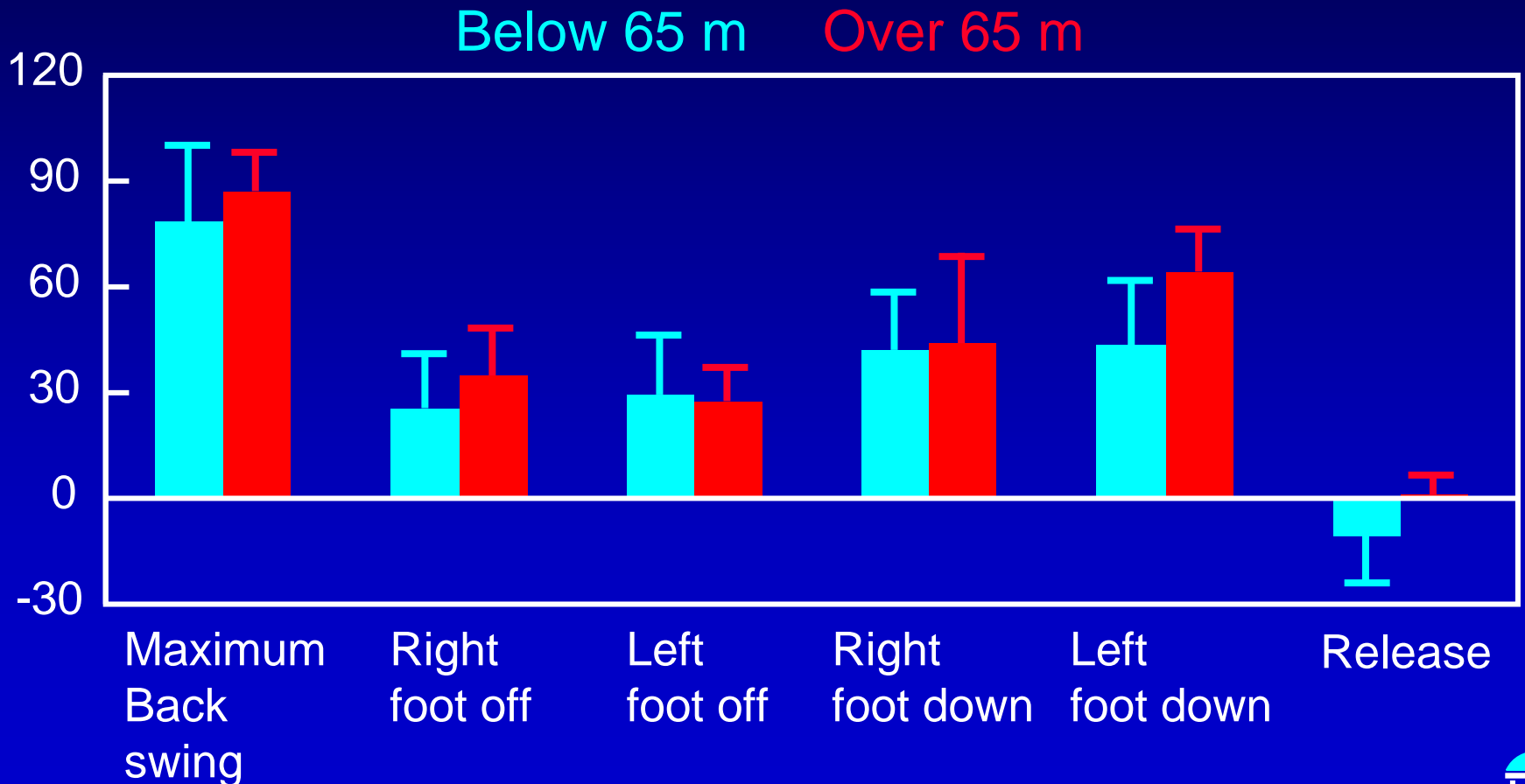
Separations

Separations

- 2/3 of the discus speed at release are obtained during the delivery
- Large hip-shoulder and shoulder-arm separations at the power position are critical for gaining discus speed during delivery
- Good separations before the flight are helpful for large separations at the power position

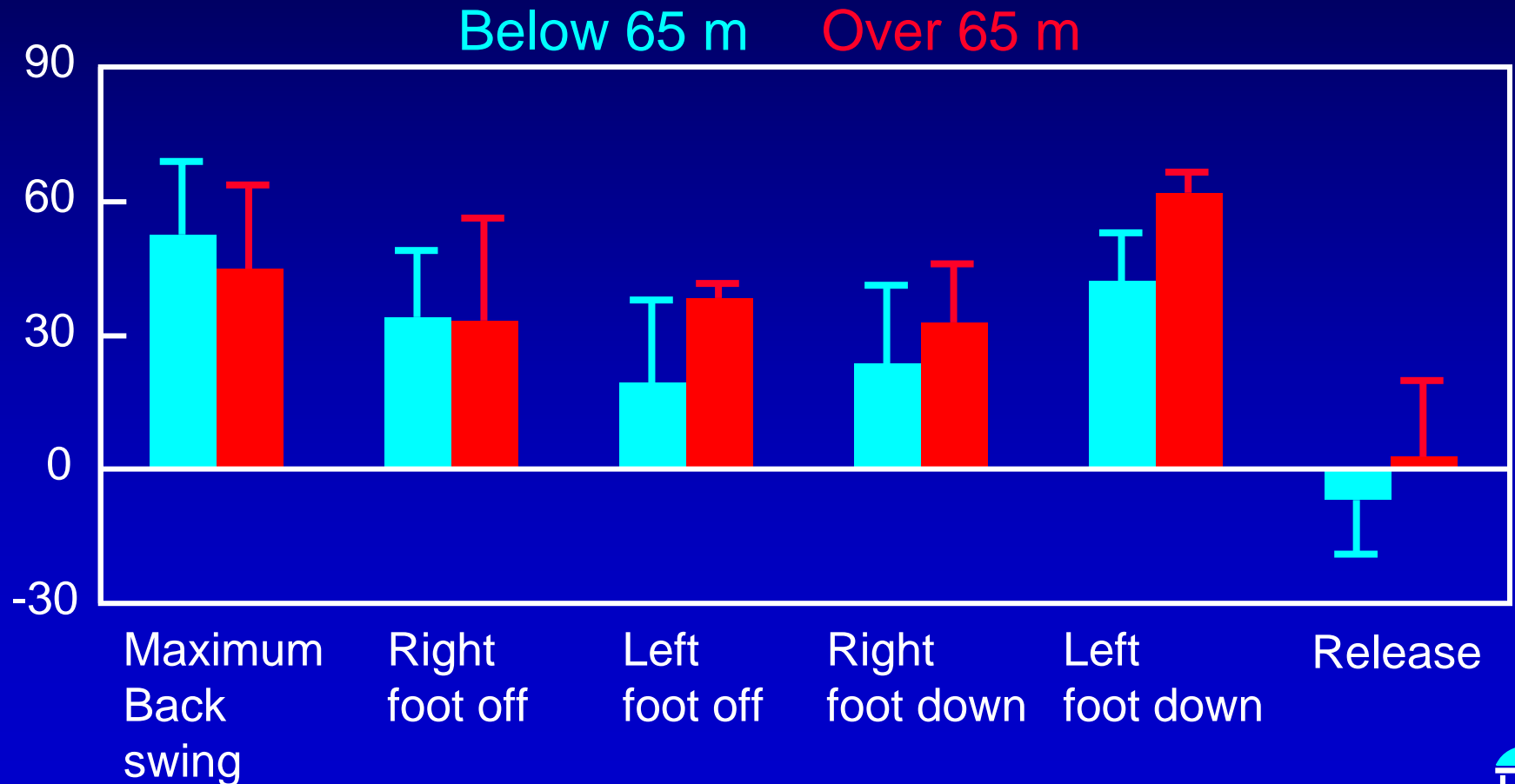
Separations

Hip-Shoulder Separation of Women Discus Throwers (deg)



Separations

Shoulder-Arm Separations of Women Discus Throwers (deg)



Have Large Separations

- Have large separations at right foot down
 - Control of speed and upper body movement before left foot off
 - Good separations at the left foot off
 - Twist the trunk during the flight

Have Large Separations

- Increase separations during single support in the middle
 - Control speed before left foot off
 - Quick and continue right leg rotation after right foot down
 - Quick left foot down

Twisting Trunk during Flight

- The importance of twisting the trunk during the flight
 - Create hip-shoulder and shoulder-arm separations
 - Appropriate foot position for power position

Right Leg Rotation and Left Leg Block

Leg Actions after Flight

- Right leg rotation
 - Increase separations
 - Provide forward drive
 - Not right leg upward push
- Left leg block
 - Provide lift
 - Assist to forward drive from right

Ground Contact during Delivery

Ground Contact during Delivery

- Theoretically, retaining contact with the ground provides continuous forward drive and vertical lift
- Some of elite throwers have both feet off the ground at release

Ground Contact during Delivery

- Retaining ground contact at the release
 - Left knee and hip were not fully extended
 - Incomplete left block
- Losing ground contact too early
 - Early loss in forward drive and vertical lift

Suggested Ground Contact Pattern

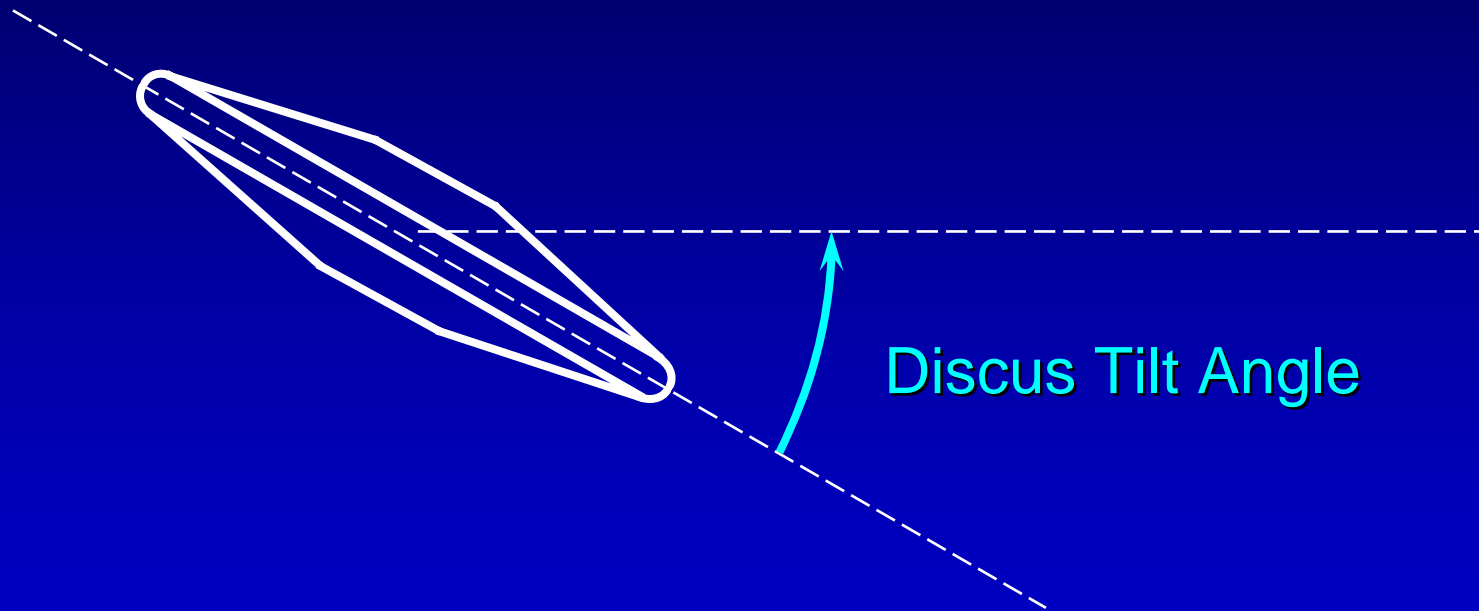
- Keep ground contact as long as possible especially the right foot until the release of the discus
- The left foot may be off the ground in the last portion of the delivery
- Jump up for reverse after the release

Aerodynamic Distance

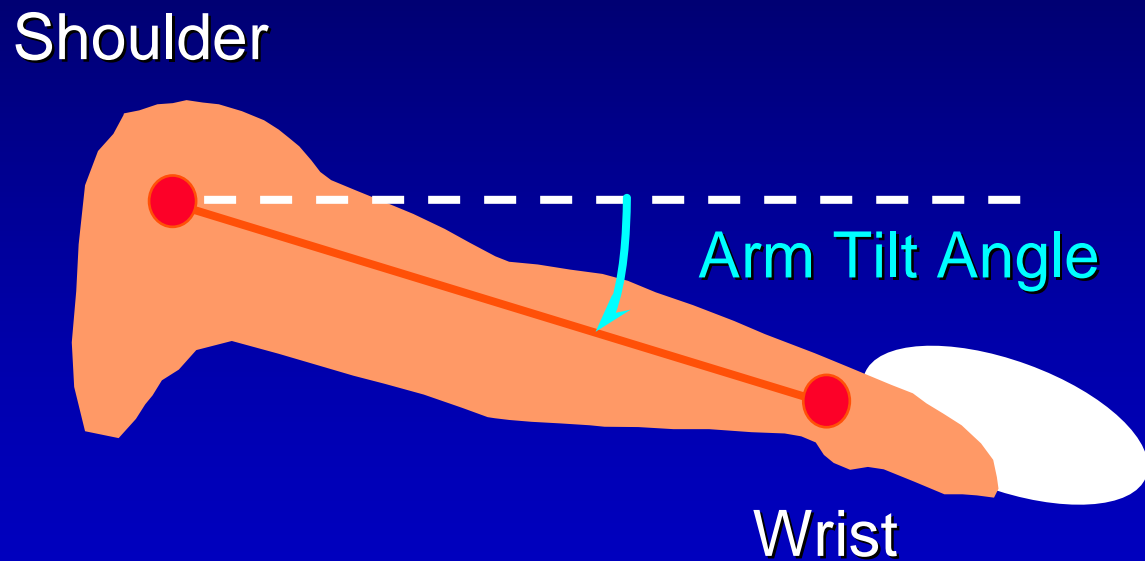
Aerodynamic Distance

- An important factor affecting official distance
 - Range: 12 m (gain) to -12 m (lose)
 - $74.99 \text{ m} - 8.14 \text{ m} = 66.85 \text{ m}$
 - $64.14 \text{ m} + 3.82 \text{ m} = 67.96 \text{ m}$

Discus Tilt Angle

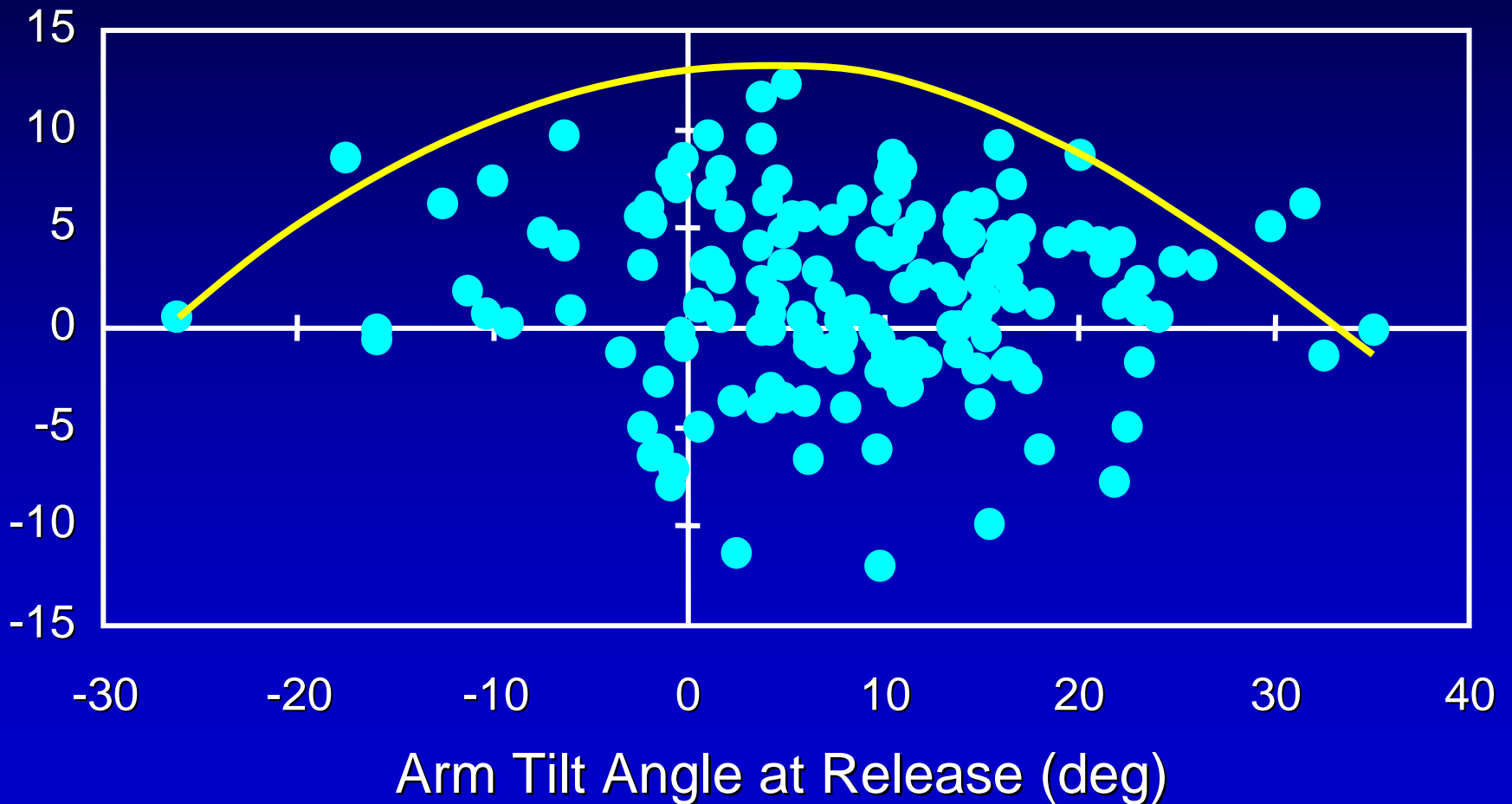


Arm Tilt Angle



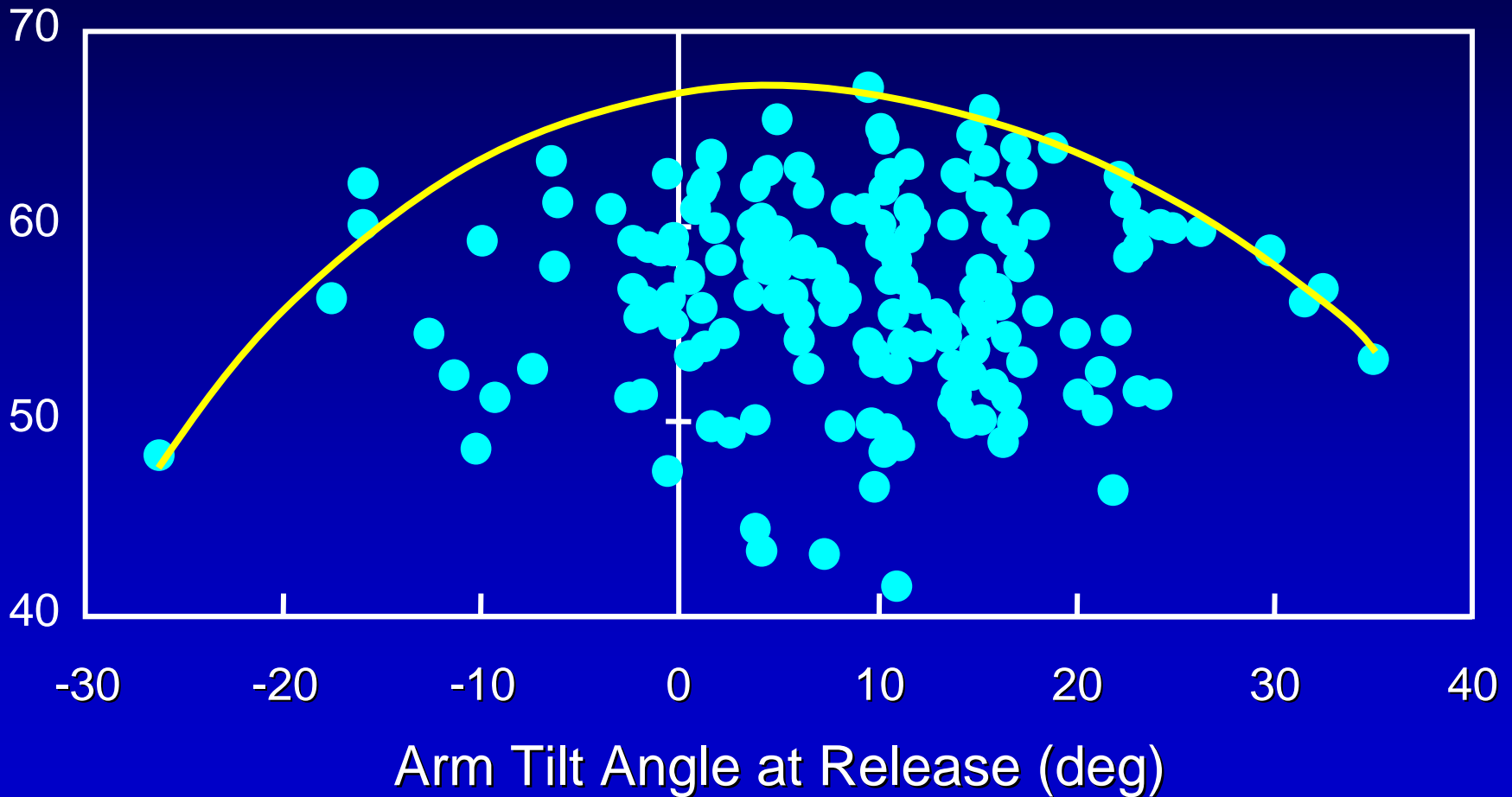
Arm Tilt Angle

Aerodynamic Distance (m)



Arm Tilt Angle

Official Distance (m)



Arm Tilt Angle

- Recommended arm tilt angle at release between 0 and 10 degrees

Good Discus Throw Technique

Good Discus Throw Technique

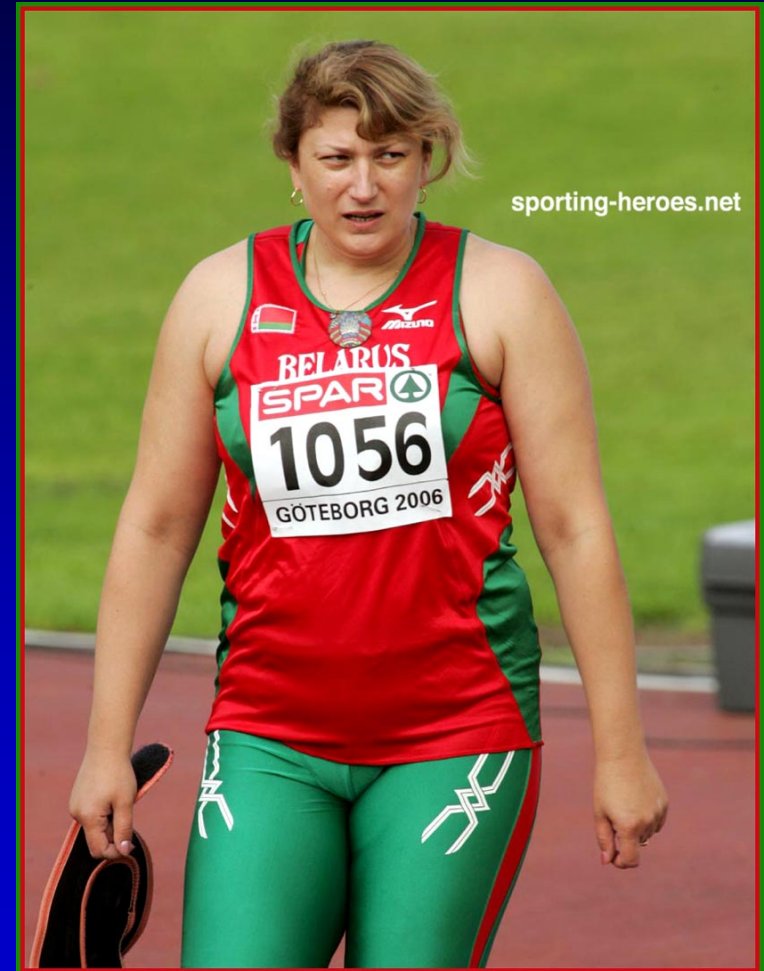
- Relaxed back swing
- Controlled unwind
- Wide right leg swing
- Vigorous forward drive
- Quick rotation of the hip and shoulder during the flight

Good Discus Throw Technique

- High discus position at right foot landing
- Continue right leg rotation
- Quick left foot landing to form the power position
- Powerful right rotation and left block
- Controlled release with discus at shoulder level

Good Discus Throwing Technique

- Irina Yatcheko
- Nationality: Belarus
- Birthday: 1965/10/31
- Height: 1.84 m
- Weight: 98 kg



Good Discus Throwing Technique

- Performance:

- 2000 Olympic Game Bronze Medal
(65.20 m)
- 2003 World Championship Gold Medal
(67.32 m)
- 2004 Olympic Game Bronze Medal
(66.17米)



Good Discus Throwing Technique

- Andy Bloom
- Nationality: USA
- Birthday: 1973/8/11
- Height: 1.80 m
- Weight: 120 kg



Good Discus Throwing Technique

- Performance

- 1997 USATF National Championships
Third Place (65.30 m)
- 1998 USATF National Championships
Second Place (66.42 m)
- 1999 USATF National Championships
Third Place (67.46 m)



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