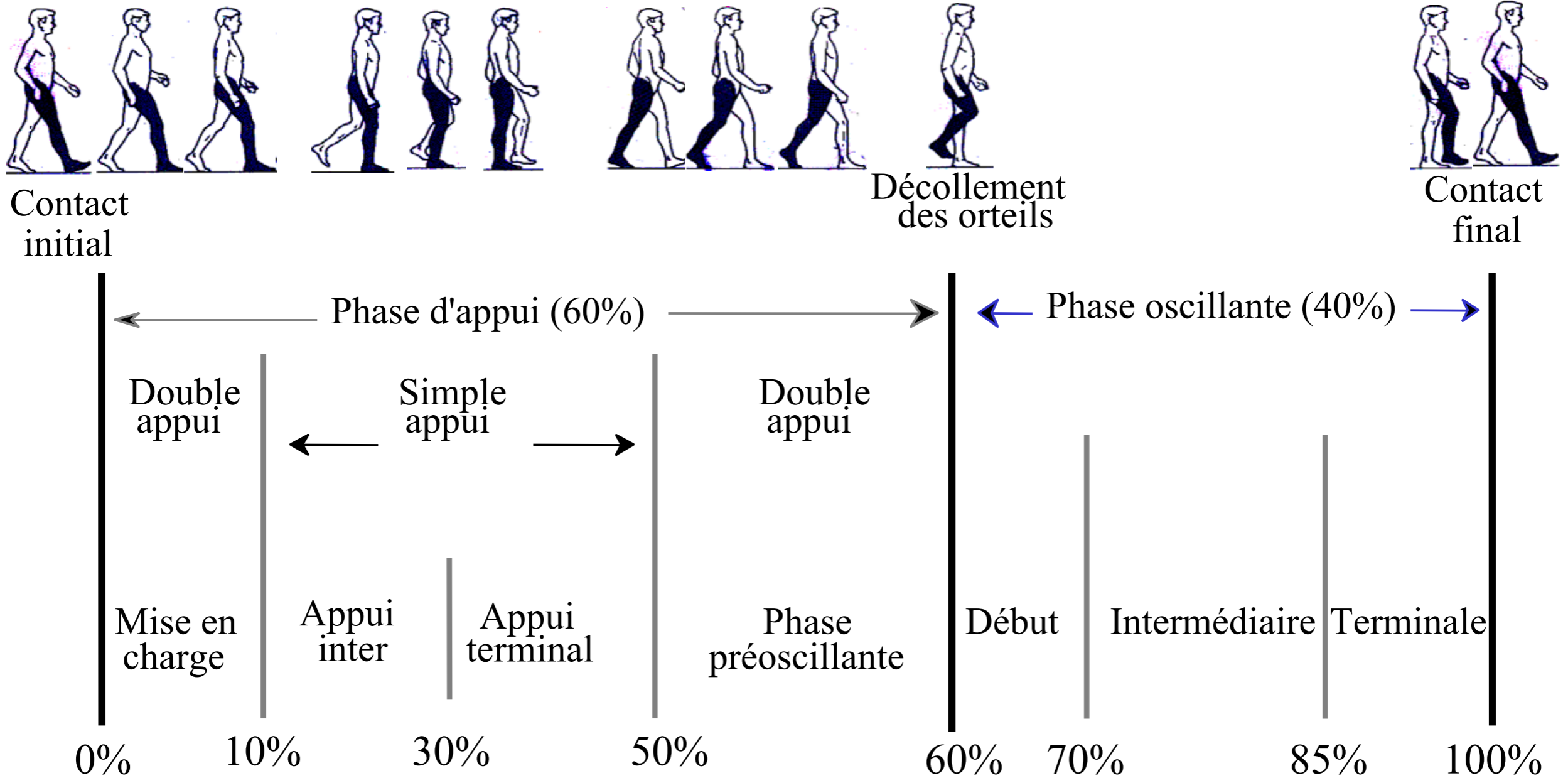
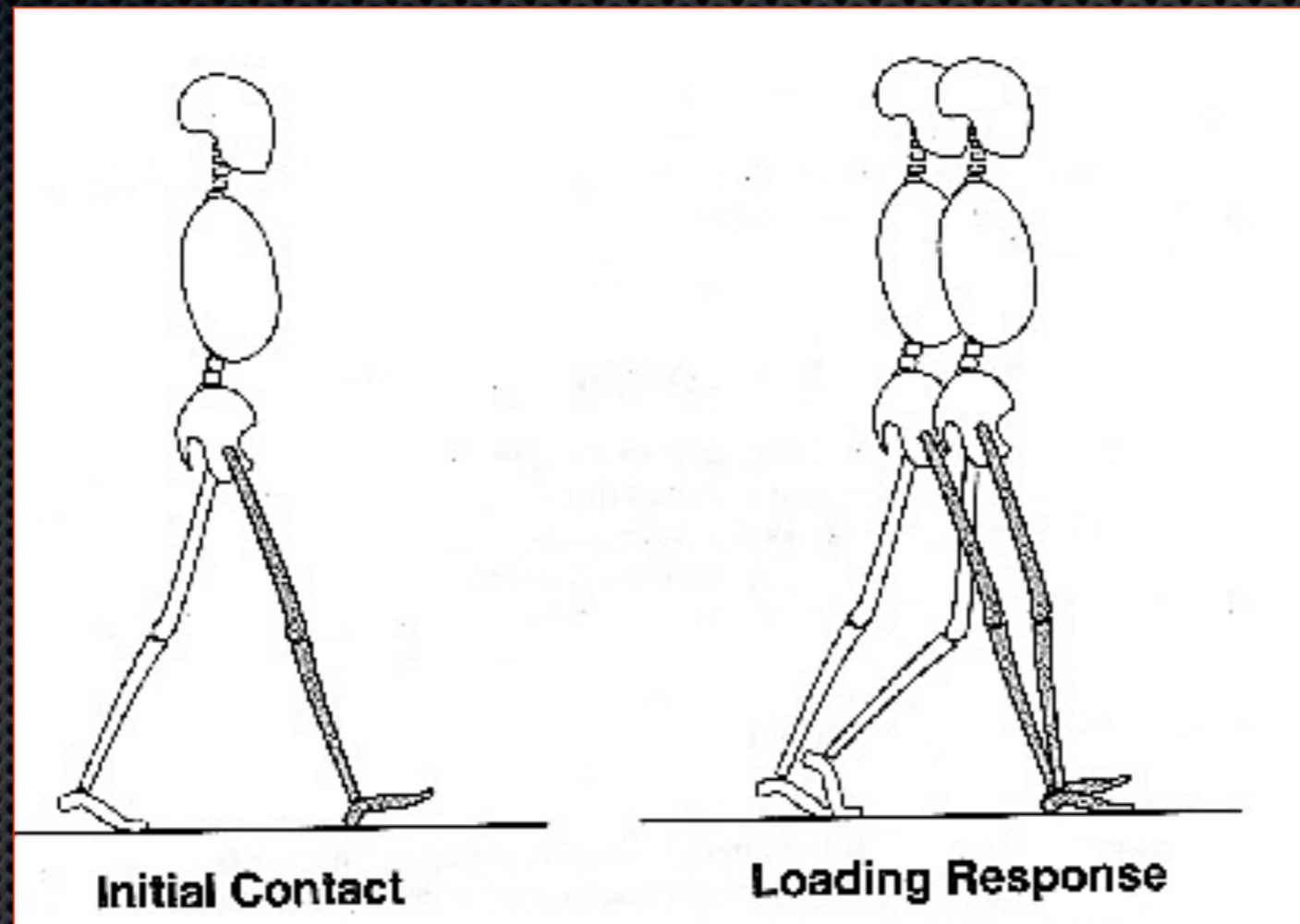


# CINETIQUE DE LA MARCHE NORMALE

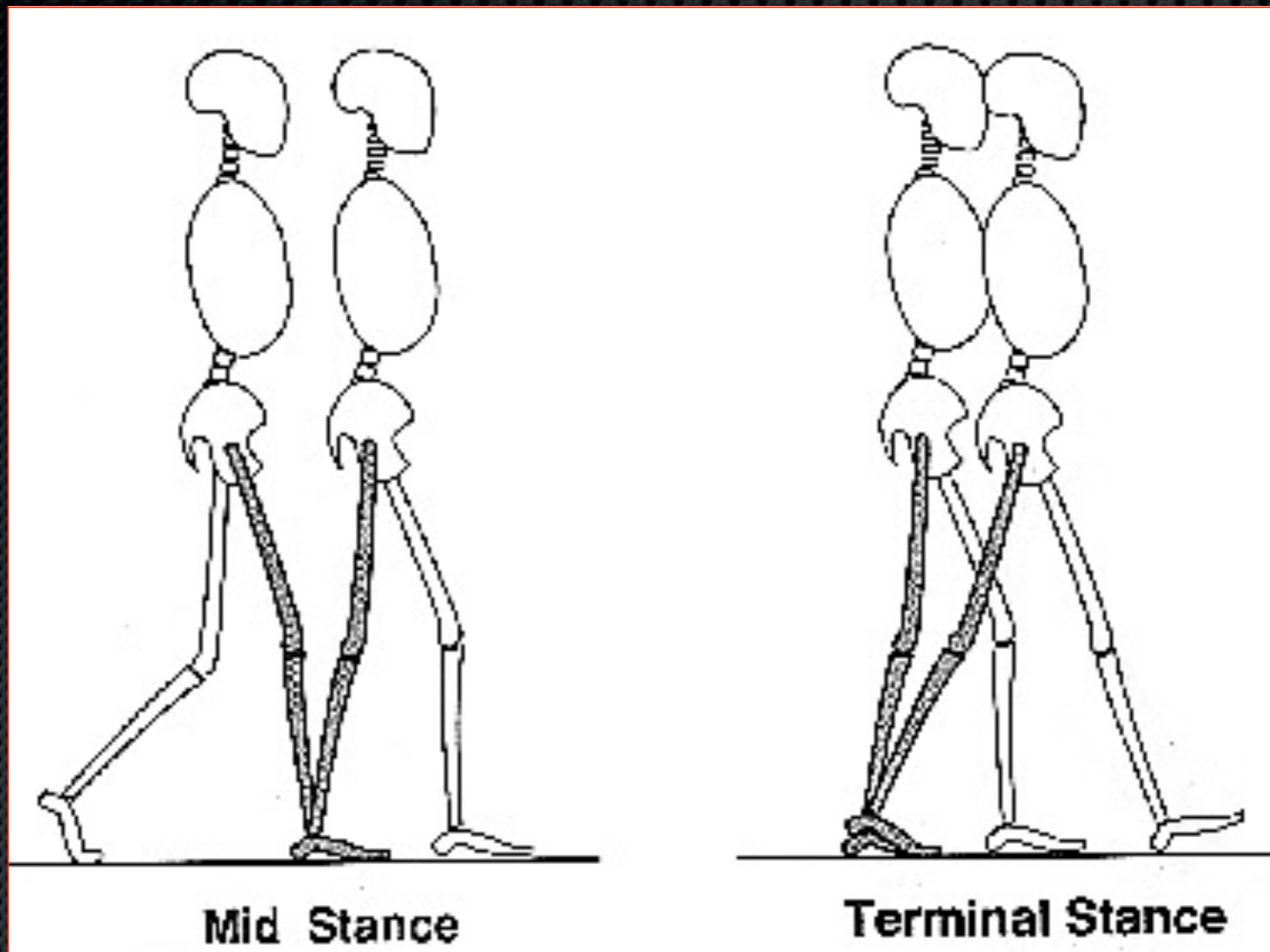
# DIVISION DU CYCLE DE MARCHÉ





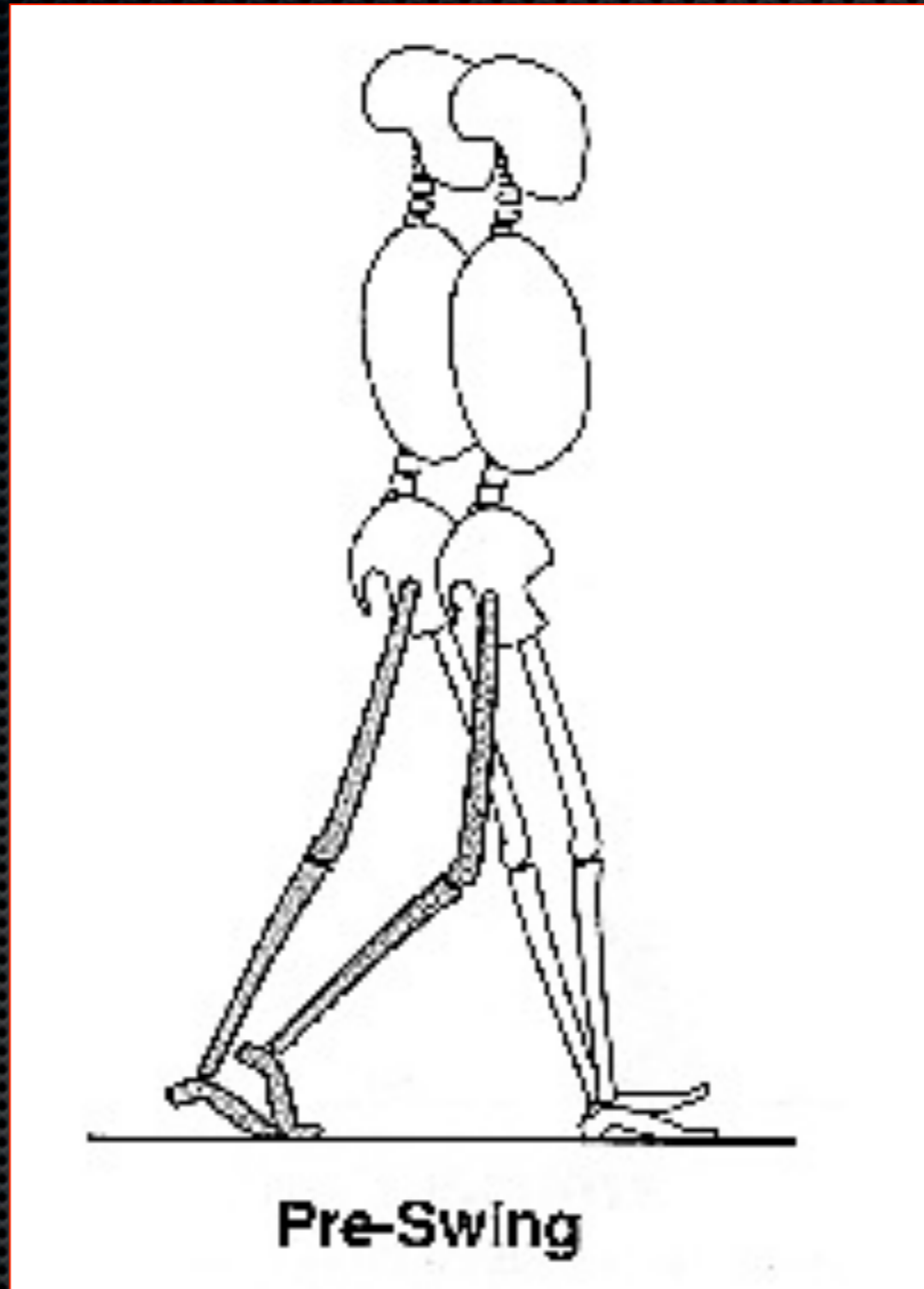
**CONTACT INITIAL**  
**0 – 2%**

**REPOSE A L'APPUI**  
**2 – 10%**

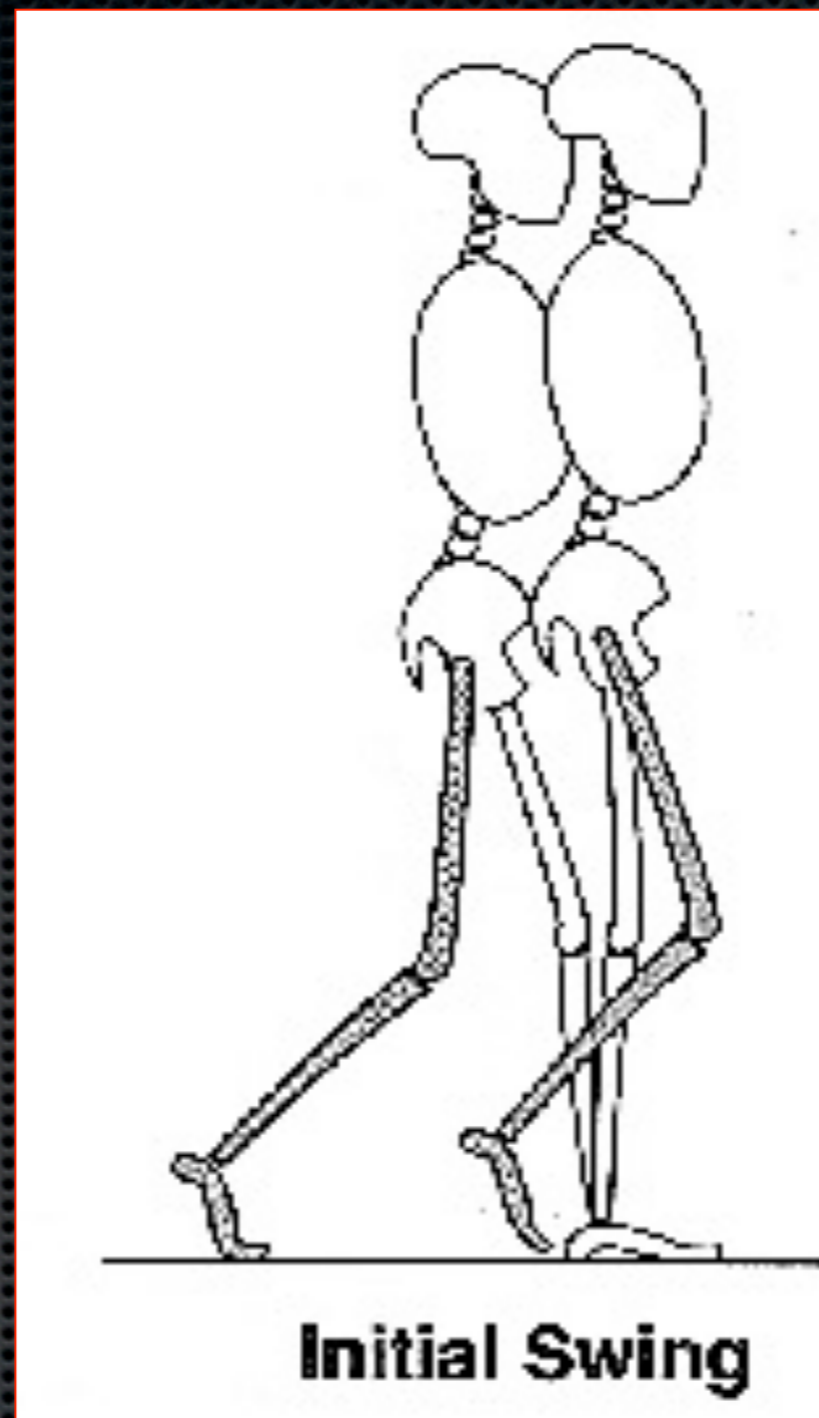


**MILIEU D'APPUI**  
10 – 30%

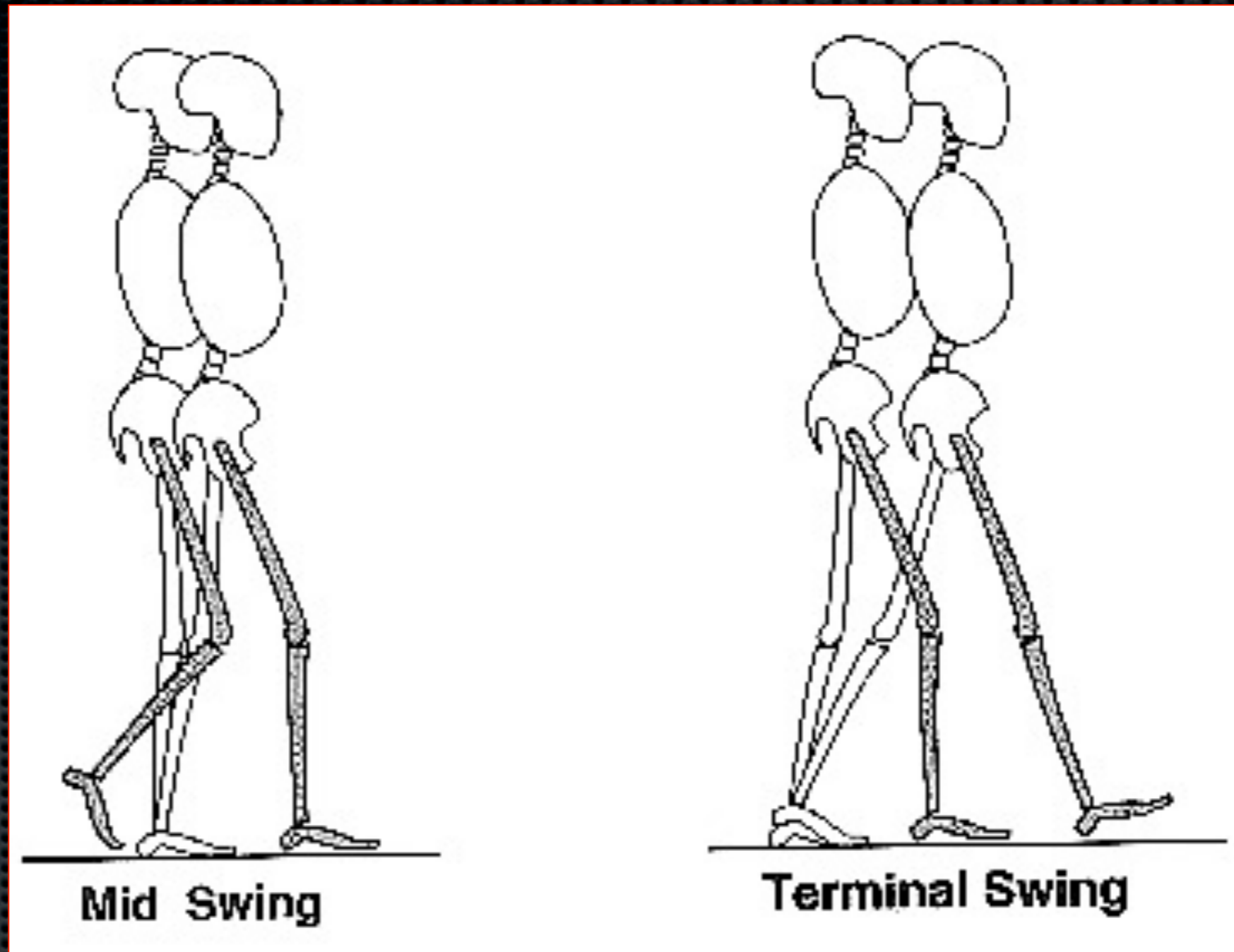
**FIN D'APPUI**  
30 – 50%



**PRE OSCILLANTE**  
**50 – 60%**



**PRE OSCILLANTE INITIALE**  
**60 – 73%**



**Mid Swing**

**Terminal Swing**

**MILIEU DE PHASE OSCILLANTE**  
**73 – 87%**

**FIN DE PHASE OSCILLANTE**  
**87 – 100%**

# La force

En physique, Une force est la modélisation (représentation simplifiée) d'une action mécanique.

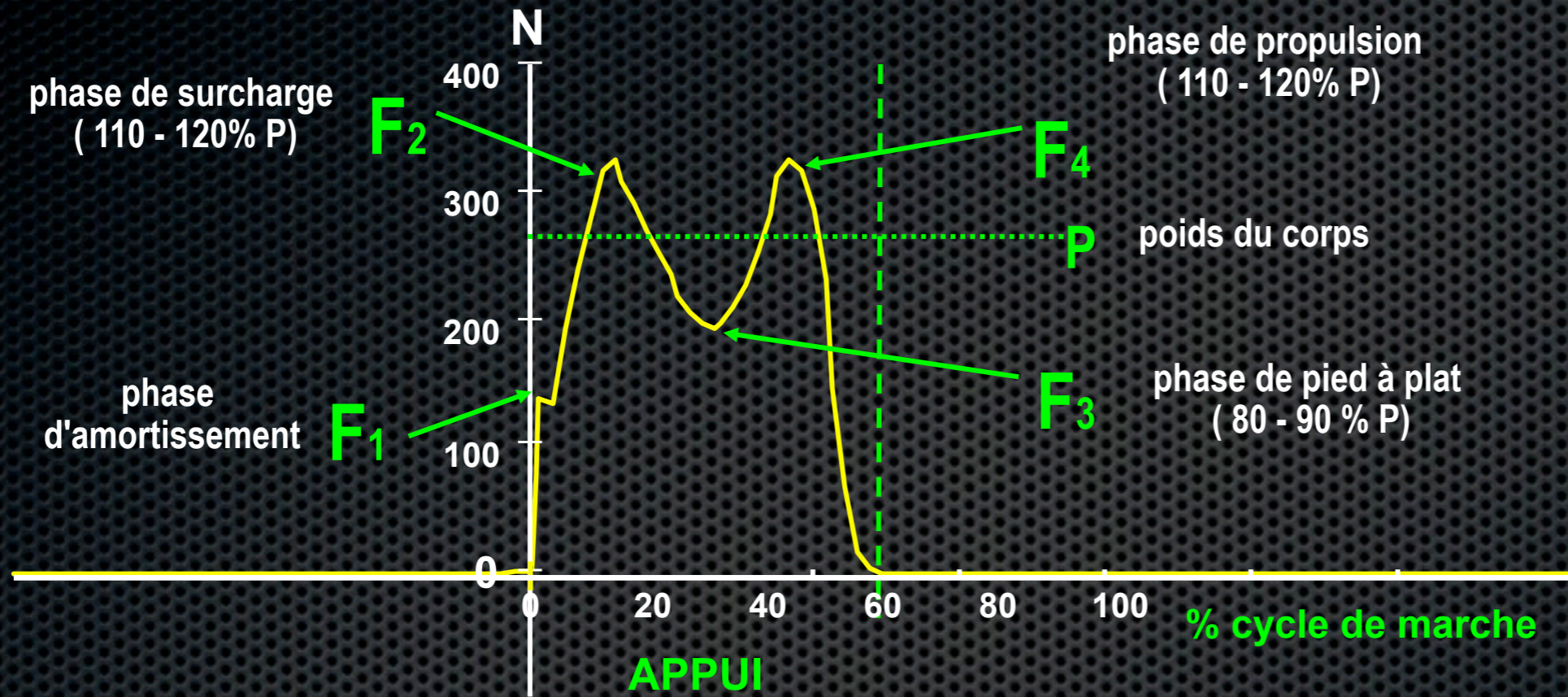
On appelle action mécanique toute cause capable de déformer un corps ou de modifier son état de mouvement ou de repos .

Elle est généralement représentée par un vecteur pour donner son sens et sa direction (au sens mathématique du terme), et elle est donnée en Newton (N).

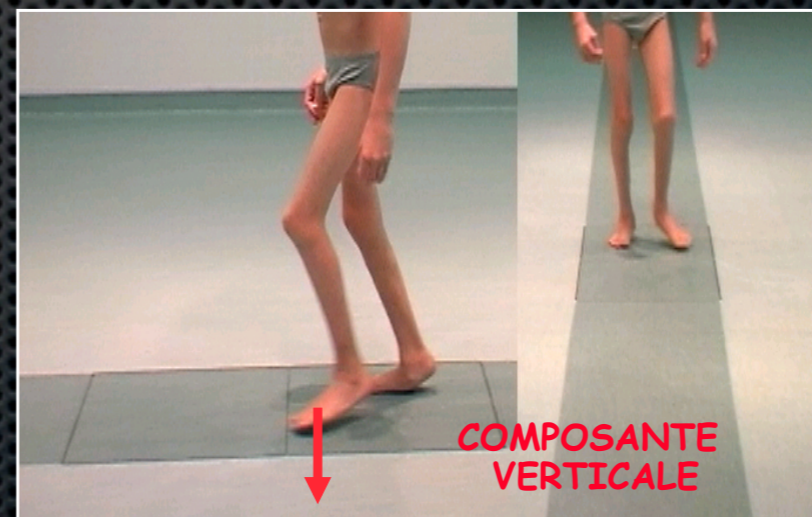
Enfin, une force peut avoir une direction et un sens identique mais une intensité différente.



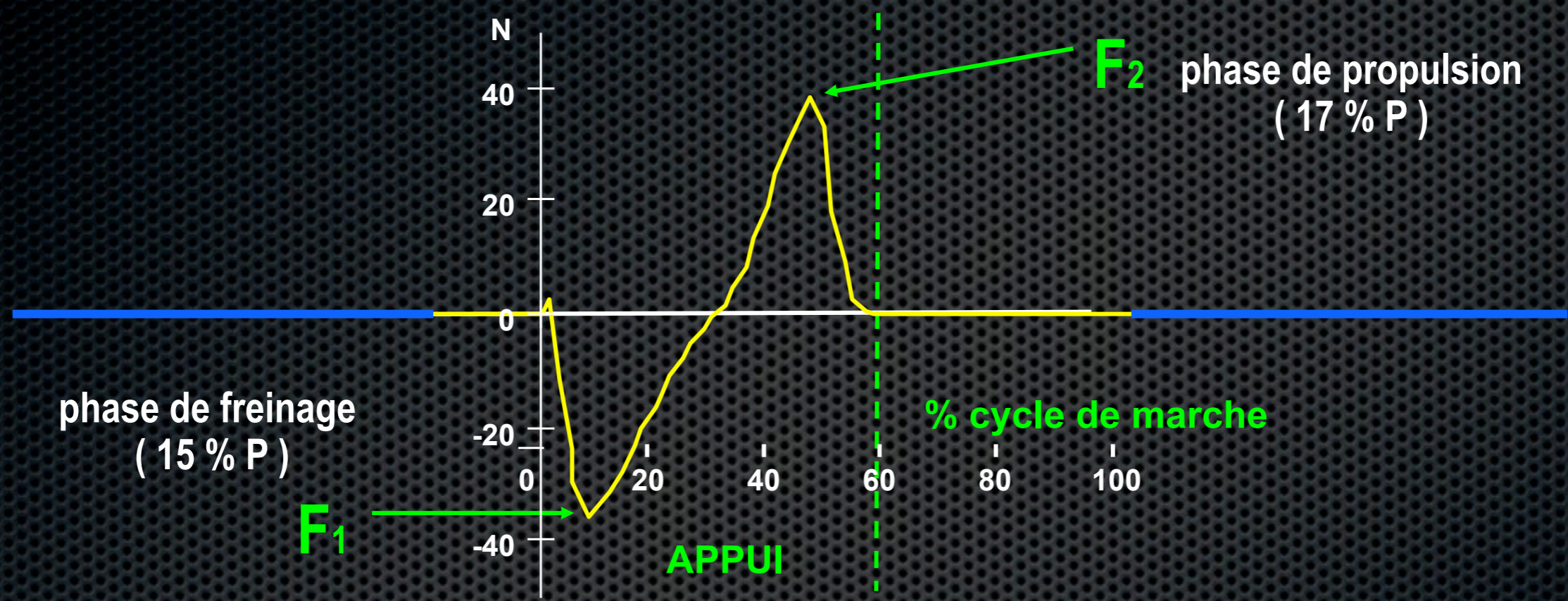
# DONNEES ENREGISTREES : FORCES D'APPUI SUR LE SOL



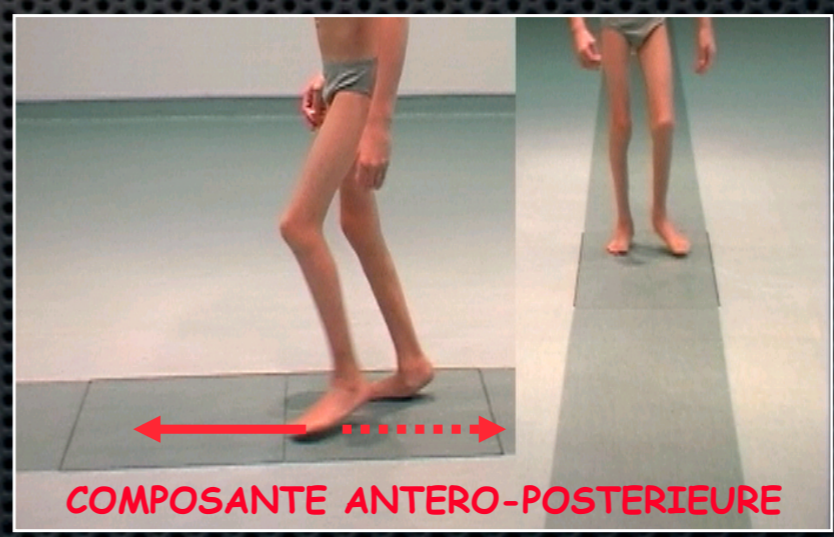
## COMPOSANTE VERTICALE



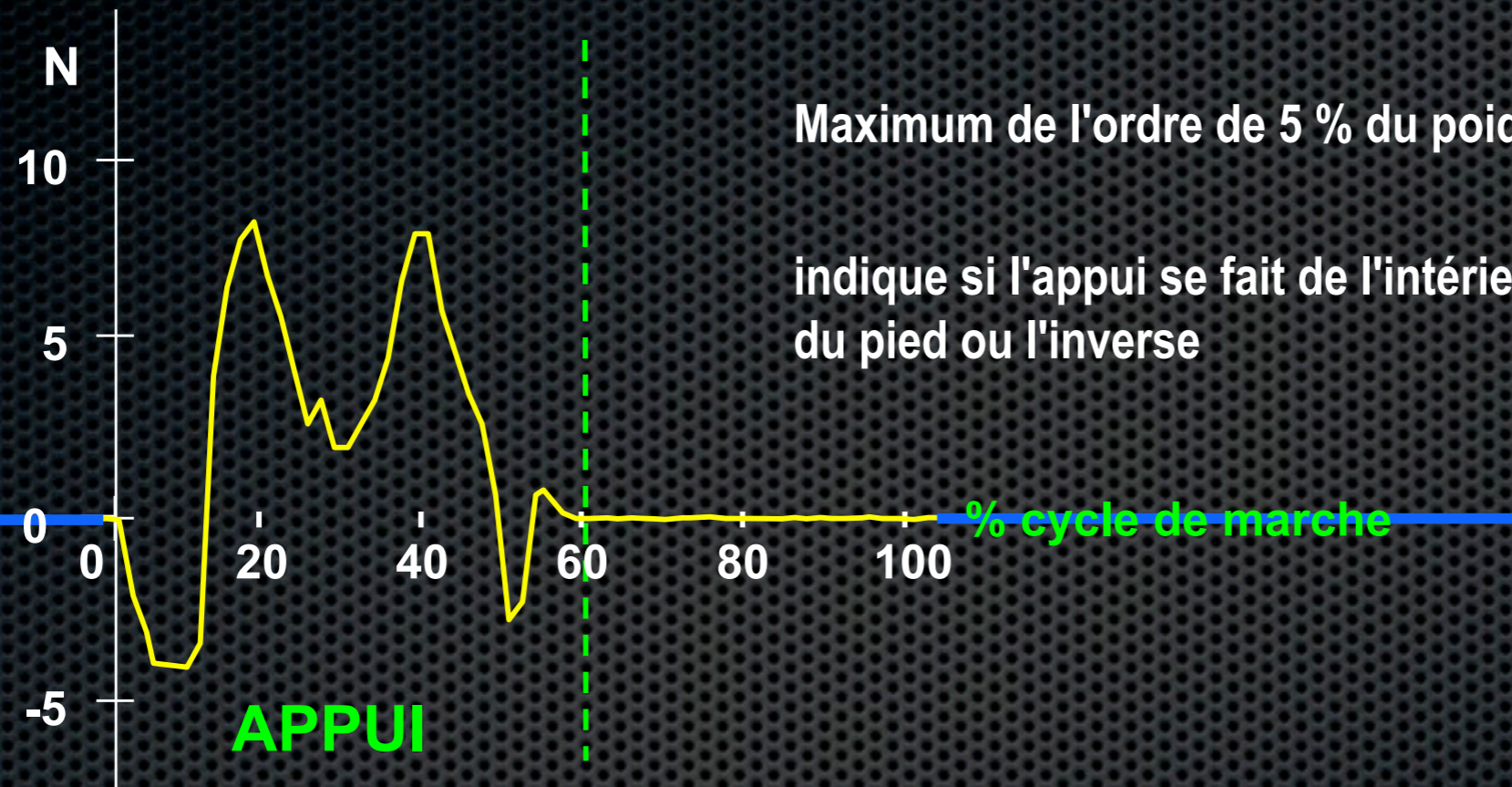
# DONNEES ENREGISTREES : FORCES D'APPUI SUR LE SOL



## COMPOSANTE ANTERO-POSTERIEURE



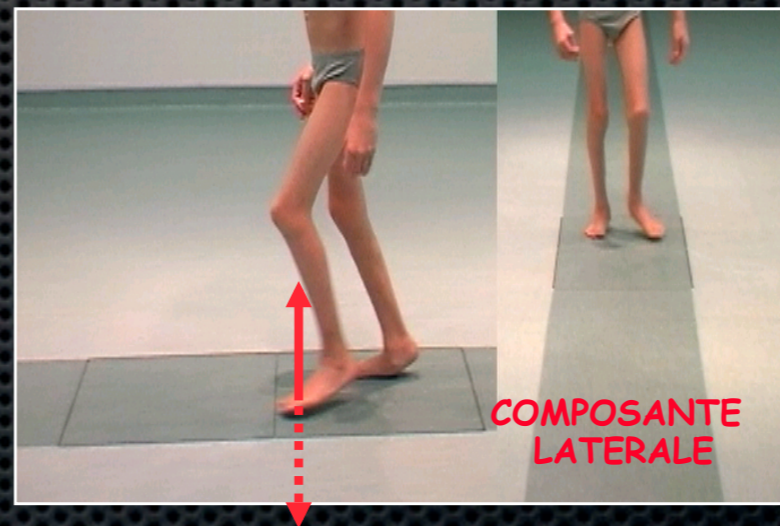
# DONNEES ENREGISTREES : FORCES D'APPUI SUR LE SOL

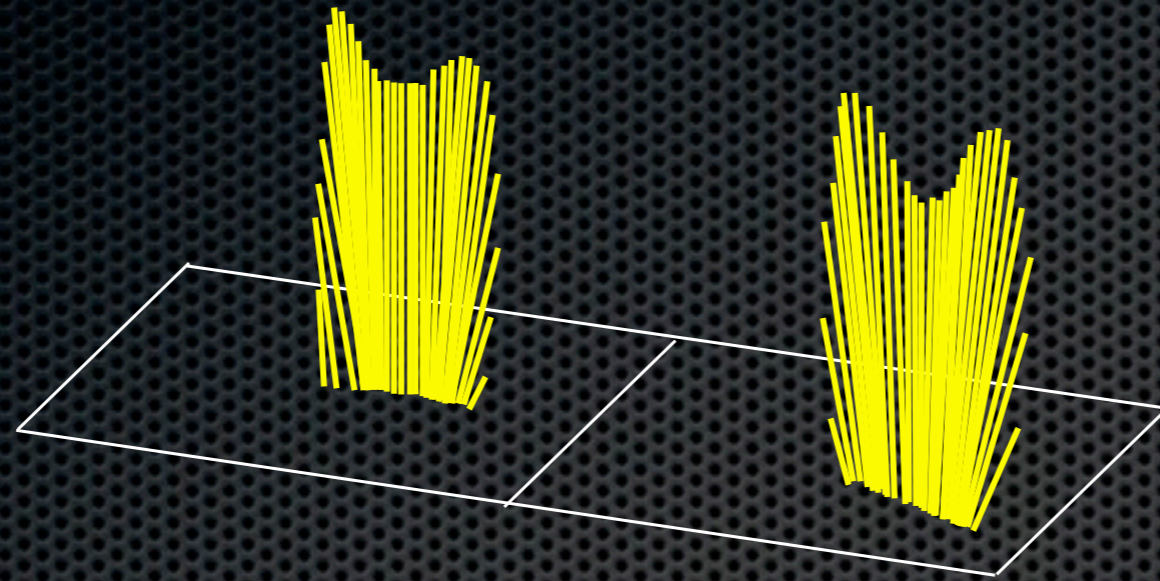


Maximum de l'ordre de 5 % du poids du corps

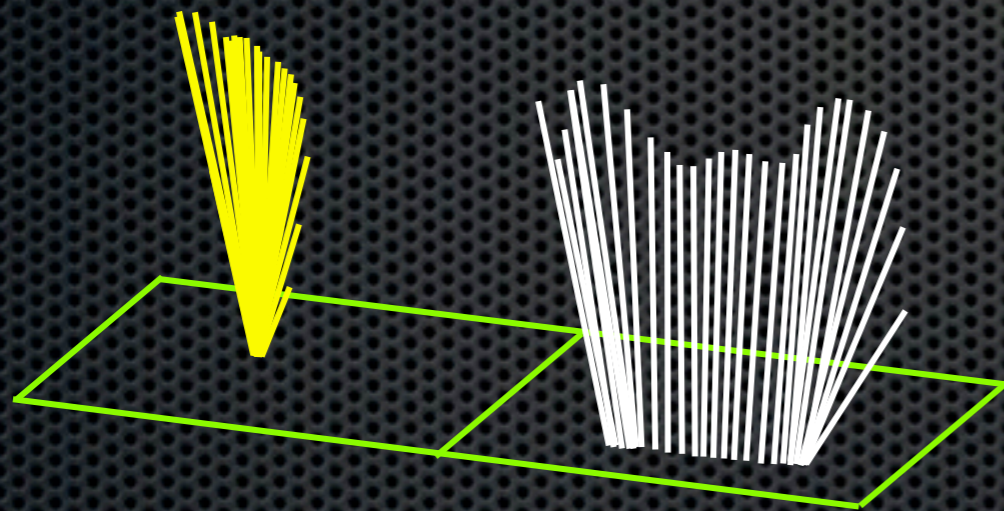
indique si l'appui se fait de l'intérieur vers l'extérieur du pied ou l'inverse

COMPOSANTE  
LATERALE

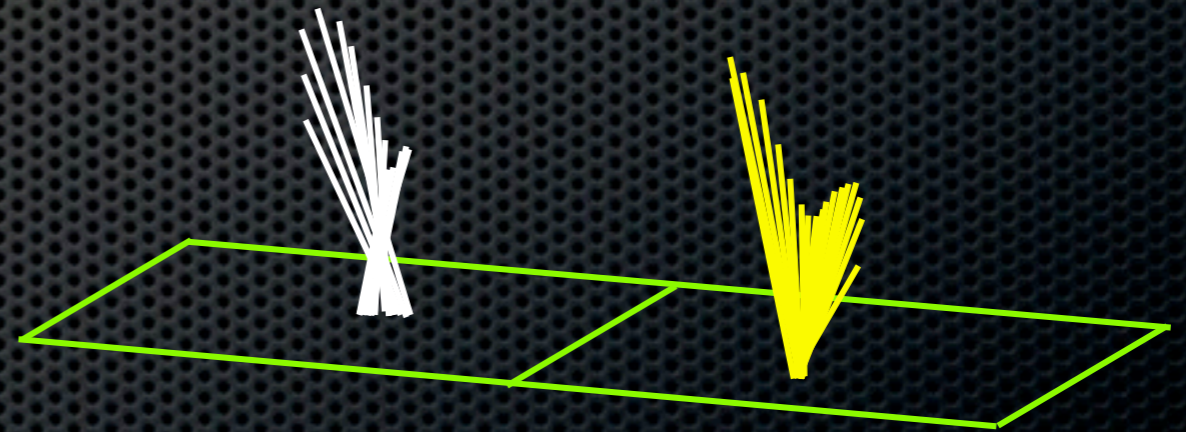




Marche normale



Hémiplégie

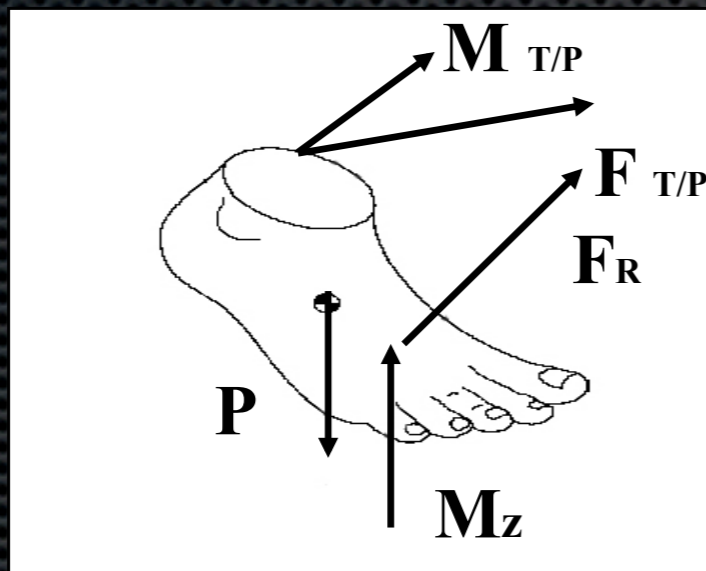


Diplégie

# ANALYSE CINETIQUE

**Moment = couple de force**

$$\mathcal{M} \text{ (Nm/kg)} = \mathbf{F} \times \mathbf{d}$$



$\mathbf{F}$  = Force (N/kg)

$\mathbf{d}$  = distance au centre de rotation (m)  
(longueur du bras de levier)

**Fourni** : Moment interne (lié à l'activité musculaire autour d'une articulation)

**Calculé** : Moment externe (lié au vecteur force de réaction du sol)

# PUISSANCE

$$P \text{ (w/kg)} = \mathcal{M} \times \omega$$

$\mathcal{M}$  : moment  
 $\omega$  : vitesse angulaire

représente l'énergie générée ou absorbée lors d'une activité musculaire

Excentrique (négative) : décélération

Isométrique (nulle) : stabilisation

Concentrique (positive) : accélération

# Mesurer la force



Plate-formes de force

Jauges de contrainte

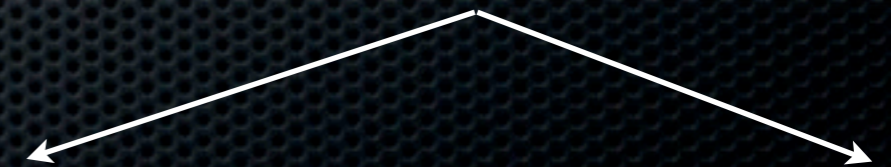
Piezoélectrique

# Mesurer la force

Contraignant :  
il faut un appui valide par  
plate-forme



Plate-formes de force



Jauges de contrainte

Piezoélectrique



# Mesurer la force

Contraignant :  
il faut un appui valide par  
plate-forme

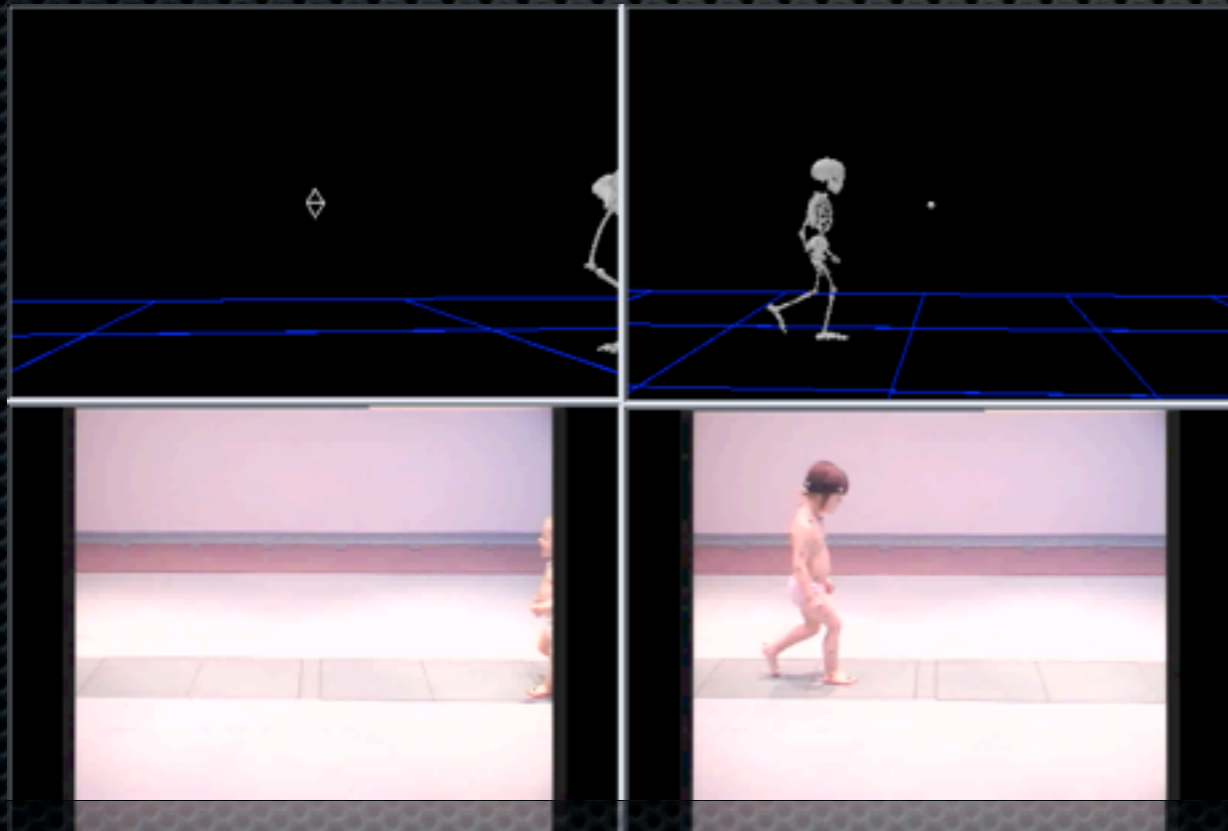
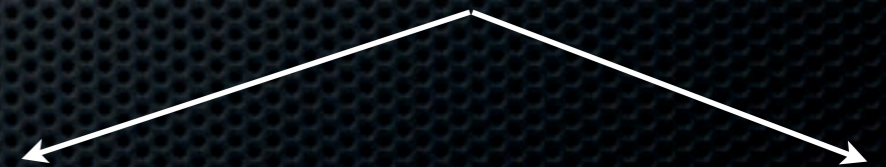


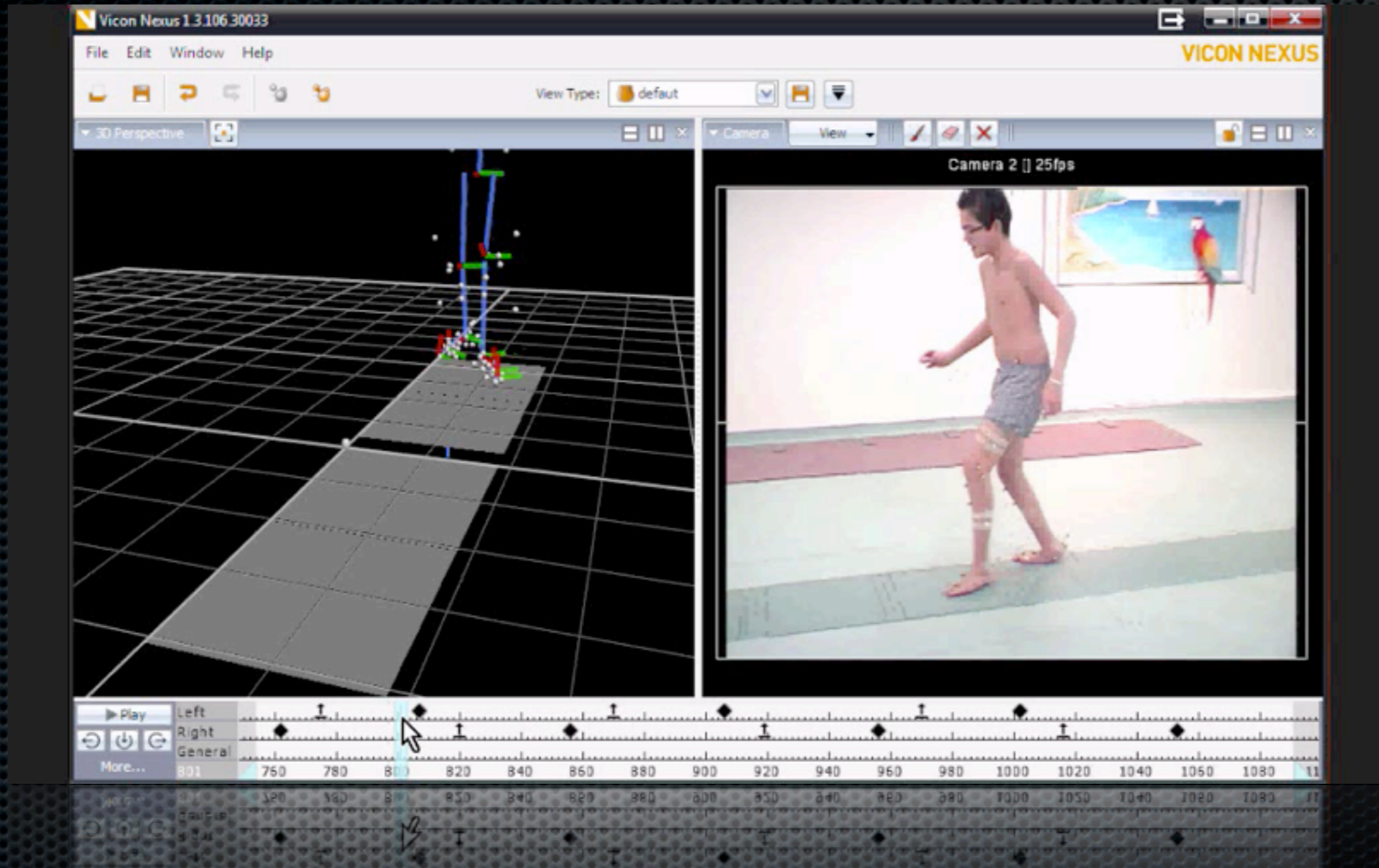
Plate-formes de force



Jauges de contrainte

Piezoélectrique

# Associé au système de capture de mouvement



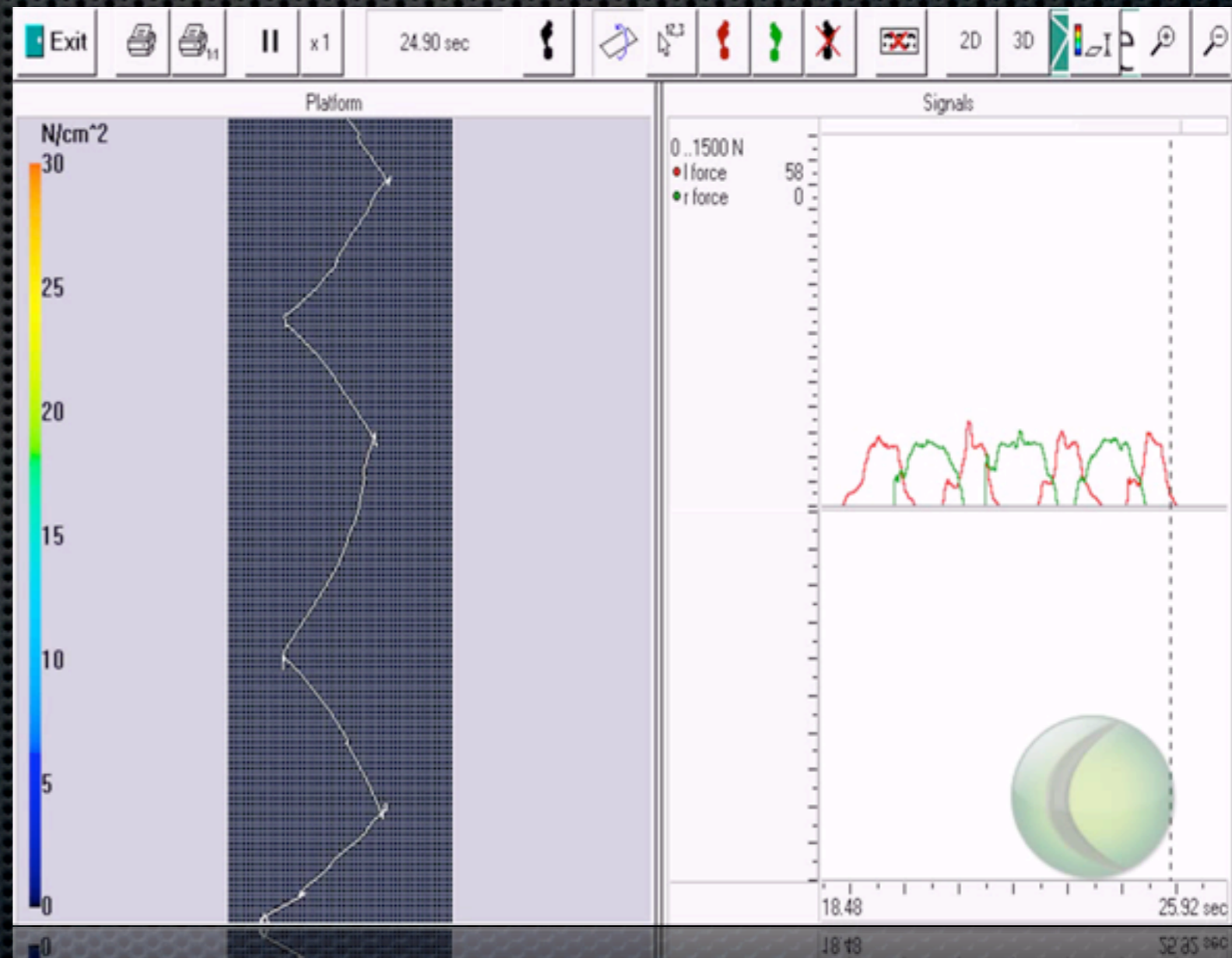
+ modélisation biomécanique

# Mesurer la force



Zebris FDM : Capteurs capacitifs calibrés

Inconvénient : une seule composante



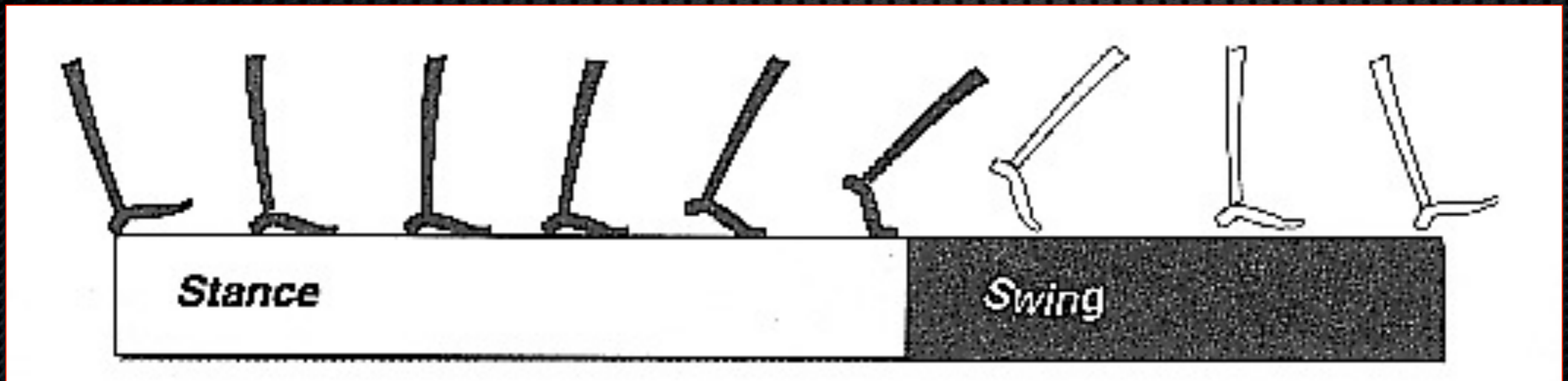


## Etudes de cas, marche pathologique



## Etudes de cas, marche pathologique

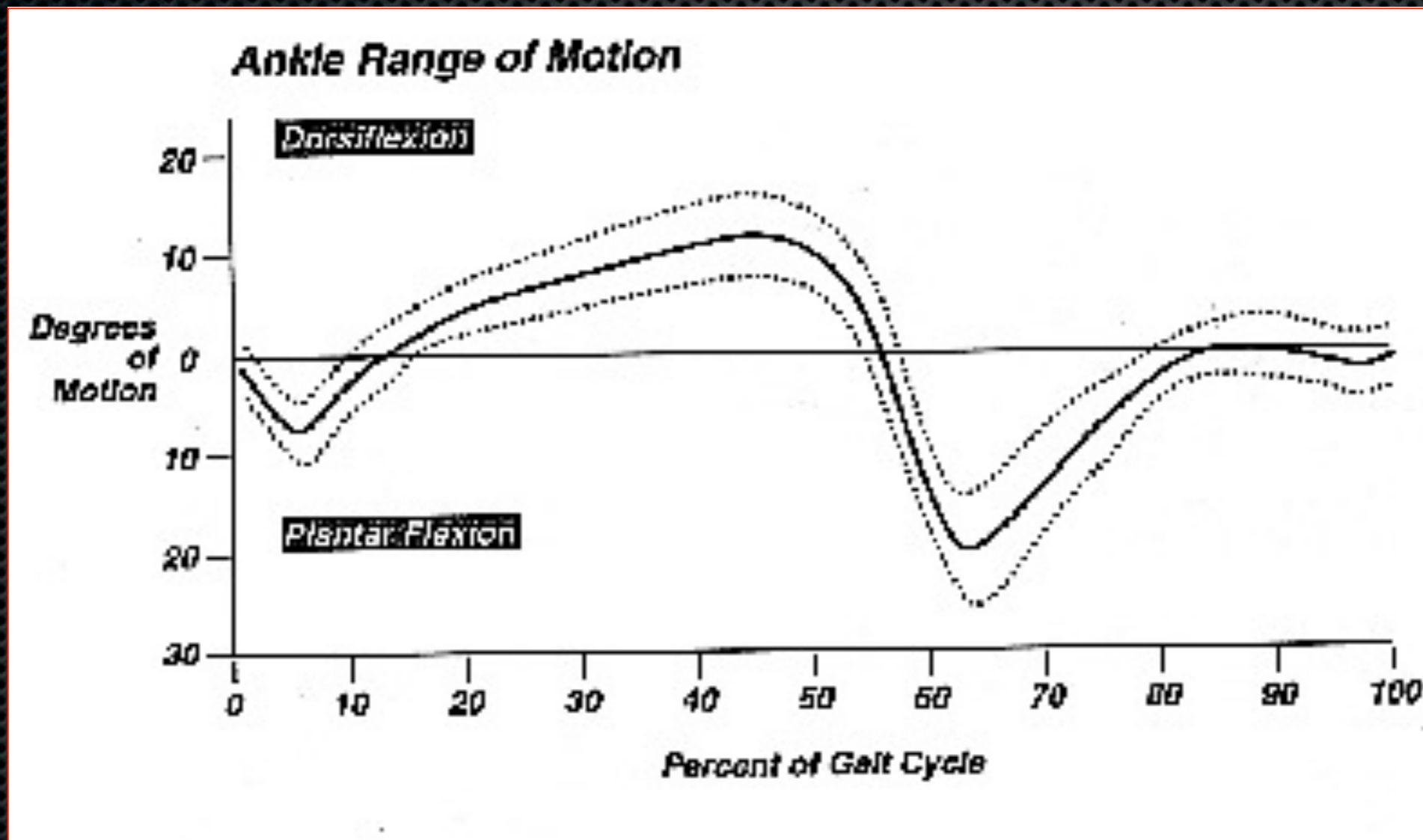




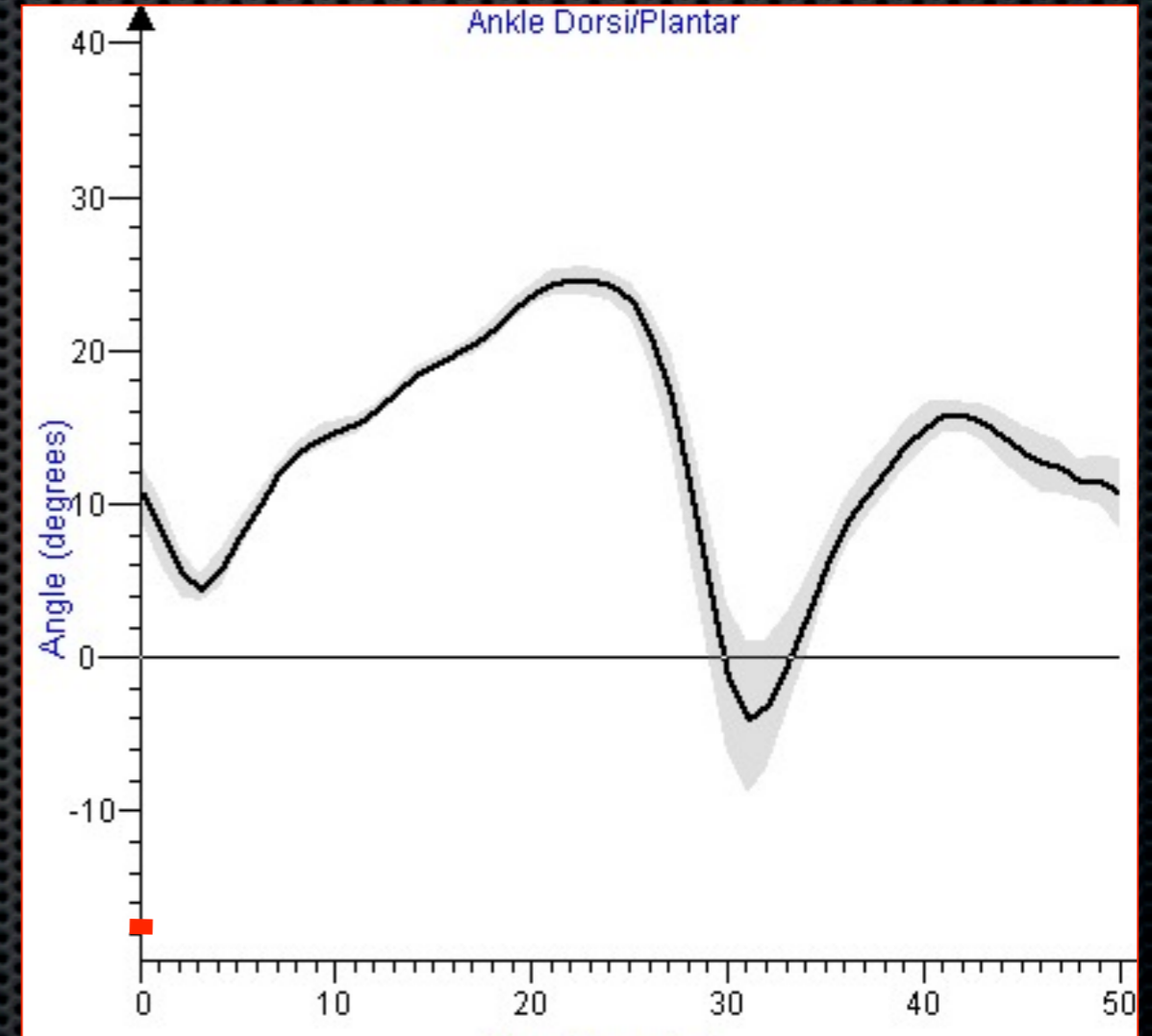
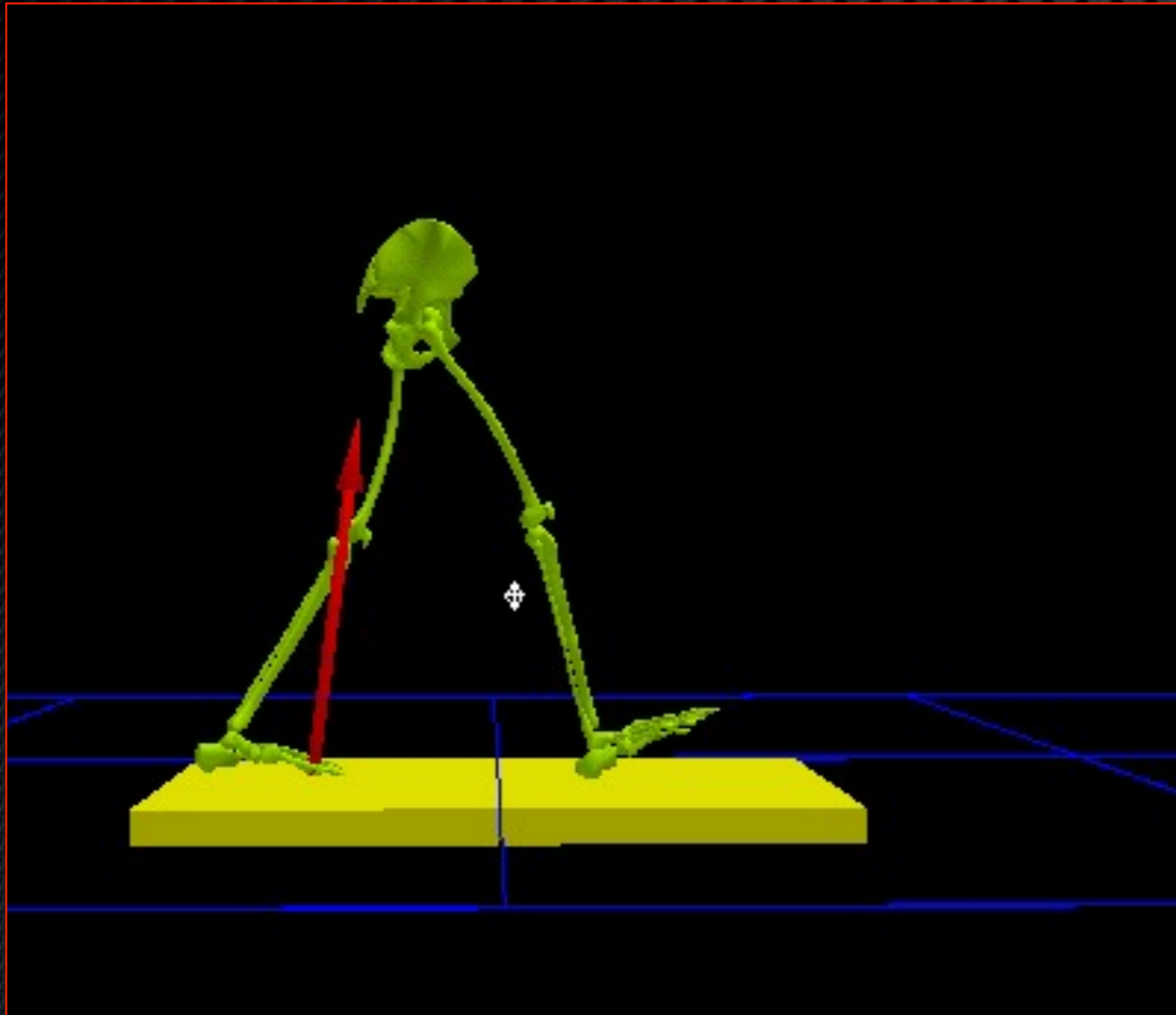
## APPUI OSCILLANTE

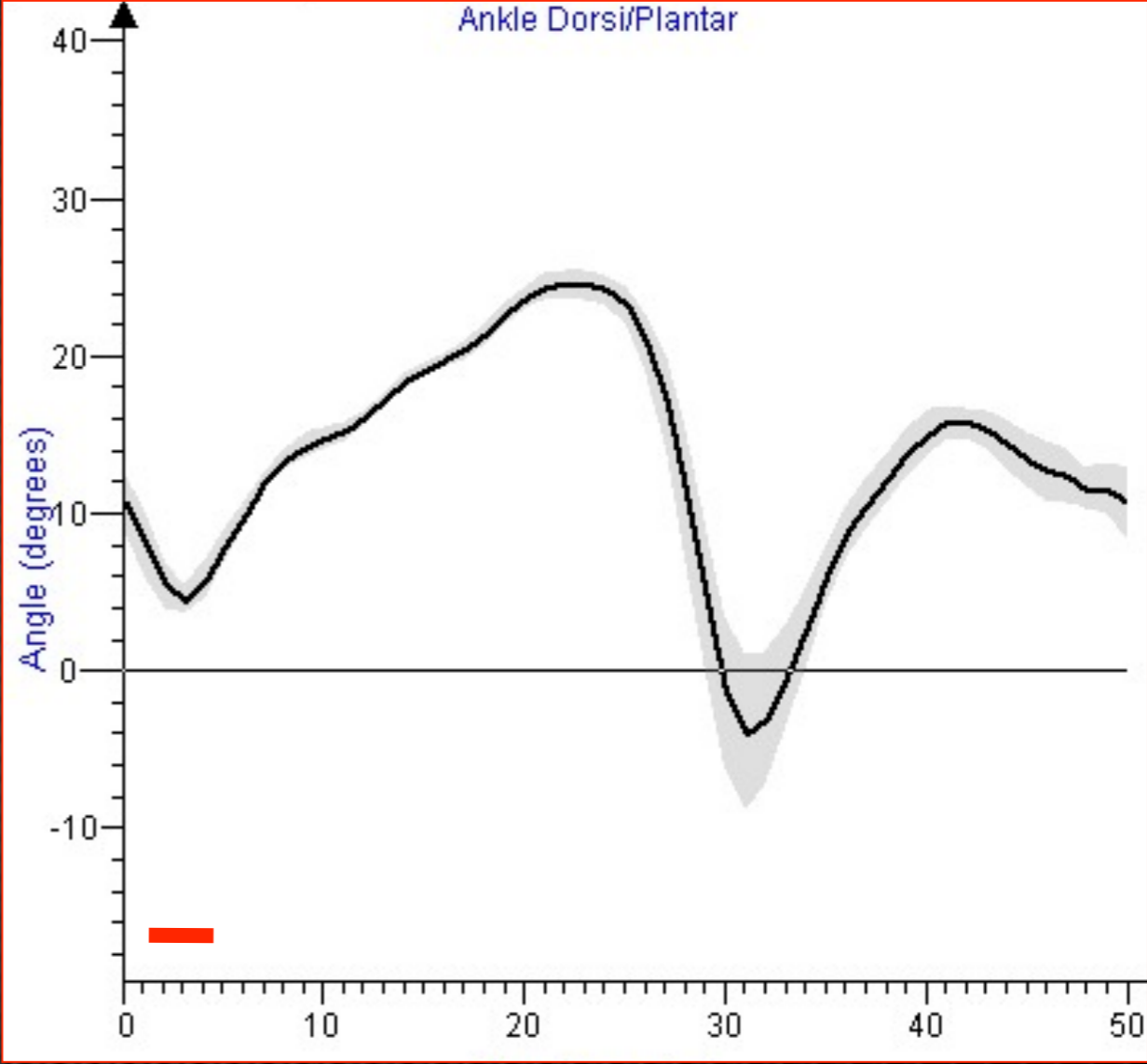
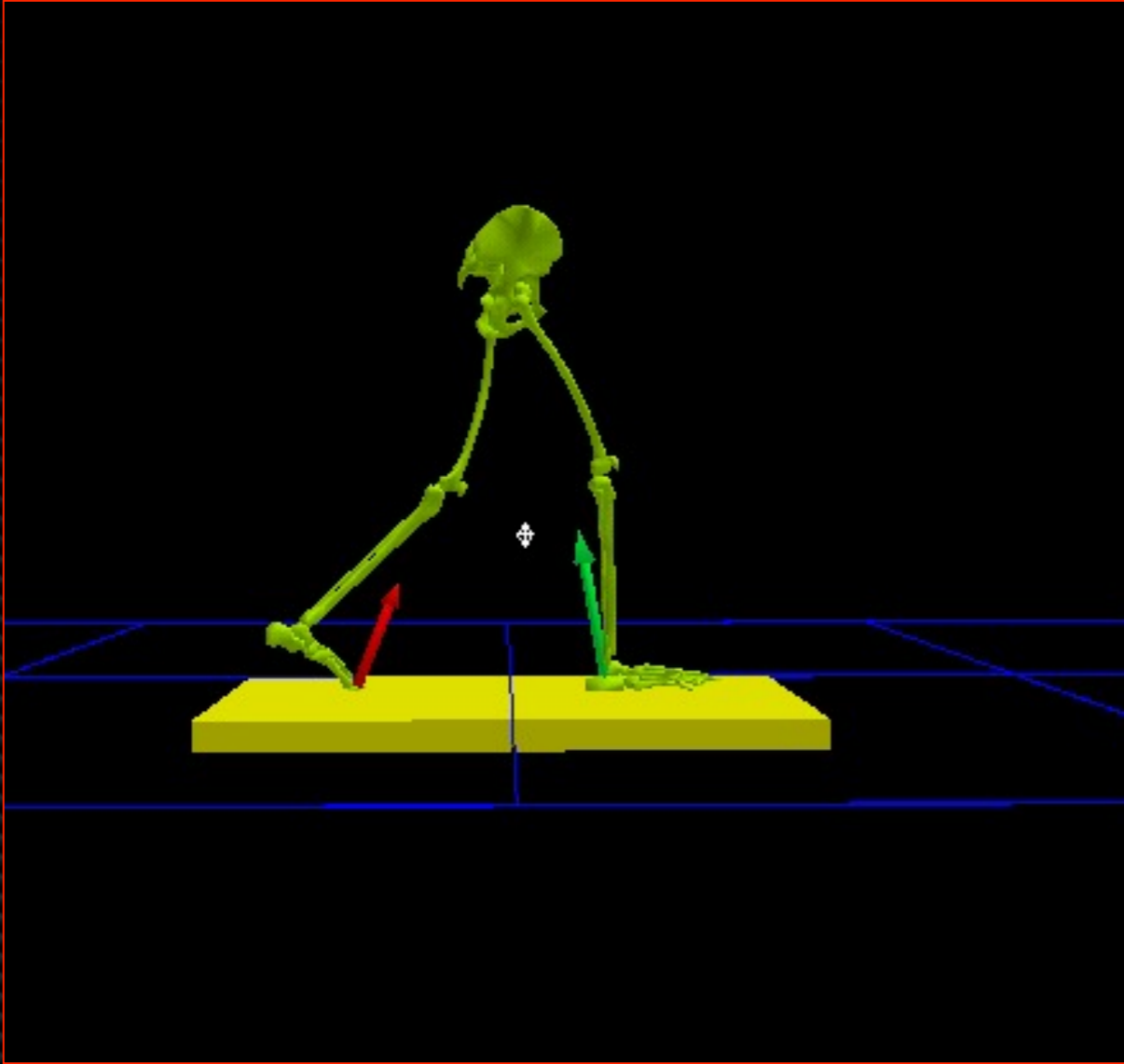
# CINEMATIQUE DE LA CHEVILLE

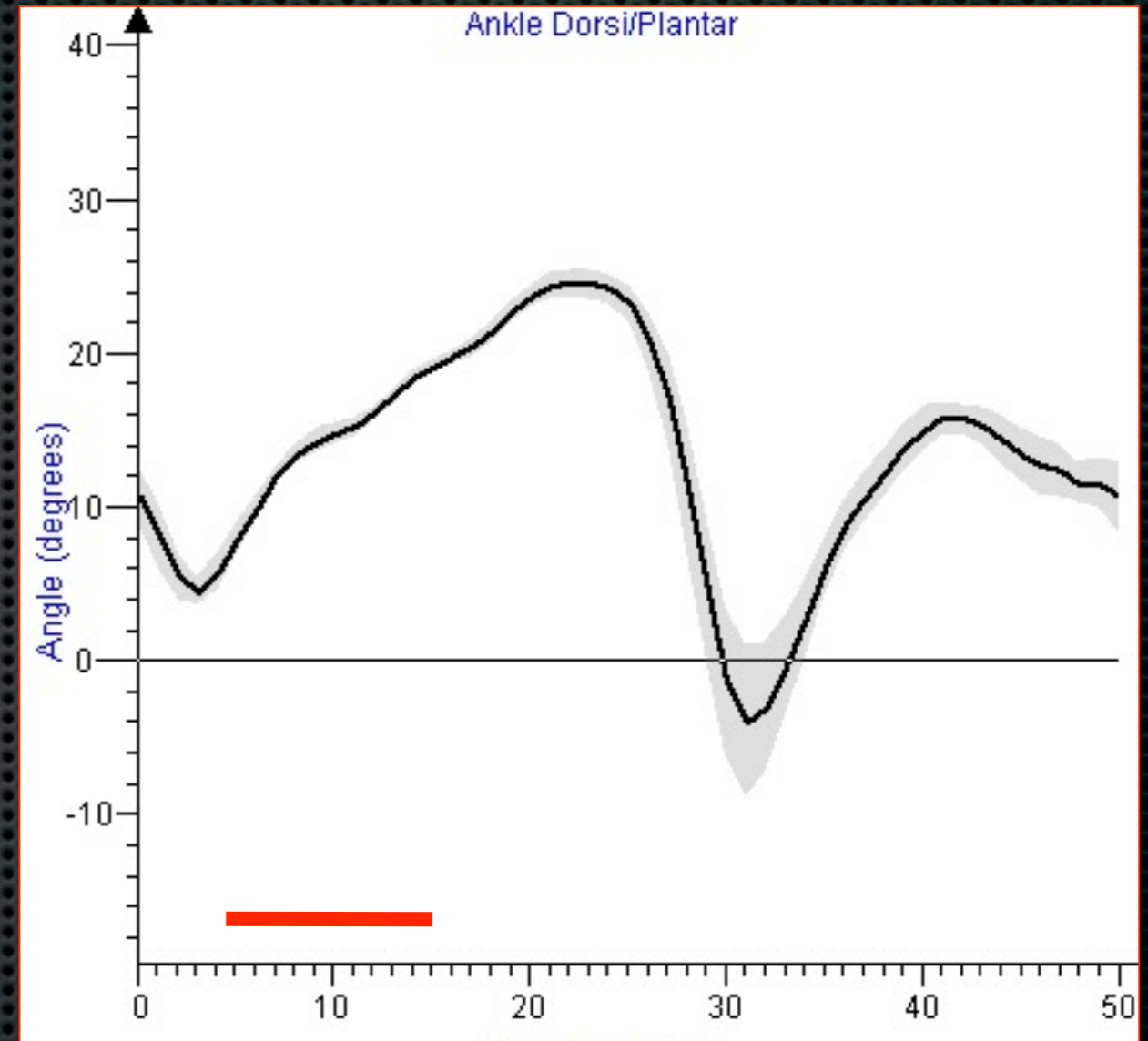
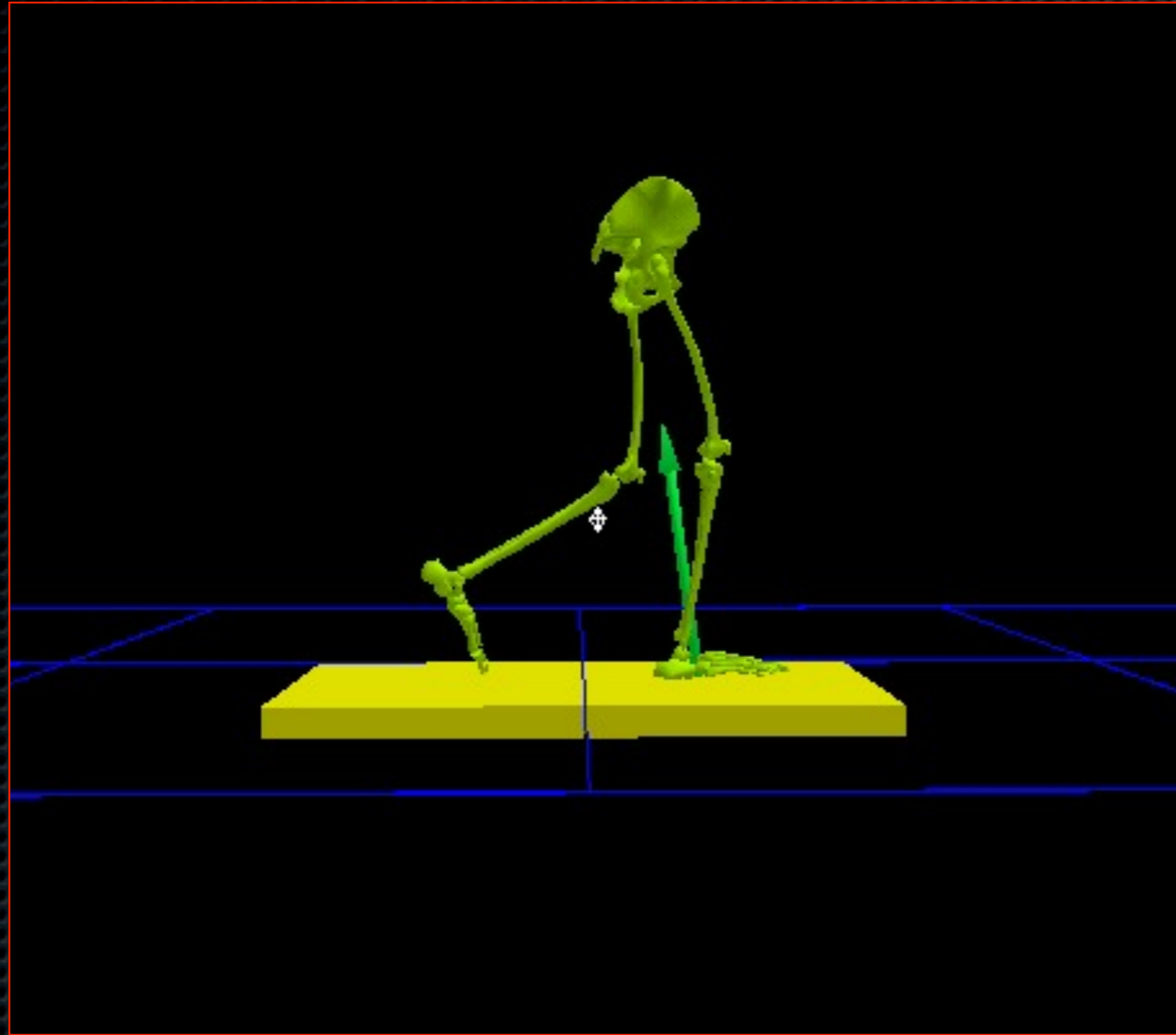
## Plan sagittal

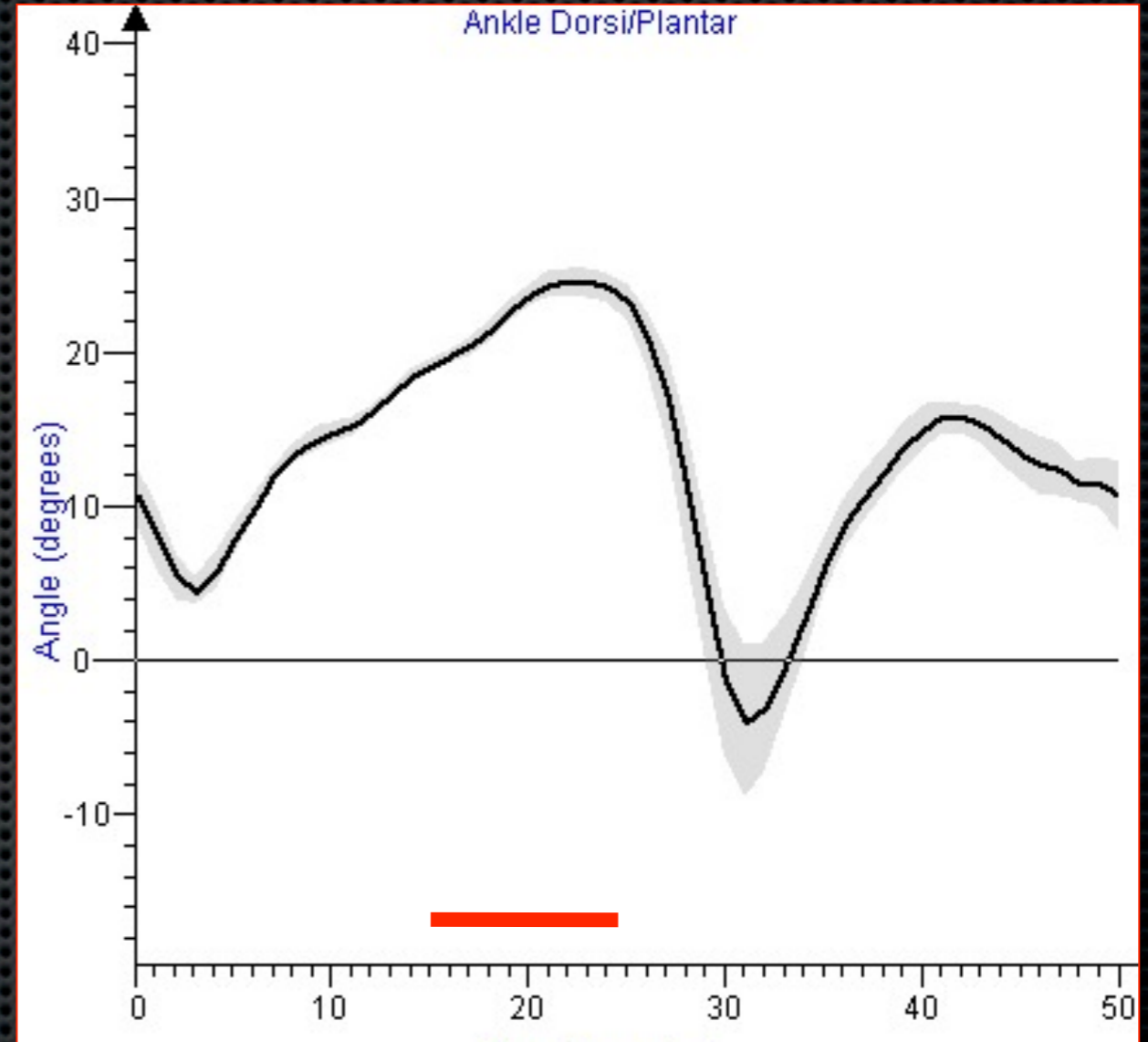
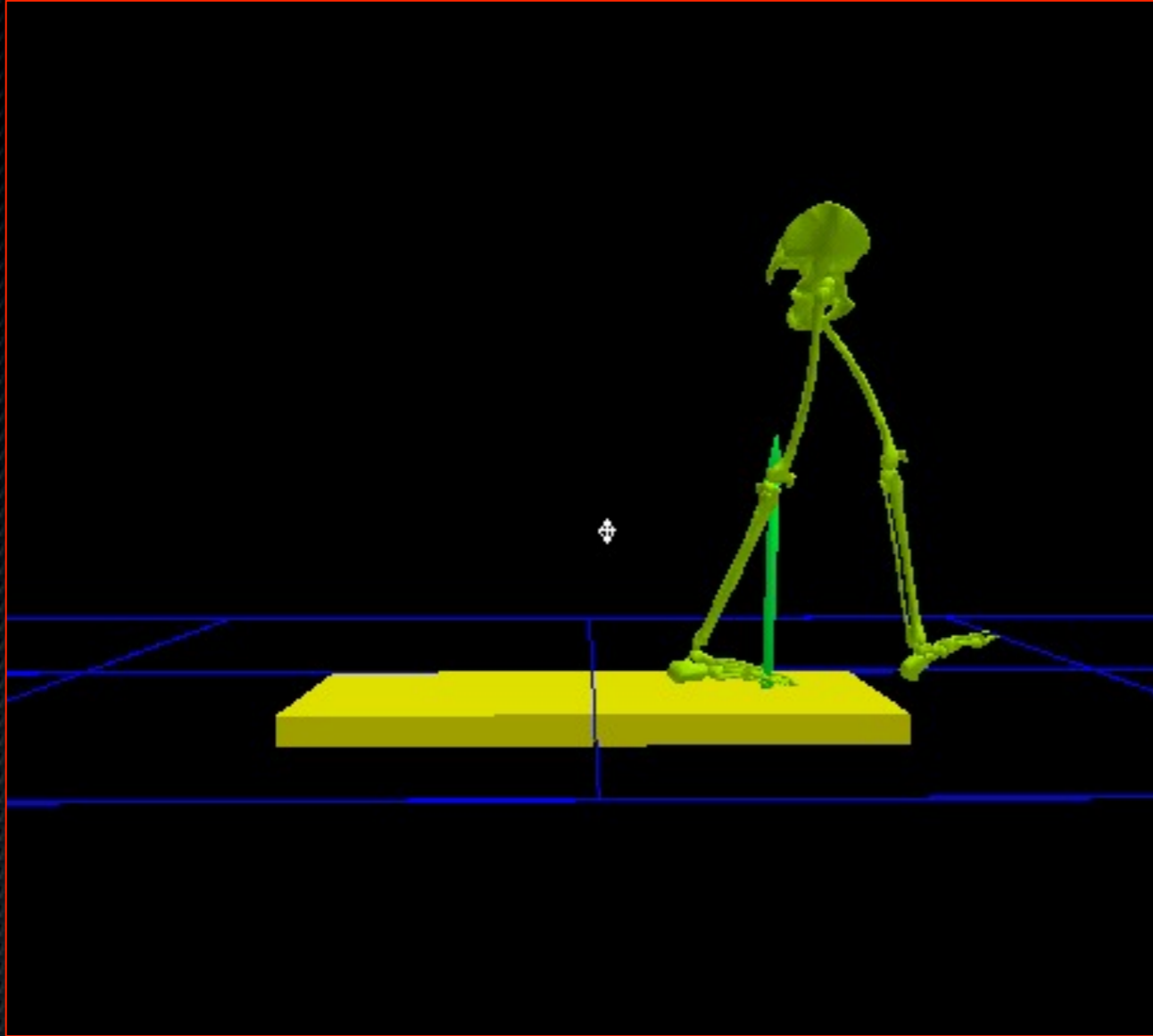


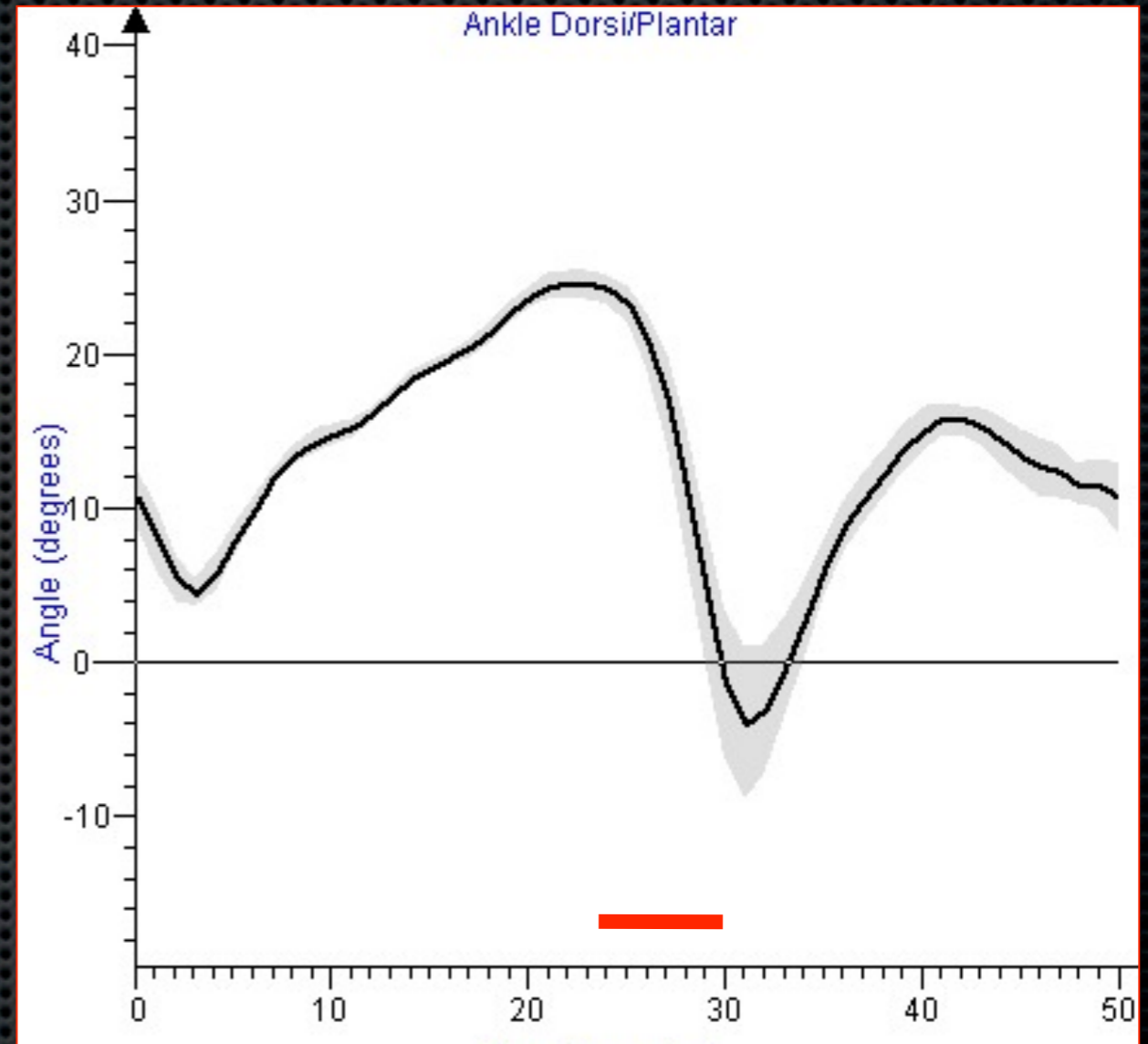
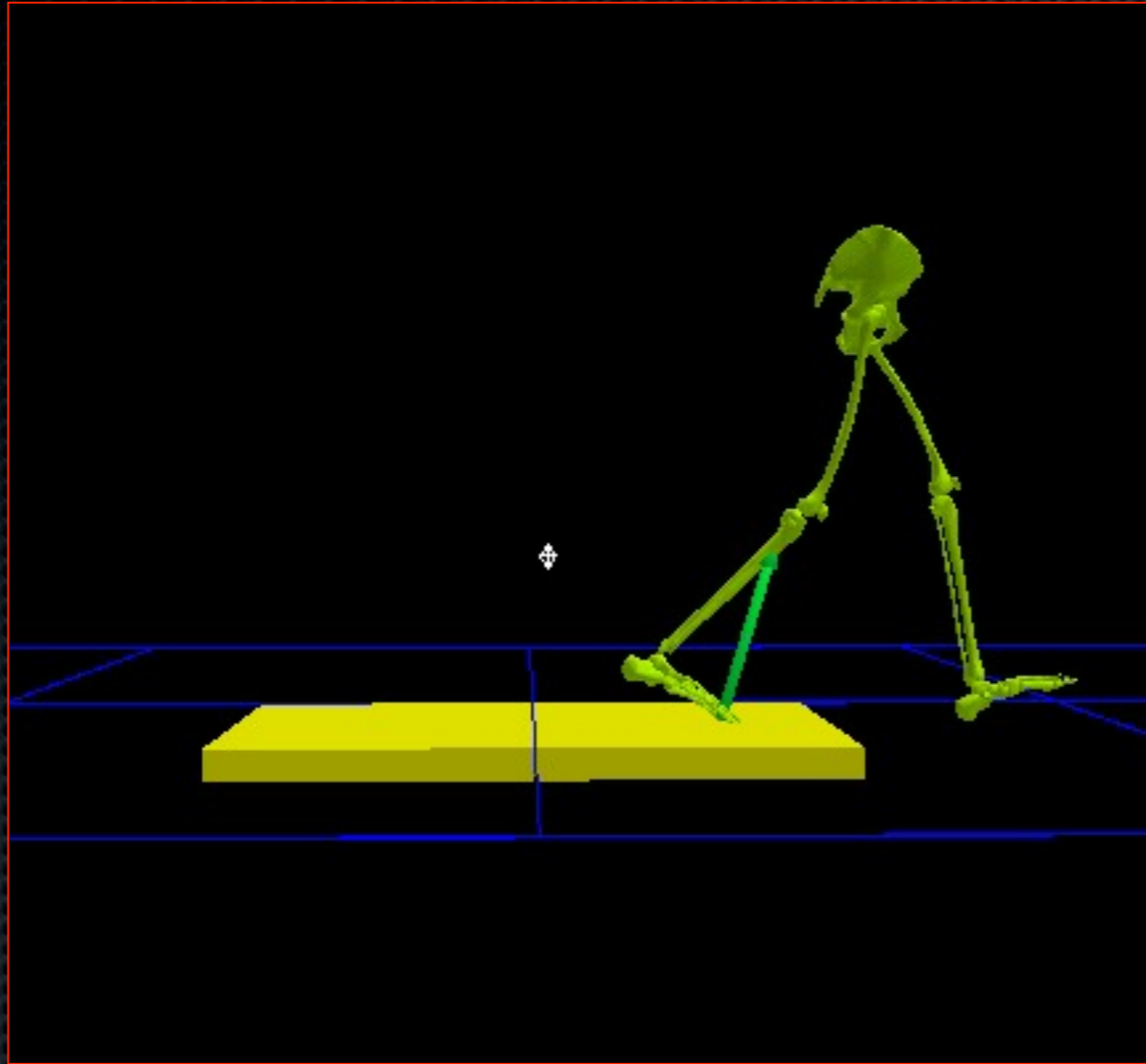


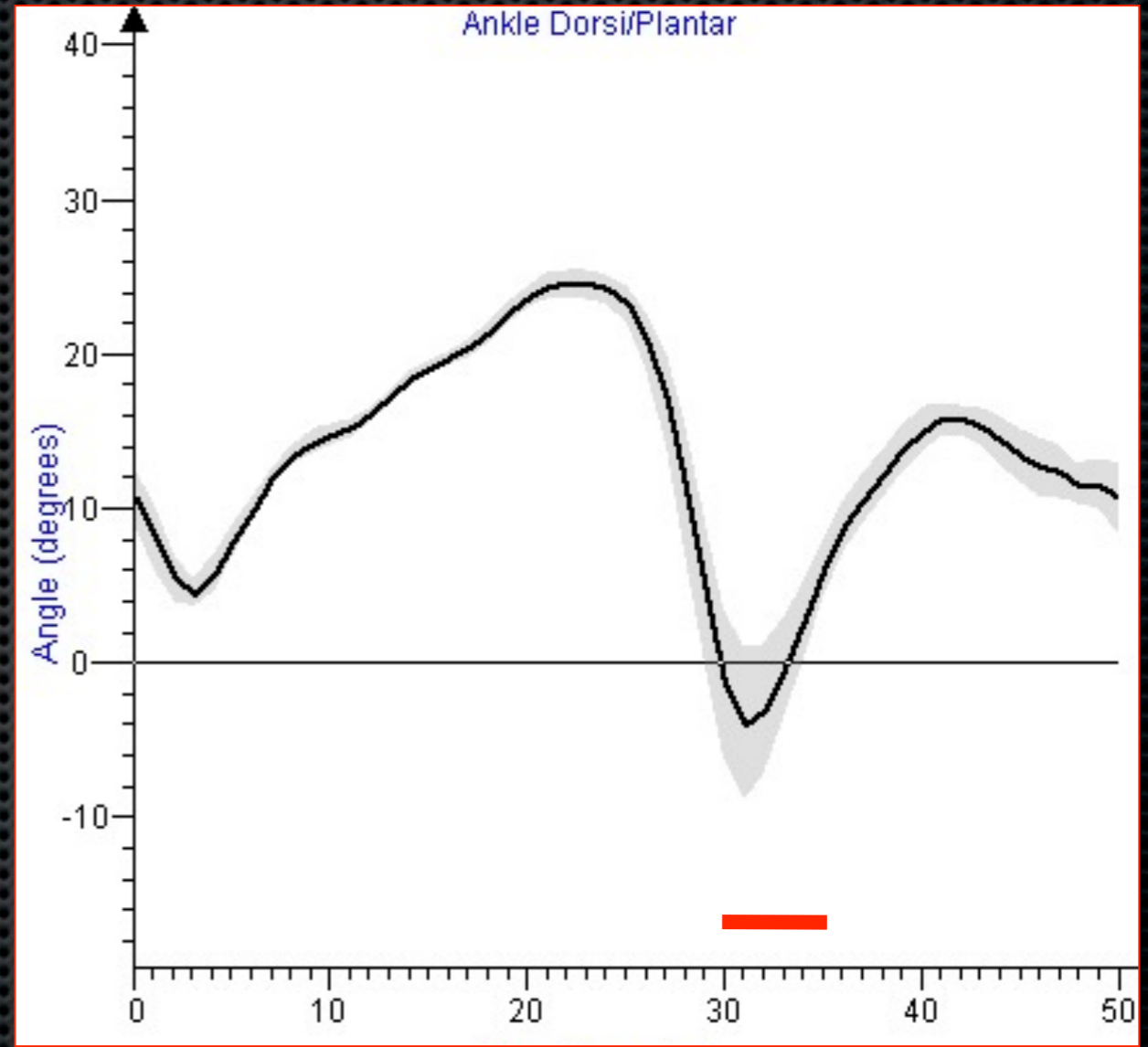
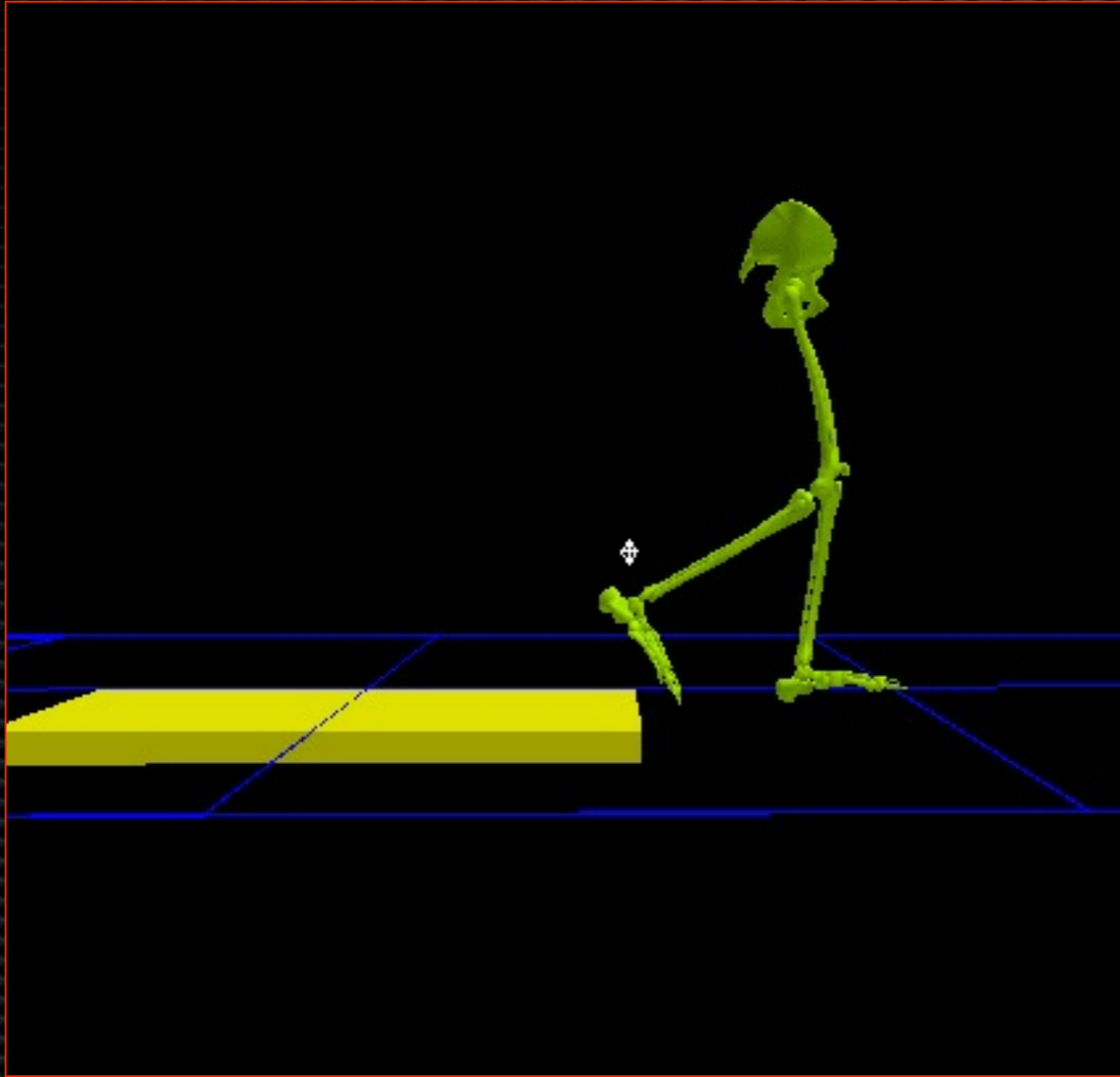


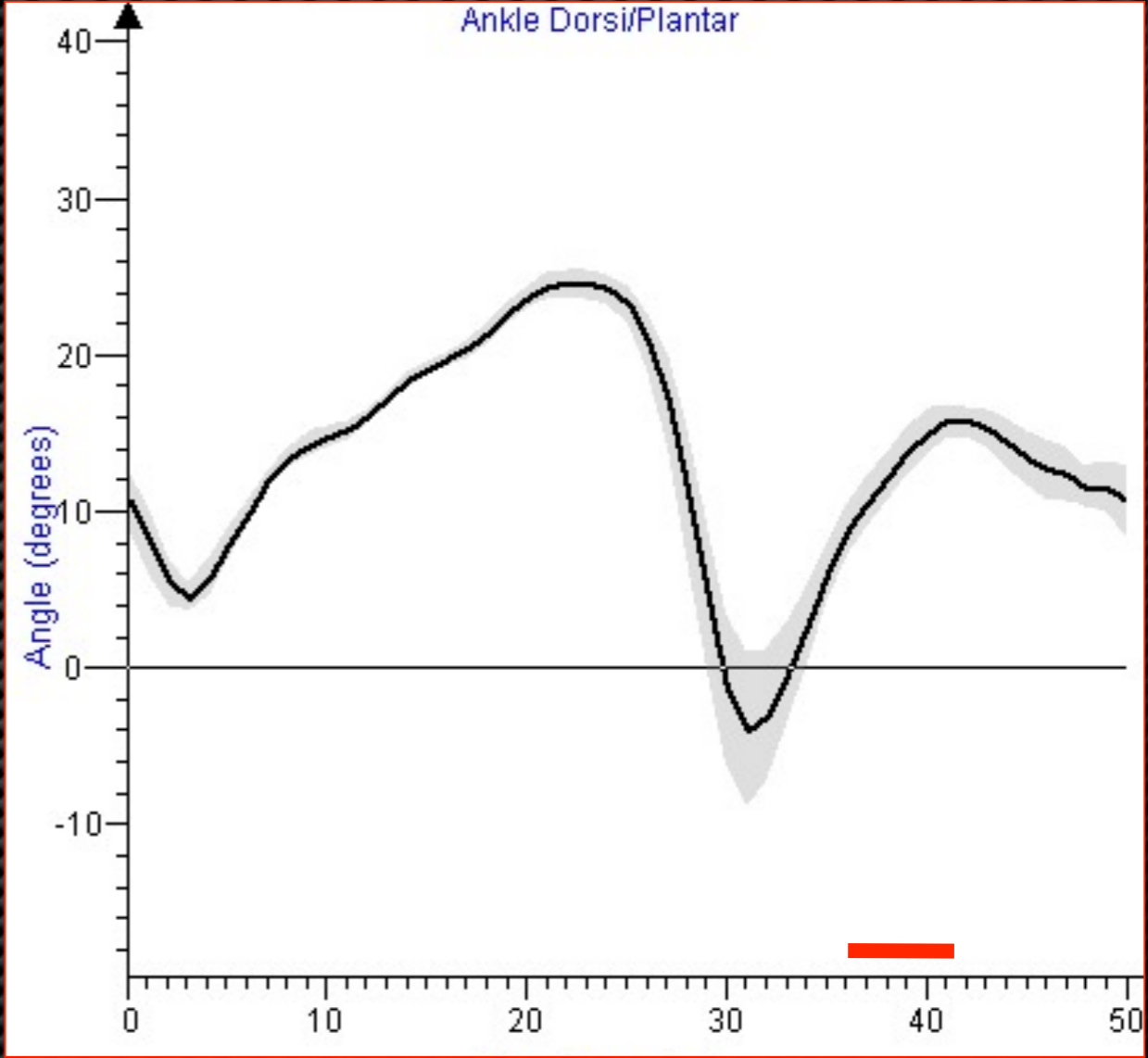
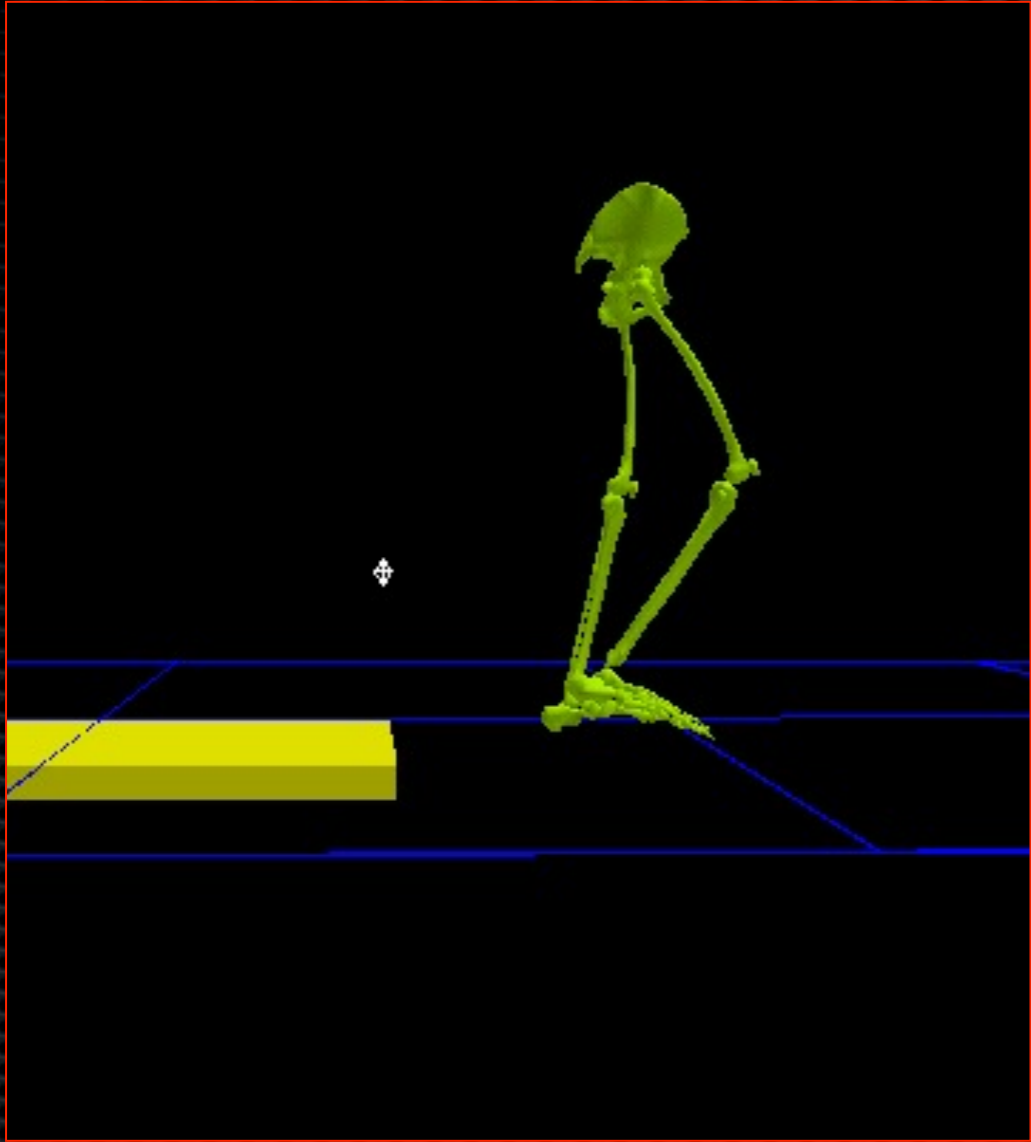


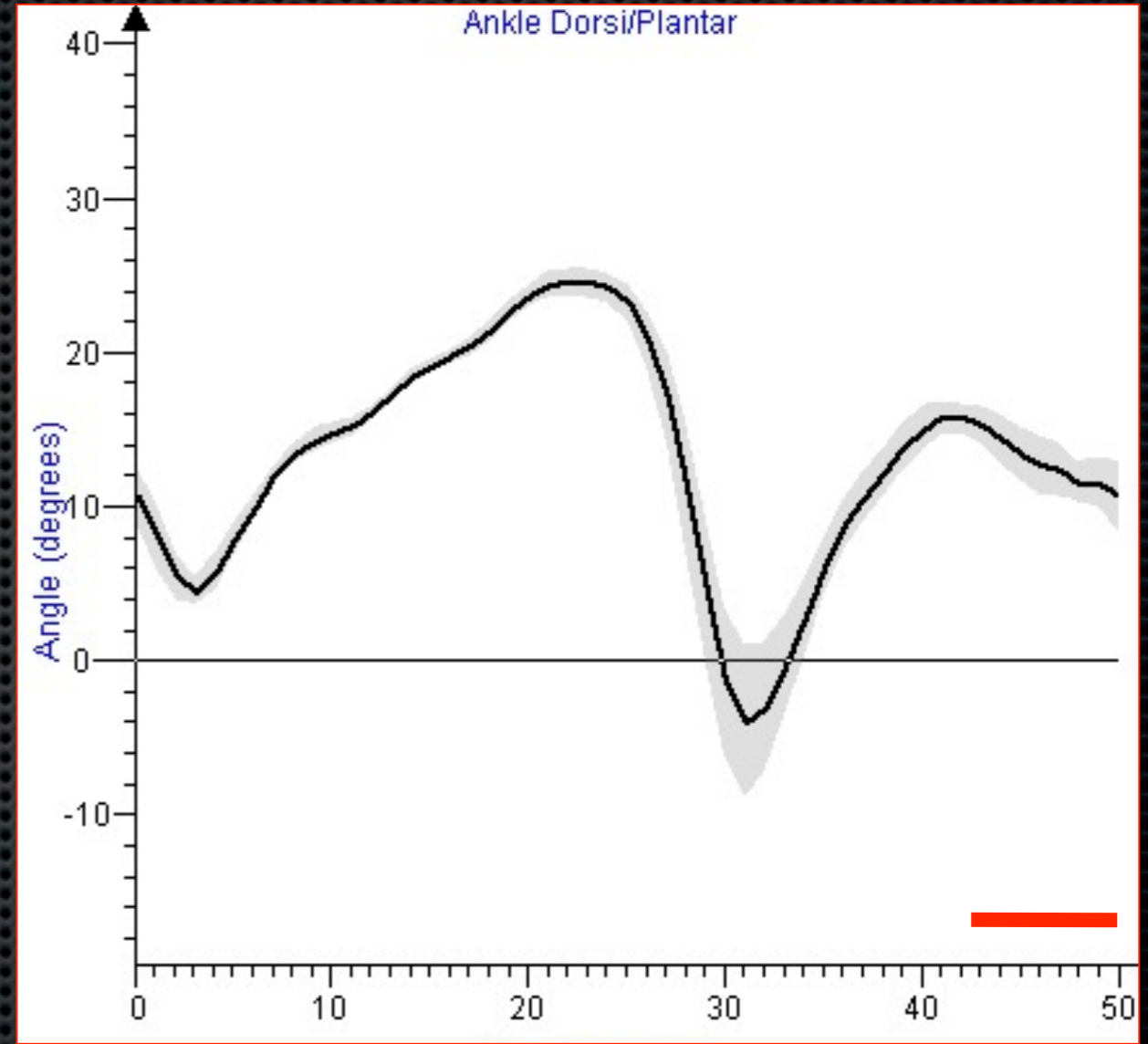
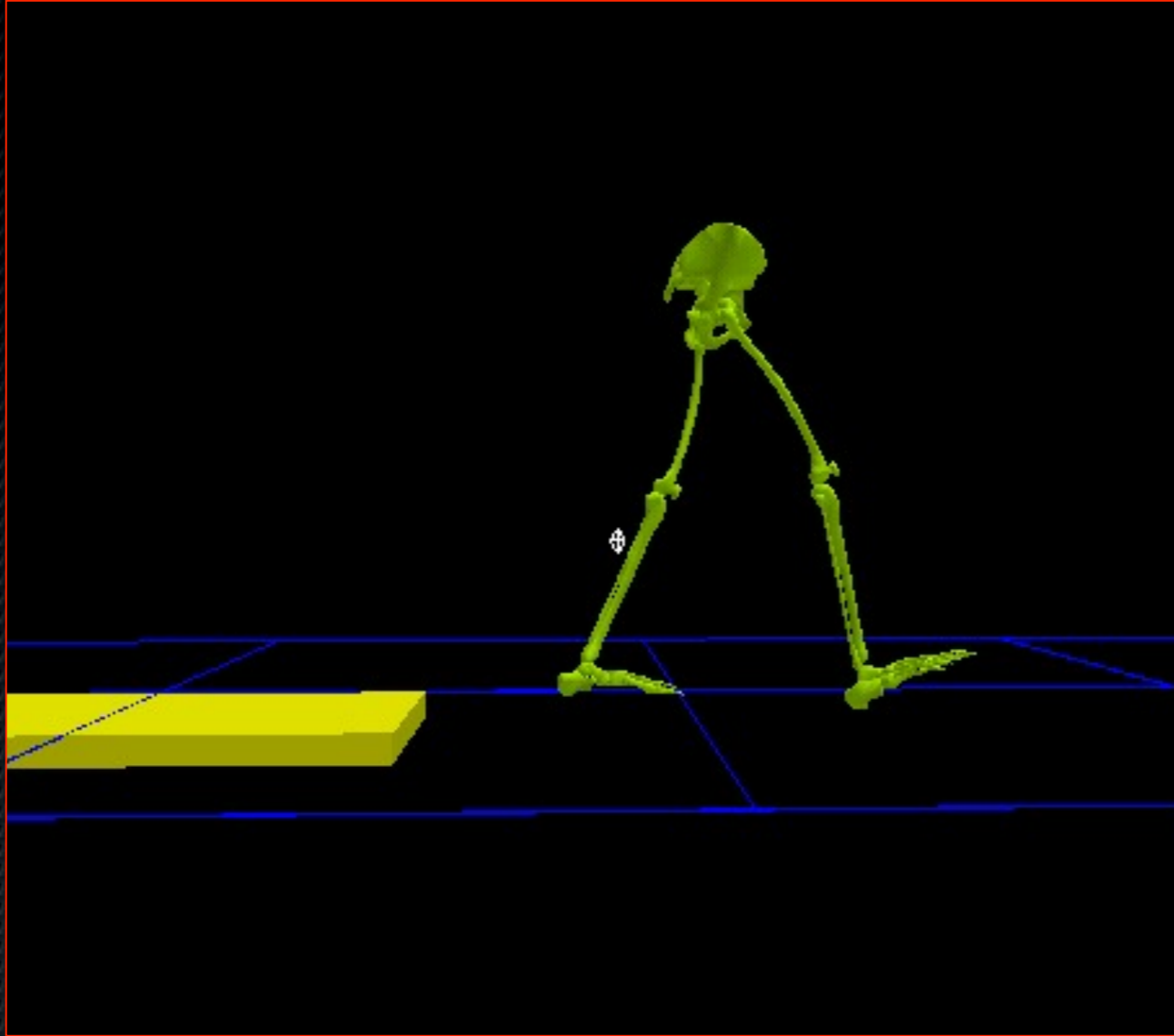




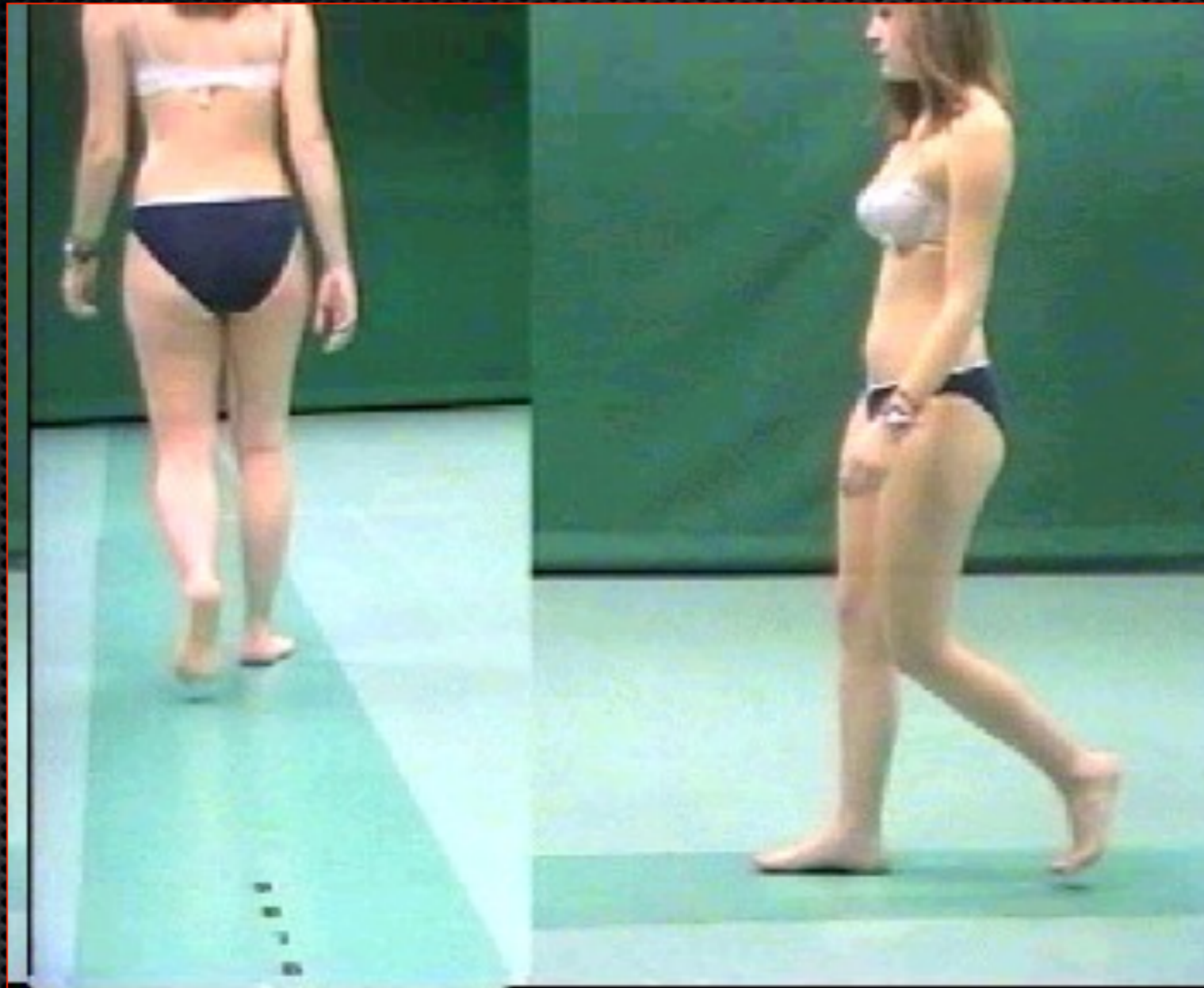






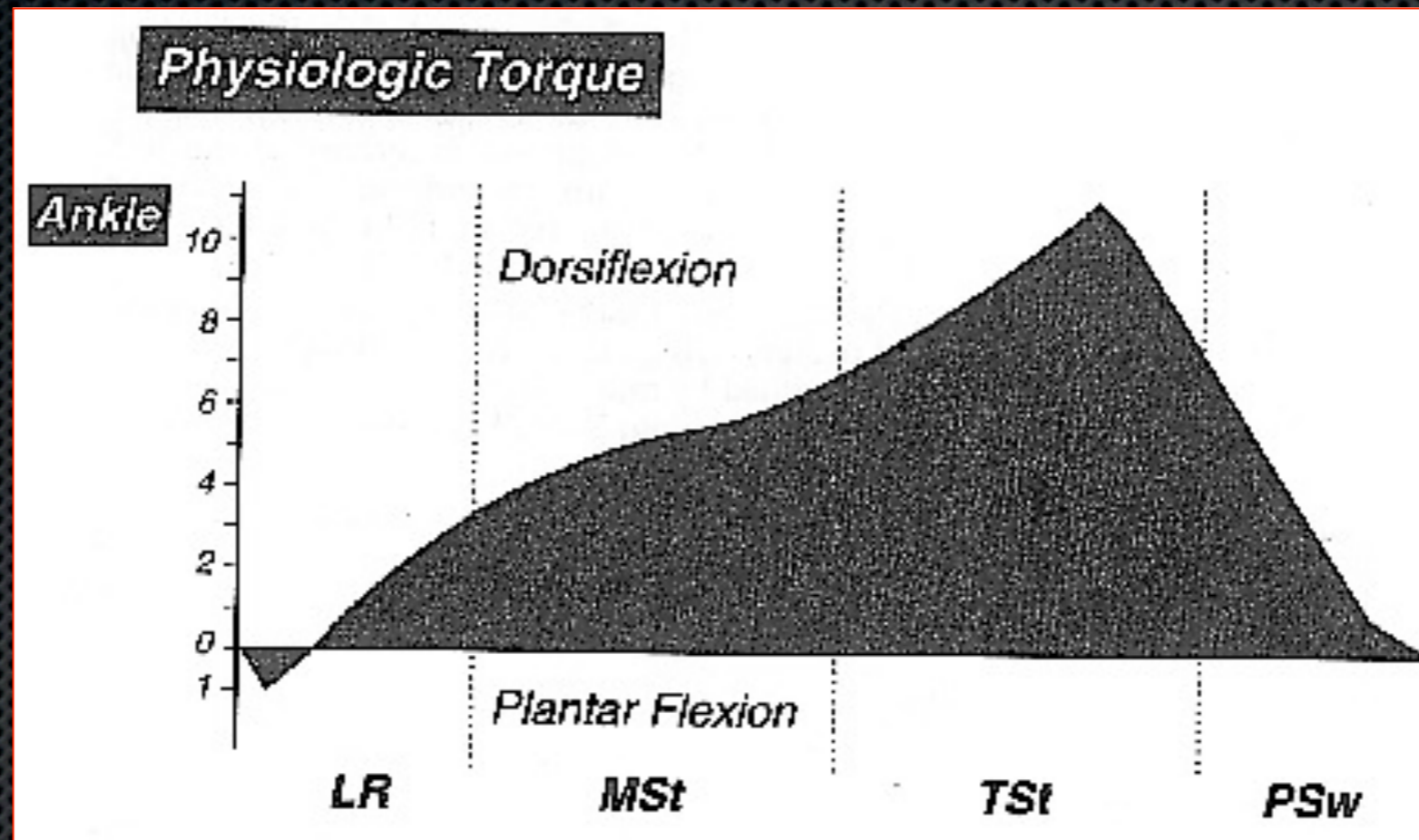


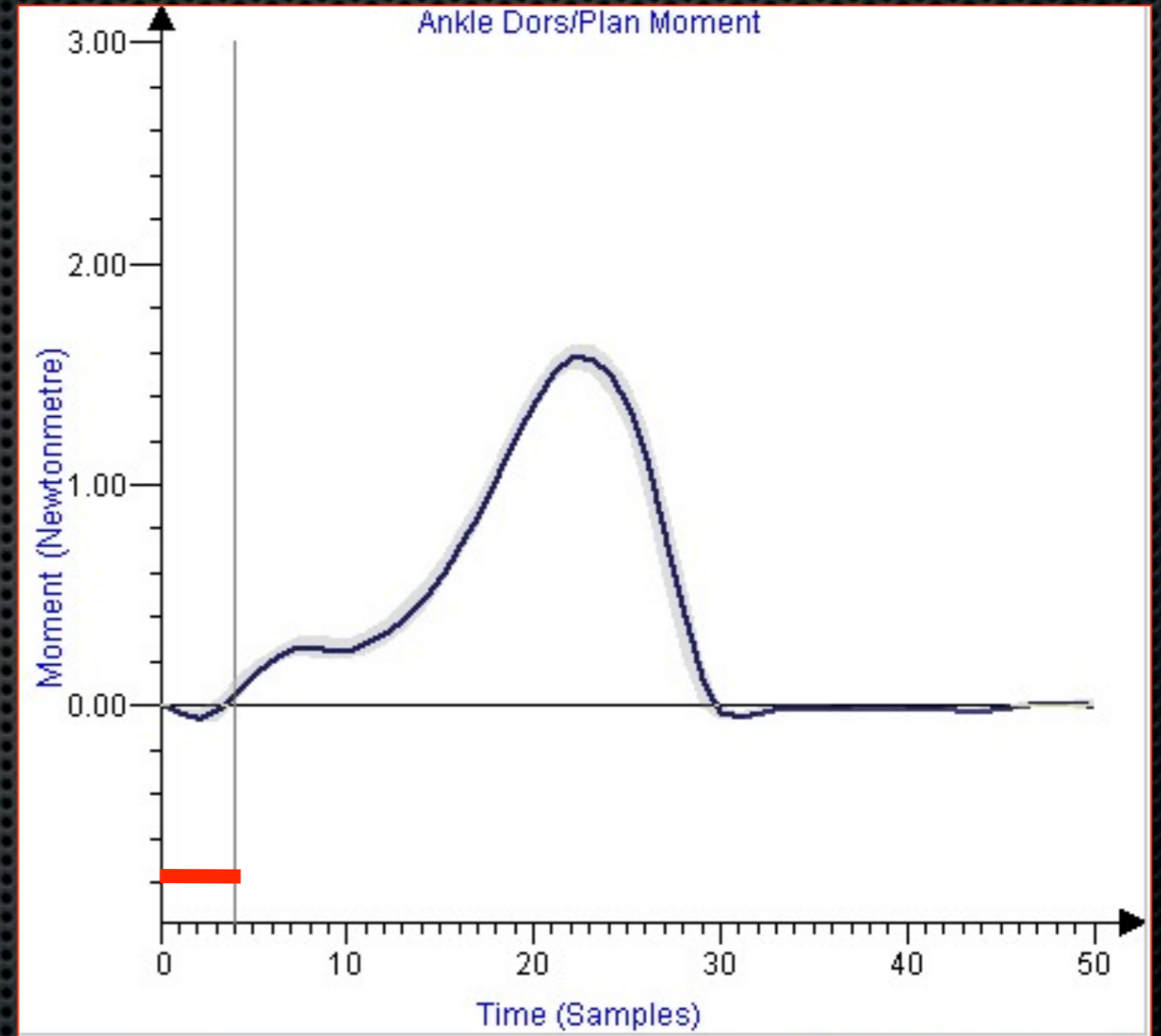
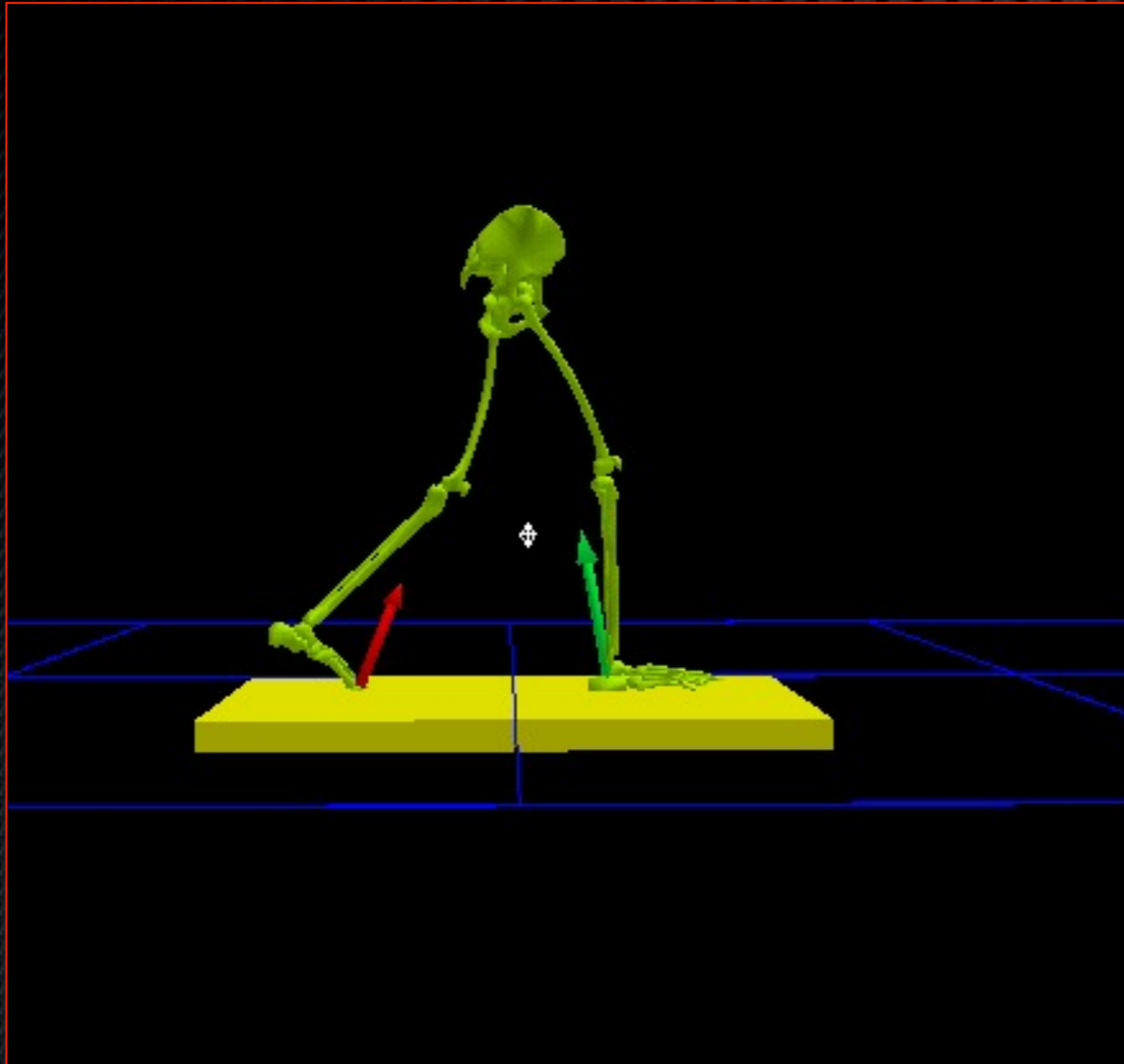


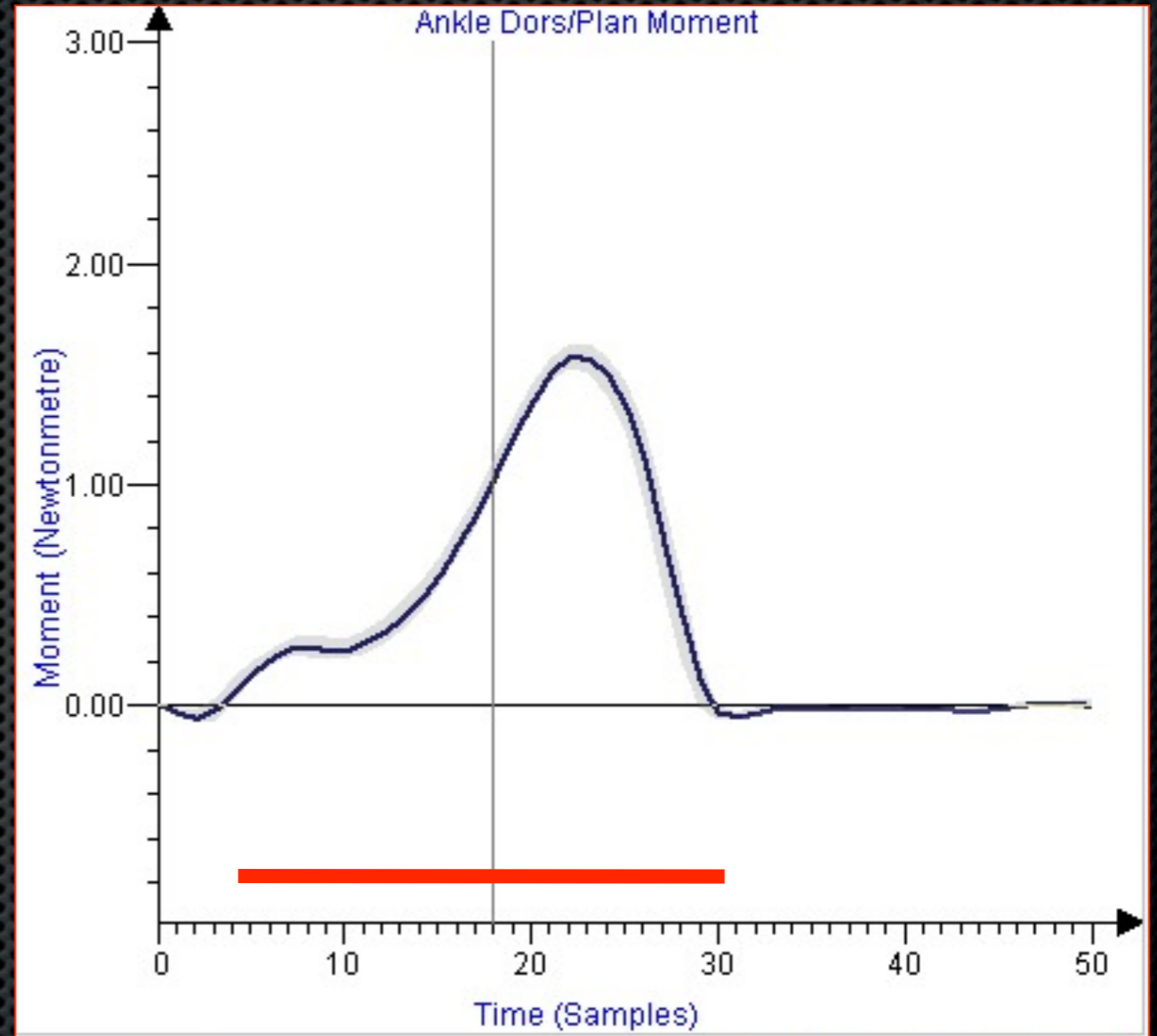
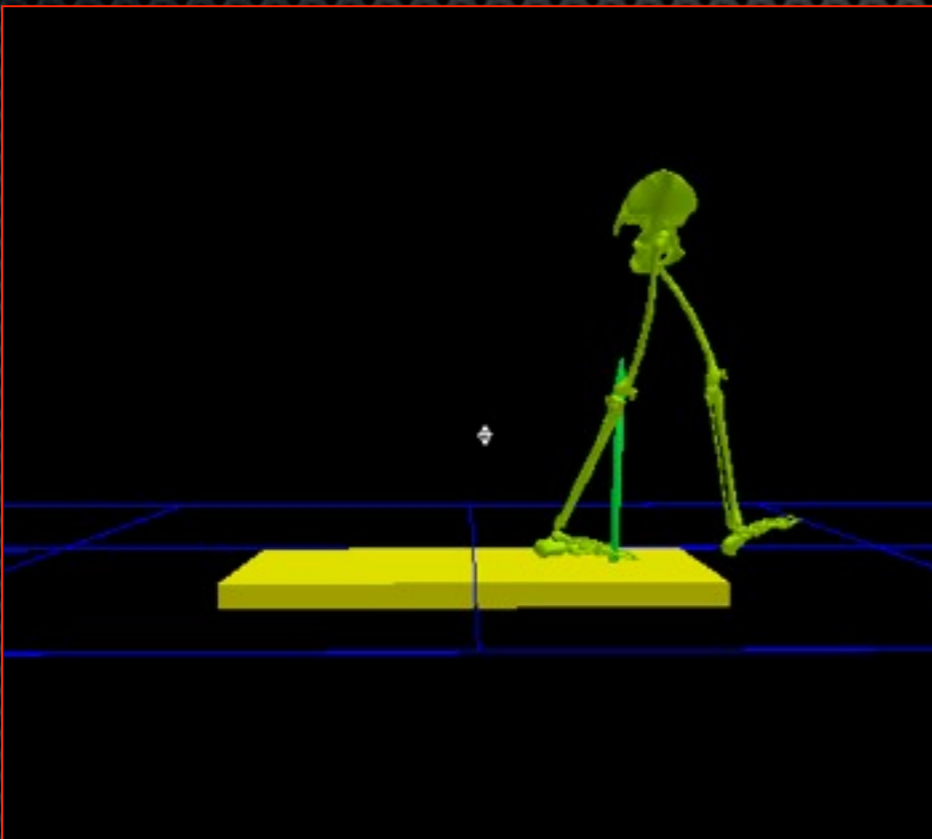
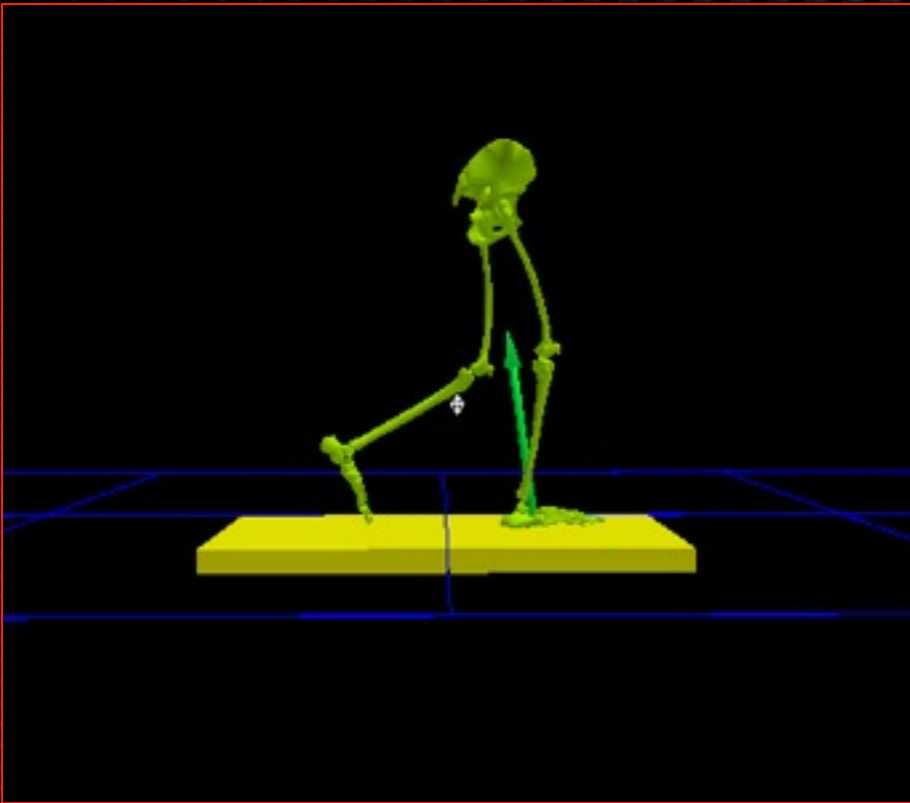


# CINETIQUE DE CHEVILLE

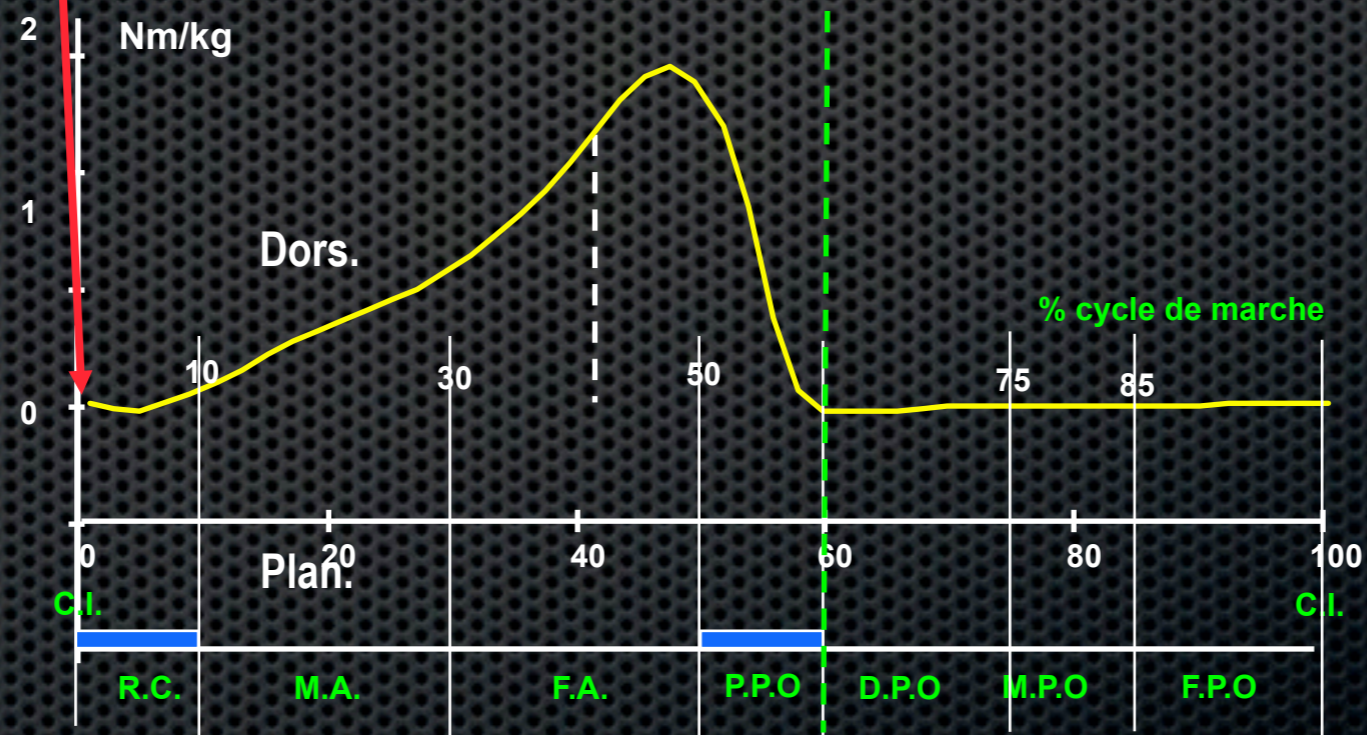
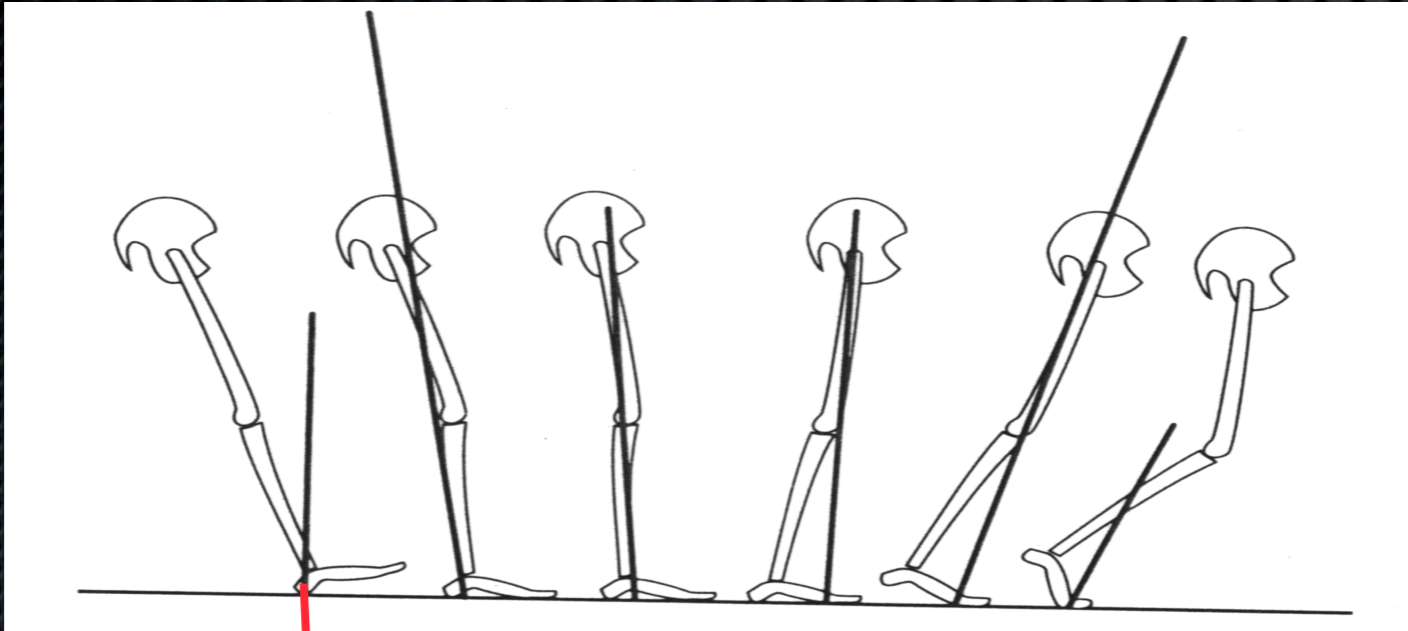
## Plan sagittal





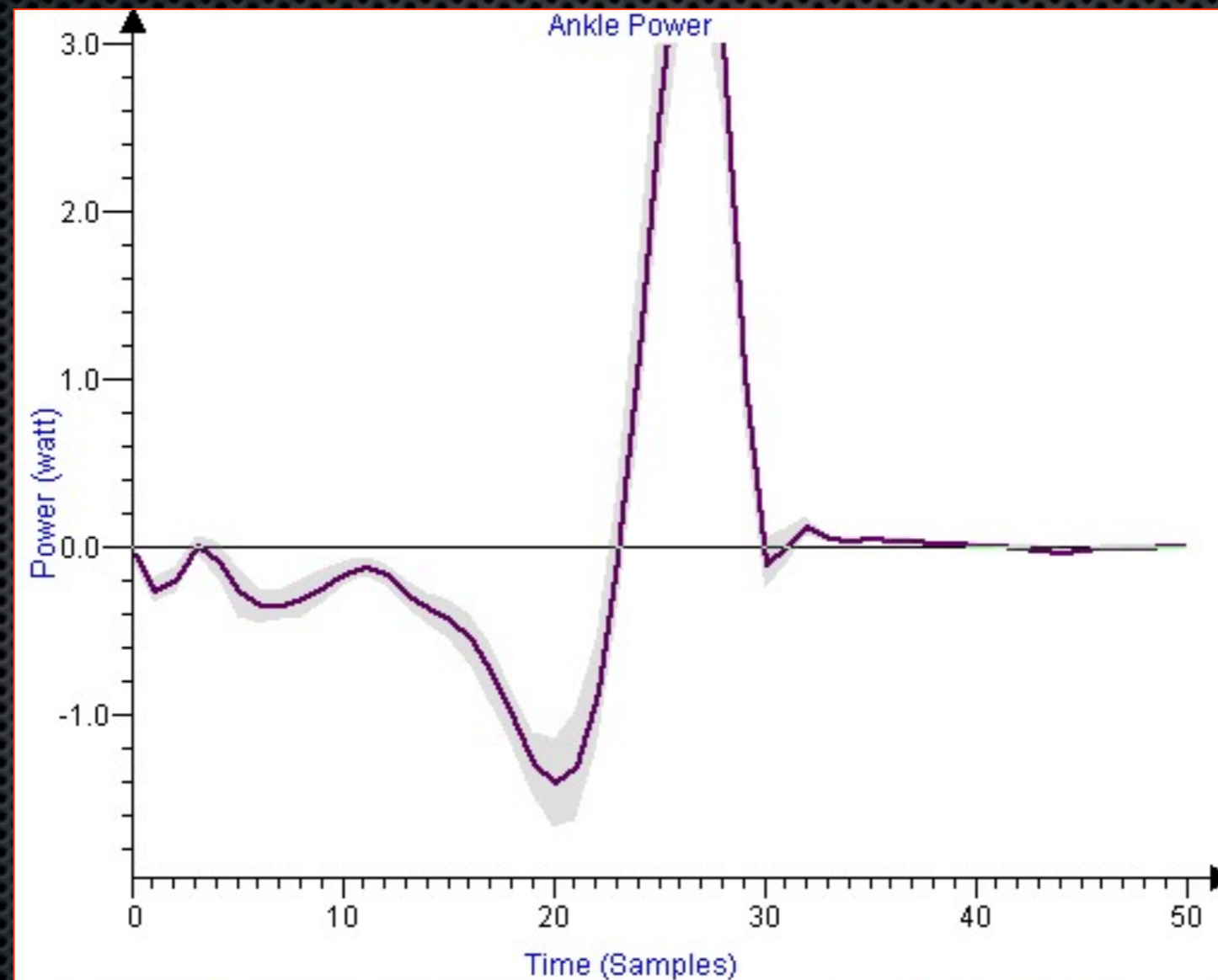


# CHEVILLE Moment

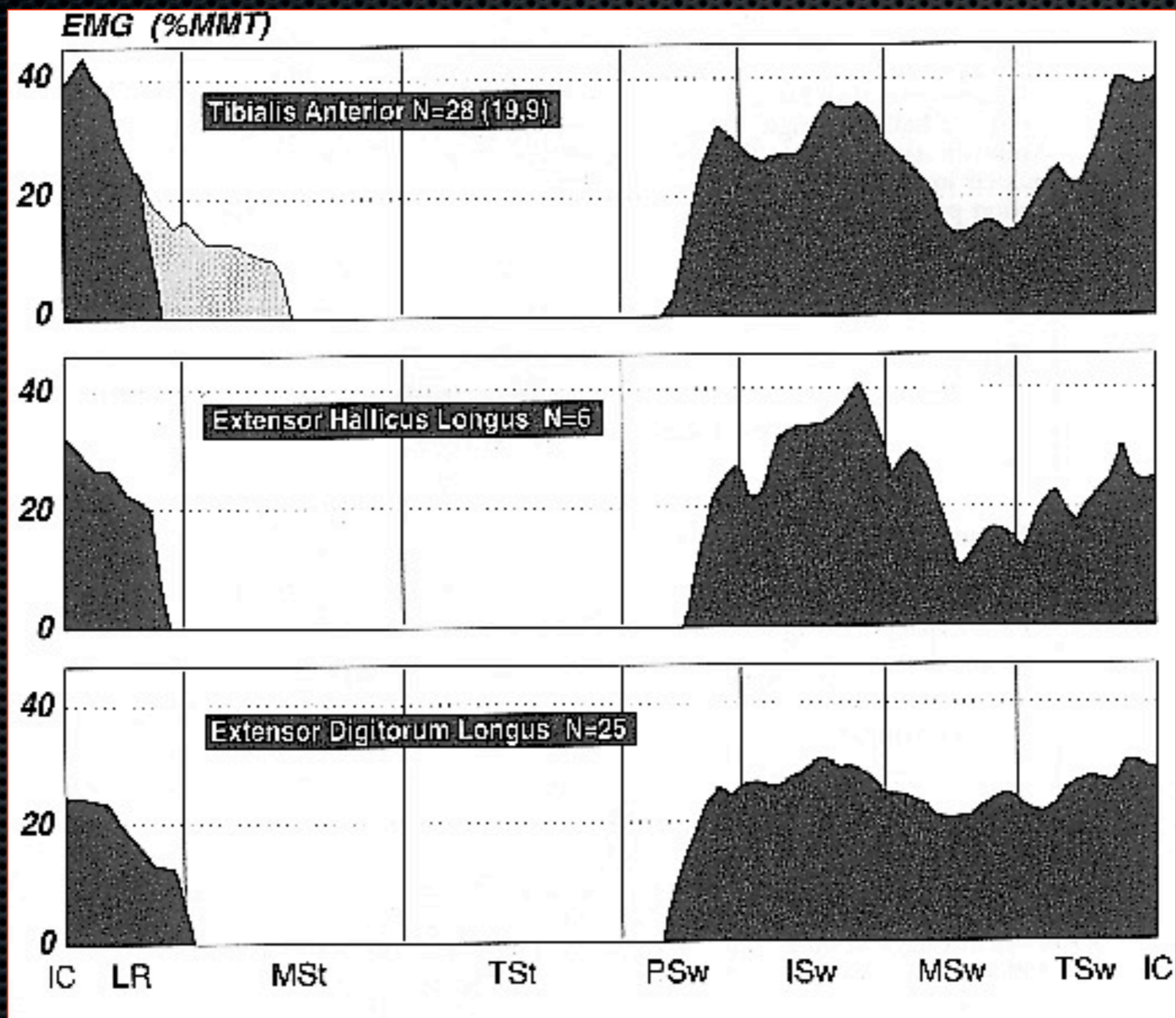


# PUISSANCE DE CHEVILLE

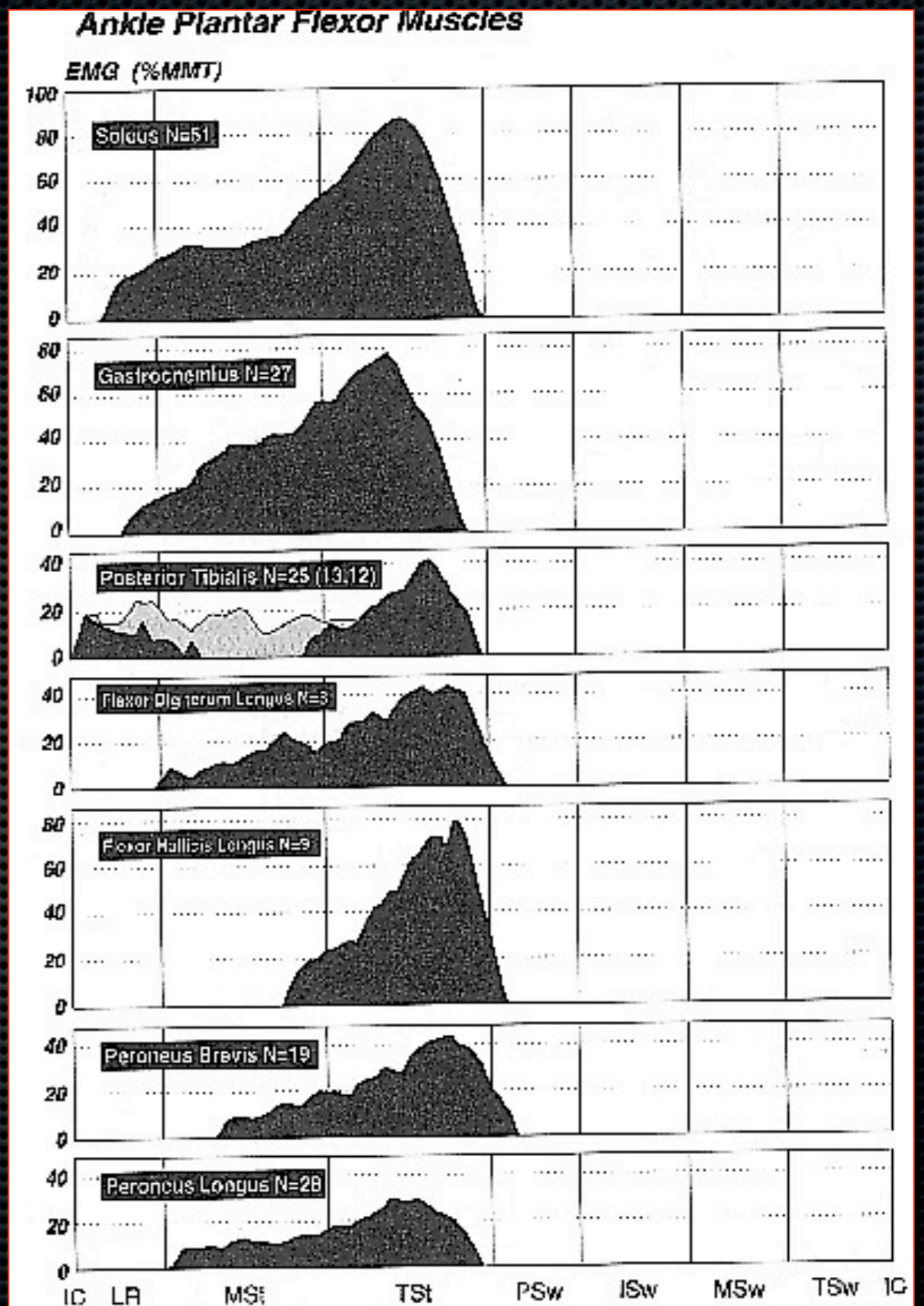
## $F \times L \times \text{Vitesse angulaire}$



# Muscles releveurs du pied



# Muscles fléchisseurs de cheville

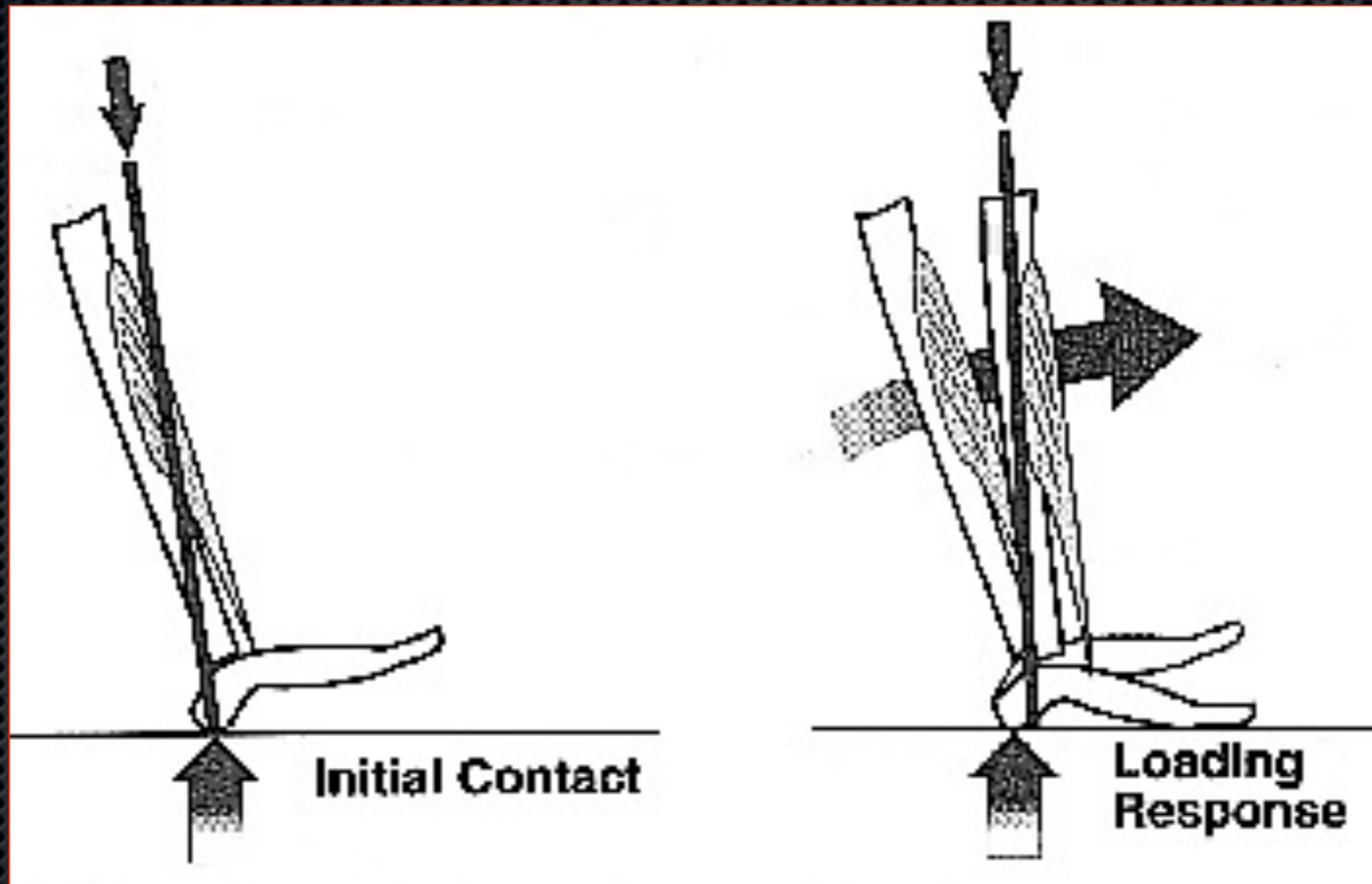




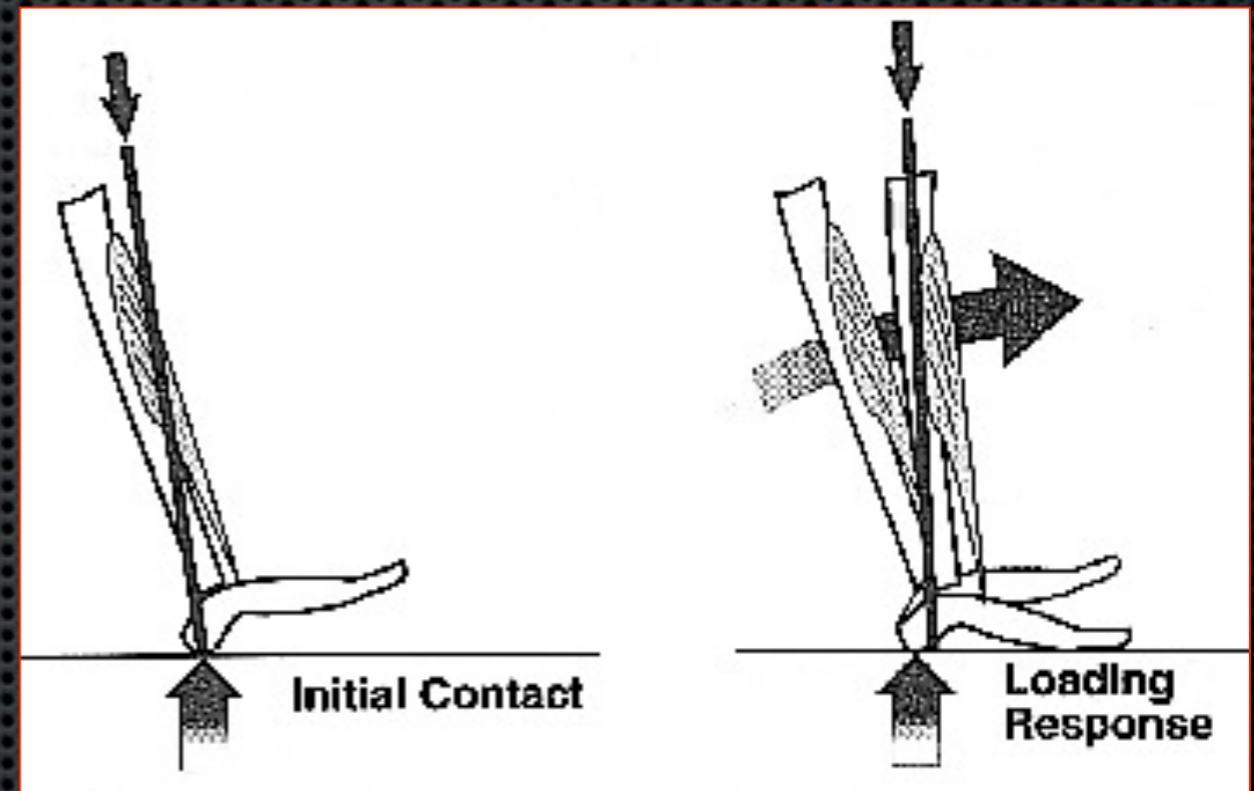
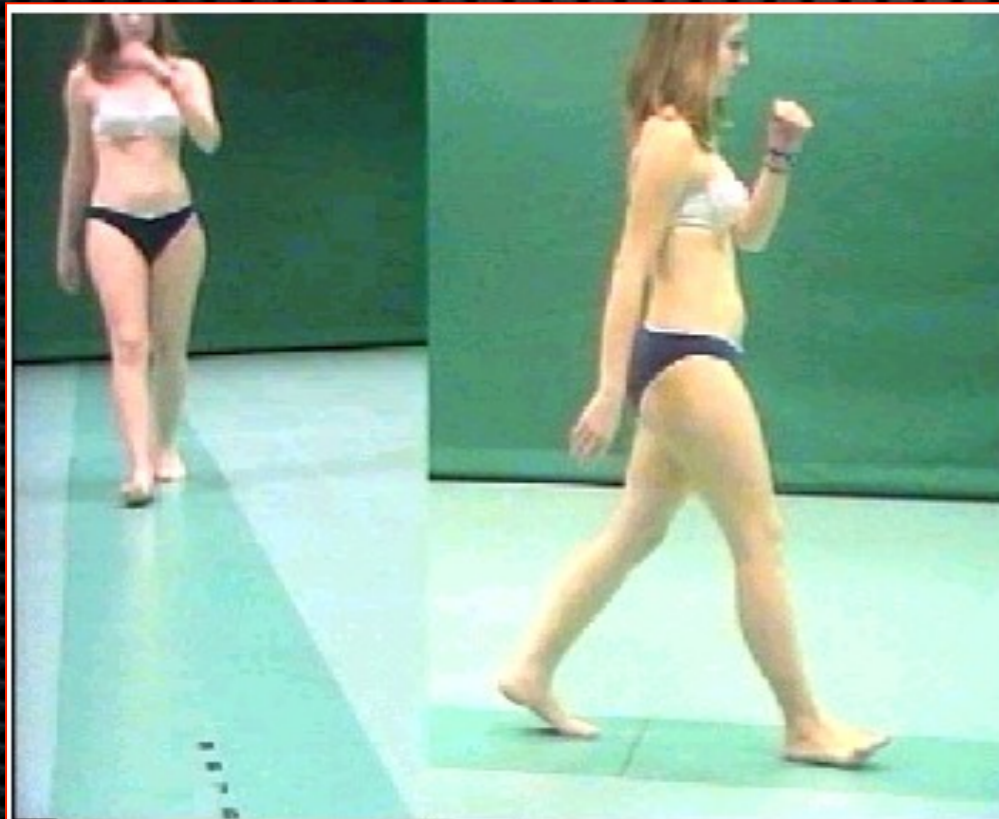
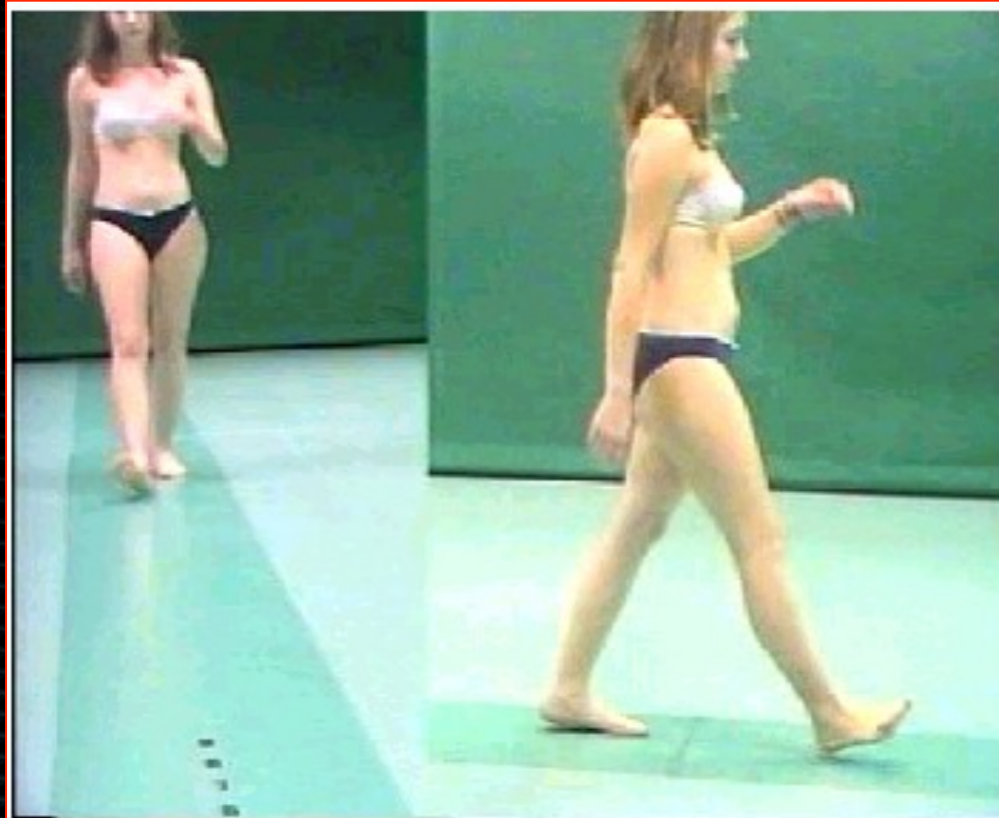
# Interprétation fonctionnelle cheville

Contact initial

Mise en appui



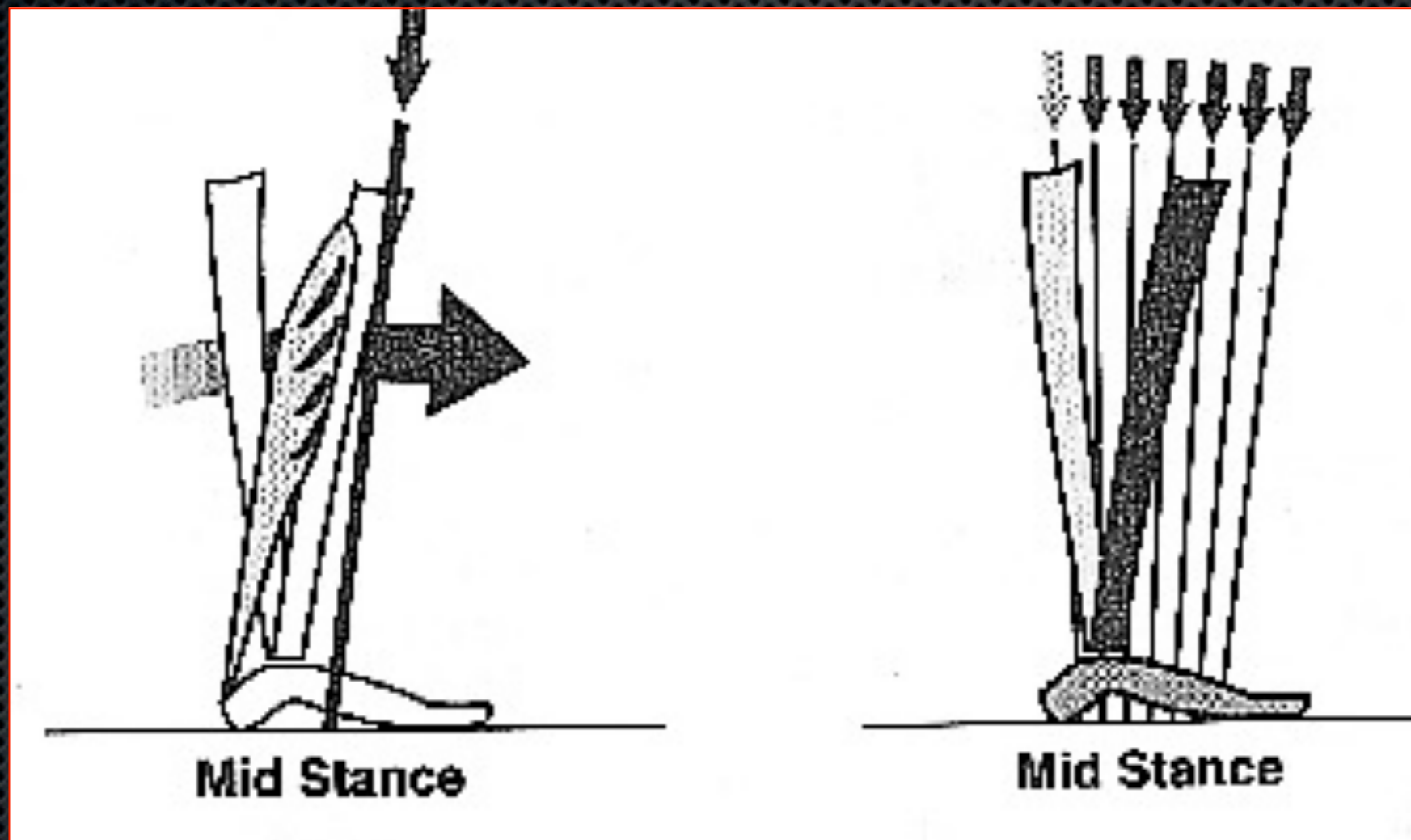
# Contact initial



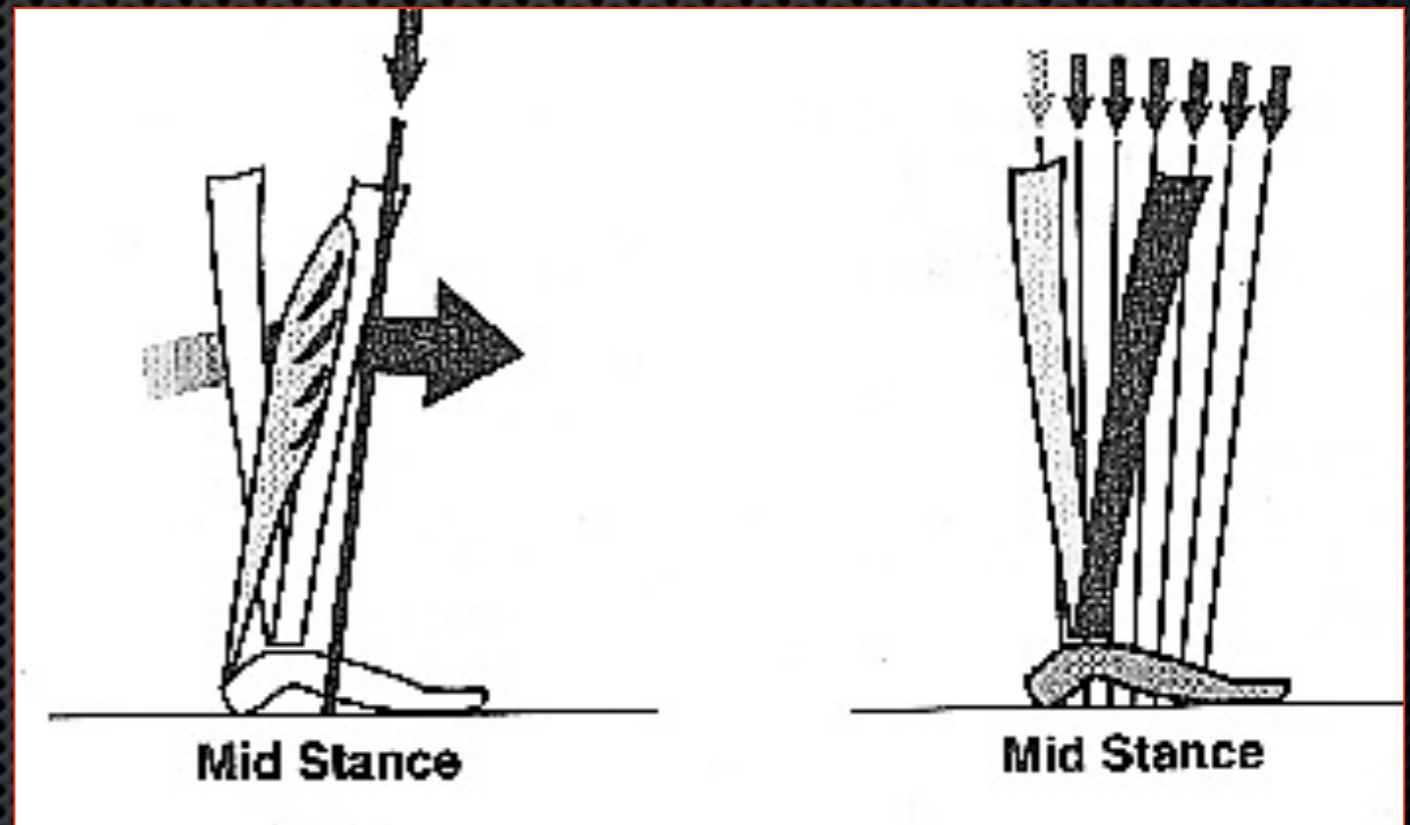
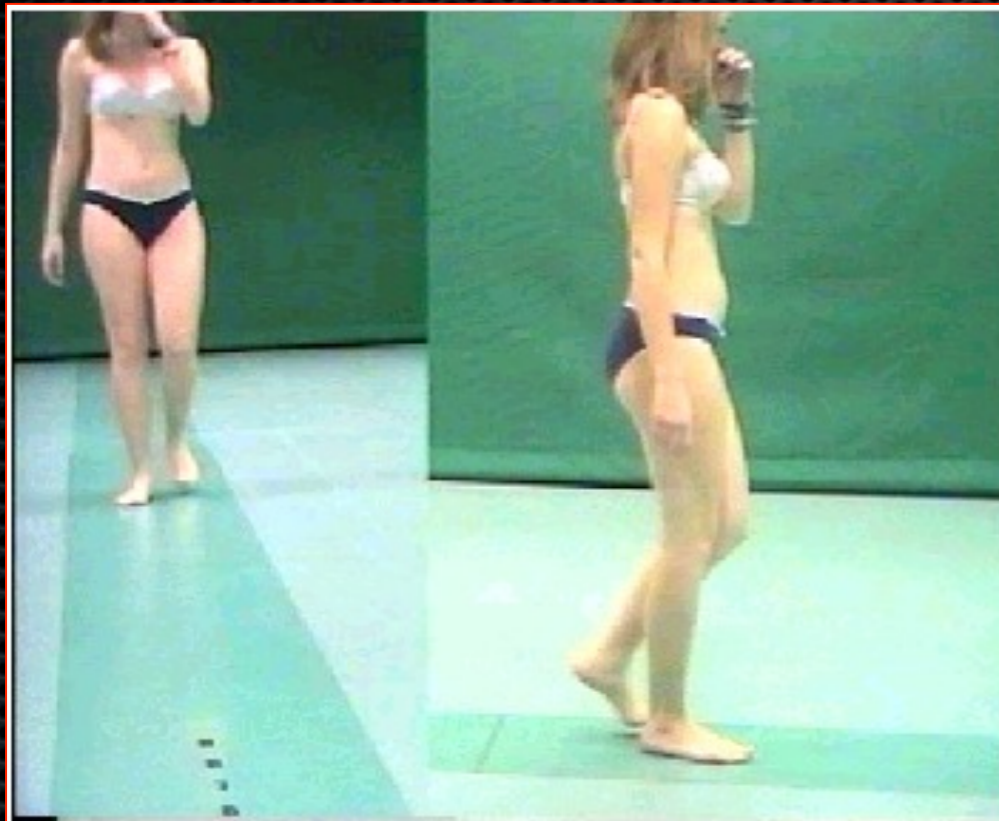
# Mise en appui

# Interprétation fonctionnelle cheville

## Milieu d'appui

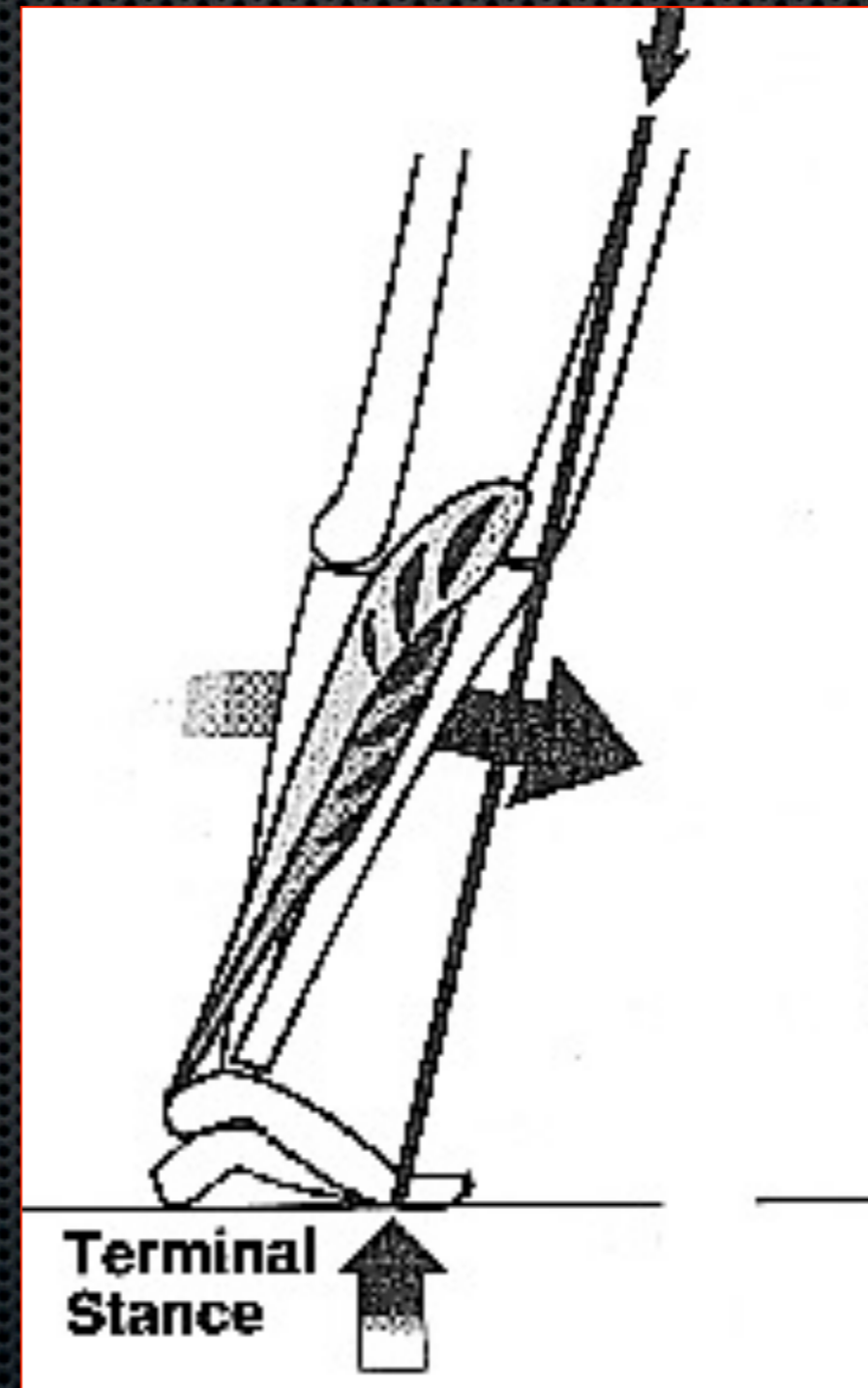


# Milieu d'appui



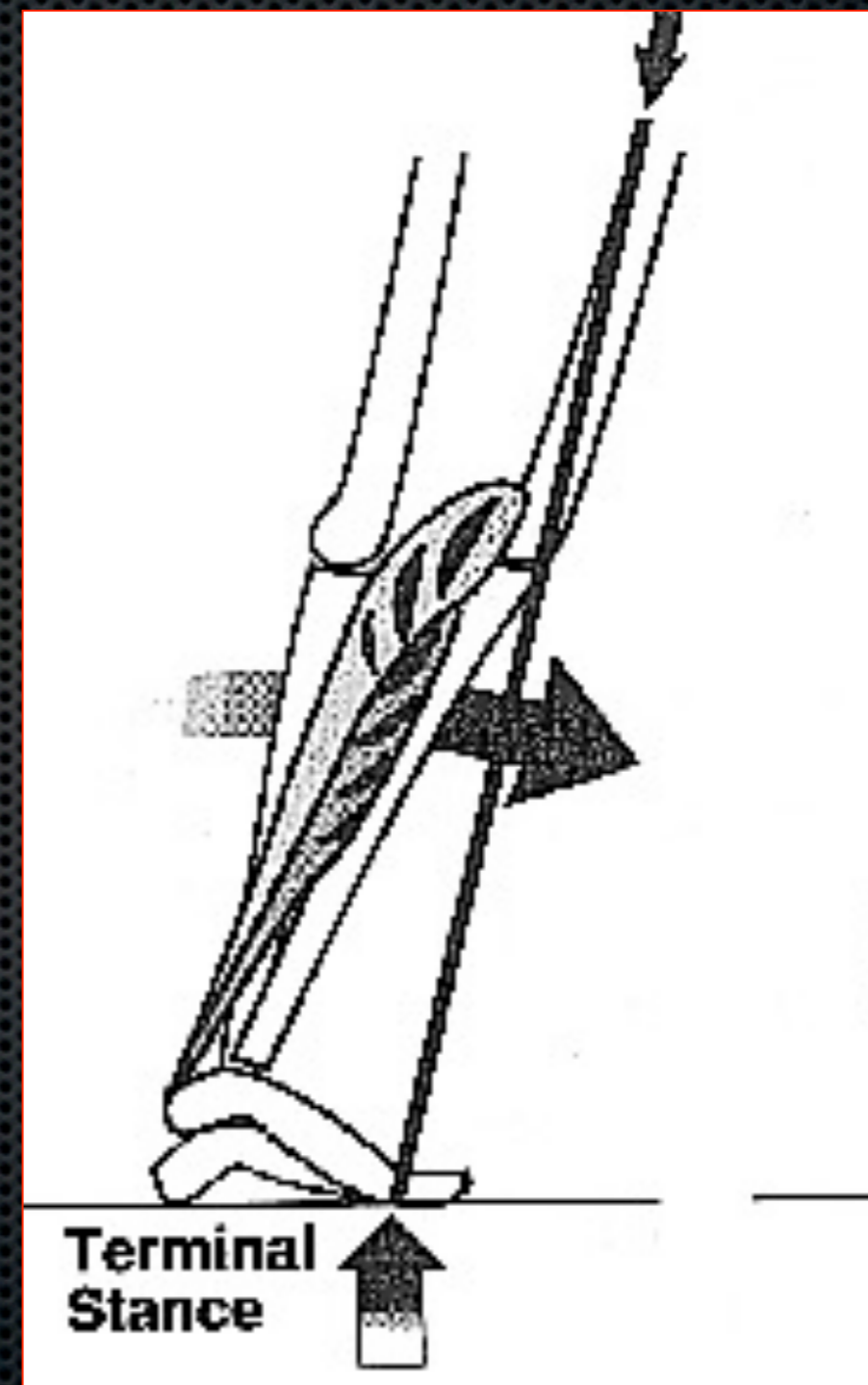
# Interprétation fonctionnelle cheville

**Fin d'appui**





**Fin d'appui**



# Interprétation fonctionnelle cheville

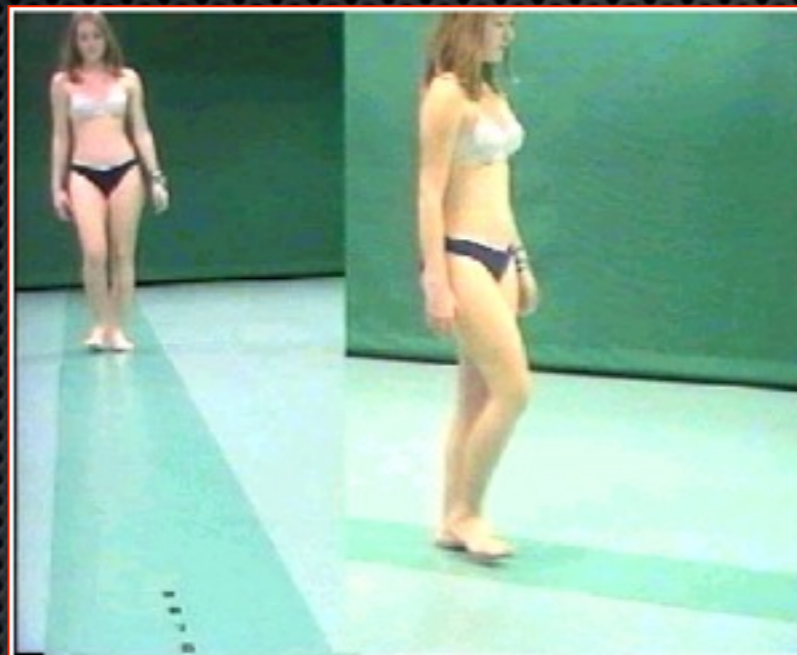
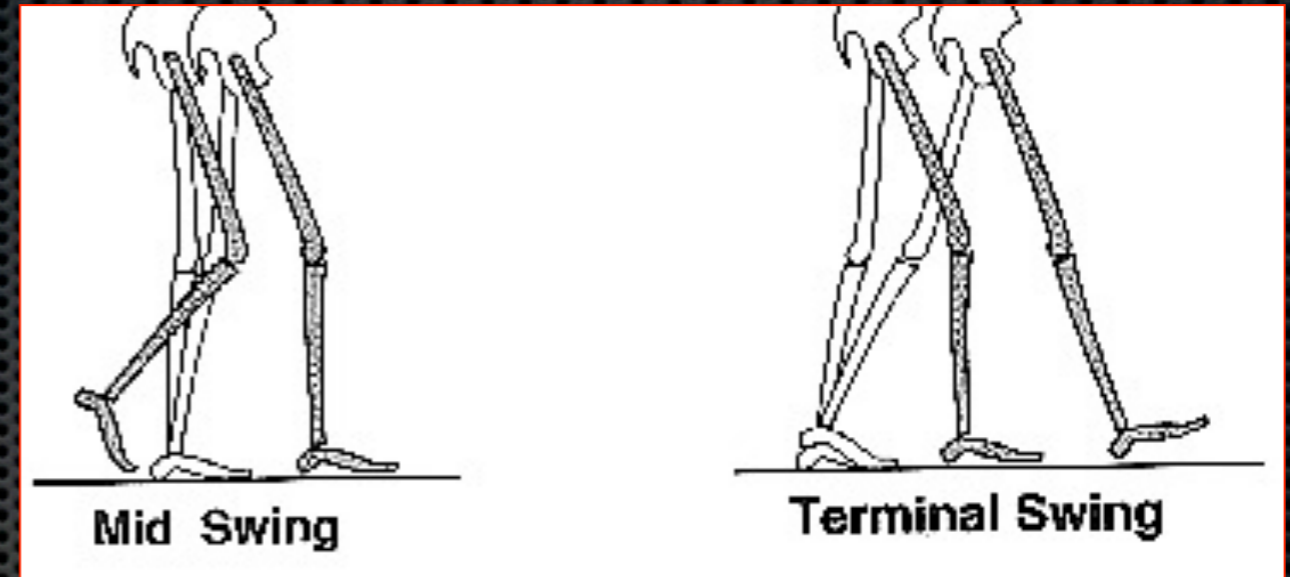
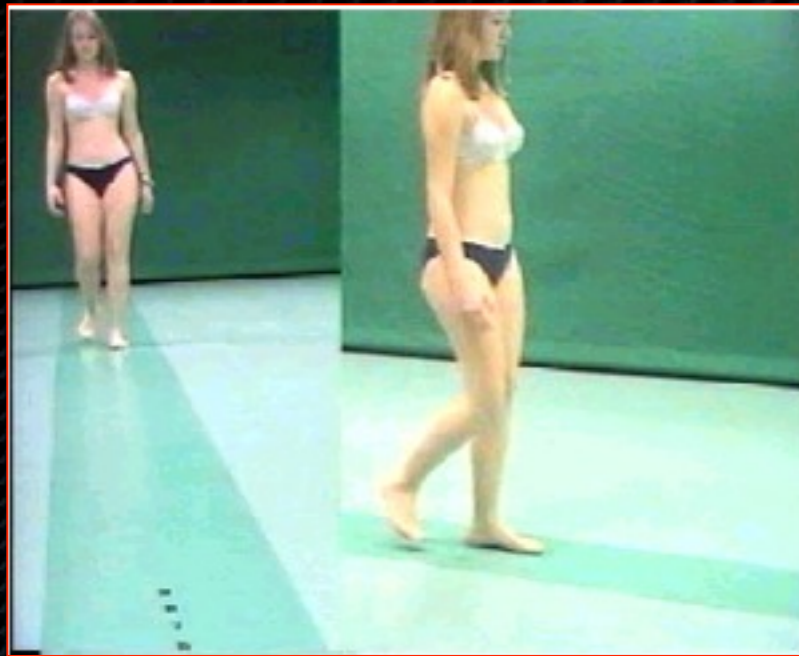
## Phase pré oscillante



# Phase pré oscillante



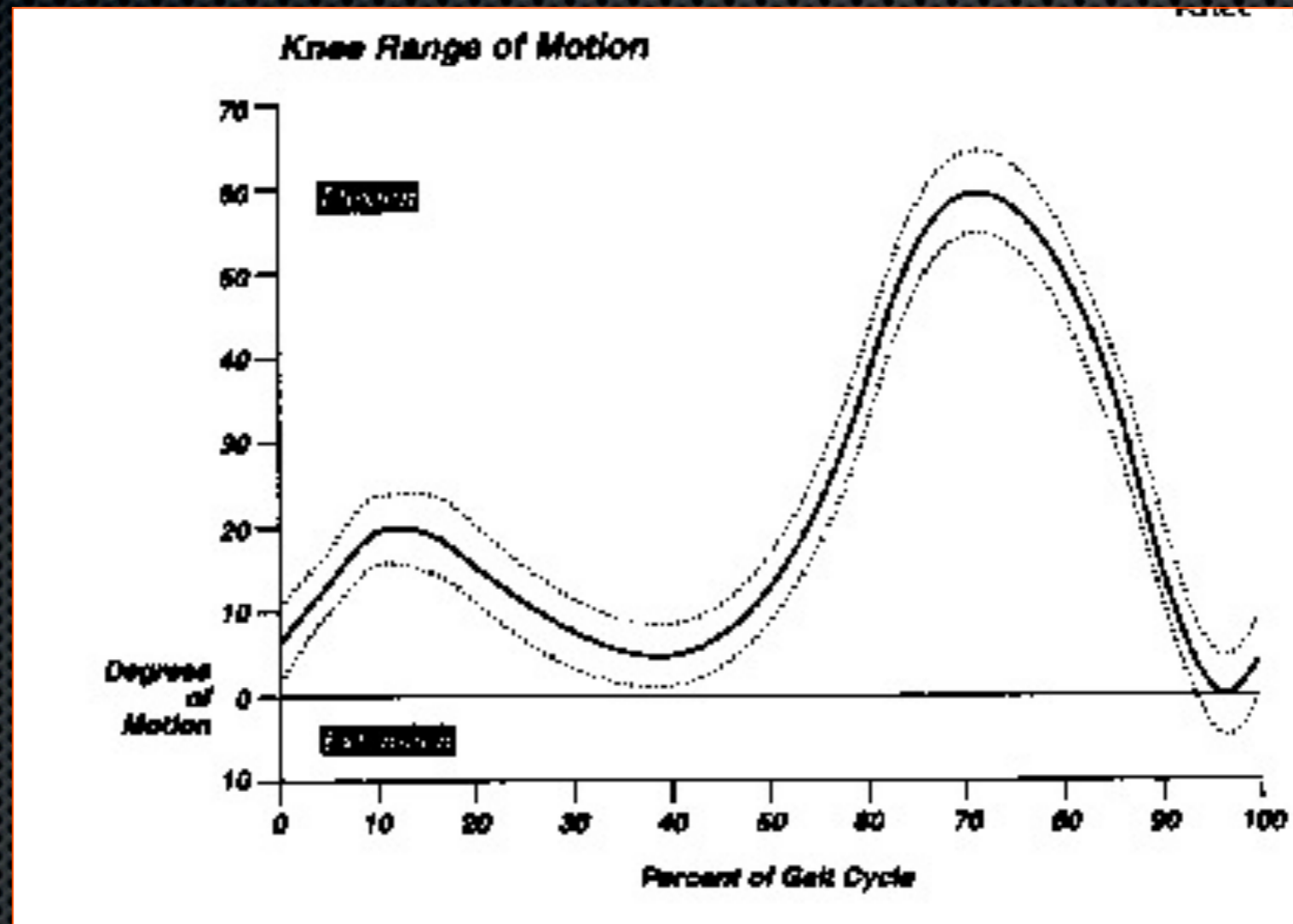




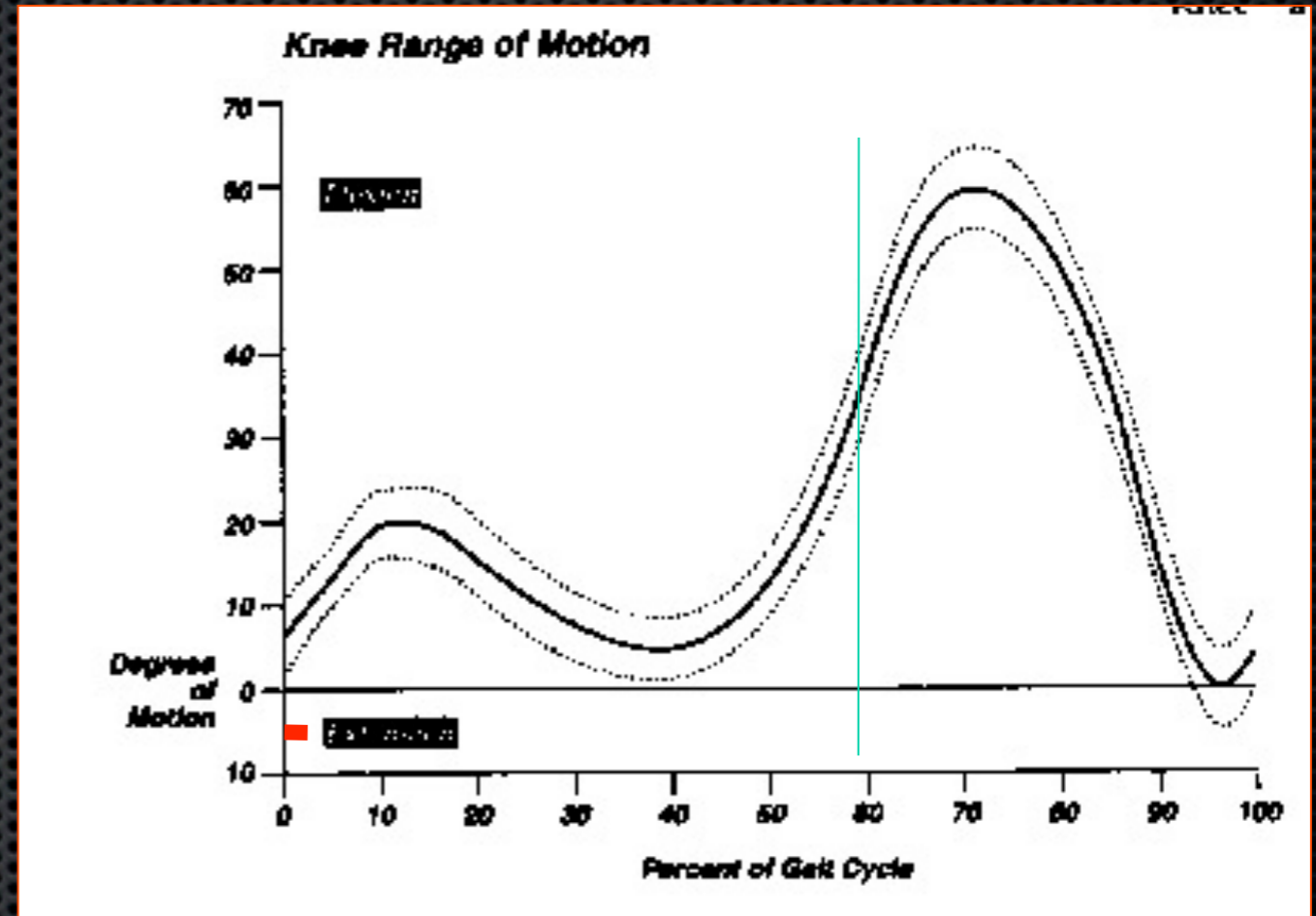
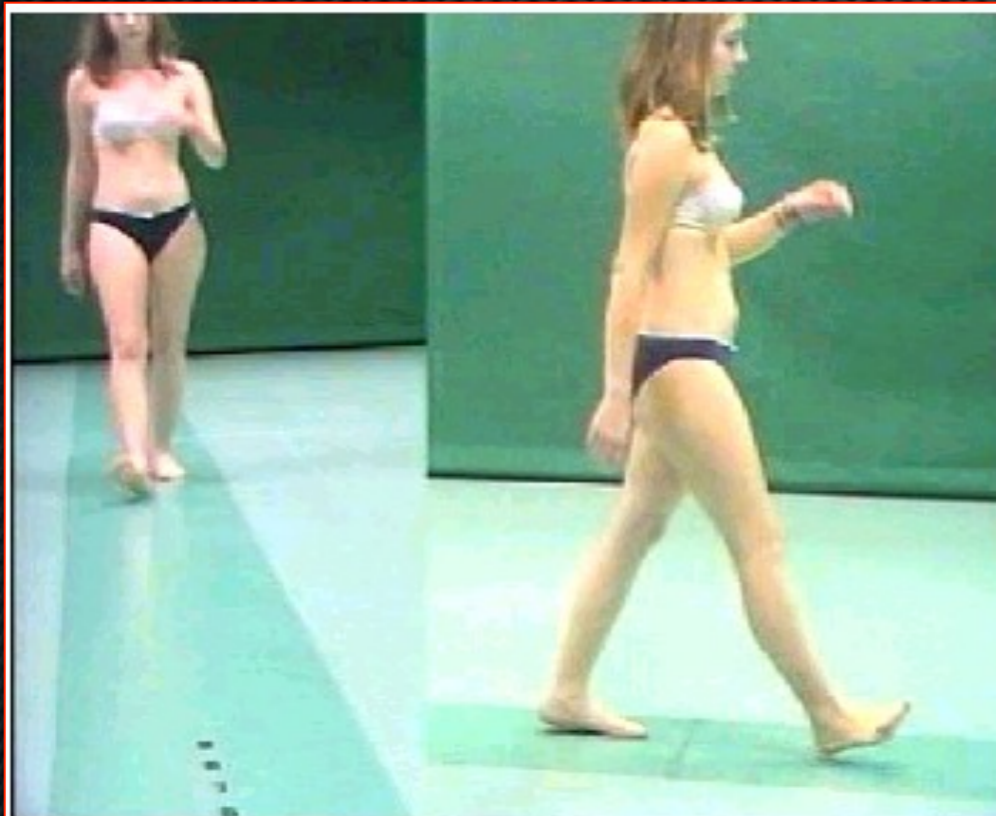
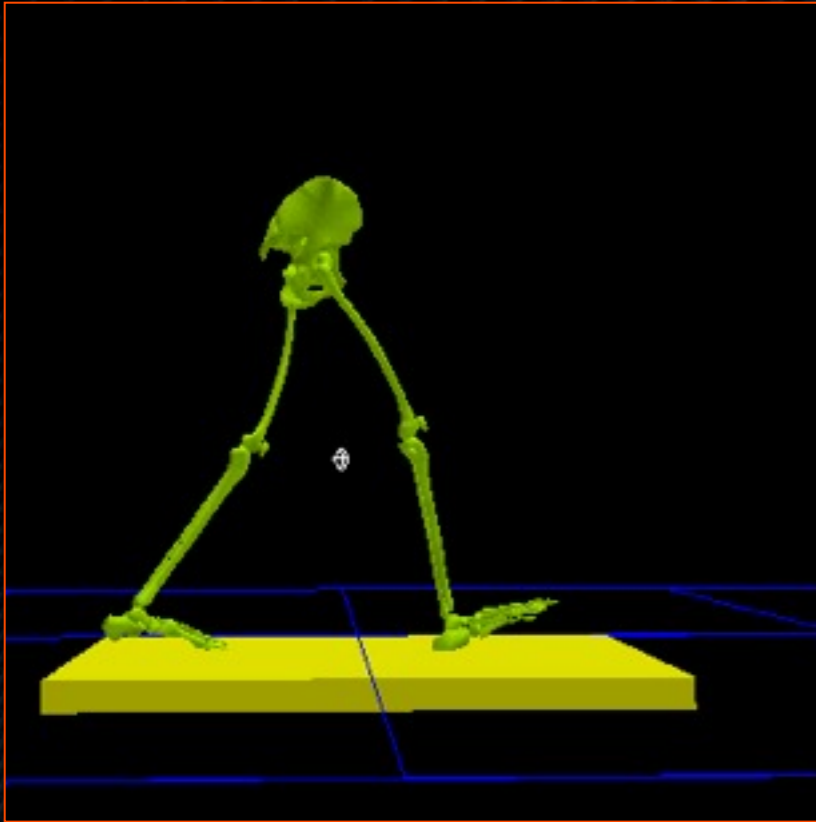
**Phase oscillante**

# LE GENOU NORMAL

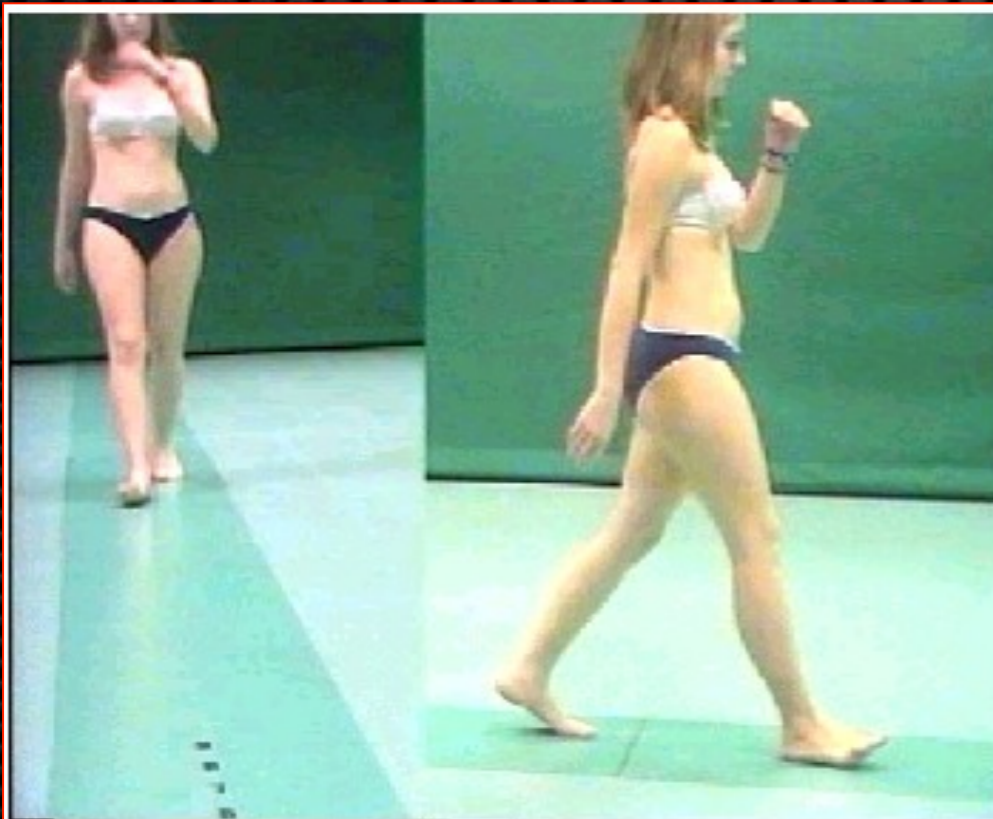
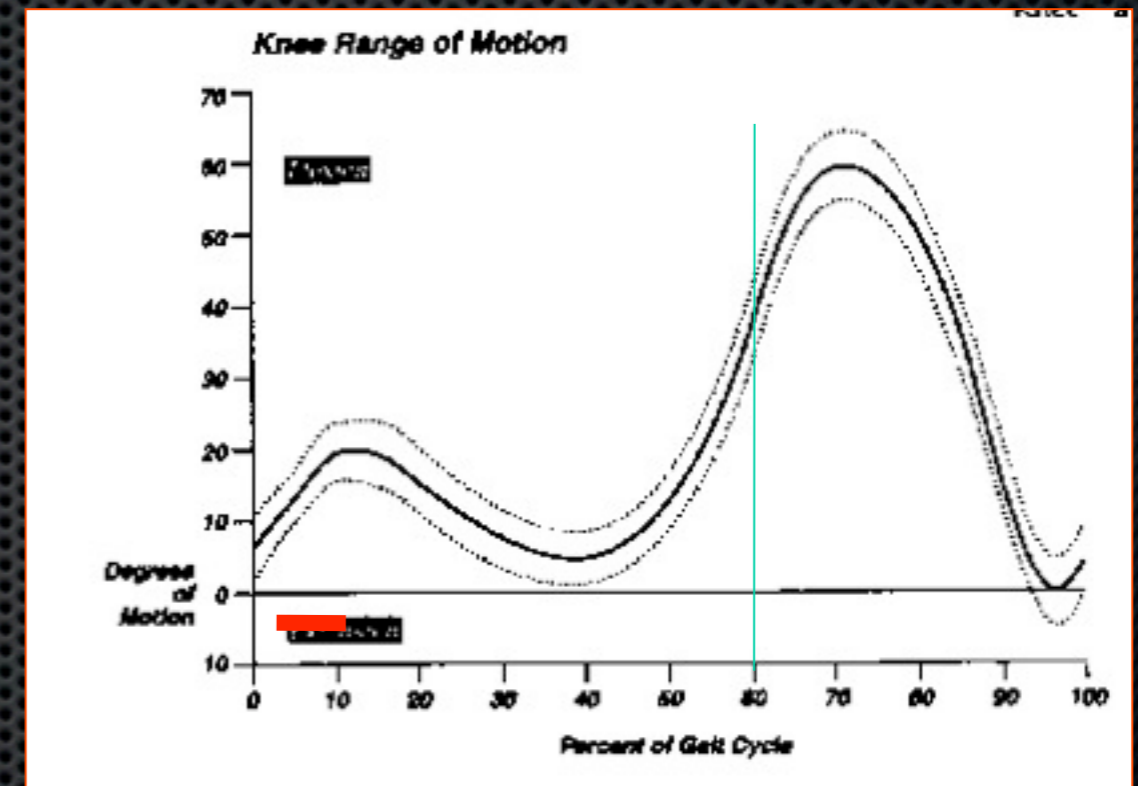
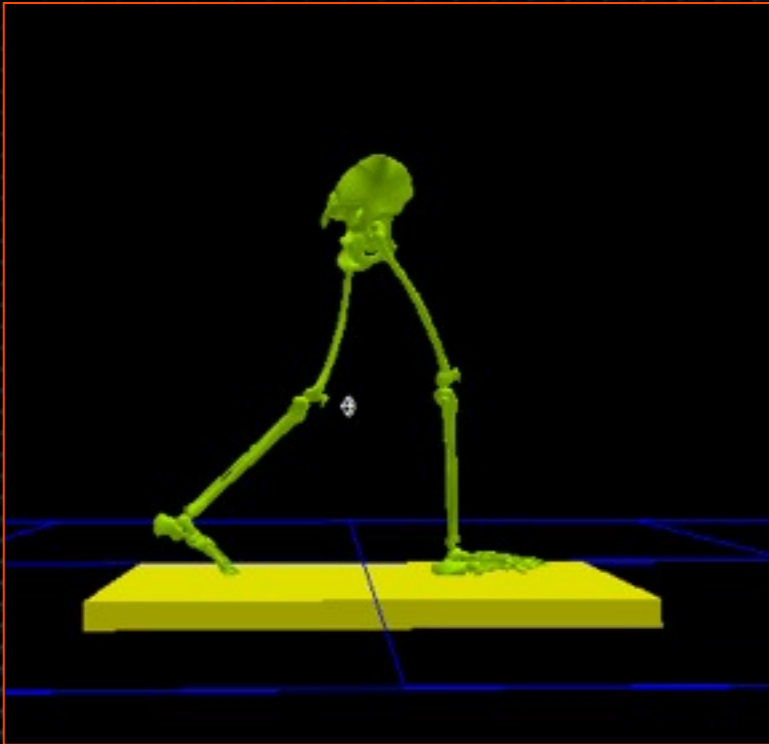
# CINEMATIQUE DU GENOU



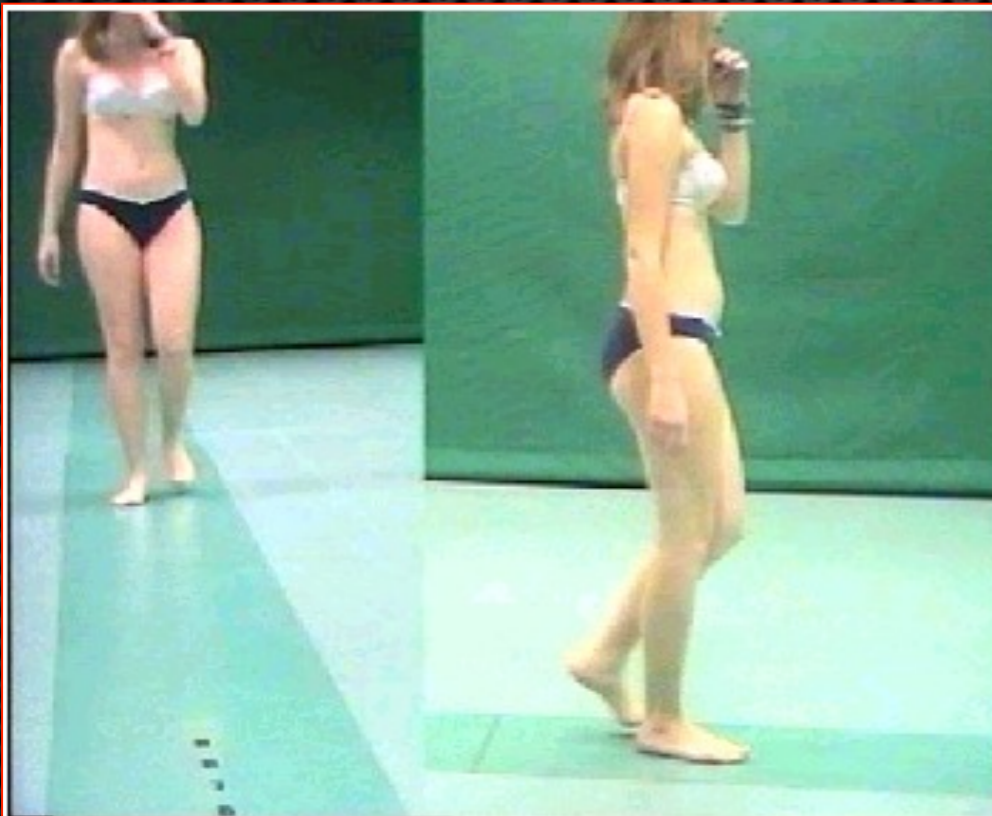
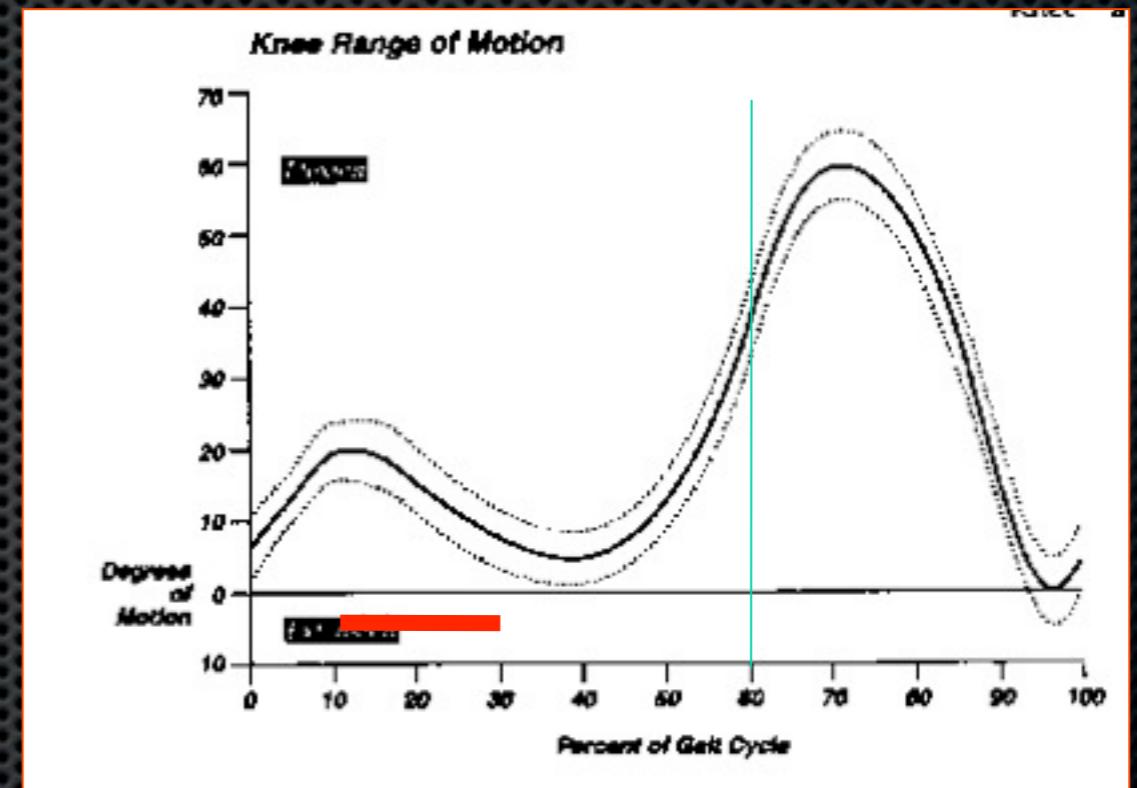
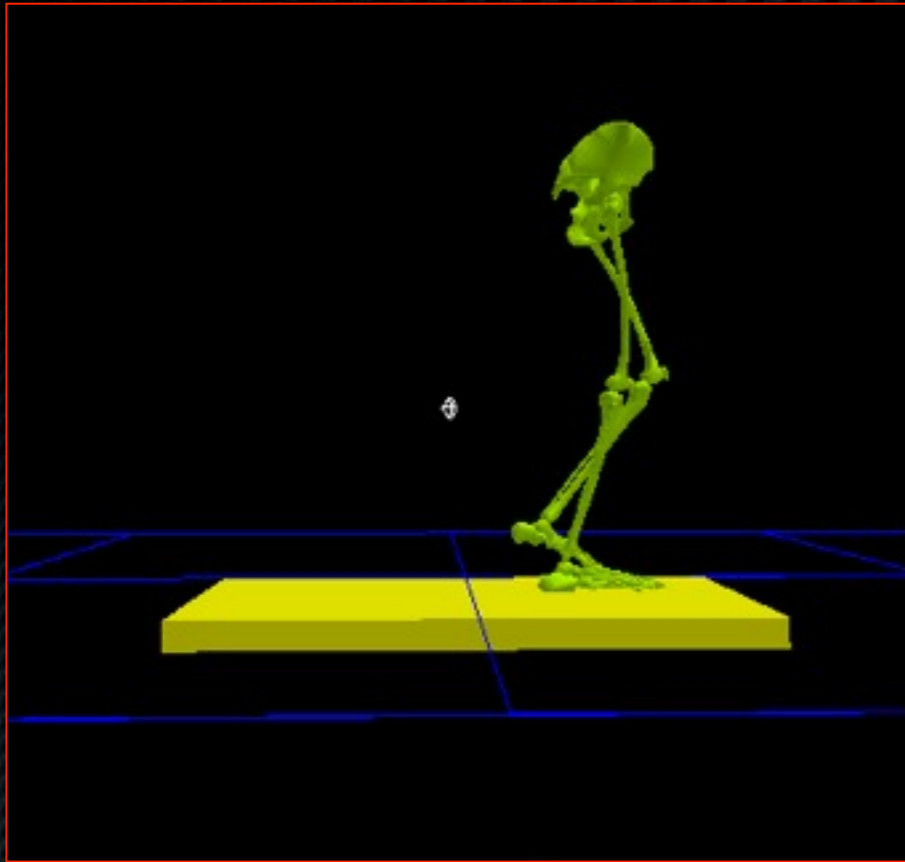
# CONTACT INITIAL



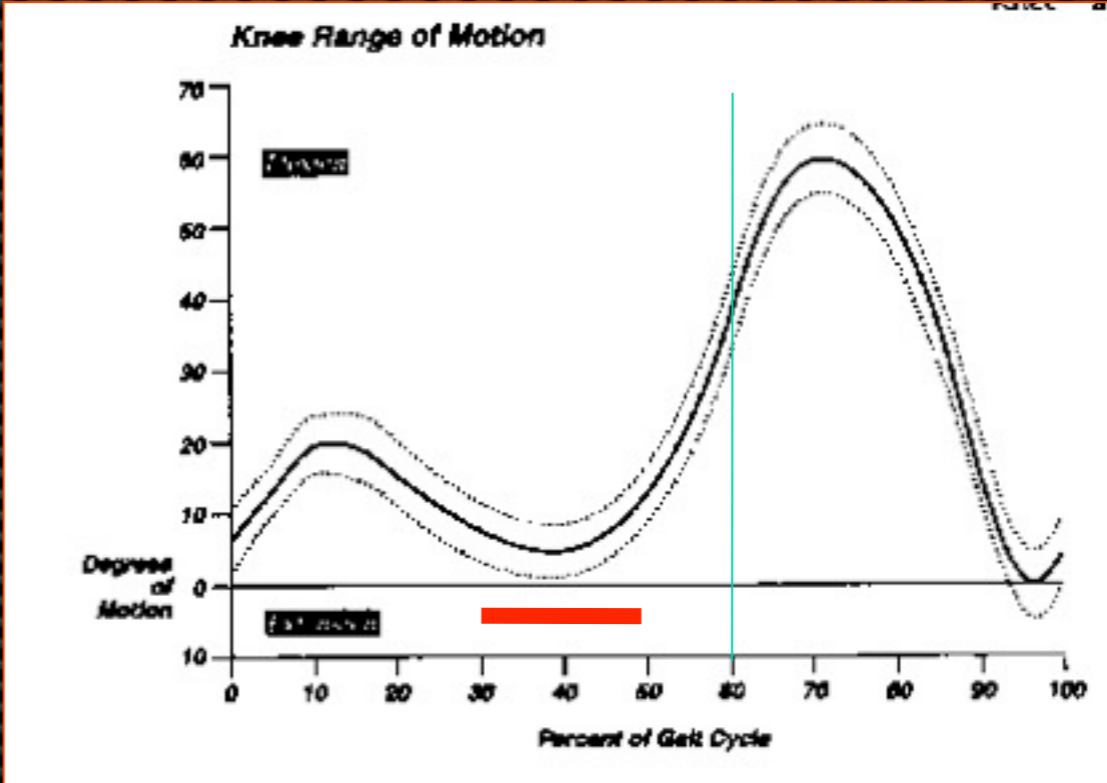
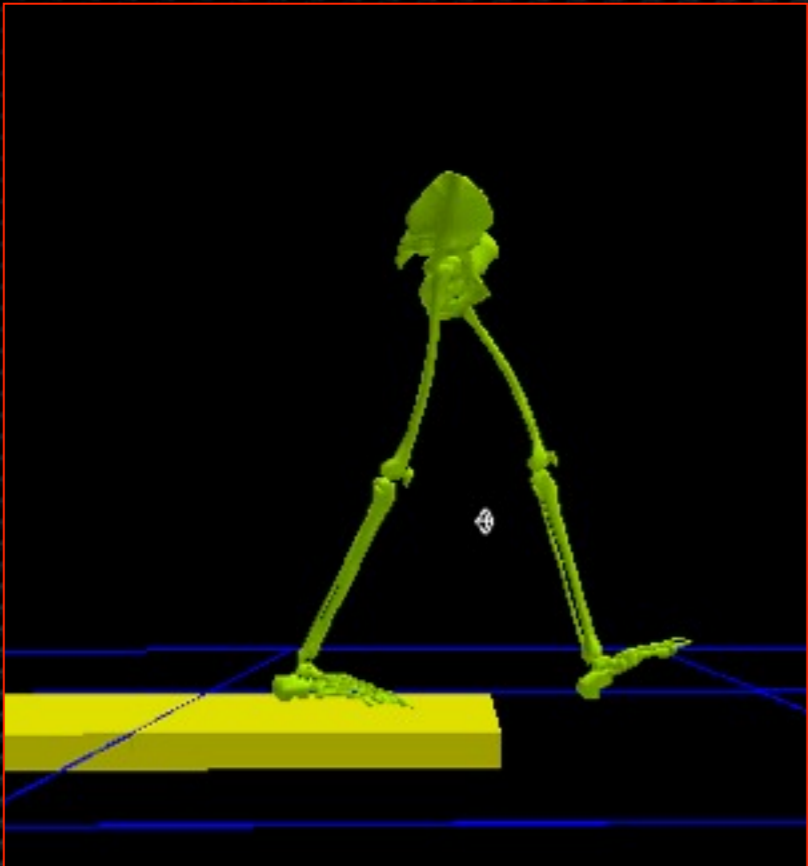
# MISE EN APPUI



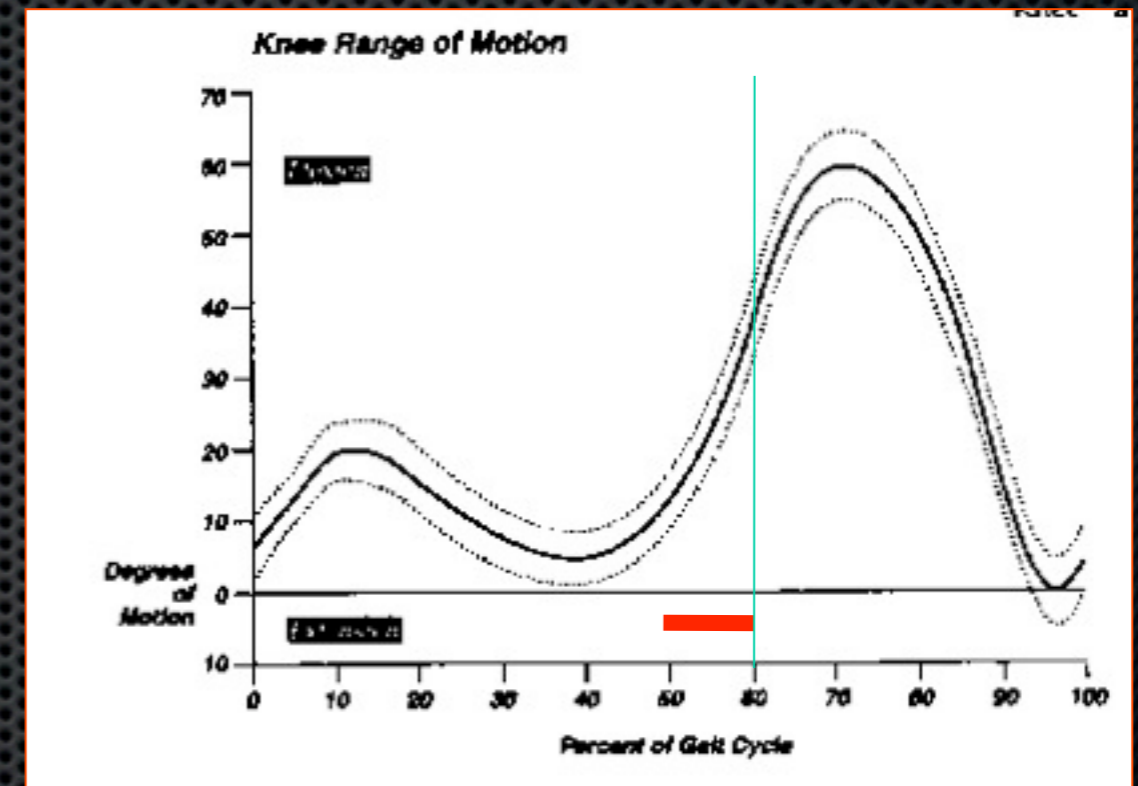
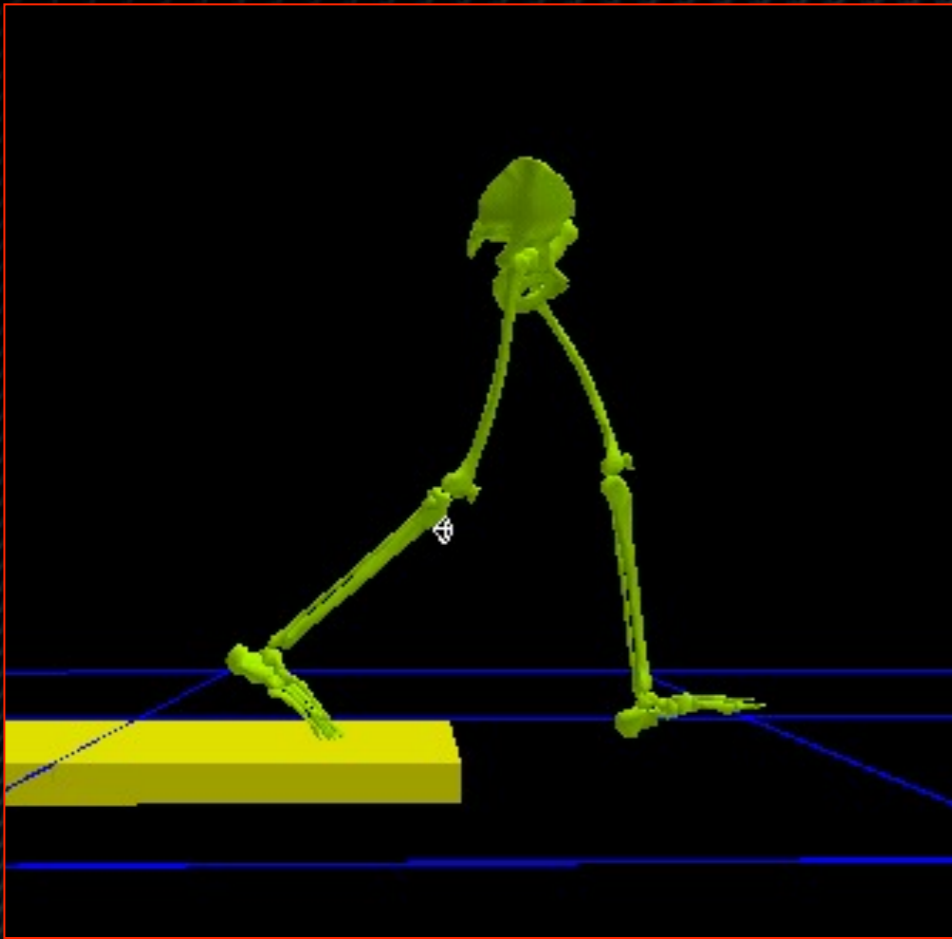
# MILIEU D'APPUI



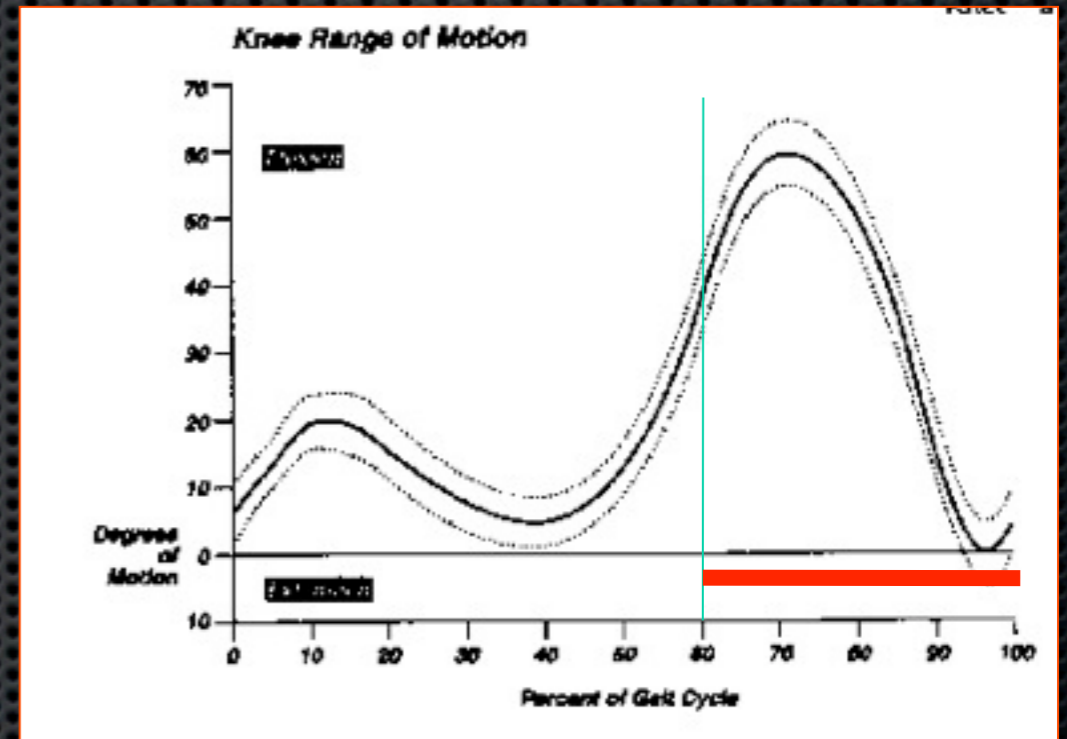
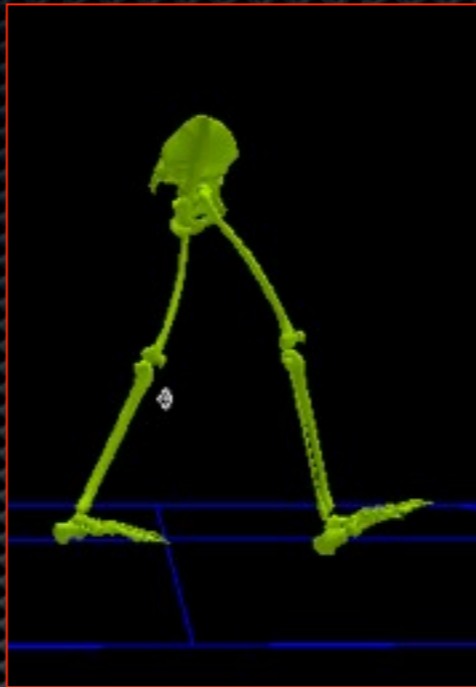
# FIN D'APPUI

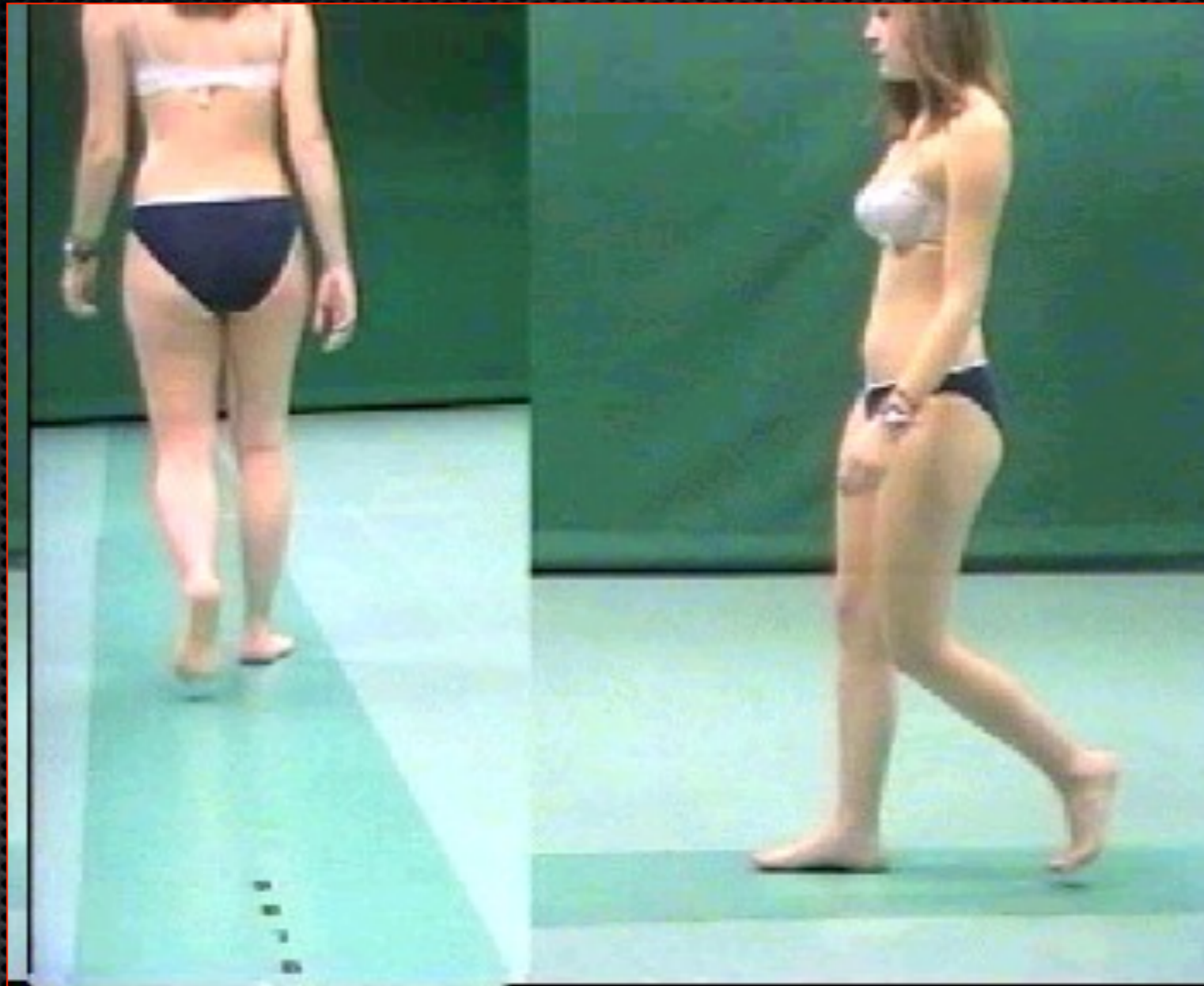


# PHASE PRE OSCILLANTE

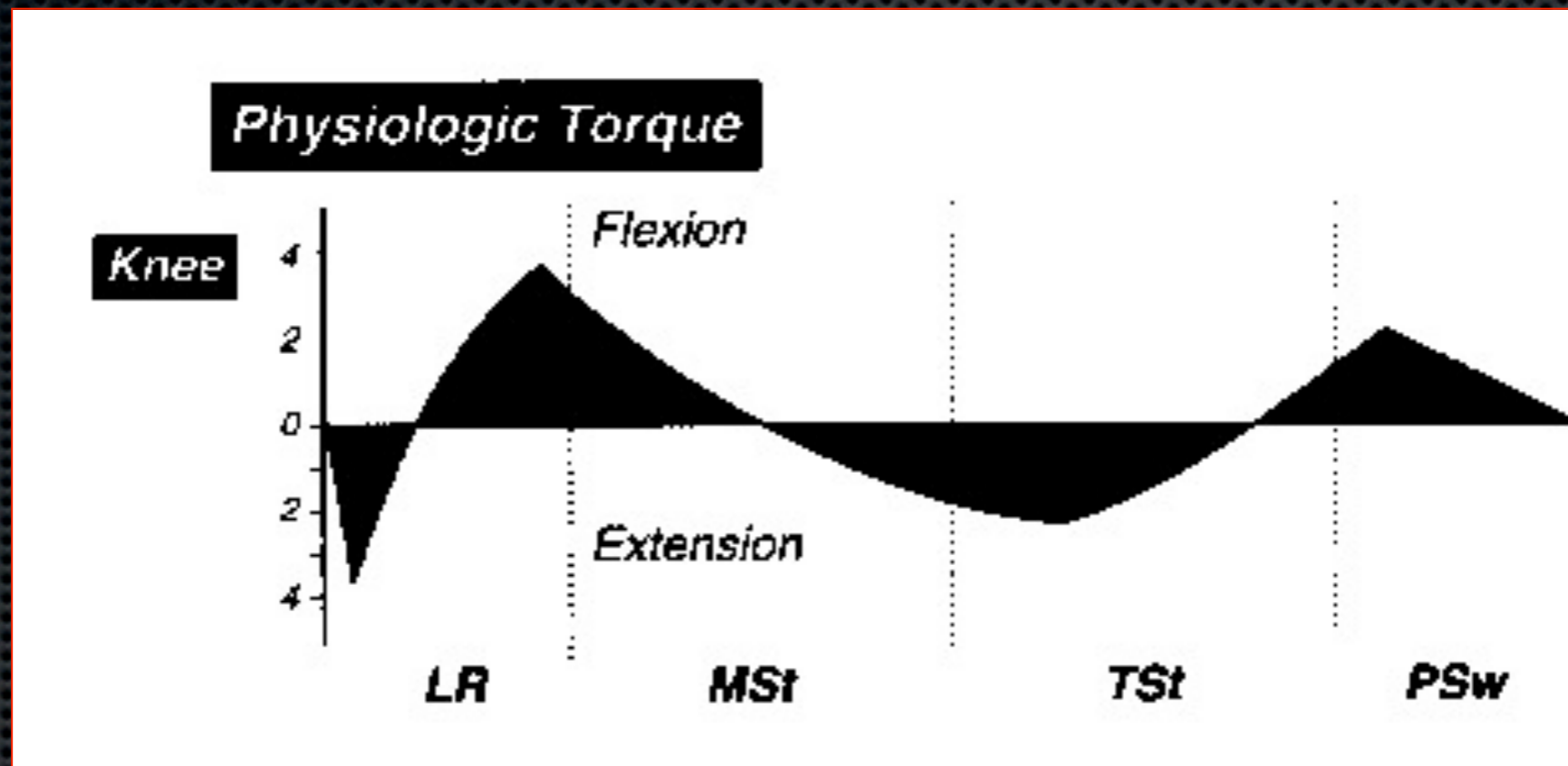




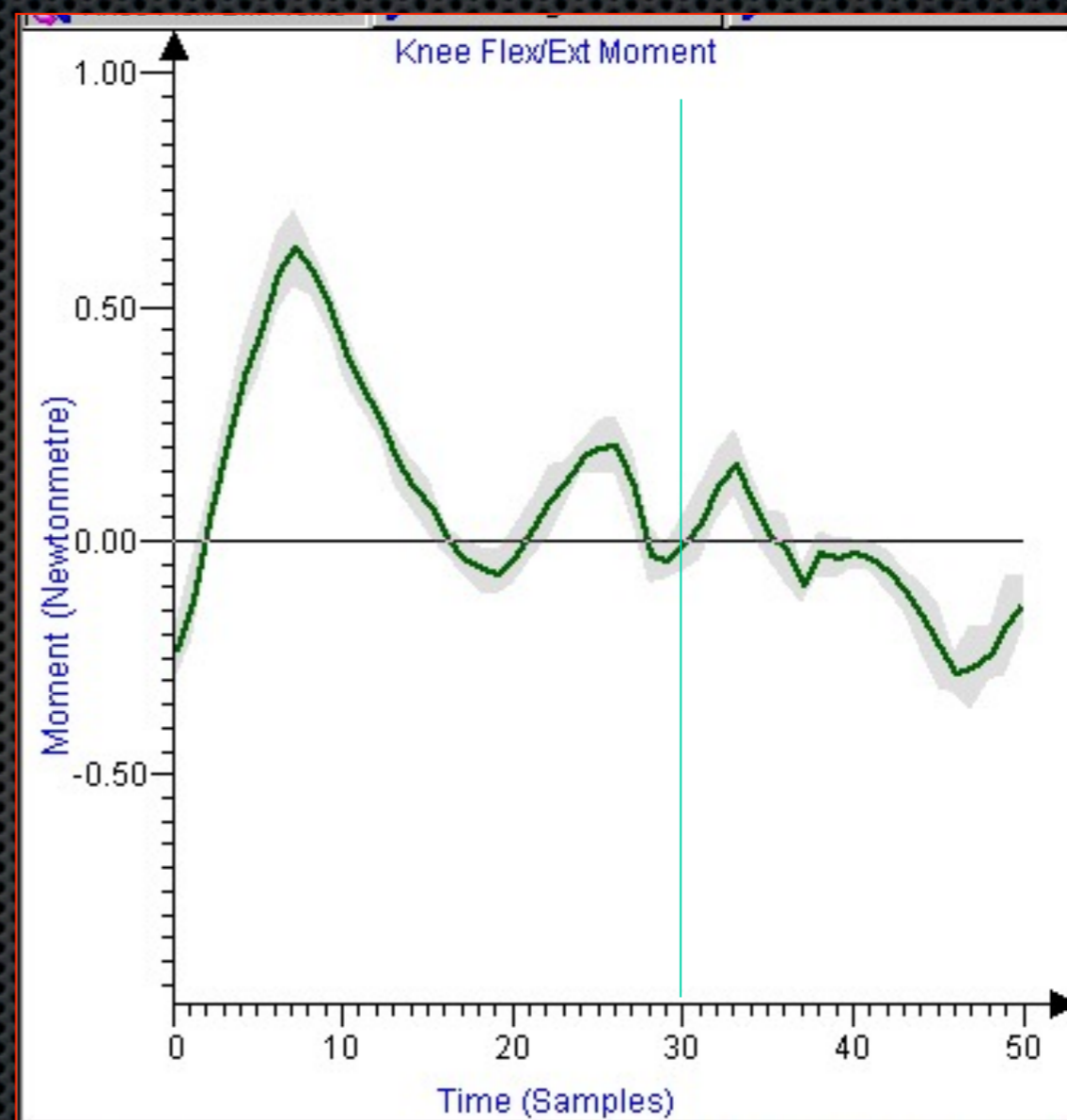
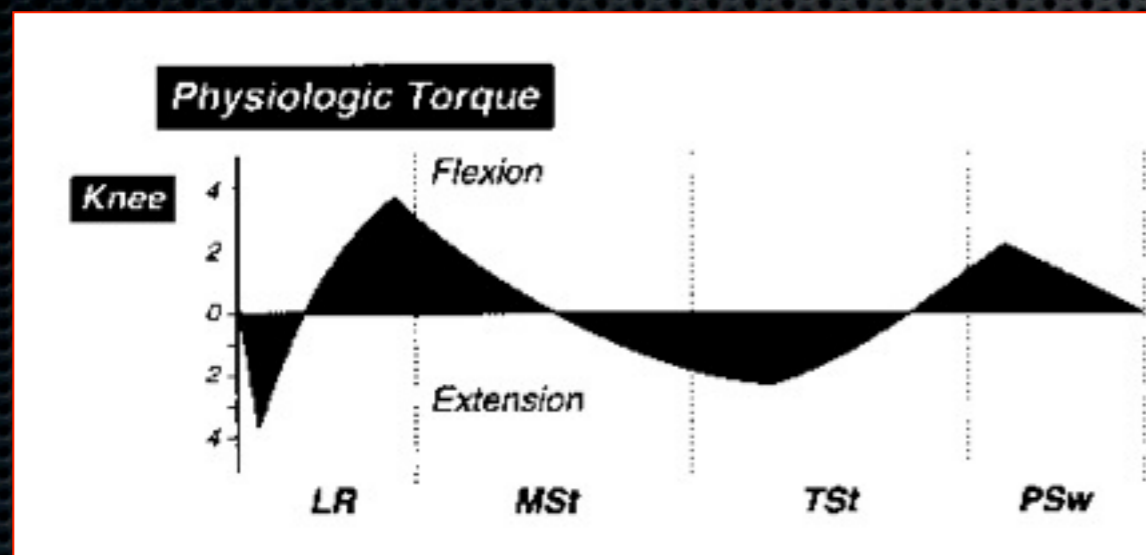




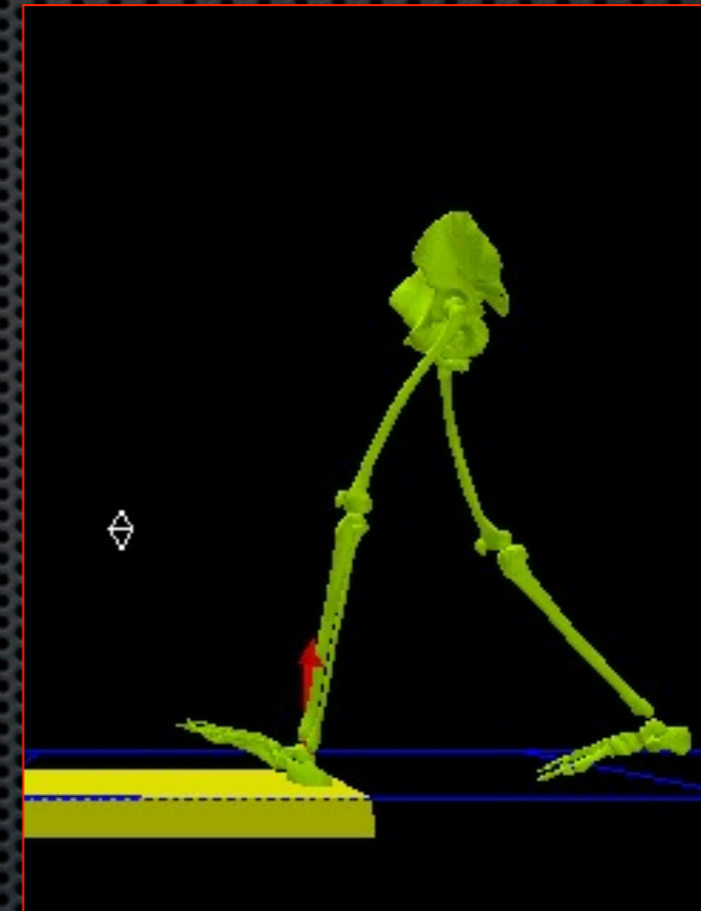
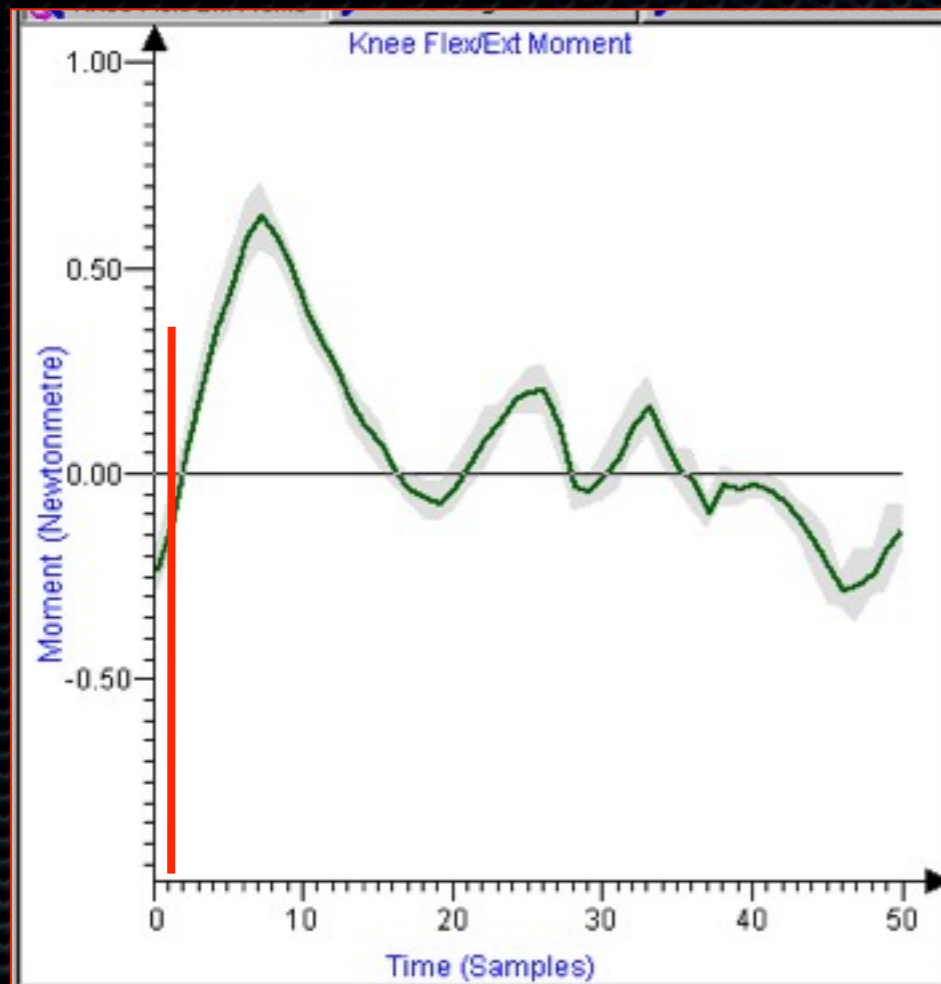
# CINETIQUE DU GENOU



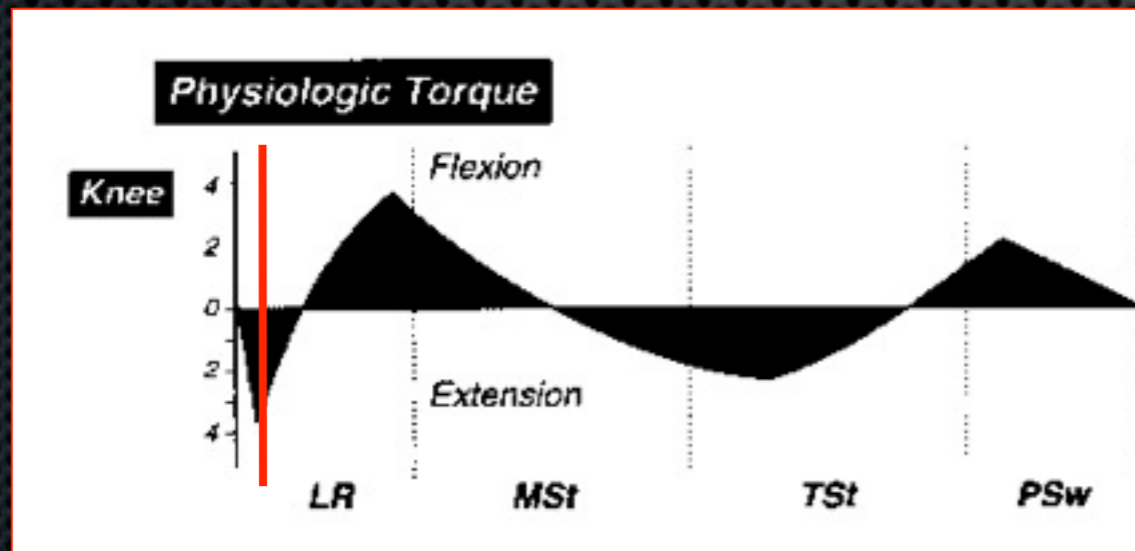
# CINETIQUE DU GENOU



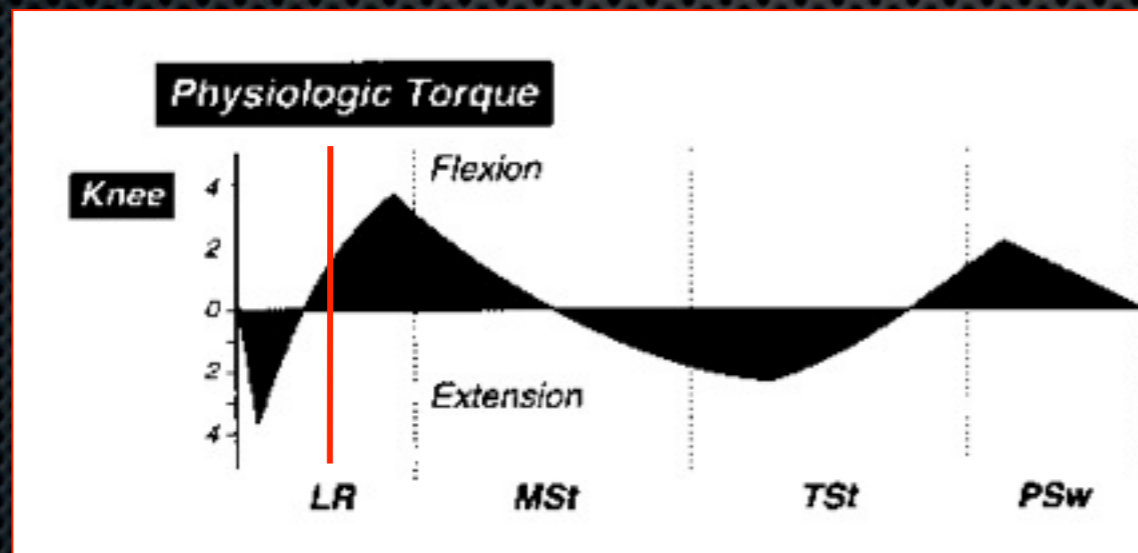
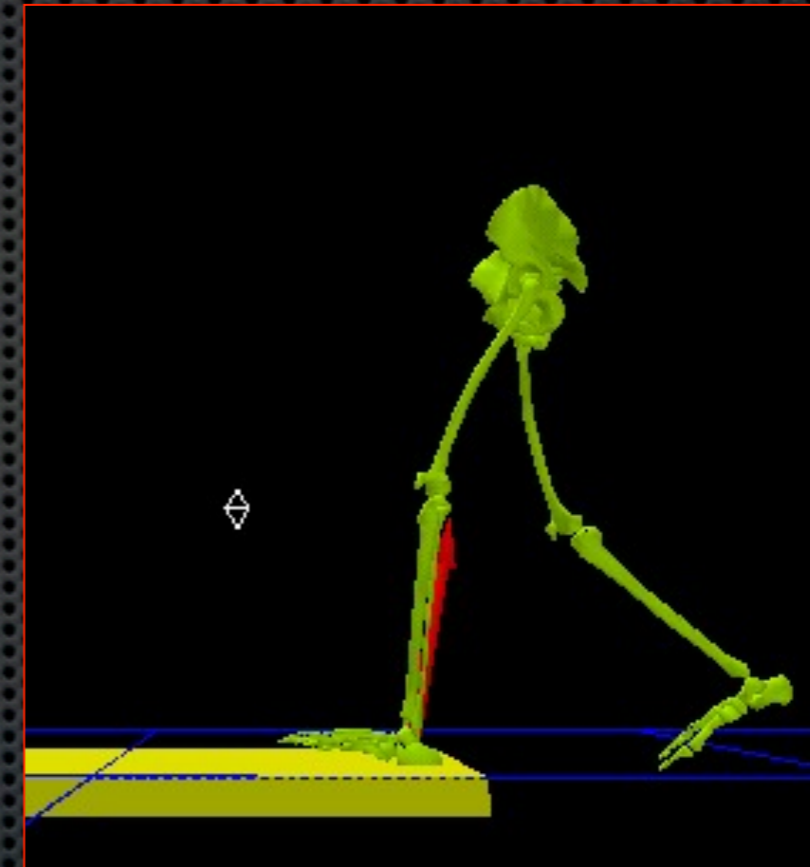
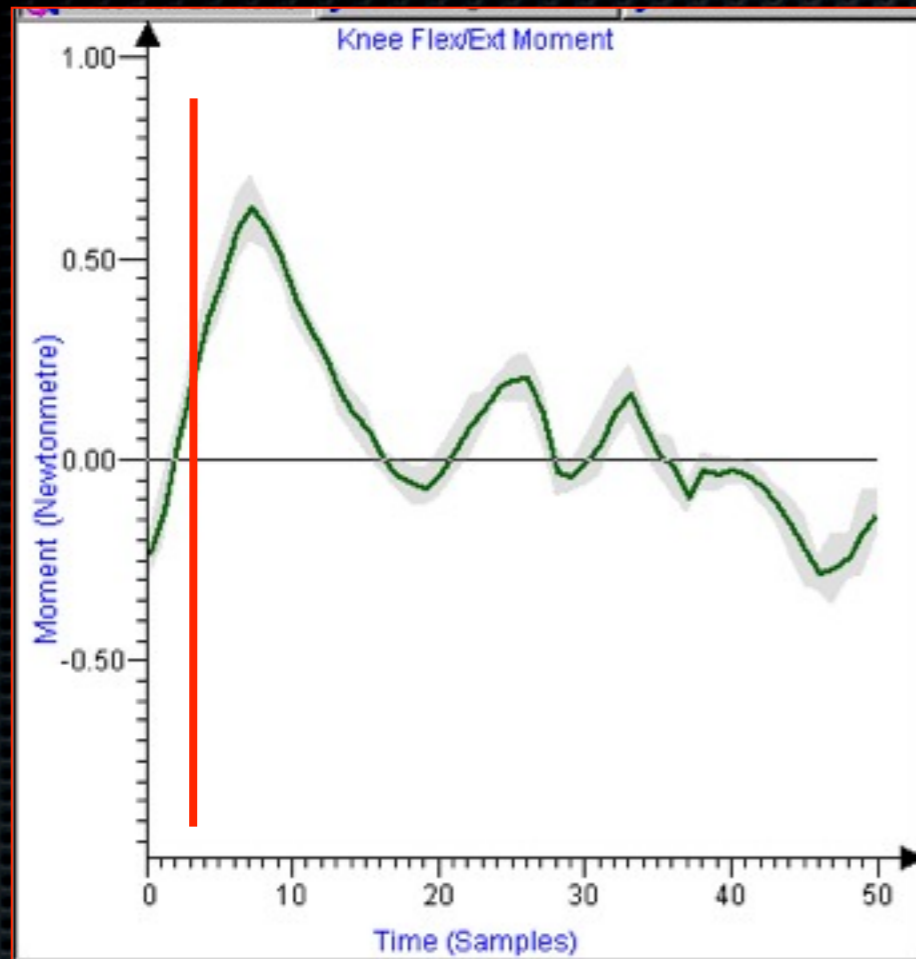
# CINETIQUE DU GENOU



**CONTACT INITIAL**  
**Vecteur en avant du genou**

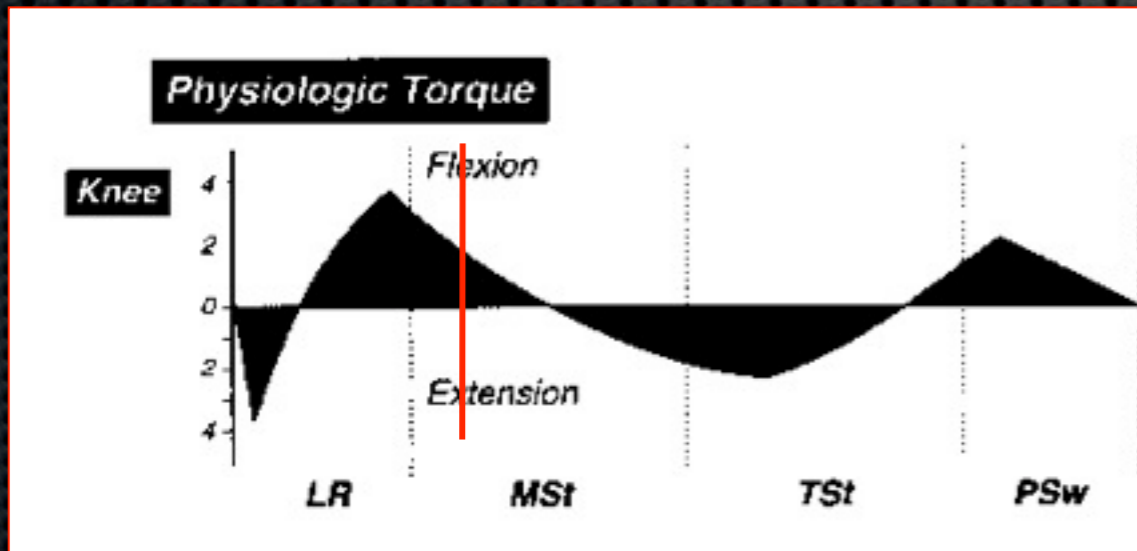
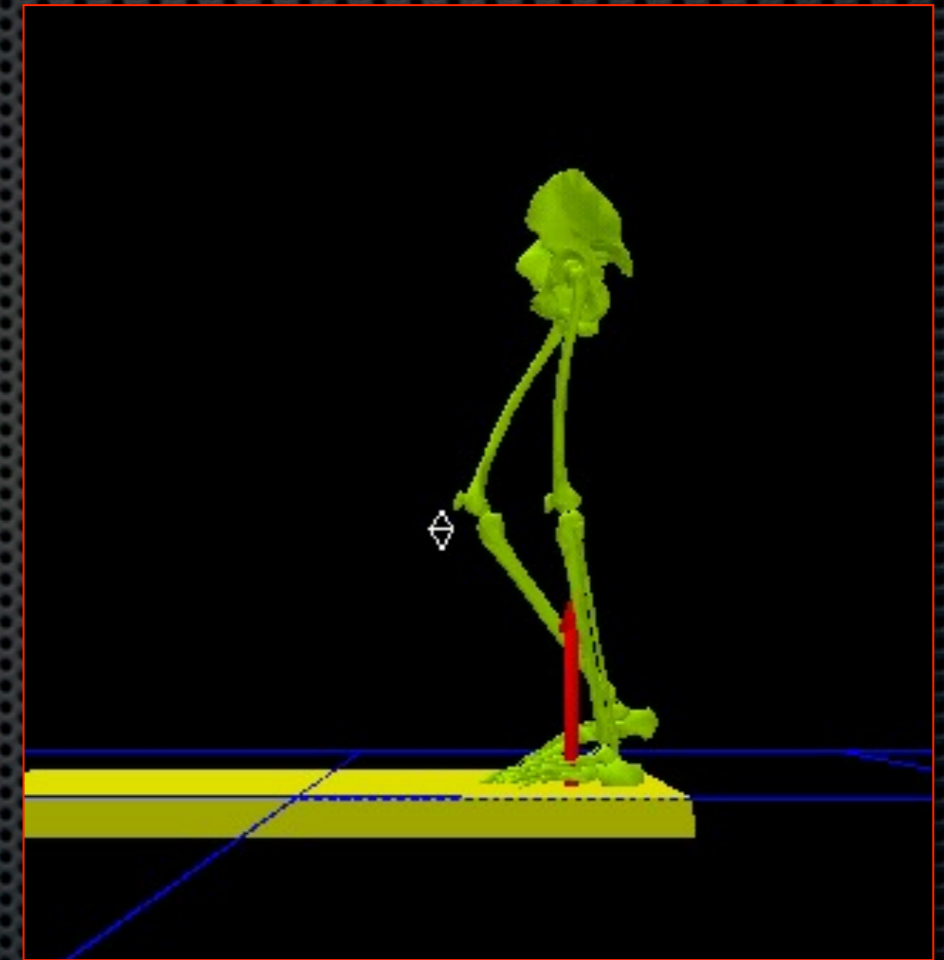
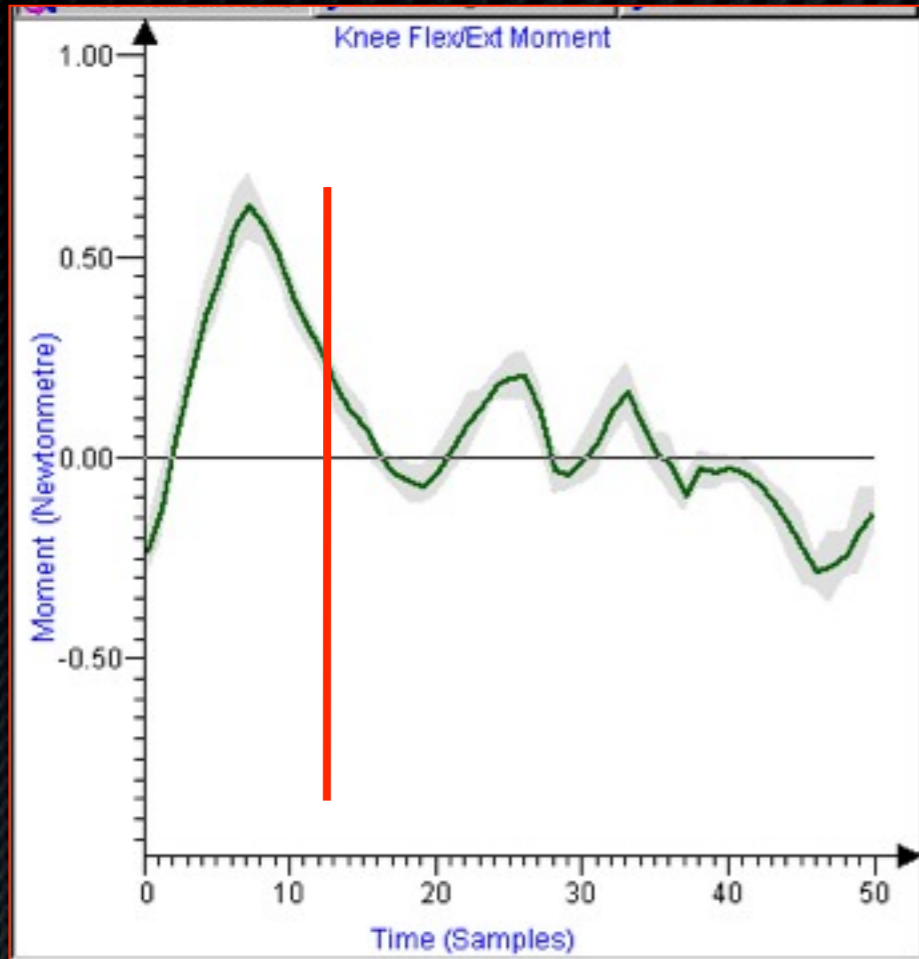


# CINETIQUE DU GENOU



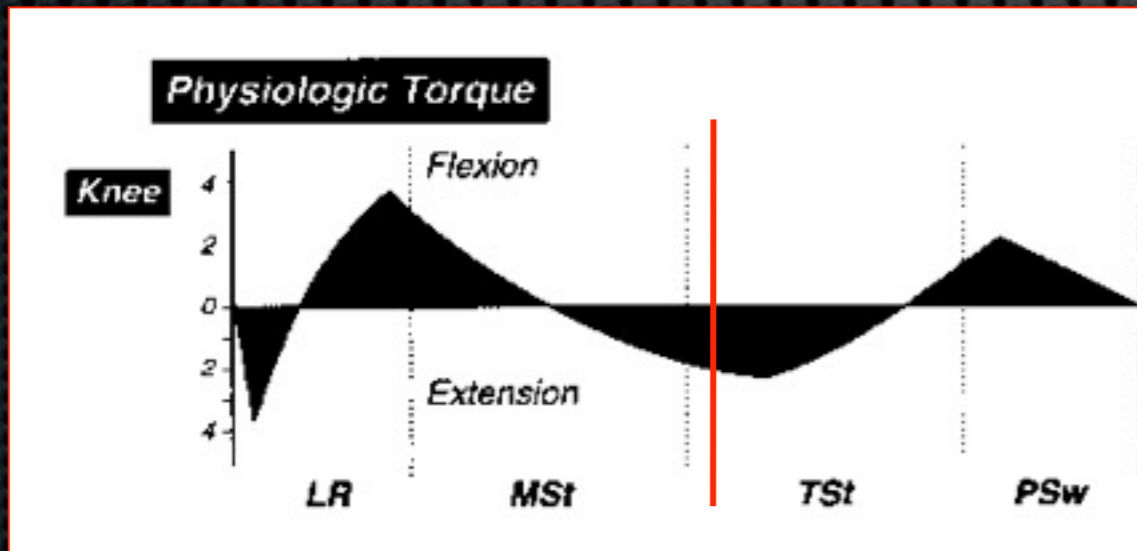
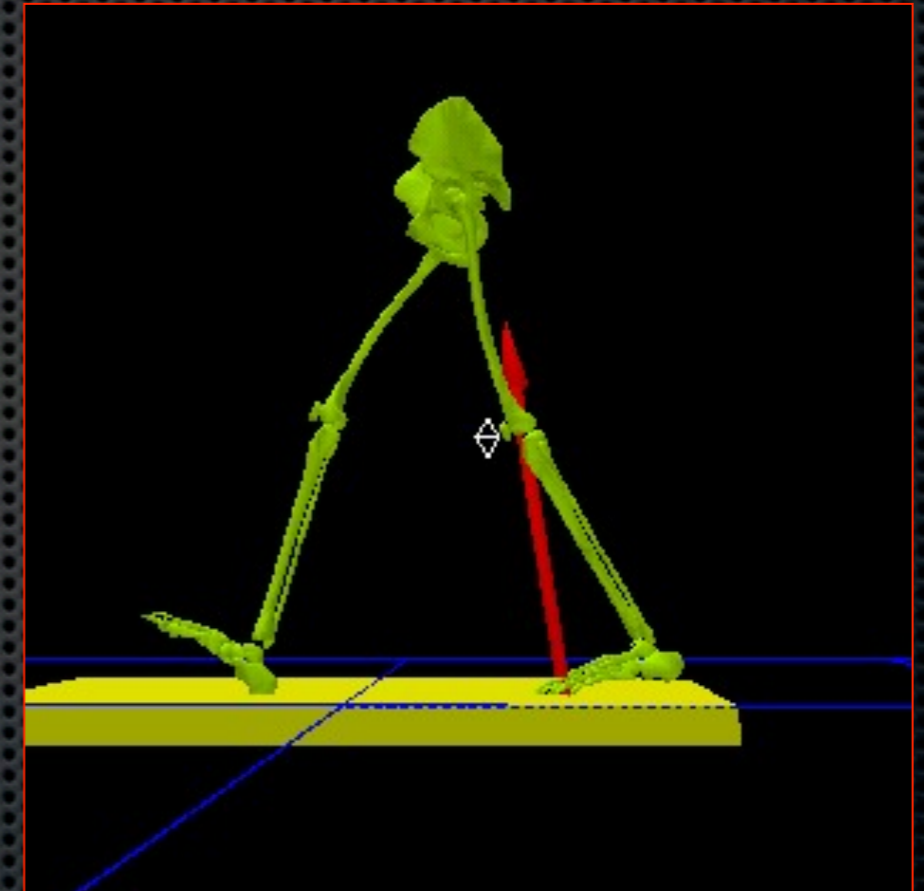
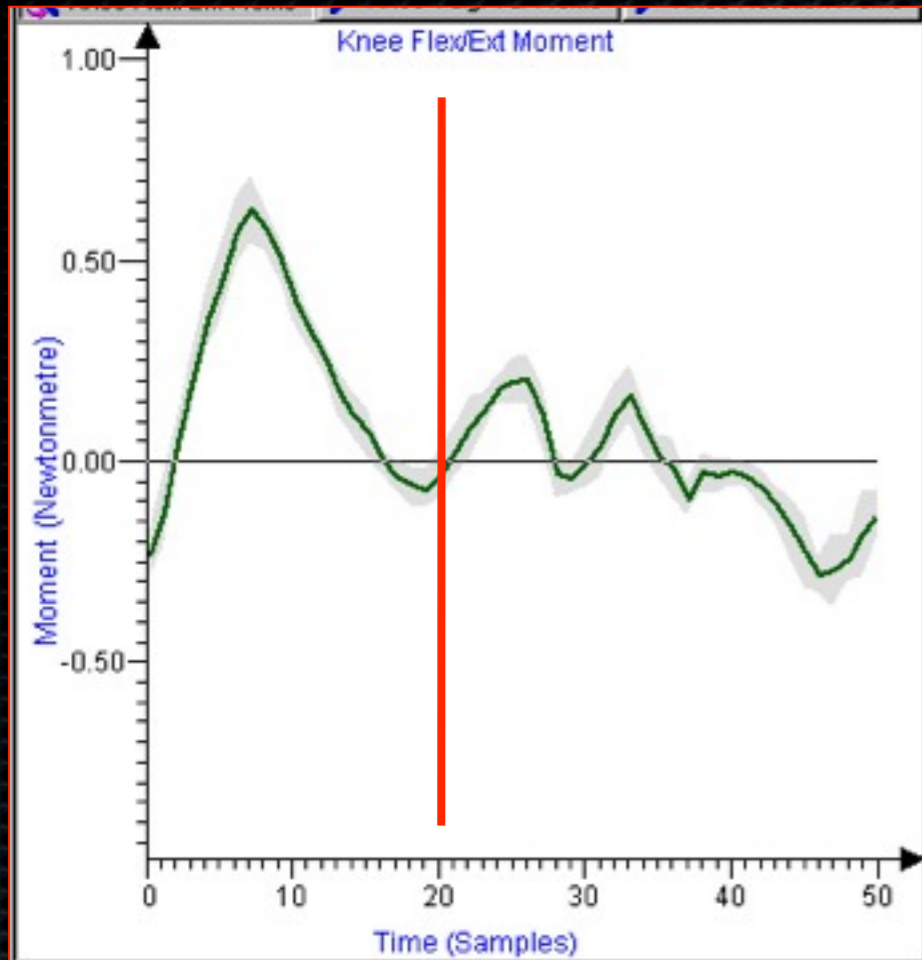
**MISE EN APPUI**  
**Vecteur en arriere du genou**

# CINETIQUE DU GENOU



MILIEU D'APPUI  
Vecteur près du genou

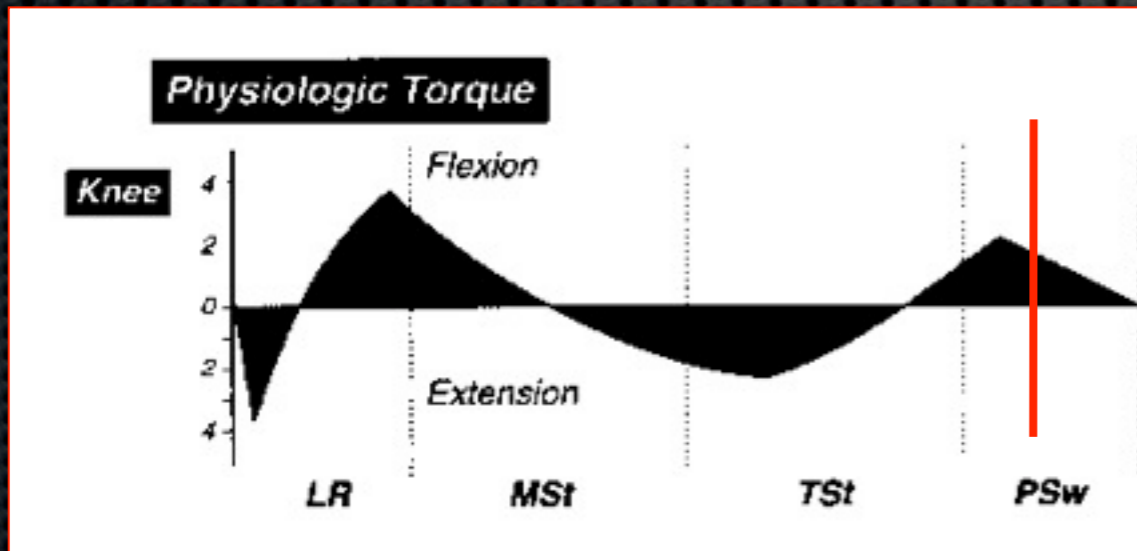
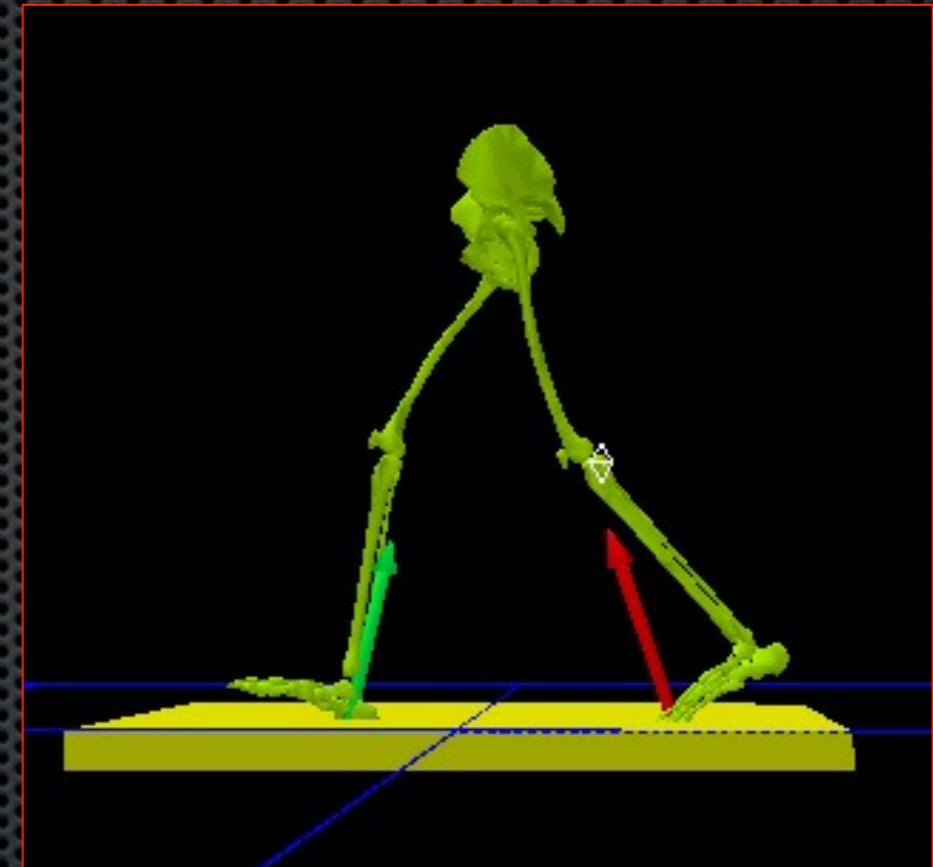
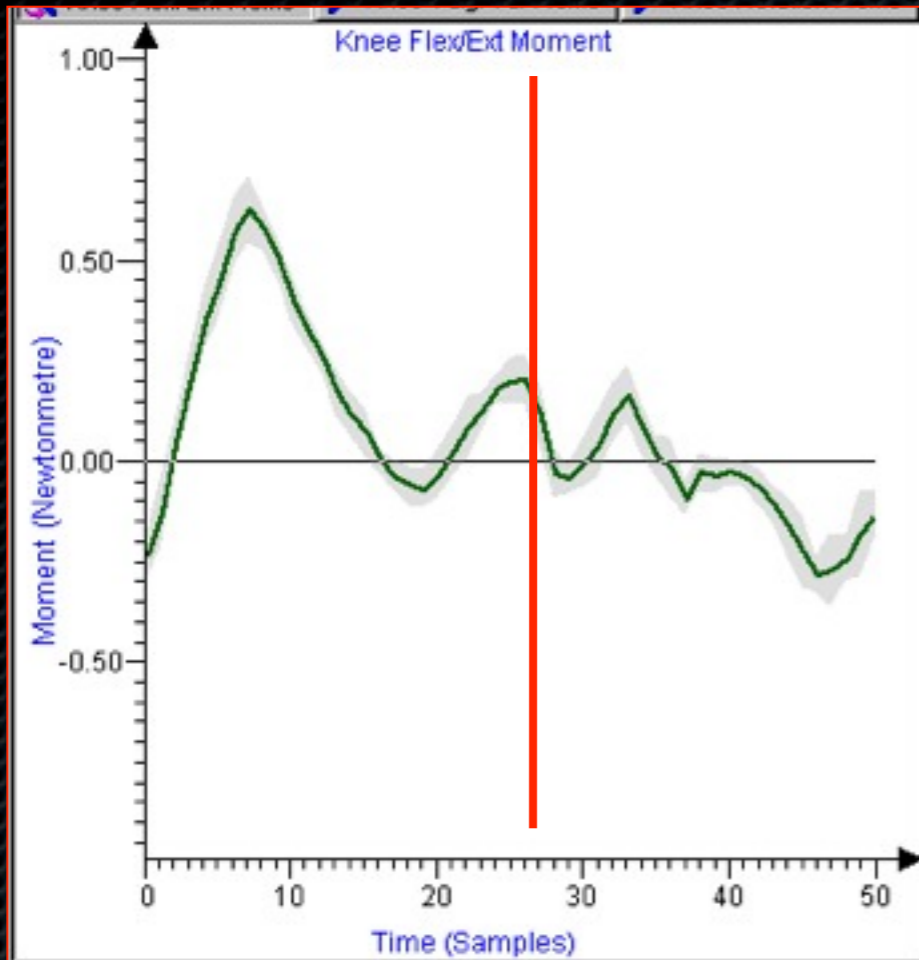
# CINETIQUE DU GENOU



**FIN D'APPUI**  
**Vecteur en avant du genou**

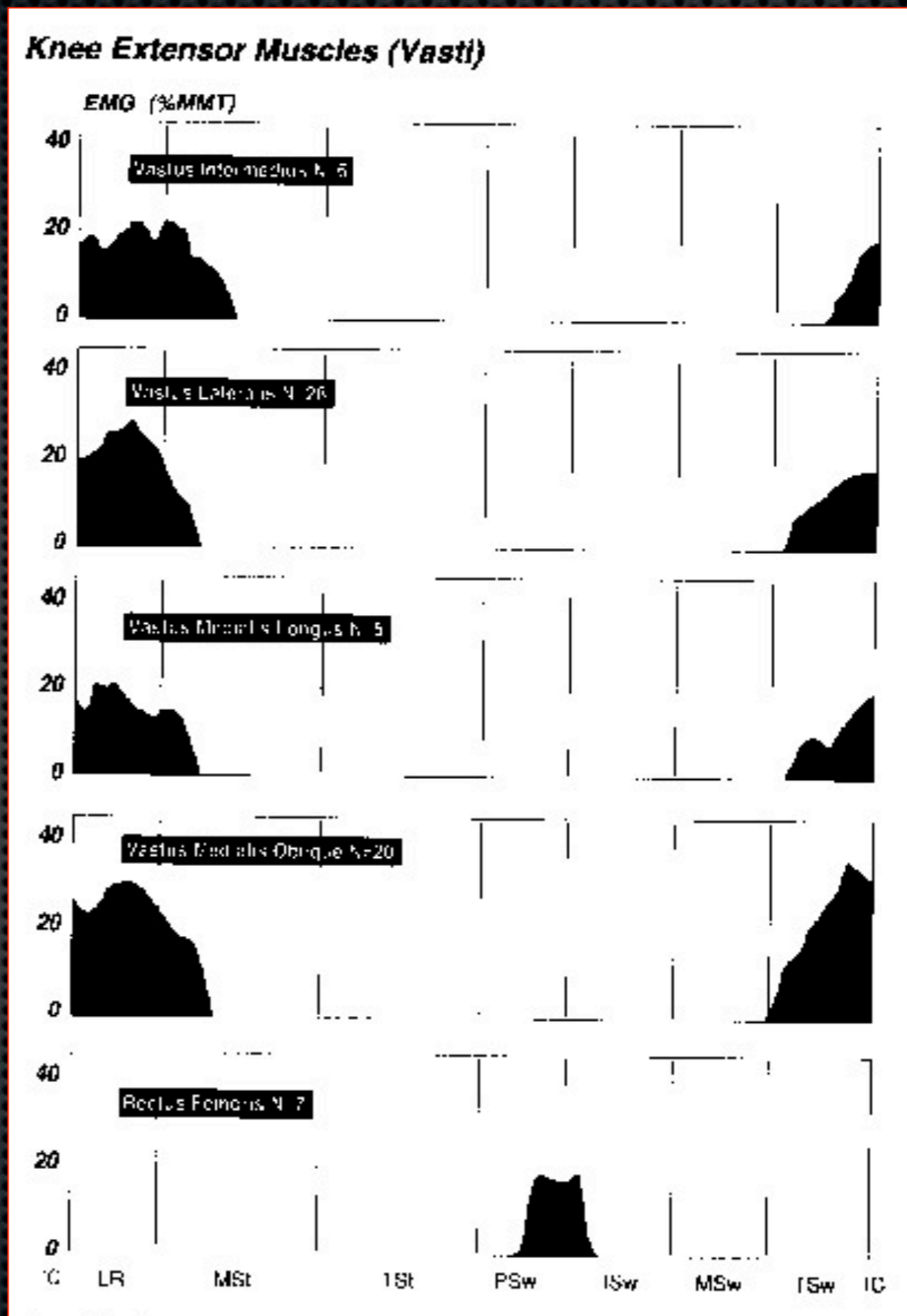


# CINETIQUE DU GENOU

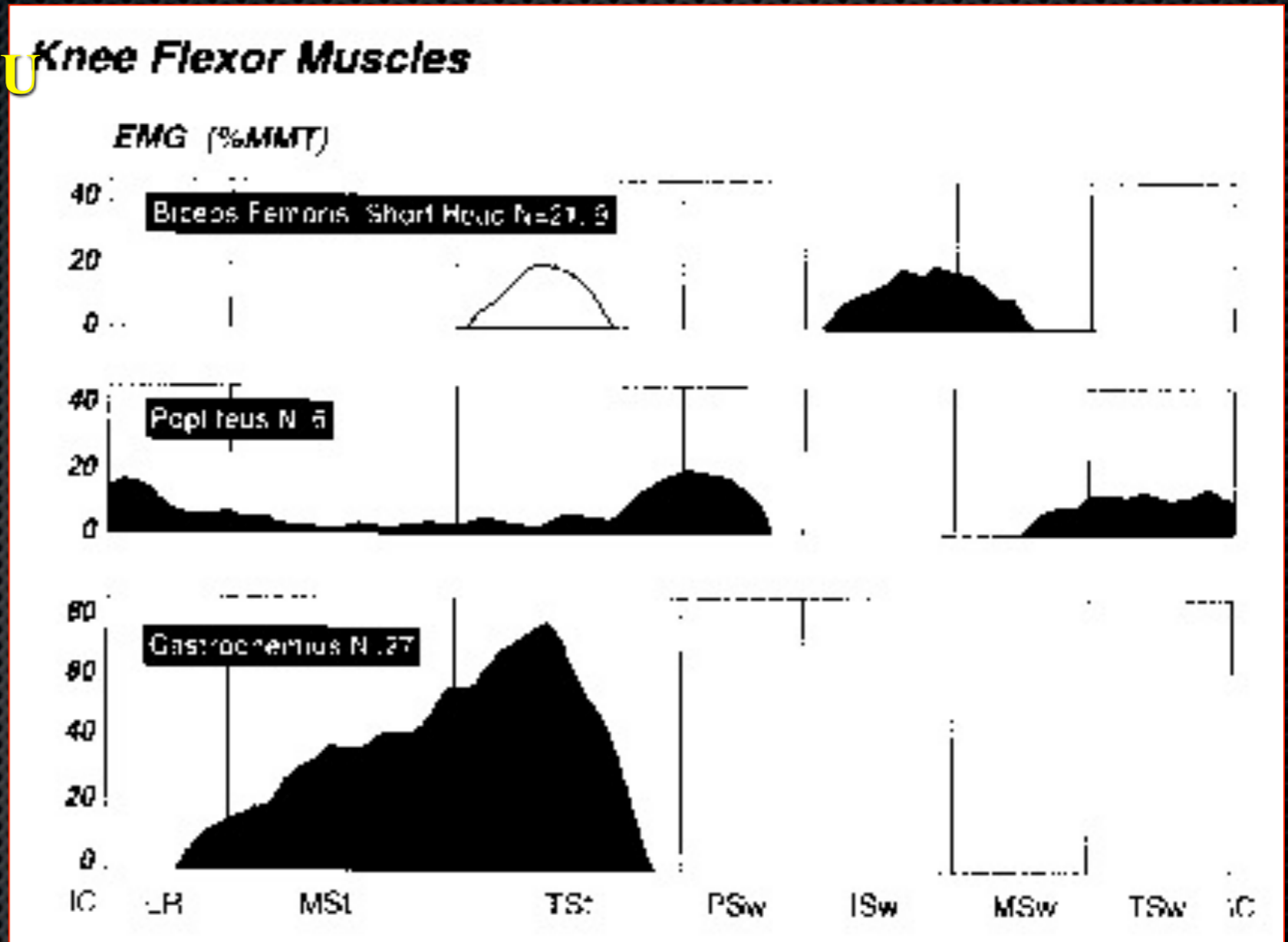


**PHASE PRE OSCILLANTE**  
**Déverrouillage**  
**Vecteur en arrière du genou**

# MUSCLES EXTENSEURS DU GENOU

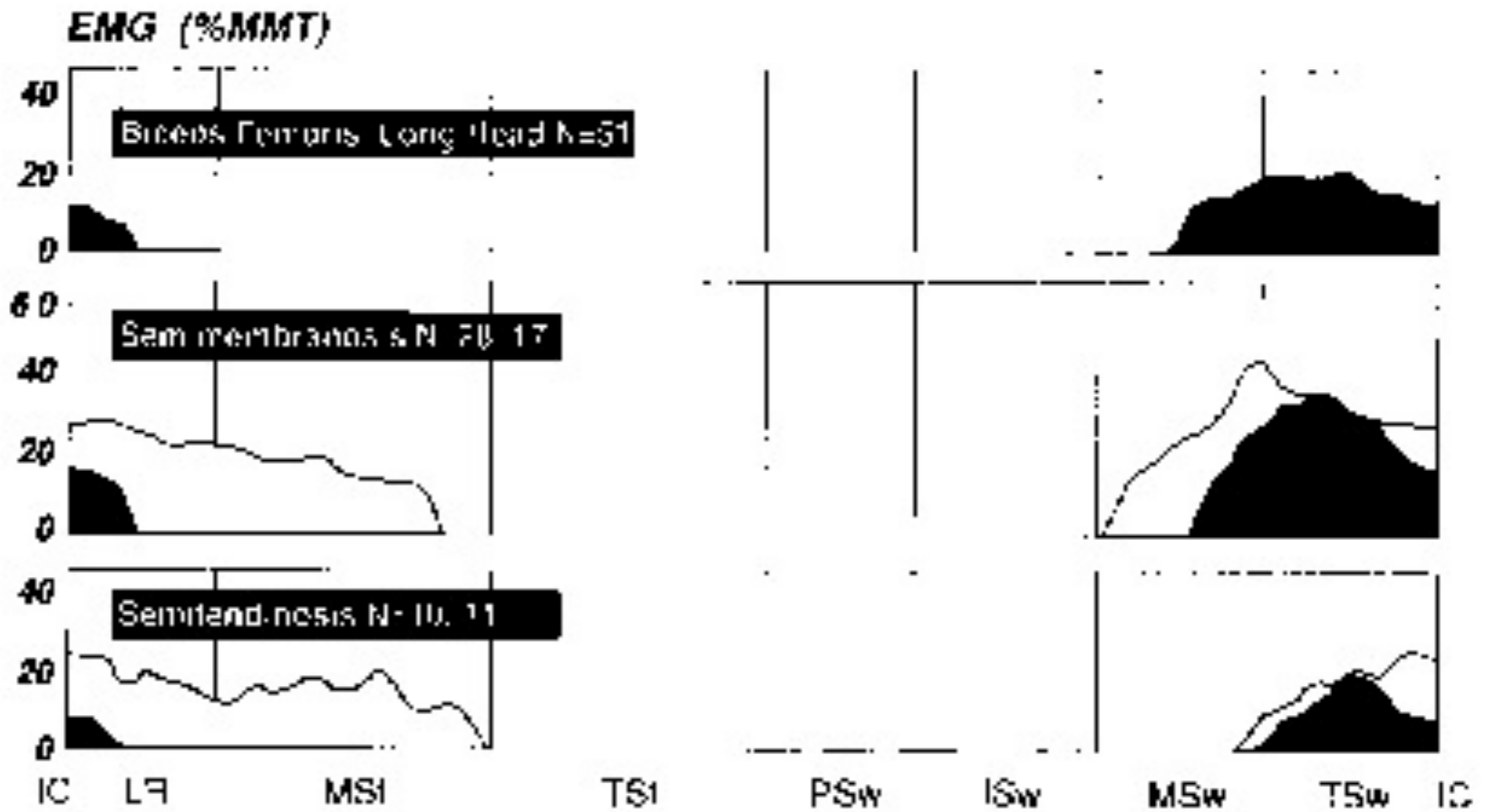


# MUSCLES FLECHISSEURS DU GENOU

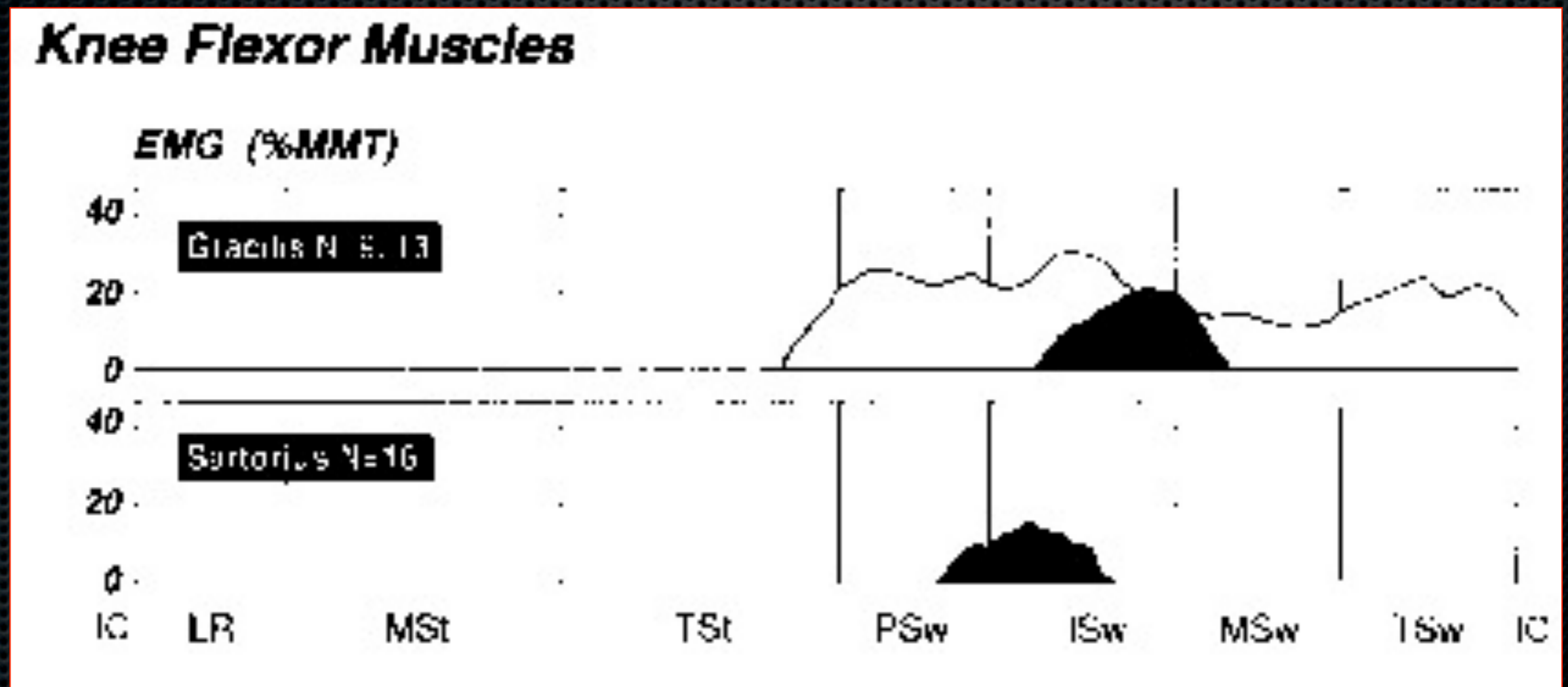


# MUSCLES FLECHISSEURS DU GENOU

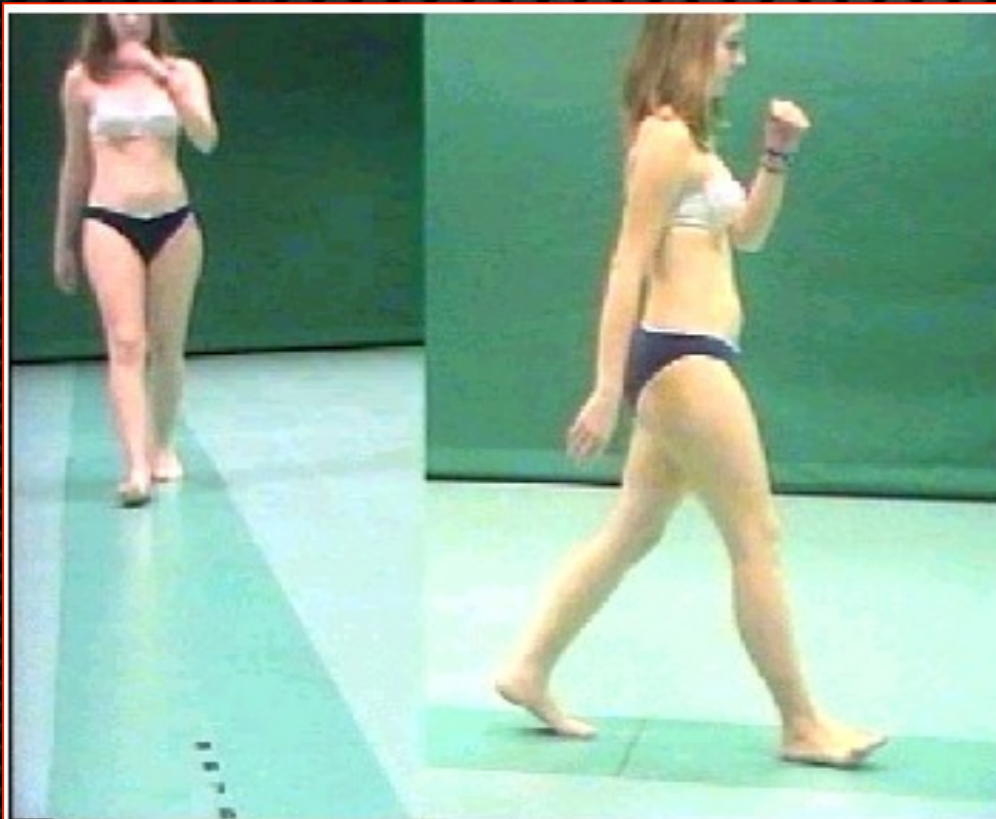
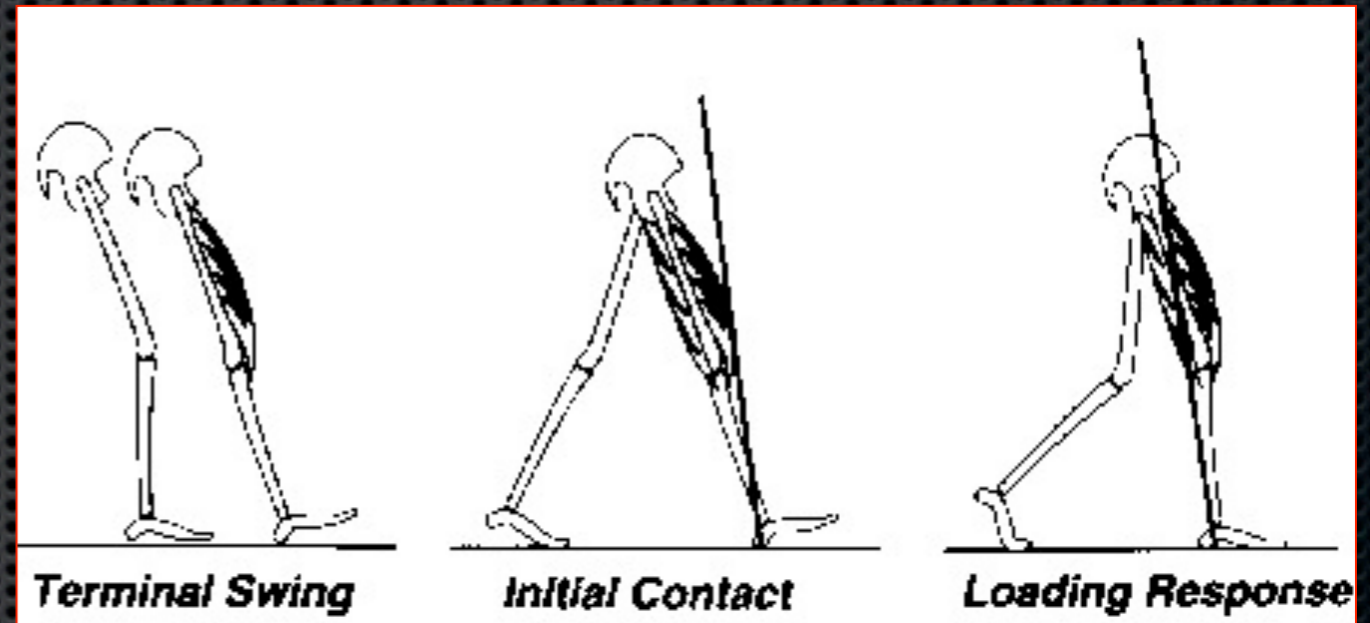
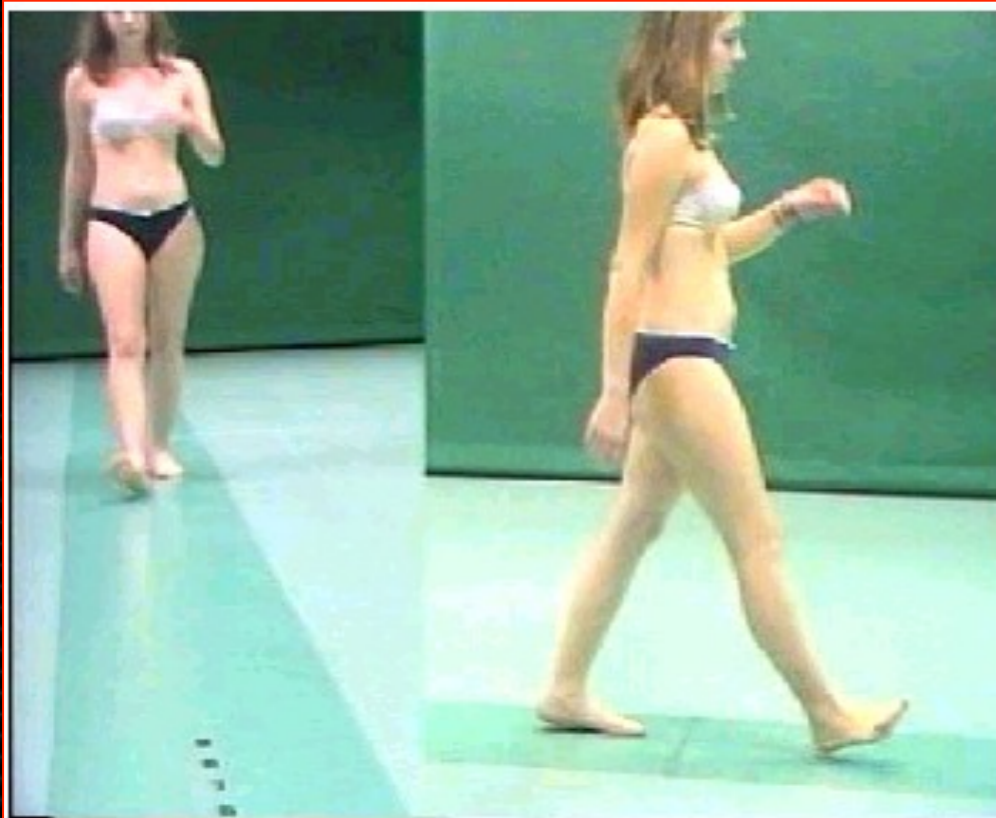
## Knee Flexor Muscles



# MUSCLES FLECHISSEURS DU GENOU

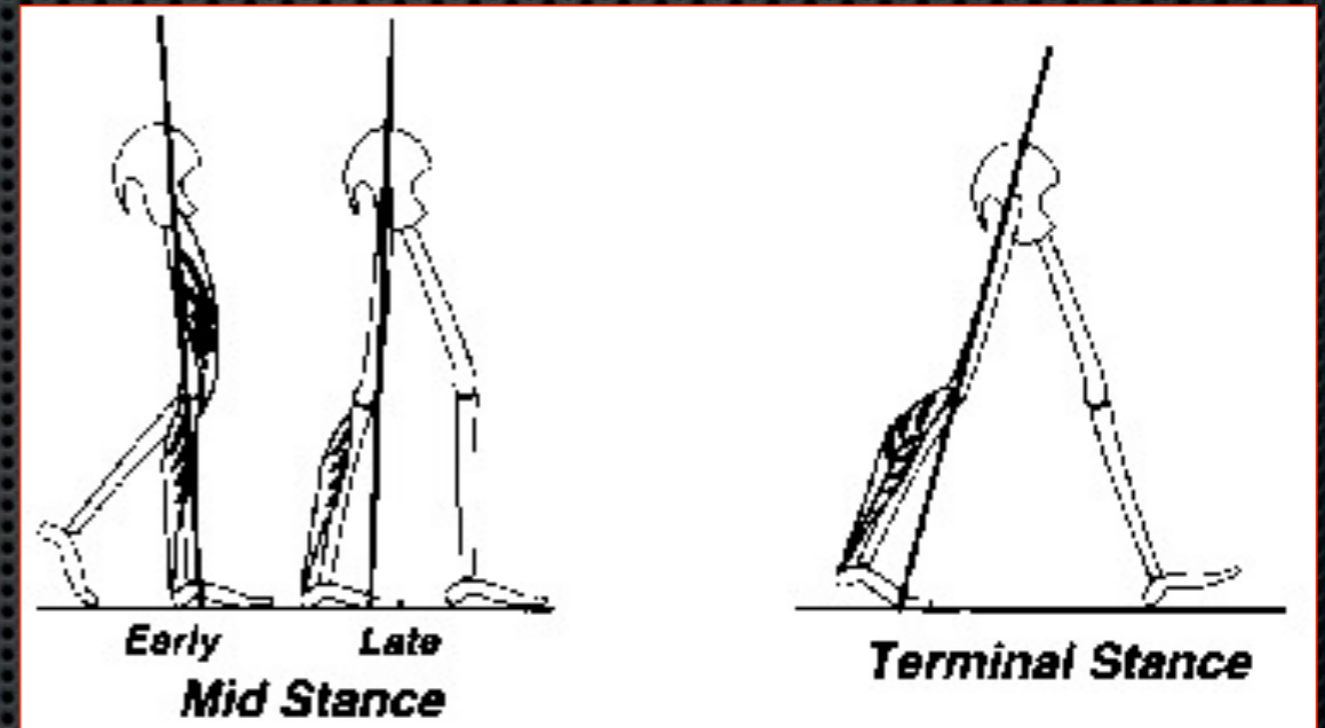


# INTERPRETATION FONCTIONNELLE



- **CONTACT INITIAL**
- **MISE EN APPUI**

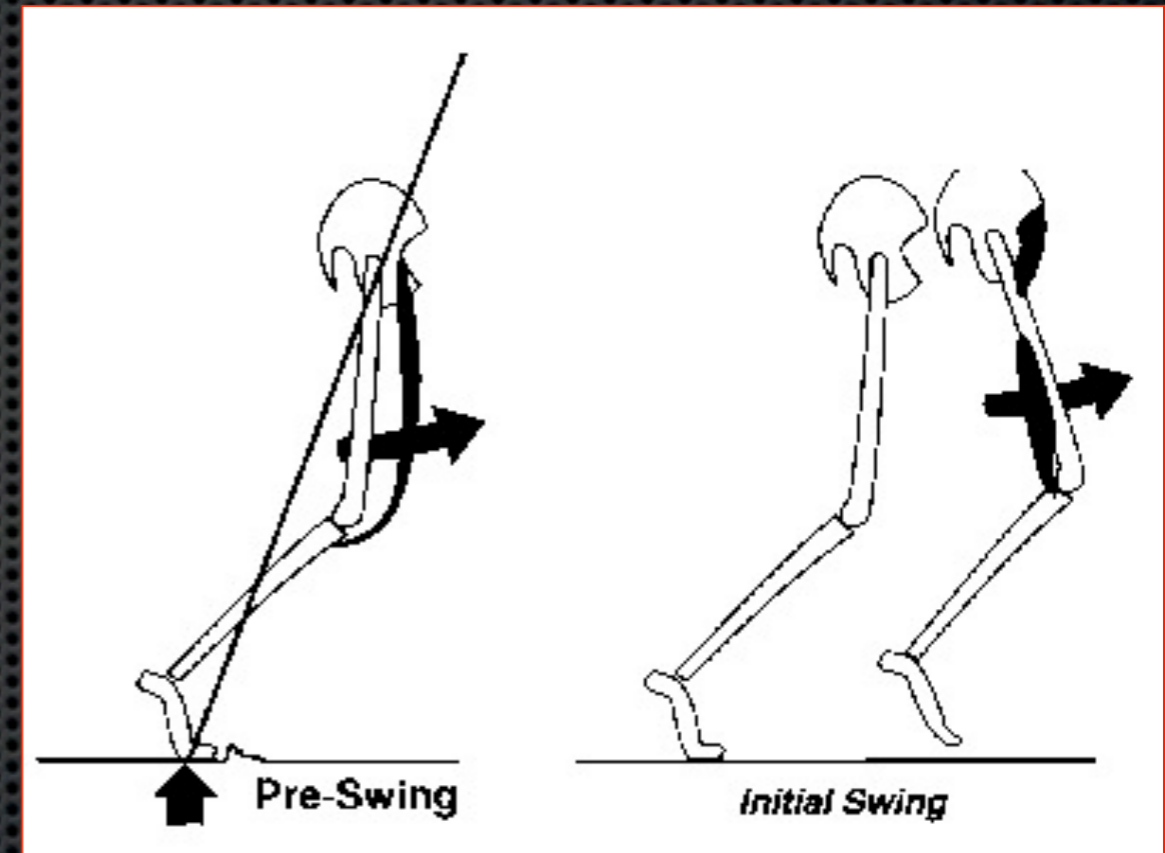
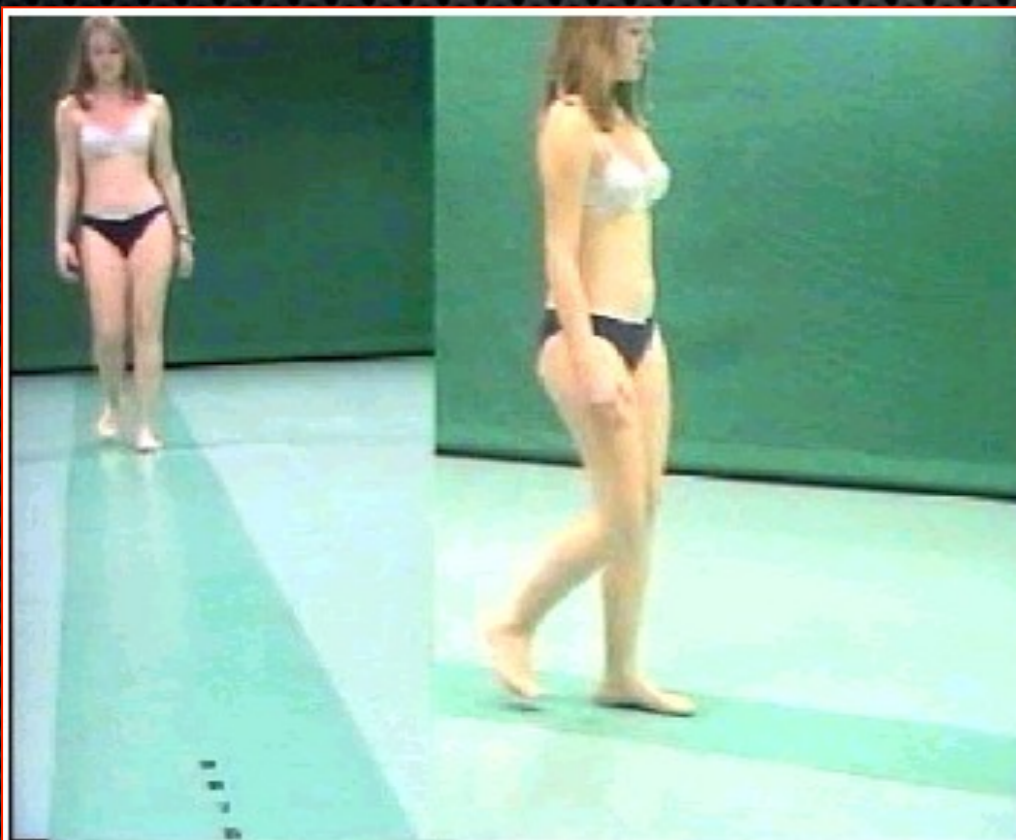
# INTERPRETATION FONCTIONNELLE



- MILIEU D'APPUI
- FIN D'APPUI



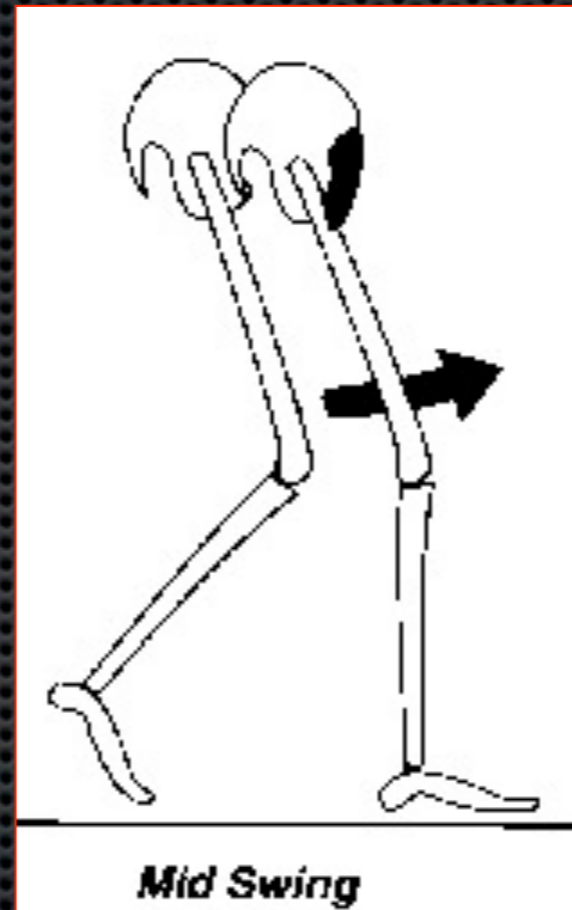
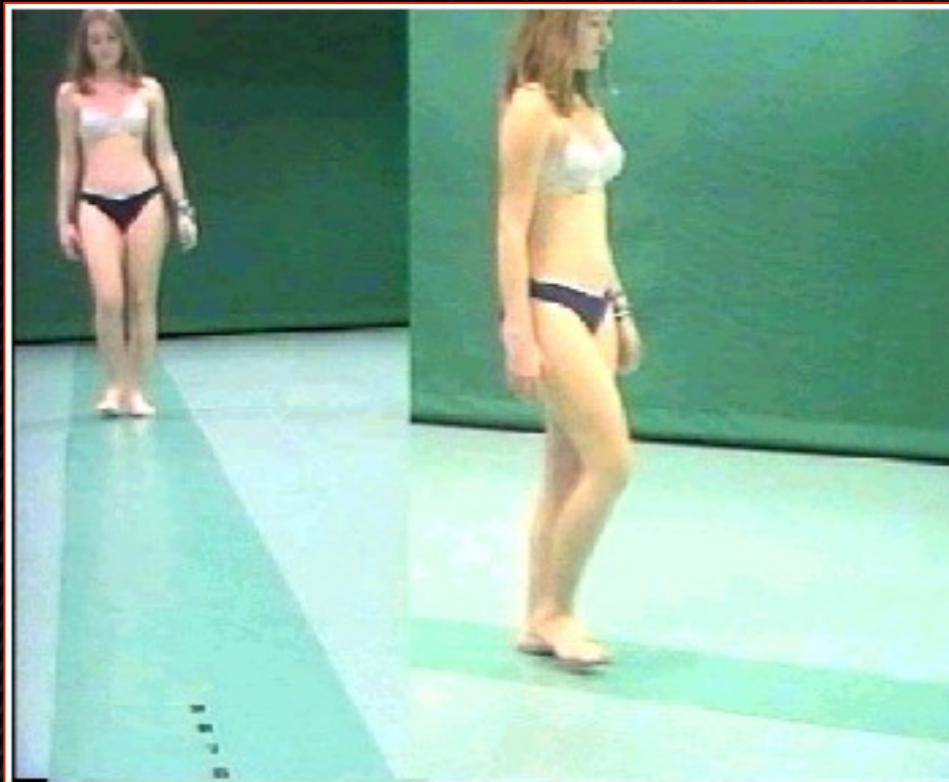
# INTERPRETATION FONCTIONNELLE



- PHASE PRE OSCILLANTE
- DEBUT PHASE OSCILLANTE



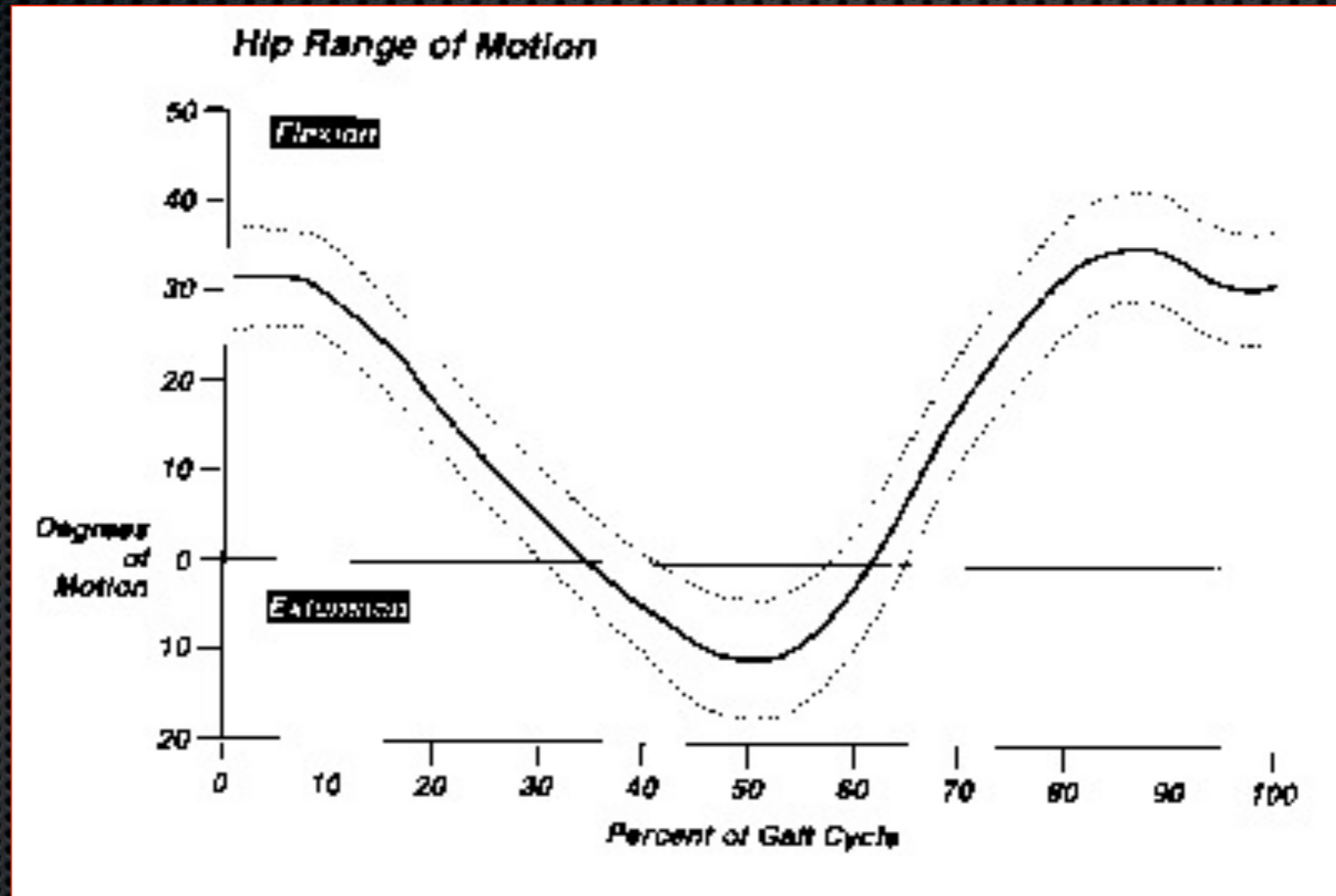
# INTERPRETATION FONCTIONNELLE

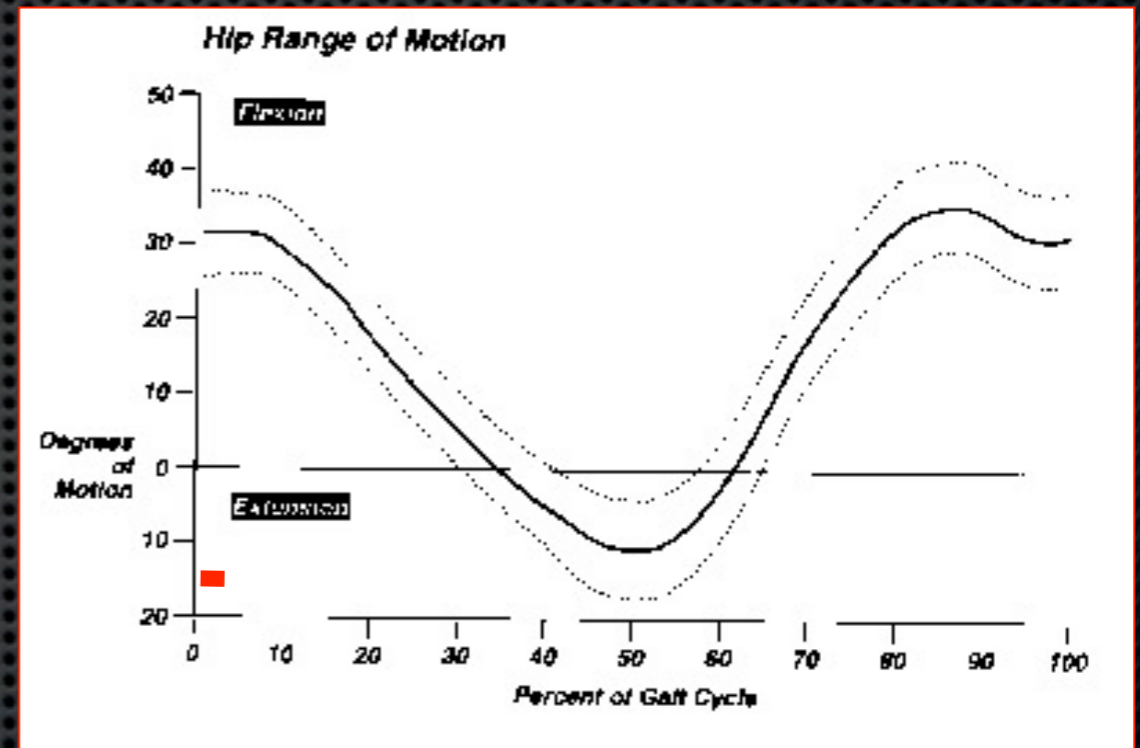
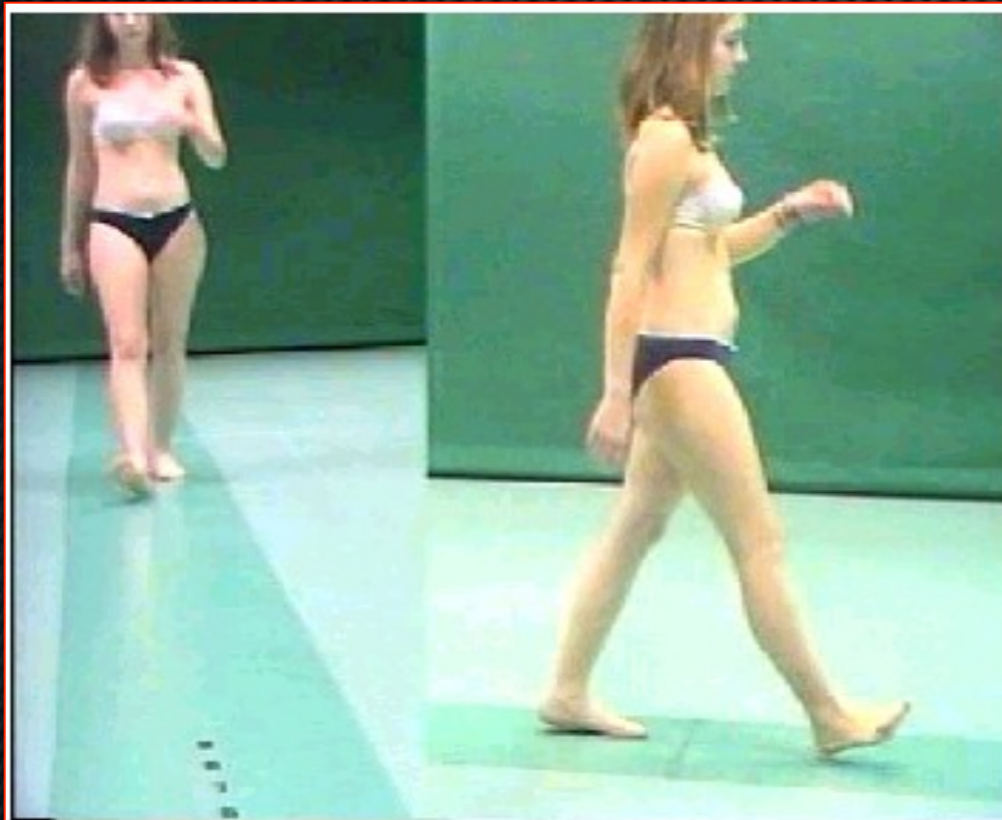
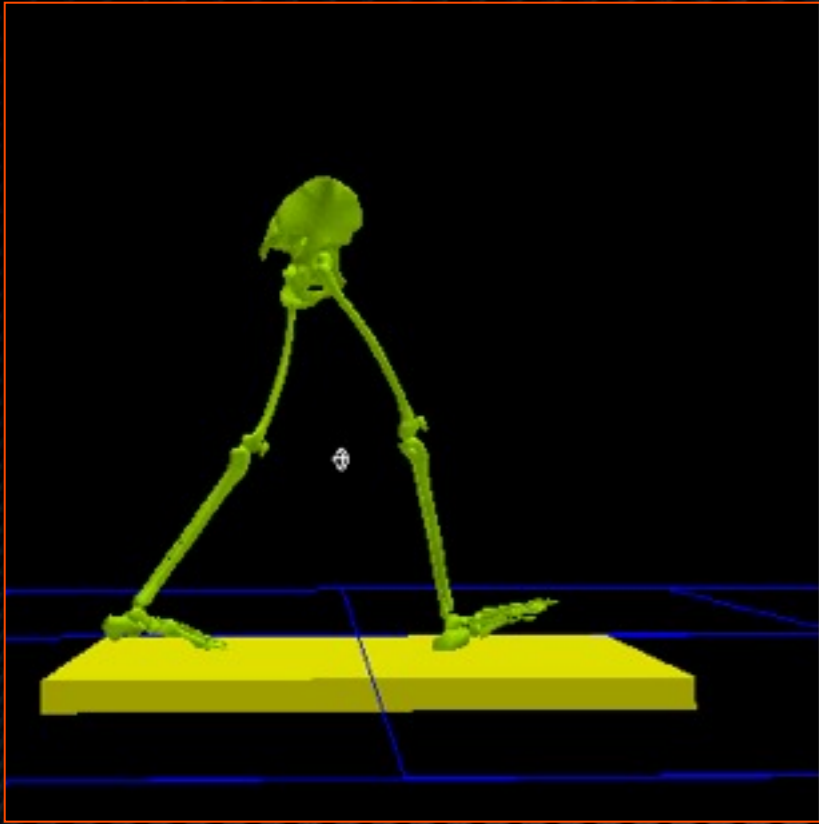


- MILIEU PHASE OSCILLANTE
- FIN PHASE OSCILLANTE

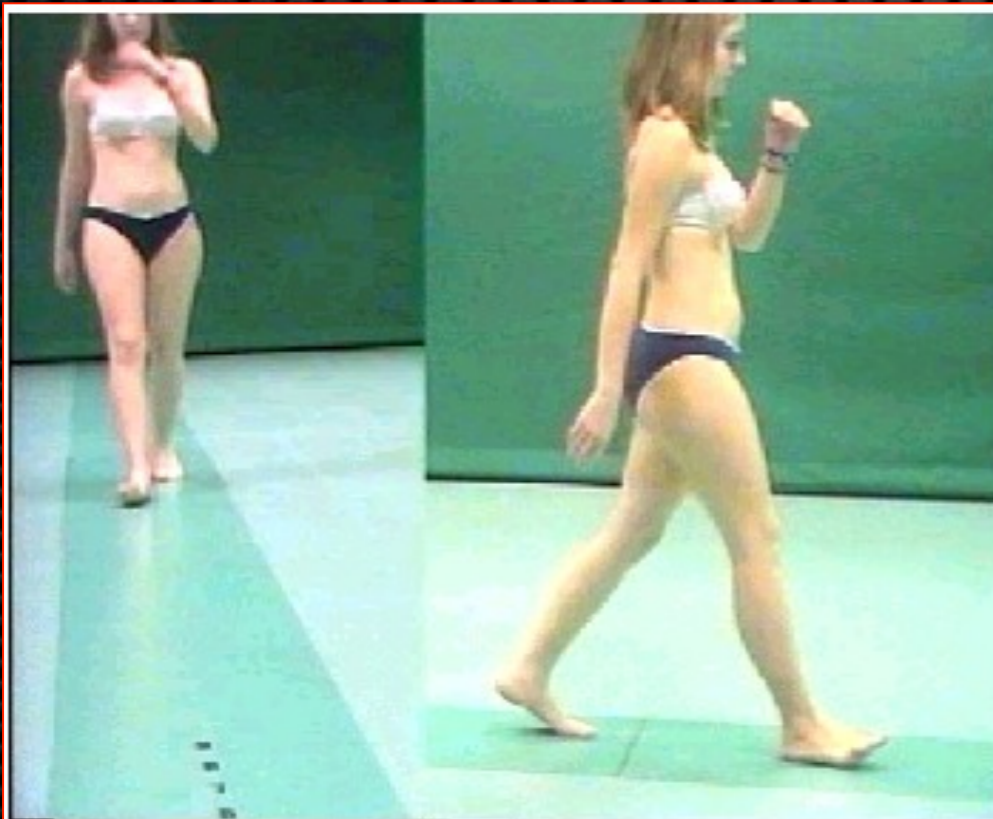
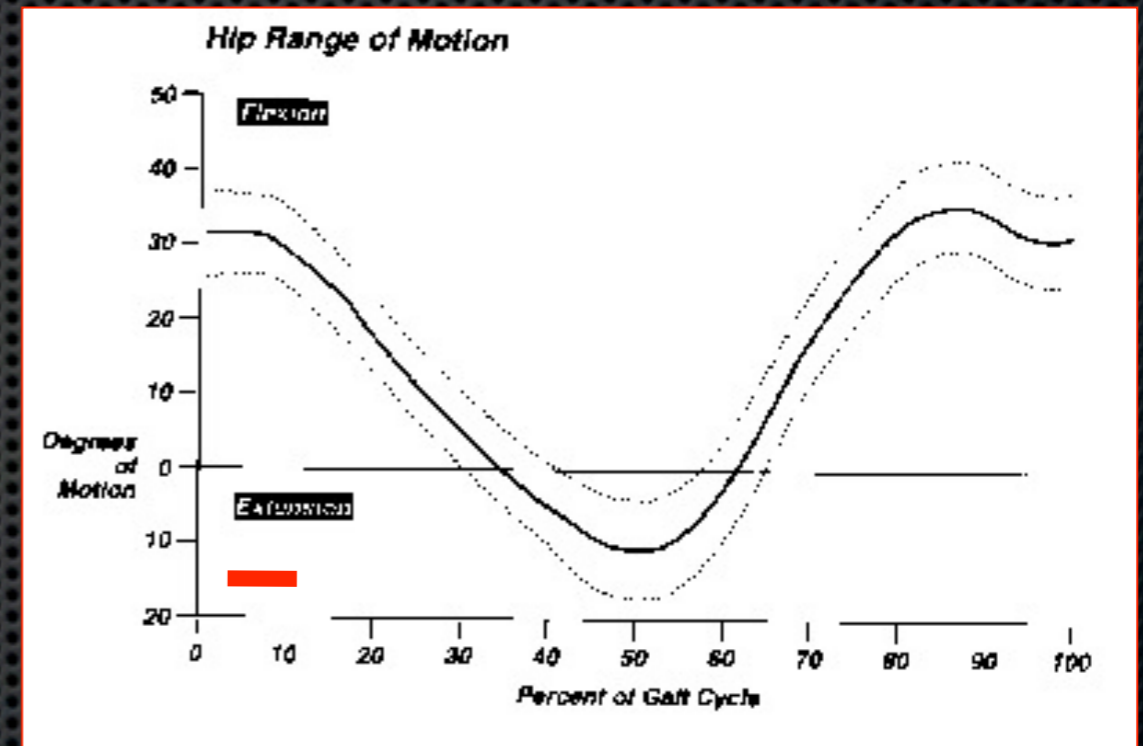
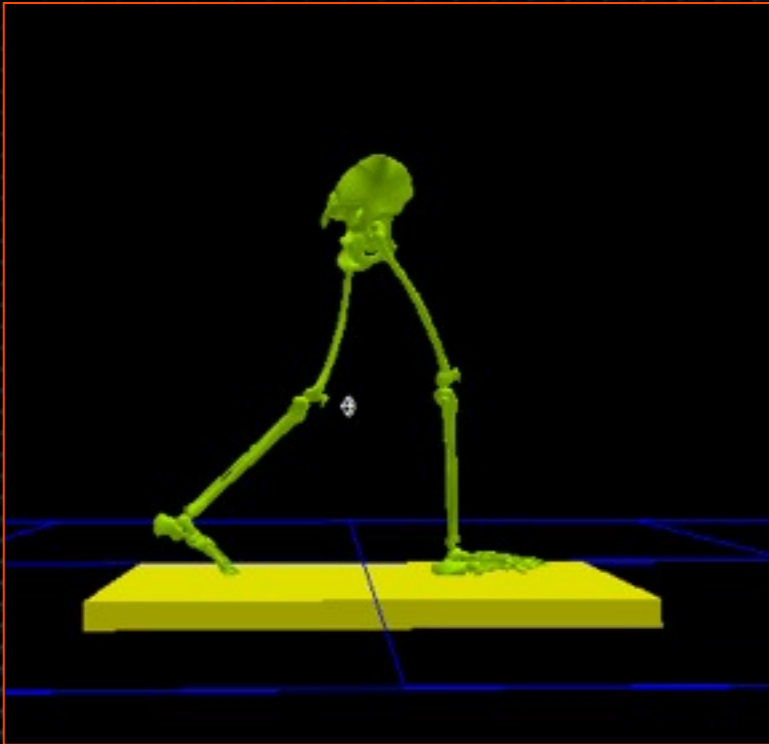
# LA HANCHE NORMALE

# CINEMATIQUE DE LA HANCHE

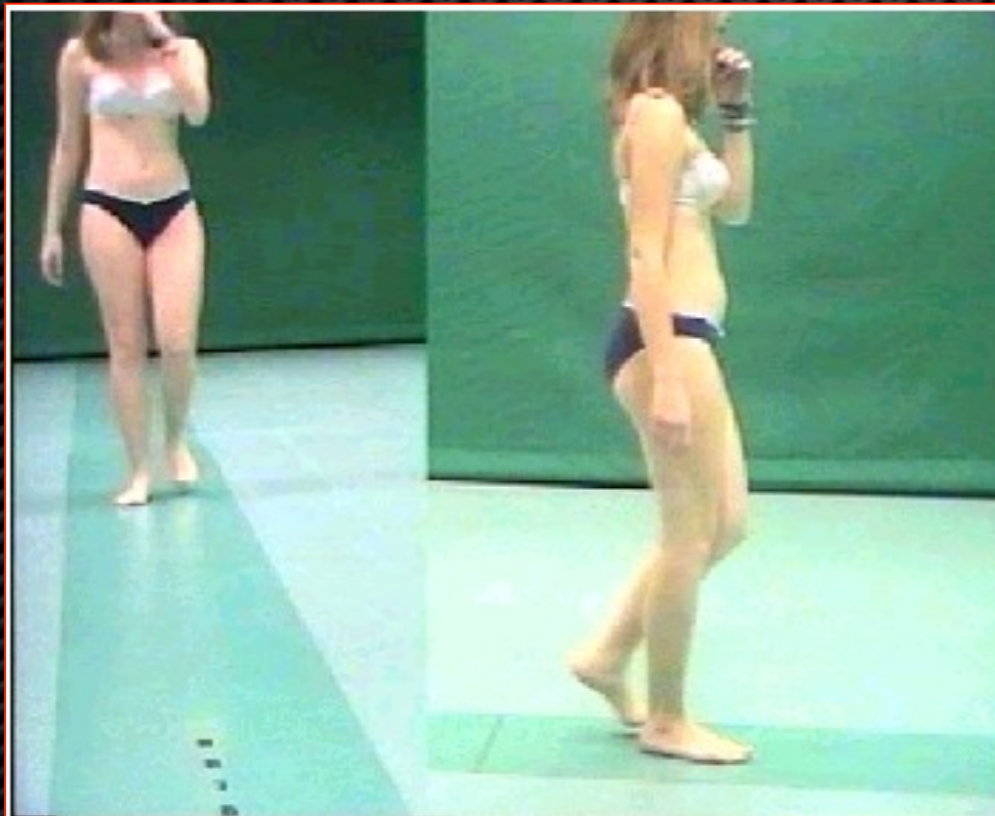
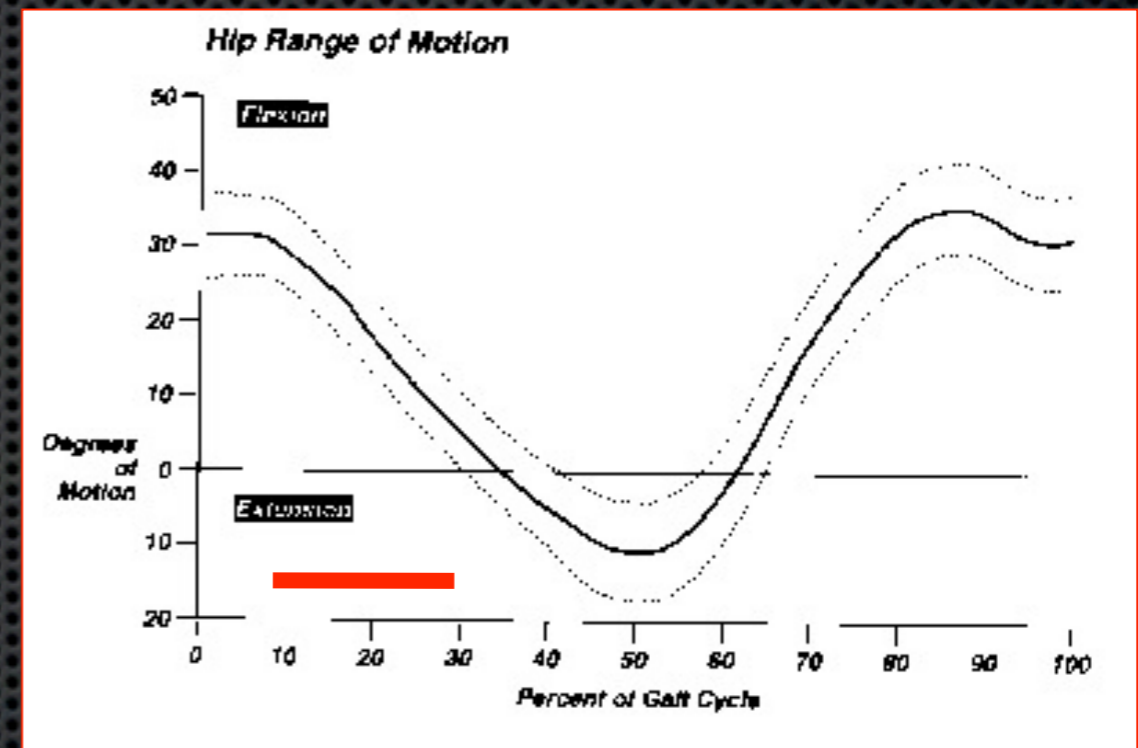
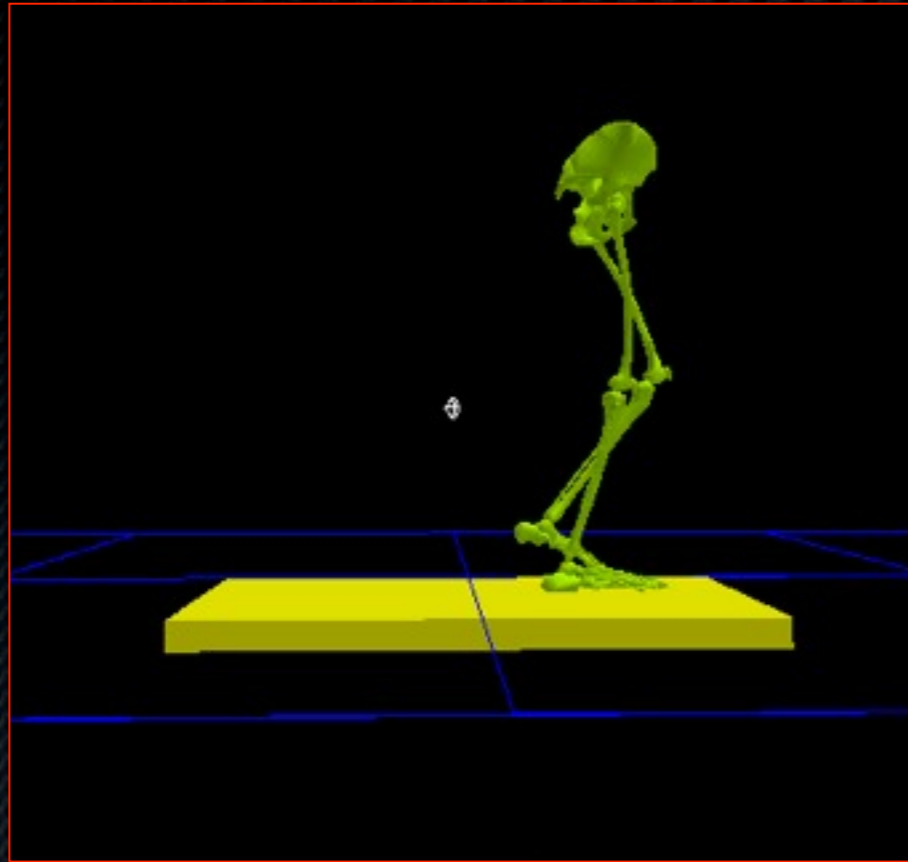




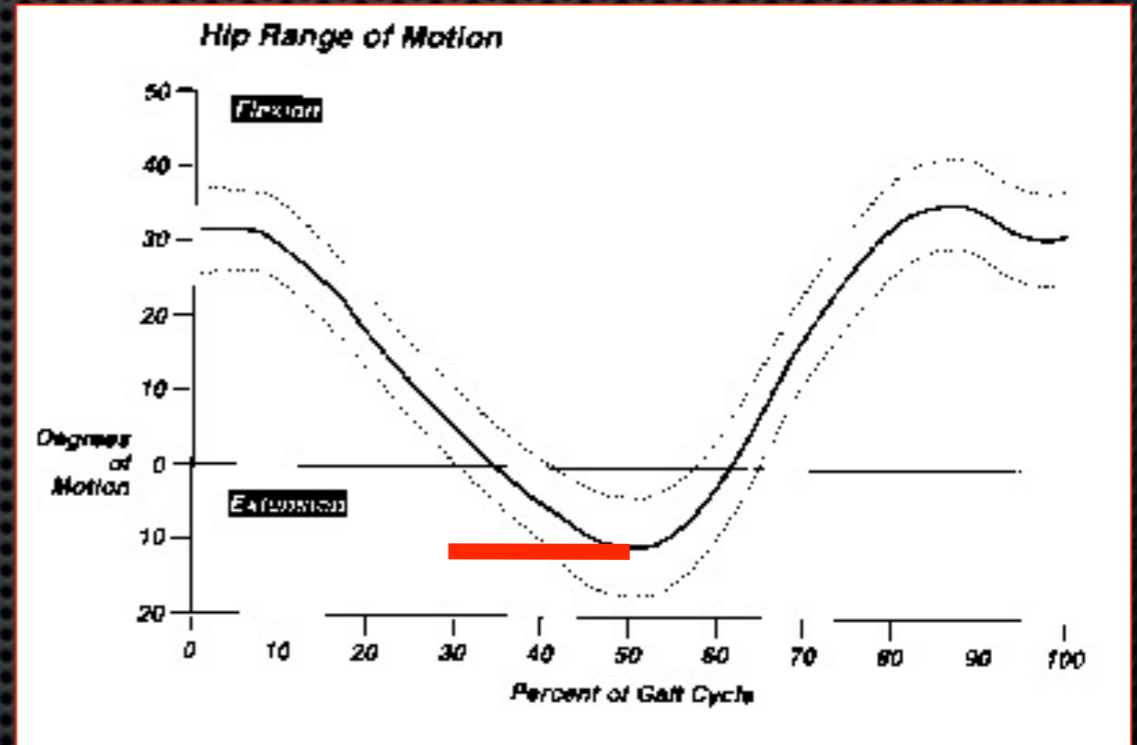
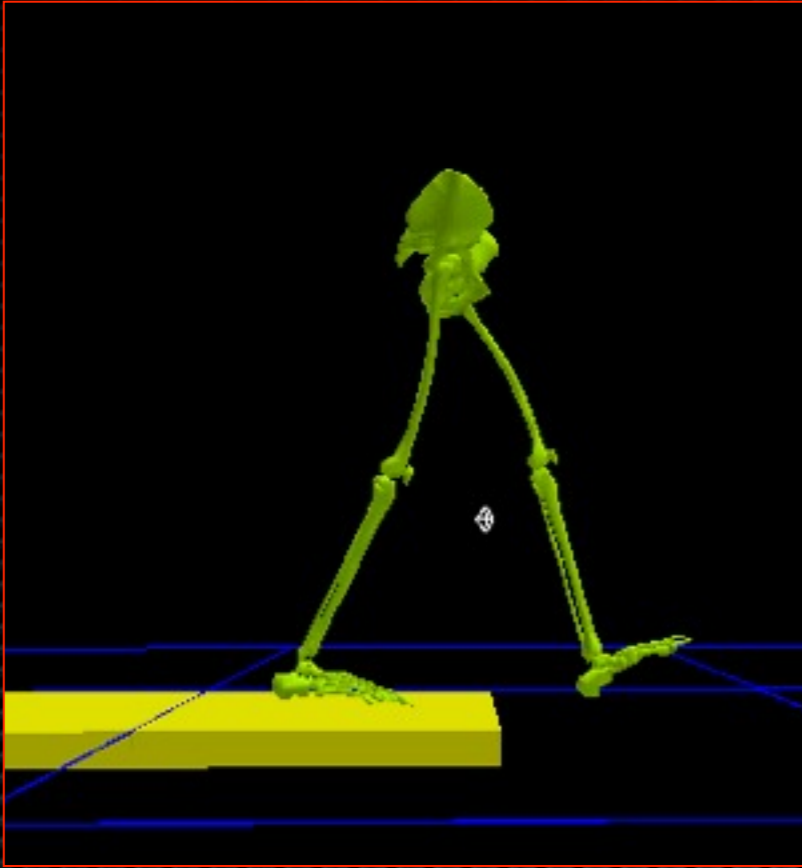
# MISE EN APPUI



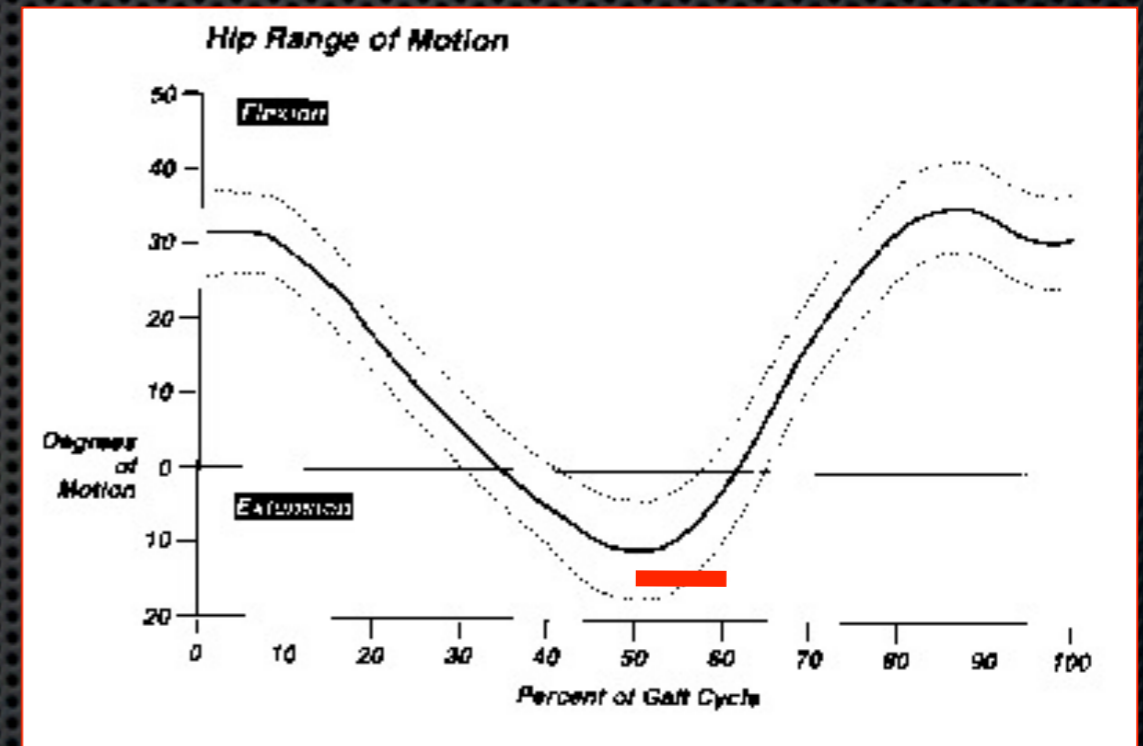
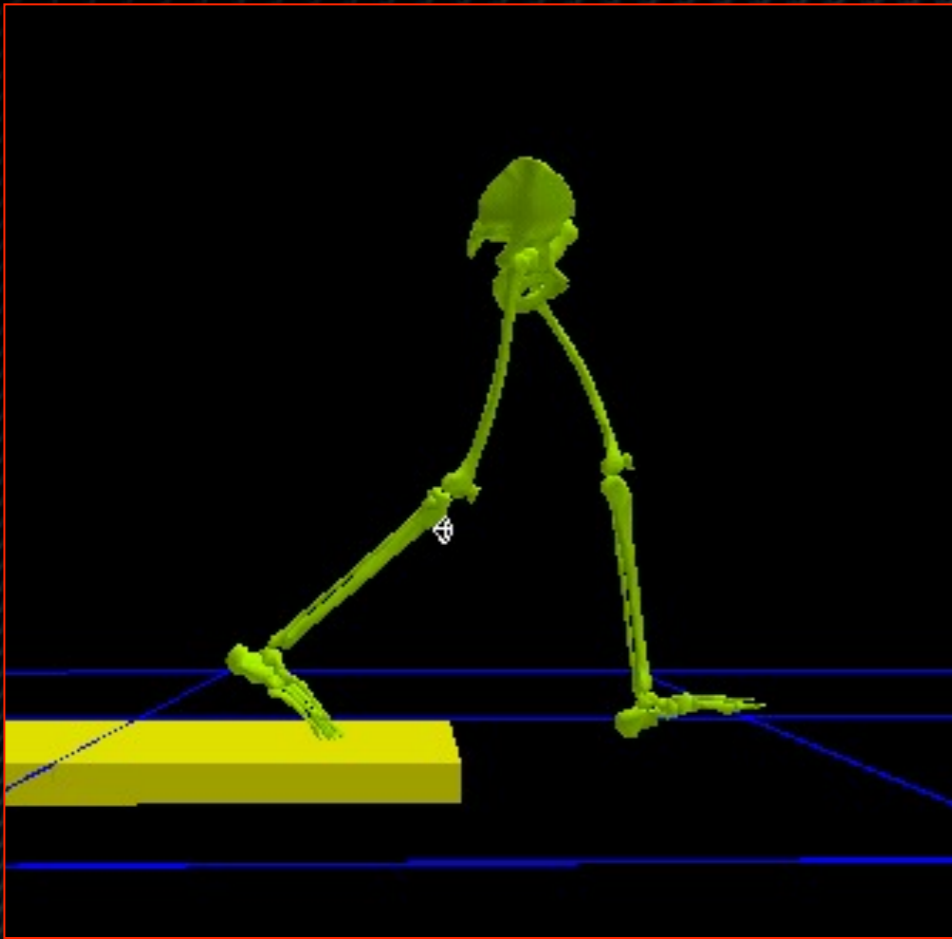
# MILIEU D'APPUI



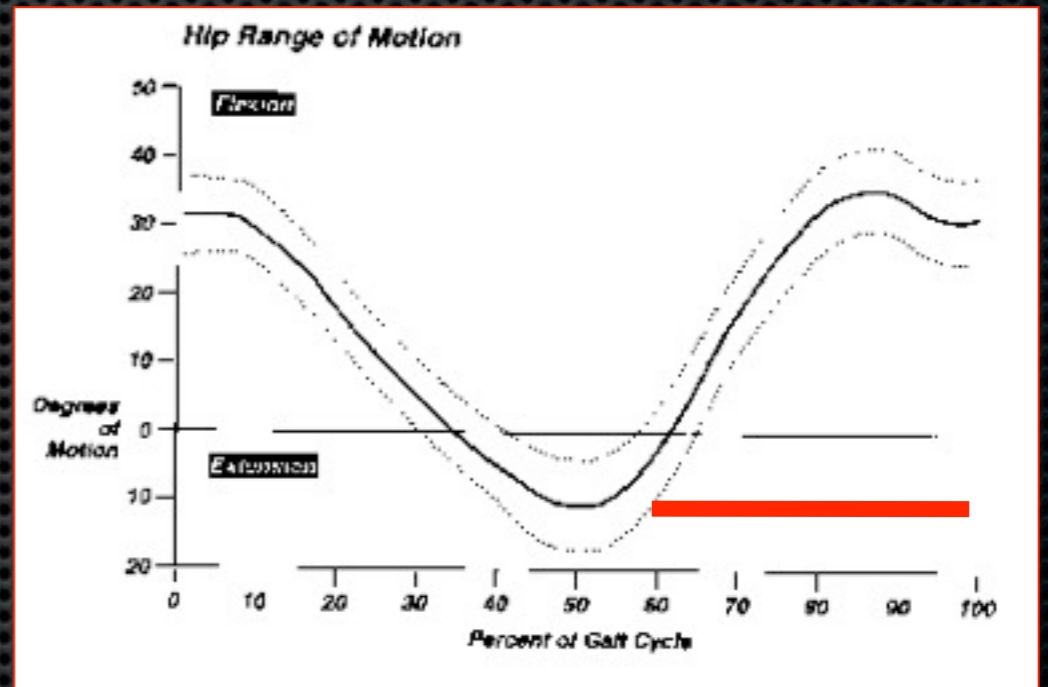
# FIN D'APPUI

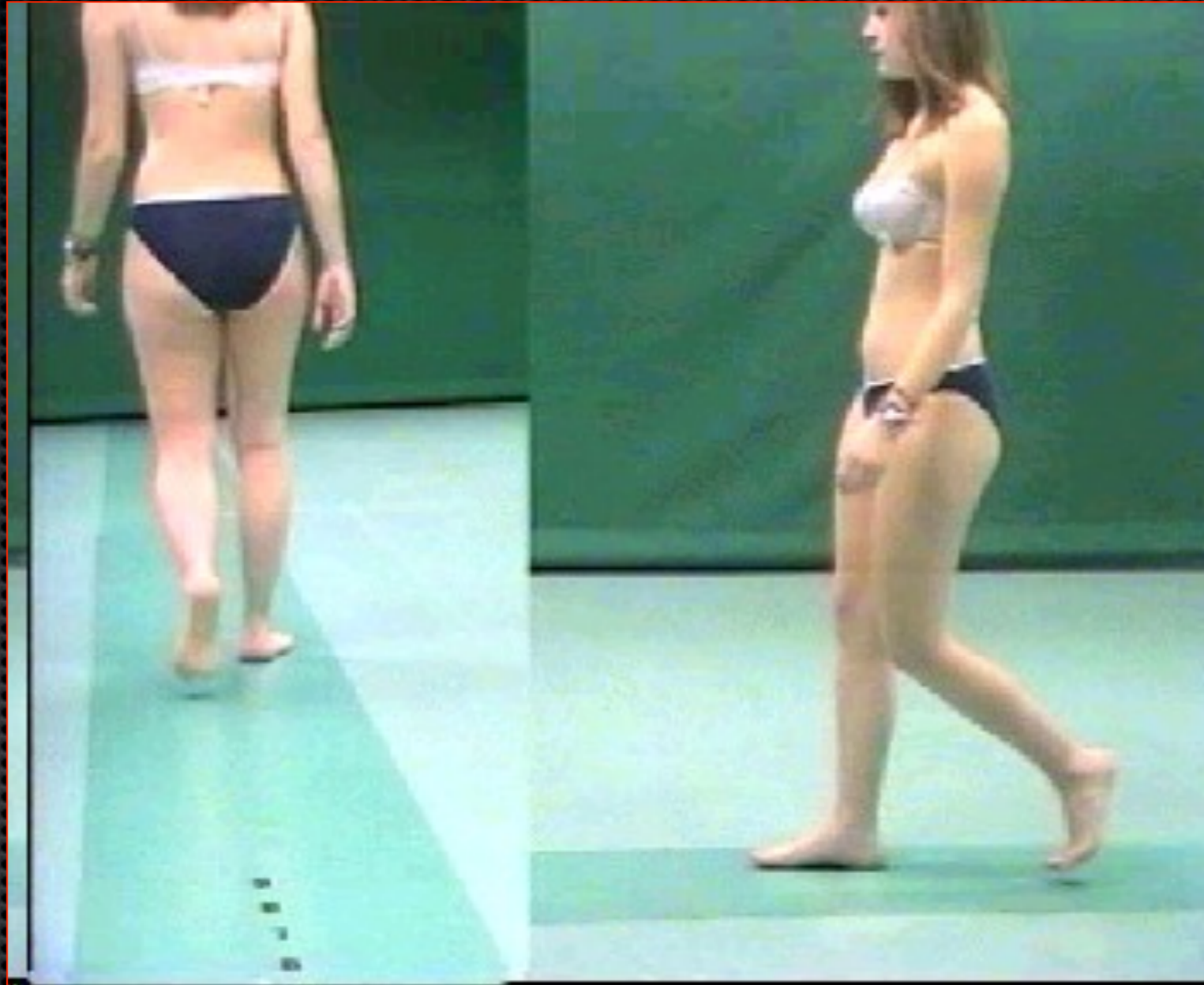


# PHASE PRE OSCILLANTE

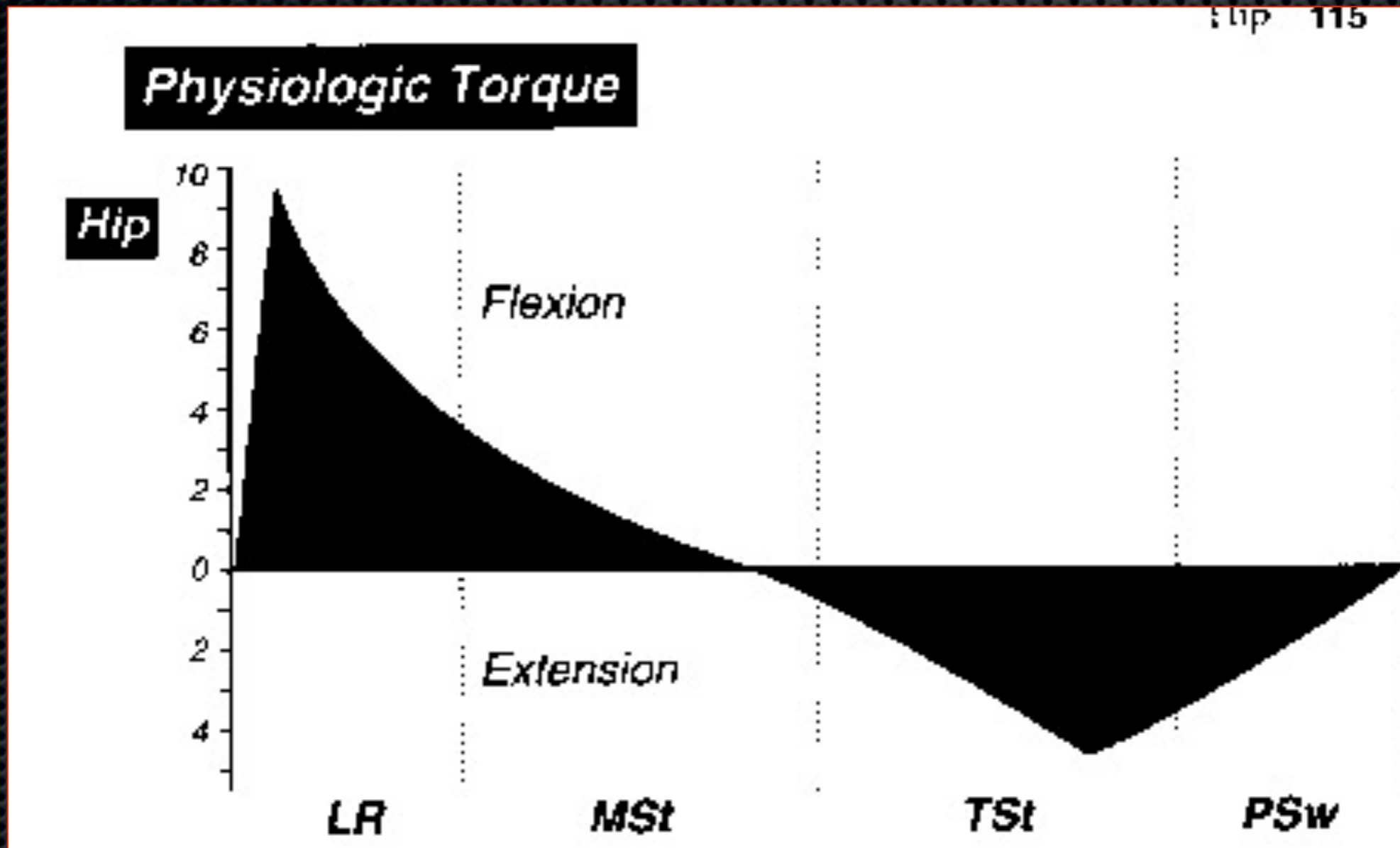




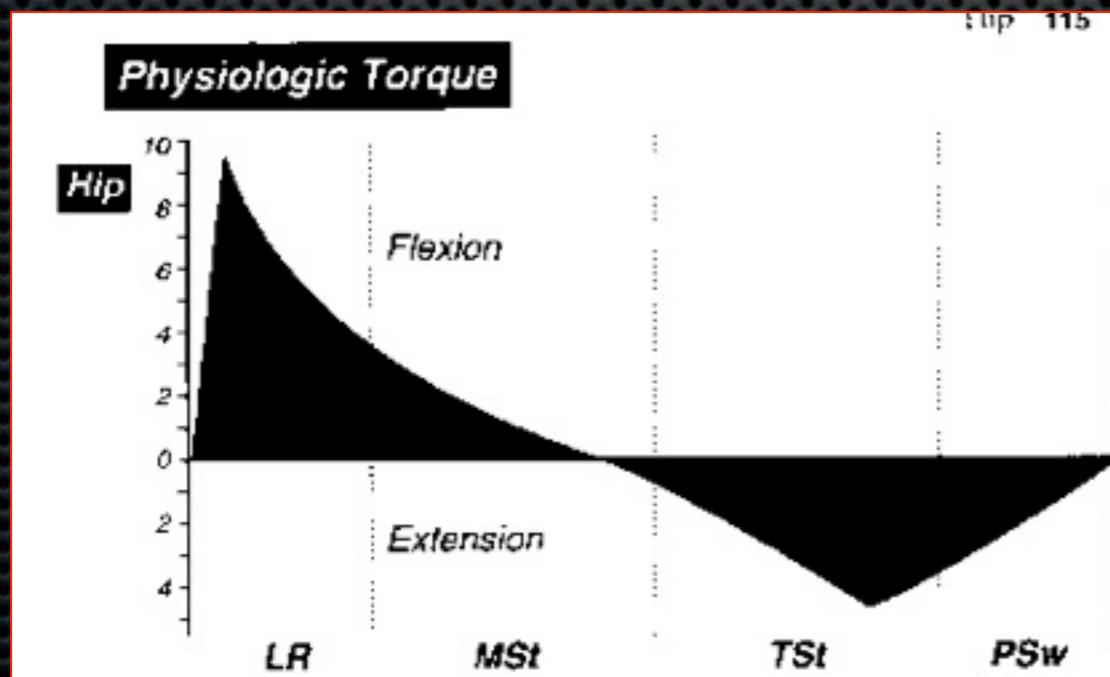
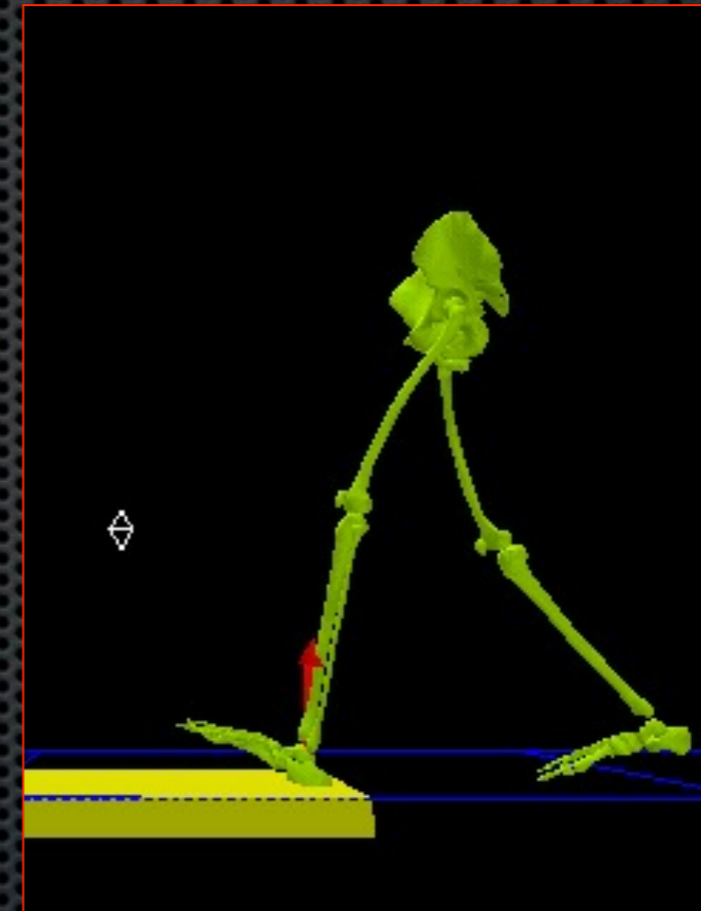
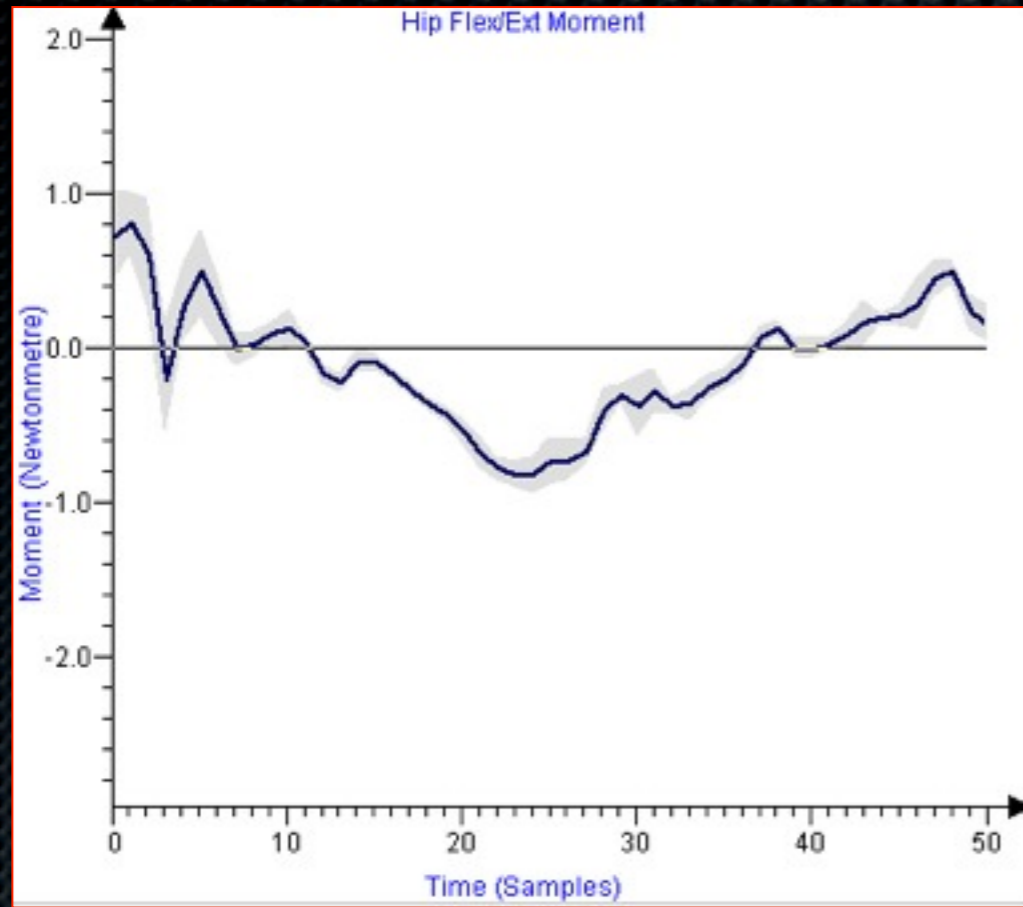




# CINETIQUE DE LA HANCHE

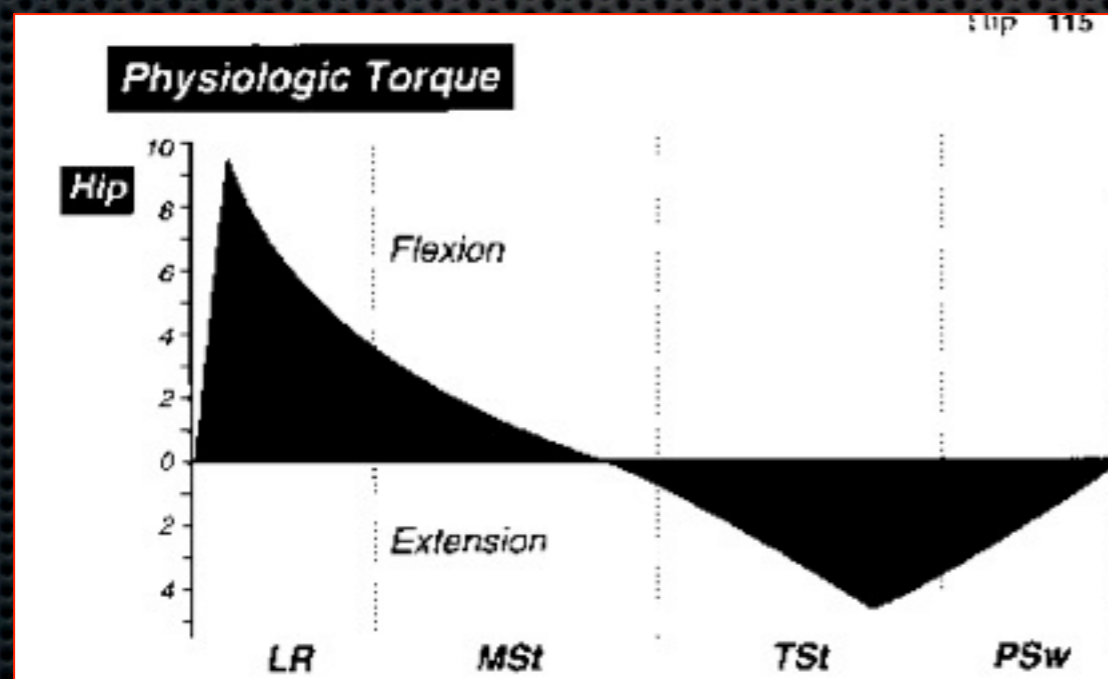
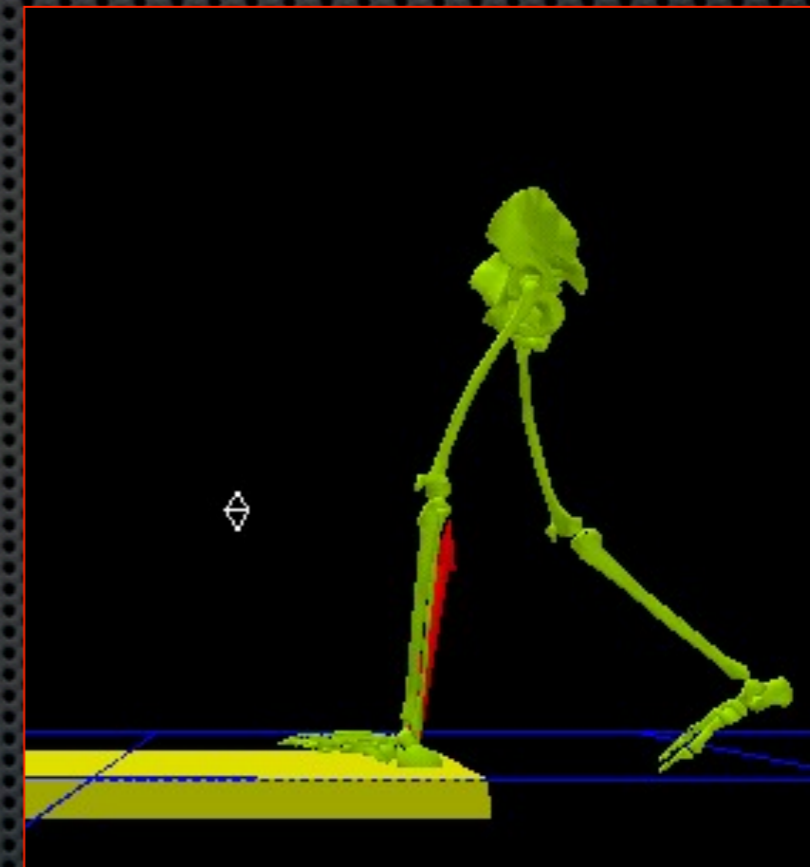
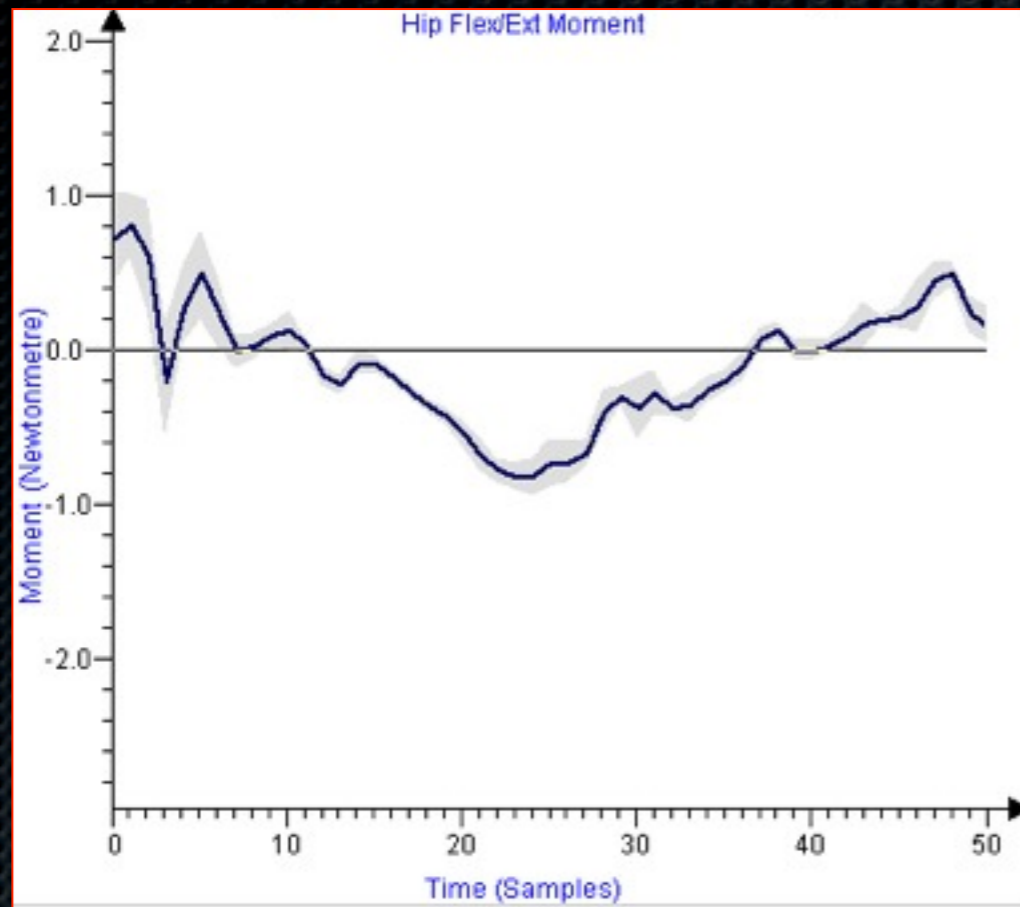


# CINETIQUE DE LA HANCHE



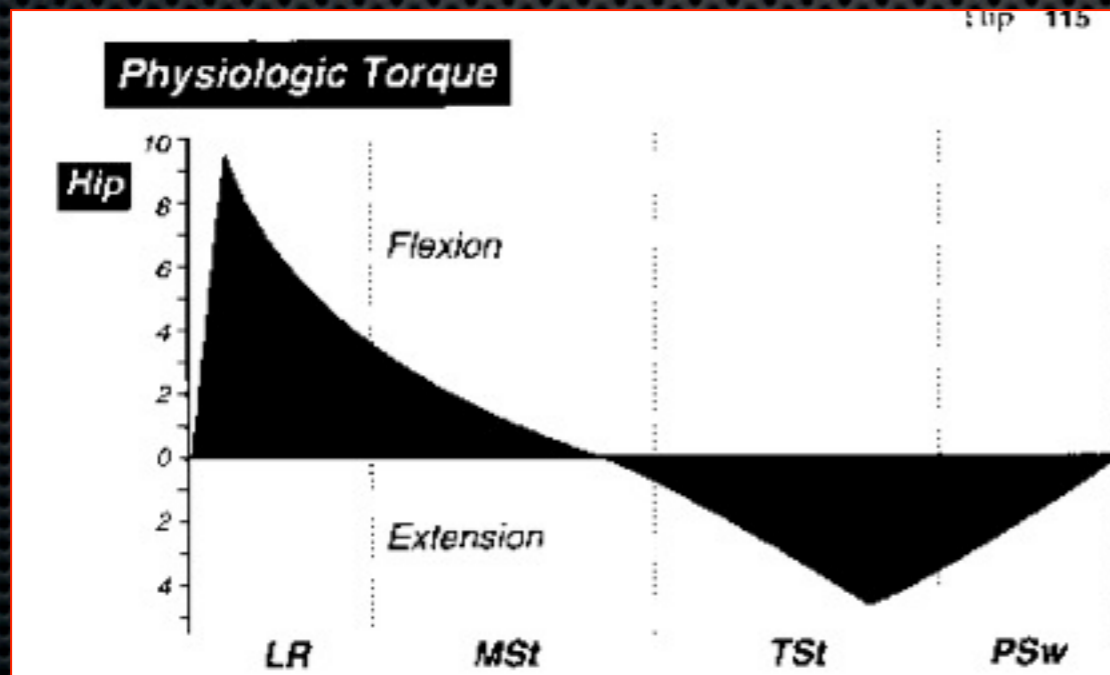
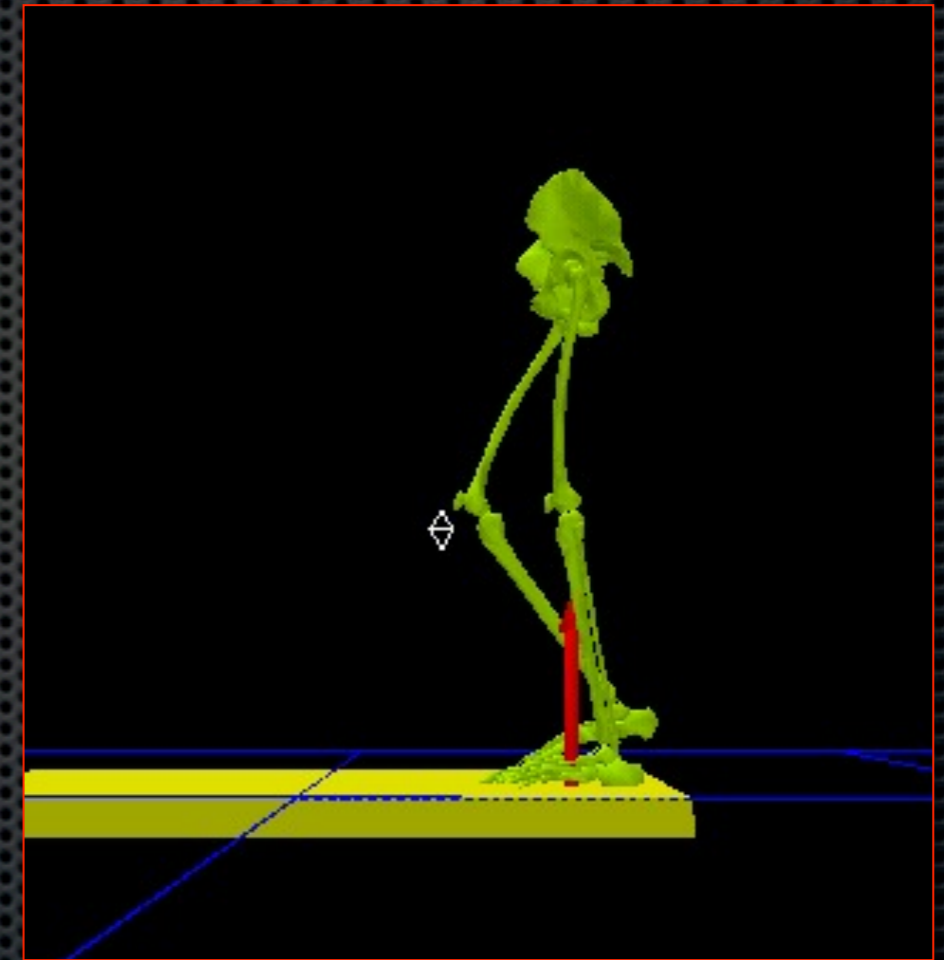
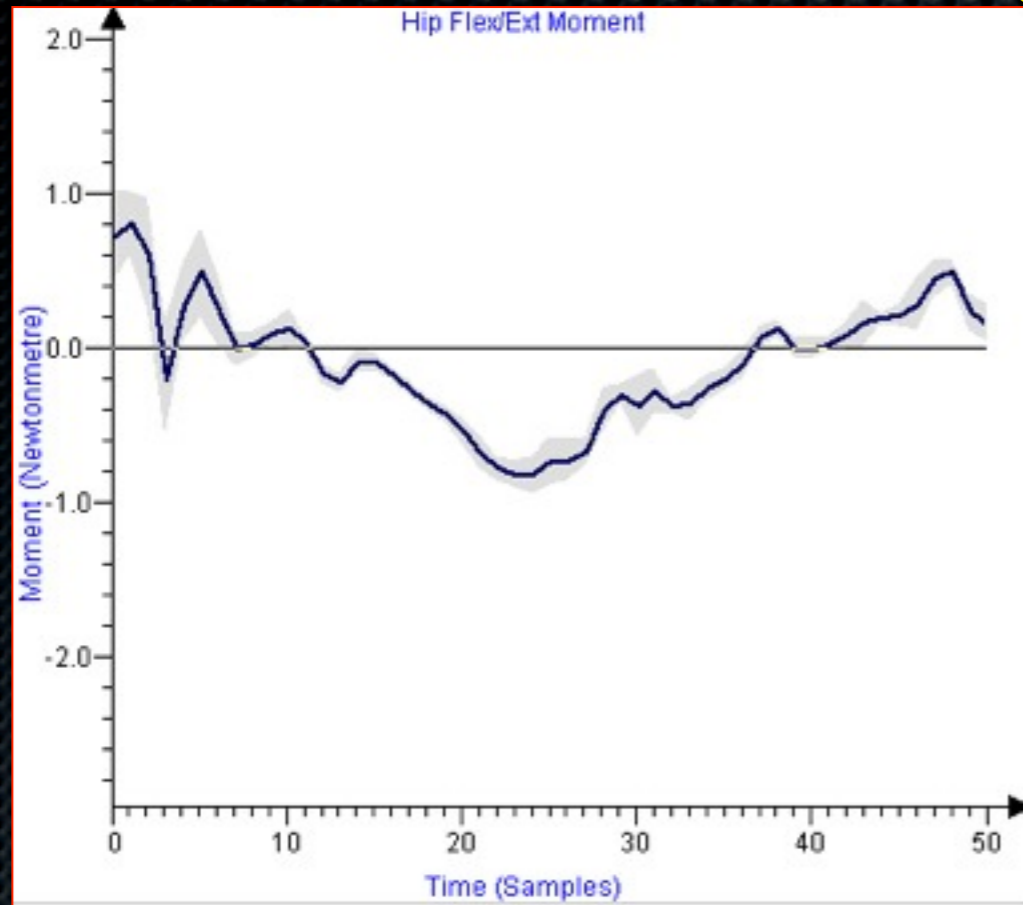
**CONTACT INITIAL**  
**Vecteur en avant de la hanche**

# CINETIQUE DE LA HANCHE



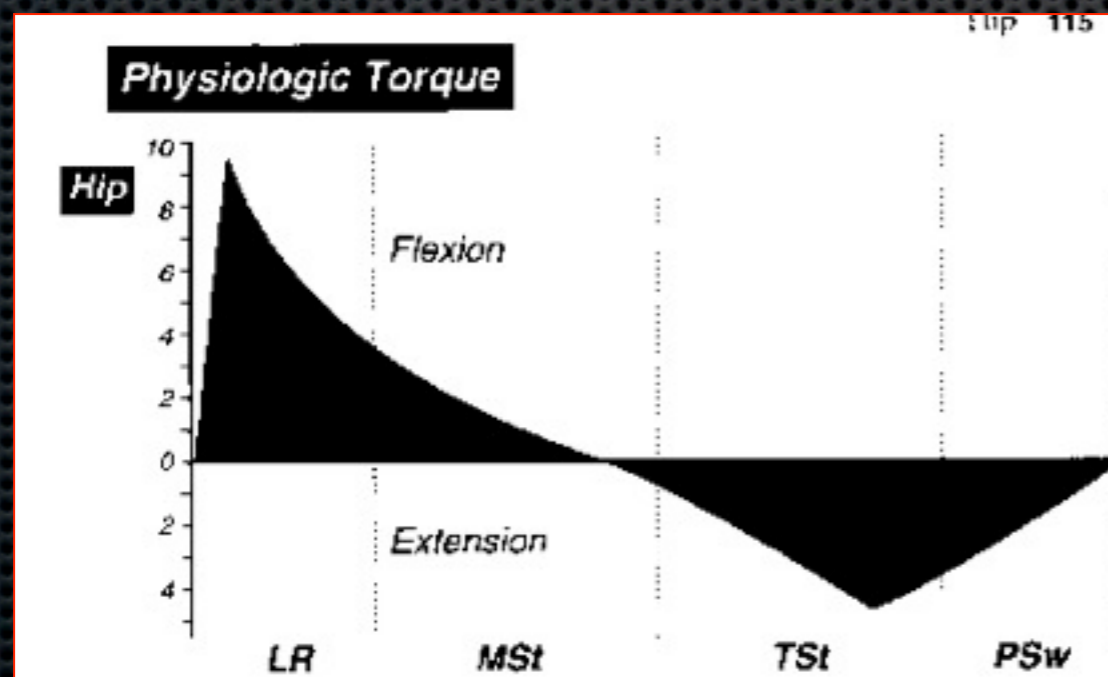
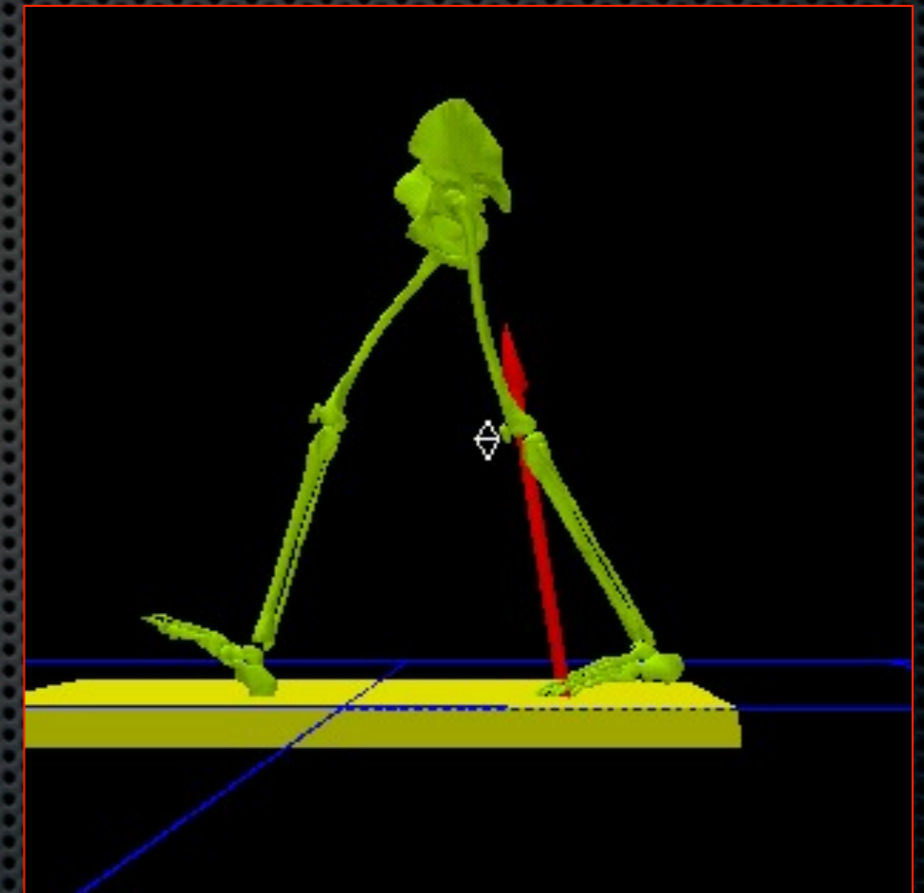
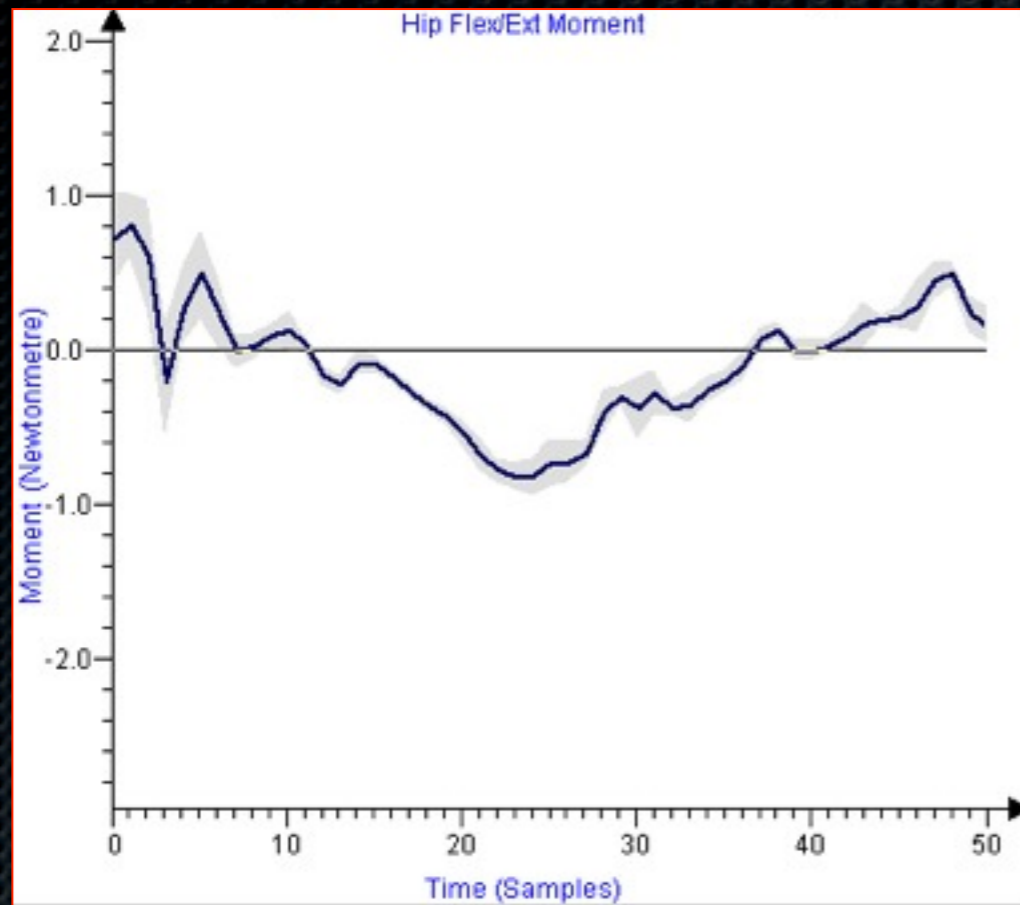
**MISE EN APPUI**  
**Vecteur en avant de la hanche**

# CINETIQUE DE LA HANCHE



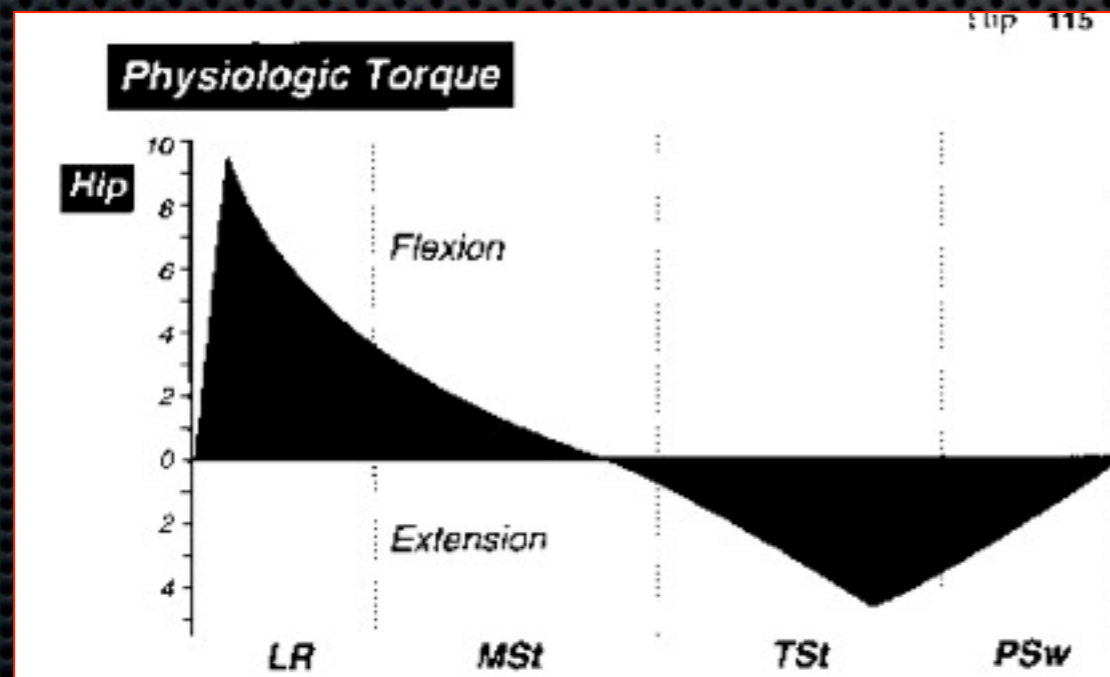
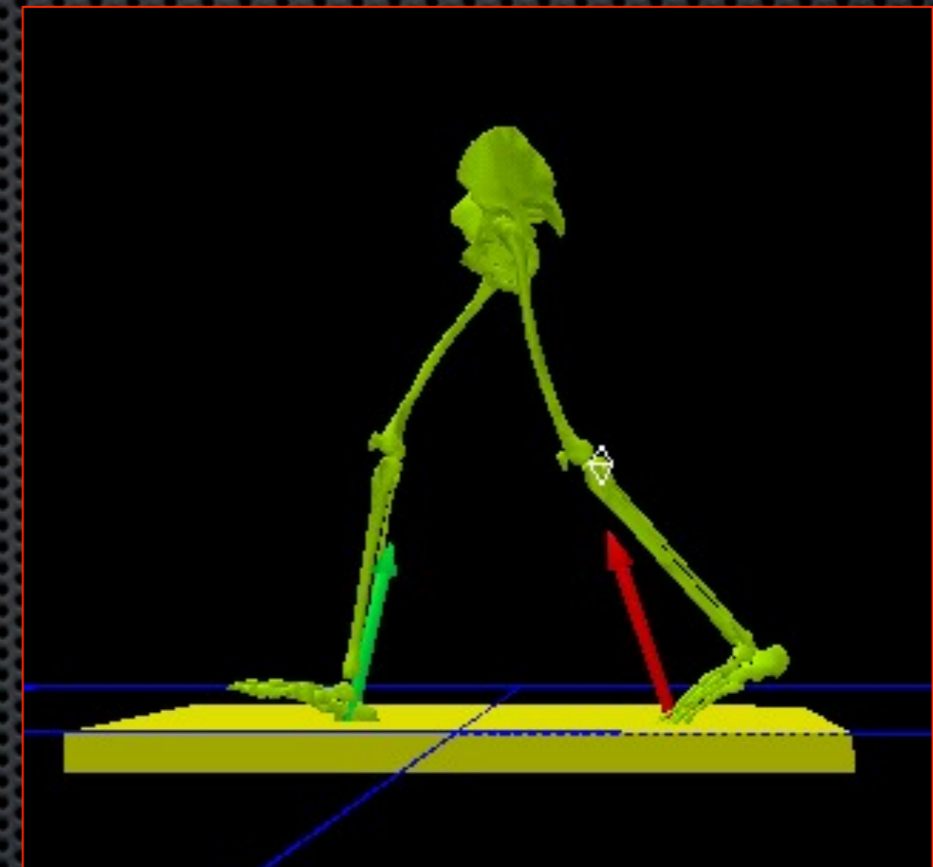
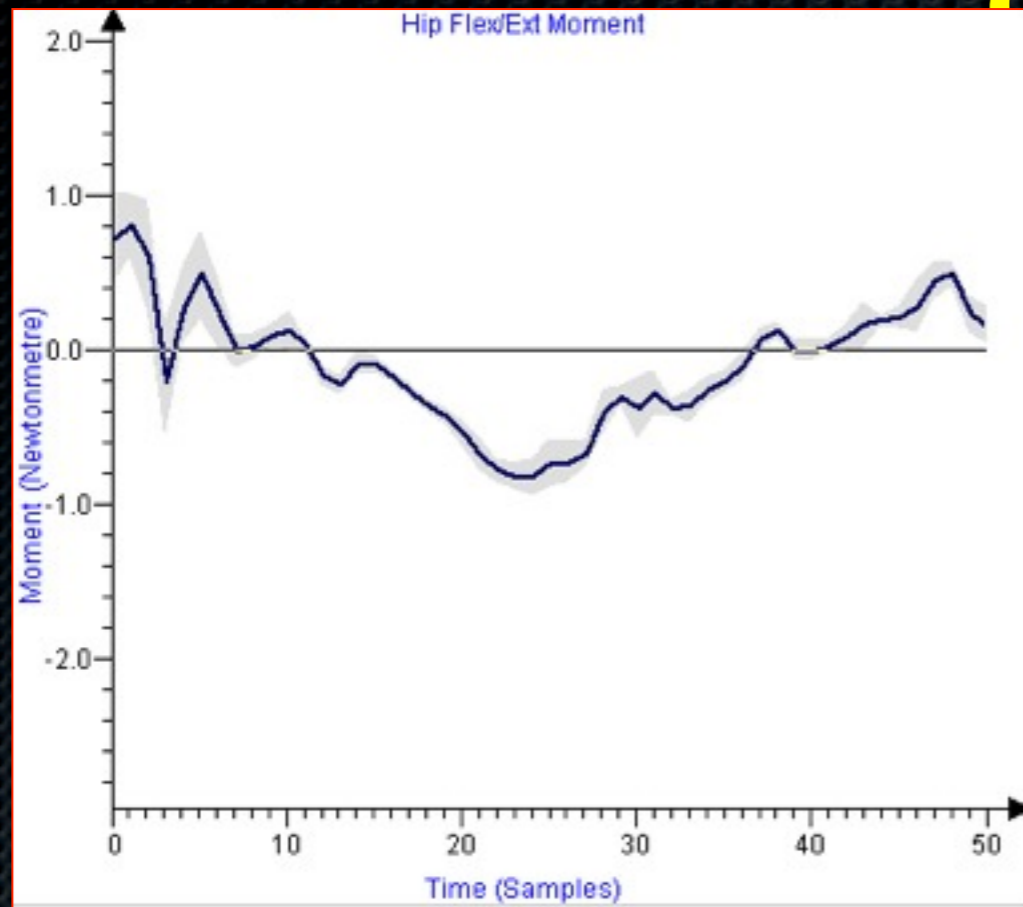
**MILIEU D'APPUI**  
**Vecteur près de la hanche**

# CINETIQUE DE LA HANCHE



**FIN D'APPUI**  
**Vecteur en arrière de la hanche**

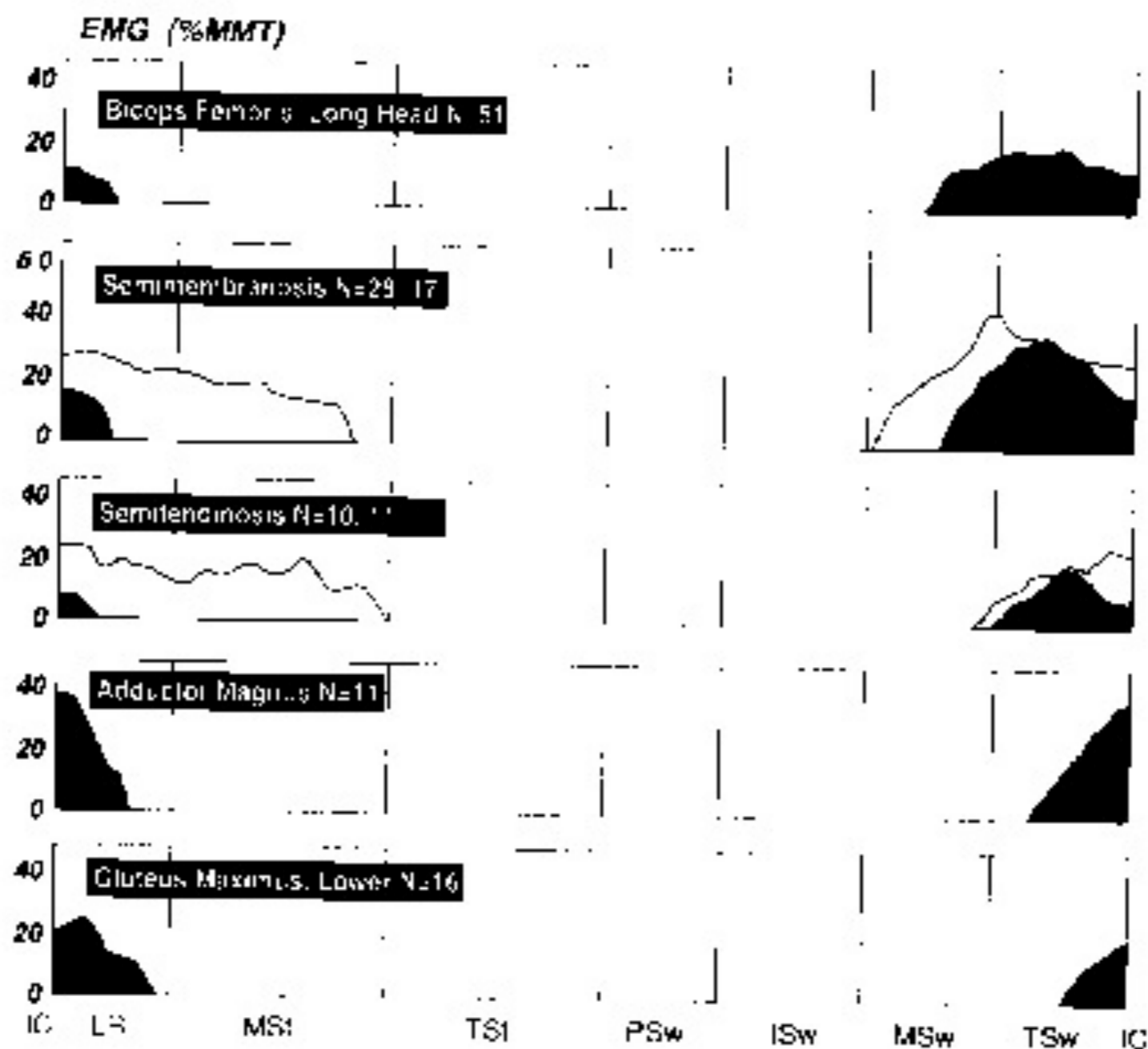
# CINETIQUE DE LA HANCHE



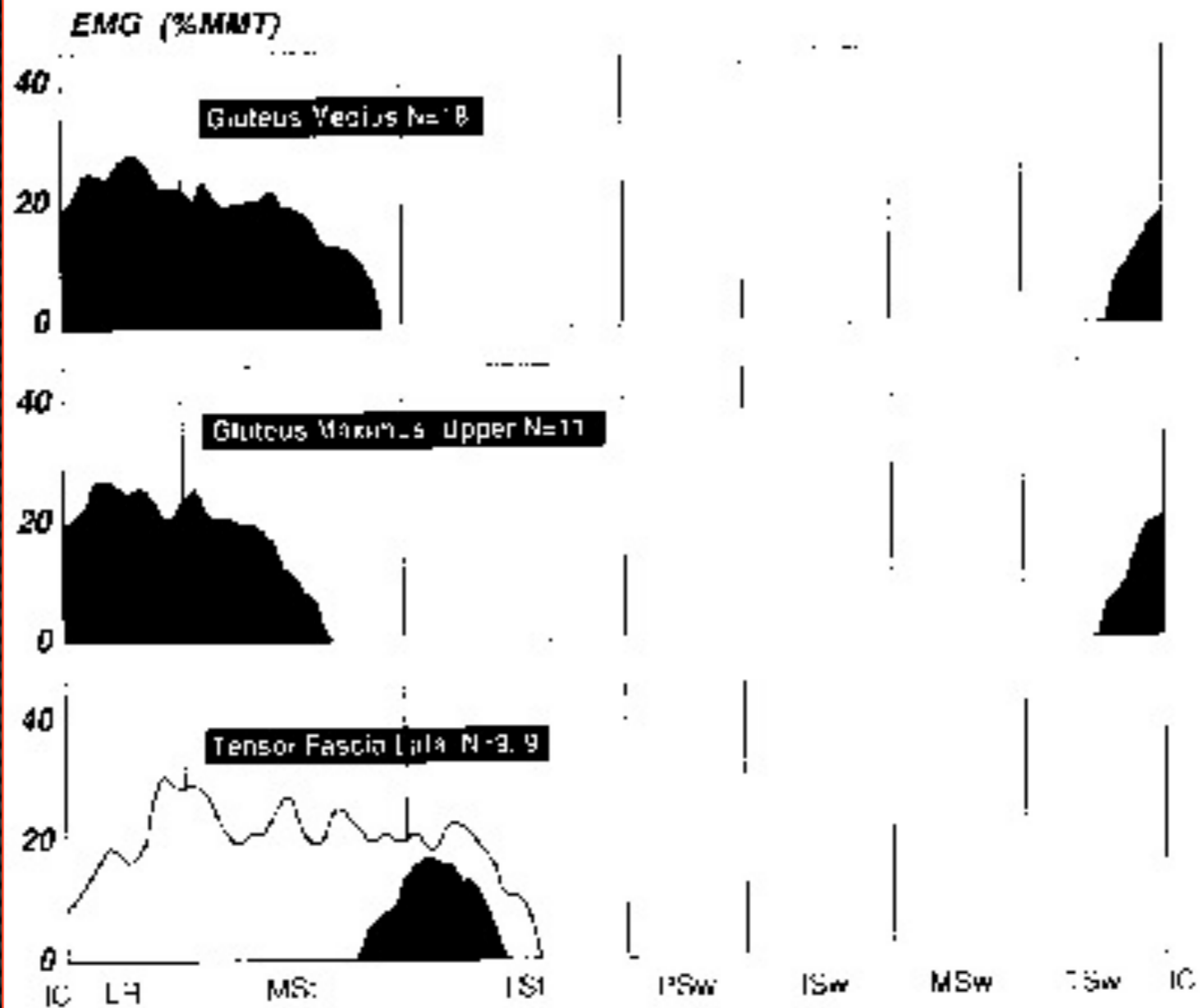
**PHASE PRE OSCILLANTE**  
**Déverrouillage**  
**Vecteur près de la hanche**



## Hip Extensor Muscles

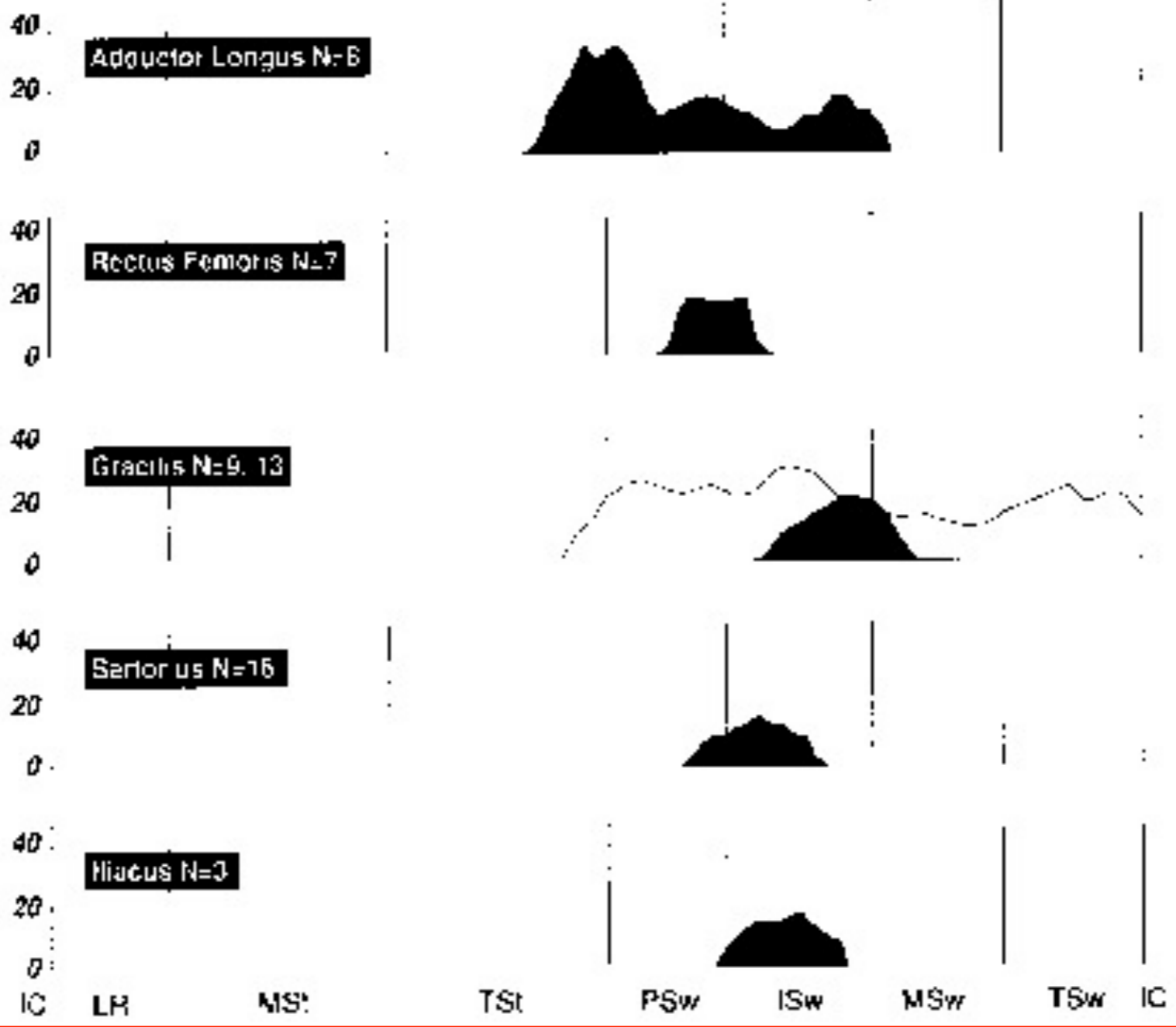


## Hip Abductor Muscles

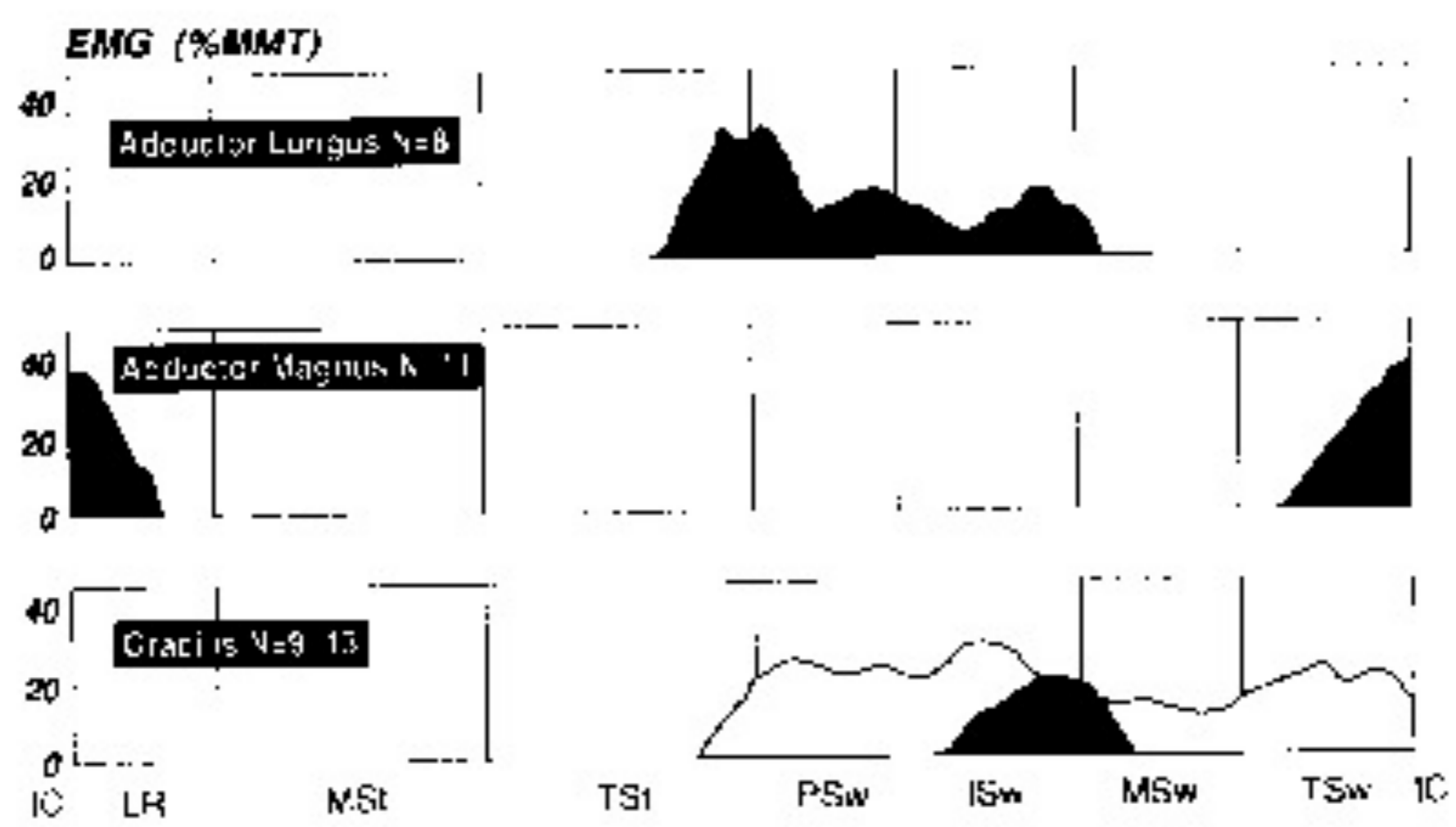


## Hip Flexor Muscles

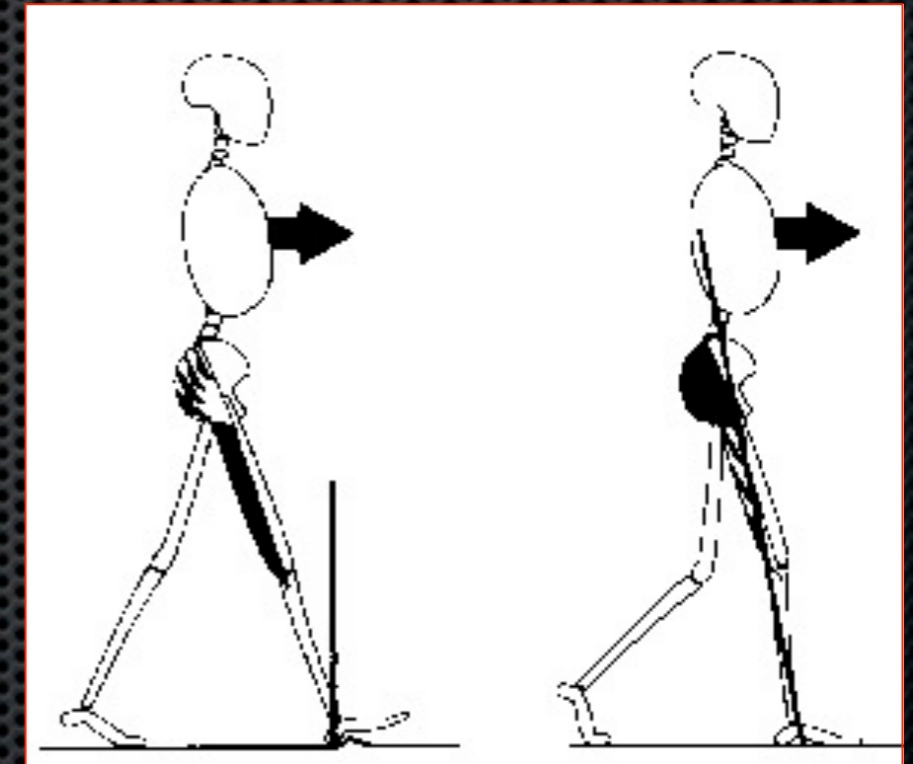
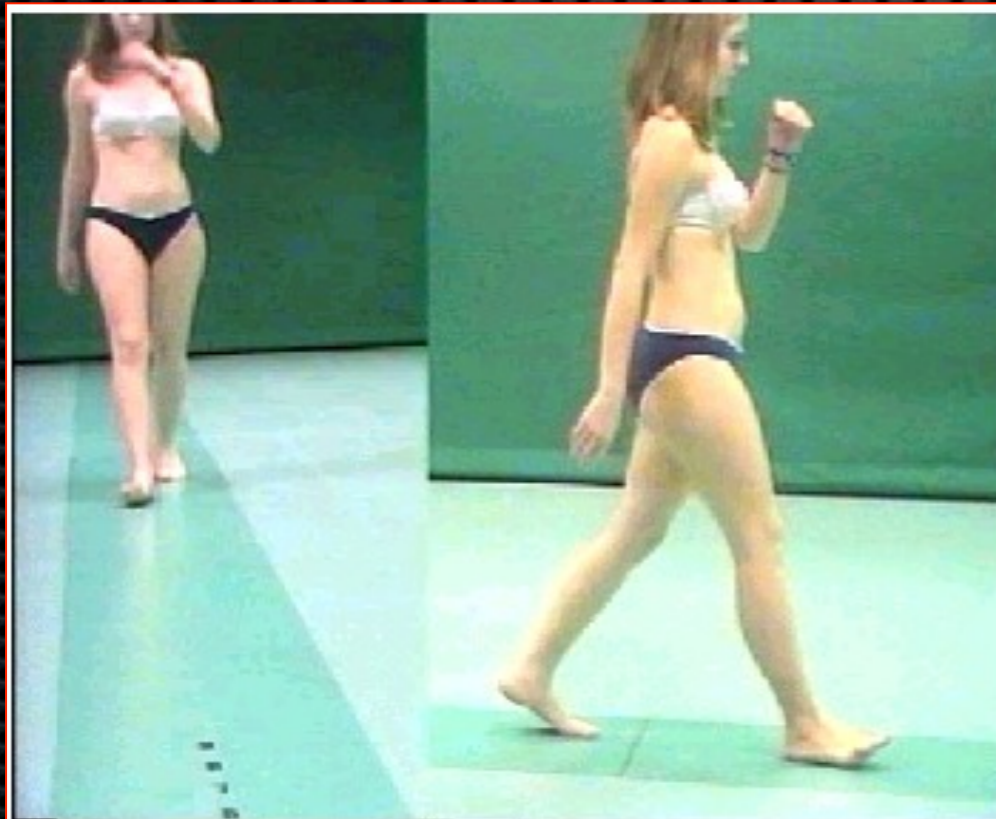
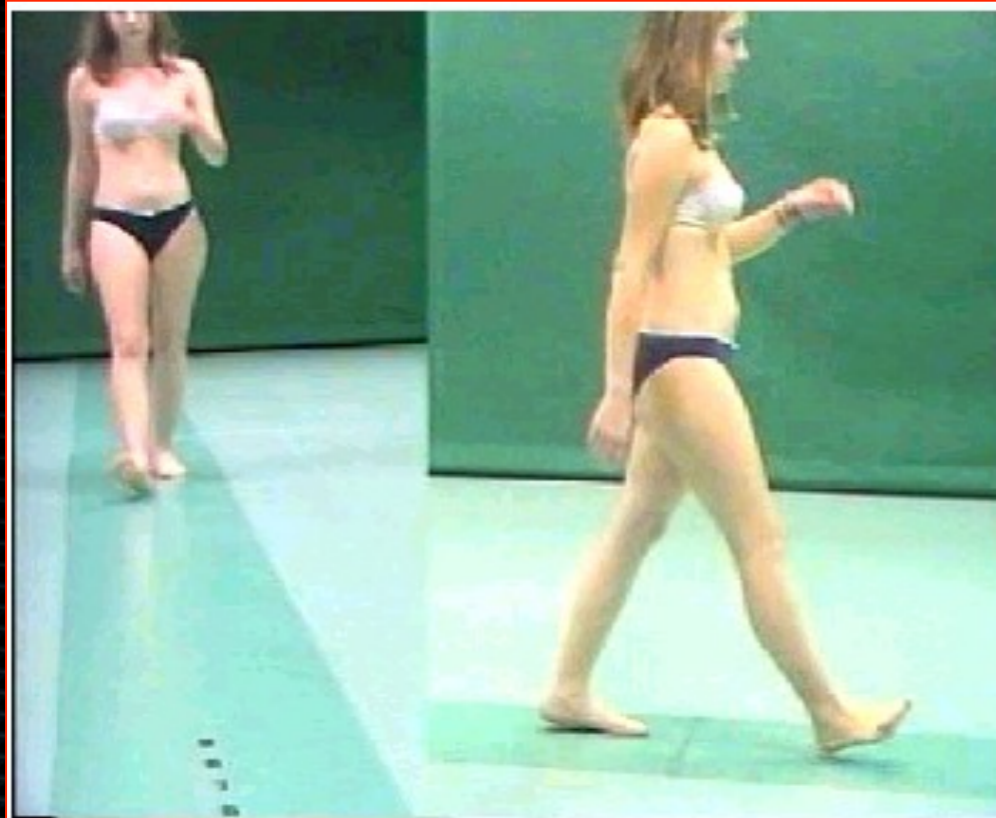
EMG (%MMT)



## Hip Adductor Muscles

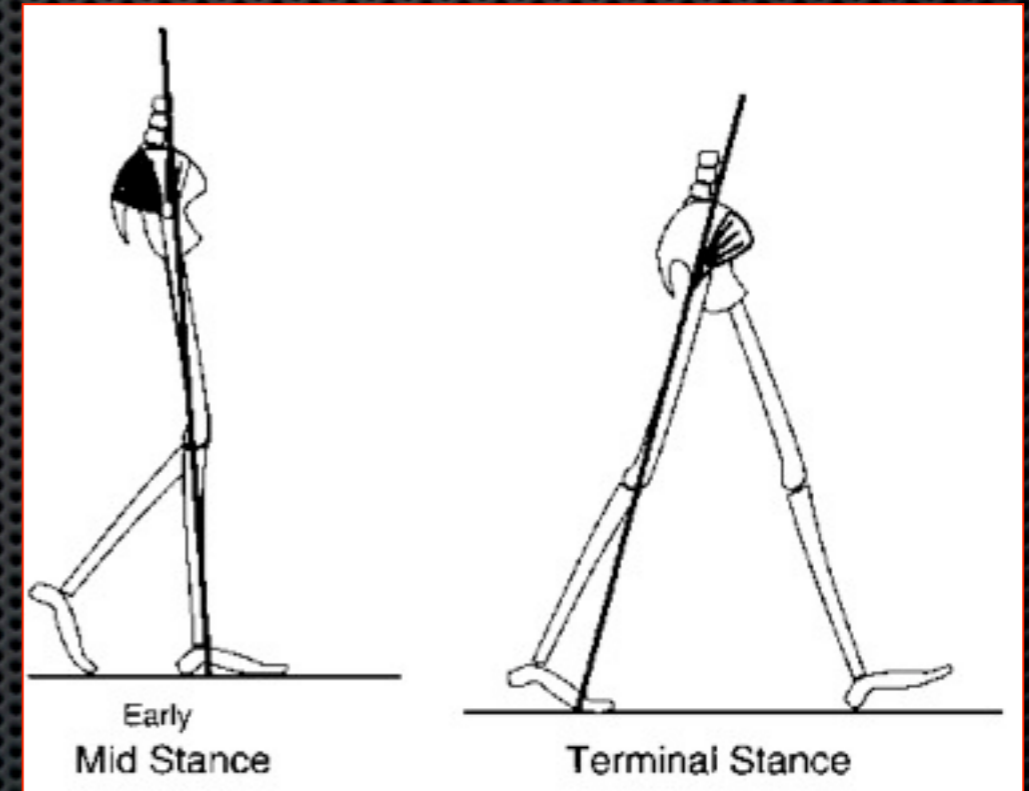
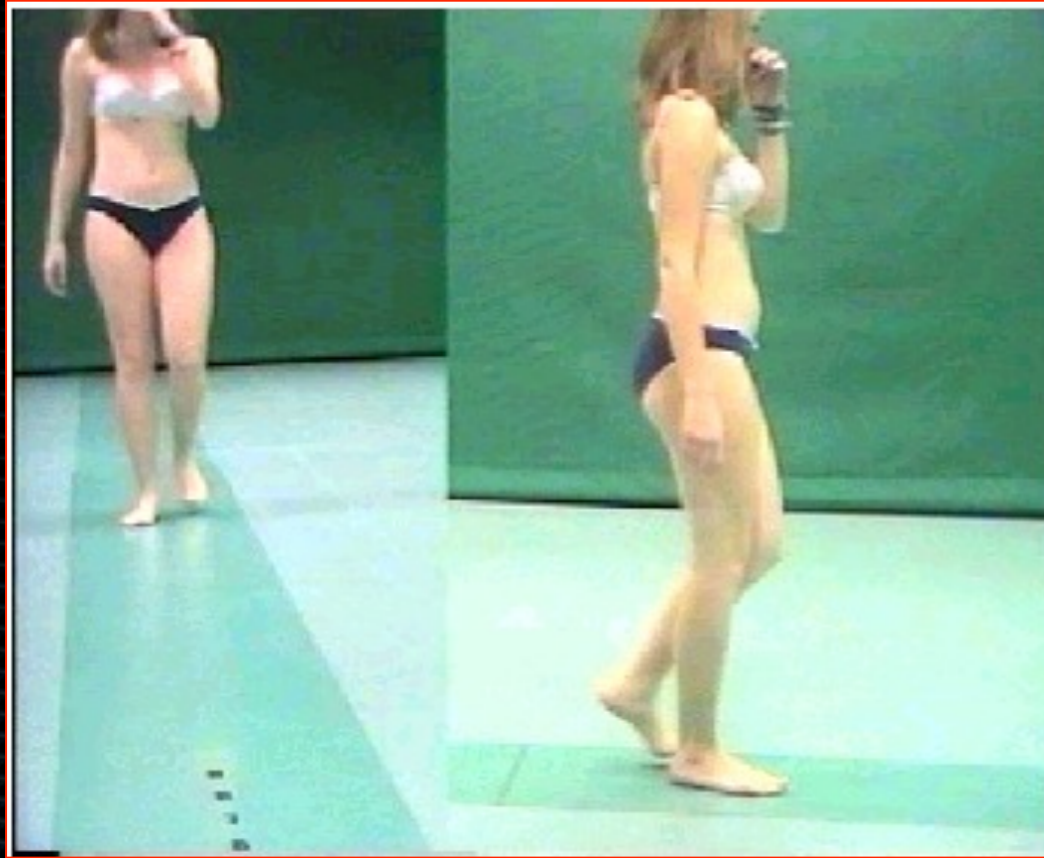


# INTERPRETATION FONCTIONNELLE



- **CONTACT INITIAL**
- **MISE EN APPUI**

# INTERPRETATION FONCTIONNELLE



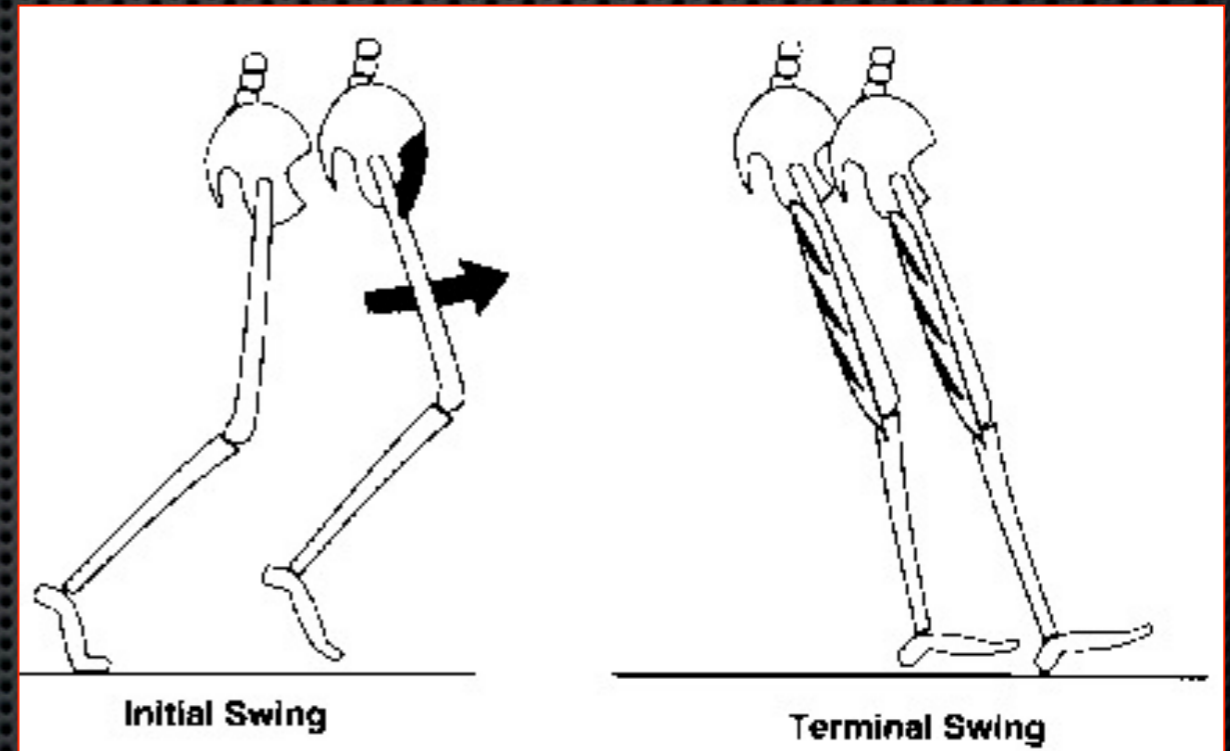
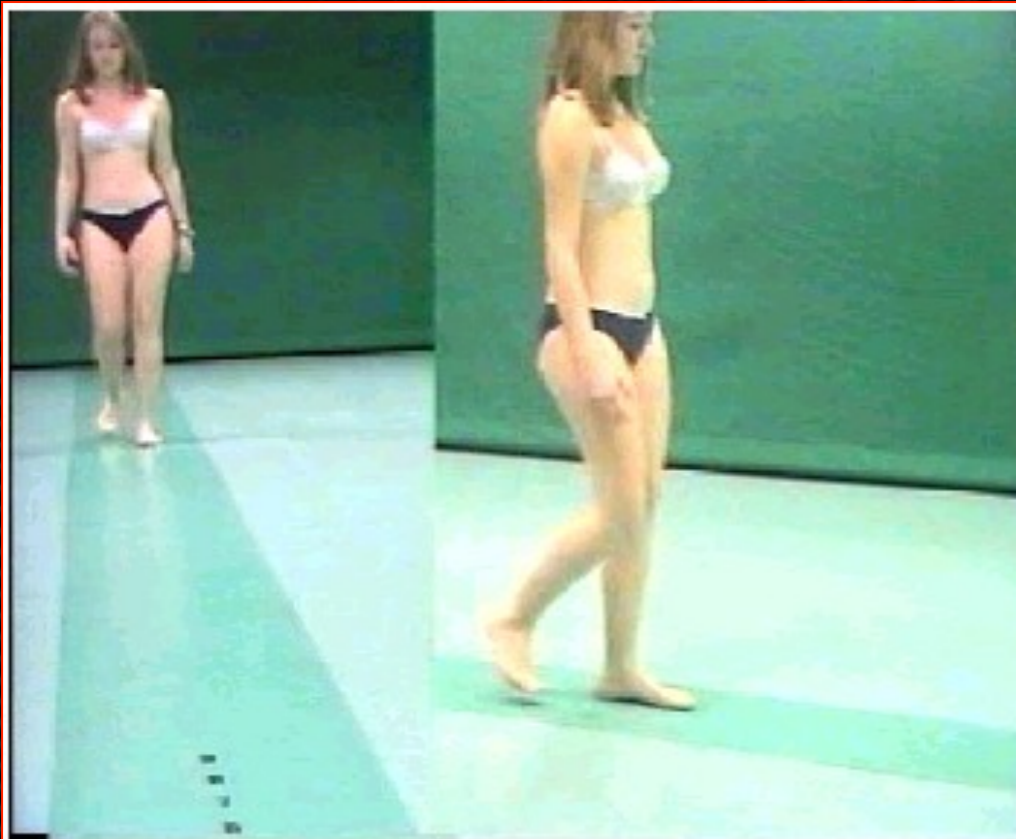
- **MILIEU D'APPUI**
- **FIN D'APPUI**

# INTERPRETATION FONCTIONNELLE



•PHASE PRE OSCILLANTE

# INTERPRETATION FONCTIONNELLE



**DEBUT PHASE OSCILLANTE**

**FIN PHASE OSCILLANTE**



VERBODEN TE WALKEN (en AR chéville, en AV  
hanche)

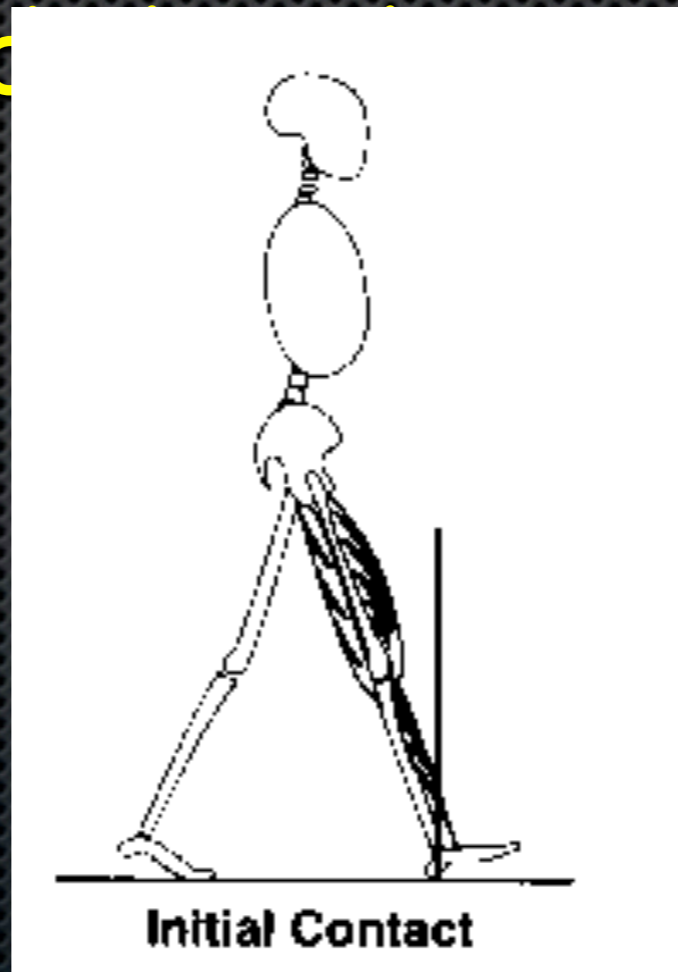
Progression douce et déccélération corporeale

GF contrôle le moment ext de flexion de  
hanche

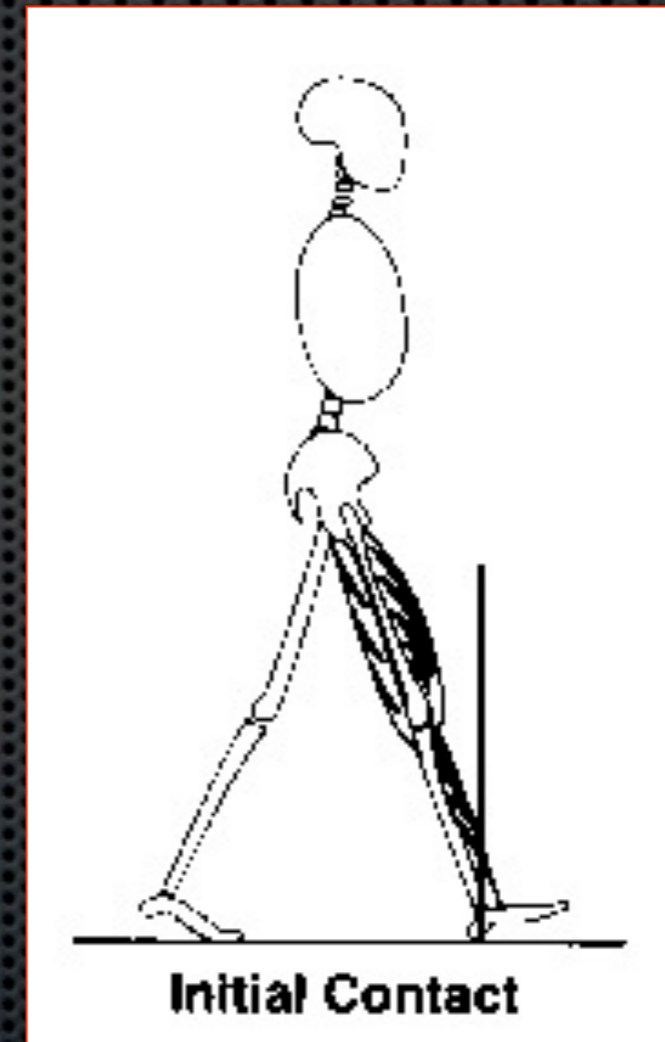
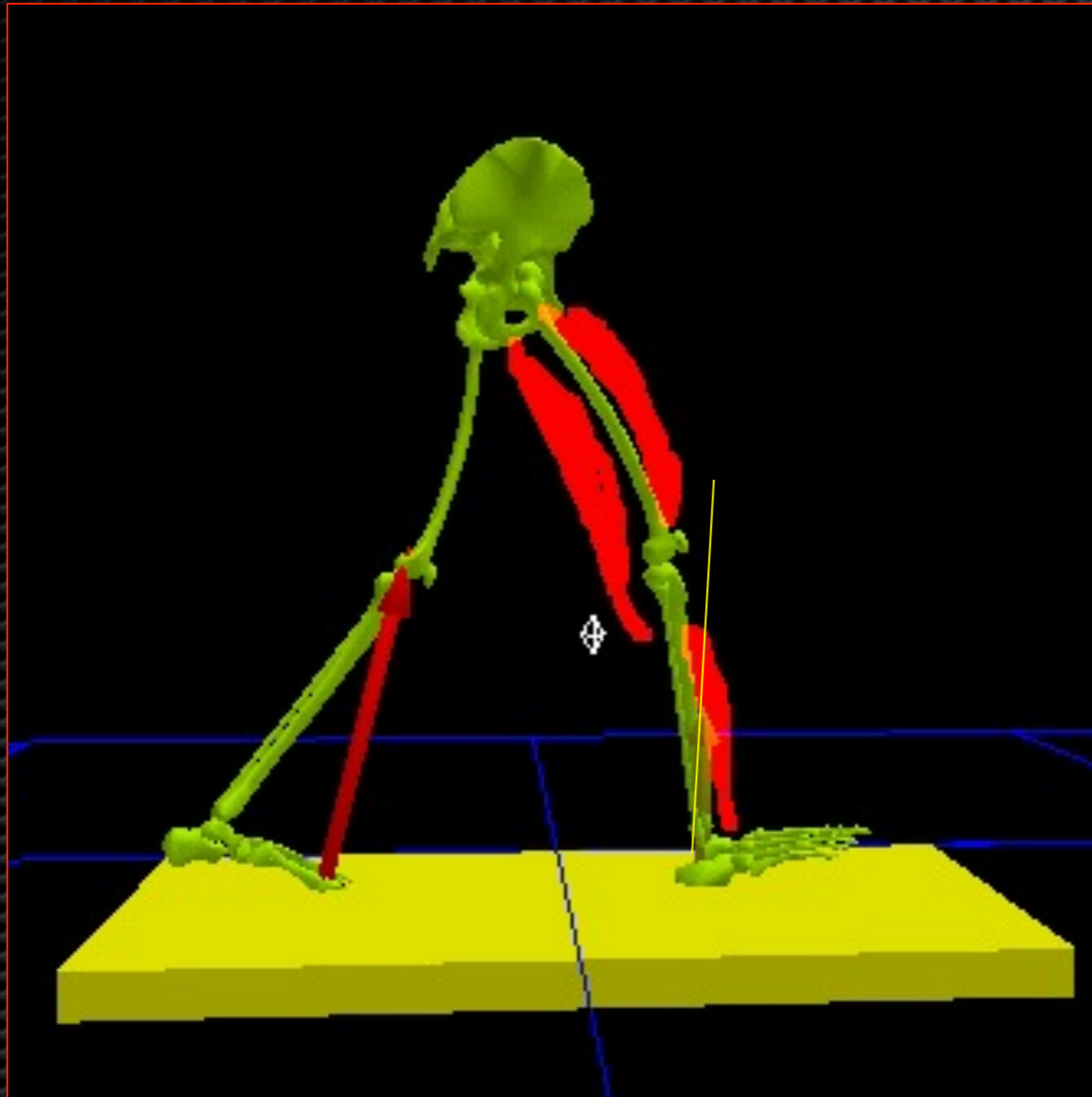
IJ évitent hyperextension de genou & flexion

Tib Ant évite

al du pied



# INTERPRETATION FONCTIONNELLE GLOBALE



# MISE EN CHARGE ( Loading response)

3 - 10%

VFR en AR cheville, en AR genou, en AV hanche

Puissance fournie par la hanche

Activité musculaire:

IJ déverrouillage genou (concentrique)

GF avance tronc au dessus fémur (concentrique)

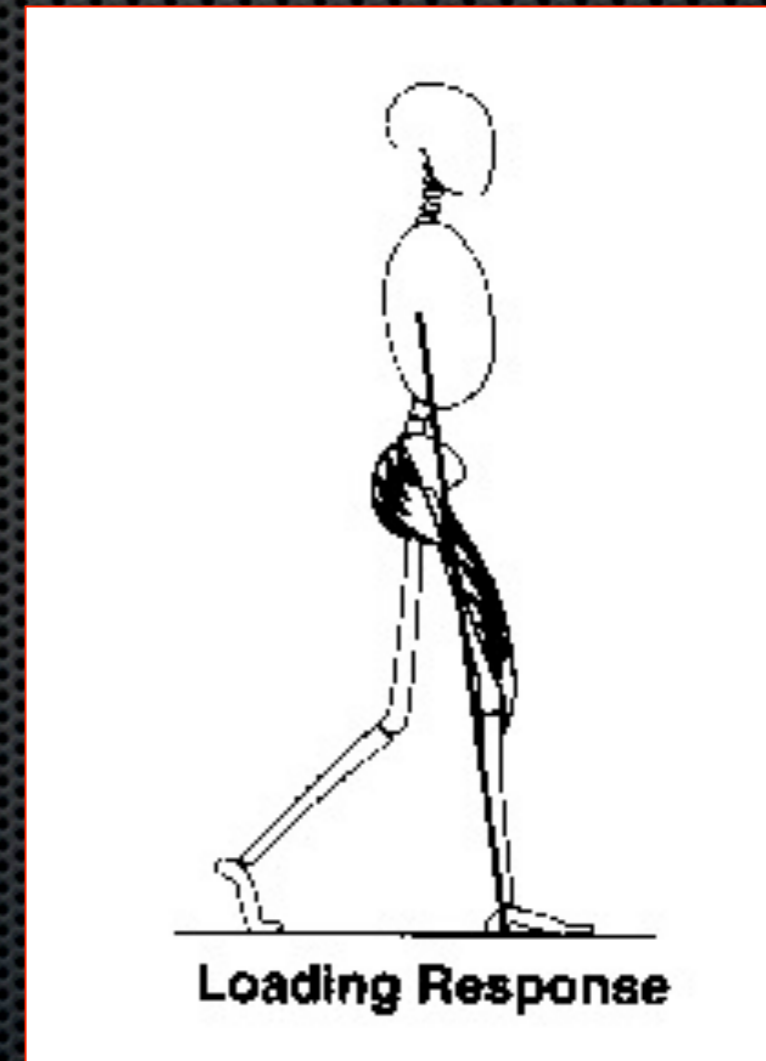
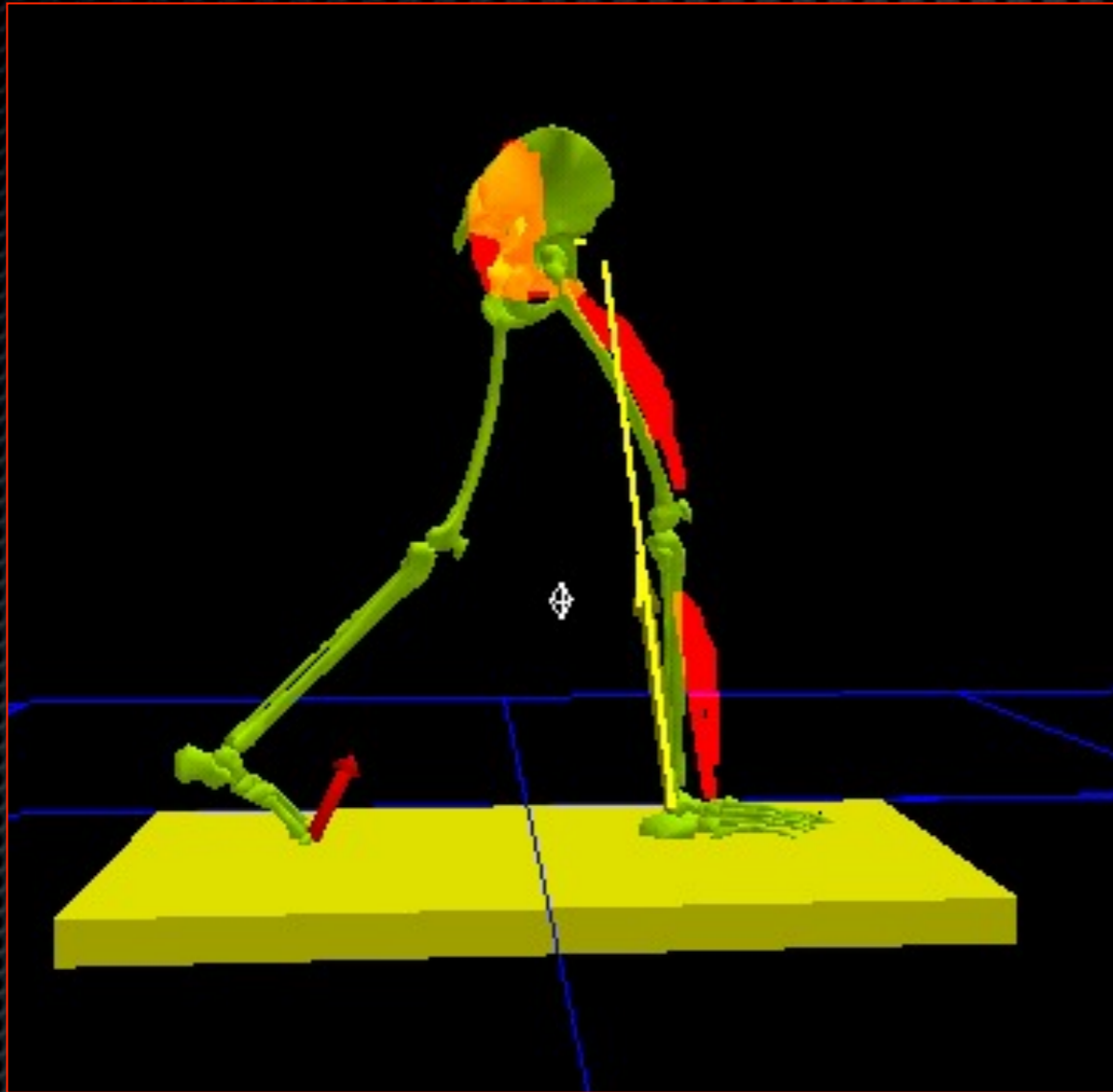
G ADD avance et tourne bassin en dedans

MF stabilise bassin (excentrique)

Q amortit (excentrique)

TA amortit (excentrique)

# INTERPRETATION FONCTIONNELLE GLOBALE



# MILIEU D'APPUI 10 - 30%

VFR par le genou puis en AV, par la hanche,  
en AV cheville

Pas de puissance par la hanche et le genou  
Avancée régulière au dessus du pied stable et fixe

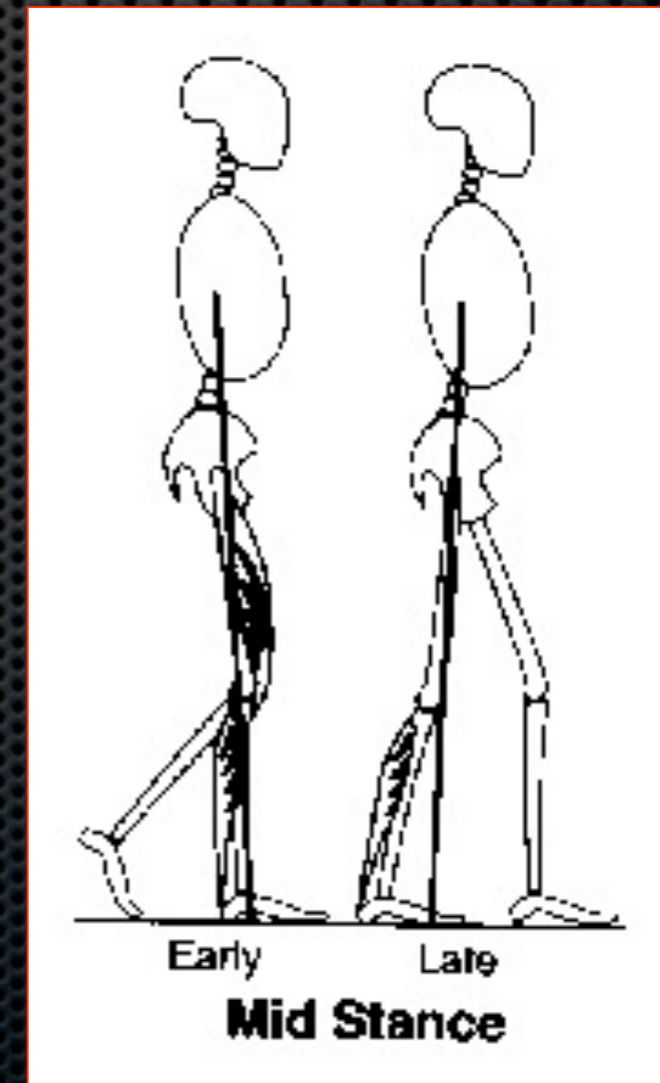
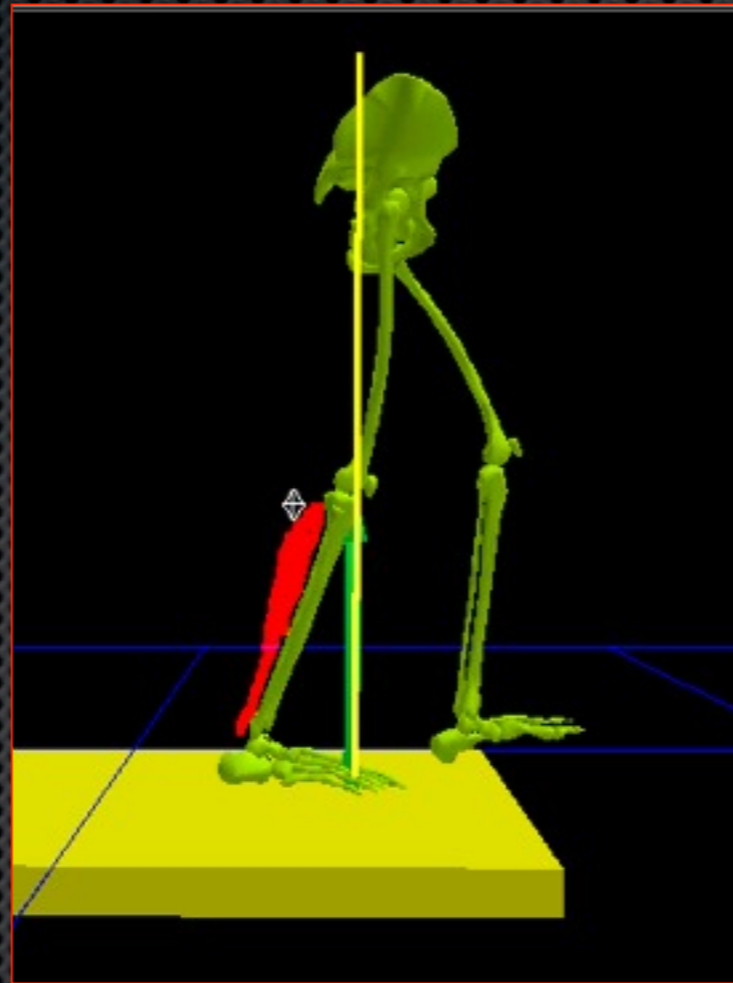
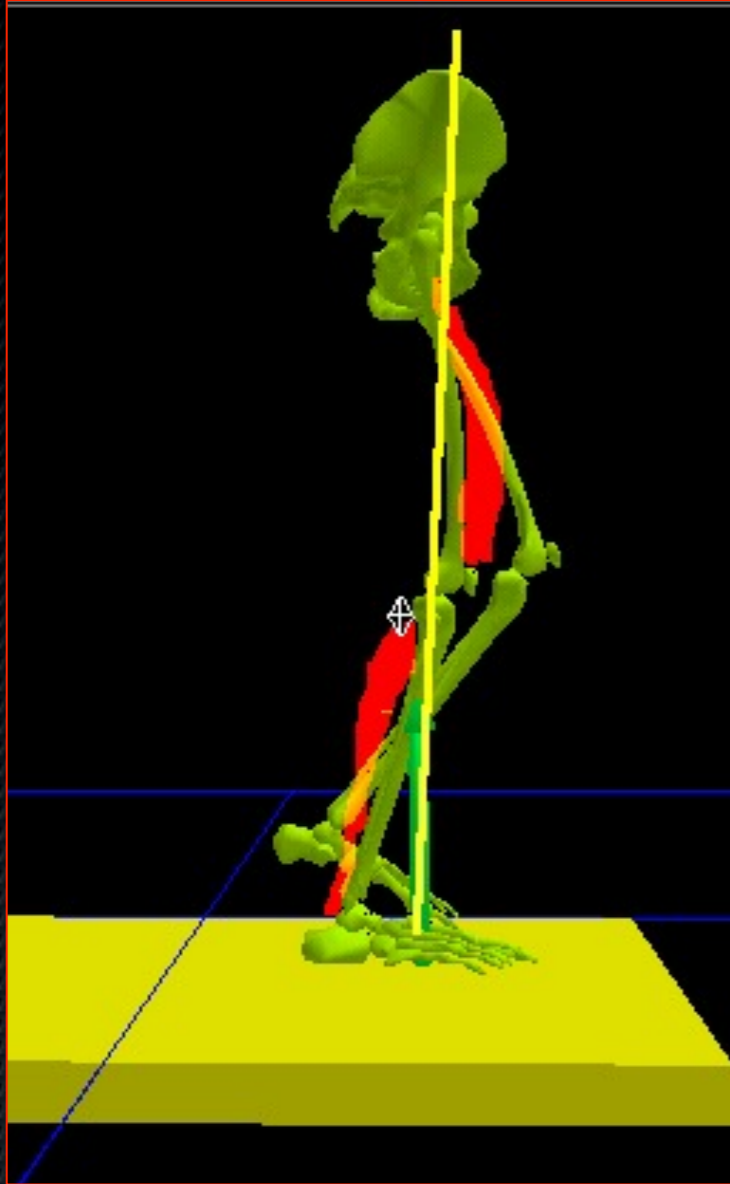
Contrôle du VFR par le triceps

Activité musculaire:

Soléaire freine avancée du tibia (excentrique)

Q stabilise au début puis cesse

# INTERPRETATION FONCTIONNELLE GLOBALE



# FIN D'APPUI 30 - 50%

VFR en AV cheville, par genou et hanche

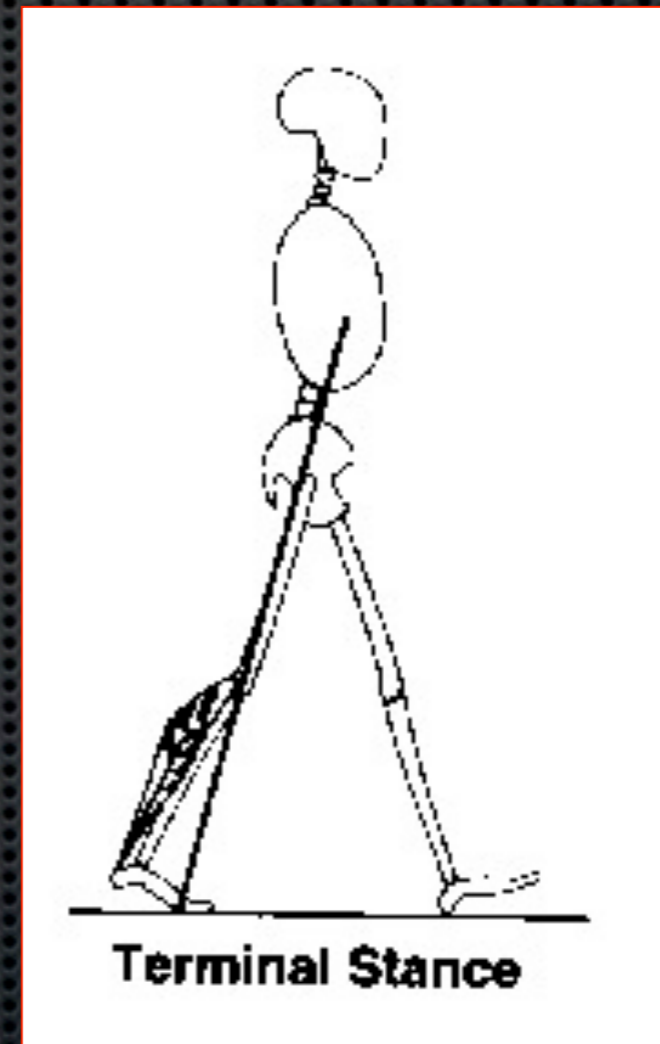
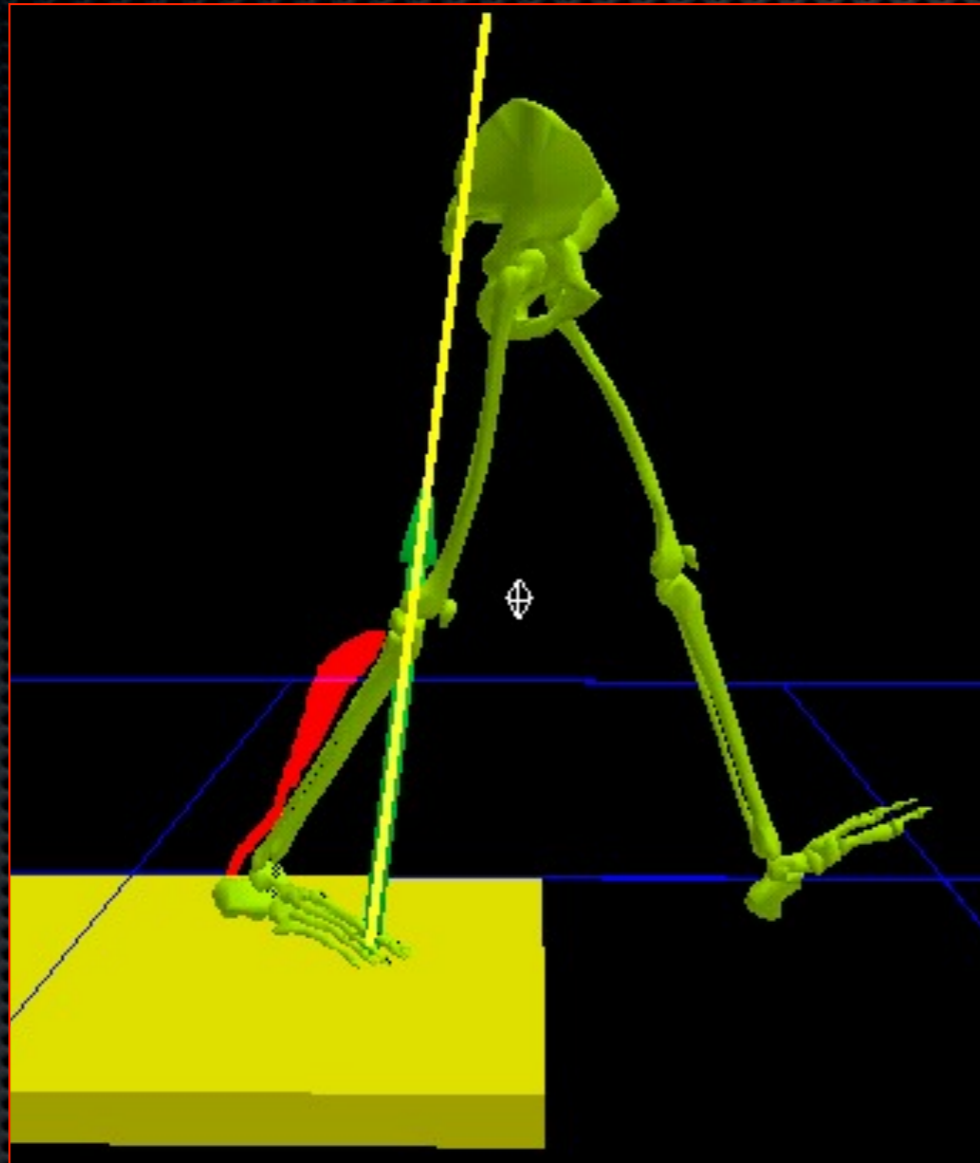
Bascule autour de l'avant pied (centre de masse en AV du point d'appui)

Renforcement activité triceps (excentrique)

Activité Péroniers et Tib Post

Activité Fléchisseur gros orteil

# INTERPRETATION FONCTIONNELLE GLOBALE





# PRE OSCILLANTE 50 -60%

VFR passe en AR genou ++++

(Avancée du tibia du fait du passage en équin  
facilitée par le transfert du poids du corps)

Activité du triceps (concentrique)

Puissance de cheville ++++

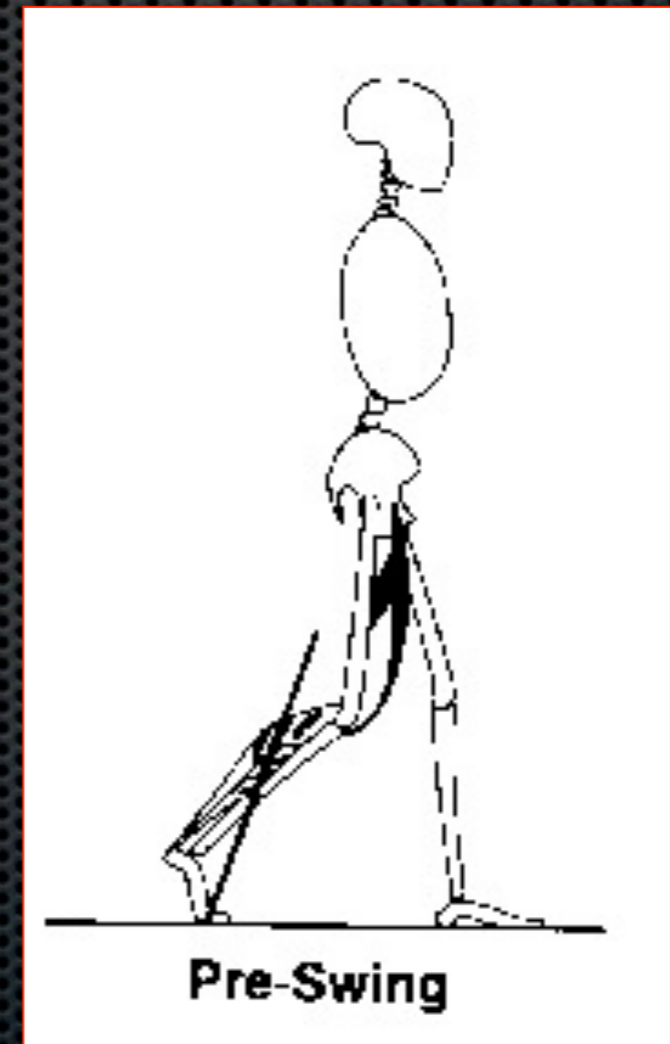
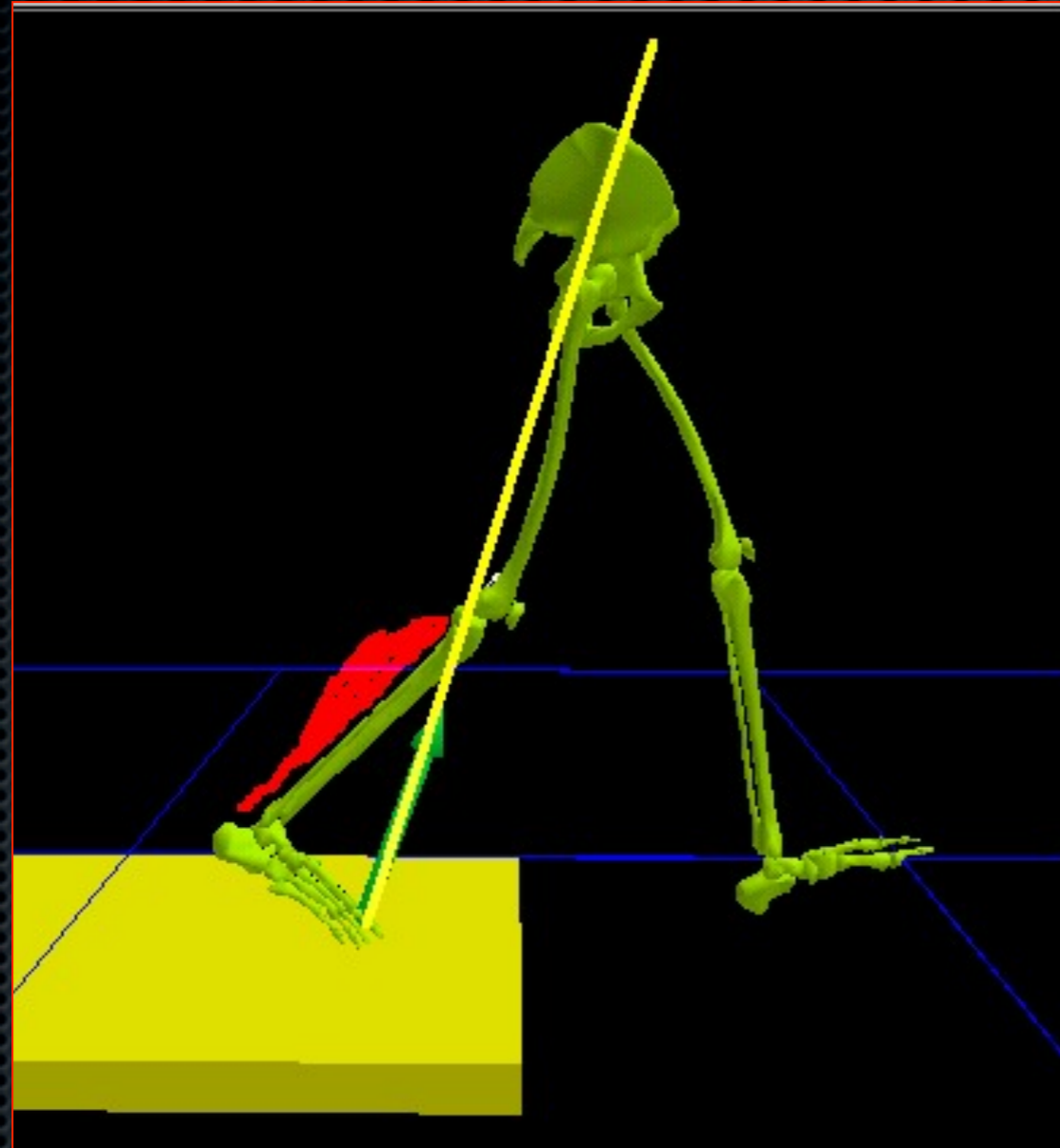
Activité Moy ADD fait avancer la cuisse

Activité Rectus Femoris

Accélère flexion de hanche (concentrique)

Contrôle flexion de genou (excentrique)

# INTERPRETATION FONCTIONNELLE GLOBALE



# DEBUT PHASE OSCILLANTE 60 - 73%

Muscles varient cadence et assurent liberté du pas

Activité fléchisseurs de hanche

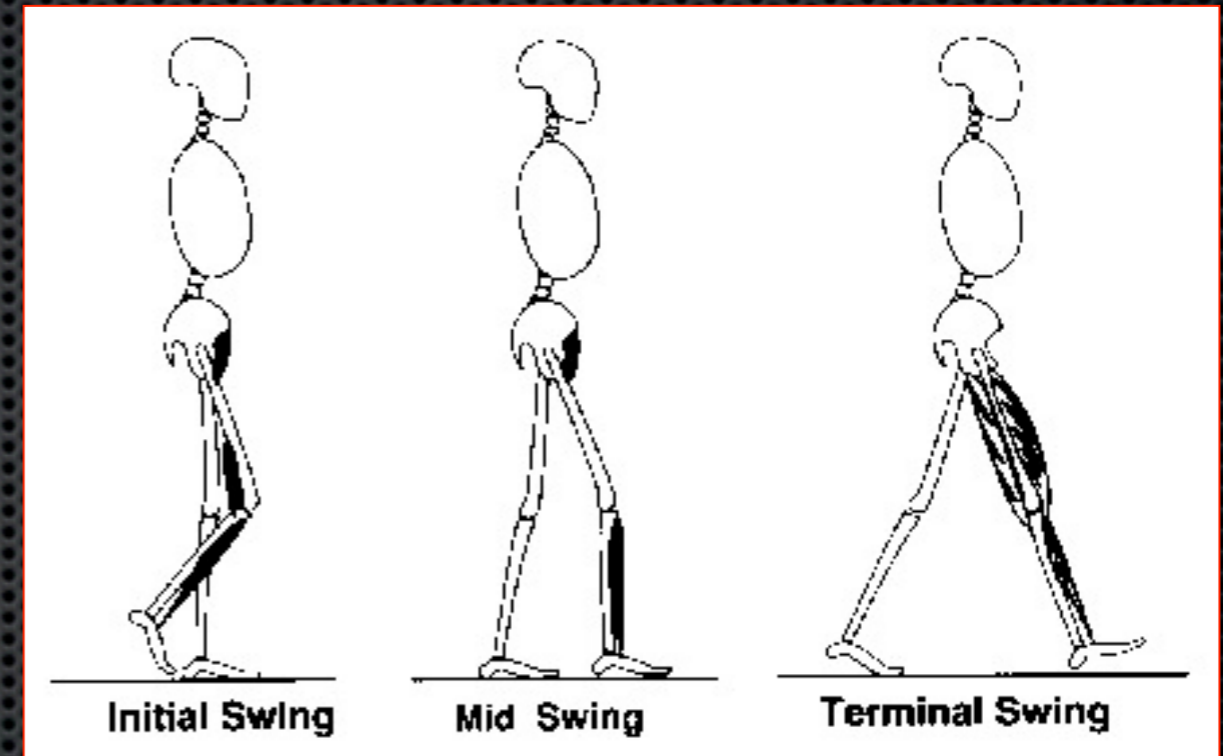
Puissance fournie par la hanche

Flexion de genou automatique (inertie de la jambe)

Activité Tib Ant

Activité courte portion biceps (vitesse lente)

# INTERPRETATION FONCTIONNELLE GLOBALE



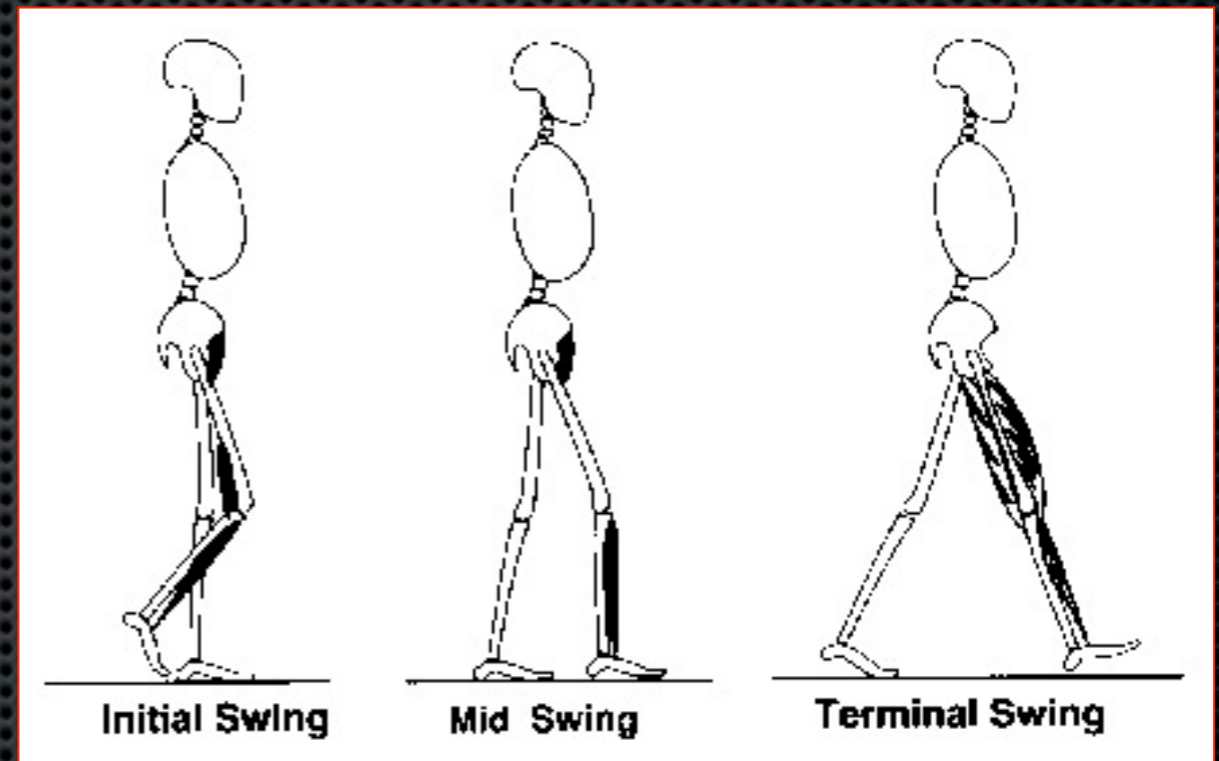
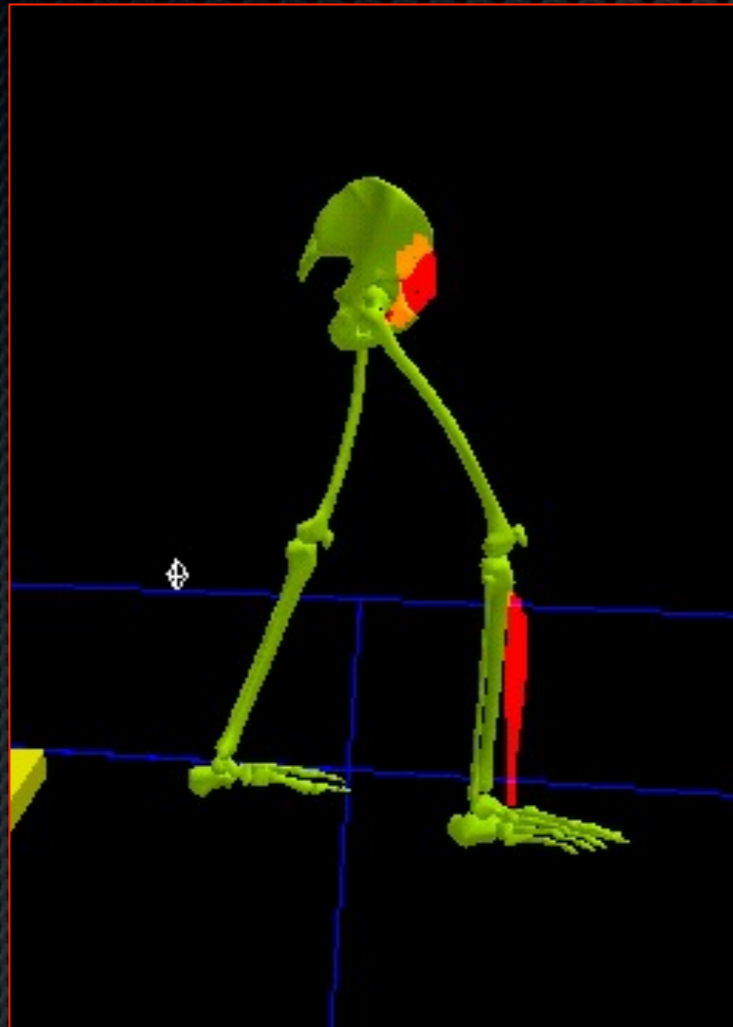
# MILIEU PHASE OSCILLANTE 73 - 86%

Pratiquement pas d'activité musculaire

Maintien de la cheville par Tib Ant

Force d'inertie propulse le membre inférieur

# INTERPRETATION FONCTIONNELLE GLOBALE



# FIN PHASE OSCILLANTE 86 - 100%

Deccélération flexion de hanche

Deccélération extension genou

Contrôle musculaire de la fin de phase oscillante

Préparation au contact initial

Activité musculaire

Fléchisseurs de hanche = 0

IJ freinent hanche et genou

Tib Ant maintient cheville

Q se prépare.....

# INTERPRETATION FONCTIONNELLE GLOBALE

