# BWF SPORTS SCIENCE PROJECT

# SPEED AND ACCURACY IN THE BADMINTON JUMP SMASH

**Mark King**

Loughborough University

# MY BACKGROUND

- Sports Biomechanist
- National level badminton player
- Elite performance research
  - gymnastics, athletics, tennis, kayaking, springboard diving, cricket
- Badminton

# SPORTS BIOMECHANICS

- mechanical understanding and explanation of movement in sport

- identify the factors that are important
  - performance
  - injuries

# PHILOSOPHY

- some factors are critical for elite performance
- other factors are less important and will be governed by coaching, individual variation etc

# METHODS IN SPORTS BIOMECHANICS

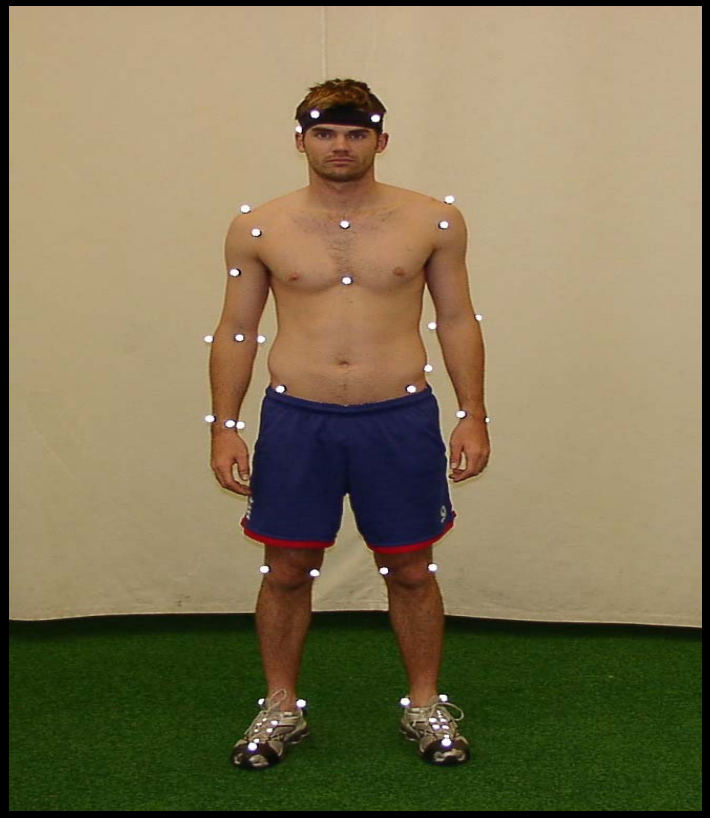
- experimental studies
  - cricket
- theoretical studies
  - tumbling

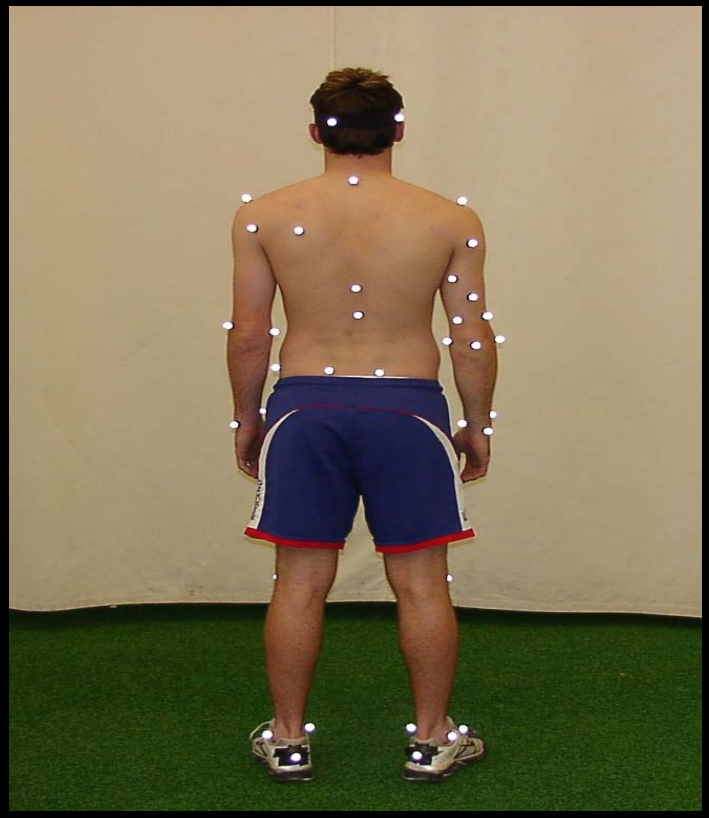
# EXPERIMENTAL – FAST BOWLING

1. what characterises the fastest bowlers?

# EXPERIMENTAL - MODERN MOTION ANALYSIS

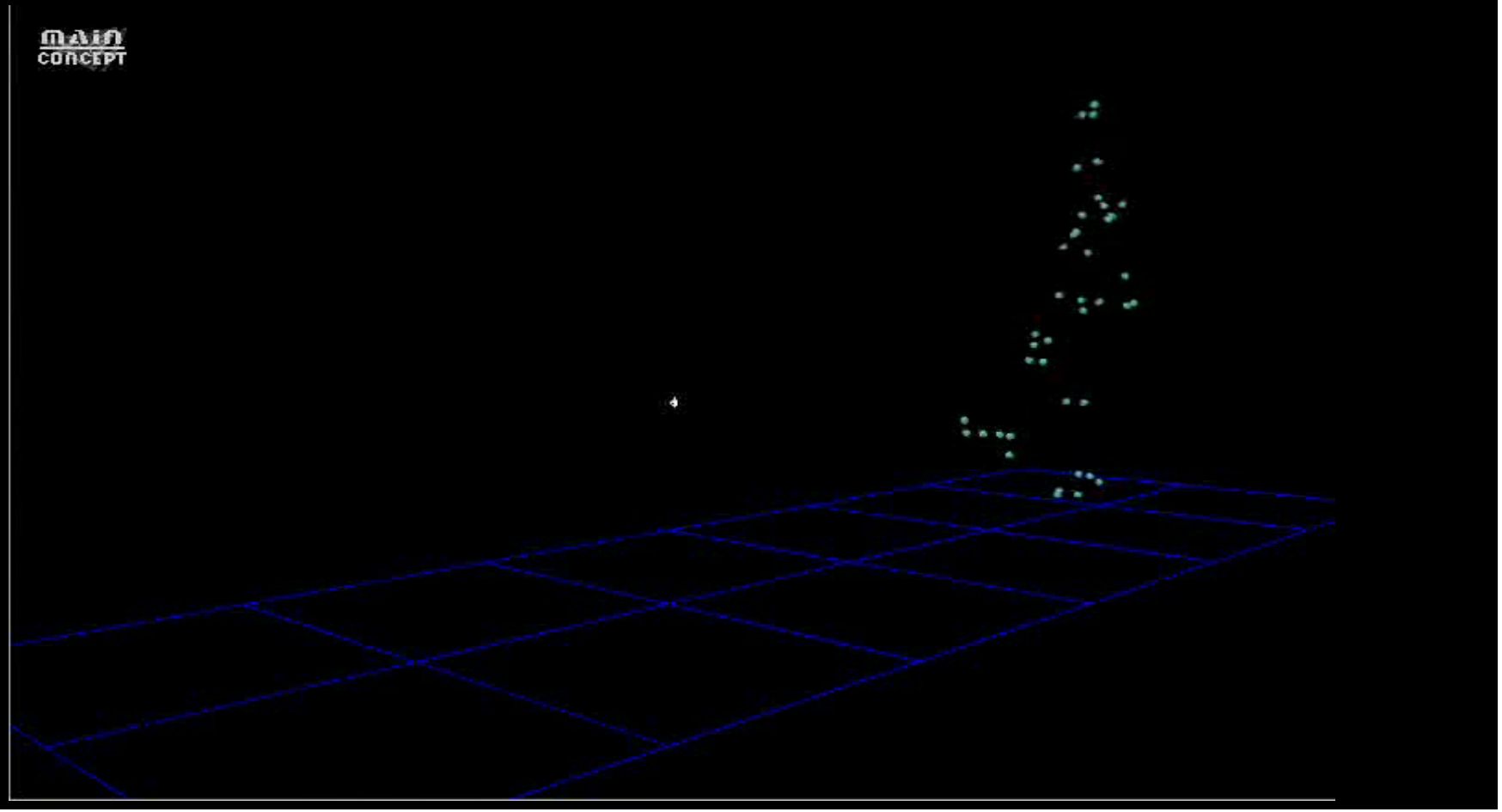
# WHOLE BODY MARKER SET



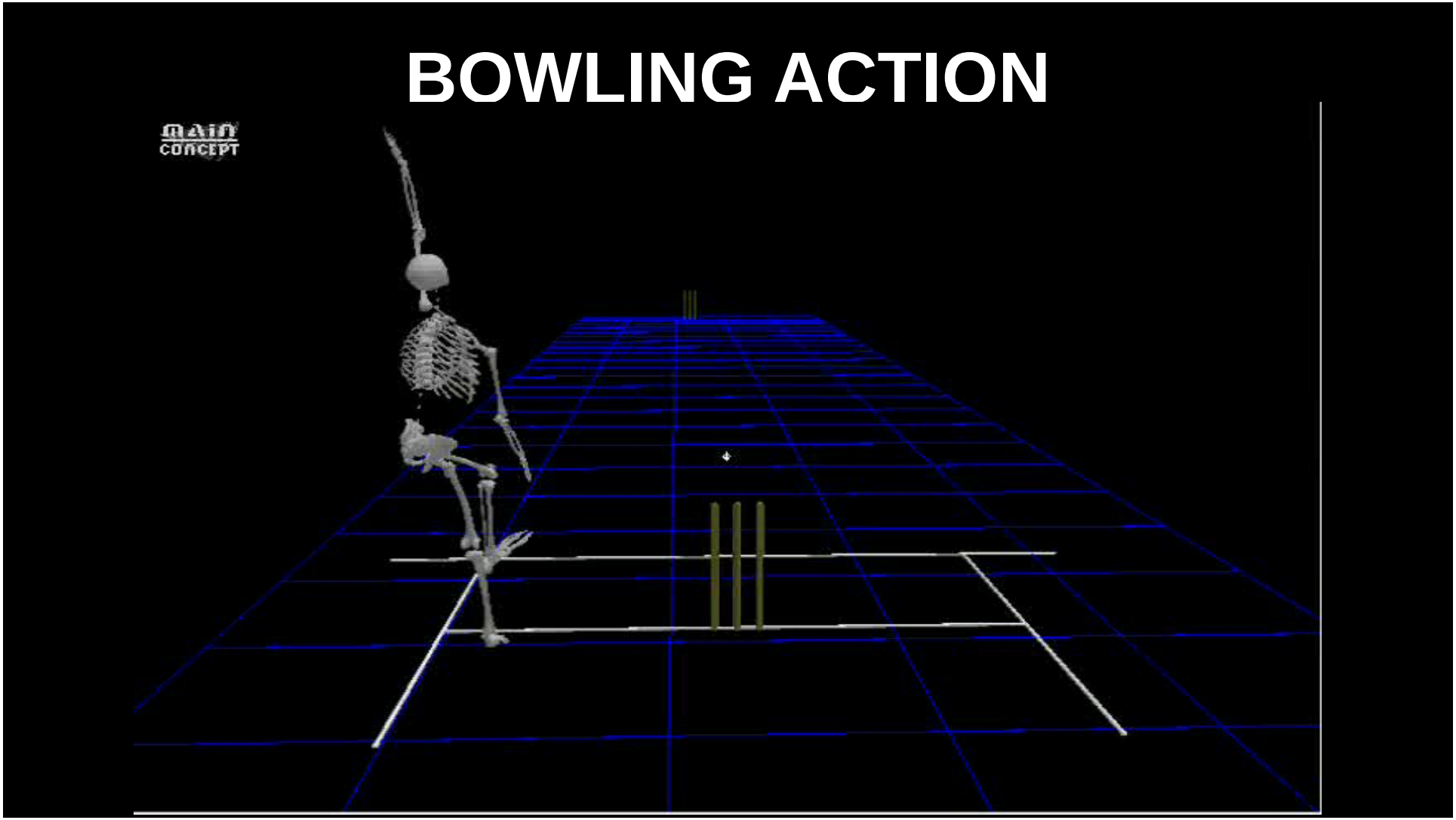


# PERFORMANCE

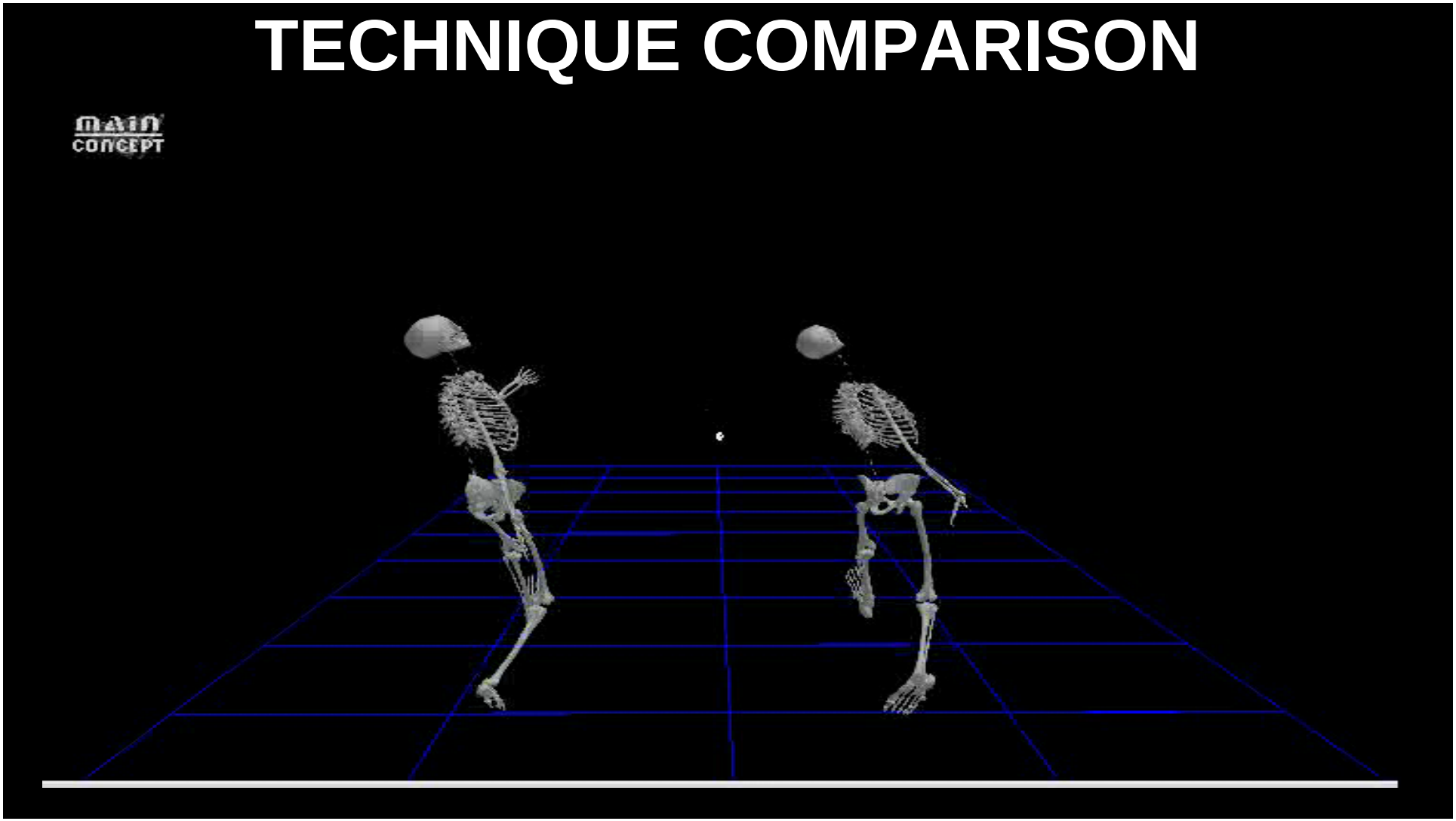
# MARKER LOCATIONS



# BOWLING ACTION



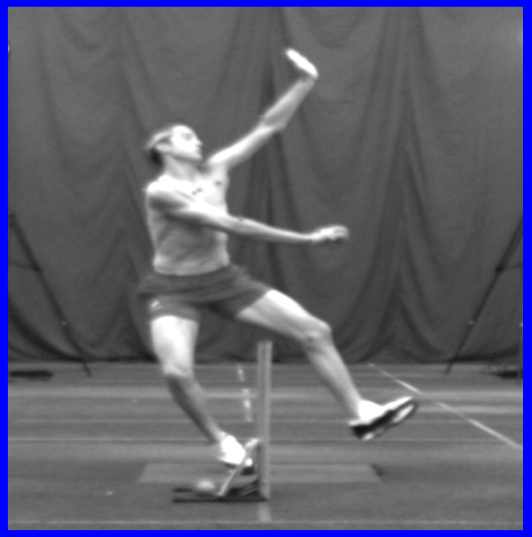
# TECHNIQUE COMPARISON



# THE FASTEST BOWLERS

# THE FASTEST BOWLERS

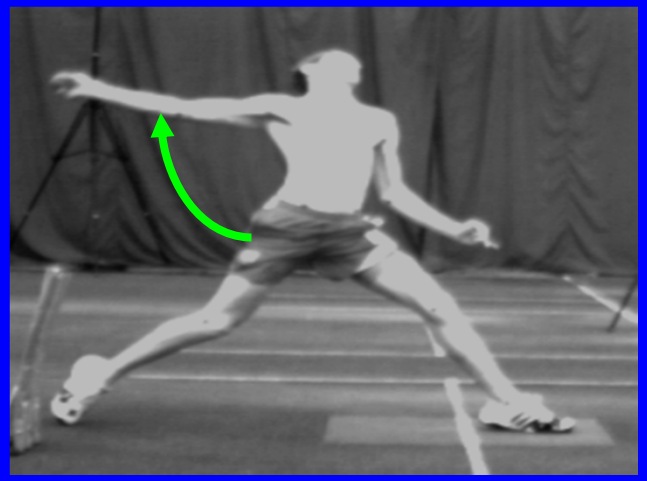
– quicker run-up



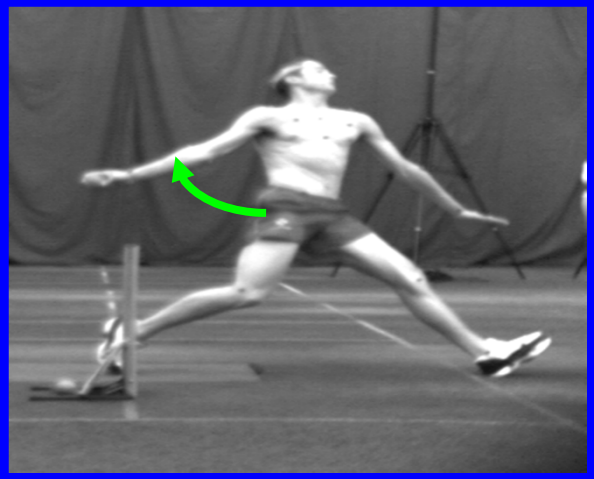
# THE FASTEST BOWLERS

– quicker run-up

– delay the bowling arm



slower



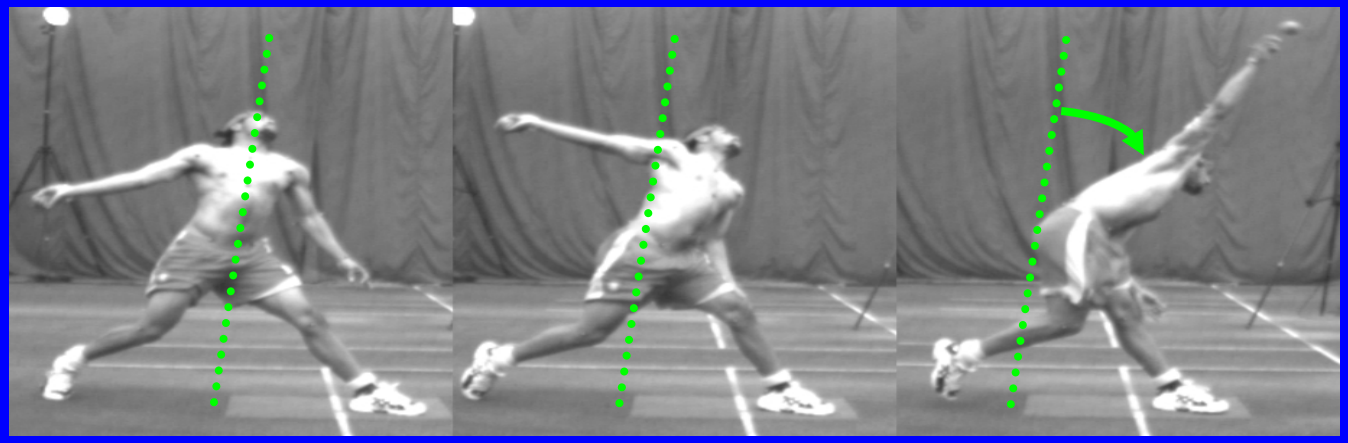
faster

# THE FASTEST BOWLERS

– quicker run-up

– delay the bowling arm

– more trunk flexion (between FFC and BR)



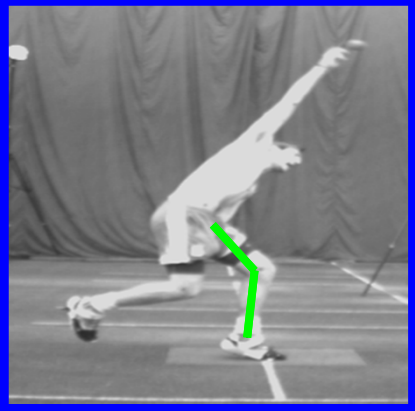
# THE FASTEST BOWLERS

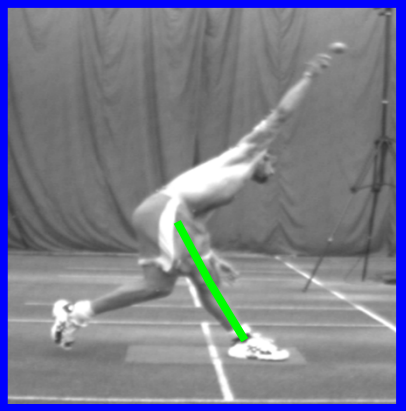
– quicker run-up

– delay the bowling arm

– more trunk flexion (between FFC and BR)

– straighter front knee (at BR)





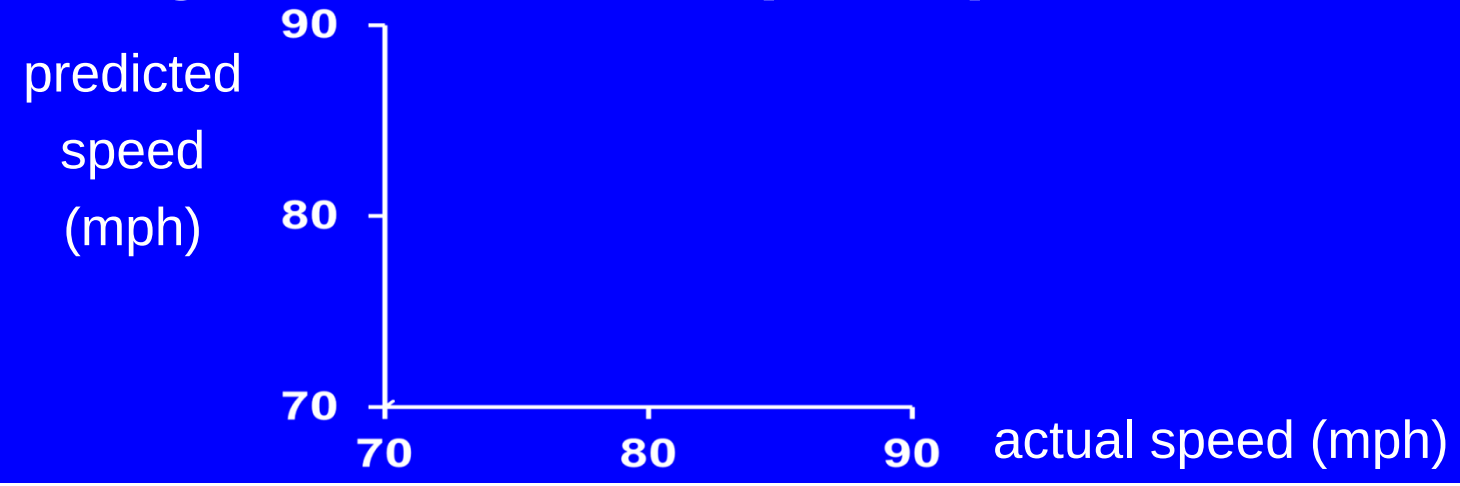
# THE FASTEST BOWLERS

– quicker run-up

– delay the bowling arm

– more trunk flexion (between FFC and BR)

– straighter front knee (at BR)



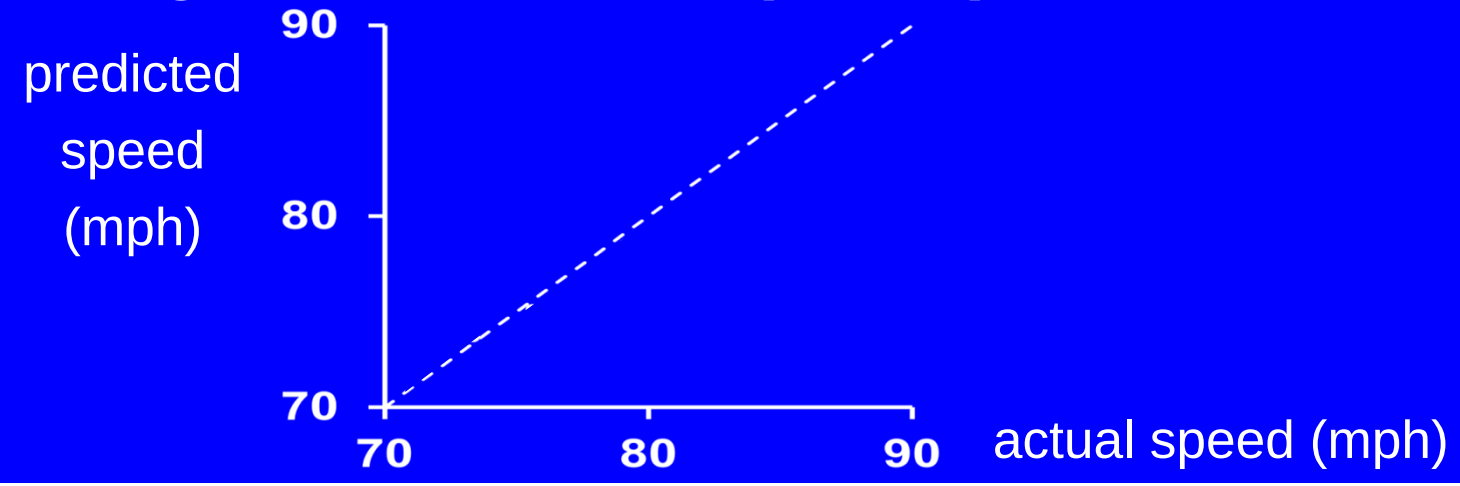
# THE FASTEST BOWLERS

– quicker run-up

– delay the bowling arm

– more trunk flexion (between FFC and BR)

– straighter front knee (at BR)



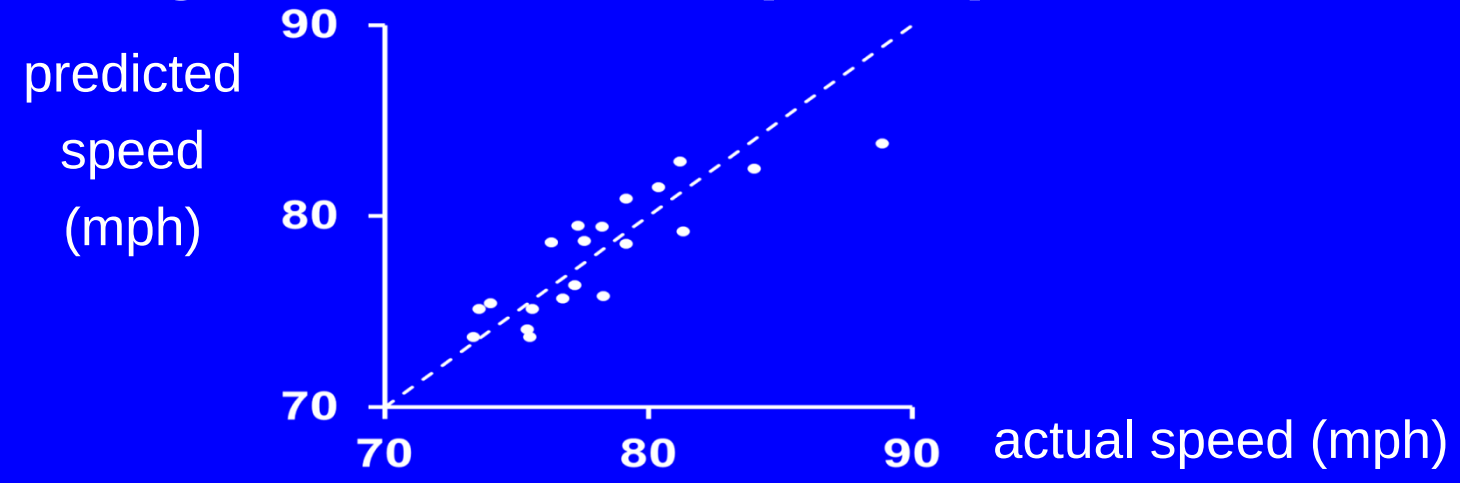
# THE FASTEST BOWLERS

– quicker run-up

– delay the bowling arm

– more trunk flexion (between FFC and BR)

– straighter front knee (at BR)



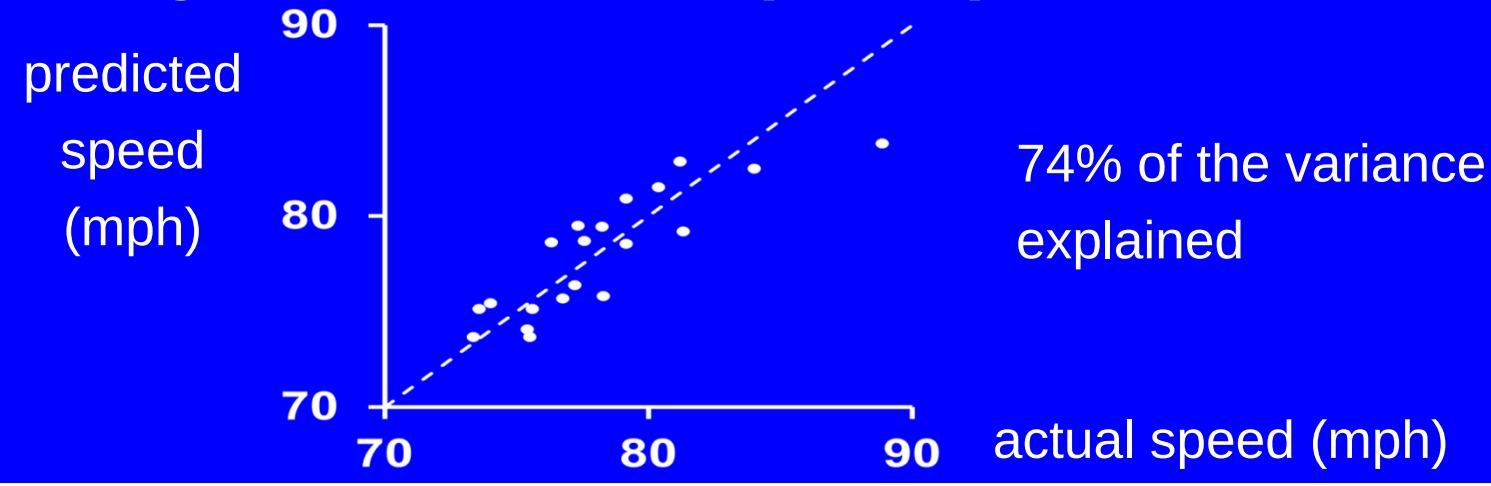
# THE FASTEST BOWLERS

– quicker run-up

– delay the bowling arm

– more trunk flexion (between FFC and BR)

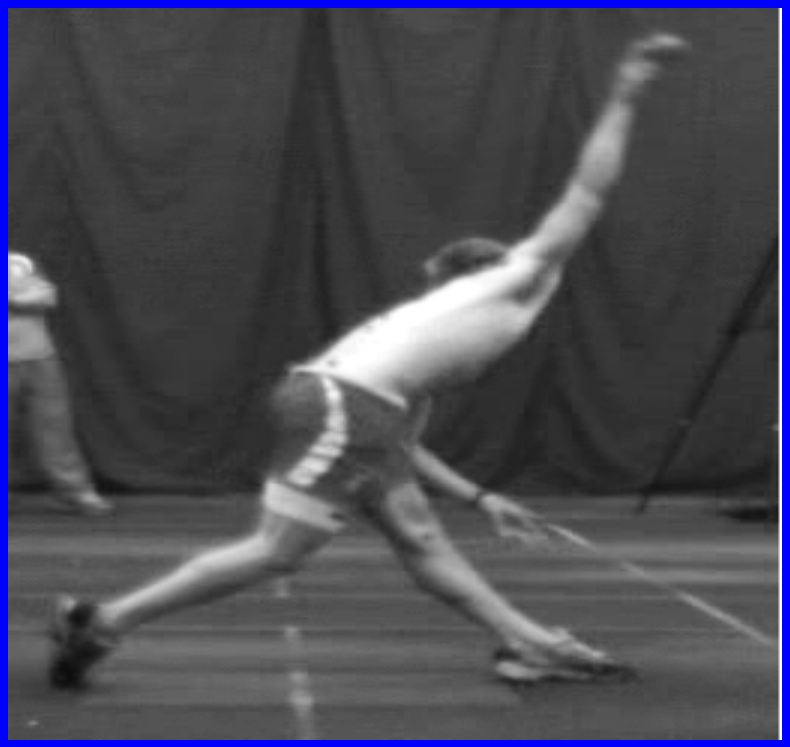
– straighter front knee (at BR)




74% of the variance explained

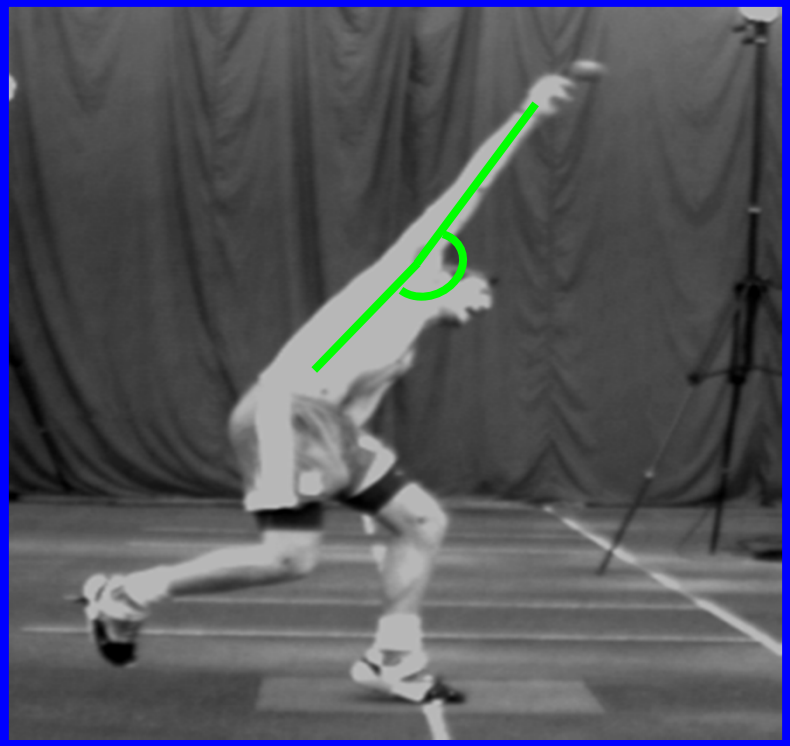
# SHAPE AT BALL RELEASE

slower

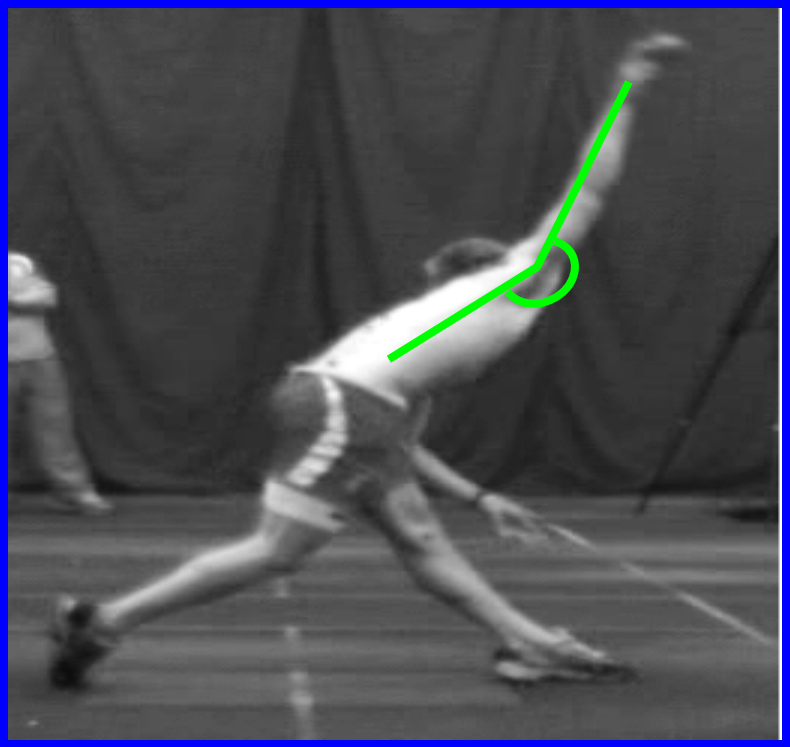


faster

# SHAPE AT BALL RELEASE

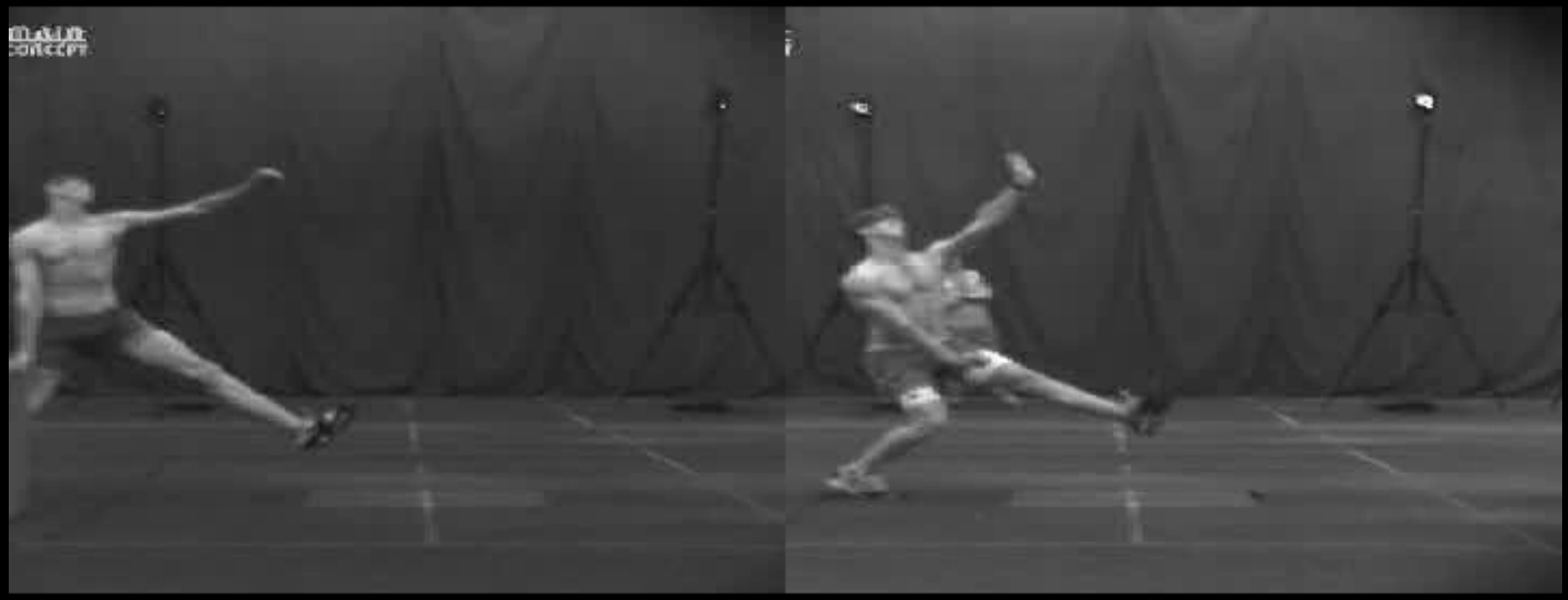


slower



faster

# FAST BOWLING



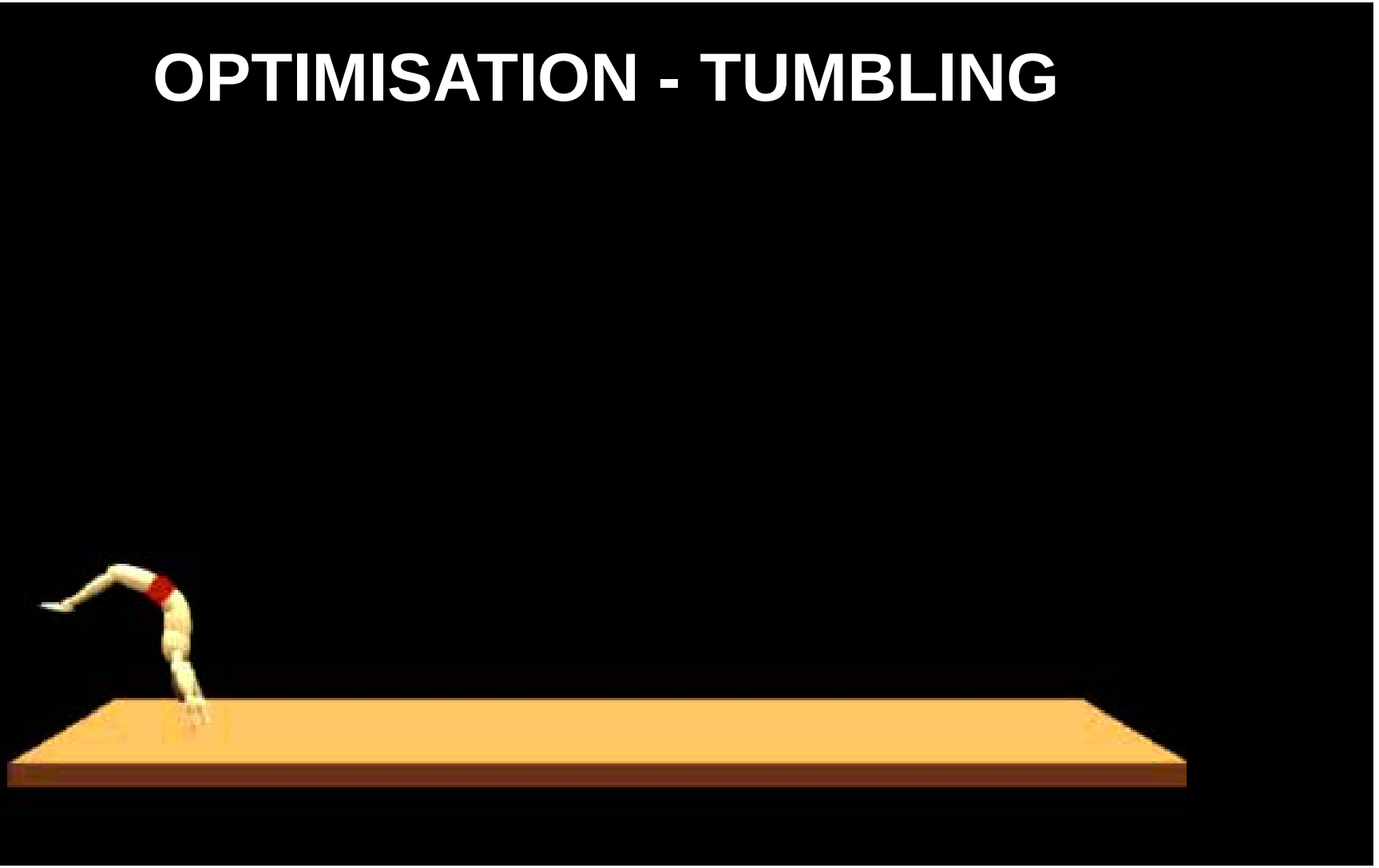
# DOUBLE LAYOUT SOMERSAULT

# THEORETICAL - TUMBLING

performance

simulation

# OPTIMISATION - TUMBLING



# TRIPLE LAYOUT SOMERSAULT

# OVERHEAD – THROWING / STRIKING

- cricket fast bowl
- baseball pitch
- tennis serve
- badminton smash

- optimum performance
  - speed, angle
  - accuracy

# FASTEST CRICKET BOWL - 160 km/h

# FASTEST BASEBALL PITCH - 169 km/h

# FASTEST TENNIS SERVE - 264 km/h

# FASTEST BADMINTON SMASH – 426 km/h

# IPL - FASTEST SMASHES

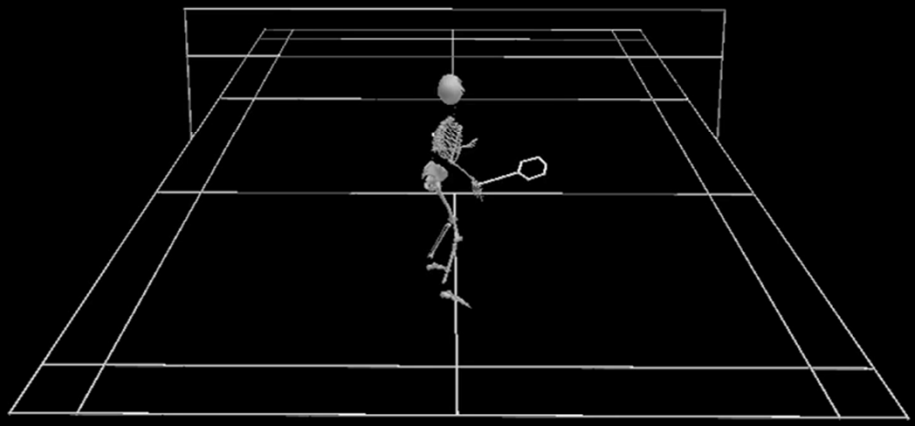
| male | speed km/h | | female | speed km/h |
|---|---|---|---|---|
| **Mads Pieler Kolding** | **426** | | **P V Sindhu** | **375** |
| **Bodin Isara** | **419** | | **Gabrielle Adcock** | **359** |
| **Ajay Jayaram** | **419** | | **Carolina Marin** | **357** |
| **Goh V Shem** | **419** | | **Ashwini Ponnappa** | **356** |
| **Vladimir Ivanov** | **419** | | **Jwala Gutta** | **348** |
| **Markis Kido** | **415** | | **Saina Nehwal** | **333** |
| **Sameer Verma** | **402** | | **Nitchaon Jindapon** | **329** |
| **Jan O Jorgensen** | **401** | | **Cheung Ngan Yi** | **324** |

# QUESTIONS

- why can some smash much faster than others?
  - strength
  - technique
  - grip

- what is the limit for an individual?
- what does optimum look like?
- can we coach someone to smash faster?

# BADMINTON SMASH - OPTIMUM?



# 1st BWF SMASH PROJECT

- accurate method for determining shuttle trajectory and speed
- impact location on the racket

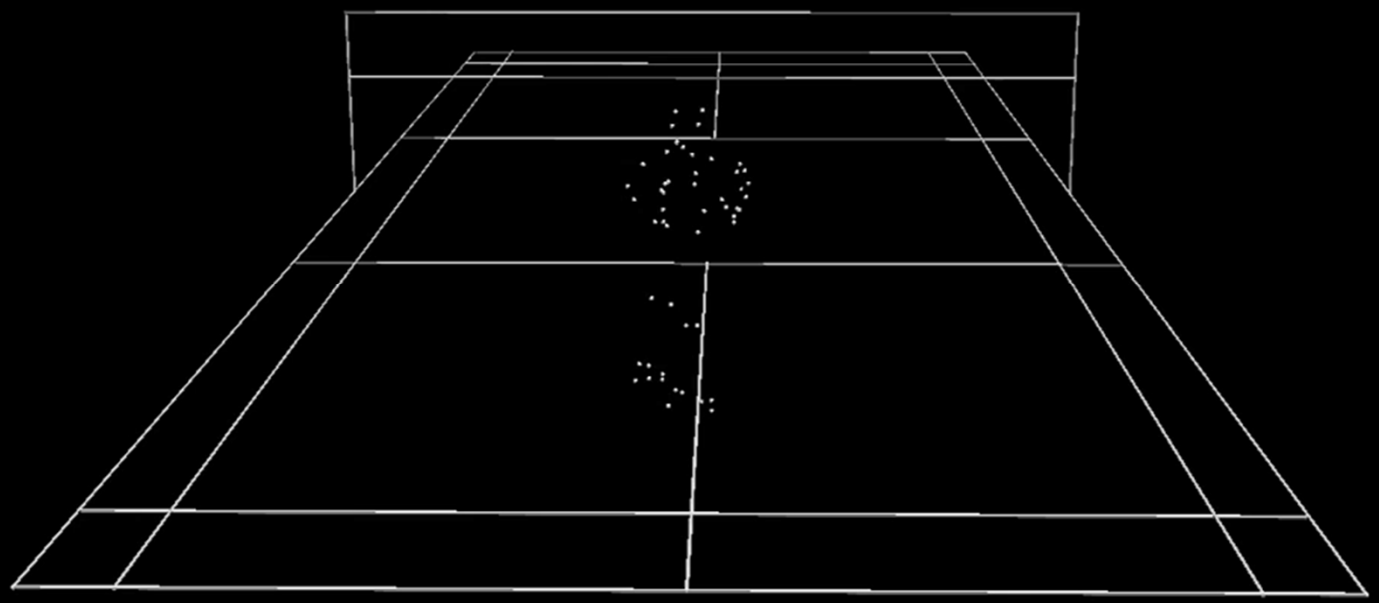
- to identify the key aspects of technique which characterise the fastest jump smashes
- accuracy in the smash

# 1st DATA COLLECTION

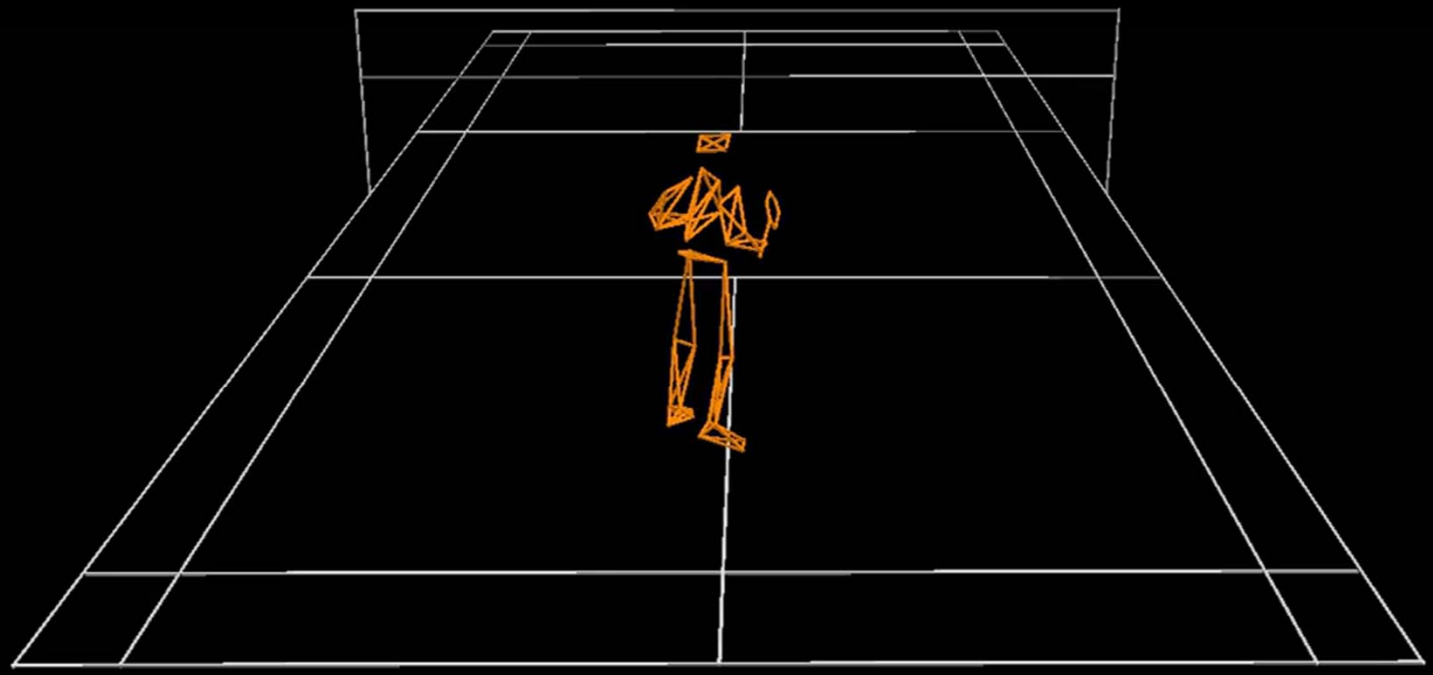
- 18 experienced players
- motion analysis (400 Hz)
- maximal jump smashes

# 1st DATA COLLECTION

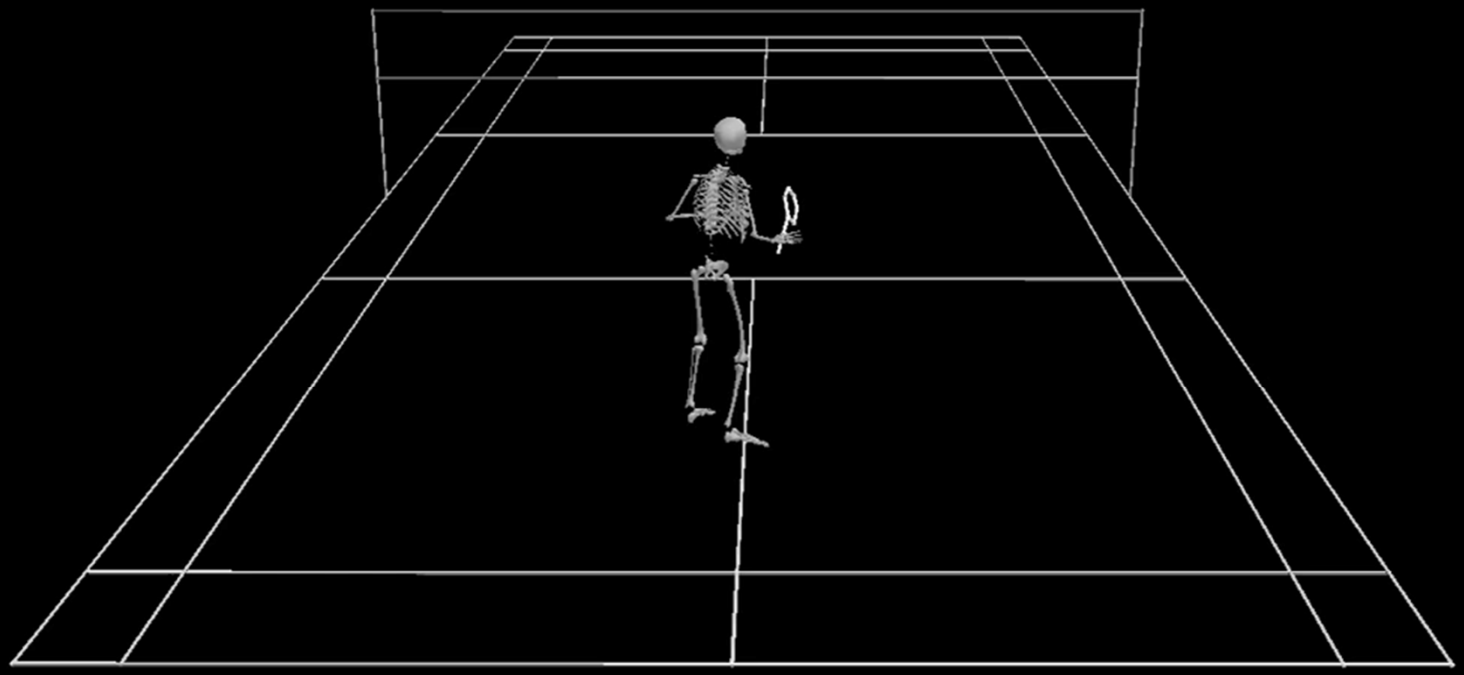
# RAW DATA



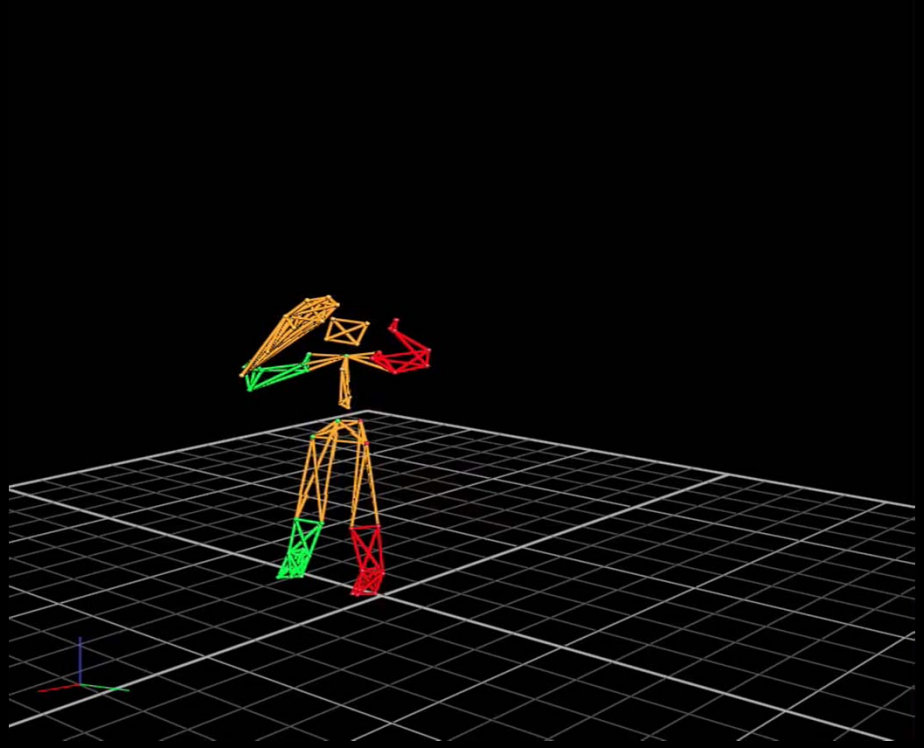
# LABELLED



# SKELETON

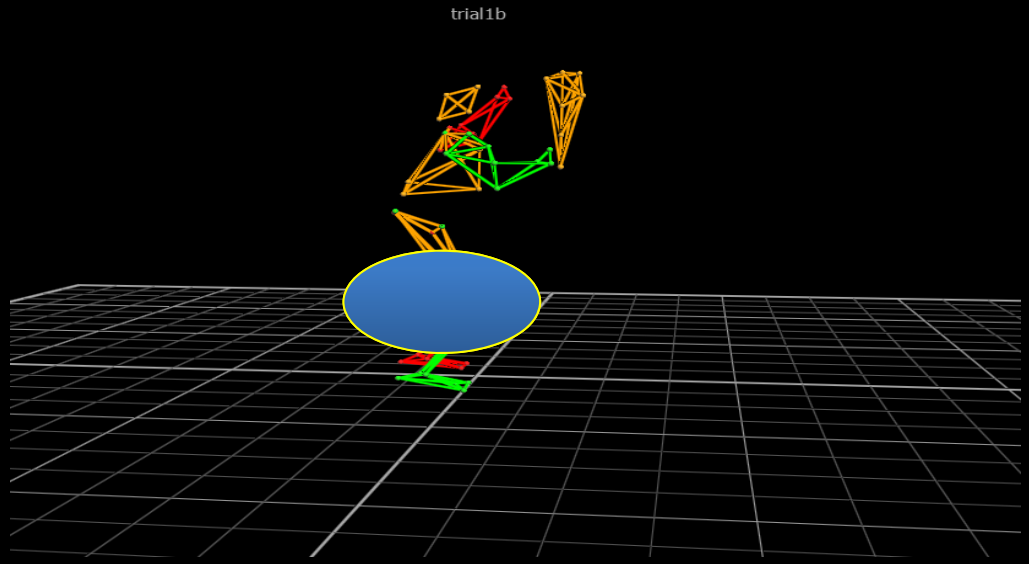


# IDENTIFICATION OF CRUCIAL INSTANTS



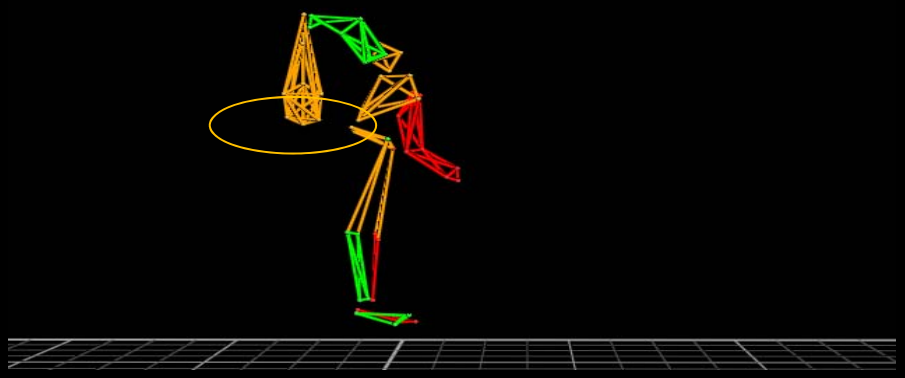
# IDENTIFICATION OF CRUCIAL INSTANTS

- **maximum knee flexion**



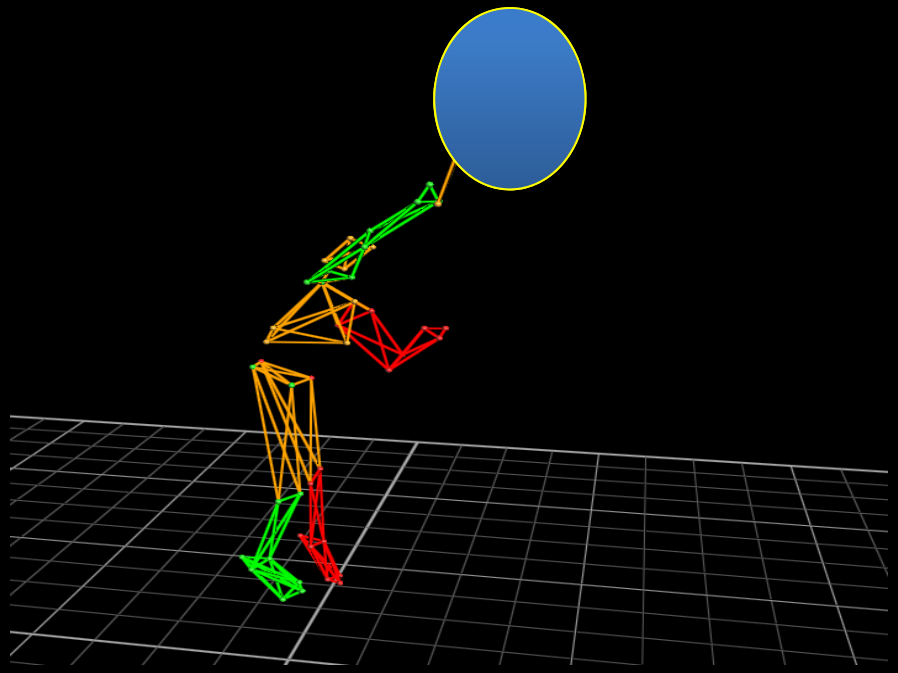
# IDENTIFICATION OF CRUCIAL INSTANTS

- **racket lowest point**

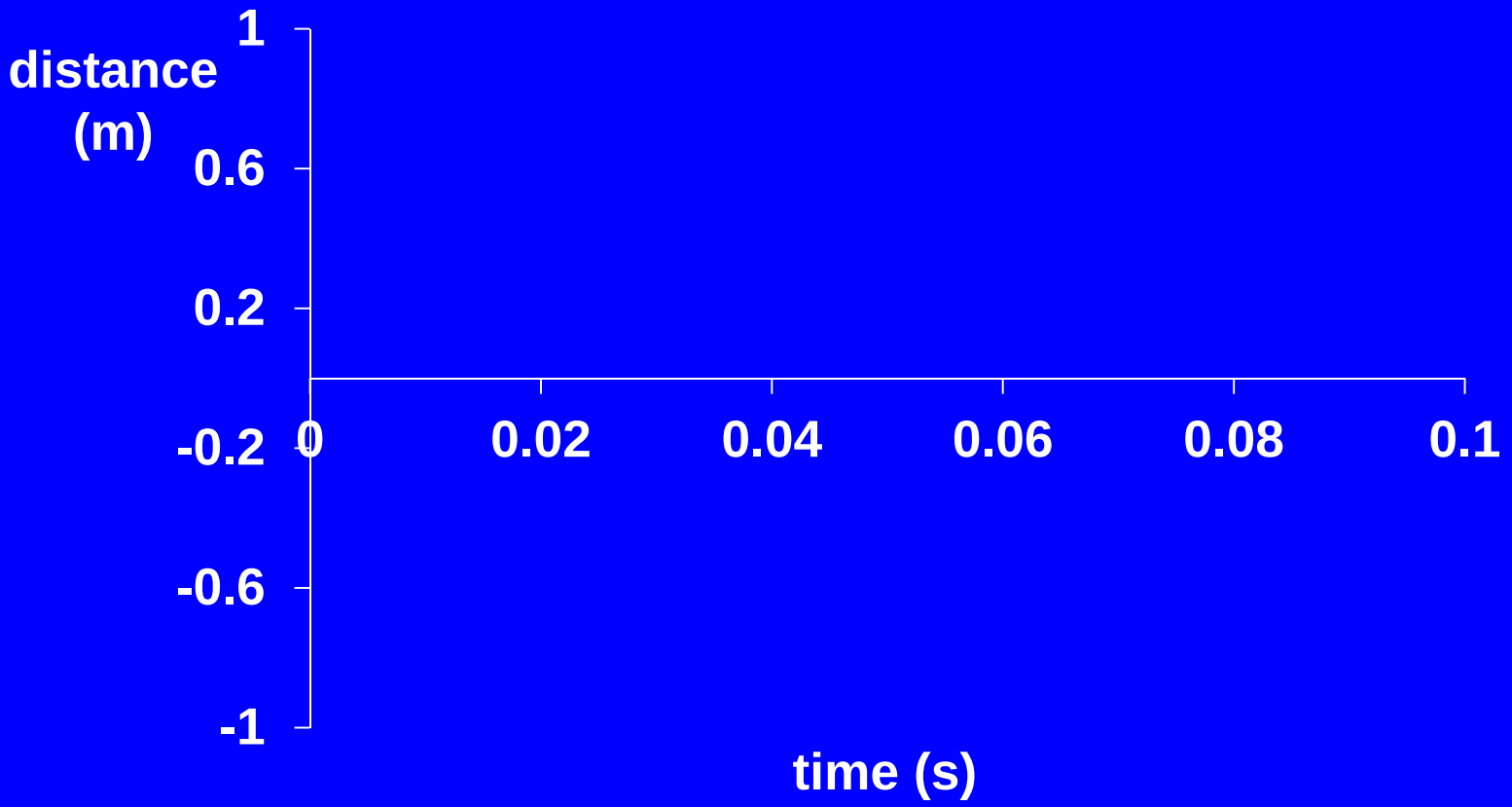


# IDENTIFICATION OF CRUCIAL INSTANTS

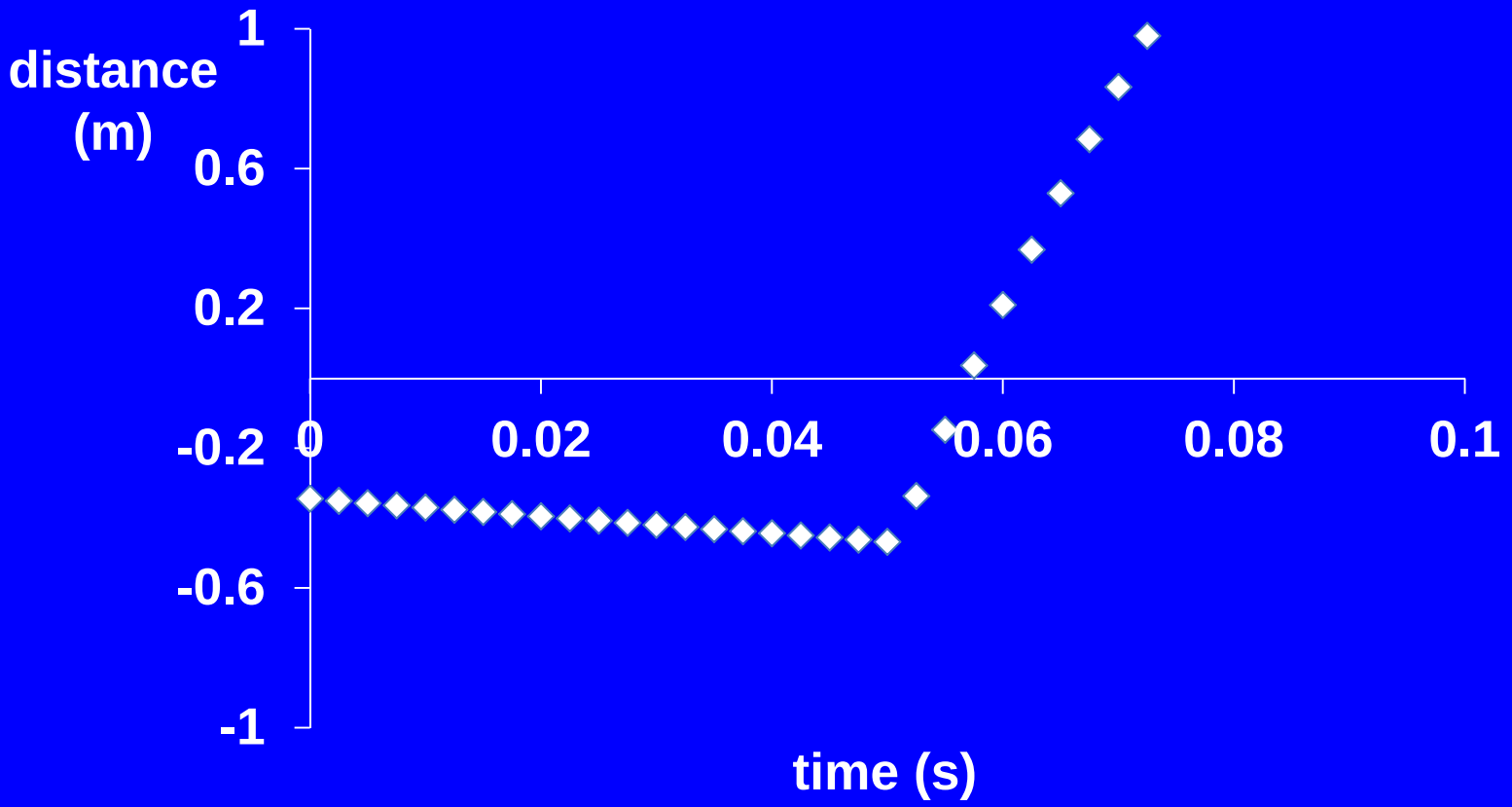
- **shuttle contact**



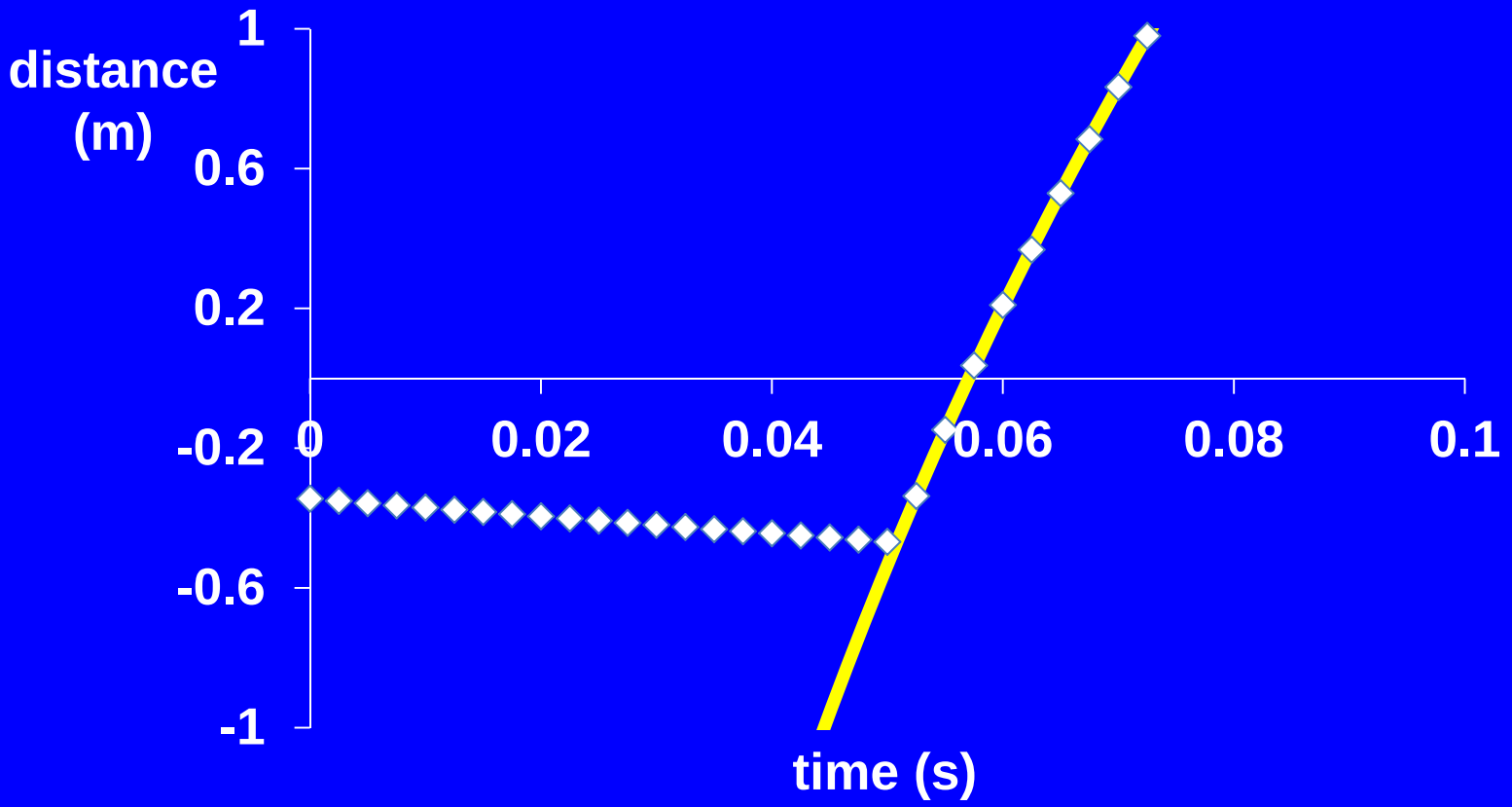
# FITTING SHUTTLE TRAJECTORY



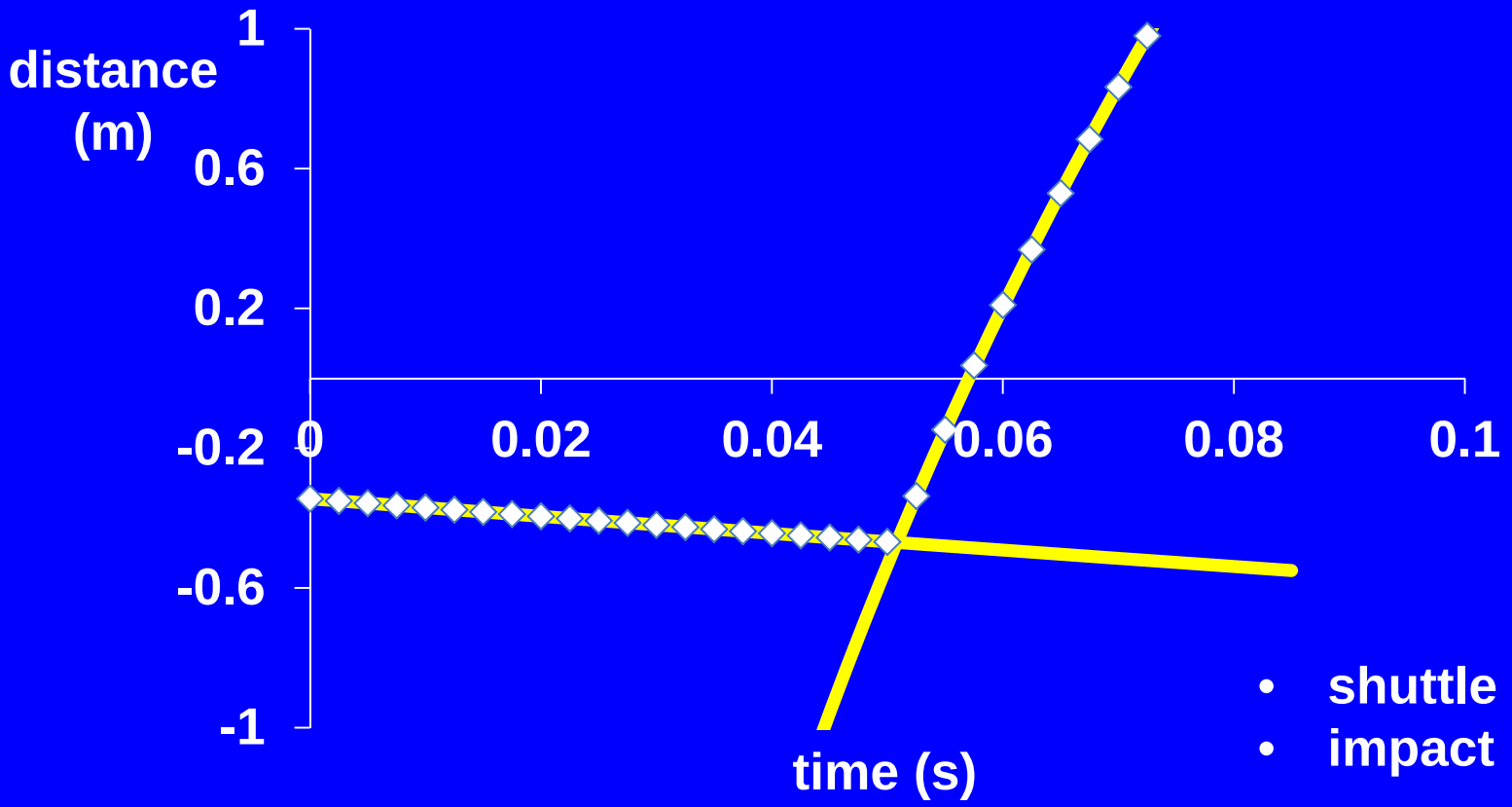
# FITTING SHUTTLE TRAJECTORY



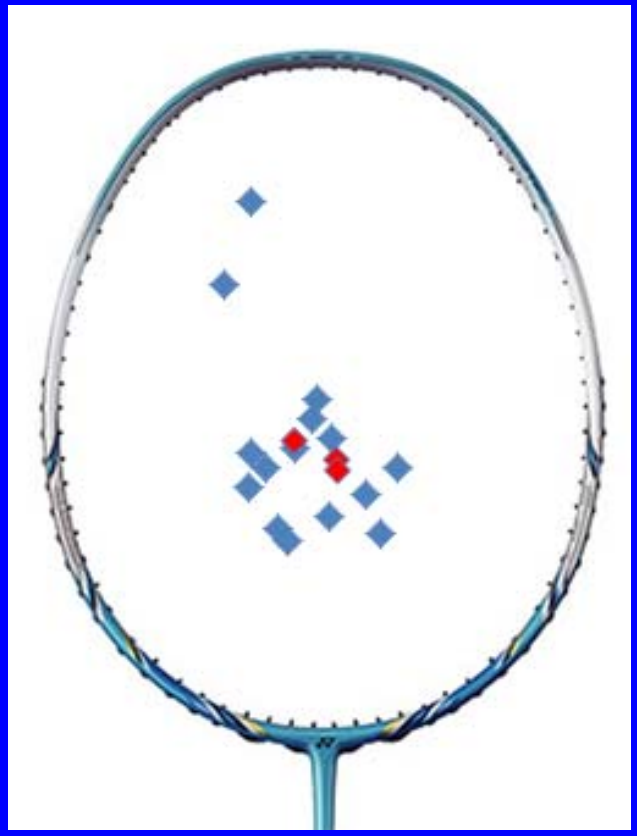
# FITTING SHUTTLE TRAJECTORY



# FITTING SHUTTLE TRAJECTORY



# RACKET IMPACT LOCATION



# DATA PROCESSING

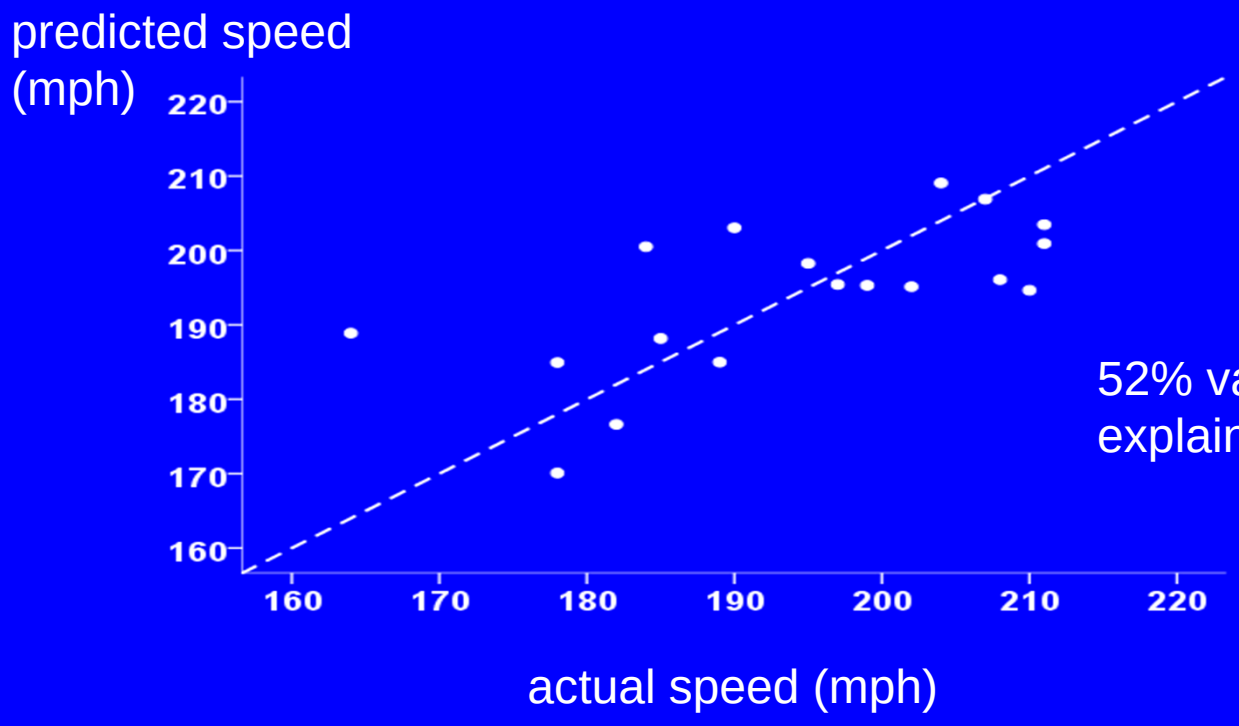
- shuttle velocity
- racket impact location

- fastest smash for each player
  - knee, wrist, elbow, and trunk angles at crucial instants

- stepwise linear regression

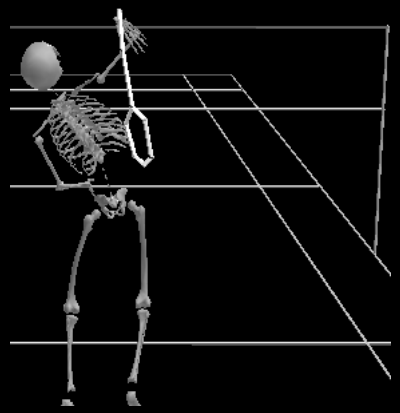
# RESULTS

# small elbow angle during backswing

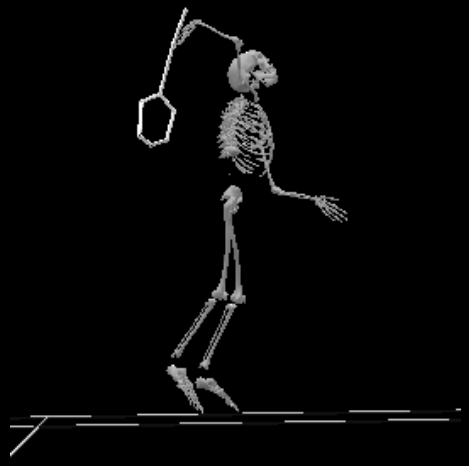



52% variation
explained

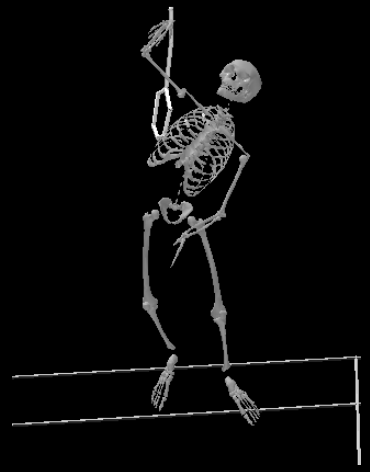
# ELBOW ANGLE



rear view

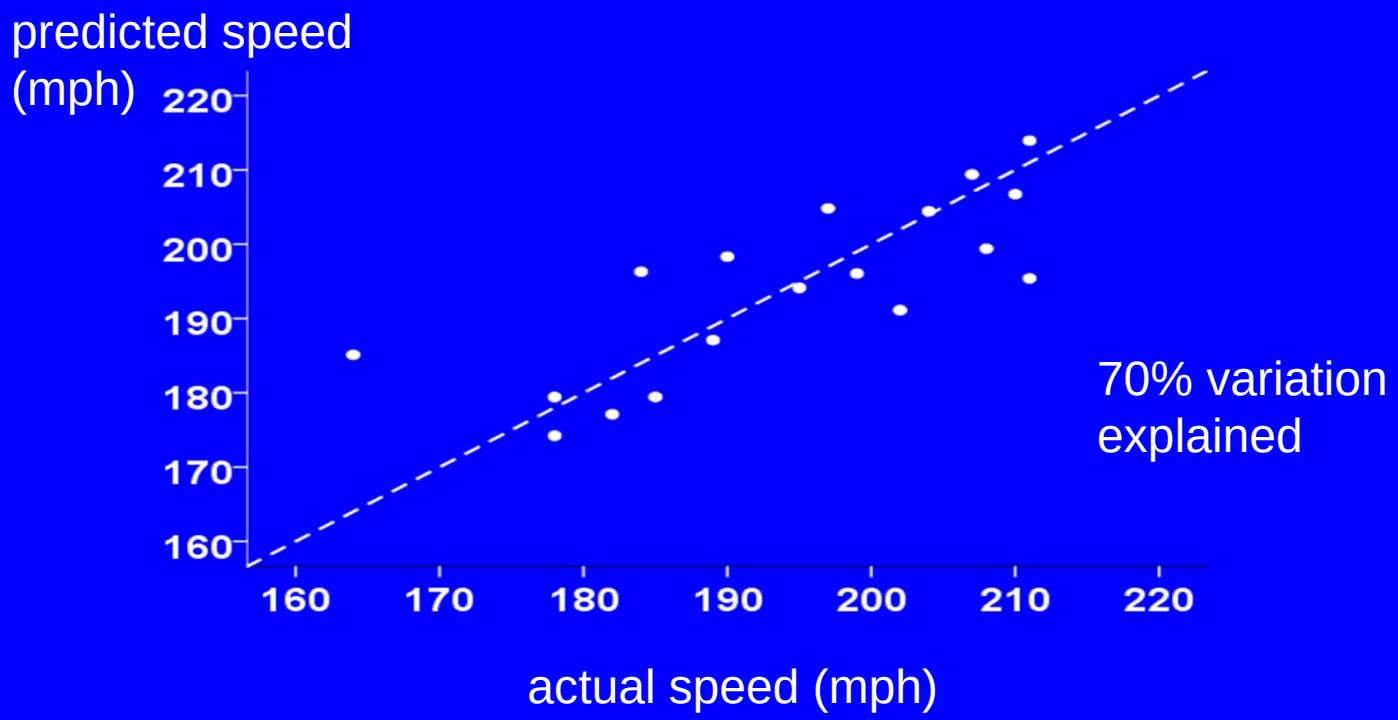


side view

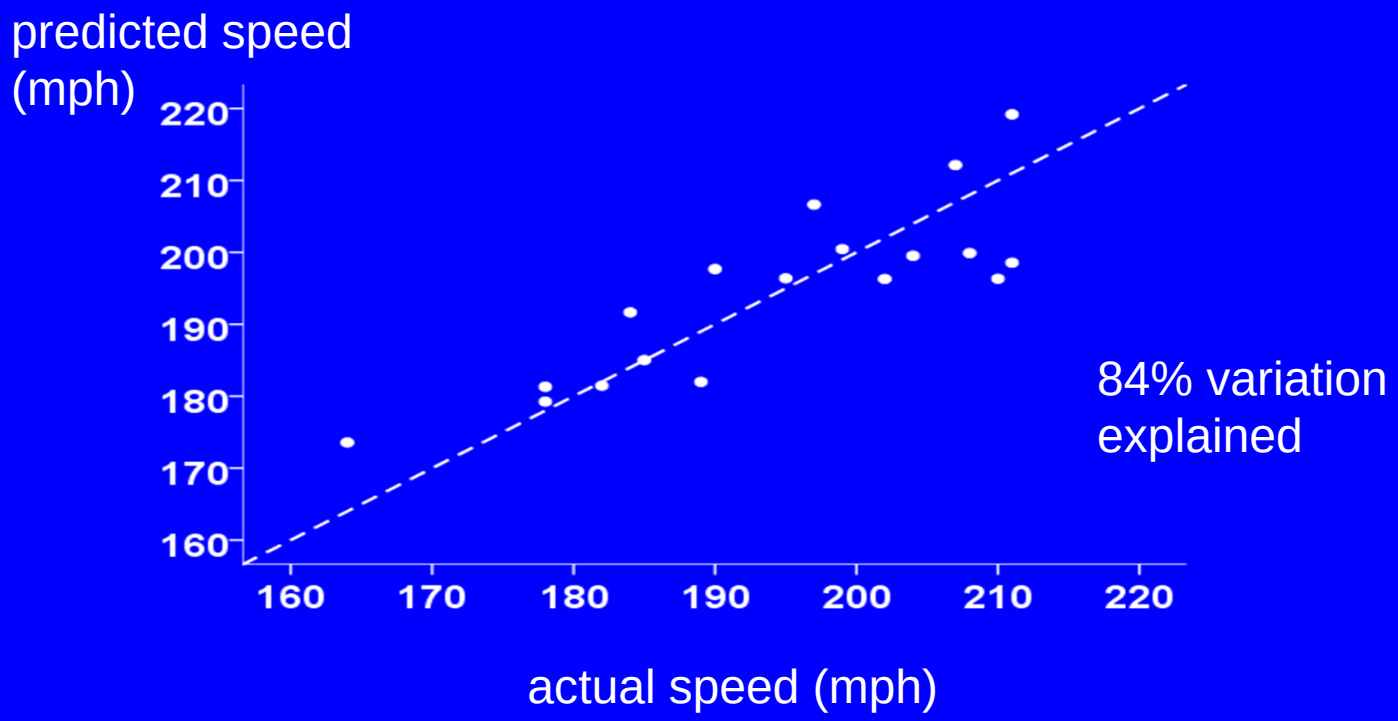


front view

# elbow angle & appropriate wrist angle at impact



# elbow, wrist and timing from preparation to impact



link to visual report

# 1st BWF SMASH PROJECT

- accurate method for determining shuttle trajectory and speed
- impact location on the racket

- to identify the key aspects of technique which characterise the fastest jump smashes
- accuracy in the smash

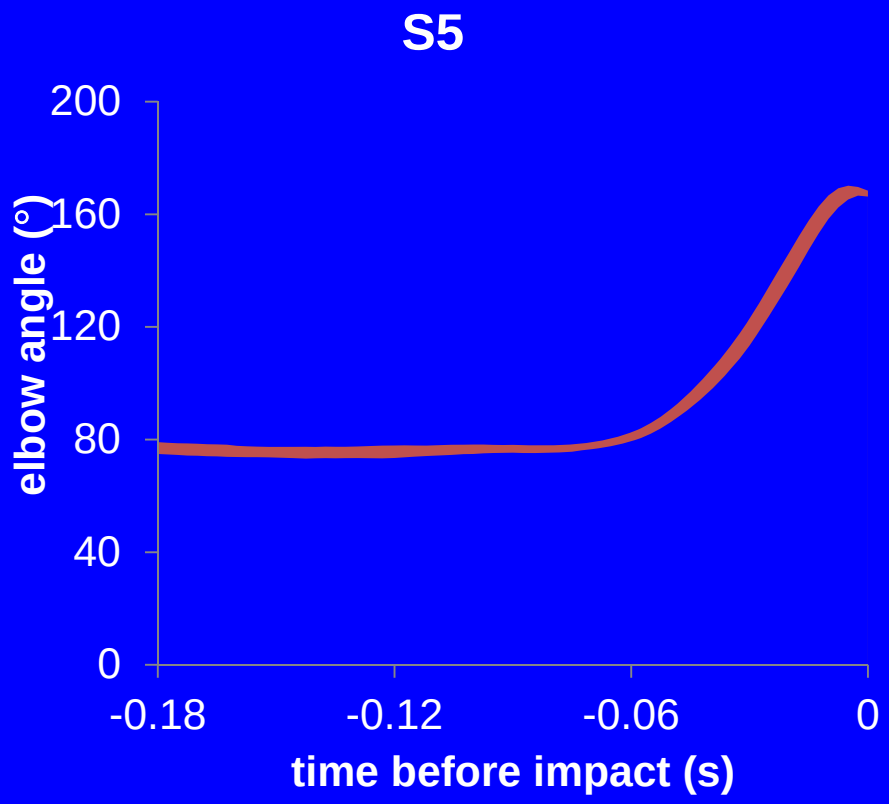
# 2nd DATA COLLECTION - LOUGHBOROUGH STUDENTS

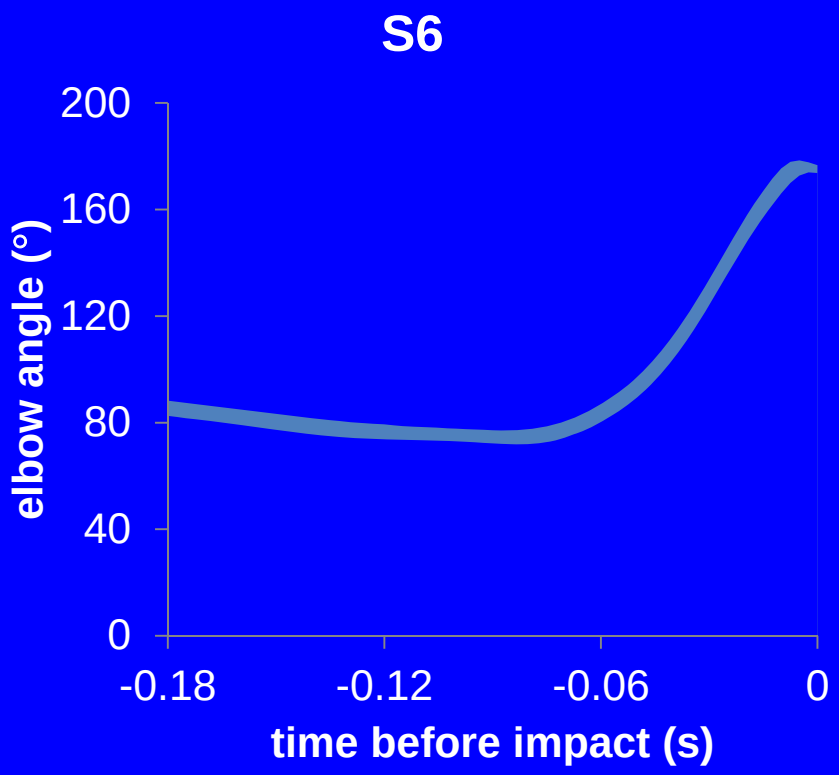
| subject | shuttle speed | vertical angle | horizontal angle |
|---|---|---|---|
| S1 | 334 ± 12 km/h | 14 ± 1° | 3 ± 7° |

| subject | shuttle speed | vertical angle | horizontal angle |
|---|---|---|---|
| S1 | 334 ± 12 km/h | 14 ± 1° | 3 ± 7° |
| S2 | 293 ± 13 km/h | 12 ± 2° | 3 ± 2° |
| S3 | 319 ± 18 km/h | 13 ± 2° | 4 ± 6° |
| S4 | 293 ± 22 km/h | 11 ± 2° | 5 ± 4° |
| S5 | 304 ± 42 km/h | 17 ± 2° | 2 ± 1° |
| S6 | 302 ± 17 km/h | 15 ± 2° | 4 ± 3° |
| S7 | 278 ± 11 km/h | 11 ± 2° | 3 ± 3° |
| S8 | 246 ± 19 km/h | 11 ± 2° | 4 ± 3° |
| S9 | 337 ± 25 km/h | 18 ± 2° | 3 ± 2° |

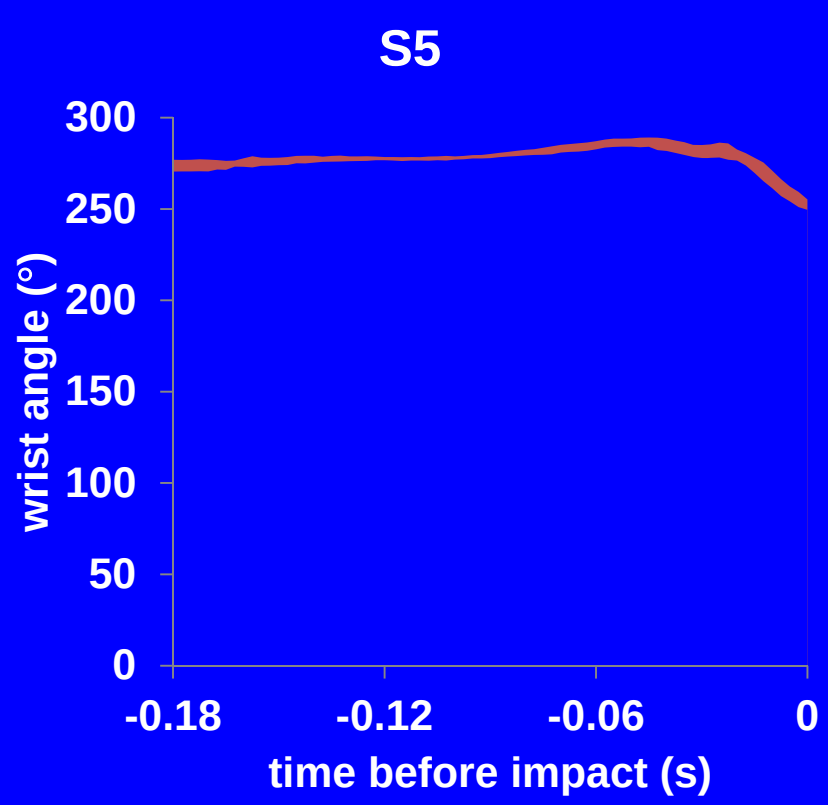
| subject | shuttle speed | vertical angle | horizontal angle |
|---|---|---|---|
| S1 | 334 ± 12 km/h | 14 ± 1° | 3 ± 7° |
| S2 | 293 ± 13 km/h | 12 ± 2° | 3 ± 2° |
| S3 | 319 ± 18 km/h | 13 ± 2° | 4 ± 6° |
| S4 | 293 ± 22 km/h | 11 ± 2° | 5 ± 4° |
| S5 | 304 ± 42 km/h | 17 ± 2° | 2 ± 1° |
| S6 | 302 ± 17 km/h | 15 ± 2° | 4 ± 3° |
| S7 | 278 ± 11 km/h | 11 ± 2° | 3 ± 3° |
| S8 | 246 ± 19 km/h | 11 ± 2° | 4 ± 3° |
| S9 | 337 ± 25 km/h | 18 ± 2° | 3 ± 2° |

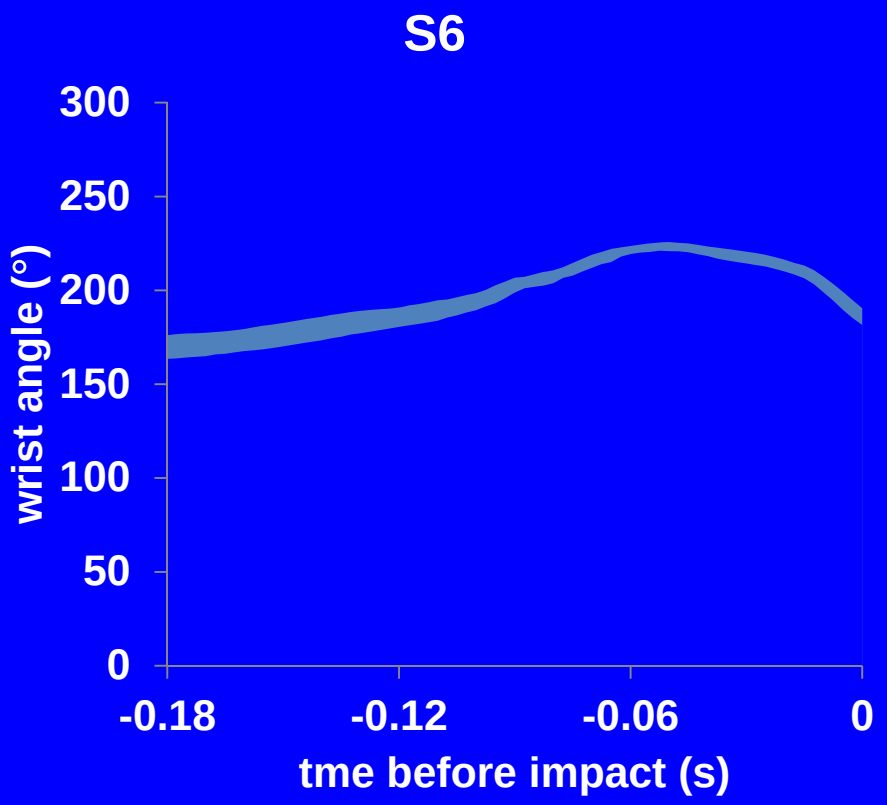
# COMPARISON S5 & S6 – elbow angle



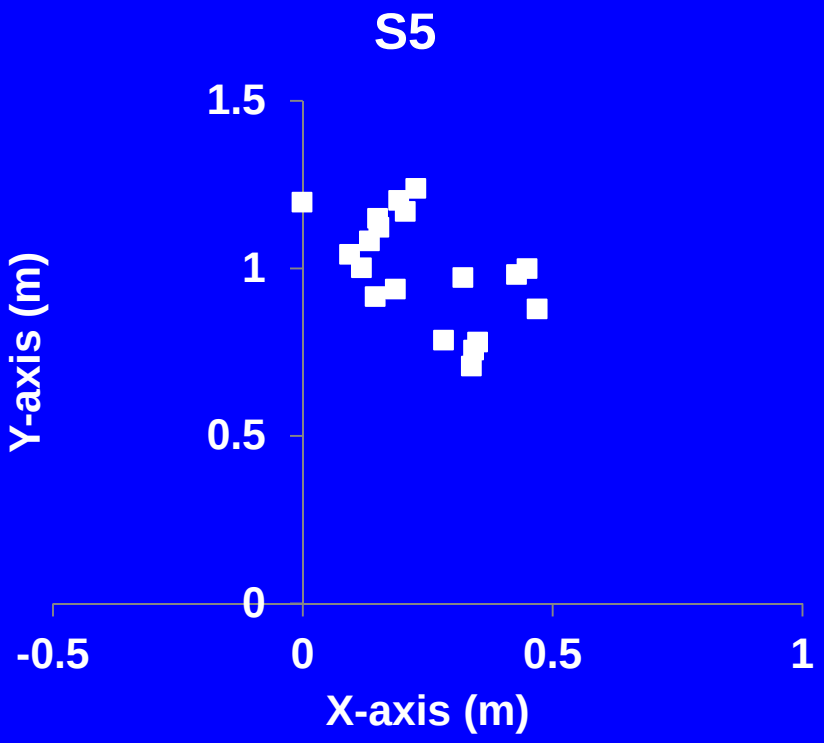



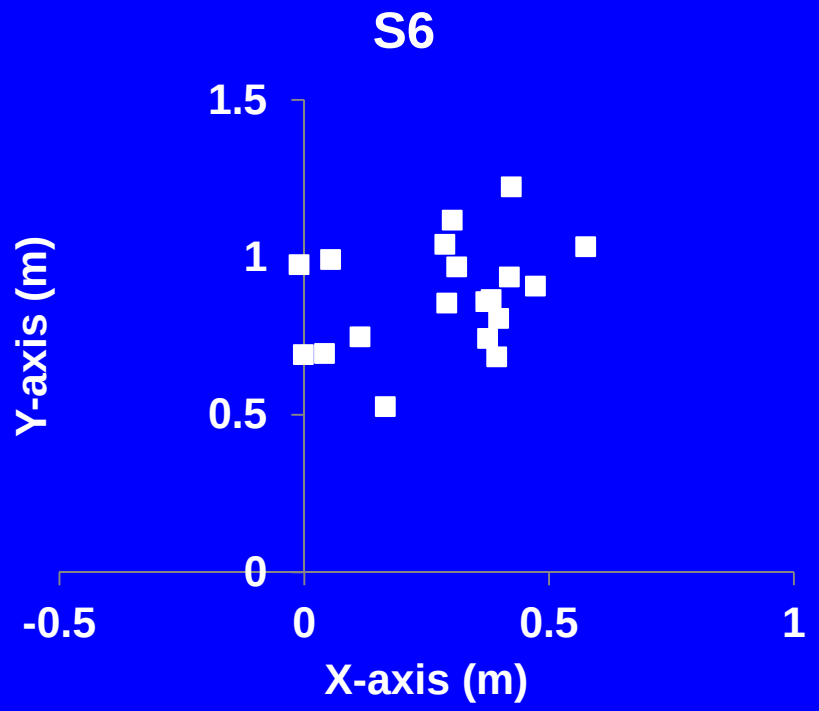
# COMPARISON S5 & S6 – wrist angle



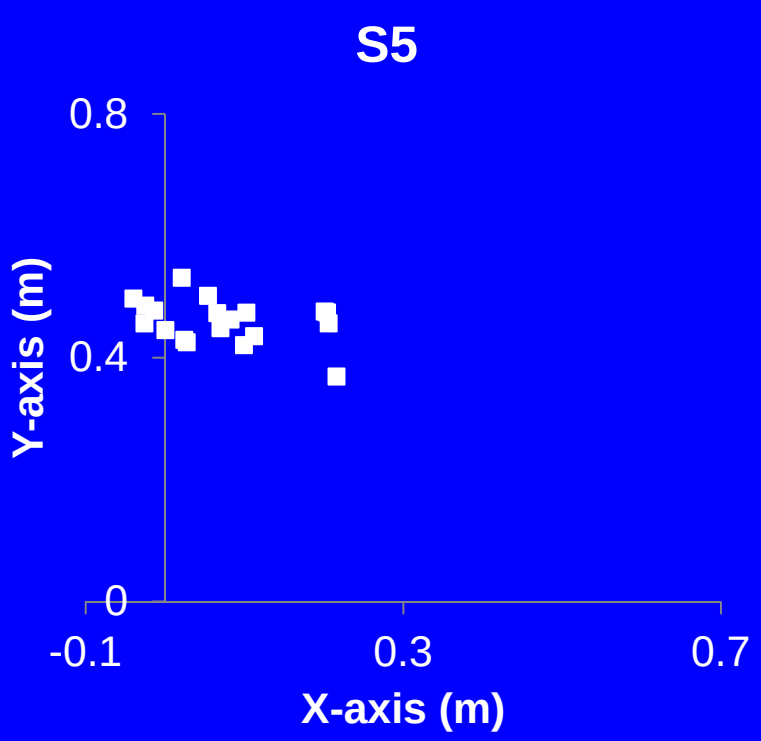



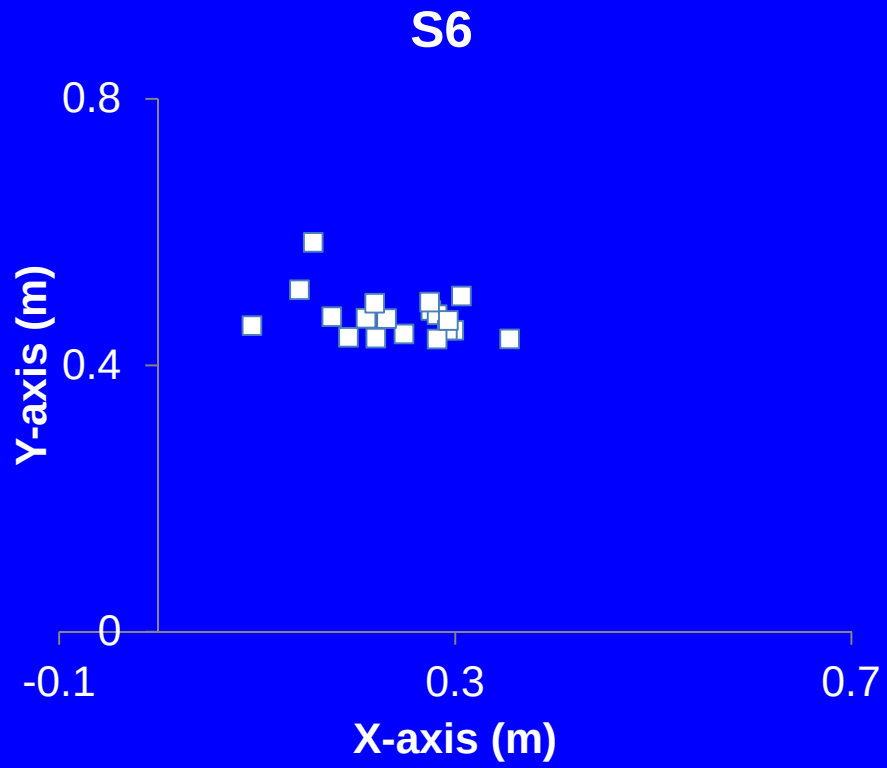
# SHUTTLE AT IMPACT – TOE AT TAKEOFF



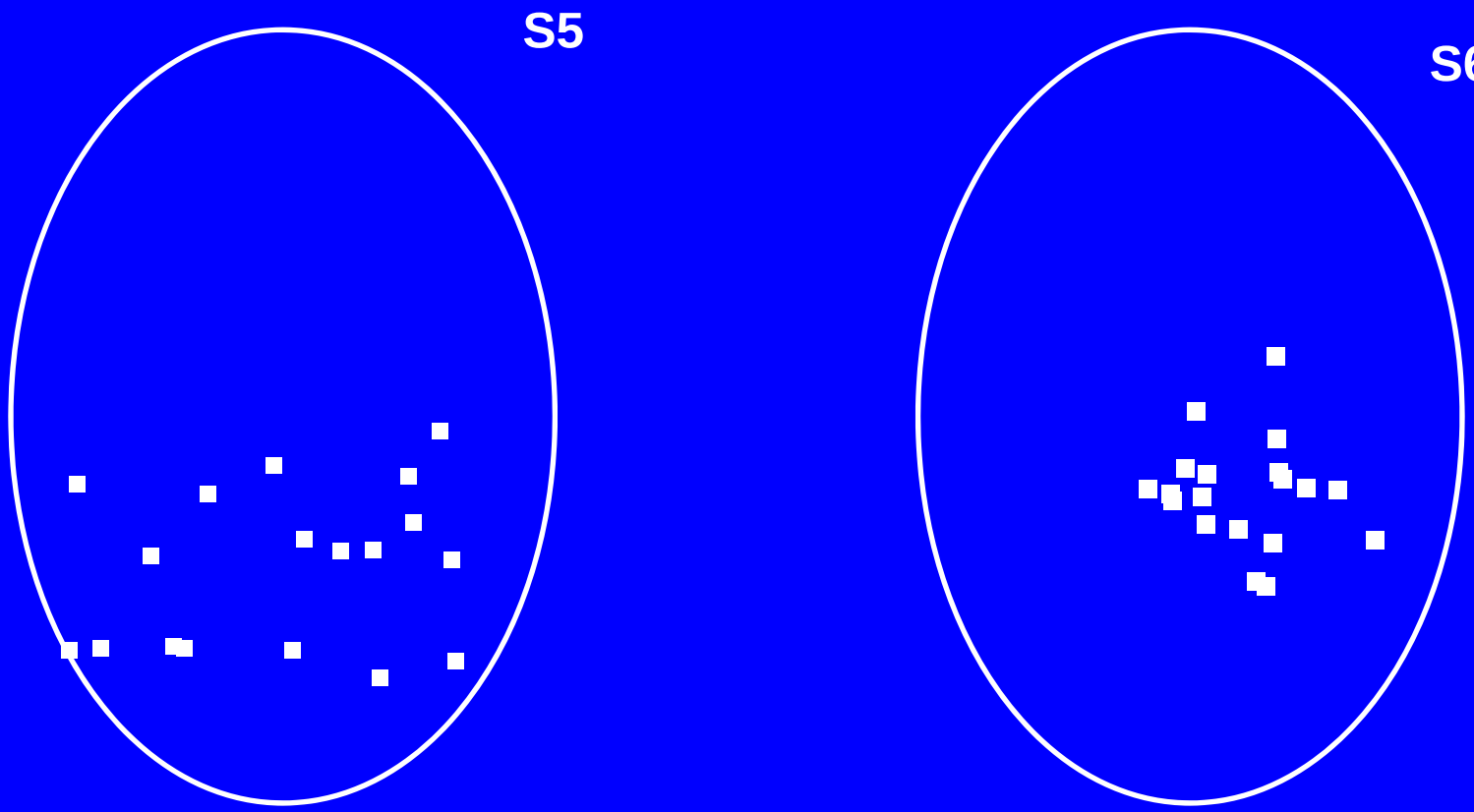



# SHUTTLE - SHOULDER VARIATION AT IMPACT



# SHUTTLE - IMPACT LOCATION ON RACKET



# 2nd BWF PROJECT – ELITE PRO PLAYERS

- normative elite smash data
- quantify differences / similarities
  - male / female
  - different countries
- key aspects of technique
  - speed, accuracy

# BWF SMASH PROJECT

- All England Championships 2016
- Badminton England December 2016
- World Championships 2017

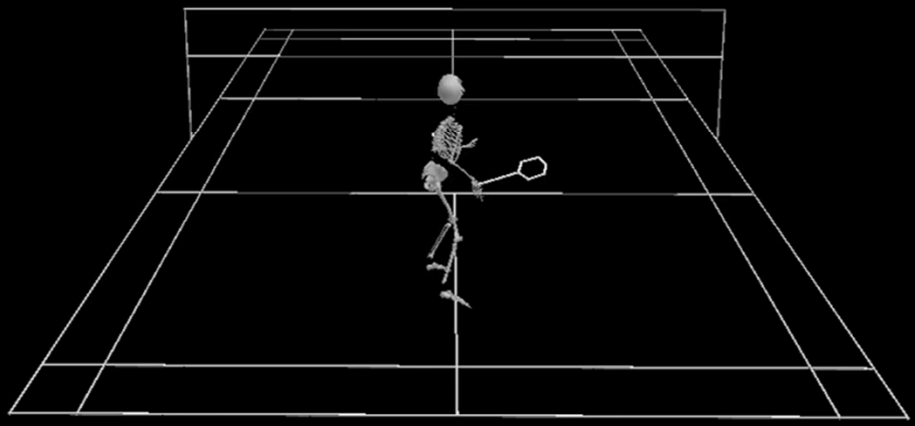
# QUESTIONS

- why can some smash much faster than others?
  - strength
  - technique
  - grip

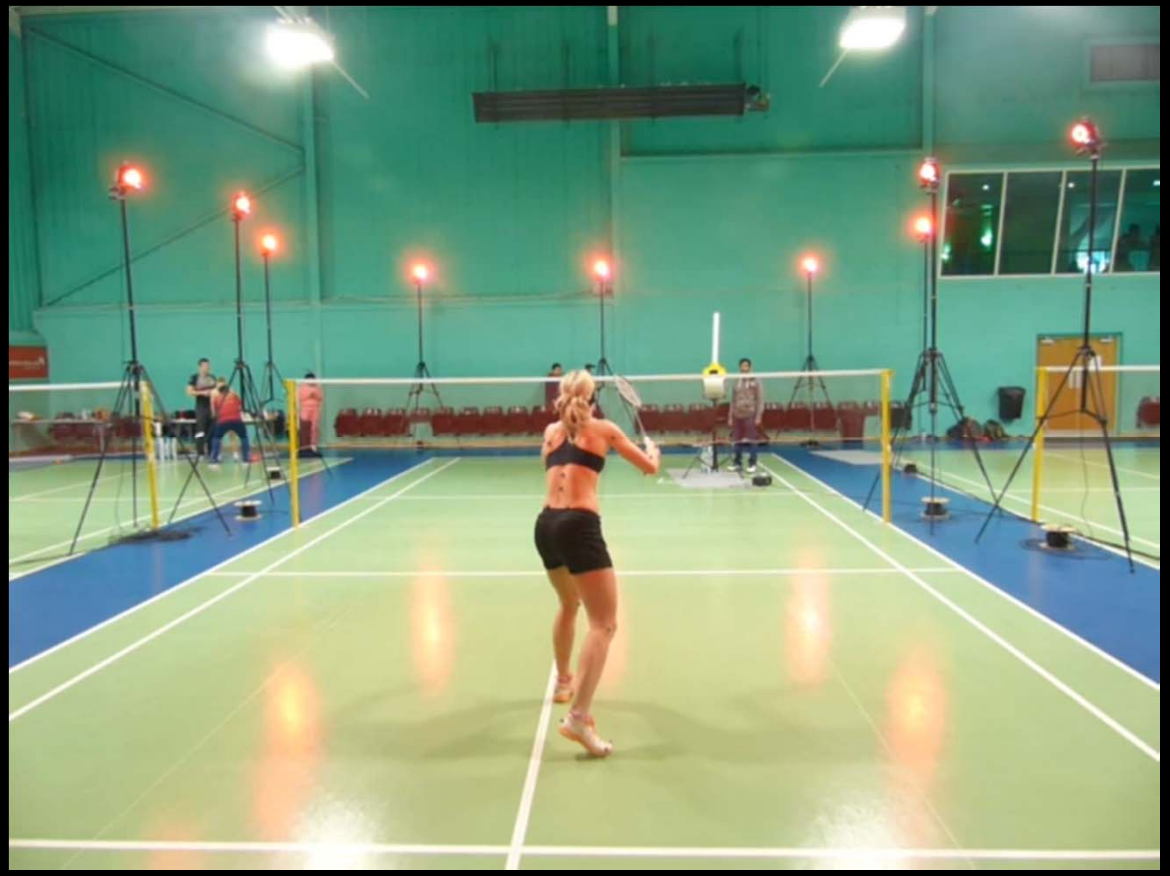
- what is the limit for an individual?
- what does optimum look like?
- how to coach young players to smash faster?

# ALL ENGLAND CHAMPIONSHIPS 2016

# FASTEST SMASH - 360 km/h



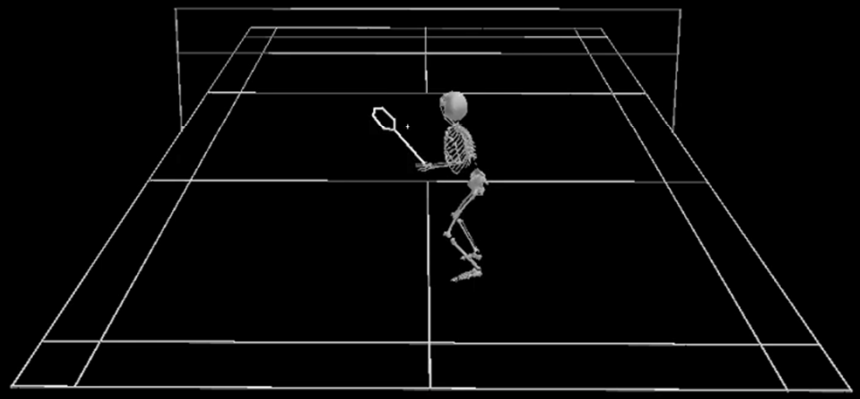
# BADMINTON ENGLAND DEC’ 2016



# BADMINTON ENGLAND DEC’ 2016

# BADMINTON ENGLAND DEC’ 2016

# BADMINTON ENGLAND DEC’ 2016

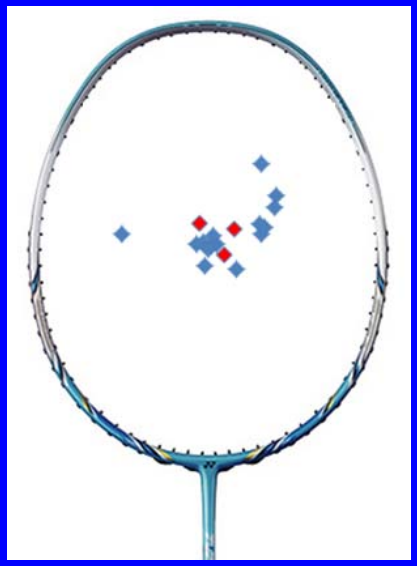


# BADMINTON WORLD CHAMPIONSHIPS 2017

# BADMINTON WORLD CHAMPIONSHIPS 2017

# ALL SMASH DATA COMBINED

- 45 male and 35 female players
- initial analysis max speed:
  - male - 384 km/h
  - female - 317 km/h



# HELP YOUNG PLAYERS TO REACH THEIR POTENTIAL

# THANK YOU


WORLD SENIOR BADMINTON CHAMPIONSHIPS 2015
MUSICA
MUSICA
2
1
3