Brief Systems analysis of Radar Optic scoring — Basically the ~~[illegible]~~ method consists of making a motion picture record behind & along the longitudinal path of a missile or series of missiles ~~[illegible]~~ fired at a target thus obtaining a two dimensional spatial position record ~~of target and~~ of the missile ~~[illegible]~~ referenced to the target.

~~Radar ranging of relative tar~~

A record of Relative radar missile and target ranging adds the third dimension which, when ~~is~~ related to the first record gives a complete spatial position record of missile ~~related~~ relative to target. This system has ~~limitations & inherent~~ accuracies absolutely dependent upon ~~certain~~ configurations in which it is used. Some of the limiting factors will now be briefly examined-

A. ~~Techniques~~ Tactical techniques -

These of course determine the possibility of utilizing this system - Factors here are ranges, missile speeds, ~~size~~ firing craft, and target configuration, to mention a few. ~~P~~ ~~Two~~

~~str~~ ~~Primary consideration must be given~~ ~~to~~ Prerequisites of coure are ability to range missile and target ~~ra~~ by radar and to photograph target at *crossover.

In obtaining ~~strike~~ valid photographic information the ~~missile must~~ ~~cross the target plane~~ ~~follow a ~~pt~~ path through the target plane within a ~~few ten~~ small angle of ~~normal to~~ the photographic plane.~~

~~℄ of camera lens~~

it is ~~som~~ assumed that the ~~target~~ missile will follow a path through the target plane along ~~the~~ the longitudinal axis of the scoring aircraft. This ~~was~~ is easily accomplished in scoring of the E-4-5-6 system by have the scoring plane fly through on an already established course. With the ~~E H~~ E-9 utilizing G.A.R. missiles this can be accomplished by pilots tracking of the missile by ~~an optical~~ a fixed reticle. ~~Tests~~ Film from test firings at H.A.D.C. show this to be apparently simple. Scoring of the E-9 using N.O.T.S. or similiar missiles can ~~will~~ of course ~~be~~ accomplished with tactics similar to E-4-5-6.

B. ~~Phots~~ Optical considerations - Optics have been no problem of consequence with scoring of the ~~N.O.T.S. mis~~ FFAR missiles

since crossover ranges have been short. On the G.A.R. missiles it will be a crucial point requiring special techniques.
~~Impact or crossover range is It is the large~~

Since the crossover range ~~the~~ will vary from one to three miles, dependending largely upon altitudes, optics, ~~a~~ especially mounted in aircraft become a ~~sie~~ problem. With long focal length lens ~~which can be~~ such as ~~are~~ used on theodolites have a ~~n~~ ~~narrow~~ f limited field of view* (12" lens = 17°) ~~and vibrat~~ with the added problems of being sensitive to vibration.

Use of ~~infra-red film here will~~ flares on missile and target plus ~~~~ infra red film will overcome many of these difficulties. ~~E~~ Exposure can be increased until halation results which renders a small point source of light into a large

~~img~~ image. Since this image is symmetrical there is no loss in ~~st~~ reduction accuracy. It also appears that much longer focal lenght lens ~~that~~ than were first considered possible may be used, especially if pilots with good tracking ability fly the craft.

Radar Considerations - ~~o~~ the largest source of trouble here lies not in actual application but in convincing people ~~that~~ involved that such tracking

Since a missile is referenced to a tgt in a two dimensional coordinate system the total errors can be expressed ~~by~~ exactly by Eq I & III and to an approximation by eq. II alone -

ΔT arises primarily from inability to determine exact time coincidence of missile and target plane - Error in relating the two sources of information can be kept negligibly small through careful assessment -

The problem then becomes one of ~~ae~~ the accuracy with ~~witt~~ which two pulses can be matched - ~~With a~~ since these pulse represent distance the time error becomes a relation ~~bet~~ involving velocities.

$$\Delta T = \frac{\text{smallest distance resolution}}{Z_m + Z_T \sin\theta + \cos\theta \, X_T}$$

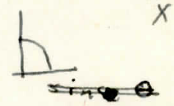
Errors in M IV scorer

1. Errors ~~arising~~ of time of crossing target plane —

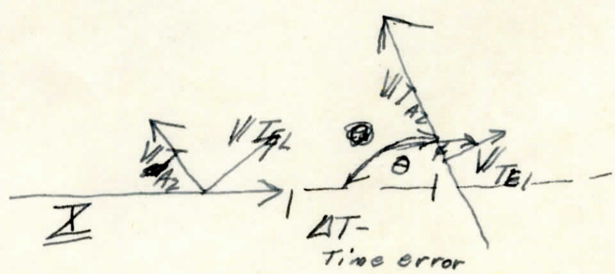
$\frac{1}{2}$ μsec pulse = $\frac{490}{\frac{1}{2}}$ = 245'

Function of tow speed + angle of attack and angular rate of missile

$\frac{y}{x}$ $\frac{y}{x}$



~~sin θ~~
cos θ

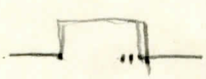


$\Delta X = \cancel{X_{T_{az}}}\ \Delta T\,(V_{M_{az}} + V_{T_{az}})\cos\theta$

$\Delta T = \dfrac{1}{Z_M + \left(Z_T \frac{\sin}{\cancel{\cos}}\theta\right)}$ X smallest dist. resolution

$d = vT$

$T =$



$\frac{490}{2} = 245$

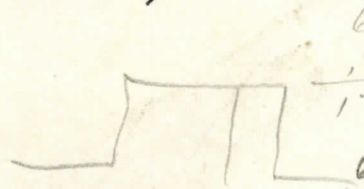
245

50'

$\frac{1}{40}$"

.025

~~600~~ 2000) 50.000
4000
10



4

600
.02
12.00

750
.8
600.

600
40
.025
600
15000

1600

1" = 1000

6") 5000

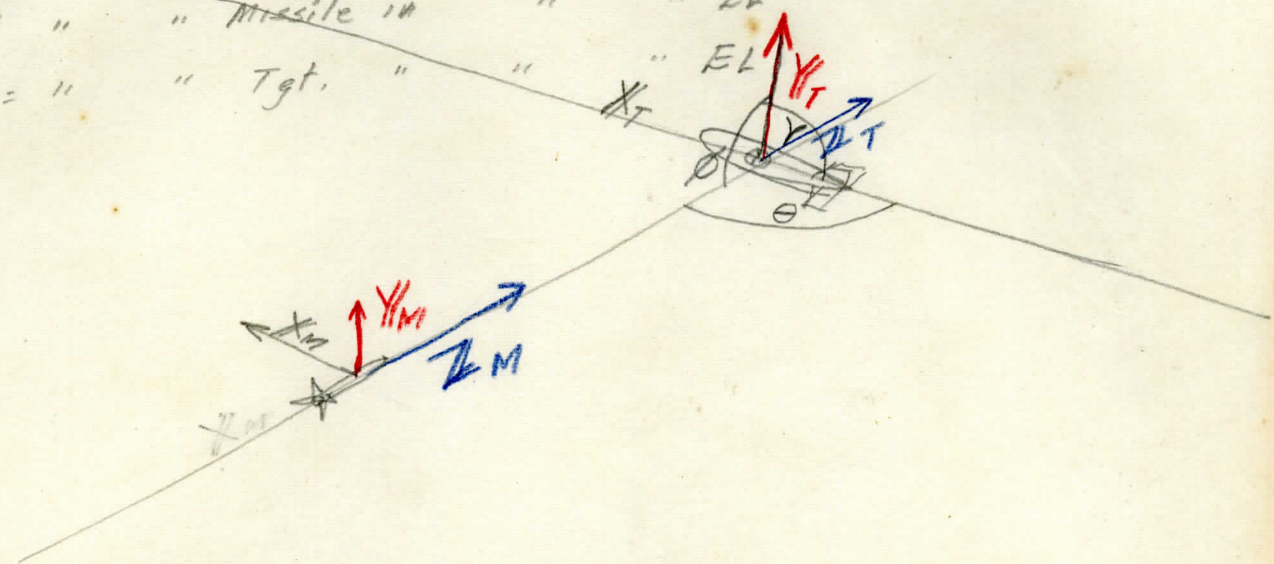
~~#~~ displayed
pulses can with care

$\mathbb{X}_M$ Velocity of missile at crossover in az.

$\mathbb{X}_T$ = " " Tgt " " " "

$\mathbb{Y}_M$ = " " ~~Missile in~~ " " El

$\mathbb{Y}_T$ = " " Tgt. " " " EL



I. $\Delta X = \Delta T(\mathbb{X}_M) + \Delta T(\mathbb{X}_T)\cos\theta$

$\mathbb{X}$ can be taken as tgt. speed since tgt is not maneuvering -

$\mathbb{X}_m$ is negligible with FFAR's ~~but~~ and is small with any missile so that it can be usually neglected with I becoming

II. $\Delta X = \Delta T(\text{target speed})\cos\theta$

III $\Delta Y = \Delta T(Y_m) + \Delta T(\mathbb{Y}_T)\cos\phi$

Th $\mathbb{Y}_T$'s is ~~usually~~ ~~under p~~ ~~usually sm~~ with a towed target ~~small~~ 0 and $\mathbb{Y}_m$ is usually small, in the case of NOTS being velocity ~~of~~ due to gravity this whole expression can usually be neglected -