

# SHOT OUTCOME AS A FUNCTION OF IMPACT LOCATION AND RACKET KINEMATICS IN THE BADMINTON JUMP SMASH

Mark King, Idrees Afzal, & Stuart McErlain-Naylor



Loughborough  
University

# FASTEST BADMINTON SMASH – 426 km/h



# QUANTIFY SHOT OUTCOME



- shuttle speed
- shuttle direction
  - downwards angle
  - direction relative to court and opposition

# CONTRIBUTING RACKET FACTORS



- racket head speed
- racket angle
- racket-shuttle impact location
- racket properties & strings

# PURPOSE

- assess shot outcome as a function of:
  - racket head speed
  - racket angle
  - racket-shuttle impact location
- quantify elite player variability
- ignoring effect of racket & strings

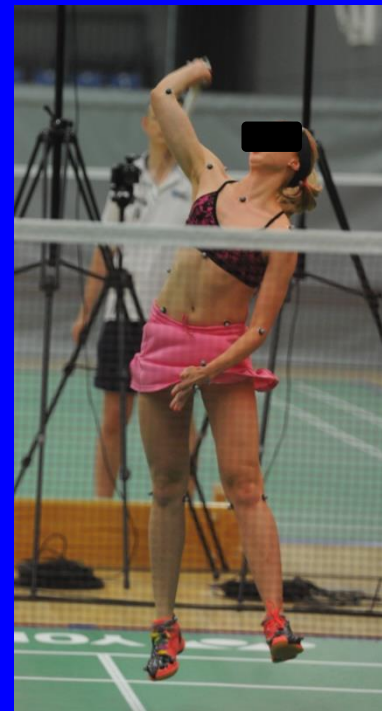
# DATA CAPTURE

- Vicon Motion Analysis System (400 Hz)
- reflective markers on racket and shuttle



# PARTICIPANTS

- 14 international players
  - 2016 All England Championships
  - 2017 World Championships



# BADMINTON WORLD CHAMPIONSHIPS 2017





# MOTION CAPTURE

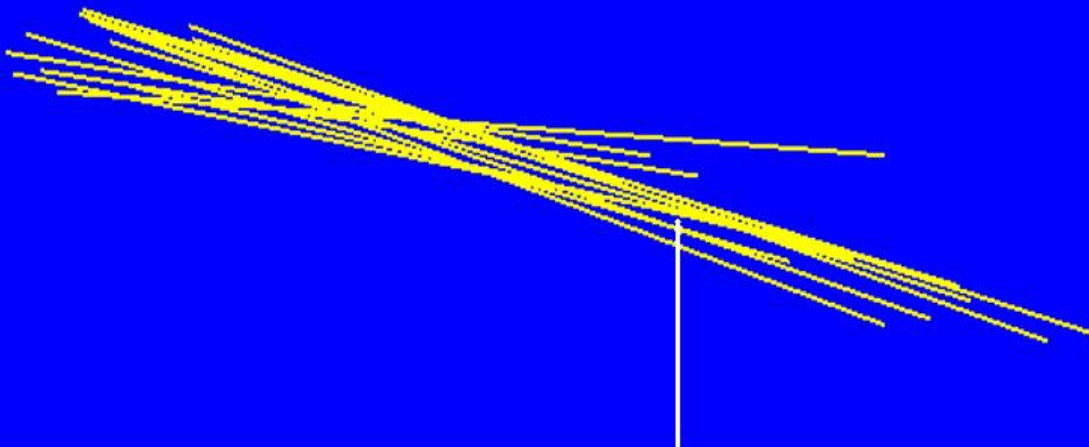


# RESULTS

# DATA SUMMARY

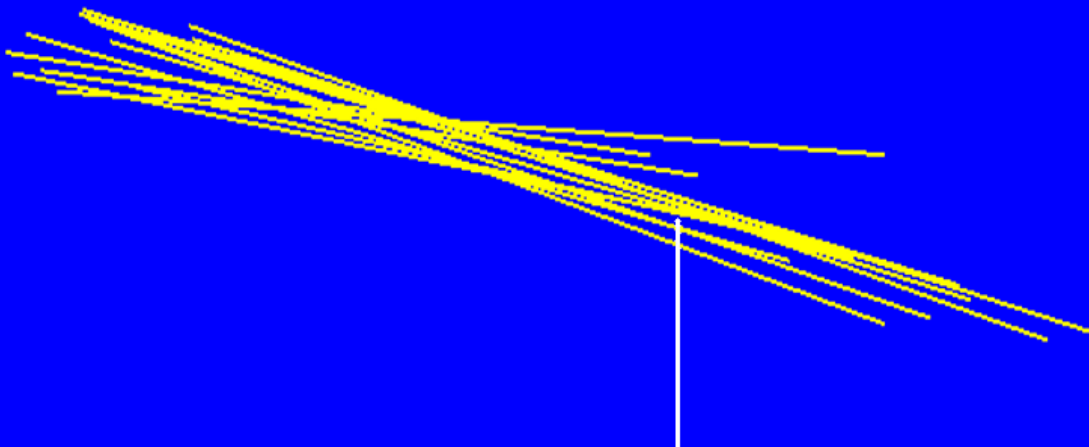
- shuttle speed
  - mean: 290 km/h
  - range: 192 to 368 km/h
- racket speed
  - mean: 203 km/h
  - range: 145 to 253 km/h

# SHUTTLE DIRECTION

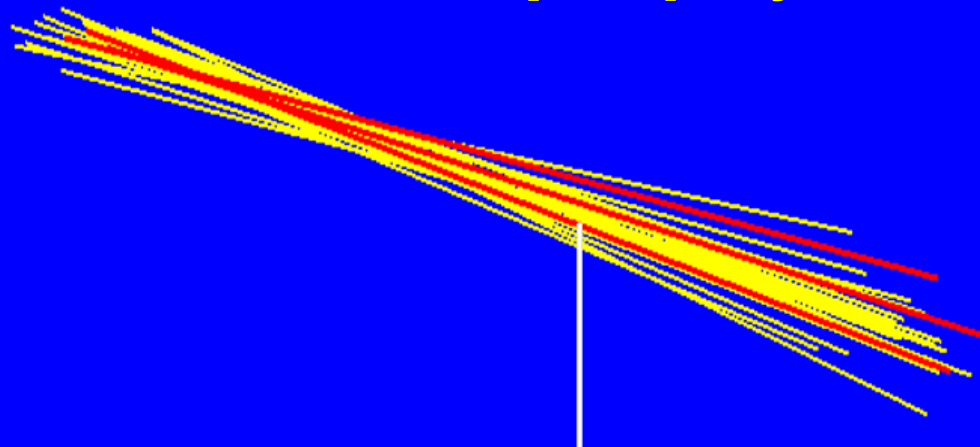


fastest per player

# SHUTTLE DIRECTION



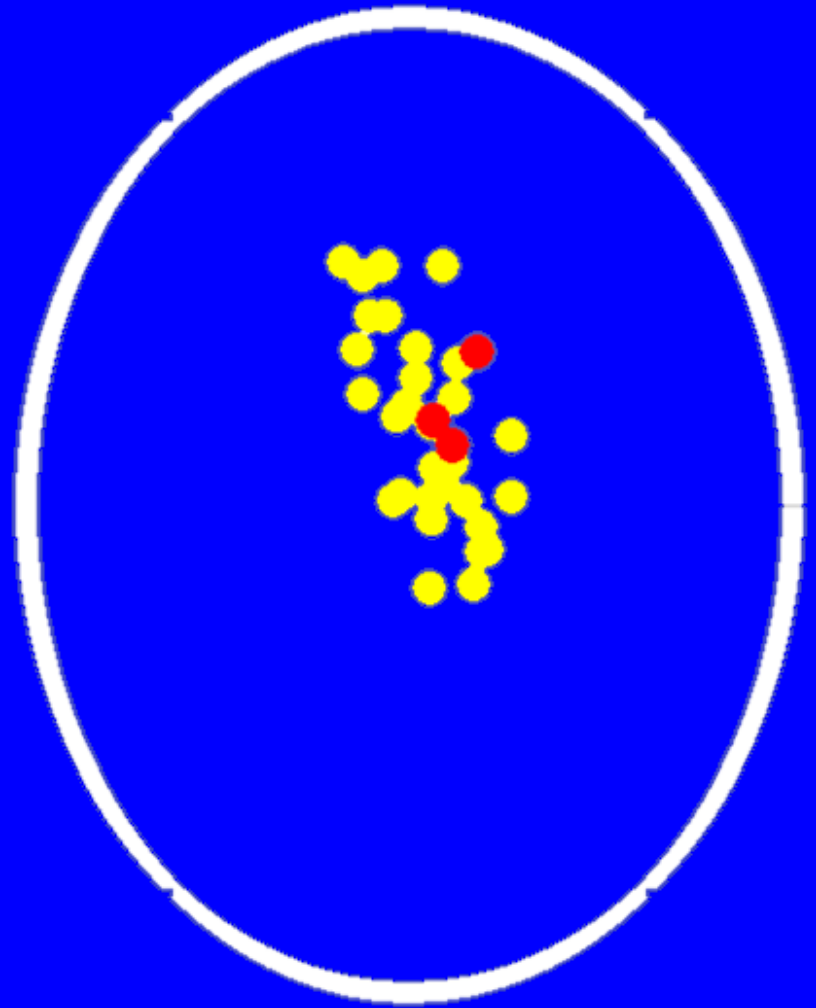
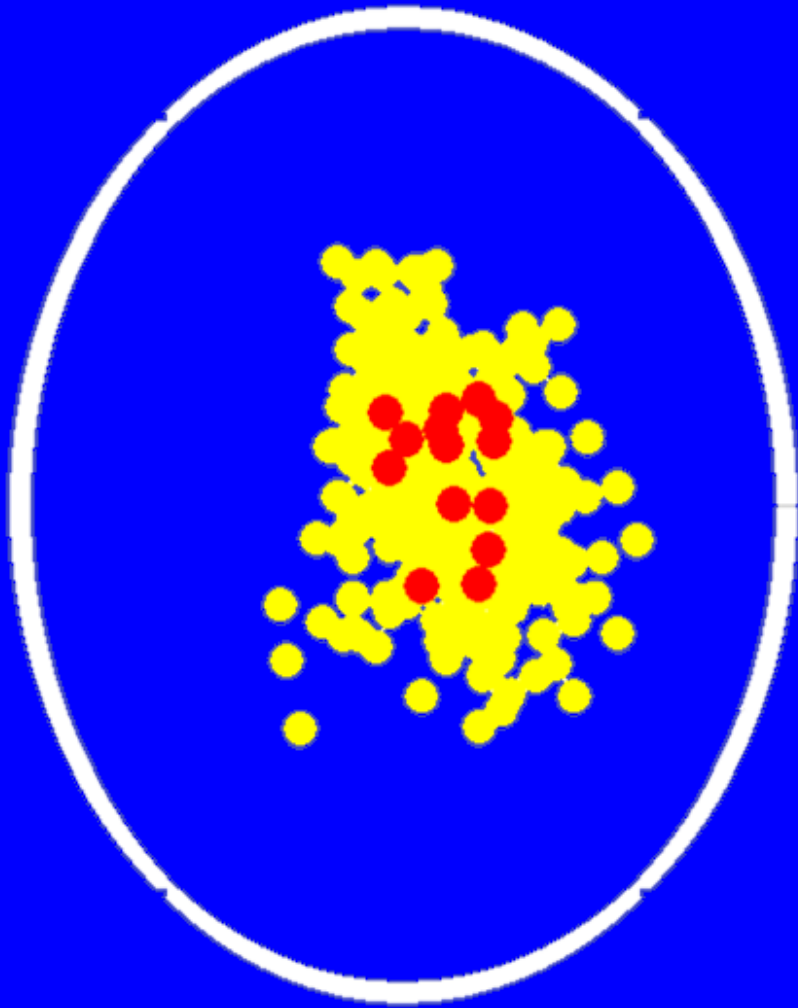
fastest per player



individual player

fastest three

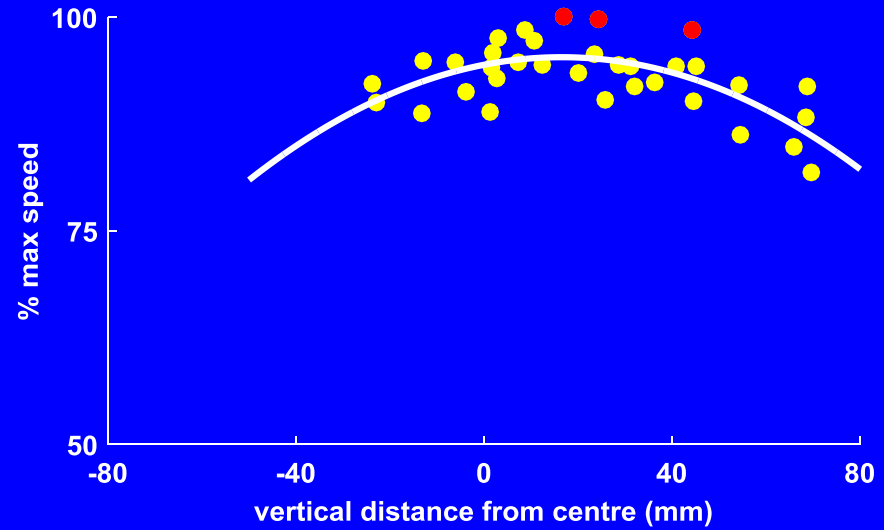
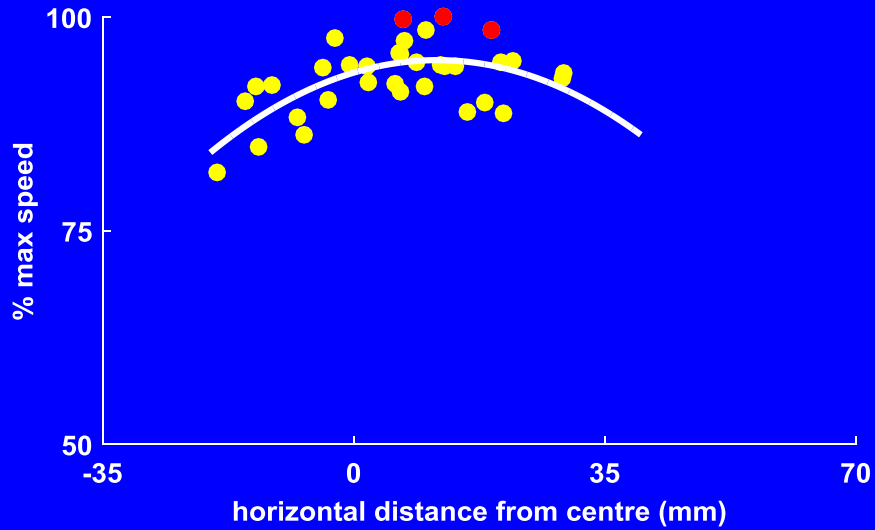
# IMPACT LOCATION



# SHUTTLE SPEED

- shuttle speed variation explained by:
  - racket head speed (**70%**)
  - longitudinal impact location (**86%**)
  - medio-lateral impact location (**89%**)

# IMPACT LOCATION

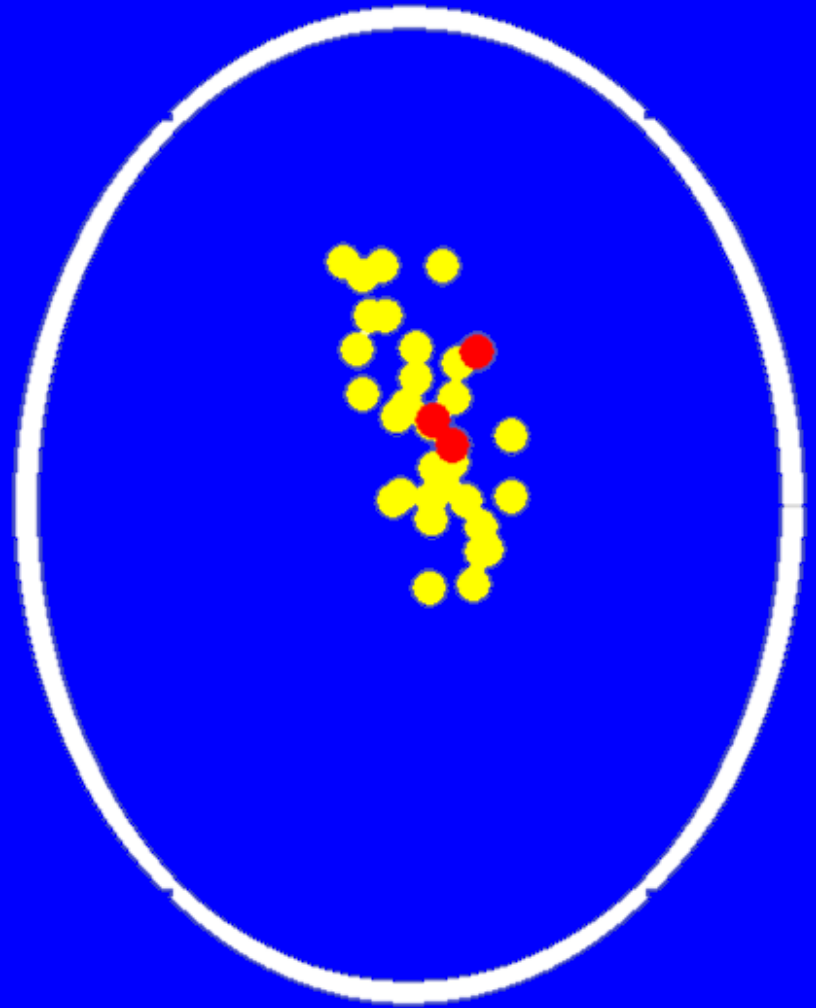
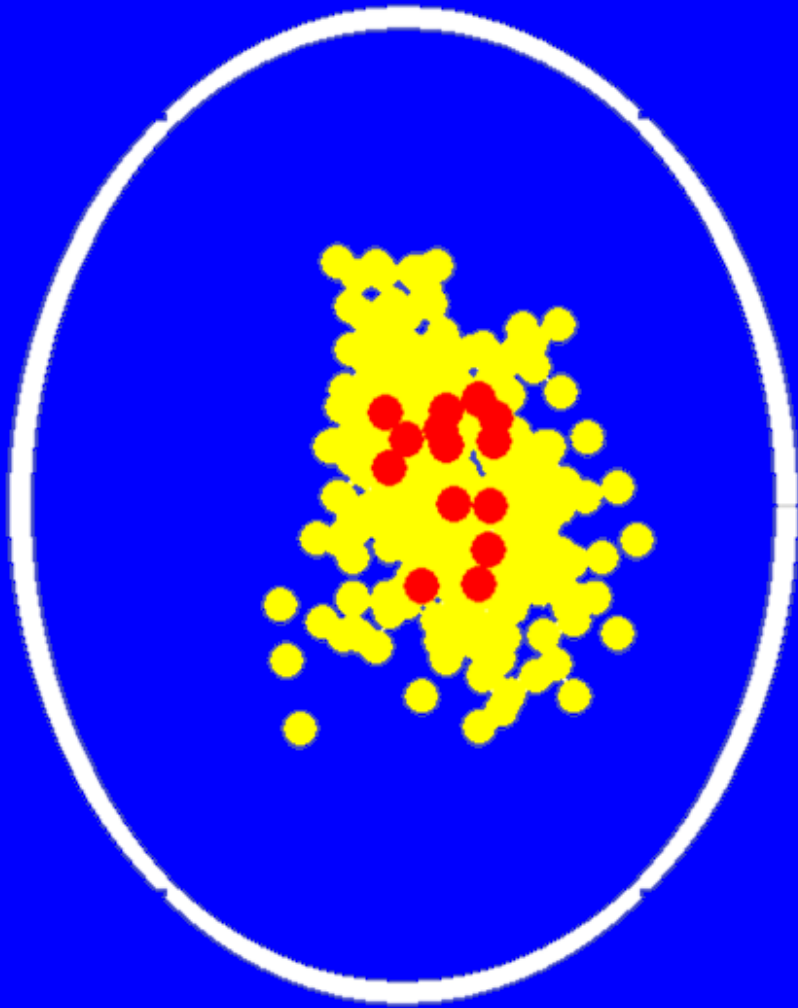




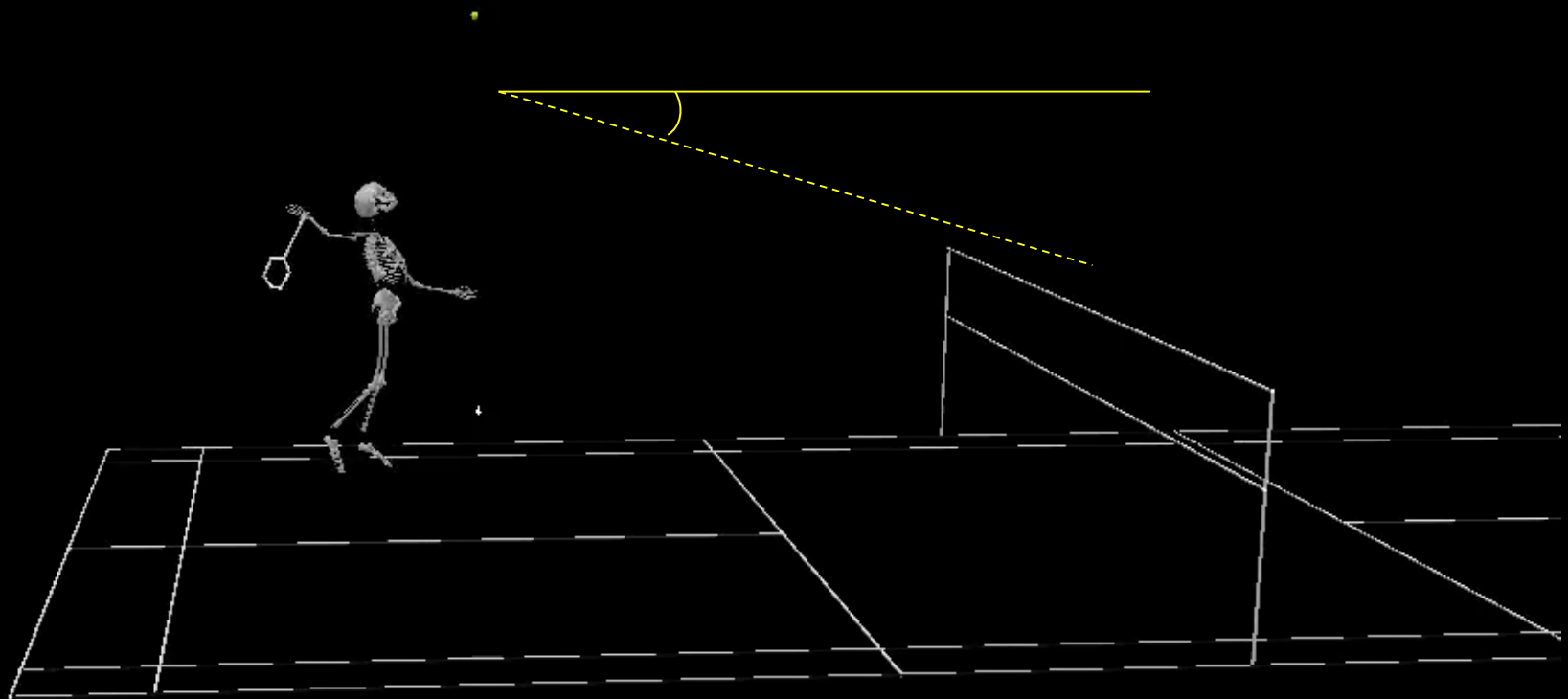
# SHUTTLE SPEED

- shuttle speed variation explained by:
  - racket head speed (**70%**)
  - longitudinal impact location (**86%**)
  - medio-lateral impact location (**89%**)
- **‘sweet region’**:
  - 1.1 cm mediolaterally
  - 3.0 cm longitudinally
  - less than 5% reduction in shuttle speed

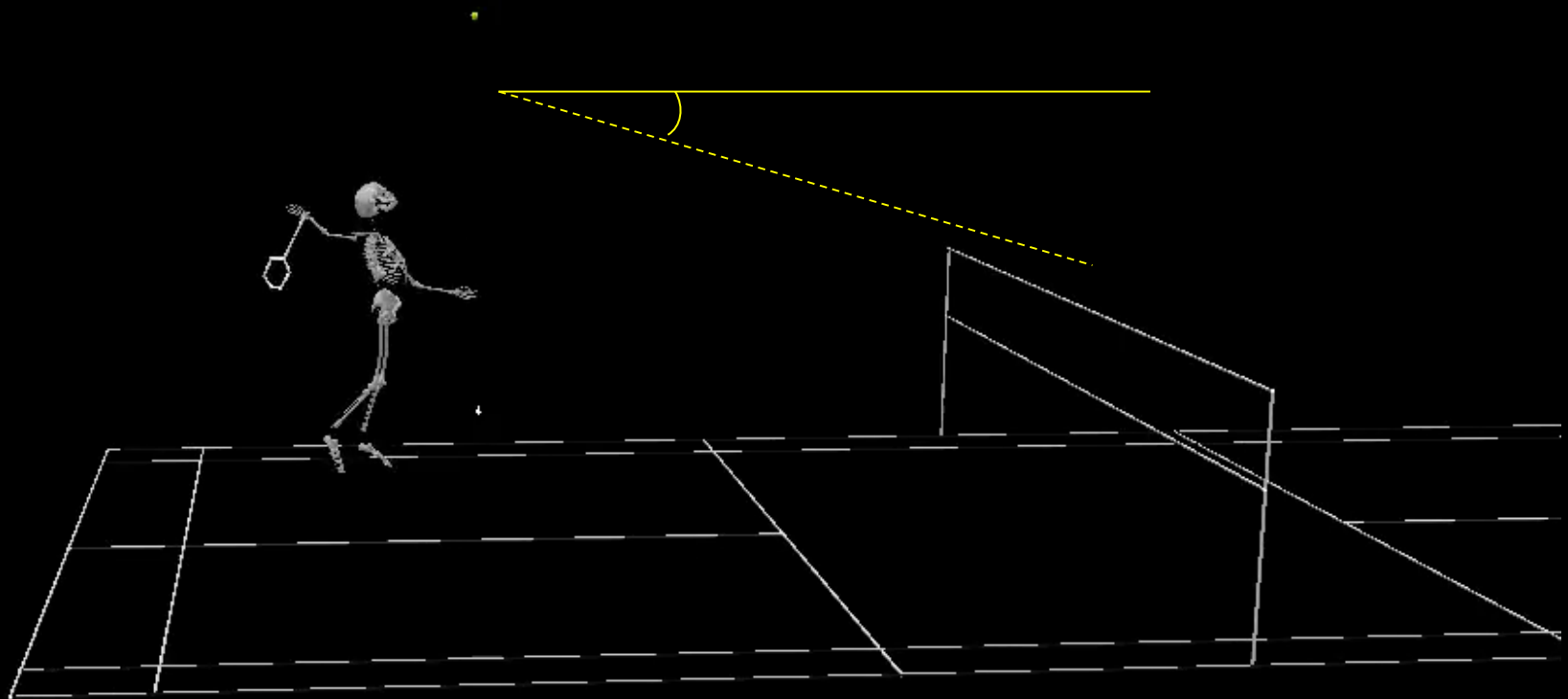
# IMPACT LOCATION



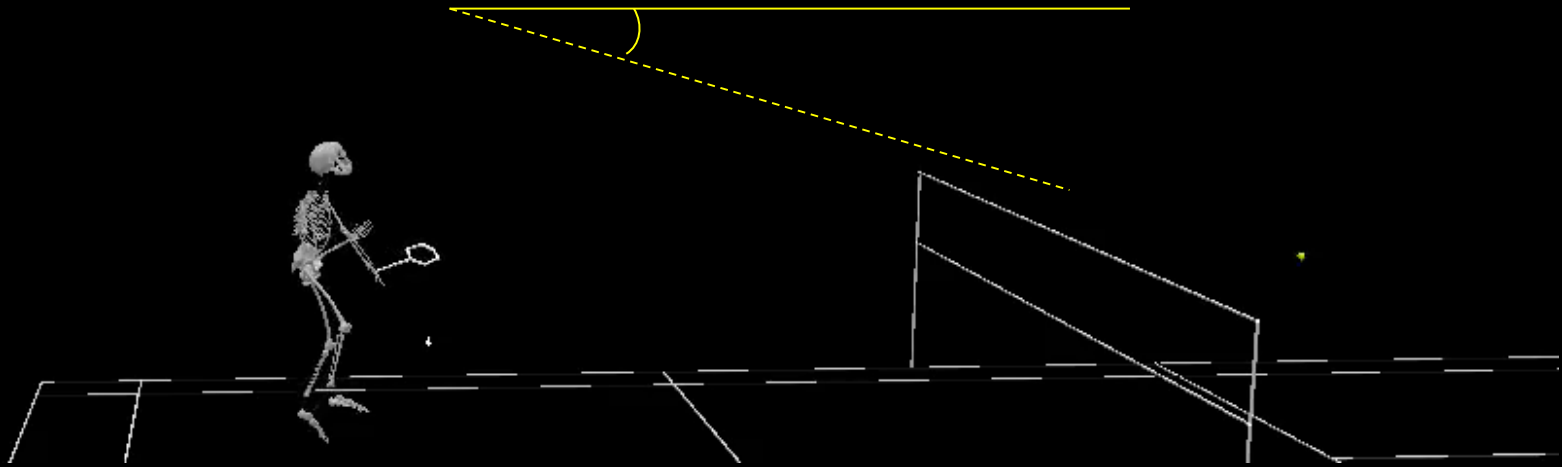
# SHUTTLE DIRECTION



# SHUTTLE DIRECTION

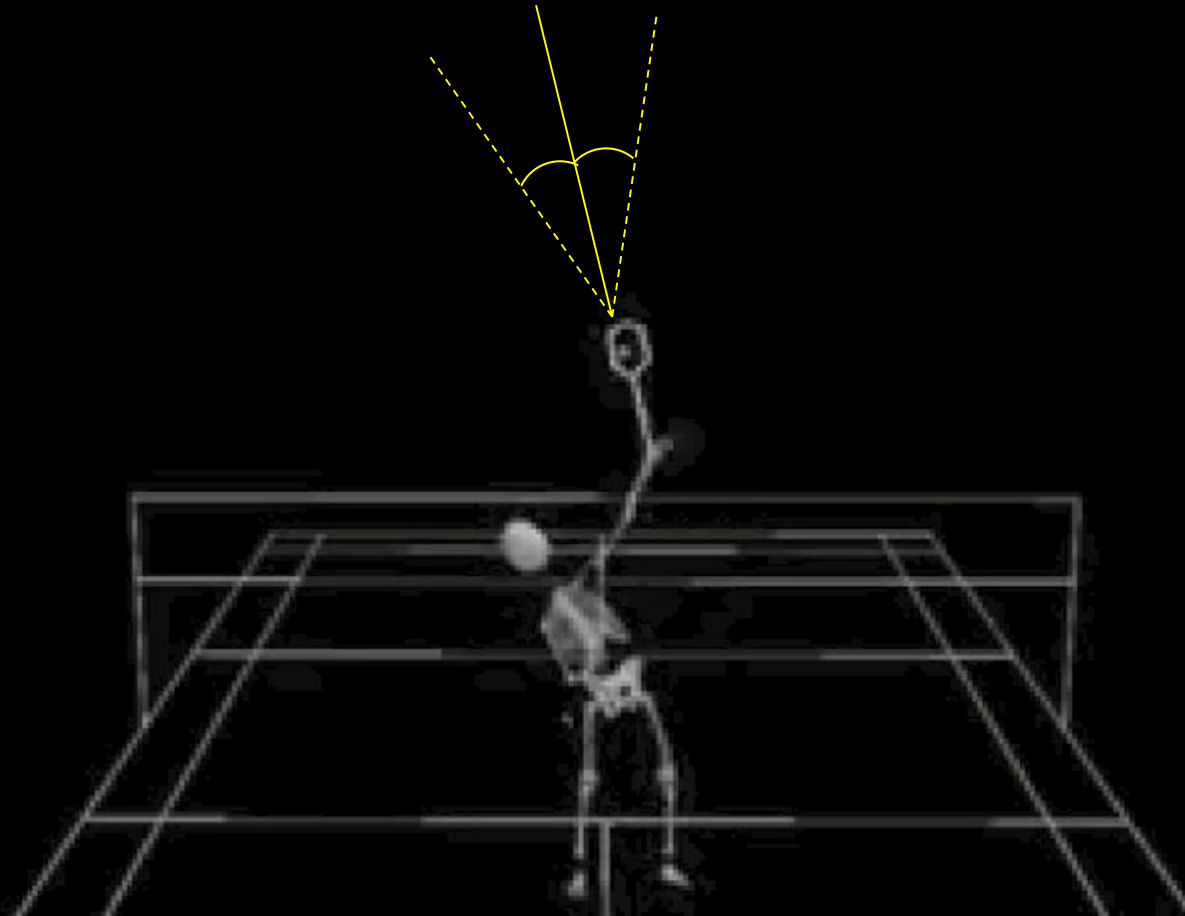


# SHUTTLE DIRECTION



- vertical shot direction explained by:
  - racket angle at impact (**64%**)
  - longitudinal impact location (**72%**)

# SHUTTLE DIRECTION



- **53%** lateral deviation explained by:
  - medio-lateral impact location

# CONCLUSIONS

- shot outcome is determined by:

# CONCLUSIONS

- shot outcome is determined by:
  - racket head speed and angle at impact



# CONCLUSIONS

- shot outcome is determined by:
  - racket head speed and angle at impact
  - impact location of shuttle on racket face

# CONCLUSIONS

- shot outcome is determined by:
  - racket head speed and angle at impact
  - impact location of shuttle on racket face
- greater understanding of margin for error

# FUTURE WORK

- methods for increasing margin for error:
  - technique
  - racket properties

**THANK YOU**



# PBL - FASTEST SMASHES 2017

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

# 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?