

1C Summary: Reader study to characterize uncertainty in volume and other reader-based sizing of nodules in CT imagery collected on scanners from several vendors. The imaging protocol is to include an ACRIN 6678 branch and an image quality-based, device-independent branch.

1. Analyze the accuracy and precision of sizing measures for all design factors including:
  - 5-6 site / device (Ind. Variables Tested)
  - 2 imaging protocol factors (Ind. Variables Tested); ACRIN6678, imaging quality-based, device-independent branch
  - Nodule characteristics (shape, size, intensity): Ind. Variables Tested Controlled
  - Reader (Ind. Variables Tested Controlled)

The 6 phantom nodules (-10HU, 3 spherical and 3 spiculated in size of 5, 10, 20mm) will be read by radiologists.

2. Determine the minimum detectable level of change that can be achieved when measuring nodules in phantom datasets.

*This will be an inference from the aim 1.*

### Power calculation Study

Since we've learned an intra and inter variation in a single site/device and one protocol from 1A, we can use an estimation of the coefficient of determination (R2) from the regression model on the relative bias (i.e. (measured size –true size)/true size\*100). The R2 was approximately 0.30 from regressing the nodule characteristics and readers on the relative bias (Appendix 1), which indicated 30% of the variation in the relative bias can be explained by the nodule characteristics and reader.

A method of multiple-regression can be considered for testing the significant difference in site/device and protocol effects in controlling nodule characteristics and reader in the outcome variable of the relative bias.

### Summary Statements

A sample size of 62 achieves 81% power to detect an R-Squared of 0.10 attributed to 2 independent variables of site/device and protocol effects using an F-Test with a significance level (alpha) of 0.05. The variables tested are adjusted for an additional 2 independent variables of nodule characteristics and readers with an R-Squared of 0.30.

This is an initial thought for setting the number of images. In 1C plan, we will have 6 phantoms\*2 protocols\*5-6 sites= 60~72 images. In this case, the study power will be close to 80%-85% to detect an R-Squared of 0.10, meaning that the protocol difference and the nodule characteristics will additionally explain the 10% variation of relative bias under controlling the reader and nodule characteristics.

**Table 1.  
Numeric Results**

Power	N	Alpha	Beta	Ind. Variables Tested		Ind. Variables Controlled	
				Cnt	R2	Cnt	R2
0.80708	62	0.05000	0.19292	2	0.10000	2	0.30000
0.80395	39	0.05000	0.19605	2	0.15000	2	0.30000
0.80721	28	0.05000	0.19279	2	0.20000	2	0.30000
0.80806	17	0.05000	0.19194	2	0.30000	2	0.30000

0.81877	12	0.05000	0.18123	2	0.40000	2	0.30000
0.85157	69	0.05000	0.14843	2	0.10000	2	0.30000
0.85592	44	0.05000	0.14408	2	0.15000	2	0.30000
0.85330	31	0.05000	0.14670	2	0.20000	2	0.30000
0.86538	19	0.05000	0.13462	2	0.30000	2	0.30000
0.87066	13	0.05000	0.12934	2	0.40000	2	0.30000
0.90360	80	0.05000	0.09640	2	0.10000	2	0.30000
0.90216	50	0.05000	0.09784	2	0.15000	2	0.30000
0.90898	36	0.05000	0.09102	2	0.20000	2	0.30000
0.90690	21	0.05000	0.09310	2	0.30000	2	0.30000
0.90861	14	0.05000	0.09139	2	0.40000	2	0.30000

### Report Definitions

Power is the probability of rejecting a false null hypothesis.

N is the number of observations on which the multiple regression is computed.

Alpha is the probability of rejecting a true null hypothesis. It should be small.

Beta is the probability of accepting a false null hypothesis. It should be small.

Cnt refers to the number of independent variables in that category.

R2 is the amount that is added to the overall R-Squared value by these variables.

Ind. Variables Tested are those variables whose regression coefficients are tested against zero.

Ind. Variables Controlled are those variables whose influence is removed from experimental error.

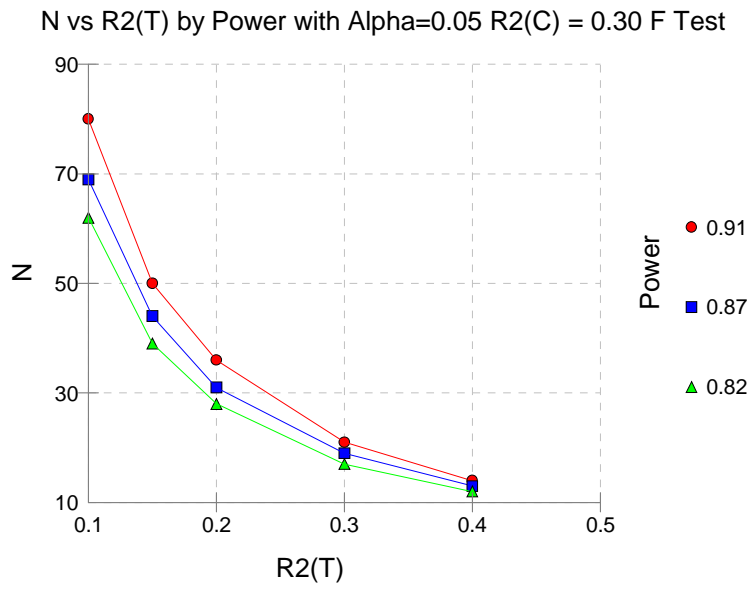
### Appendix1

```
. reg pcdiff slice_5mm ovoid lobulated spiculated intensityHU100 size_mm order_id session
_Ireader_2 _Ireader_3 _Ireader_4 _Ireader_5 _Ireader_6 if vol==1
```

Source	SS	df	MS	Number of obs =	480
Model	65751.0911	13	5057.77624	F( 13, 466) =	14.47
Residual	162865.312	466	349.496378	Prob > F =	0.0000
Total	228616.403	479	477.278503	R-squared =	0.2876
				Adj R-squared =	0.2677
				Root MSE =	18.695

pcdiff	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
slice_5mm	-3.597743	1.706596	-2.11	0.036	-6.951319 -.2441661
ovoid	-4.119627	4.673706	-0.88	0.379	-13.30378 5.06452
lobulated	5.444625	2.698365	2.02	0.044	.1421549 10.7471
spiculated	-2.013896	2.698365	-0.75	0.456	-7.316366 3.288574
intensit~100	2.858539	1.706596	1.67	0.095	-.4950381 6.212115
size_mm	.3041635	.2698365	1.13	0.260	-.2260835 .8344106
order_id	3.467392	1.706596	2.03	0.043	.1138157 6.820969
session	-.2525518	1.706596	-0.15	0.882	-3.606128 3.101025
_Ireader_2	5.977652	2.955911	2.02	0.044	.169087 11.78622
_Ireader_3	-4.765562	2.955911	-1.61	0.108	-10.57413 1.043003
_Ireader_4	-16.9857	2.955911	-5.75	0.000	-22.79427 -11.17714
_Ireader_5	-18.60195	2.955911	-6.29	0.000	-24.41051 -12.79338
_Ireader_6	-25.67342	2.955911	-8.69	0.000	-31.48198 -19.86485
_cons	-1.061574	6.033728	-0.18	0.860	-12.91826 10.79511

Appendix 2: Graphic illustration of sample size and study power  
**Chart Section**



**References**

Cohen, Jacob. 1988. Statistical Power Analysis for the Behavioral Sciences, Lawrence Erlbaum Associates, Hillsdale, New Jersey.