10 things you need to know about ROTEM

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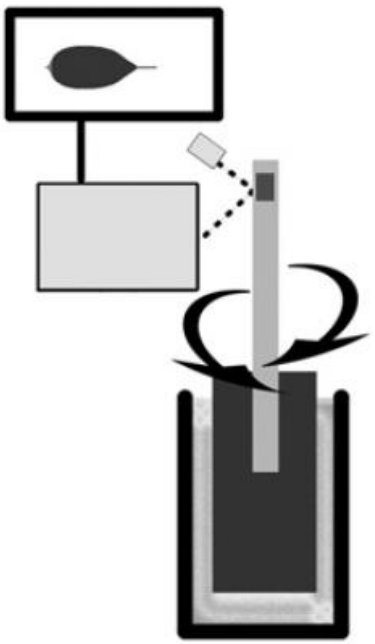
rotational thromboelastometry

rotem

It’s been around for a while

History



—First introduced in 1948

—Predates the PTT

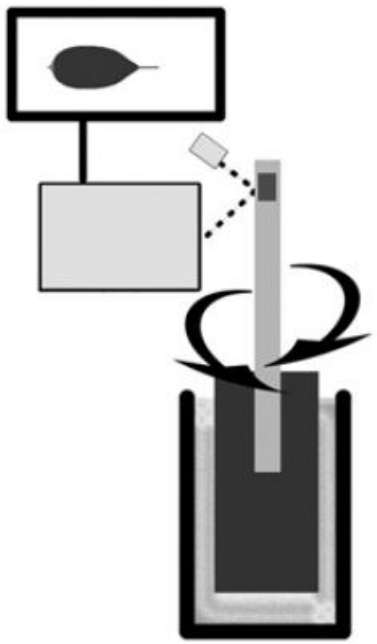
—Major methodological improvements have converted it from a research test to a rapid and simple POCT

—ROTEM recently licensed for use in the US and Canada

—Decade of use in Europe

It’s faster

Speed



—No transport time

—It's such a simple test that even a surgeon could do it

—It's small

—The test uses whole blood

—You can make decisions 10 minutes after ROTEM starts running


1
2
3
4

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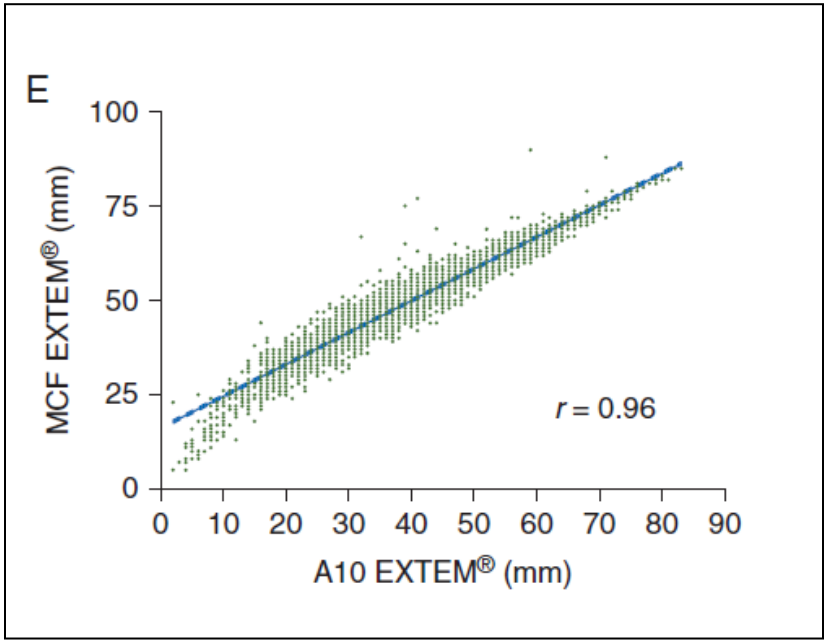
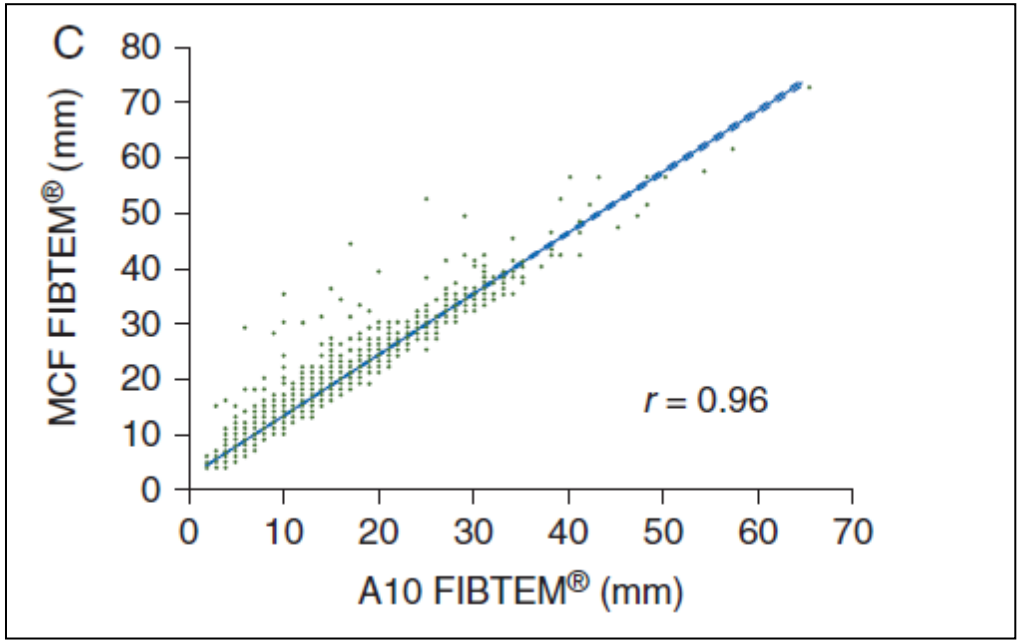
Fast interpretation of thromboelastometry in non-cardiac surgery: reliability in patients with hypo-, normo-, and hypercoagulability

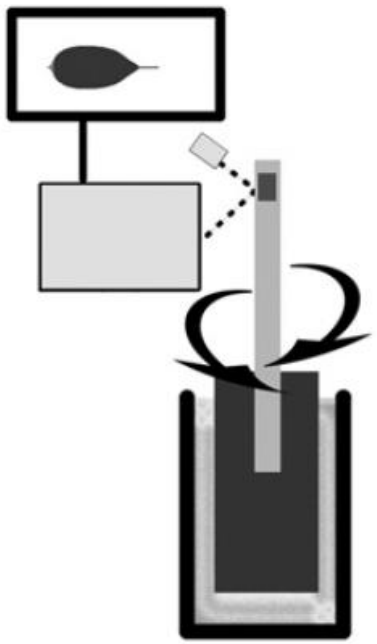
K. Görlinger[1*†], D. Dirkmann[1†], C. Solomon[2] and A. A. Hanke[3]





The design is simple

Design

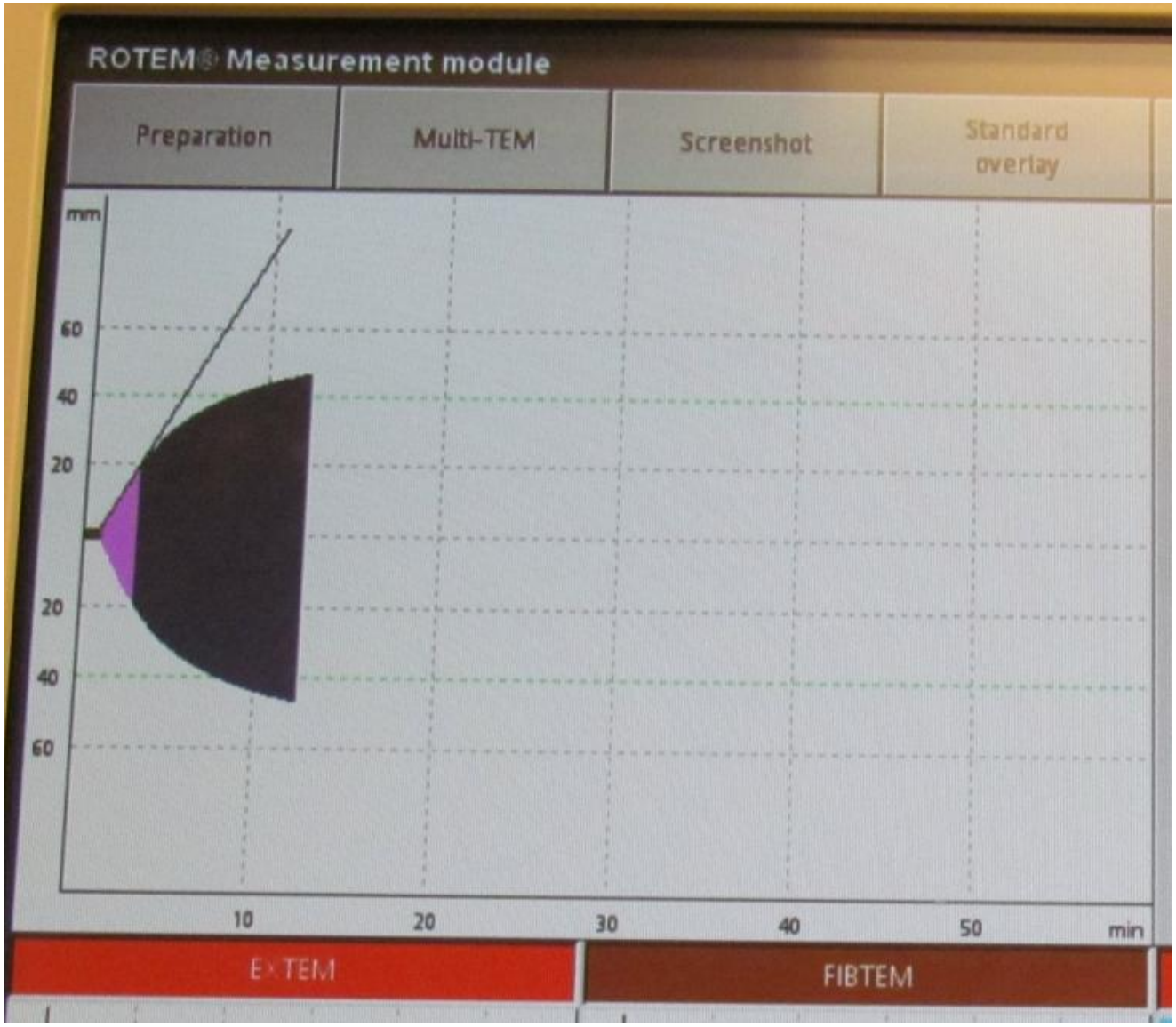


—Whole blood placed in a cuvette

—Plastic pin rotates back and forth at an angle of 4.75

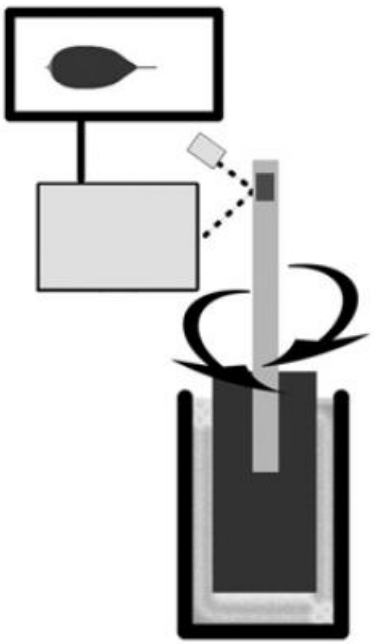
—As the clot forms, the pin is pulled by fibrin strands creating torque on the pin

—The torque is measured optically and presented to the operator as a clot tracing


ROTEM® Measurement module
Preparation
Multi-TEM
Screenshot
Standard overlay
mm
60
40
20
20
40
60
10
20
30
40
50
min
EXTEM
FIBTEM

Two curves for each patient

EXTEM & FIBTEM

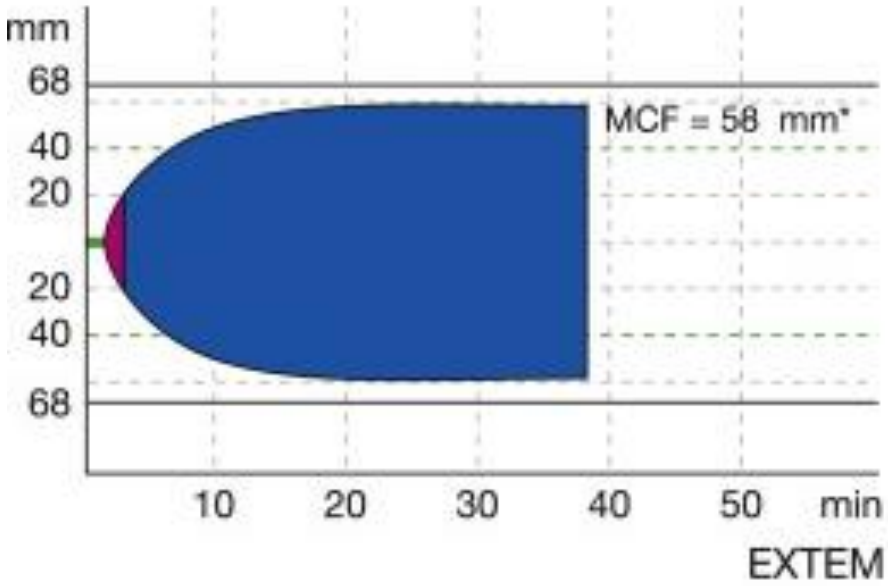


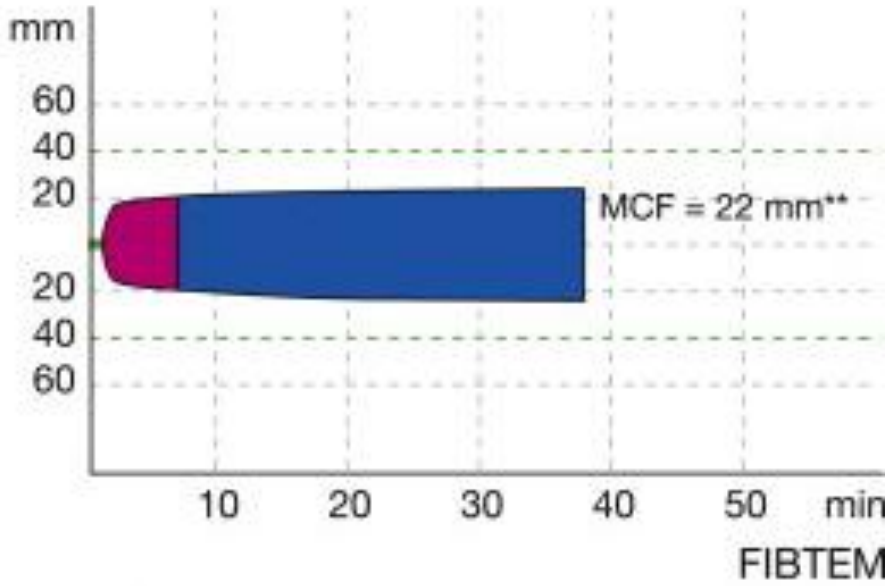
—EXTEM uses tissue factor as its activator (plus $CaCl_2$)

—FIBTEM estimates the extent of fibrin polymerization

  —Platelets paralyzed with cytochalasin-D

  —Same activation system as the EXTEM





B * Reference range: 50–72 mm

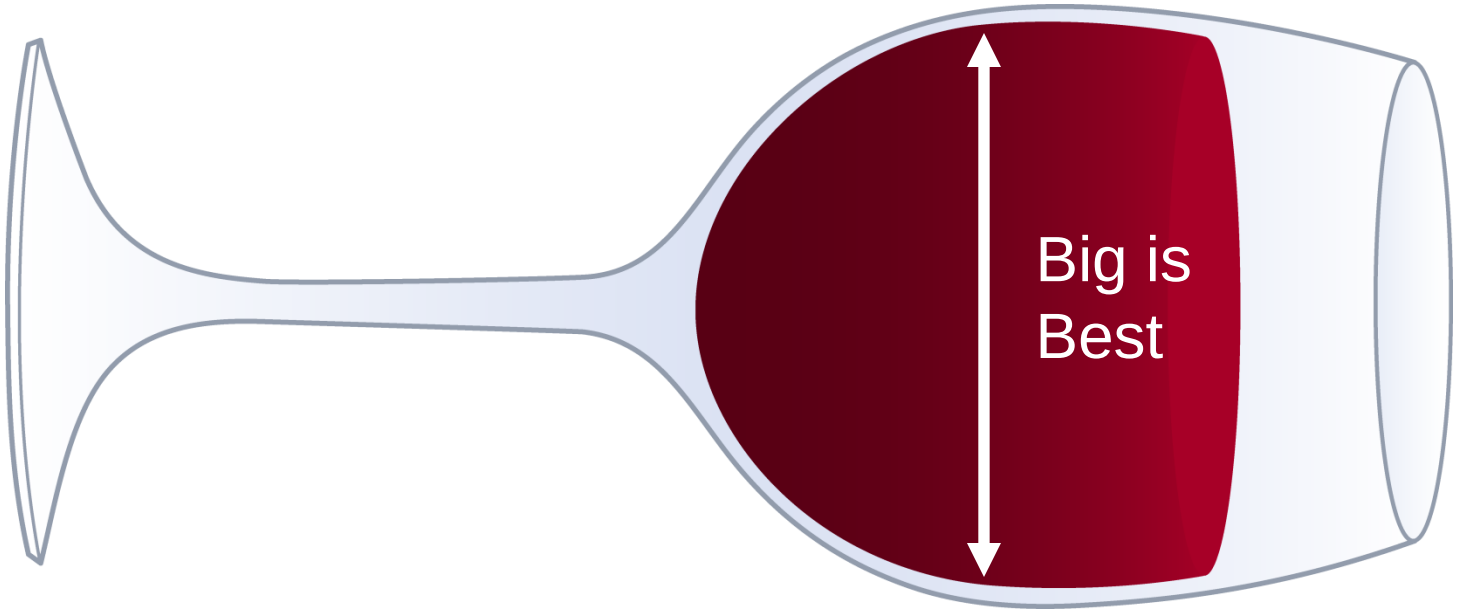
** Reference range: 9–25 mm

The fatness of the curve is called “Maximal clot firmness”

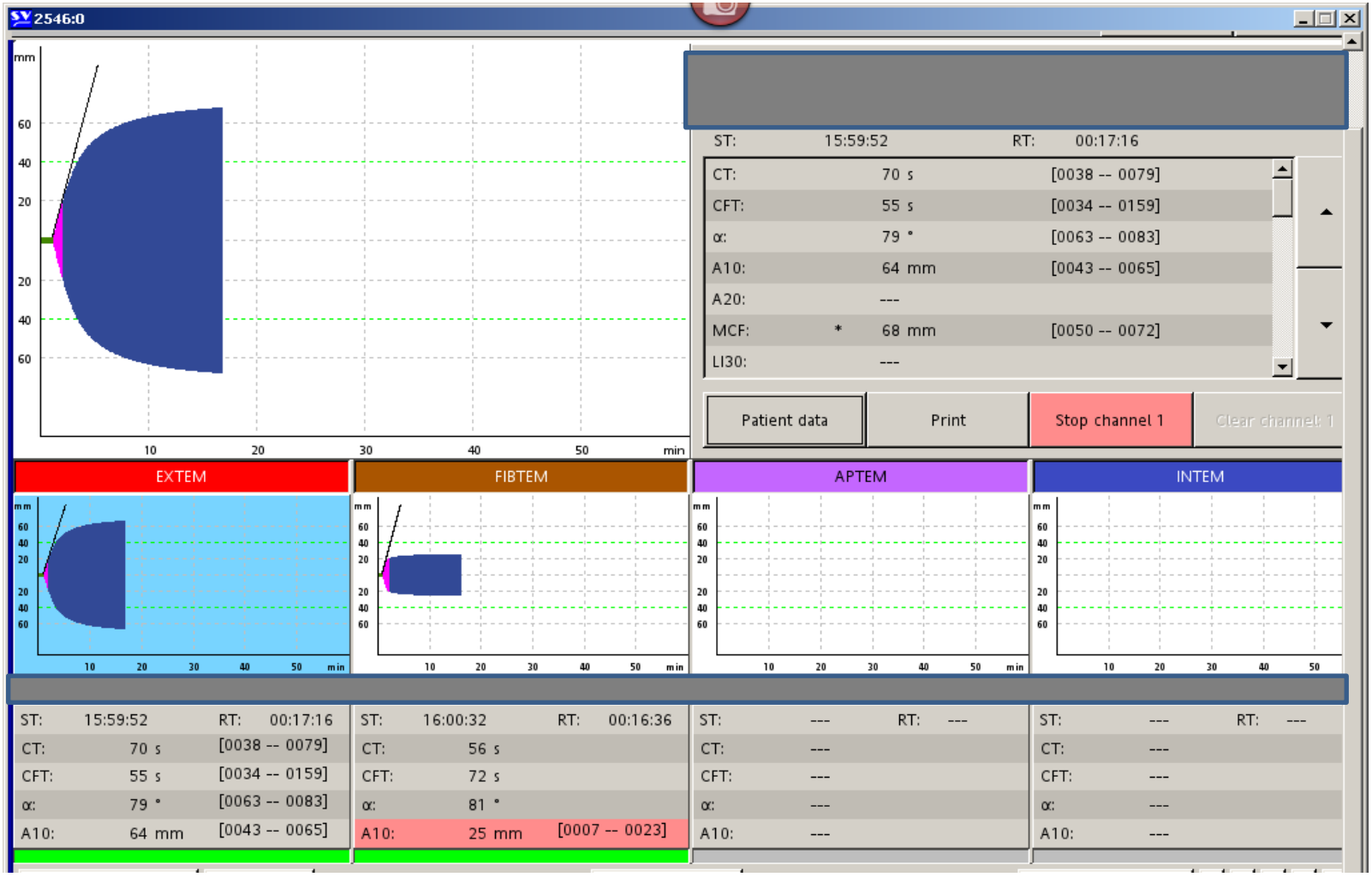
or

“MCF”

Fat is good



What a “normal” “fat” trauma ROTEM curve should look like



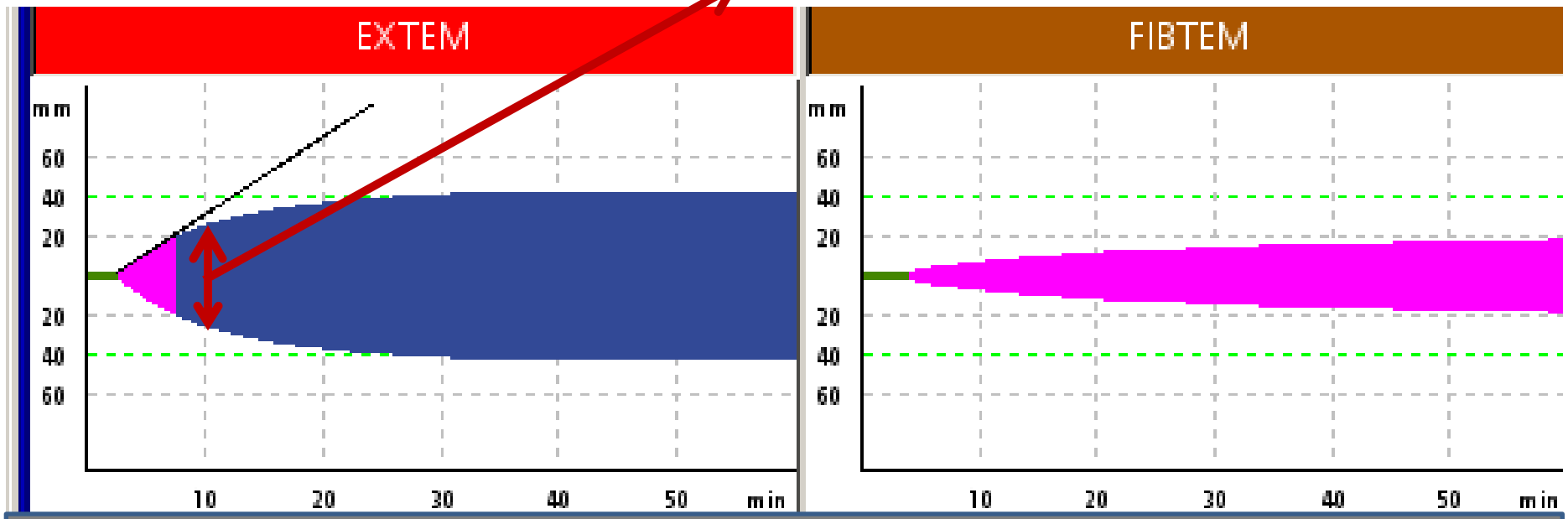
EXTEM MCF estimates functional platelet count [and α angle]

Good correlation between platelet counts and EXTEM MCF

PLT<50

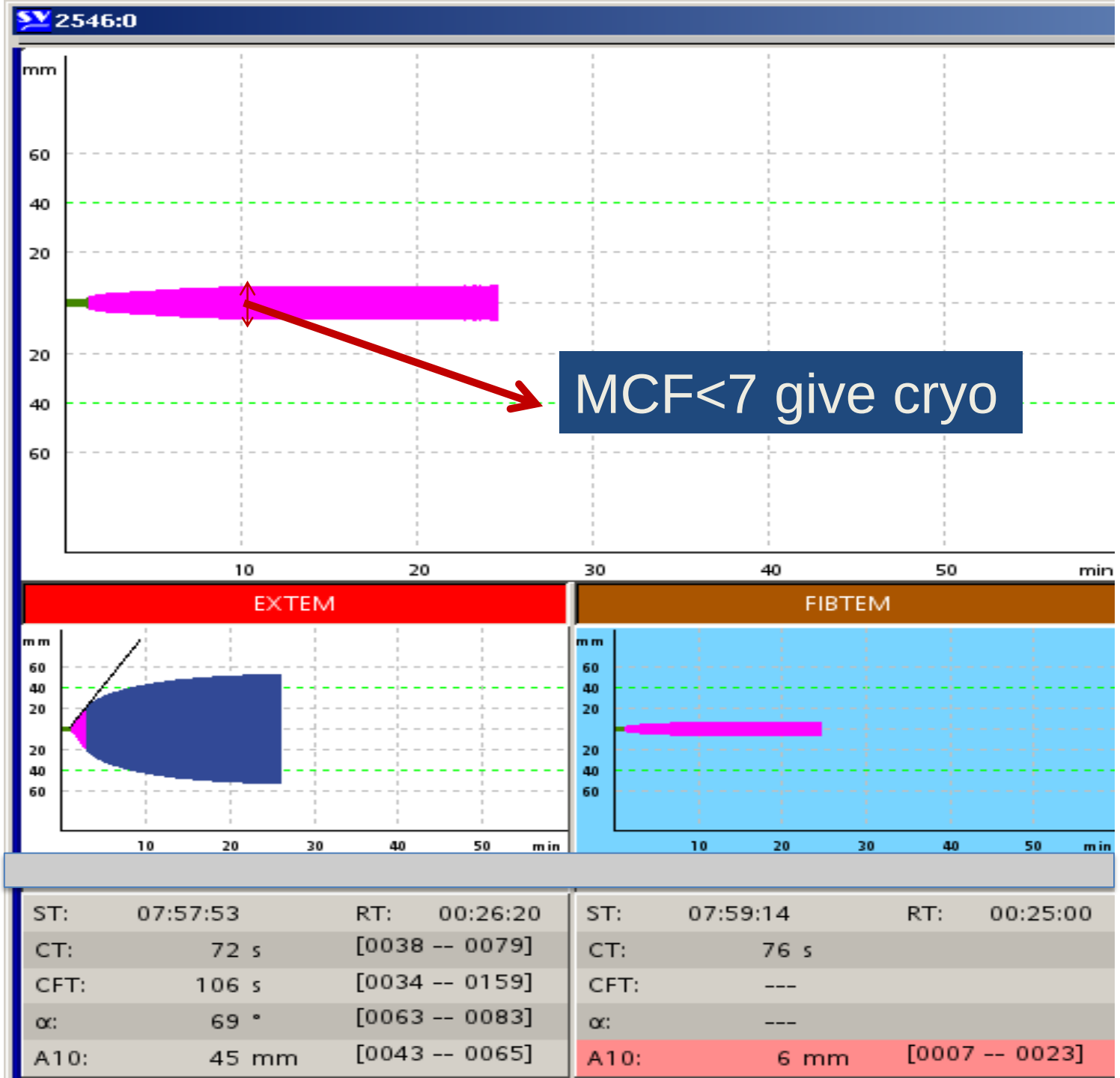
MCF substantially drops

MCF<35 give platelets



ST:	15:38:21	RT:	01:10:58	ST: 15:40:04	RT: 01:09:16
CT:	164 s	[0038 -- 0079]		CT: 248 s	
CFT:	297 s	[0034 -- 0159]		CFT: ---	
α:	45 °	[0063 -- 0083]		α: ---	
A10:	30 mm	[0043 -- 0065]		A10: 9 mm	[0007 -- 0023]

Fibrinogen estimated by FIBTEM MCF

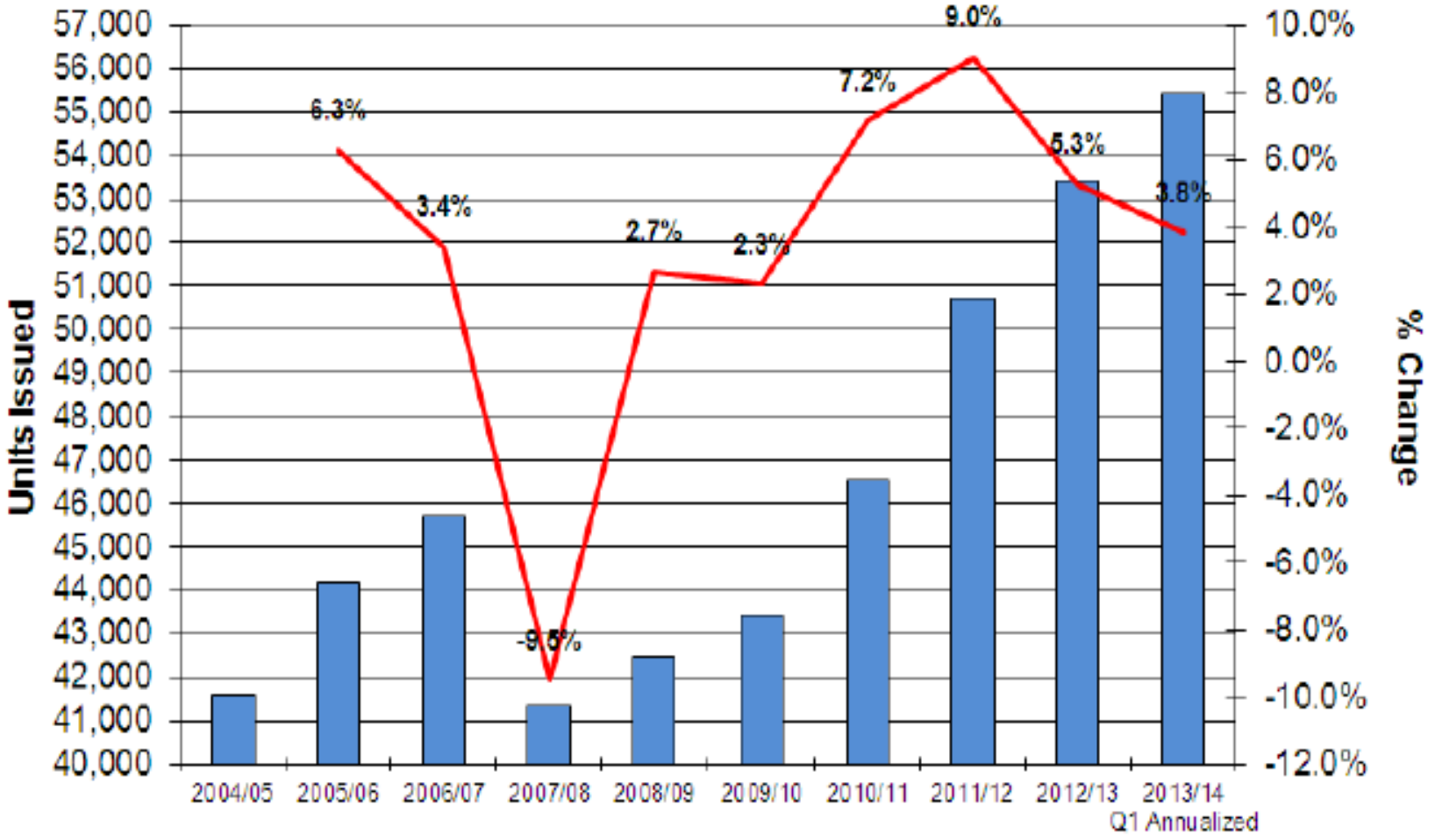

2546:0
mm
60
40
20
20
40
60
10
20
30
40
50
min
MCF<7 give cryo
EXTEM
FIBTEM
ST: 07:57:53 RT: 00:26:20
CT: 72 s [0038 -- 0079]
CFT: 106 s [0034 -- 0159]
α: 69 ° [0063 -- 0083]
A10: 45 mm [0043 -- 0065]
ST: 07:59:14 RT: 00:25:00
CT: 76 s
CFT: ---
α: ---
A10: 6 mm [0007 -- 0023]

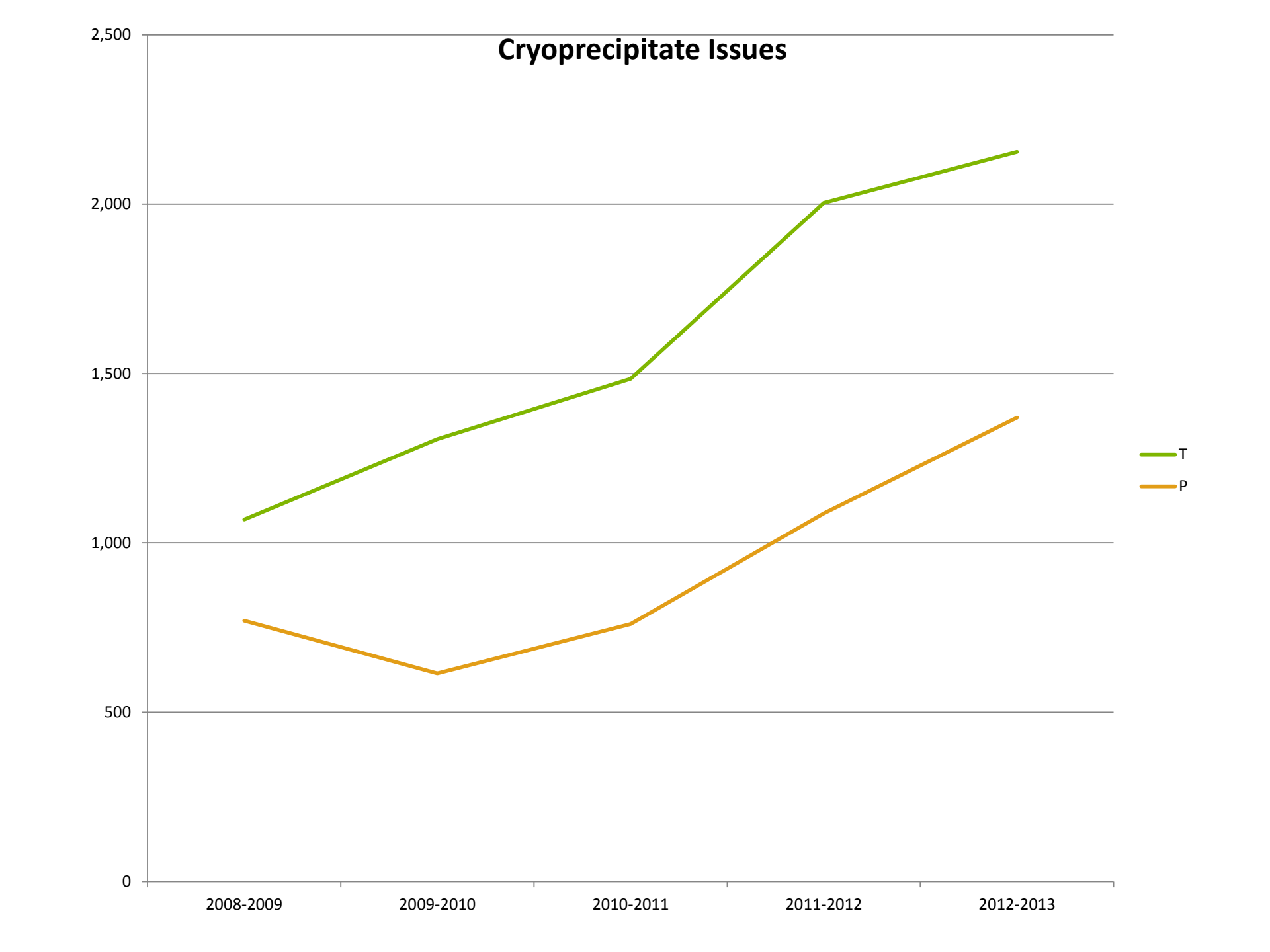
Correlation between Clauss fibrinogen and MCF on FIBTEM is

r=0.909

Theusinger, et al. Anesth Analg 2013;117:314–21

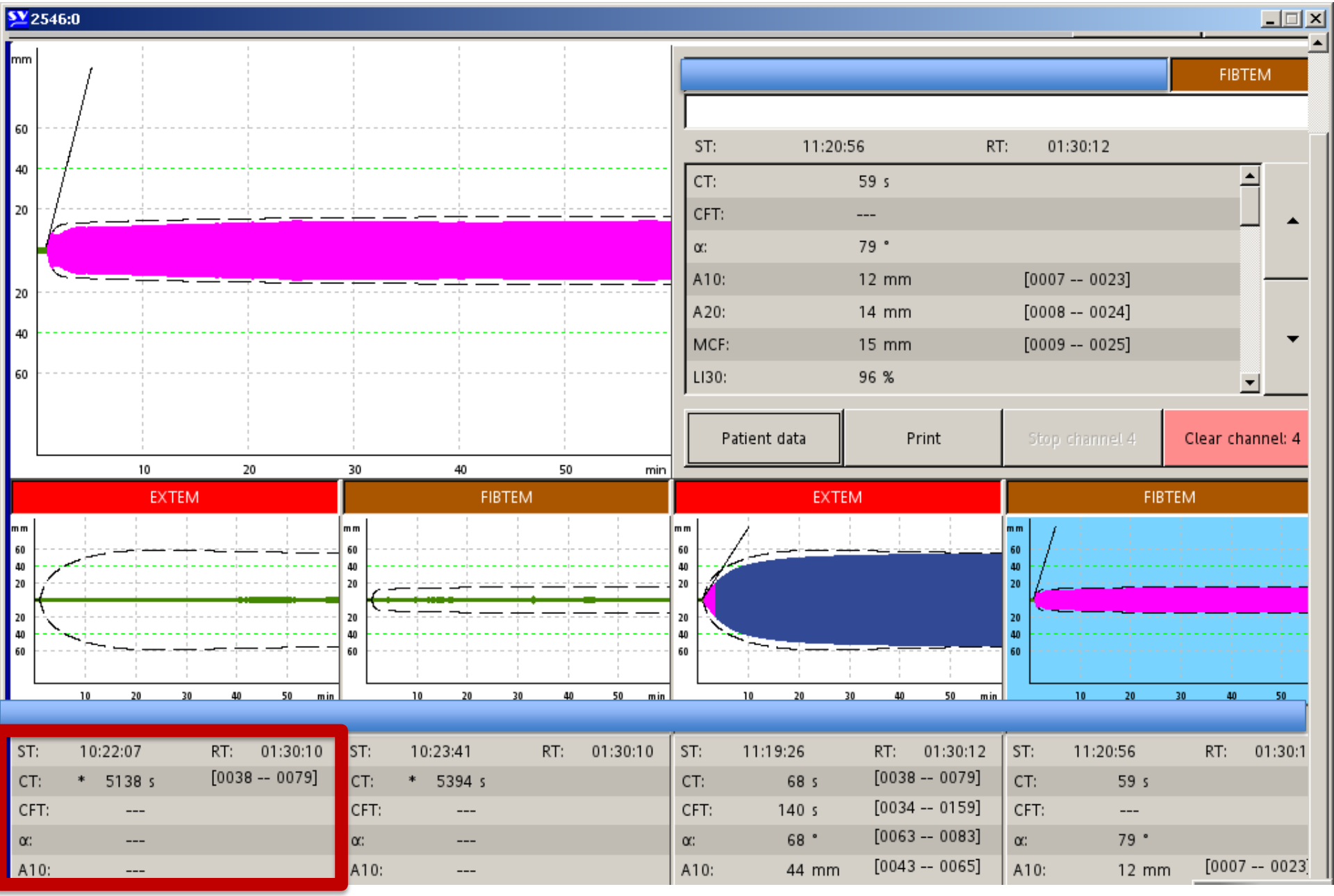
Cryoprecipitate Units Issued & Fiscal Period Growth Rates

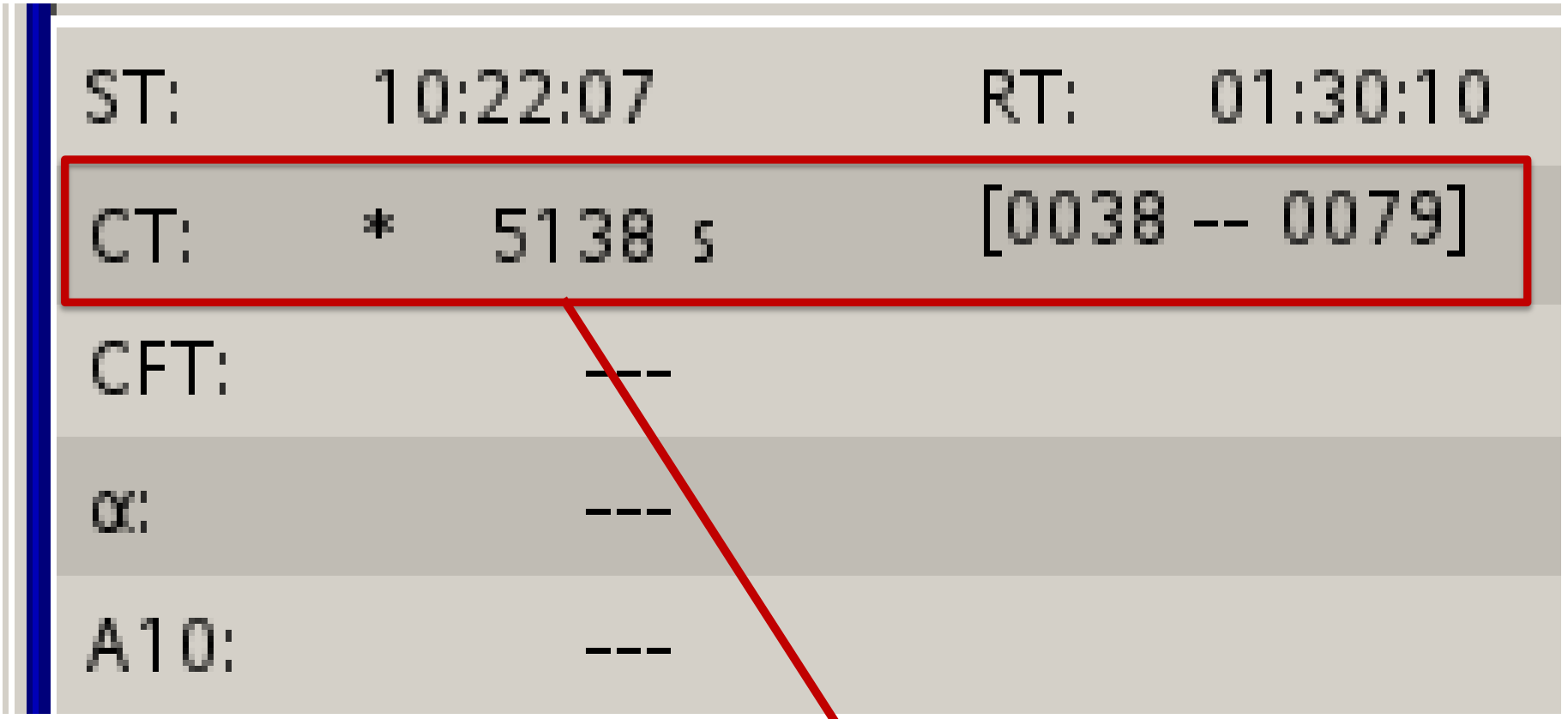



Cryoprecipitate Issues
2,500
2,000
1,500
1,000
500
0
2008-2009
2009-2010
2010-2011
2011-2012
2012-2013
T
P

7

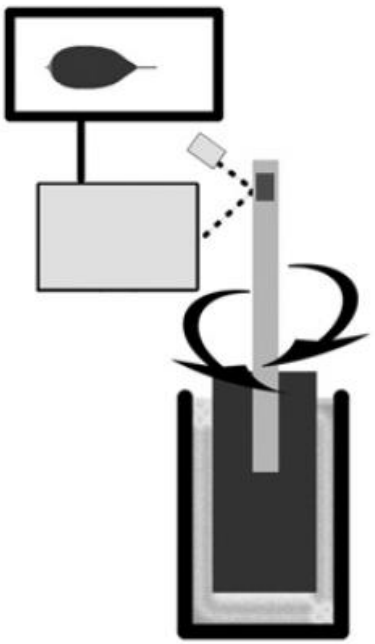
CT used to estimate clotting factors


2546:0
mm
60
40
20
20
40
60
10
20
30
40
50
min
FIBTEM
ST: 11:20:56 RT: 01:30:12
CT: 59 s
CFT: ---
α: 79 °
A10: 12 mm [0007 -- 0023]
A20: 14 mm [0008 -- 0024]
MCF: 15 mm [0009 -- 0025]
LI30: 96 %
Patient data
Print
Stop channel 4
Clear channel: 4
EXTEM
FIBTEM
EXTEM
FIBTEM
ST: 10:22:07 RT: 01:30:10
CT: * 5138 s [0038 -- 0079]
CFT: ---
α: ---
A10: ---
ST: 10:23:41 RT: 01:30:10
CT: * 5394 s
CFT: ---
α: ---
A10: ---
ST: 11:19:26 RT: 01:30:12
CT: 68 s [0038 -- 0079]
CFT: 140 s [0034 -- 0159]
α: 68 ° [0063 -- 0083]
A10: 44 mm [0043 -- 0065]
ST: 11:20:56 RT: 01:30:1
CT: 59 s
CFT: ---
α: 79 °
A10: 12 mm [0007 -- 0023


ST: 10:22:07 RT: 01:30:10
CT: * 5138 s [0038 -- 0079]
CFT: ---
α: ---
A10: ---
CT>100 give plasma

It detects hyperfibrinolysis

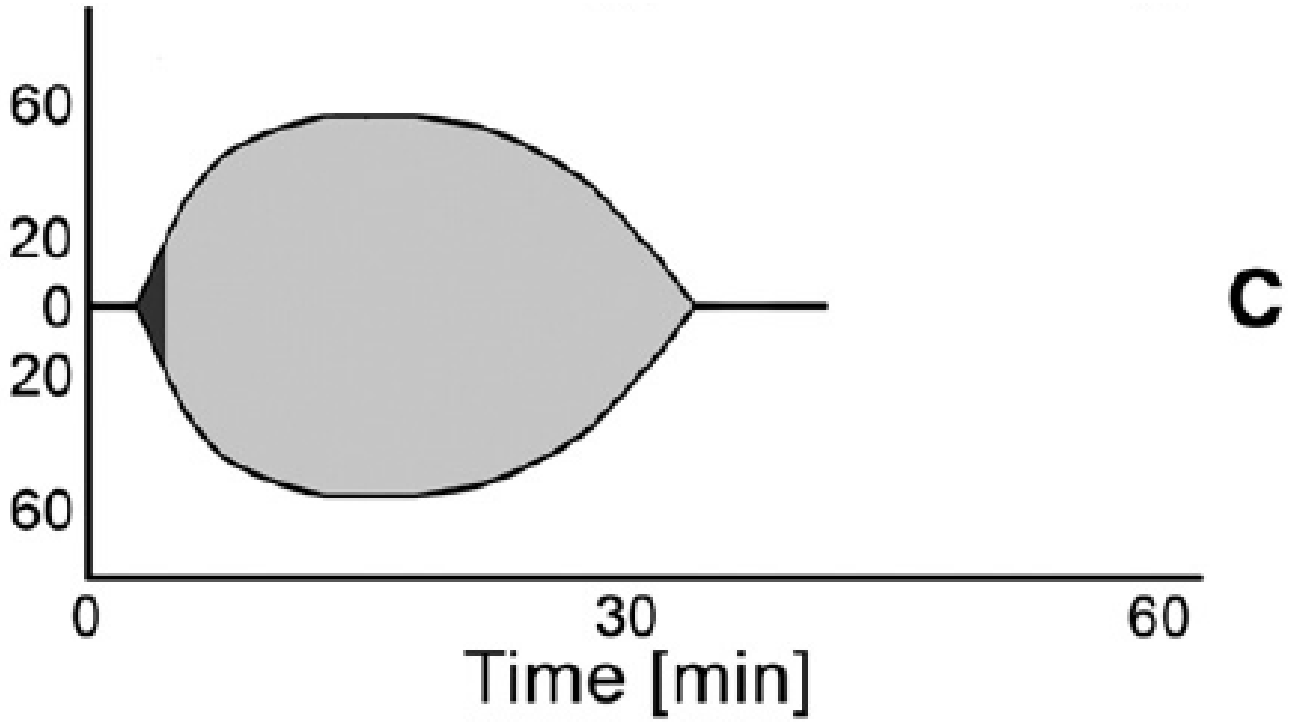
Hyperfibrinolysis



—Approximately 10% of trauma patients will have hyperfibrinolysis detected on ROTEM

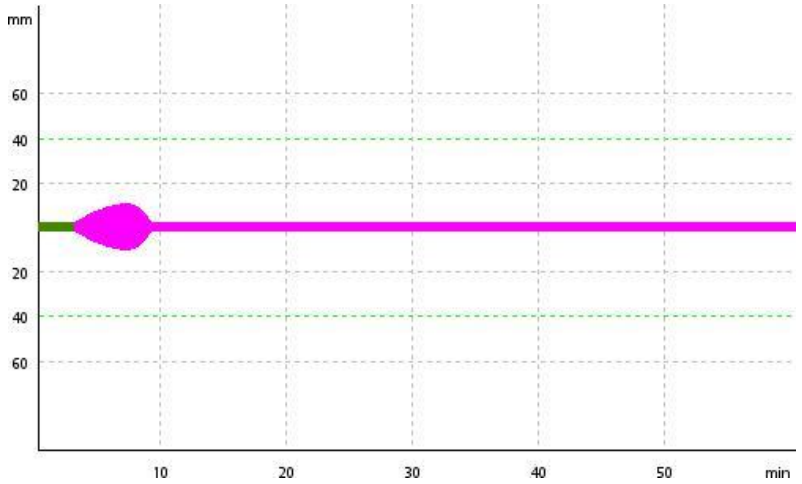
—Only detectable when plasmin-antiplasmin complexes >30x normal

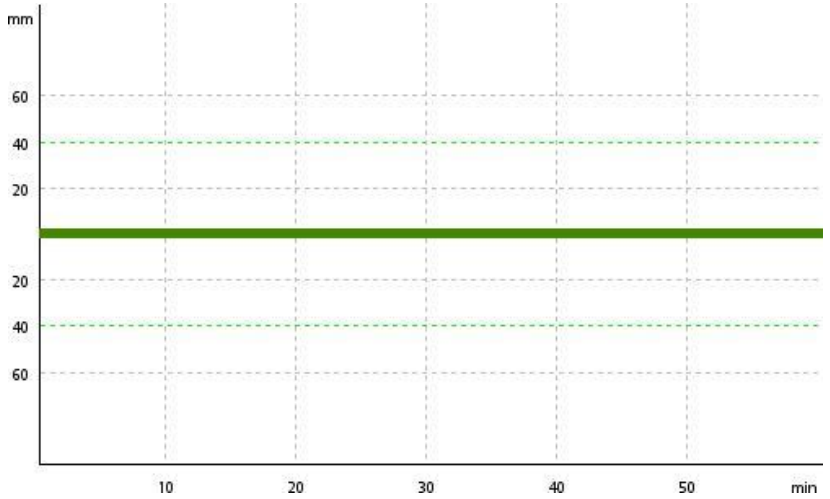
—In trauma patients t-PA is released from PAI-1 allowing conversion of plasminogen to plasmin


60
20
0
20
60
0
30
60
Time [min]
C

Jogger struck by SUV
Air lifted, severe pelvic fracture

Tranexamic acid 1 + 1 gram given per protocol

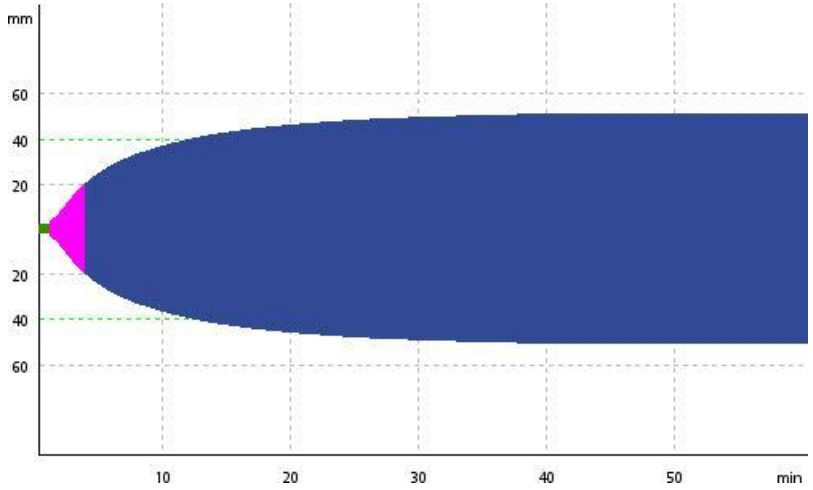


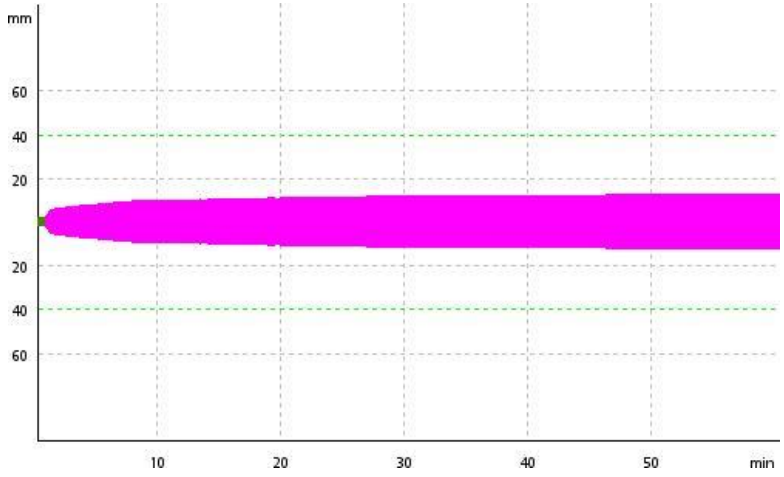


EXTEM on arrival
MCF 10 mm
Clot lysis at 30 min 0%

FIBTEM on arrival
No clot
[INR 2.9, fibrinogen 0.29]

4 more grams of tranexamic acid
8 units of FFP, 2 doses of platelets, & 10 cryo

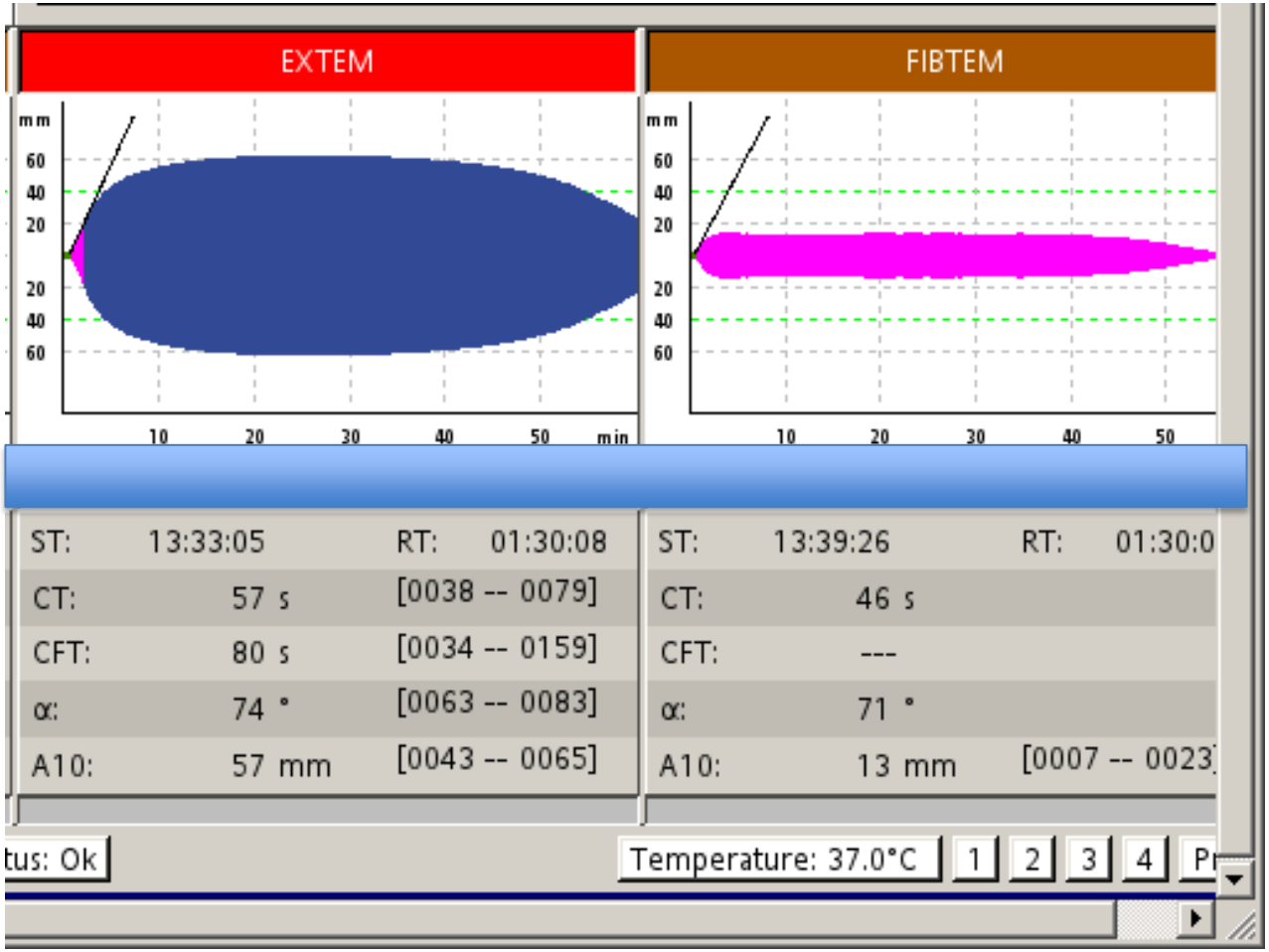




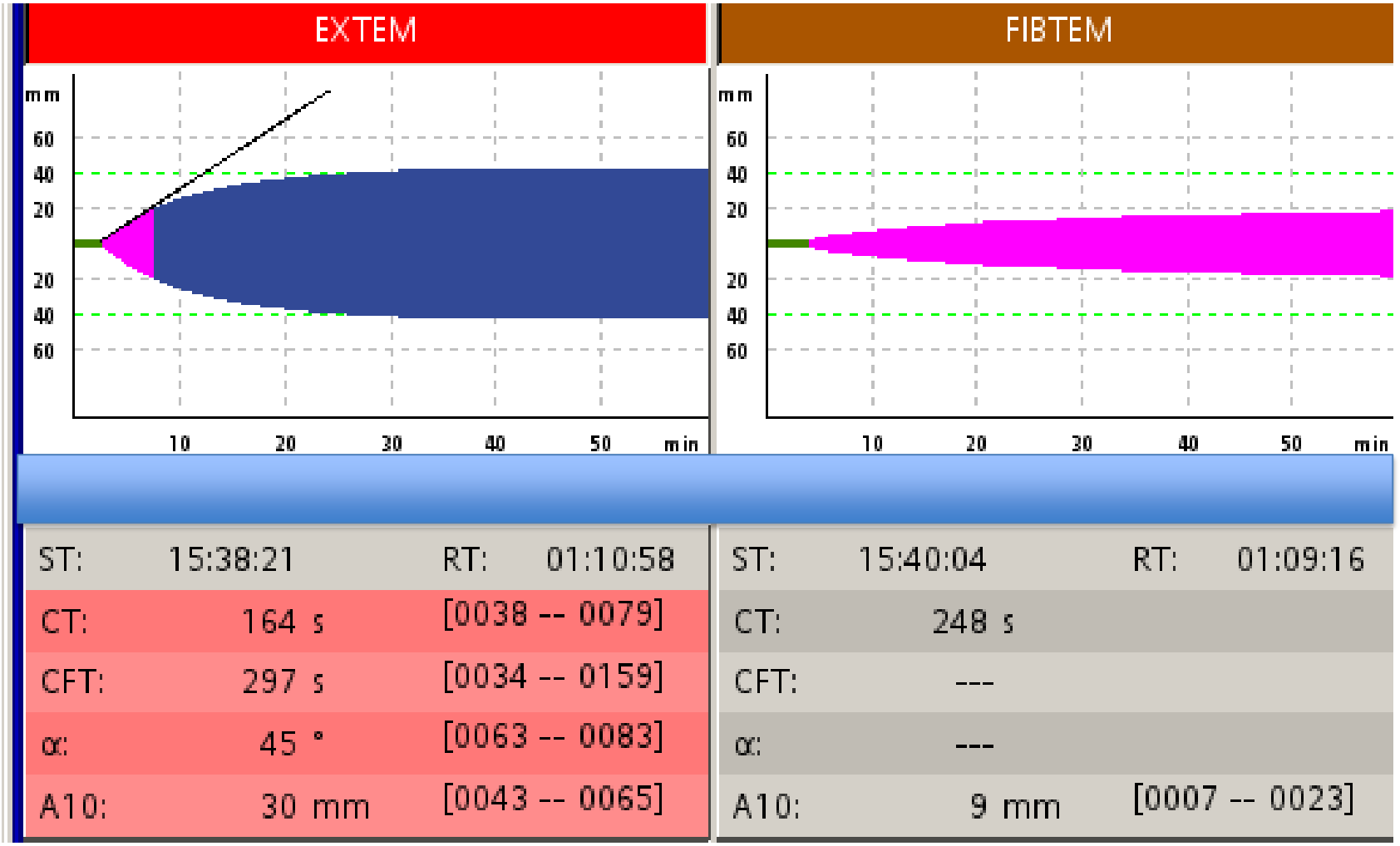
EXTEM at 4 hours
MCF - 51 mm
Lysis index at 30 min 100%

FIBTEM at 4 hours
11 mm
[INR 1.35, fibrinogen 1.6]

13:05 1 + 1 gram TXA
INR 0.97 Fibrinogen 2.5

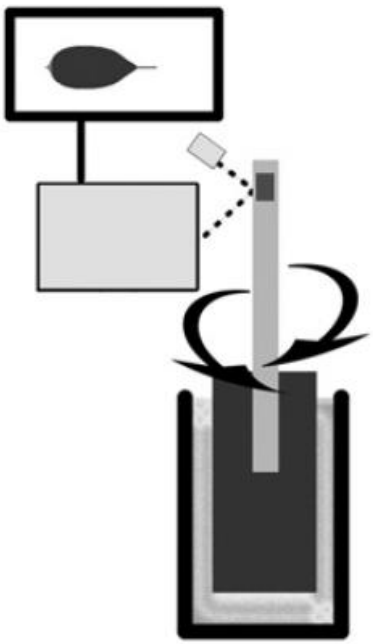


Repeat at 15:35



9 Hematocrit effects the results

Hematocrit



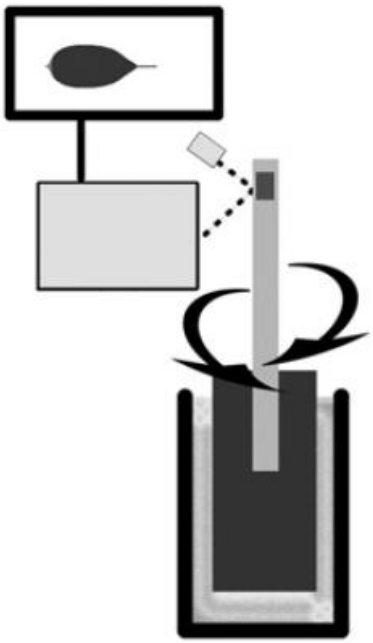
—RBC interfere in vitro with MCF by blocking clot formation

—In contrast, in vivo, RBCs probably assist with clotting (moving platelets to vessel wall)

—Anemic patients “gain” 10 mm on MCF (Hct 28% vs. 41%)

Lots of other limitations

Limitations

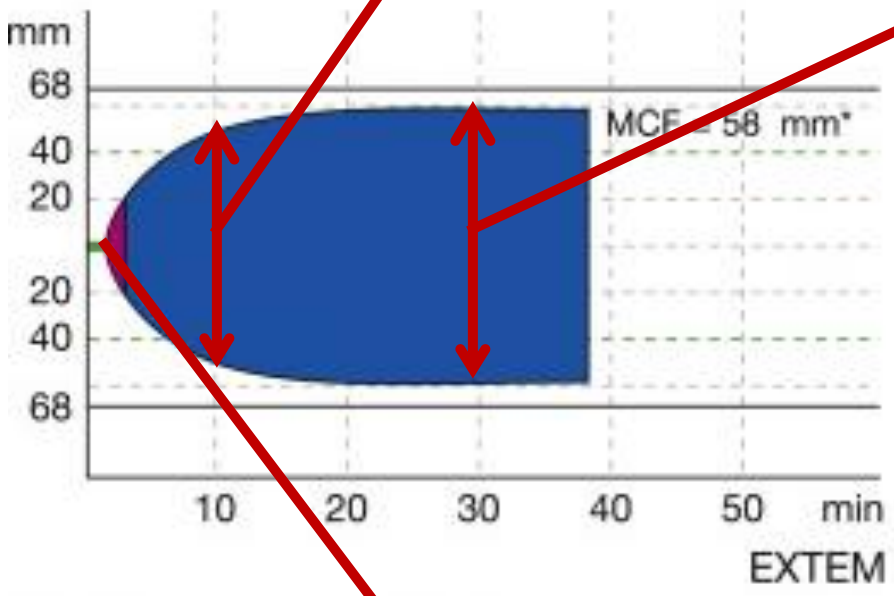


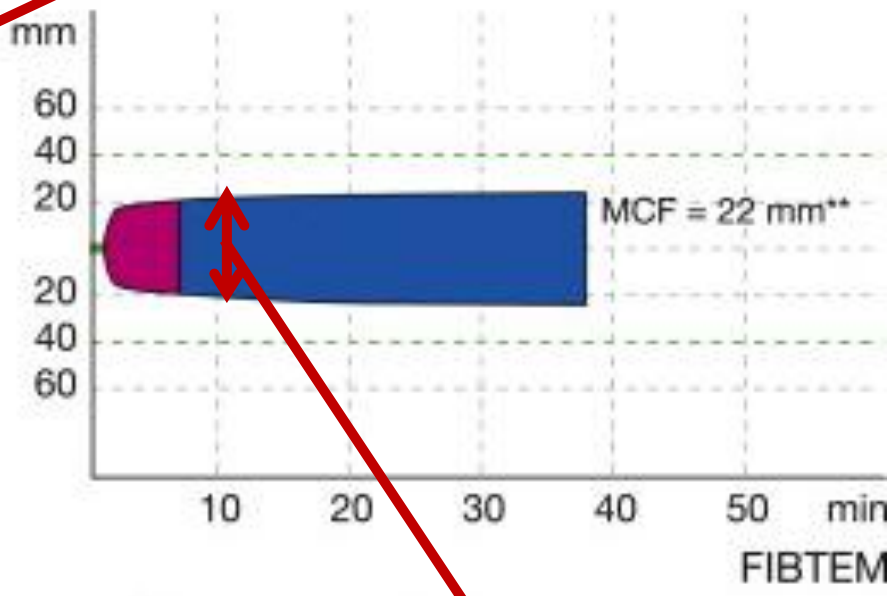
- You may see normal curves with some antiplatelet agents (ASA, Clopidogrel)
- Flat line when fibrinogen is zero (unable to "see" clotting factor/platelet function)
- Endothelial contribution not measured (vWD, CT diseases)
  - NOAC affect ROTEM (eg. Xa inhibitors prolong CT on EXTEM)
  - Coumadin affects CT (289 at INR 3), α angle, and MCF (20 mm at INR 3)
- We have no idea what the ROTEM "transfusion triggers" should be
  - ROTEM guided algorithms show a reduction in blood transfused – just lower triggers?

Easy guide to ROTEM (cardiac surgery)

MCF<35 give platelets **2**

Lysis index <95% MORE tranexamic acid **4**



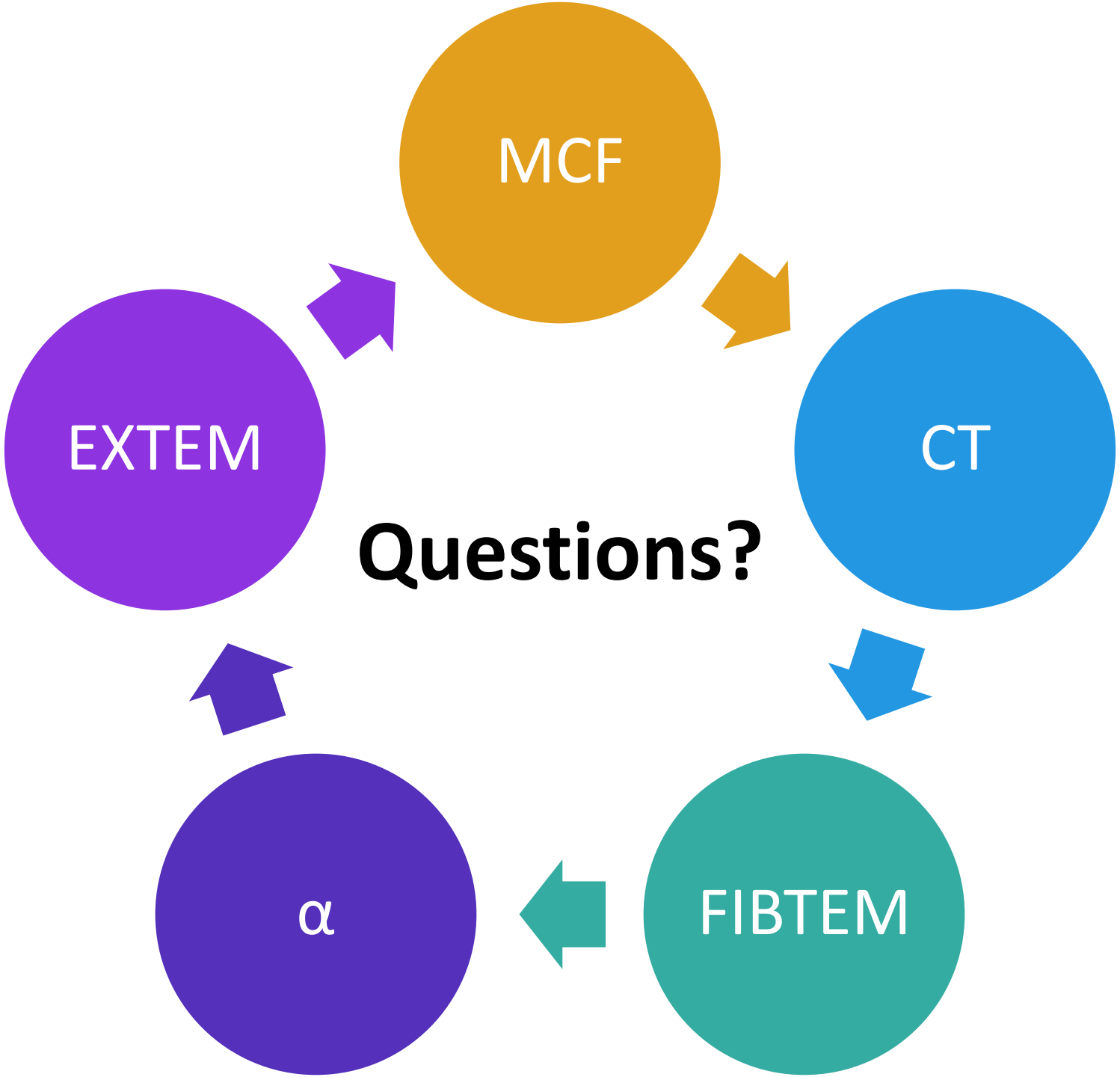


B * Reference range: 50–72 mm

** Reference range: 9–25 mm

CT>90 give 4 plasma **3**

MCF<7 give 10 cryo or fibrinogen 4 grams **1**


MCF
CT
FIBTEM
α
EXTEM
Questions?