Topic 5 – Screening of an Elite Triple Jumper (Quintic and RSscan syncronisation)

Proposed subject usage:

Podiatry
Physiotherapy
Strength and Conditioning
Sports science (1st /2nd and 3rd year)
Coaches

Objective

- To show how video analysis and RSscan can be used within an in season fitness screening assessment.
- To calculate the peak forces, loading rates and weight profile during a back squat.
- To identify any possible injuries due to leg dominance, asymmetry or potential high loading rates.

Introduction

Force

A body's state of being in rest (stationary) or in motion can be changed by the action of another body. The action exerted by this body that causes the change is termed a force. Therefore a body in motion can accelerate, decelerate or have the path of motion altered by the force another body exerts on it. Alternatively a body at rest can be made to move when an external force is placed upon it.

Force is measured in Newton's (N). A force of 1N is the force that will produce an acceleration of $1ms^{-2}$ in a body of 1Kg mass.

$$\text{Force (N)} = \text{Mass (Kg)} \times \text{Acceleration } (ms^{-2})$$

Rate of Force Development

Strength work has been shown to improve performance particularly for sprinters, and jumpers but it is not beneficial in developing rate of force - the speed with which force is achieved. For example it takes around 400 ms to develop maximum force during a squat exercise, but the foot-ground contact time in during the sprint phase of a triple jump is around 90 ms. Therefore if an athlete cannot generate force quickly, they cannot continue to accelerate down the runway.

$$\text{Rate of Force Development } (Nms^{-1}) = \text{Force exerted (N)} / \text{Time (S)}$$

Method

Video footage was taken at 50hz, along with RSscan data at 100Hz. The video has been calibrated and digitised, Raw data collected from the 1 metre RsScan plate has been exported into excel, pressure distribution peak force and loading rates have been calculated. (See spreadsheets below). Still images have been exported from the video to illustrate the athlete's body position at key points.

Functions of the software used:

Digitisation module
Calibration
Export *.avi function
Interactive graph and data displays
Export data
Image capture
Quintic and RsScan Synchronisation
Quintic RSscan Key Controller

Results

Bodyweight 71.6Kg (702.4N)
Peak Force (PF): 4309N, (6.13 Body Weights (BW))
PF occurs at frame: Quintic: 117, RsScan: 37
Peak Rate of Force Development (PRFD) occurs at frame: Quintic: 101, RsScan: 21
PRFD: 4800Ns^{-1}
Rate of Force Development (RFD) @ PF: 2300Ns^{-1}
Elapsed time between PRFD and RFD @ PF: 0.32s
Left/Right Force Distribution at PF: 41% / 59%
Toes/Heels Force Distribution at PF: 57% / 43%
Knee angle at PF: 251º/109º
Angular velocity of the knee at PF: 153.8º/s

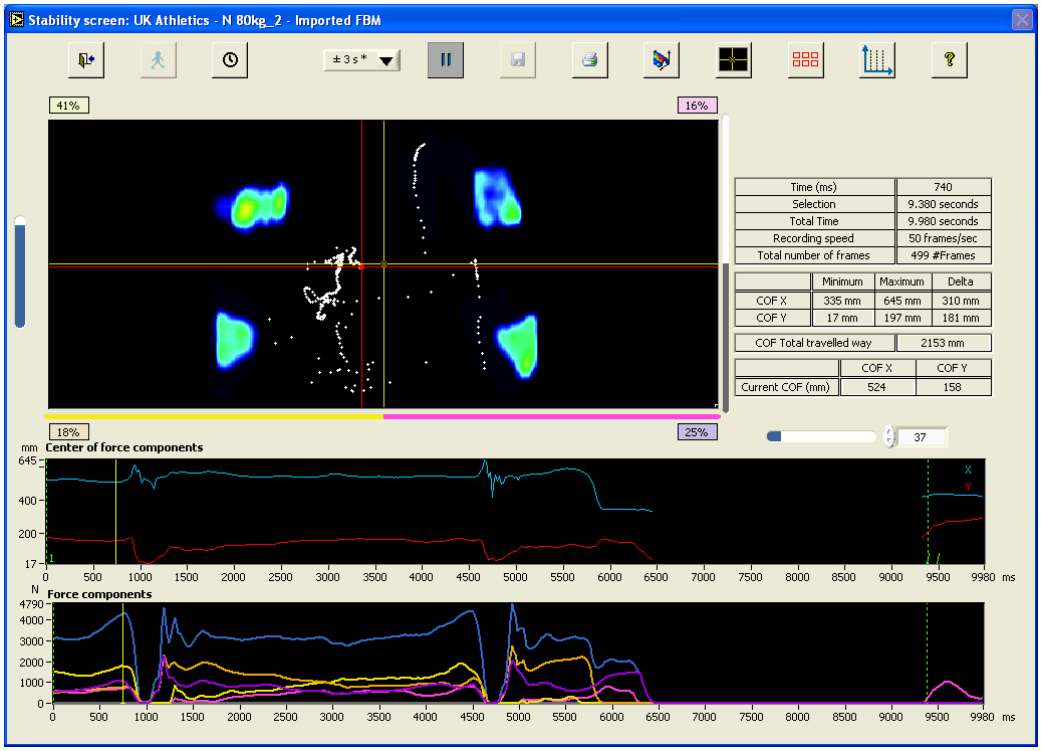
80Kg Bar

Illustration 1a

Peak Force
4309N

Illustration 1b

Peak Rate of force Development
4800Ns^{-1}



RSscan at Peak Force 4309N (6.13BW)

Conclusion

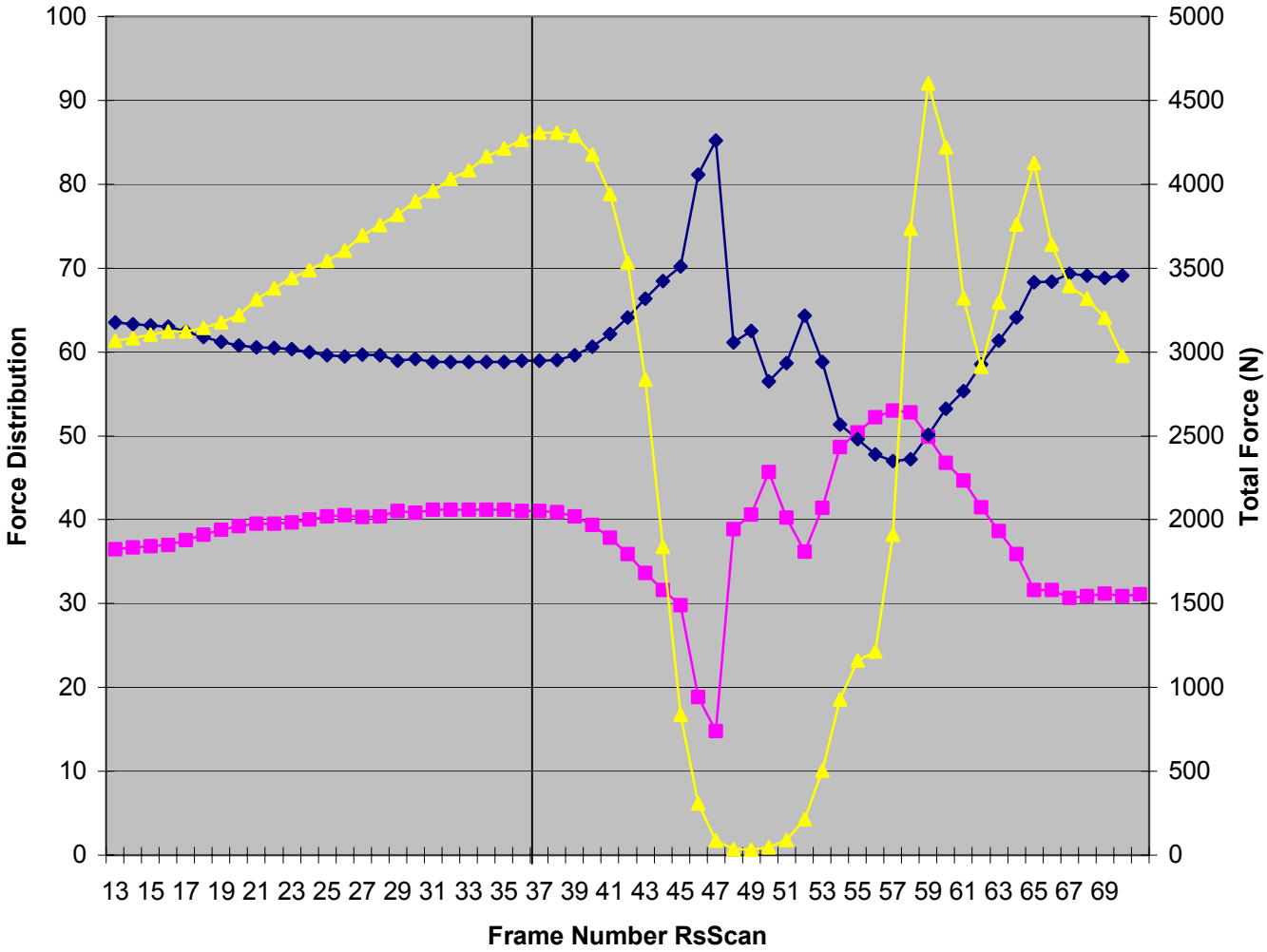
In conclusion the results illustrate that the peak force of 4309N is generated when the knee angle is 109º during the drive/extension phase of the squat. Peak rate of force development ($4800Ns^{-1}$) is generated 320ms prior to peak force in the drive/extension phase

The results also indicate that at peak force, force distribution divided by 41% through the athletes left foot and 59% through the right foot. If the weight is divided by the toes and heels then the results show that 57% goes through the athlete's toes and 43% through the athlete's heels at Peak Force. These results suggest that there is a slight dominance towards the athlete's toes and right side during the technique of an 80Kg squat. The dominance towards the toes during the extension phase of the squat can be due to the actual physical movement of the athlete, as due to the athlete driving upwards, the athletes feet plantar flex resulting in more pressure being directed though the balls of the athletes feet.

However the asymmetry towards the athlete's right side is a concern as the difference is 18%. Due to the magnitude of difference between the athletes left and right side, the athletes sports science team where notified, to help identify the cause of this problem i.e, a restriction in range of motion on one side, muscular tightness, and develop a suitable intervention program.

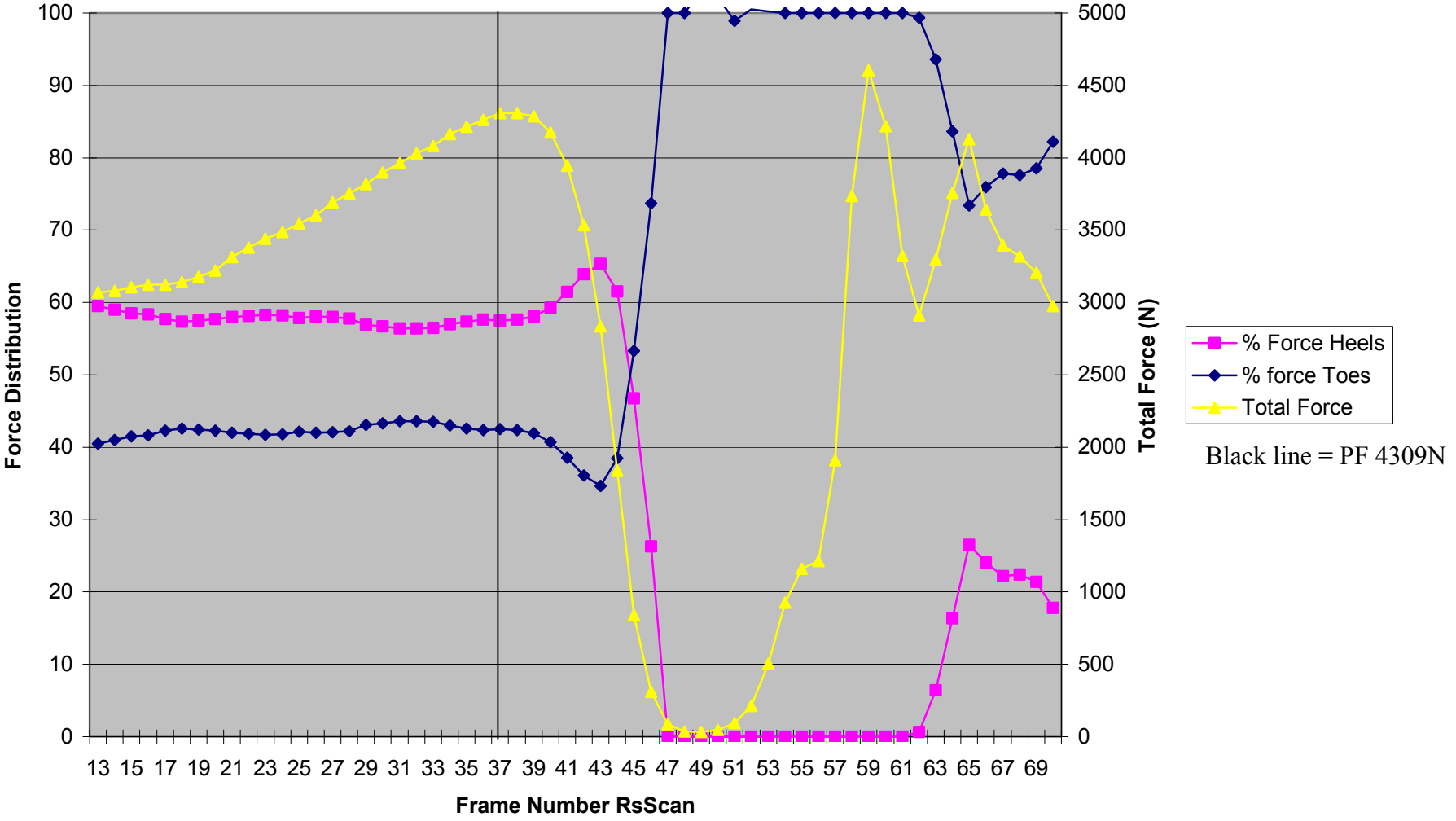
This case study is an example of one lift using one-weight performed during a vigorous fitness screening session. By using different loads the sport science support team can look at the effects that power or endurance skills have on peak force, rate of force as well as weight distribution profiles.

Force Distribution During an 80Kg Front Squat



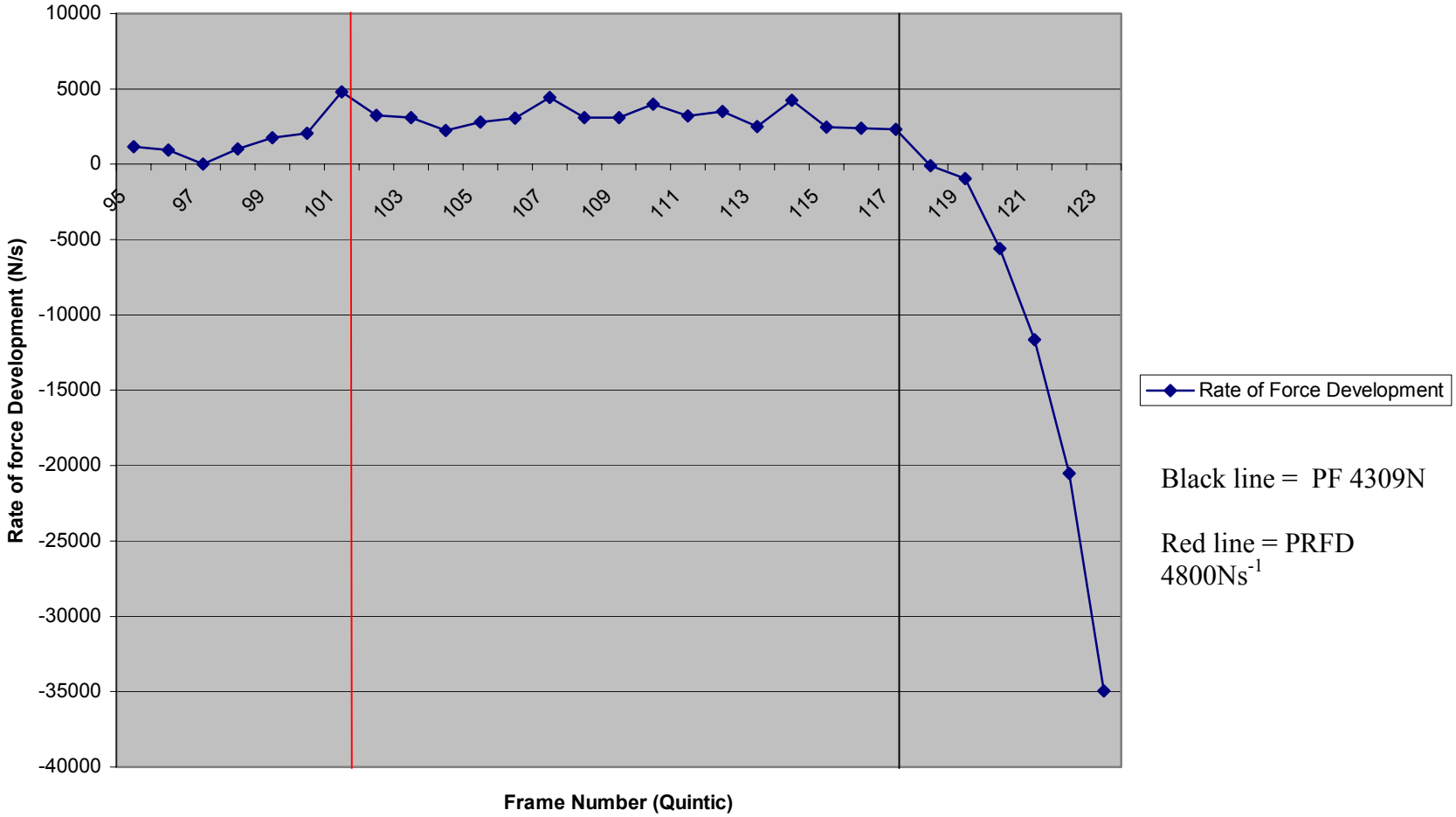
Black line = PF 4309N

Force Distribution During a 80Kg Front Squat



Black line = PF 4309N

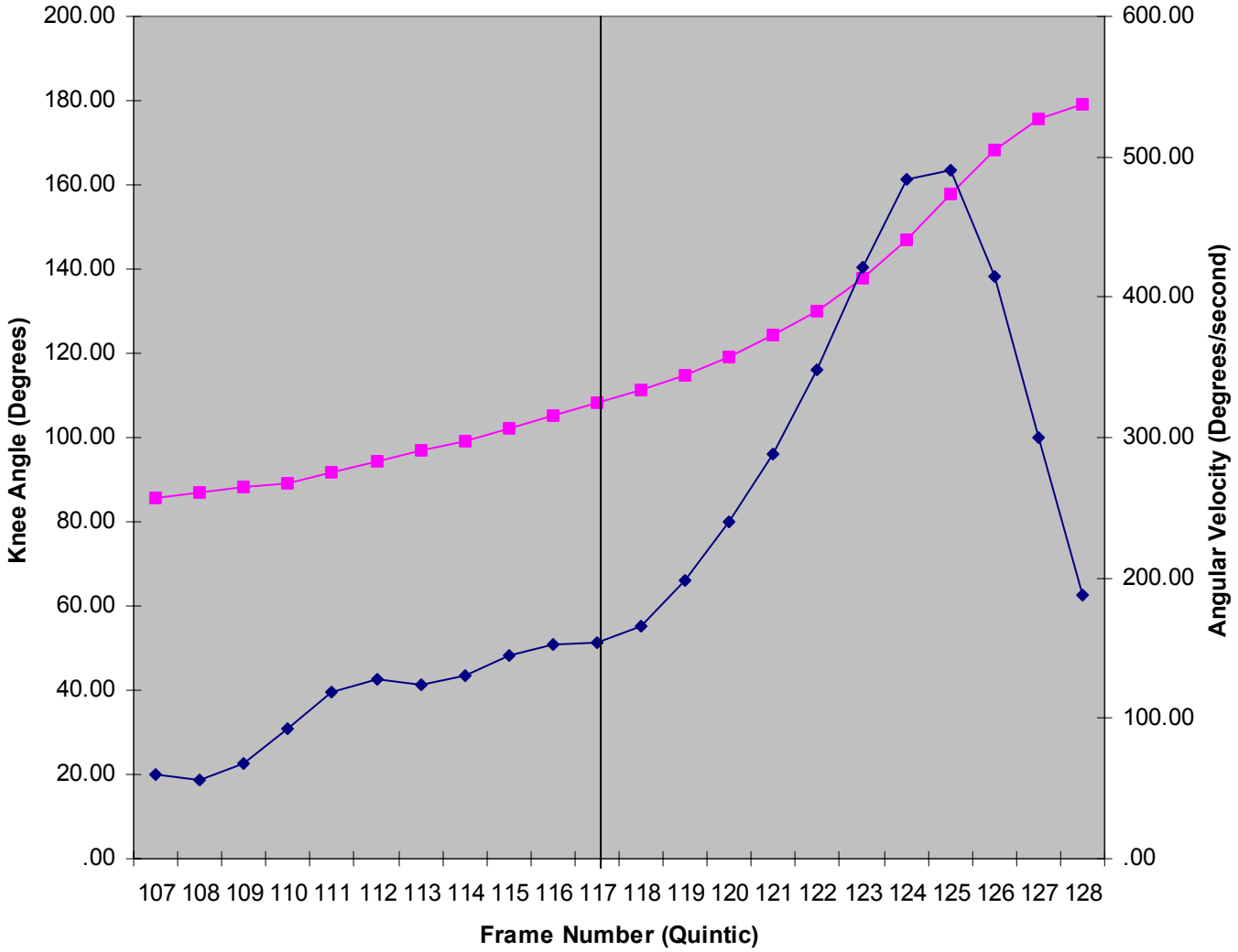
Rate of Force Development During the Drive Phase of a 80Kg Front Squat



Black line = PF 4309N

Red line = PRFD $4800Ns^{-1}$

Knee Angle Displacement and Angular Velocity During an 80Kg Front Squat



Black line = PF 4309N