Intro

What is EMP?

And potential EMP derived from mathematical models of High altitude Nuclear burst induced EMP.

Presented and prepared by

Merlyn Cousins

AKA DrForbin

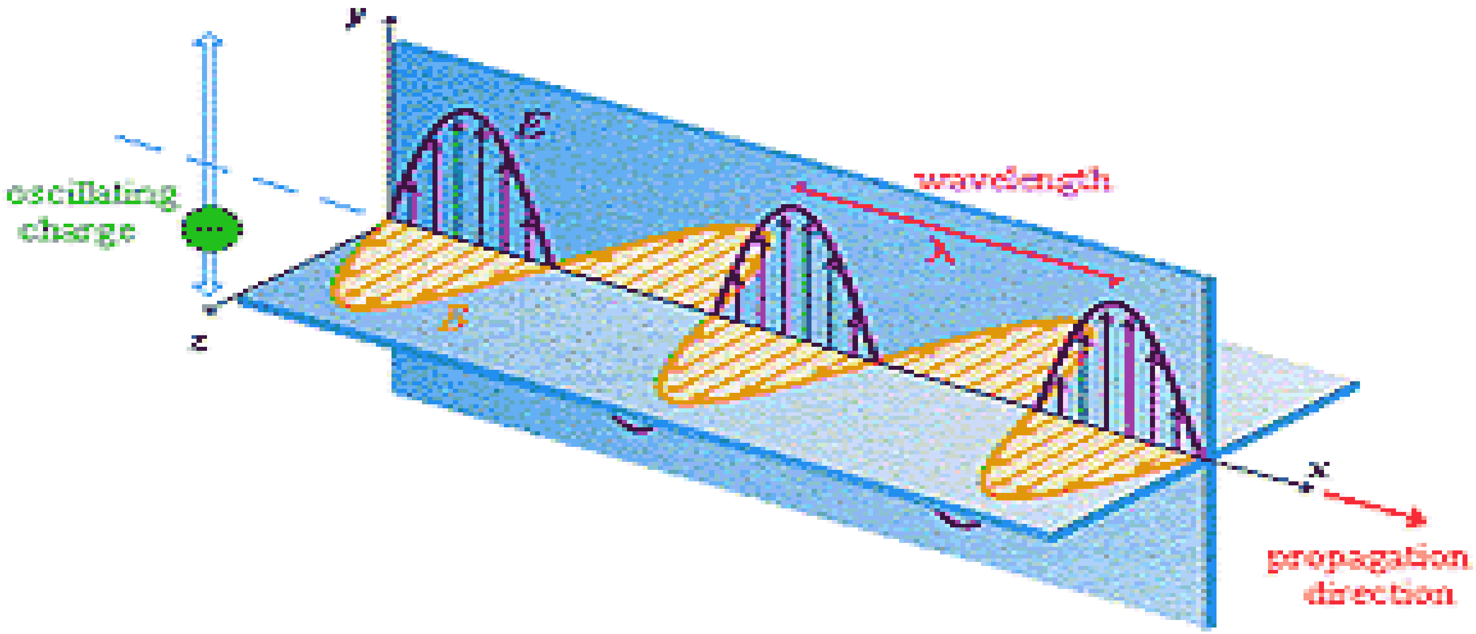
Definition

- Emp is an Electro Magnetic Pulse of short duration caused by an atomic fission or thermonuclear weapon.
- Emp can also be caused by solar flares
- In the case of solar flares the process is quite similar to emp generated by a blast except the origin of the charged particles are the sun.
- E1 pulse;
- Maxima rise time approx 5ns (.5 shakes)
- Pulse width approx 40ns (4 shakes)

Photons

- Electric and magnetic field alternating at right angles to each other.
- The alternating magnetic field induces an alternating electric field. Alternating electric field induces an alternating magnetic field.
- By using some quite advanced math James Clark Maxwell was able to show the wave propagated at a rate of 299,792,458m/s
- An ether was not require as a media of propagation.
- See Michelson–Morley experiment.

Alittle Physics (the Photon)



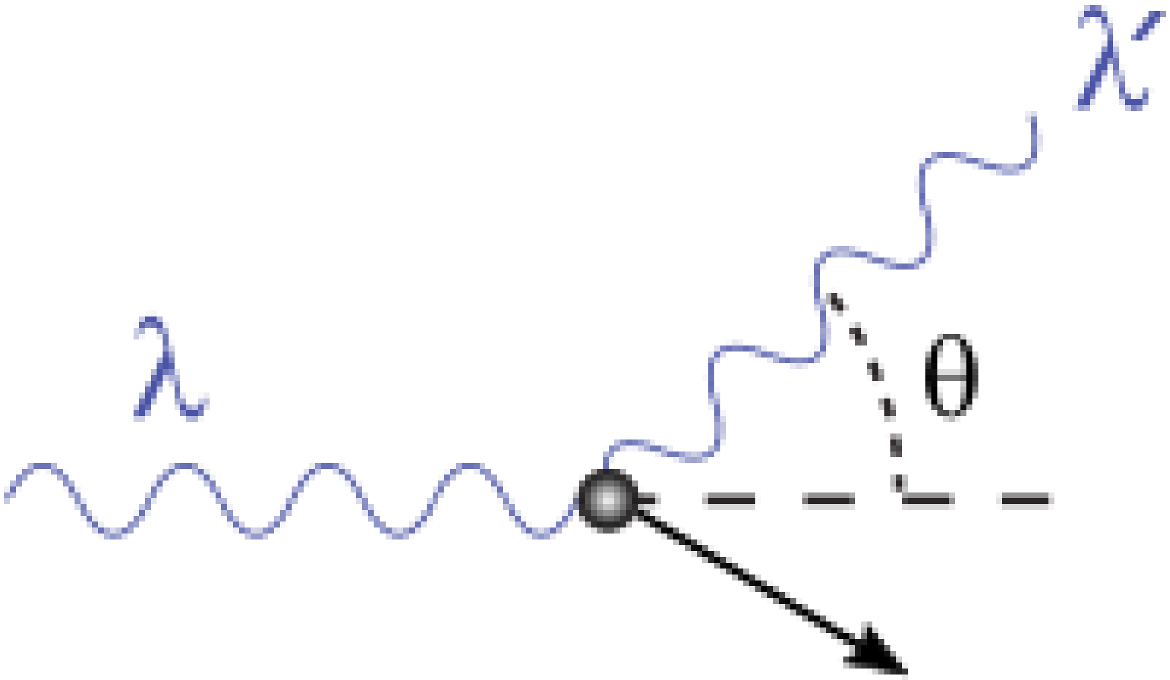
Energy of a Photon

- $E = hf = hc/\lambda$. $h = 6.626*10-34$ Js
- h is plank's constant.
- From Physicist Max Plank.

Compton scattering

- From experiment by Arthur Holly Compton
- Was meant to prove particle nature of the photon.
- Photon strikes a particle imparting a portion of it's energy to the particle causing it to scatter.
- The particle moves in one direct with a portion of the photons energy and the photon move off in another with a decreased energy.
- Of course energy is conserved

Compton scattering



So how does it work?

- Blast occurs producing Gamma rays (High energy form of Photons)
- Electrons are blown off of atoms due to the Compton effect.
- The electrons then spiral down the magnetic flux lines of the earth
- The acceleration of the electrons cause the electrons to emit photons
- The fields (electric and magnetic) radiate out and intersect the target and create the EMP.
- Please refer to slides below showing process and absorption region.

Blast production of EMP

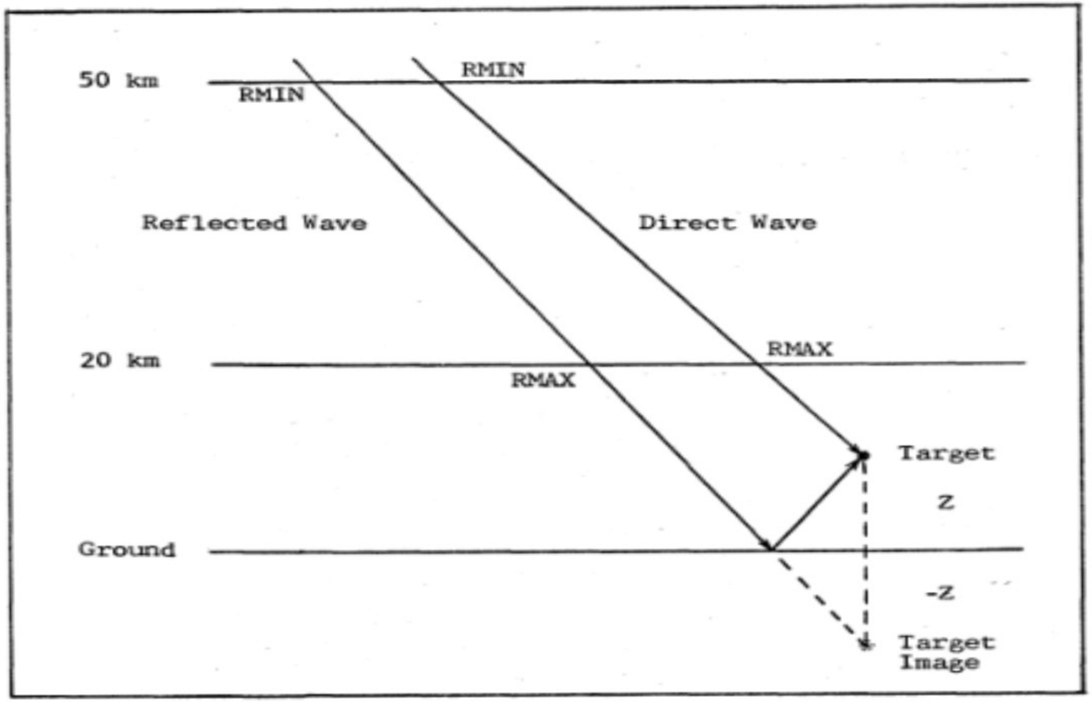


Fig. 3. Target Geometry

Another view with magnetic flux lines

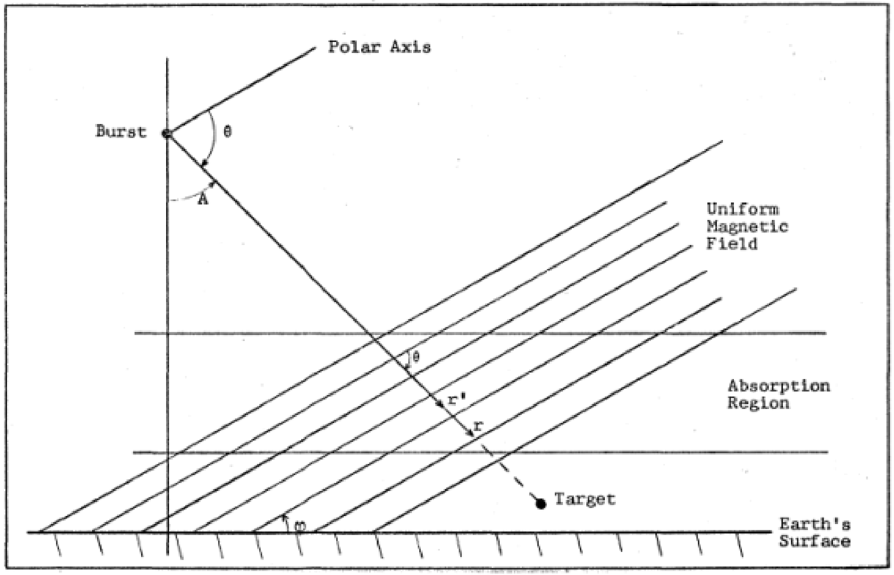
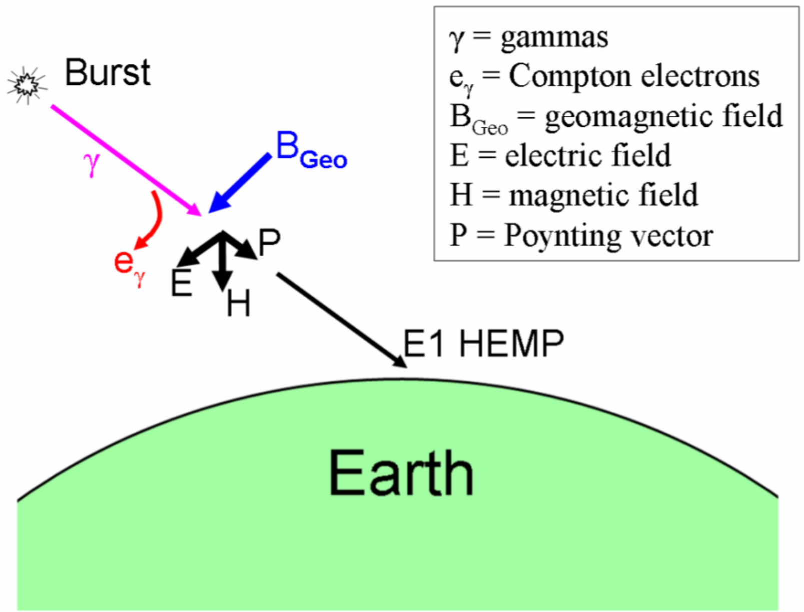


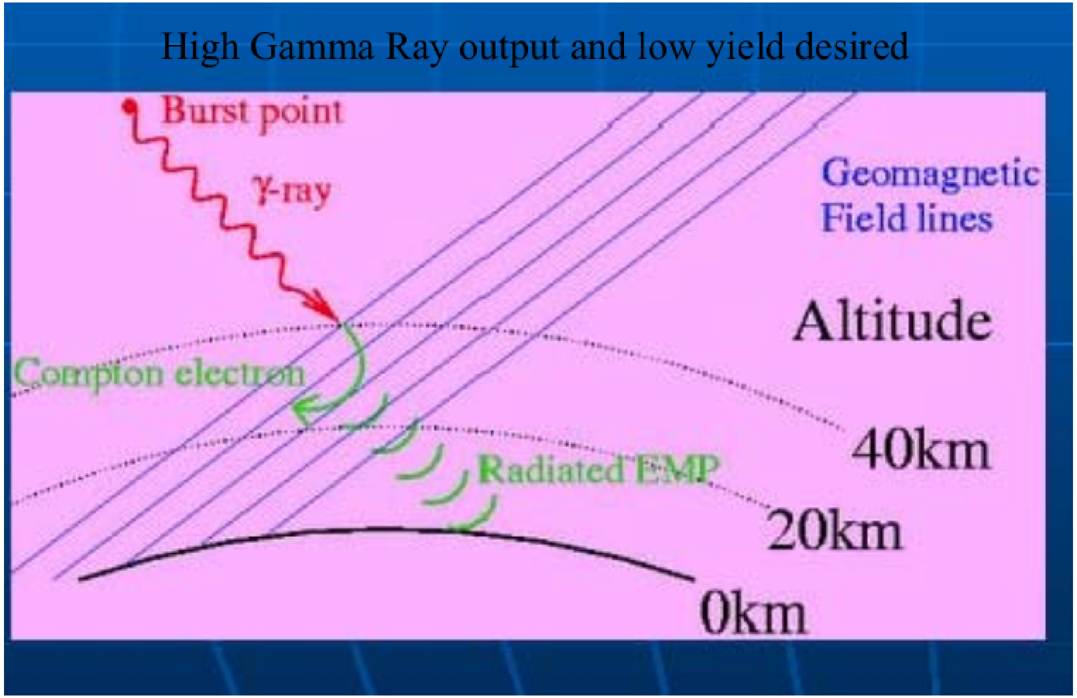
Fig. 1. Geometry of the Burst

More Slides

E1 EMP diagram good



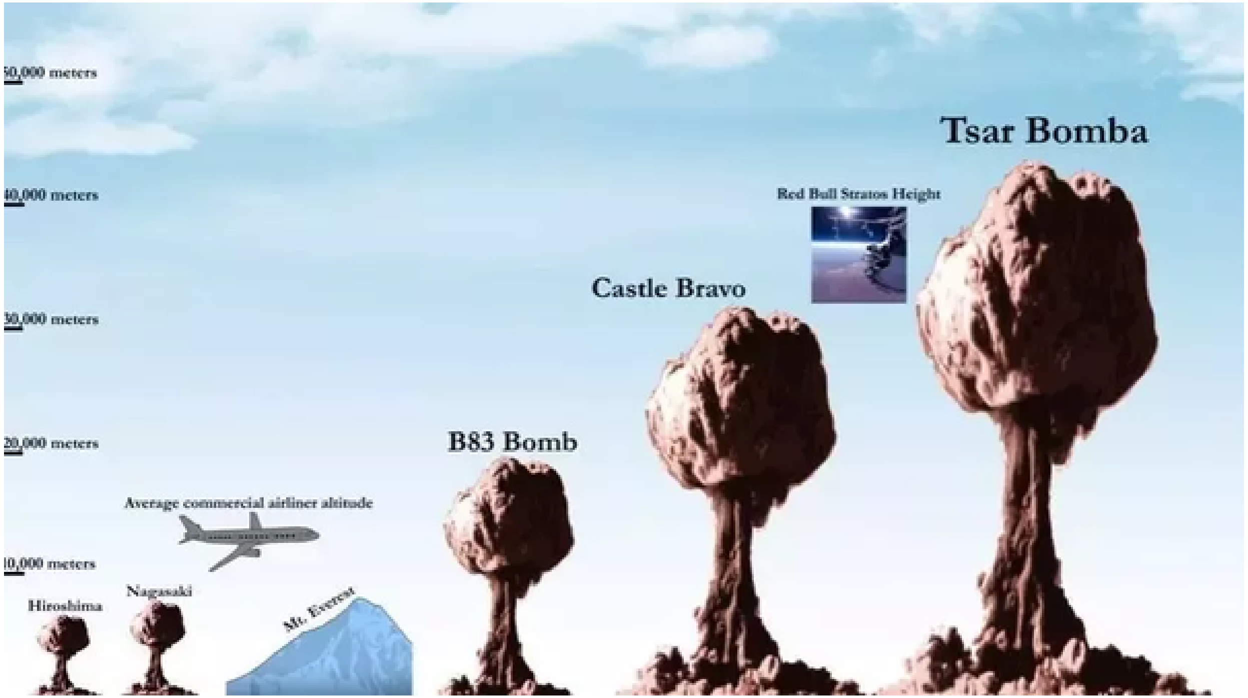
More slides


High Gamma Ray output and low yield desired
Burst point
γ-ray
Geomagnetic
Field lines
Altitude
Compton electron
Radiated EMP
40km
20km
0km

Notes on Blast Yield

- All models use what is called Prompt gamma Yield.

  This is not the Yield of the device as a totality, but represents as a general statement about .1% of the total energy of the device being converted to gamma rays. So to create 100Kons energy of Gamma radiation yield would require a bomb of 100,000/.001=100Mton. Approx twice the size (57 Mton) of the tested Tsar Bomb. The Tsar design was suppose to have been able to produce 100Mton but was scaled back. As it stands it was the largest single man made explosion in history. The energy released was equivalent to over 1500x the combined energy released in Hiroshima and Nagasaki and 10 times ALL the bombs dropped during World War II.



50,000 meters
40,000 meters
30,000 meters
20,000 meters
10,000 meters
Tsar Bomba
Red Bull Stratos Height
Castle Bravo
B83 Bomb
Average commercial airliner altitude
Hiroshima
Nagasaki
Mt. Everest

FOFT FUNCTION

```
      FUNCTION FOFT(T)
C
C           F(T) IS THE POMRANNING MODEL FOR TIME DEPENDENCE
C           OF NUCLEAR WEAPON YIELD IN RETARDED TIME
      INTEGER OUX
      COMMON OUX,AP,BP,RNP,TOP
      TSHAKE=1.E8*T
      DENOM=(BP+AP*EXP((AP+BP)*(TSHAKE-TOP)))*RNP
      FOFT=(AP+BP)*EXP(AP*(TSHAKE-TOP))/DENOM
      RETURN
      END
```

AP	BP	RNP	TOP	
1/shakes	1/shakes	shakes	shakes	(units)
2.2	.25	5.62603	2.23	Grouse (left chart)
1.7	2.8	1.6	1.2	Sunny (right chart)

Meaning of variables

4 variables are defined for the time value function

Alpha, Beta, RNP, TOP Independent variable in time except RNP

Alpha-Defines the left side of the slope.

TOP- Defines the top of the pulse

Beta- Defines the right side of the slope

RNP- Scaling factor to equate integral to 1 in integration interval

FOFT from Chapman

/home/mercou/download/emp_Sim/EEMP-MODELING/EMP -Terry Chapman- thesis.pdf

III. Code Description

General Approach

Equations (56), (57), (58), and (59) were chosen as the simplest ones to solve numerically. Of course, Eqs (24), (25), (27), and (33) are used to obtain the Compton currents and conductivity needed to solve Eqs (56) and (57).

The B - field equations are not solved since

$$E = cB \tag{60}$$

can be used to obtain B once E is found. This relationship is based on the assumption that the EMP pulse is a spherical wave propagating in free space, below the absorption region.

The function used for the time dependence of the weapon yield is the one recommended by Pomranning (Ref 3).

$$f(\tau) = (1/N)\,\frac{(\alpha+\beta)\ \exp\ (\tau-\tau_0)}{\beta + \alpha\ \exp\ [(\alpha+\beta)(\tau-\tau_0)]} \tag{61}$$

where N is chosen such that

$$\int_0^\infty f(\tau)d\tau = 1 \tag{62}$$

and $\alpha > \beta$.

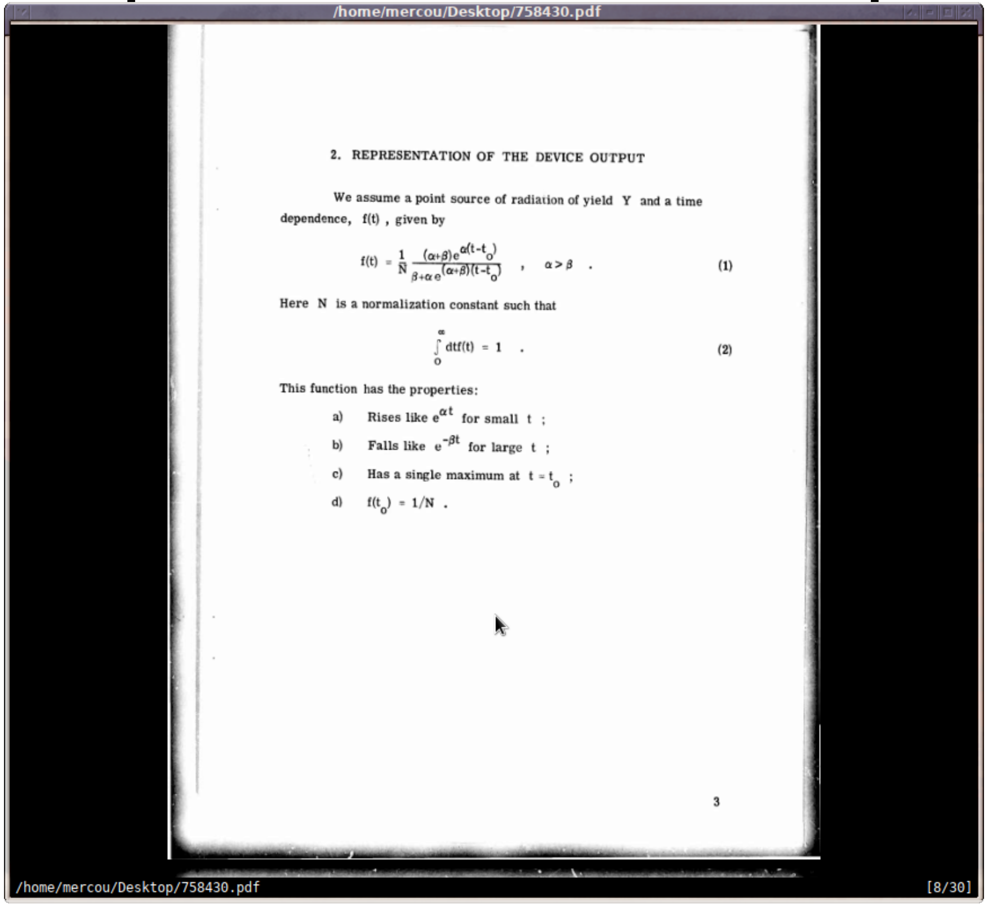
This function rises like $e^{\alpha\tau}$ for small τ, falls like $e^{-\beta\tau}$ for large τ, and has a single maximum at τ_0.

Figure 2 presents a flow chart which is descriptive of the approach taken solving the equations. The top of the absorption region is assumed to be at 50 km altitude and the bottom of the absorption region is assumed to be

FOFT from Seiler

$$f(t) = \frac{(a + \beta)\ \exp a\ (t - t_0)}{\beta + a \exp\left[(a + \beta)(t - t_0)\right]}$$

Time dependence function properties



/home/mercou/Desktop/758430.pdf

2. REPRESENTATION OF THE DEVICE OUTPUT

We assume a point source of radiation of yield Y and a time dependence, $f(t)$, given by

$$f(t) = \frac{1}{N}\,\frac{(\alpha+\beta)e^{\alpha(t-t_o)}}{\beta+\alpha e^{(\alpha+\beta)(t-t_o)}} \quad , \quad \alpha > \beta \quad . \tag{1}$$

Here N is a normalization constant such that

$$\int_0^\infty dt f(t) = 1 \quad . \tag{2}$$

This function has the properties:

a) Rises like $e^{\alpha t}$ for small t ;

b) Falls like $e^{-\beta t}$ for large t ;

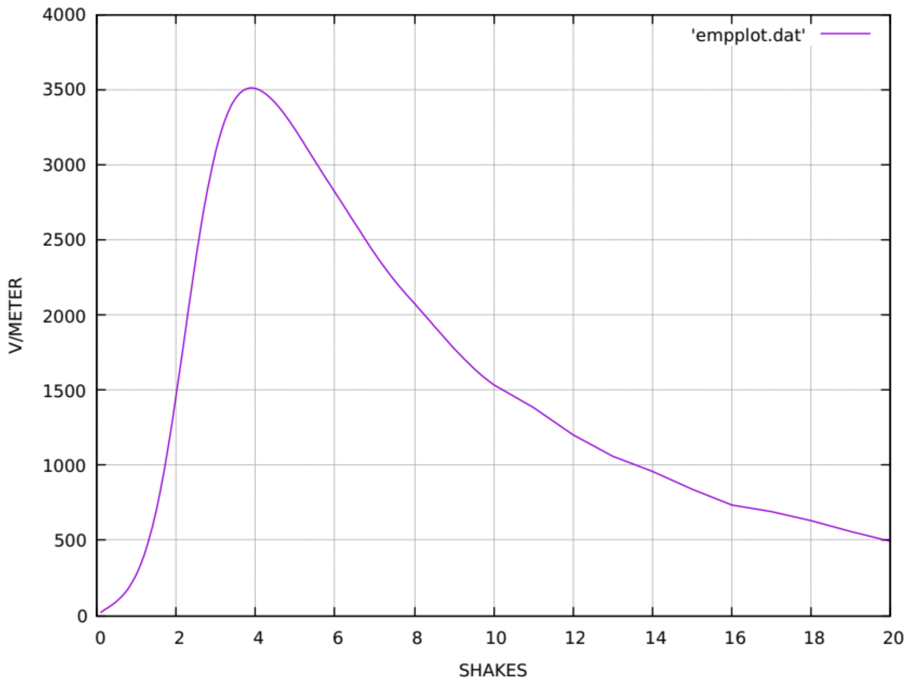
c) Has a single maximum at $t = t_o$;

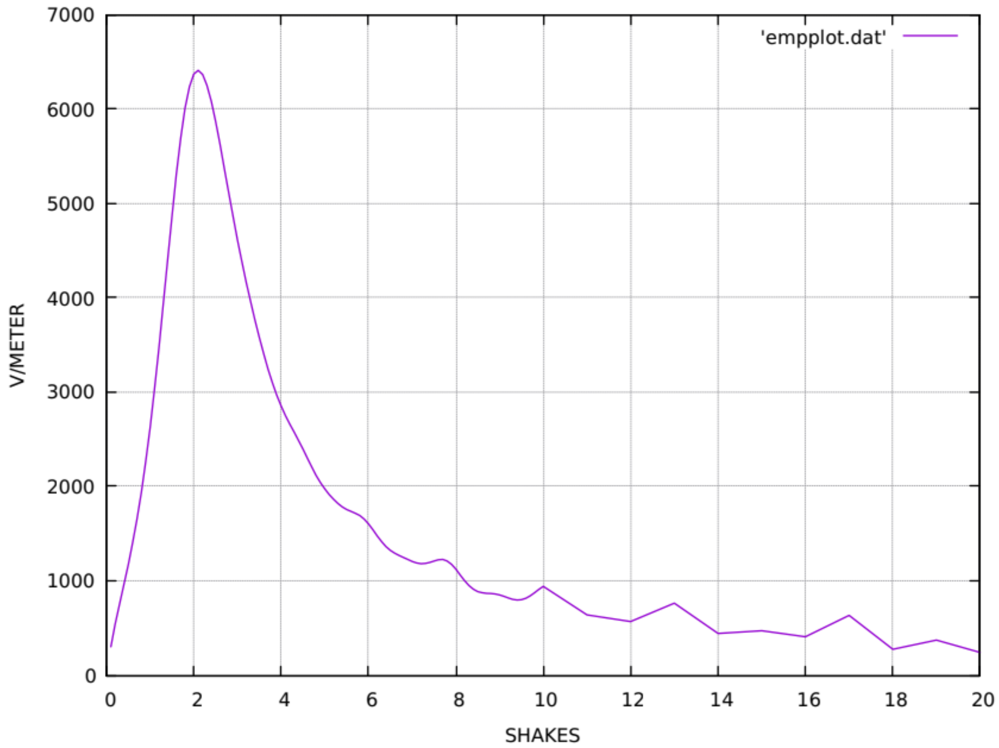
d) $f(t_o) = 1/N$.

3

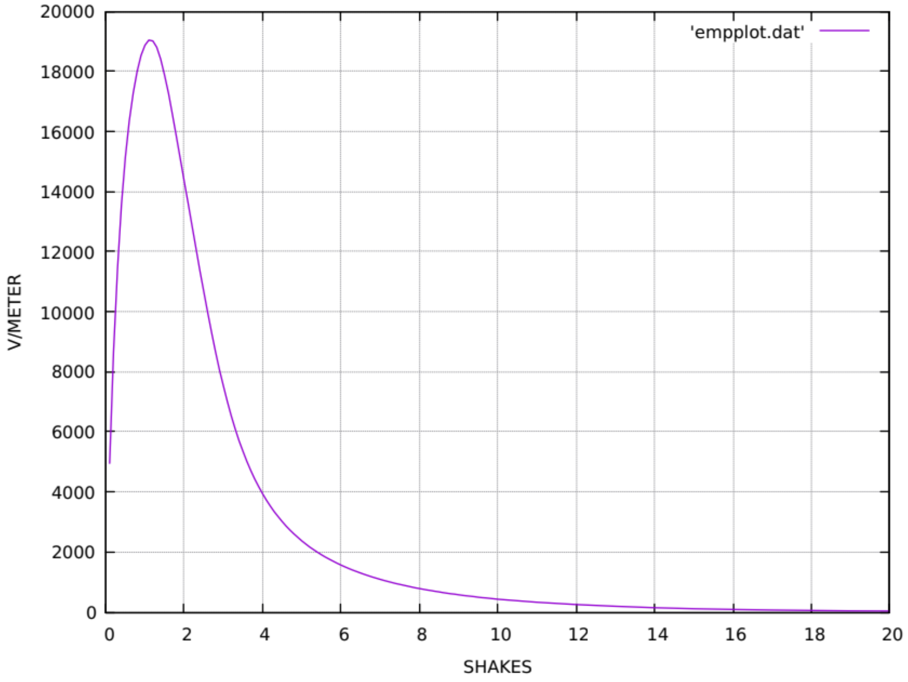
/home/mercou/Desktop/758430.pdf [8/30]

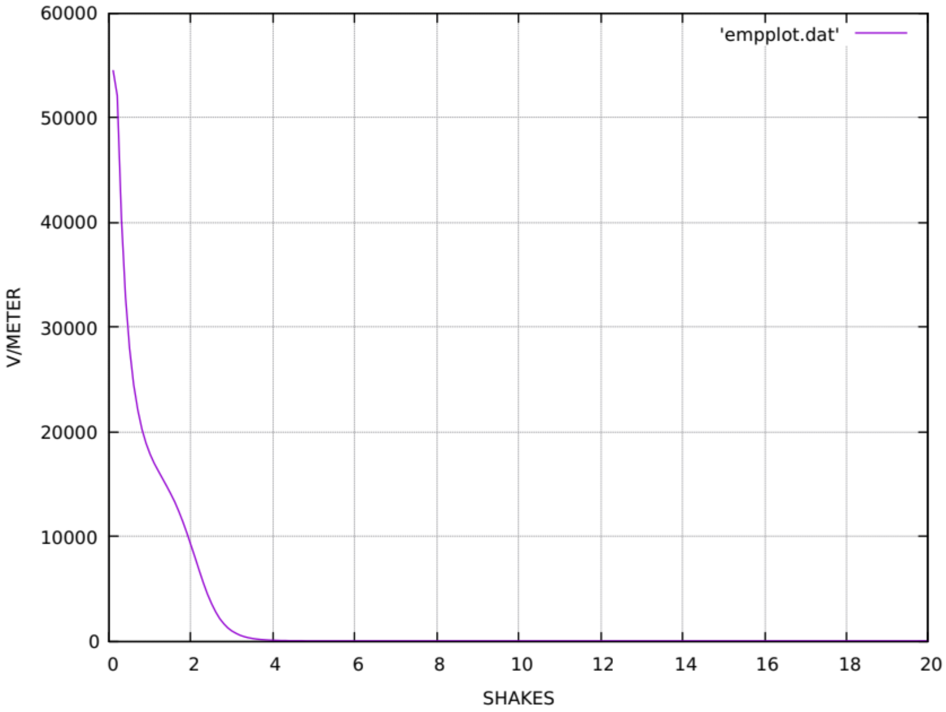
.001Ktons Yield



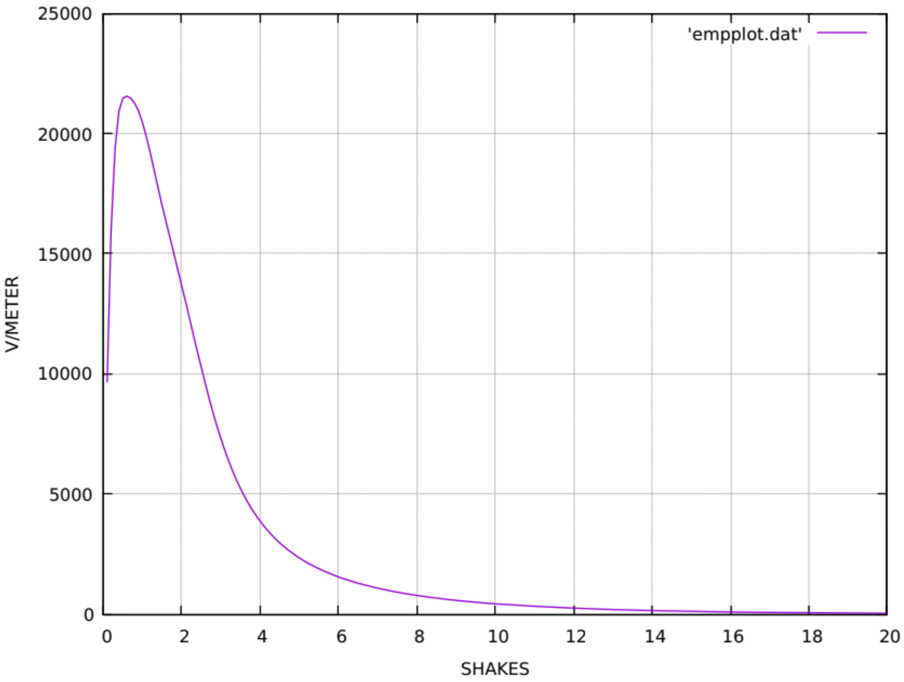


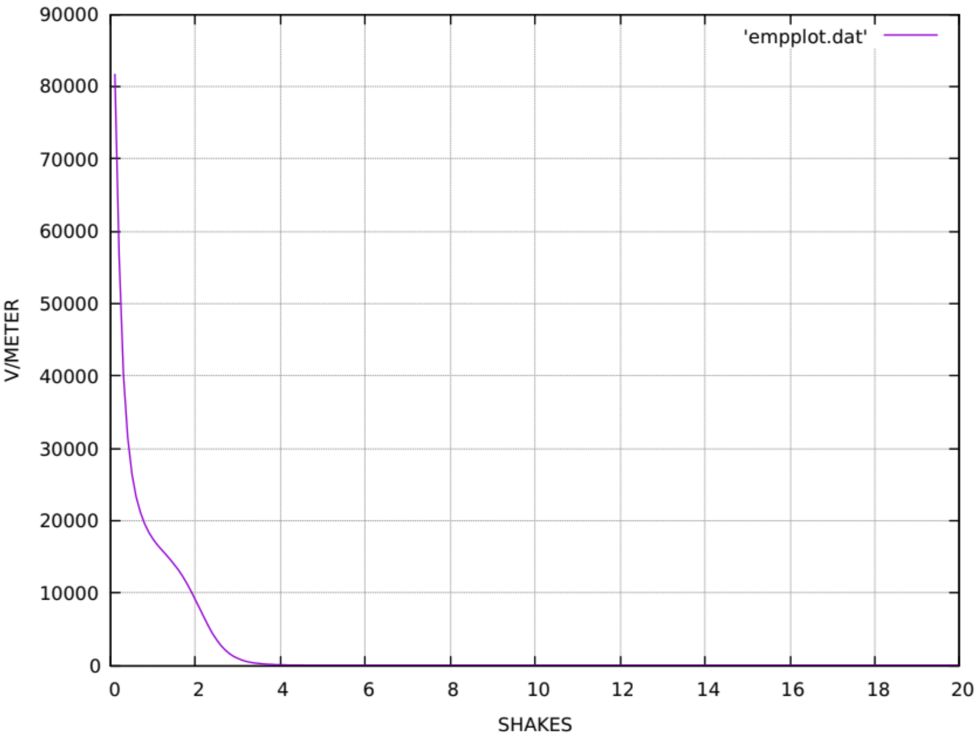
.25Ktons Yield



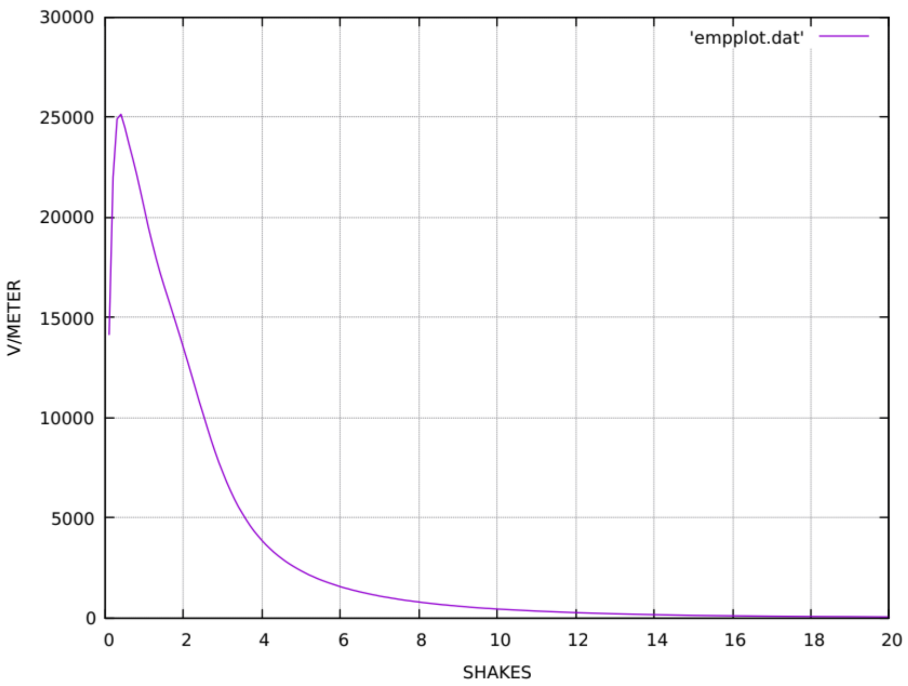


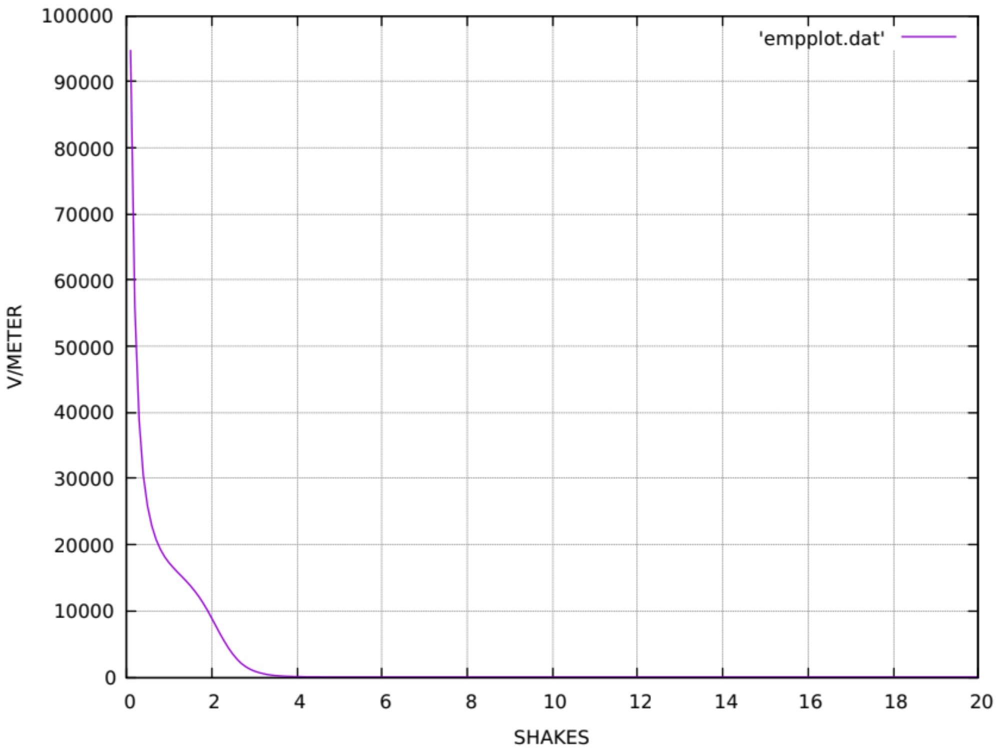
.50Ktons Yield



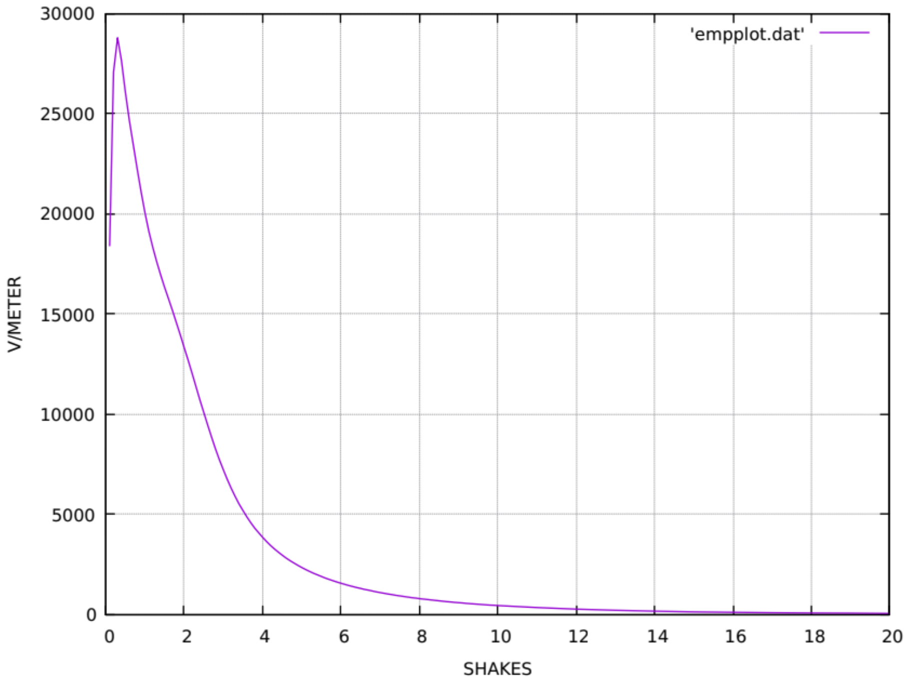


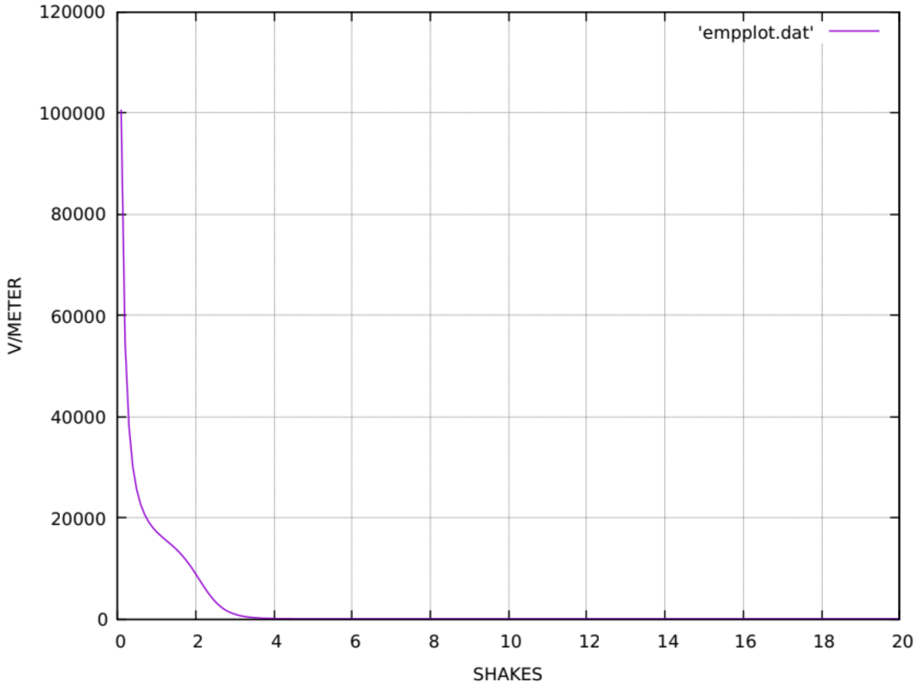
.75Ktons Yield





1 Ktons Yield



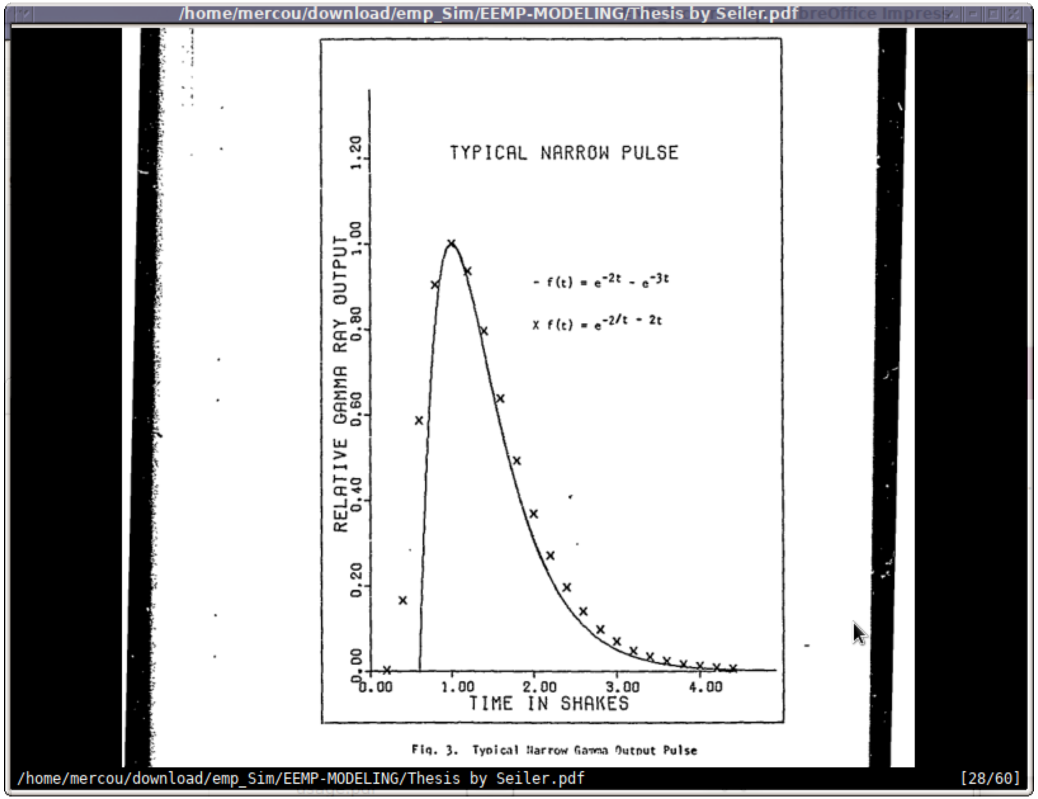


My derived constants

The following section will show my derived constants.

- Methodology
- Derived constants
- Run for .001,.25,.50,.75,1 Ktons
- Comparison

Seiler pulse gamma yield f(t)



The objective is to reproduce pulse as exemplified by Seiler (see previous slide) using the FOFT pulse equation shown previously.The restraints and requirements are a peak at 5ns or .5 shakes $a>b$ and the definite integral from 0 to inf equals 1. The equation must also mimic the general shape of the pulse. Rolloff time is 40ns (4 shakes).

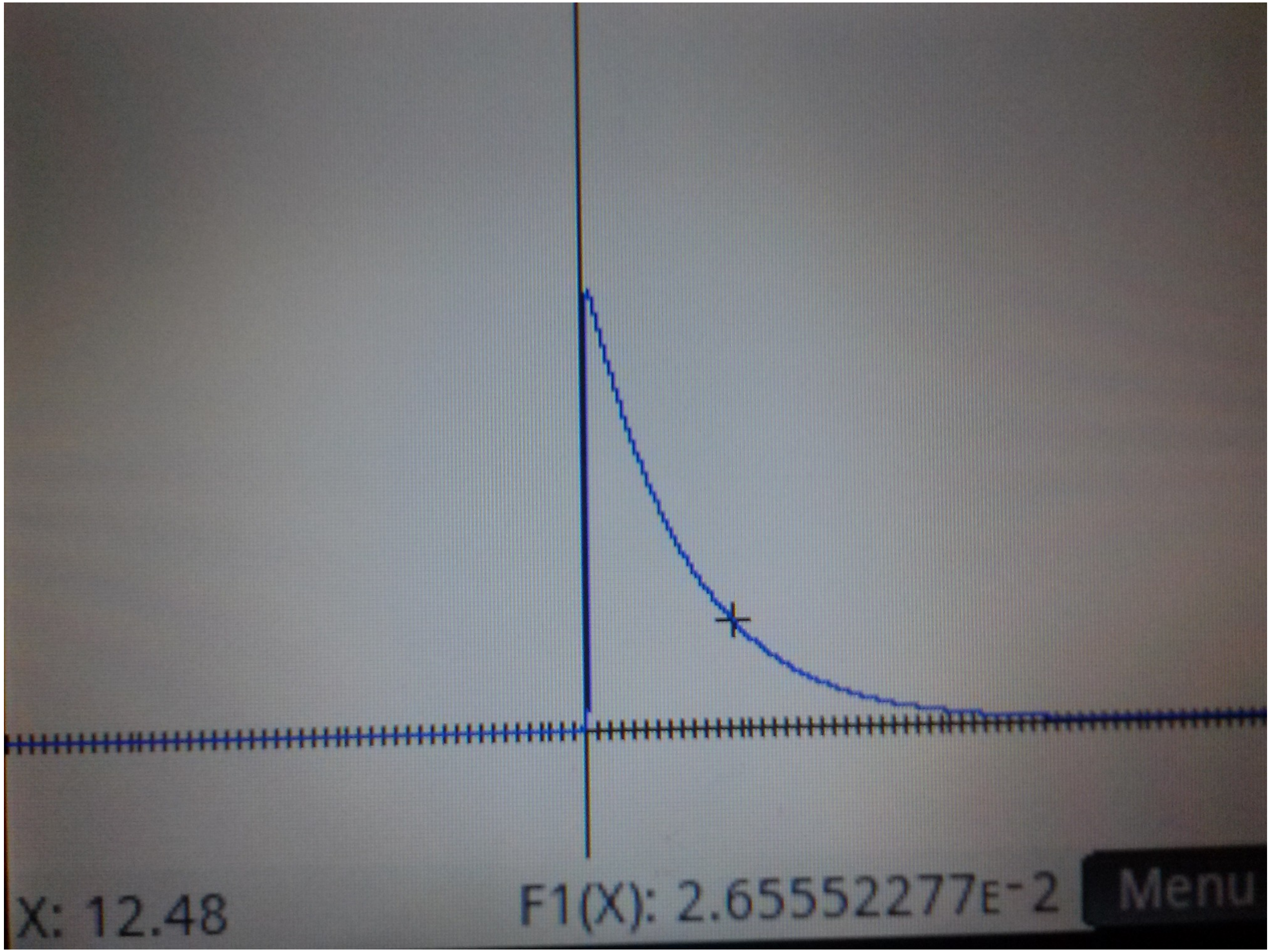
Derived constants

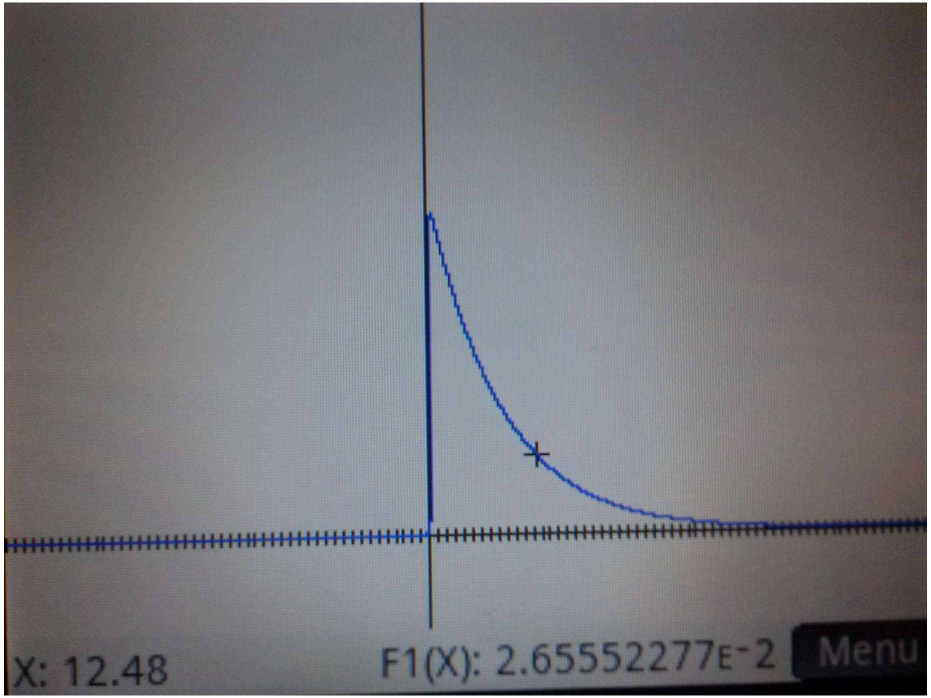
AP	BP	RNP	TOP
19	.12	9	.5

Using these constants mimics Seiler pulse closely and fulfills the requirement of integration equaling 1.

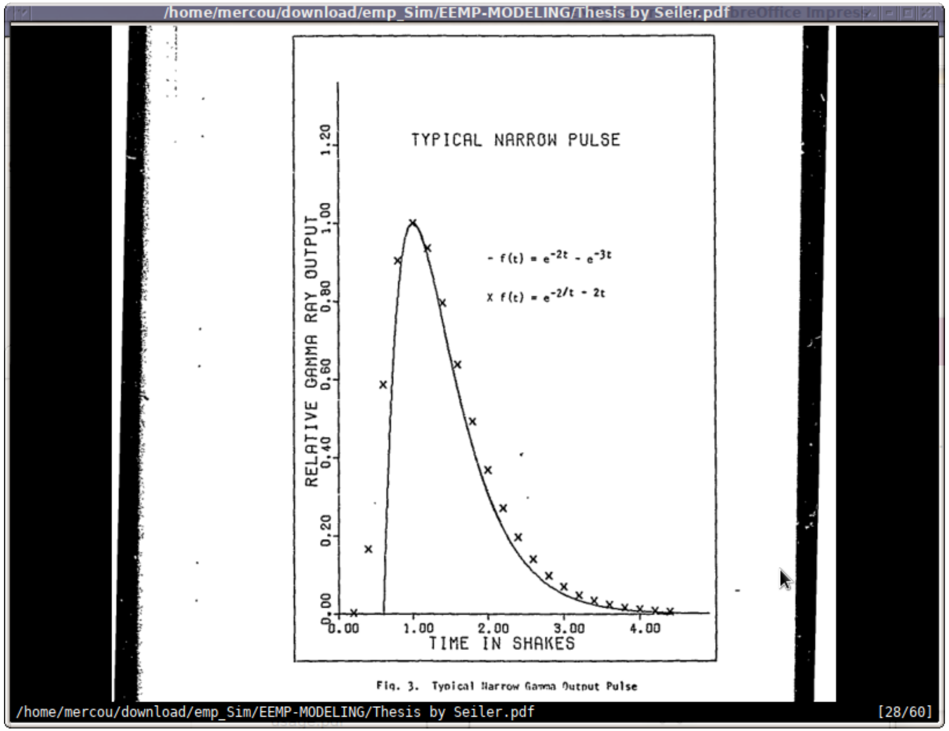
Peak gamma yield is also achieved at .5 shakes into run.

See following slides to illustrate.

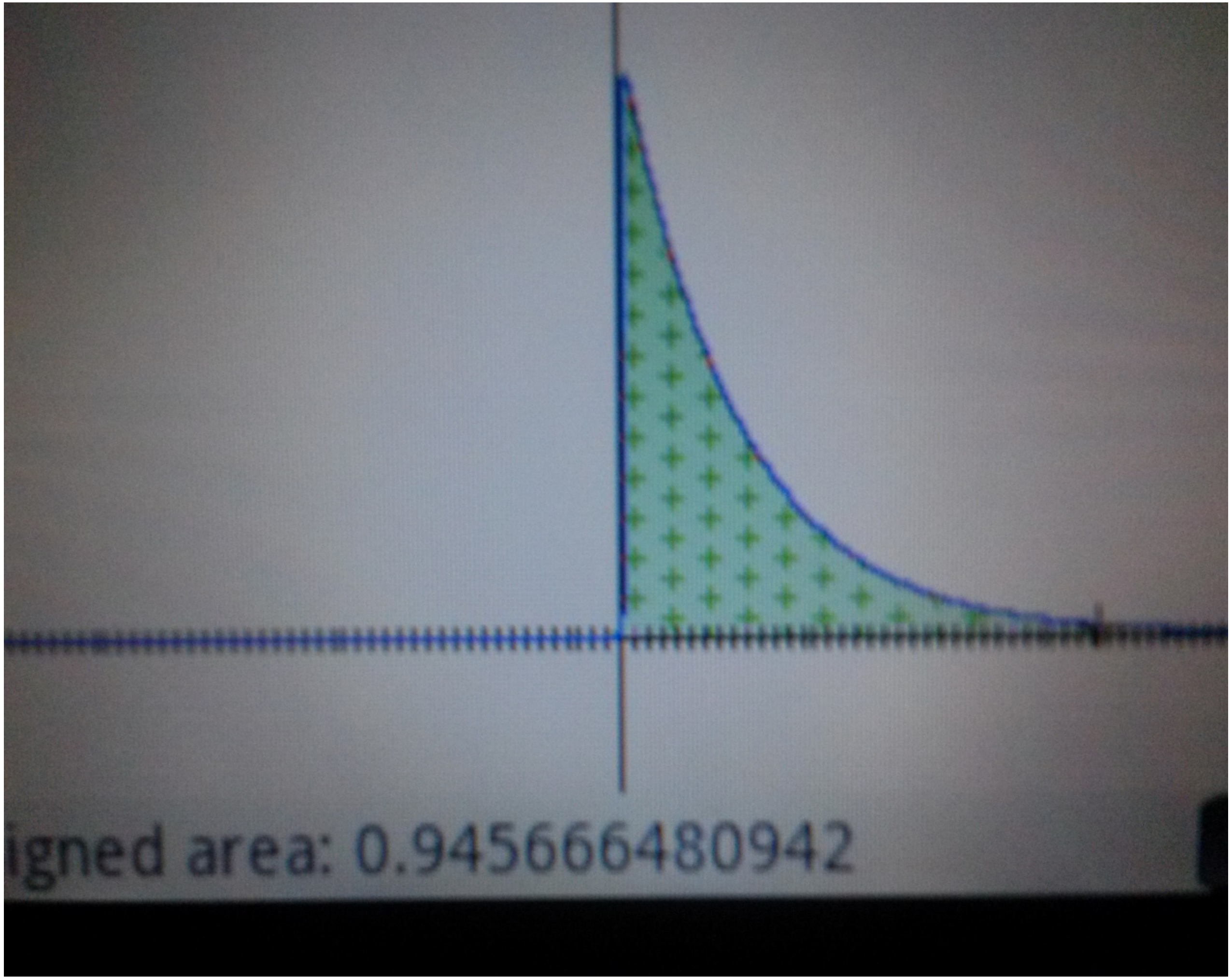

X: 12.48
F1(X): 2.65552277E-2
Menu



X: 12.48
F1(X): 2.65552277E-2
Menu



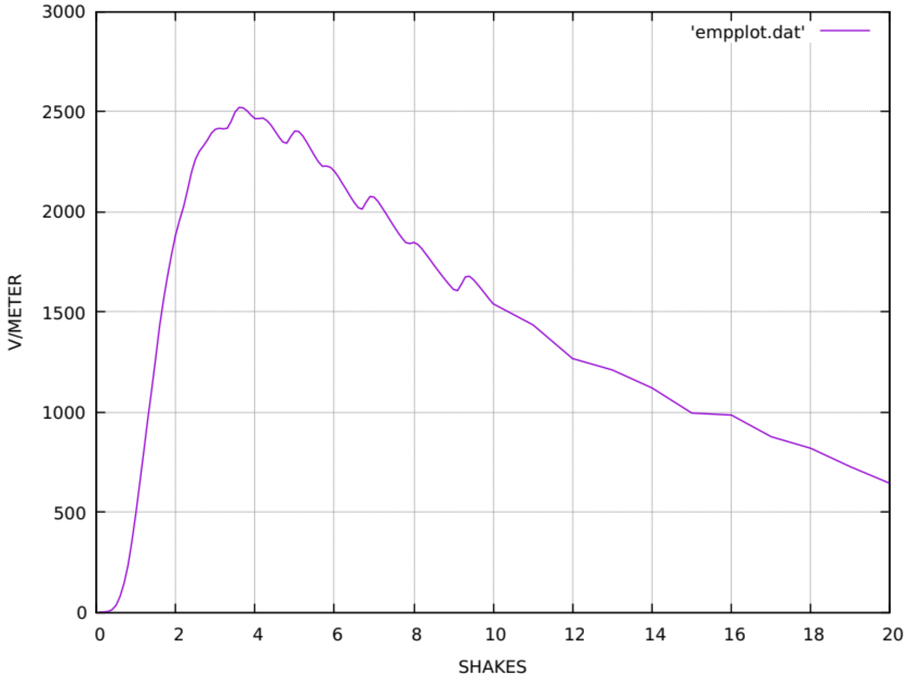
/home/mercou/download/emp_Sim/EEMP-MODELING/Thesis by Seiler.pdf
TYPICAL NARROW PULSE
RELATIVE GAMMA RAY OUTPUT
TIME IN SHAKES
- f(t) = e^-2t - e^-3t
X f(t) = e^-2/t - 2t
Fig. 3. Typical Narrow Gamma Output Pulse
/home/mercou/download/emp_Sim/EEMP-MODELING/Thesis by Seiler.pdf
[28/60]


igned area: 0.945666480942

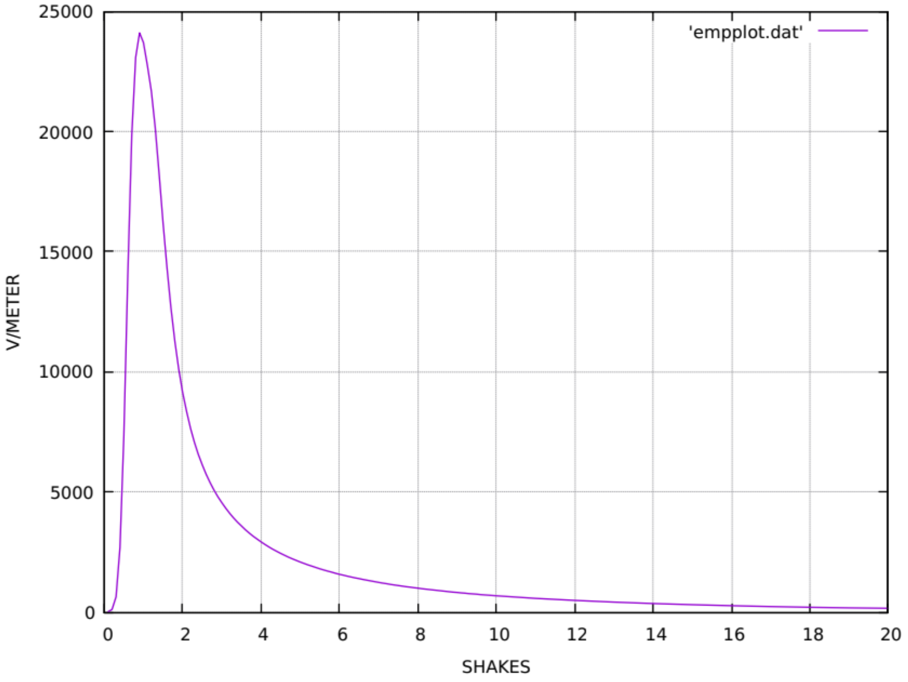
Once previous constants were employed an additional problem arose, namely at certain points in the calculation a NaN (NOT a NUMBER) error was encounter. After debugging it was ascertained that the problem so too small of word size. The original code was run on a CDC 6600 supercomputer which had a word size of 60bits. I therefore reasoned that the default wordsize on an intel arch was too small. Changing some variables (see source) to DOUBLE PRECISION solved the problem.


CONTROL DATA

.001 Ktons

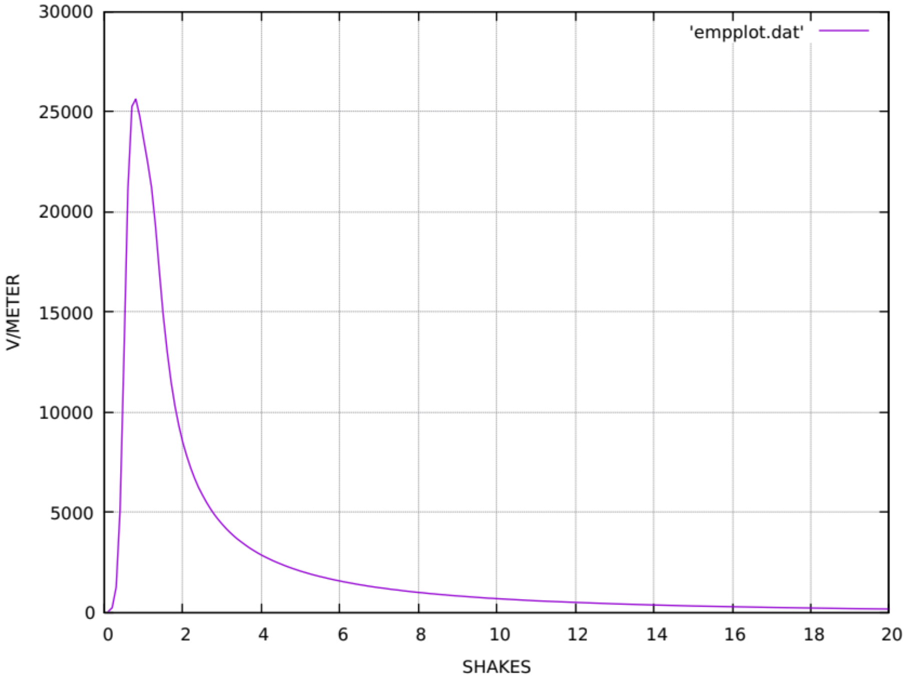

'empplot.dat'
V/METER
SHAKES
3000
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
16
18
20

.25Ktons



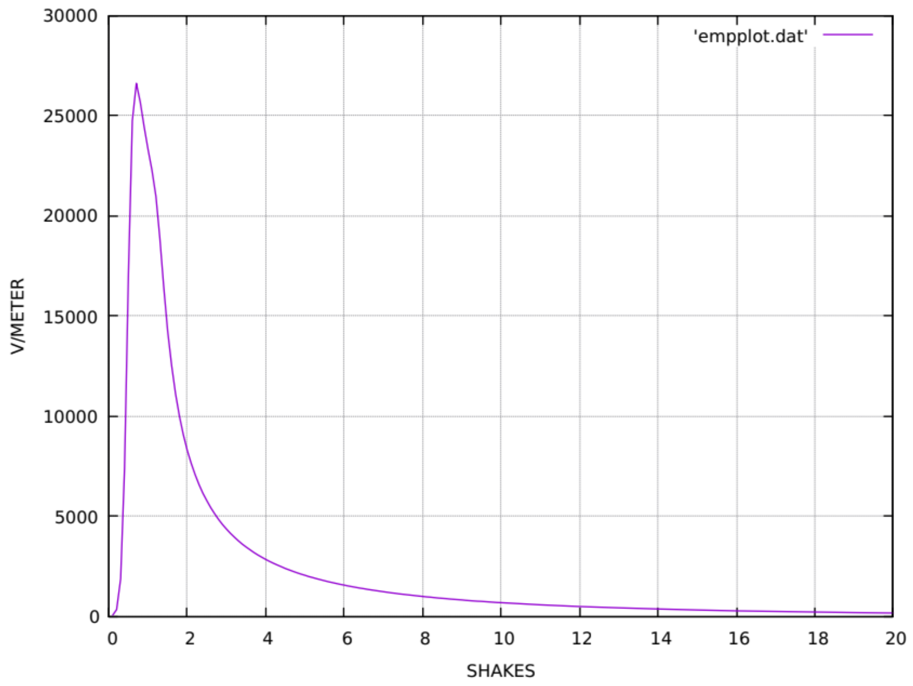
'empplot.dat'
25000
20000
15000
10000
5000
0
V/METER
0
2
4
6
8
10
12
14
16
18
20
SHAKES

.50Ktons



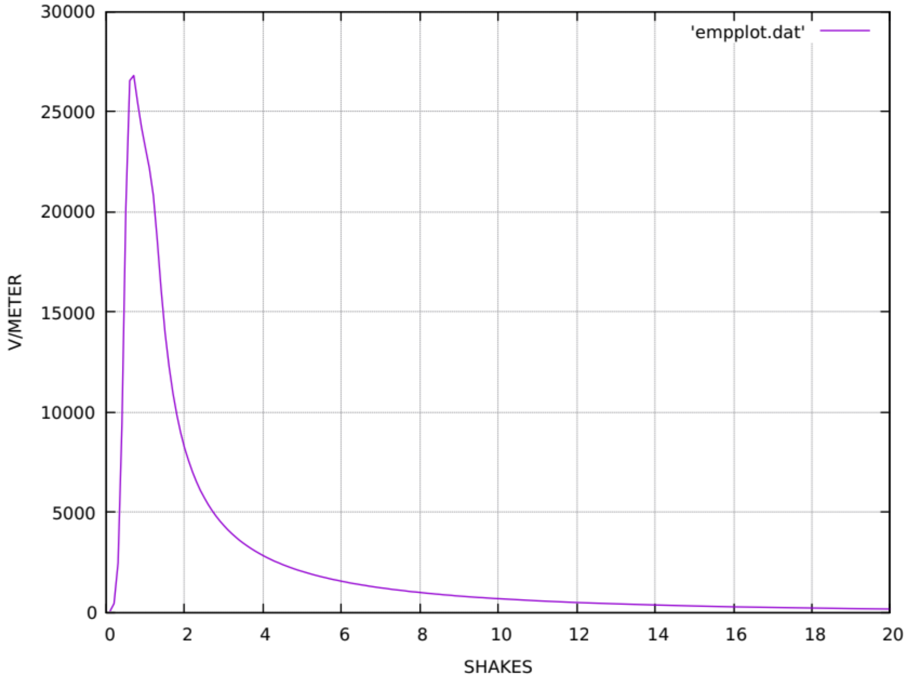
'empplot.dat'
30000
25000
20000
15000
10000
5000
0
V/METER
0
2
4
6
8
10
12
14
16
18
20
SHAKES

.75Ktons



'empplot.dat'
30000
25000
20000
15000
10000
5000
0
V/METER
0
2
4
6
8
10
12
14
16
18
20
SHAKES

1Ktons

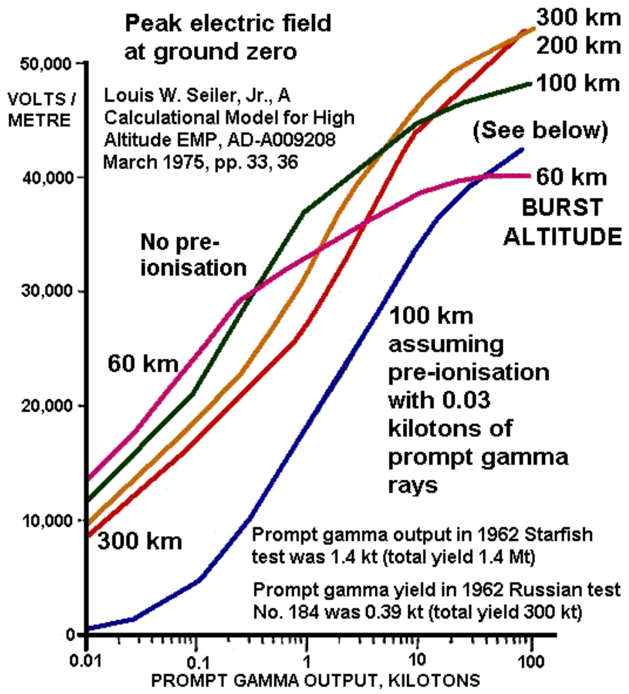


'empplot.dat'
30000
25000
20000
15000
10000
5000
0
V/METER
0
2
4
6
8
10
12
14
16
18
20
SHAKES

Notes

- The accuracy of the previous mathematical runs has not been verified.
- Please refer to cleaned up and amended fortran source code
- https://github.com/drforbin/EEMP-MODELING
- EEMP (Enhanced EMP Modeling)

Seiler emp as F(x) of prompt gamma yield



Chapman .001Ktons yield

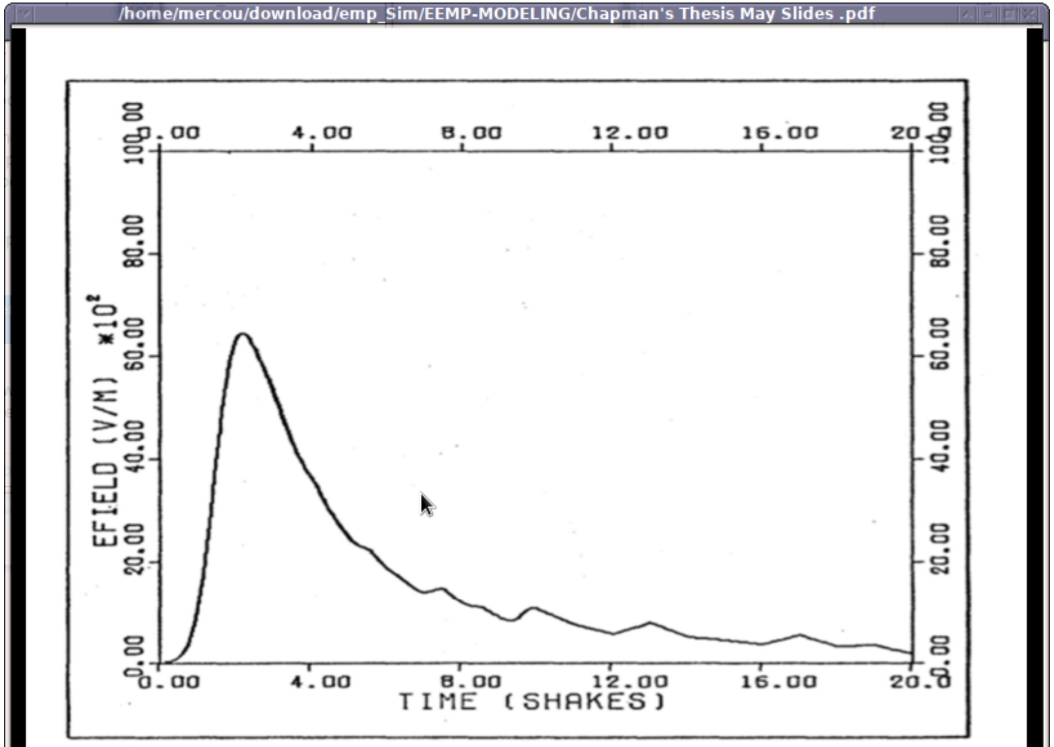


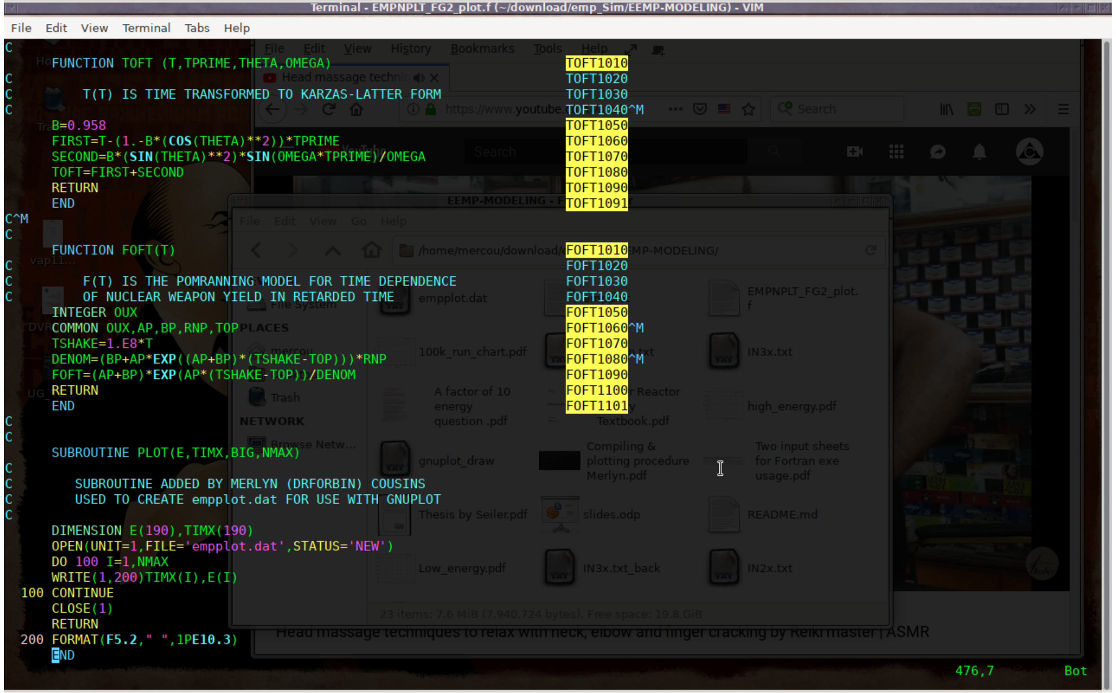
Fig. 5. Plot of E(τ) at target from a typical run

Changes added functions

Following slide shows function added for plotting purposes.

Function writes txt file which can be ran through gnuplot to produce a plot.

Added CALL for plotting



Conclusion

Based on all available data (to the presenter) the grouse constants appear to produce figures which more closely track emp as f(x) of gamma yield. Please consider the max is slightly over 50Kv/m for a gamma yield of 100Ktons (seiler chart). Using grouse's constants the 1Kton emp is ~28Kv/m, ~34Kv/m for seiler chart, and well over 100Kv/m using sunny's constants. My constants produce a result near 27Kv/m

Grouse's constants track the only available data more closely than does the sunny constants.

My constants are the more conservative but are the only constants which fully reproduce the Seiler gamma pulse faithfully using the Pommranning equation.

cont

More work has to be done to nail down exactly how these four constants interact in order that more reliable conclusions can be reached. As it stands the findings are riddled with inconsistencies.

But given both Grouse’s, My numbers and Seiler’s produce ~ a 30Kv/m EMP using a prompt gamma yield of 1Kton, which would translate into about a total weapon yield of 1000/.001=1Mton it still would pose a serious treat to unshielded electronic devices.

cont

In closing consider the fact that the U.S. among other nations has given up any pretense of civil defense as well as any major ground based ICMB systems opting for submarine based systems. It begs the question if expending money to harden infrastructure is really necessary or prudent. This is a question for political discussion. As this paper is meant to be technical in nature this aspect is rendered out of scope but is brought up as food for thought.

HAVE FUN with the Apocalypse