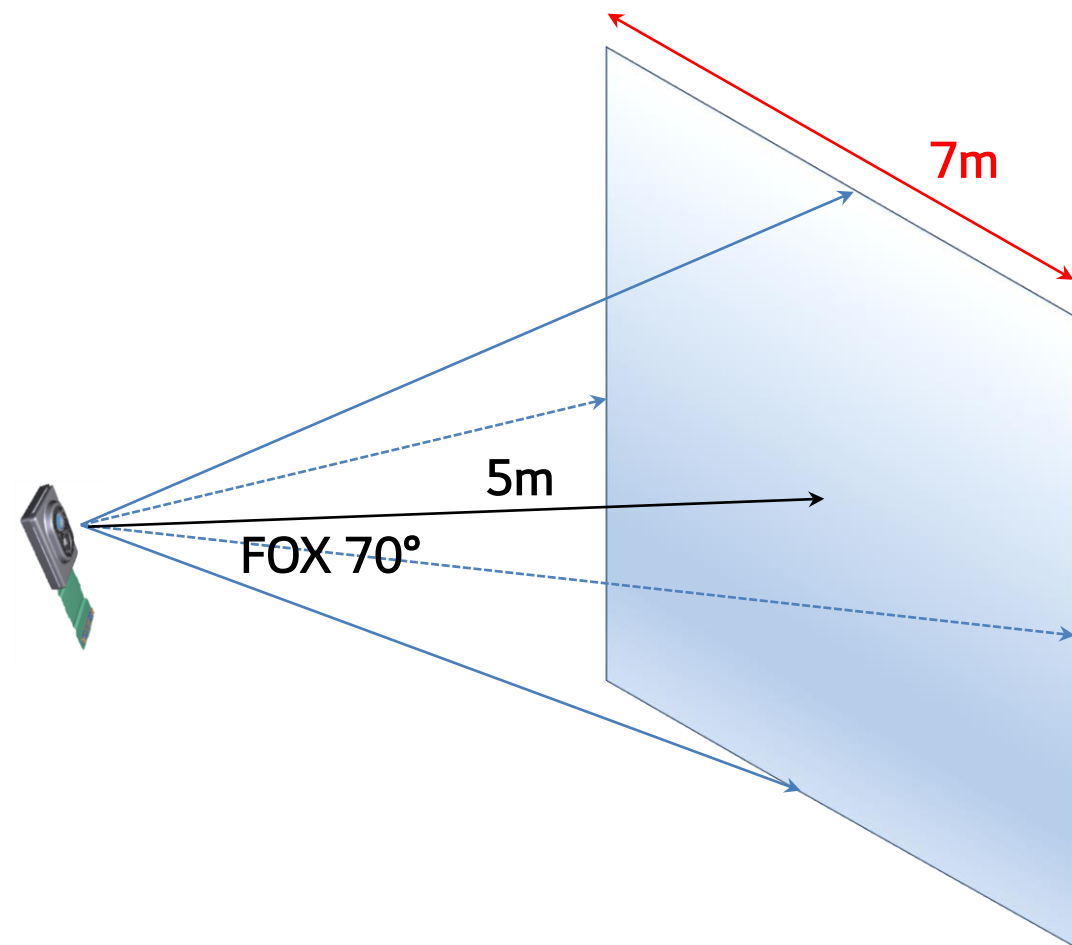


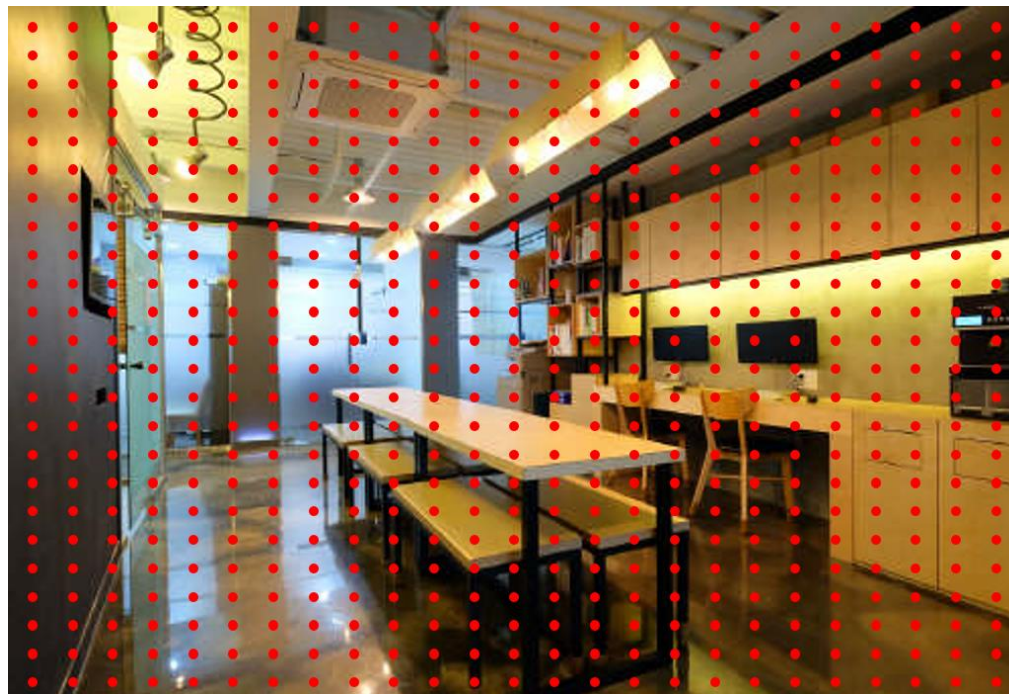
Unified Calibration

1. Basic theory

How to measure



576 Spots dispersion (24x24)



a) Distance (ToF)
→ Depth Calibration

b) Spot characteristic
→ Multi-plane Calibration

Machine Integration (PRI Unified Calibration)

Rail Station (x1ea)

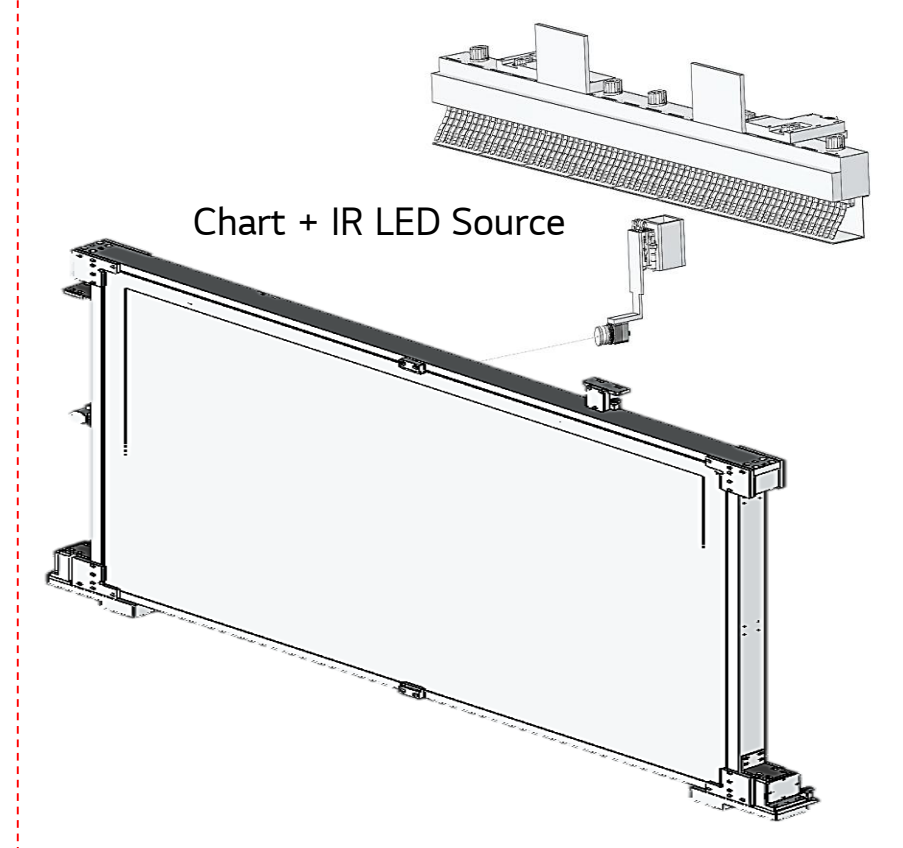
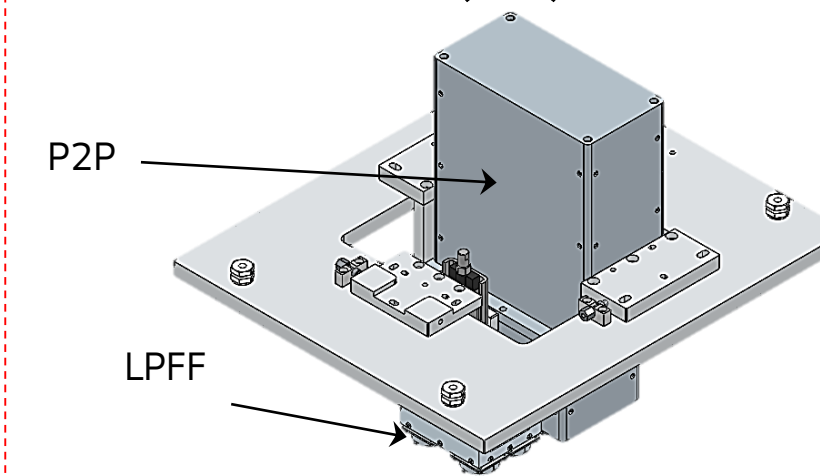


Chart + IR LED Source

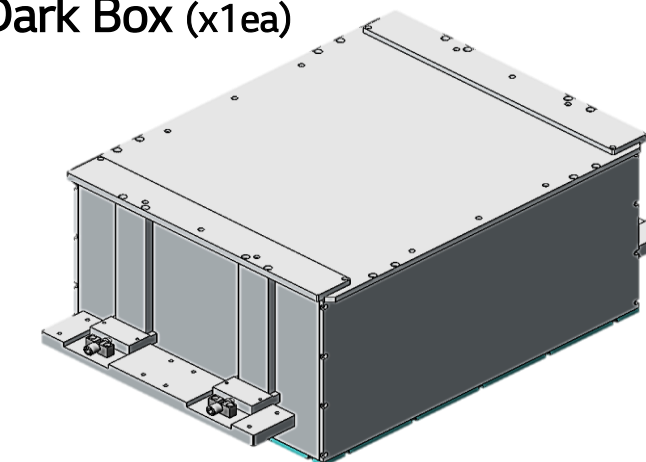
LPFF / P2P Station (x3ea)



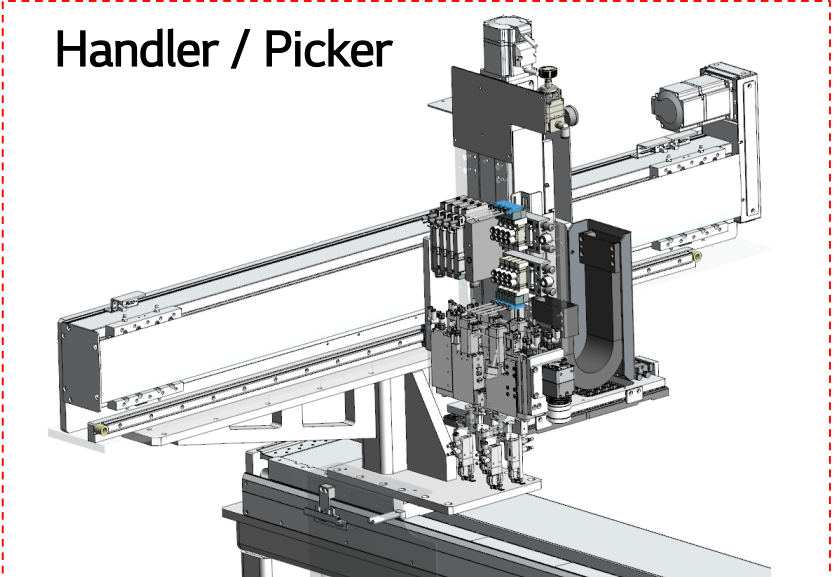
P2P

LPFF

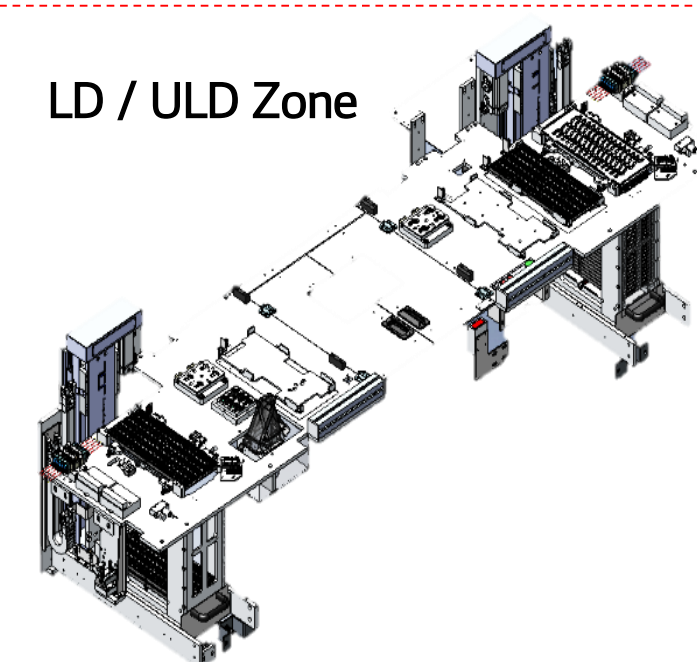
Dark Box (x1ea)



Handler / Picker



LD / ULD Zone



2. Test Station

Test Sequence

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	# of Frame	Bank Interleaved	Related Item
Dark Box	Reference Scan	30cm	Y	Y	N	280	0x0F	Reference scan laser intensity, T0 timing
	ImageX4_DarkBox	30cm	N	Y	N	180	0x0F	Spot Finder
	Gate_Timing_Scan	-	Y	N	N	224	0x0F	Gate delay, Image stray delay
	TOF_DarkBox_OP	30cm	Y	Y	N	40	0x0F	Depth quality (*Related with ToF 60cm)
LPFF	Image_FFLP	-	Y	N	Y	-	0x0F	FFLP RI Symmetry
	DNL_CW_ShortRange	-	Y	N	Y	400	0x0F	Differential Non Linearity
	DNL_CW_Normal	-	Y	N	Y	400	0x0F	
	DNL_Short_BIST	-	Y	N	N	-	0x0F	Built in Self Test
	DNL_Normal_A_BIST	-	Y	N	N	-	0x0F	
Depth	ImageX4_100cm	100cm	N	Y	N	180	0x0F	Spot quality, Stray quality, Pulse shape quality
	TOP_100cm_OP	100cm	Y	Y	N	40	0x0F	Depth quality, Calibration quality
	Image_100cm	100cm	Y	N	Y	45	0x01	Intrinsic calibration
	Image_90cm	90cm	Y	N	Y	45	0x01	
	Image_80cm	80cm	Y	N	Y	45	0x01	
	TOF_60cm_OP	60cm	Y	Y	N	40	0x0F	Depth calibration
P2P (NVM)	P2P_Scan	-	Y	Y	N	420	0x01	Rx pixel to Pixel time calibration

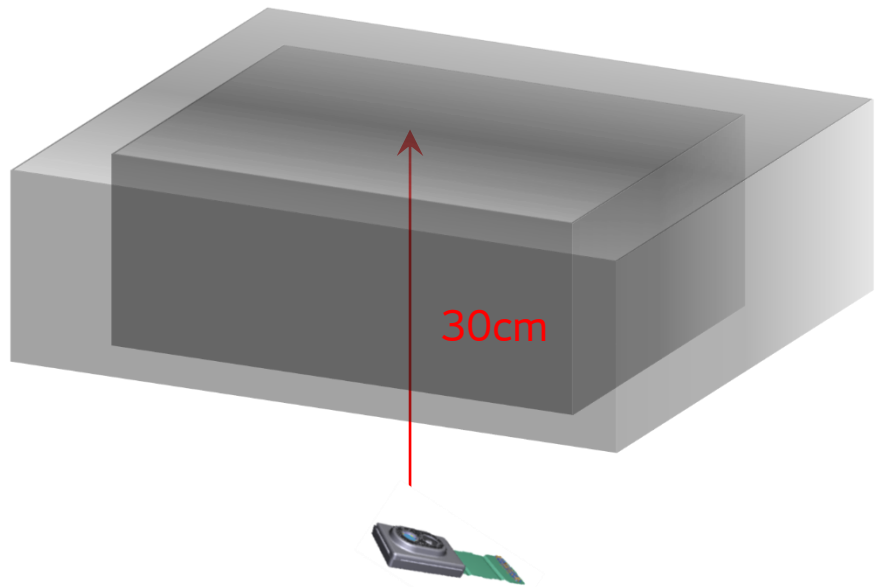
Dark Box

3. Test Sequence; Dark_Box

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	Reference Scan	30cm	Y	Y	N	0x0F	Reference scan laser intensity, T0 timing
	ImageX4_DarkBox	30cm	N	Y	N	0x0F	Spot Finder
	Gate_Timing_Scan	-	Y	N	N	0x0F	Gate delay, Image stray delay
	TOF_DarkBox_OP	30cm	Y	Y	N	0x0F	Depth quality (*Related with ToF 60cm)

Test condition



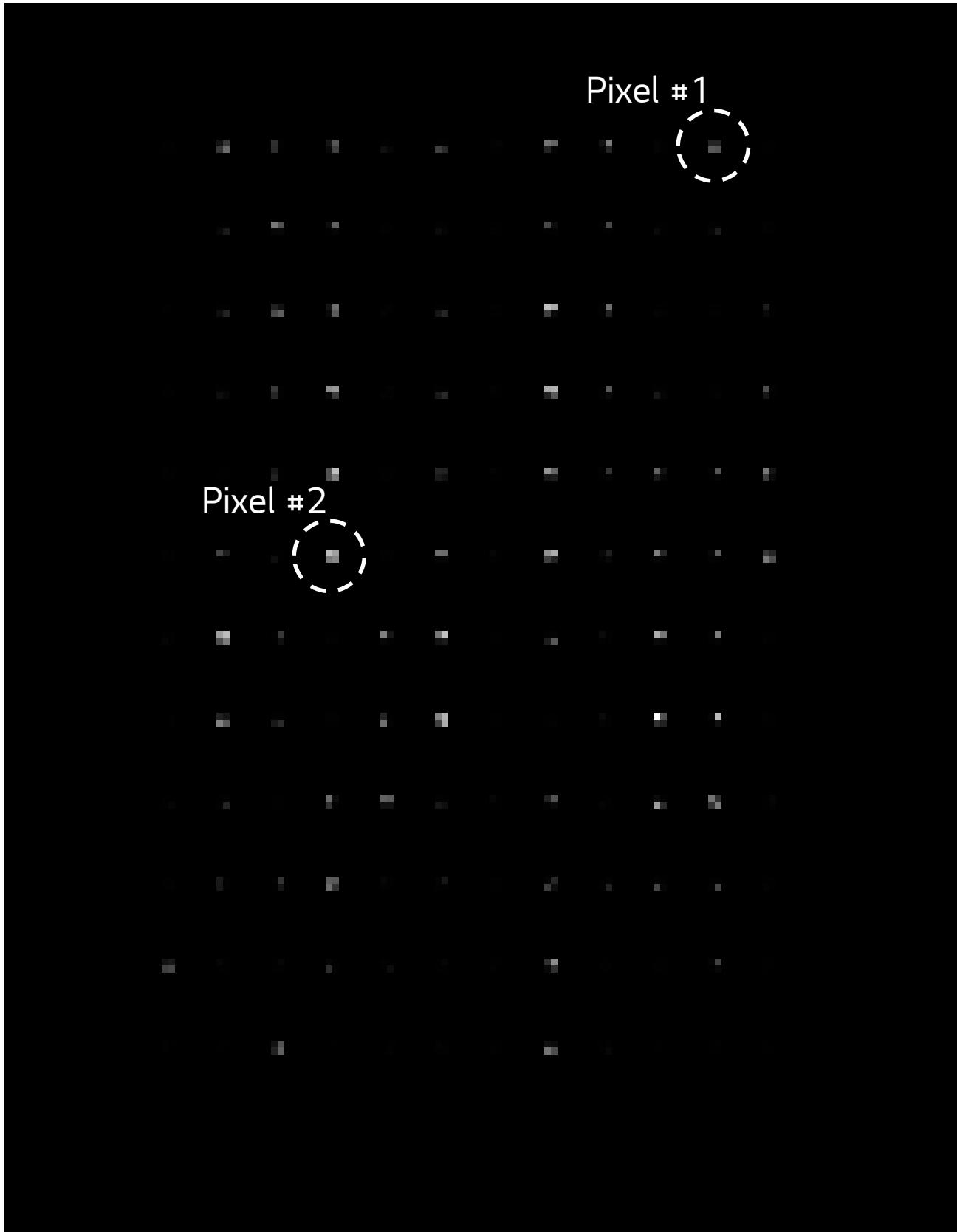
	Distance
Top reflectance	10±2%@960nm
Side reflectance	5%@960nm ↓
Reflectance type	Mirror-like
Flatness	0 ± 0.5 ° (Set-up Spec.)
Distance	30 ± 0.1 cm (Set-up Spec.)

3. Test Sequence; Dark_Box – ReferenceScan

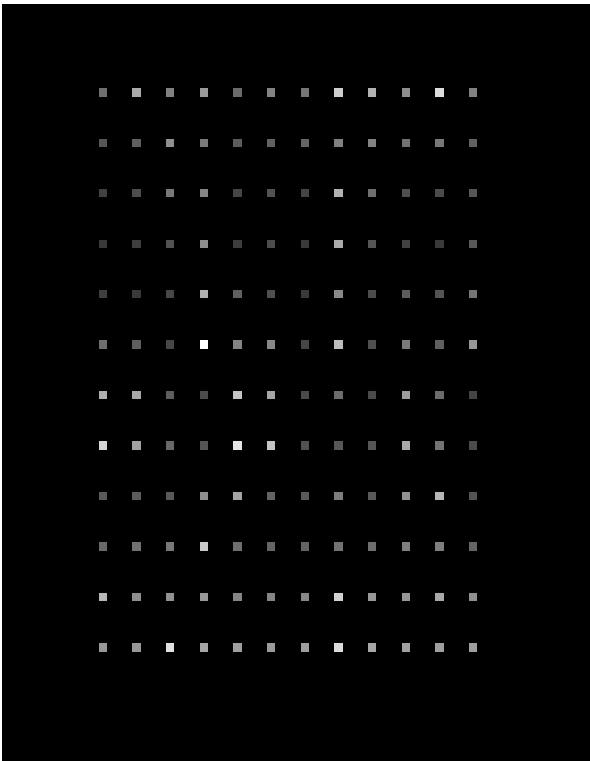
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	Reference Scan	30cm	Y	Y	N	0x0F	Reference scan laser intensity, T0 timing

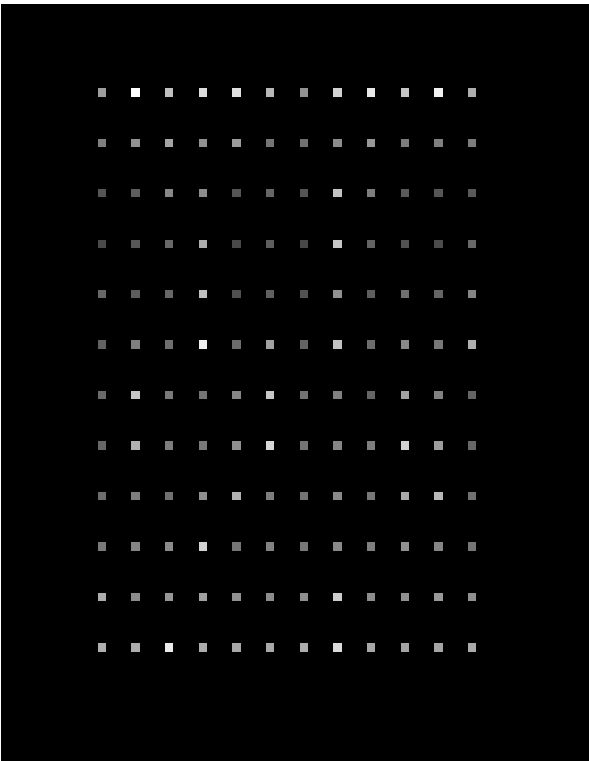
Reference Scan Image



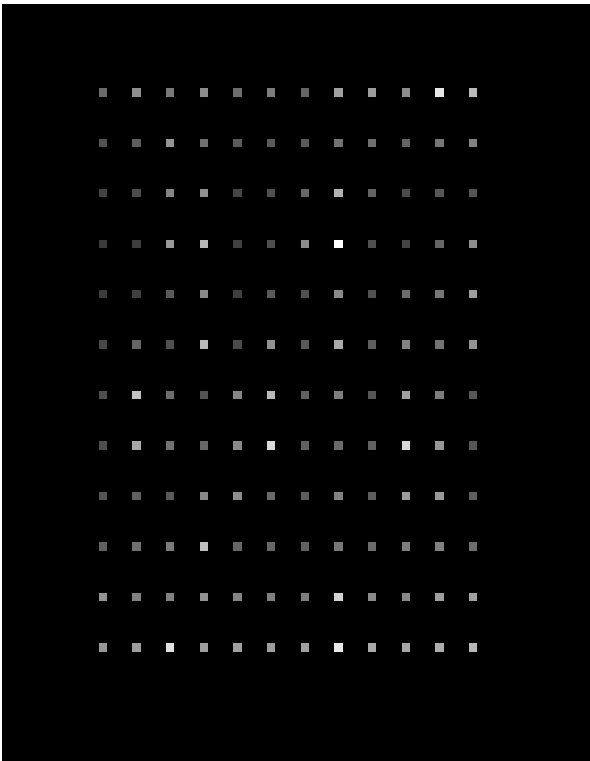
Kirk_Bank_1



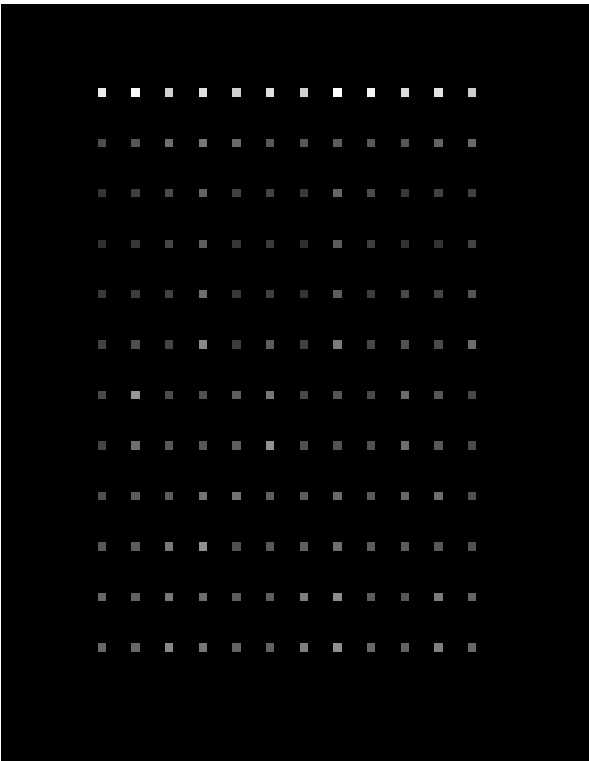
Kirk_Bank_2



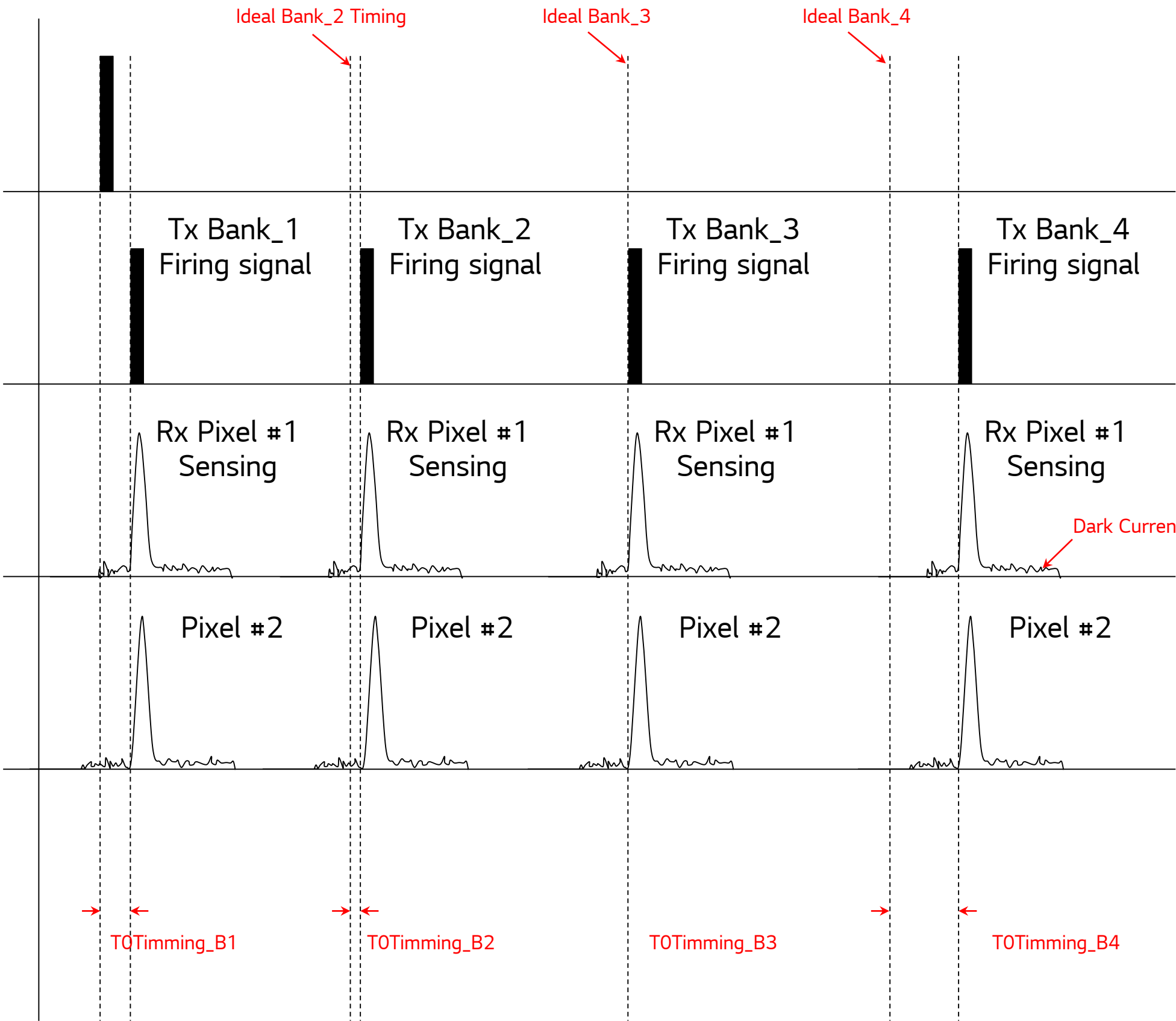
Kirk_Bank_3



Kirk_Bank_4



F-sync

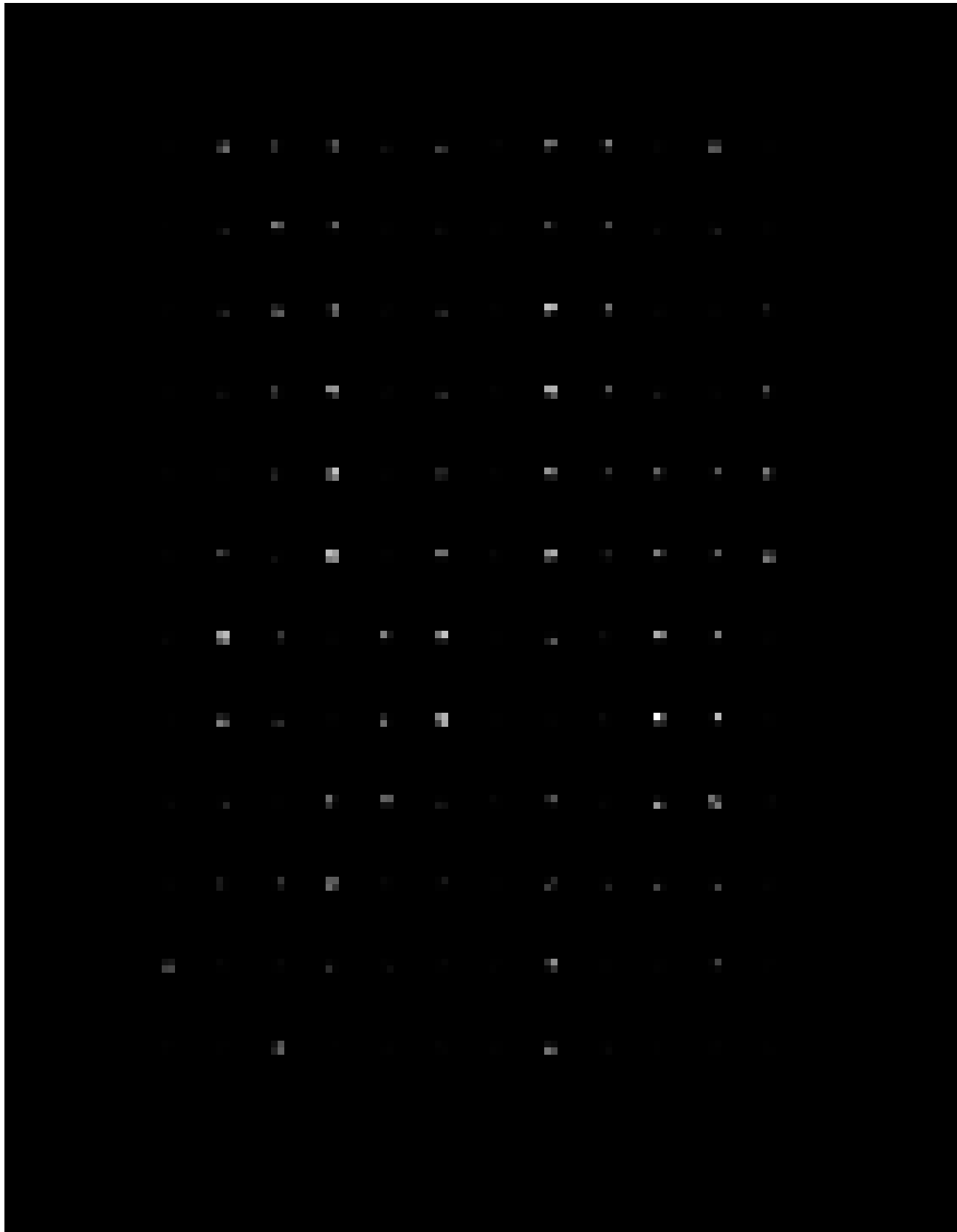


3. Test Sequence; Dark_Box – ReferenceScan

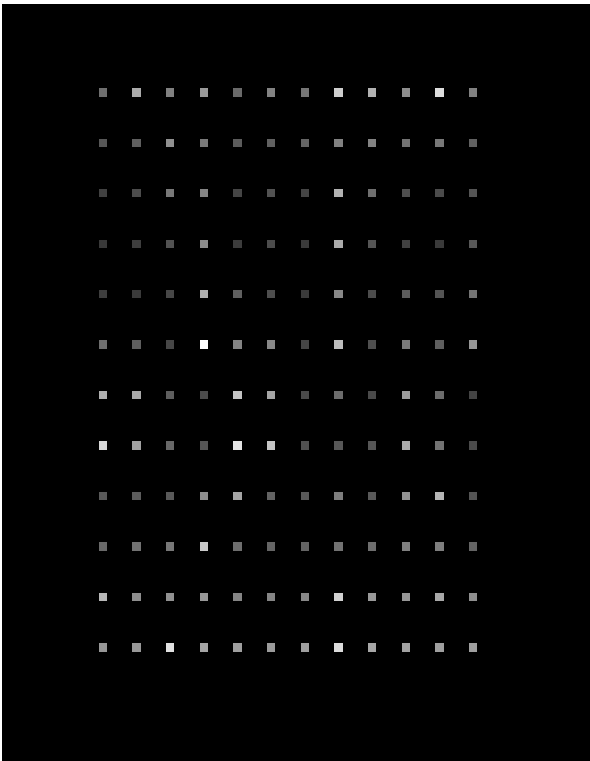
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	Reference Scan	30cm	Y	Y	N	0x0F	Reference scan laser intensity, T0 timing

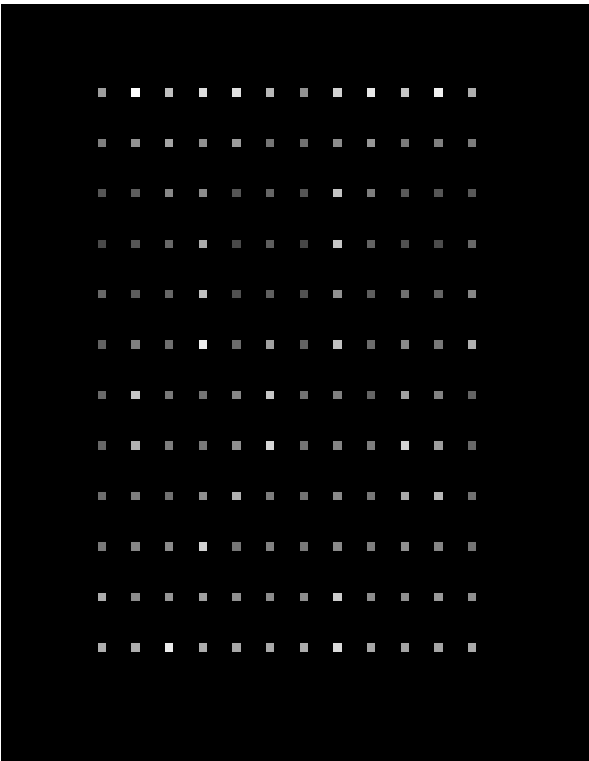
Reference Scan Image



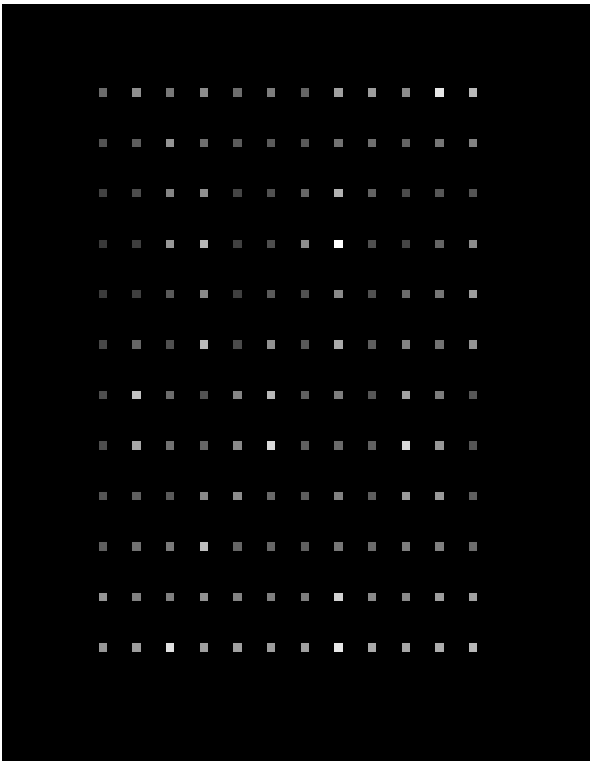
Kirk_Bank_1



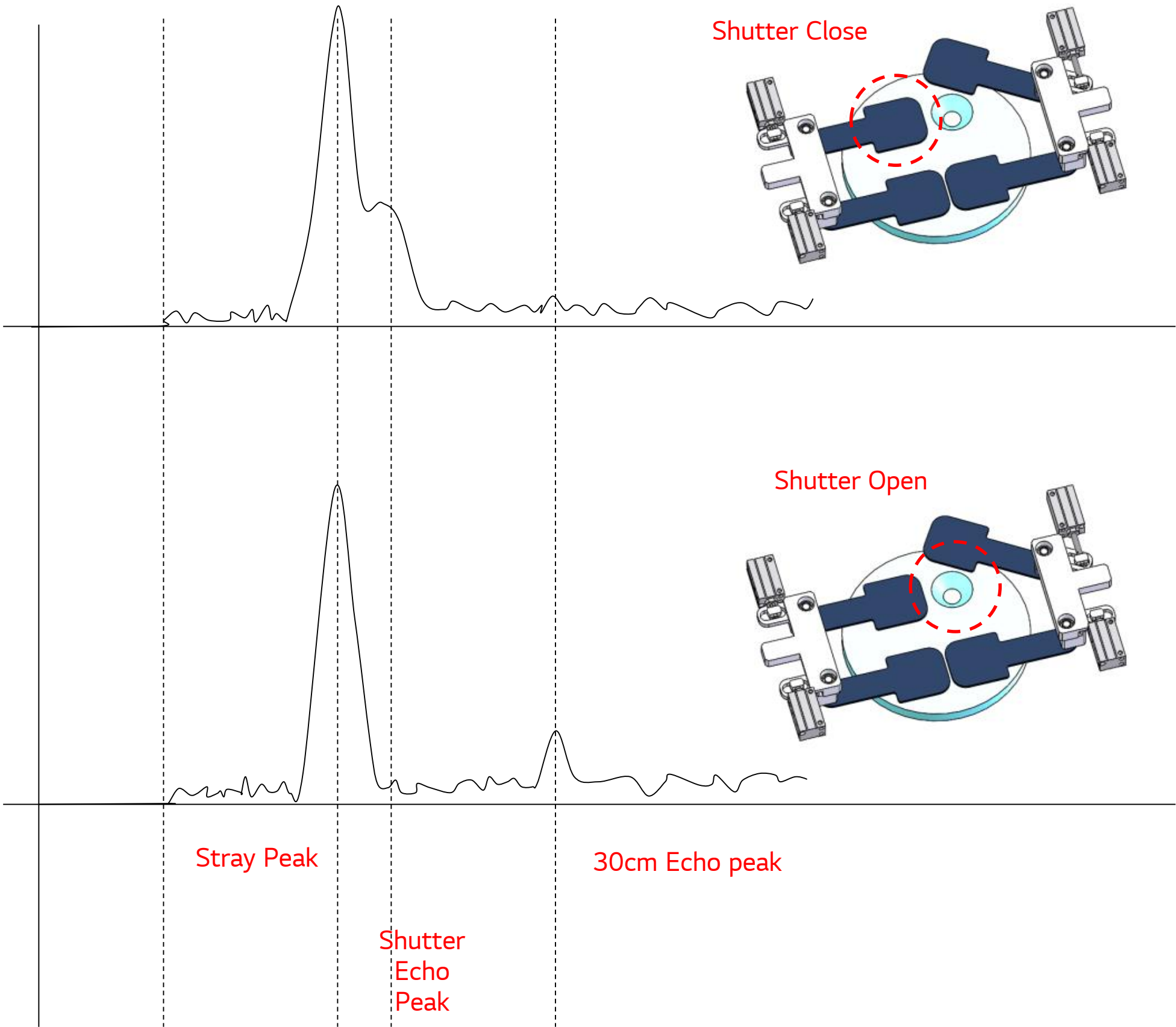
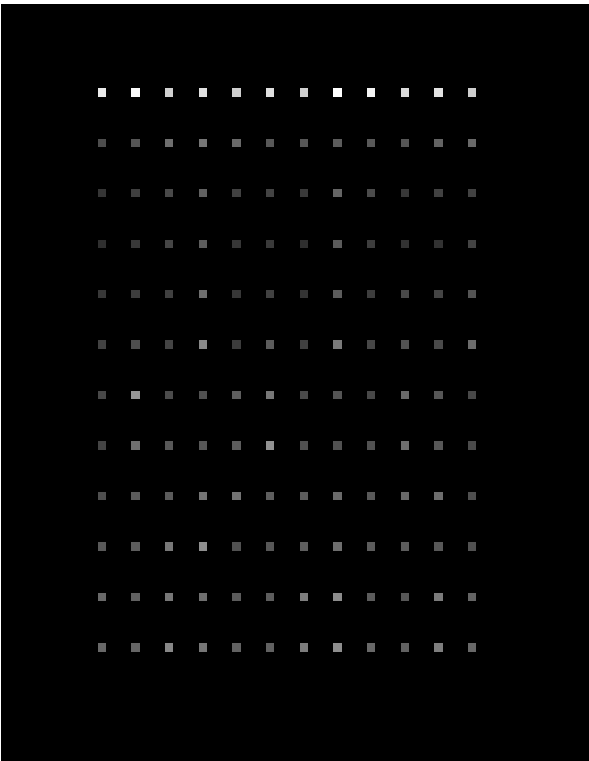
Kirk_Bank_2



Kirk_Bank_3



Kirk_Bank_4

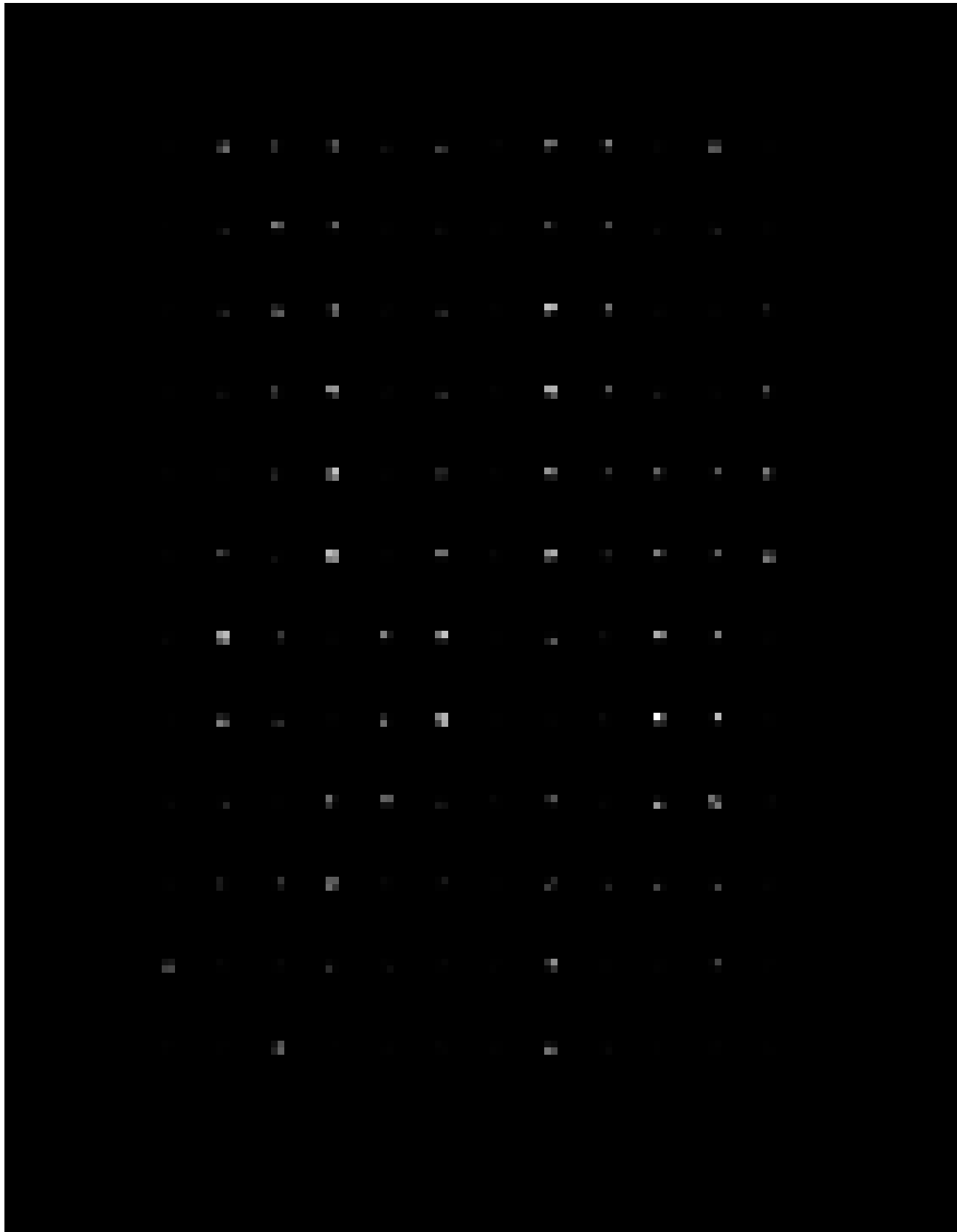


3. Test Sequence; Dark_Box – ReferenceScan

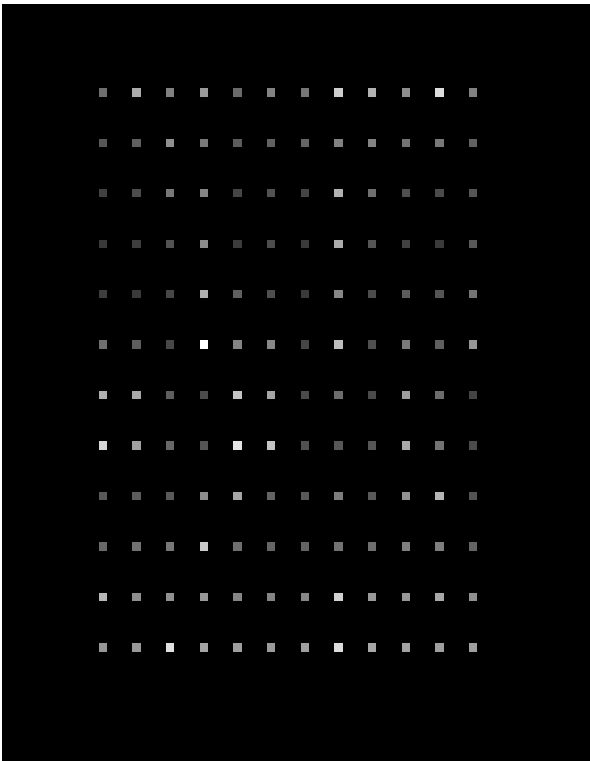
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	Reference Scan	30cm	Y	Y	N	0x0F	Reference scan laser intensity, T0 timing

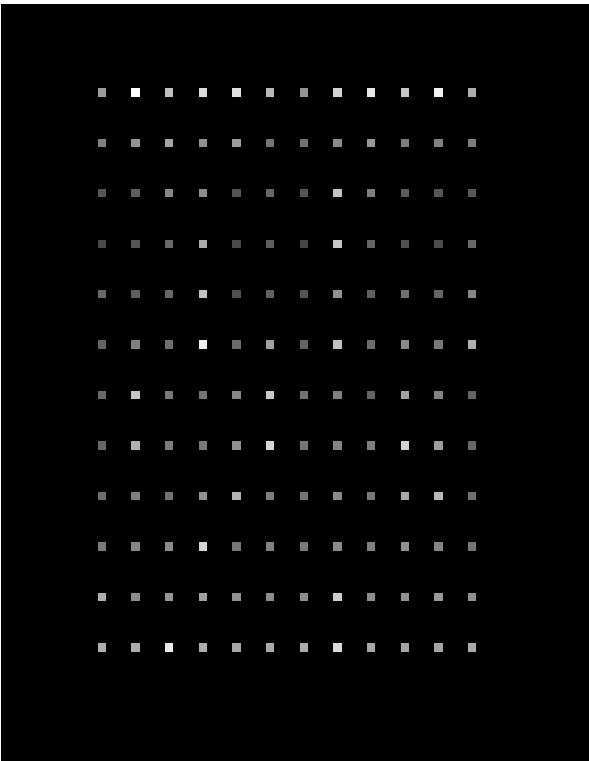
Reference Scan Image



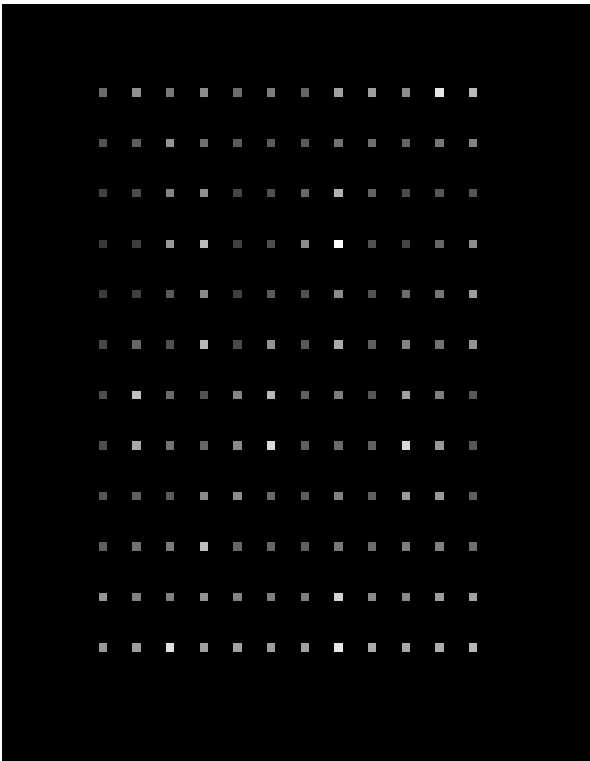
Kirk_Bank_1



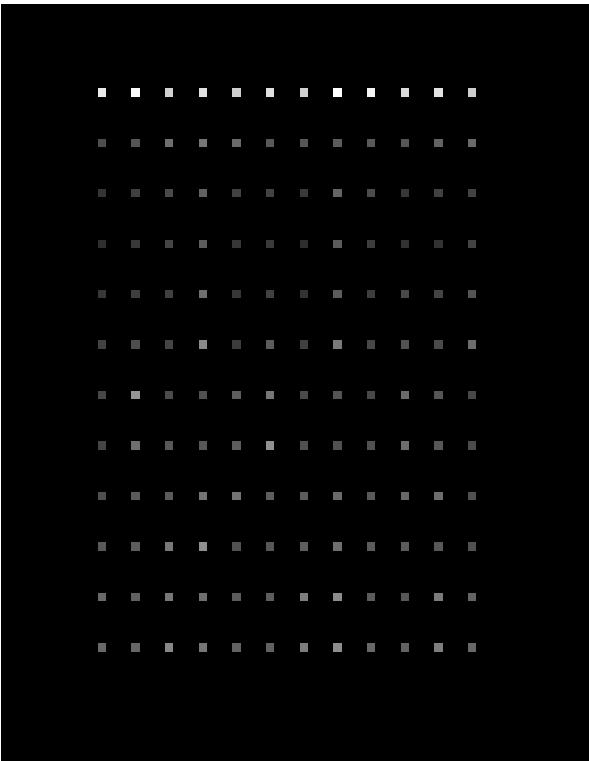
Kirk_Bank_2



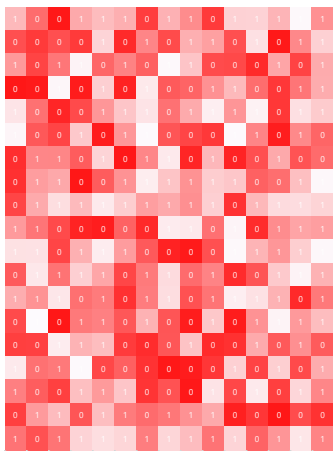
Kirk_Bank_3



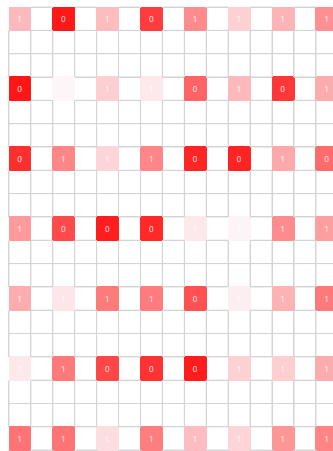
Kirk_Bank_4



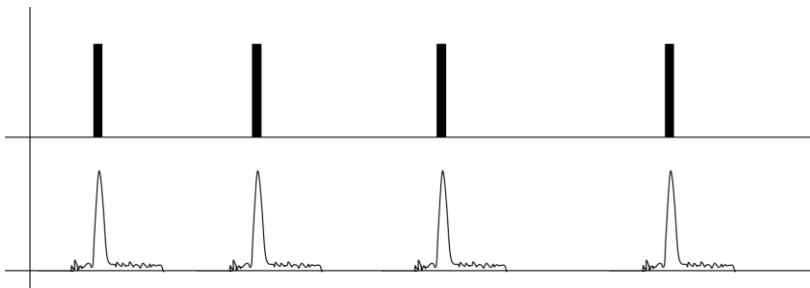
1. Stray Measurement by Periscope



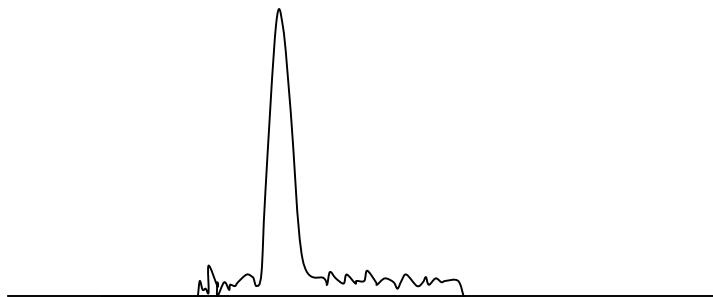
2. Average value from fixed pixel (Before Spot finder)



3. Histogram analysis (Timing calculation per Bank)



4. Histogram analysis (Dark Current - noise level)

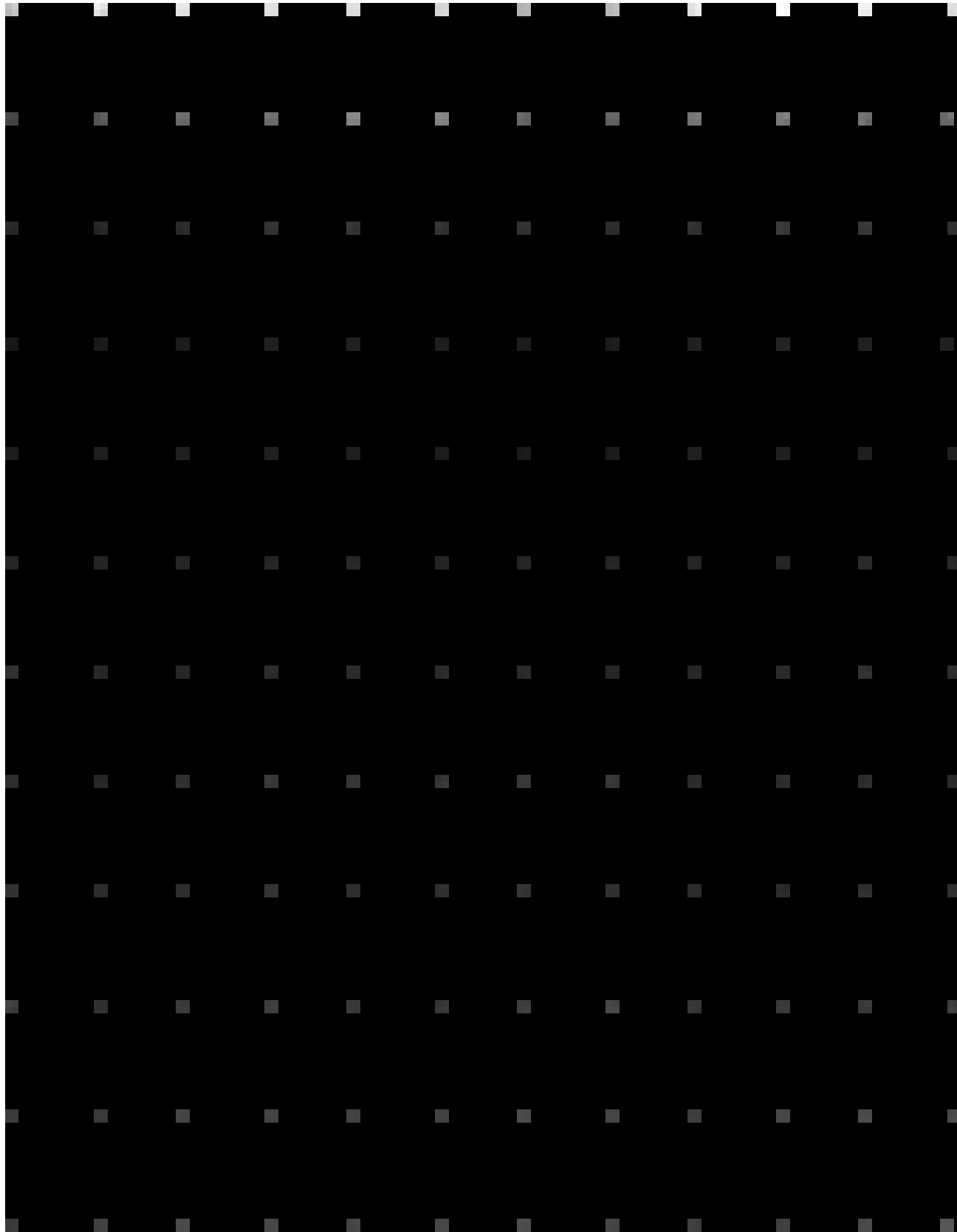


3. Test Sequence; Dark_Box – GateTiming

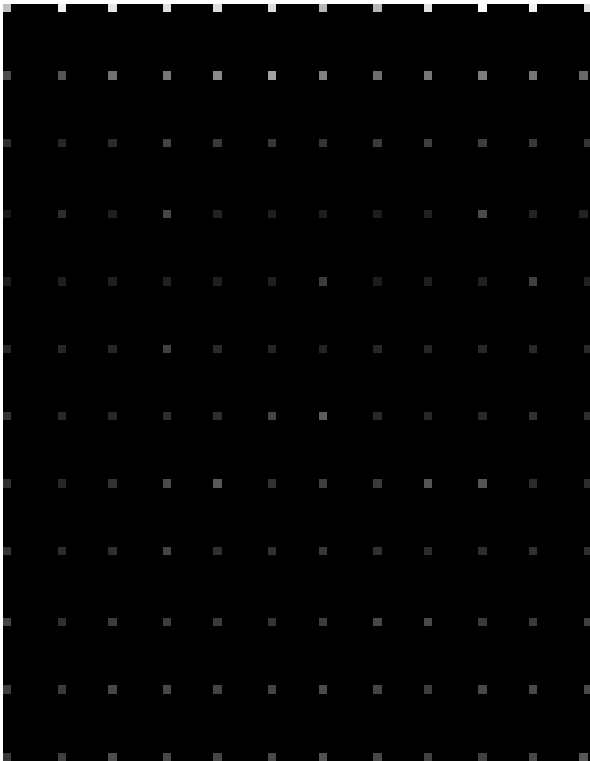
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	Gate_Timing_Scan	-	Y	N	N	0x0F	Gate delay, Image stray delay

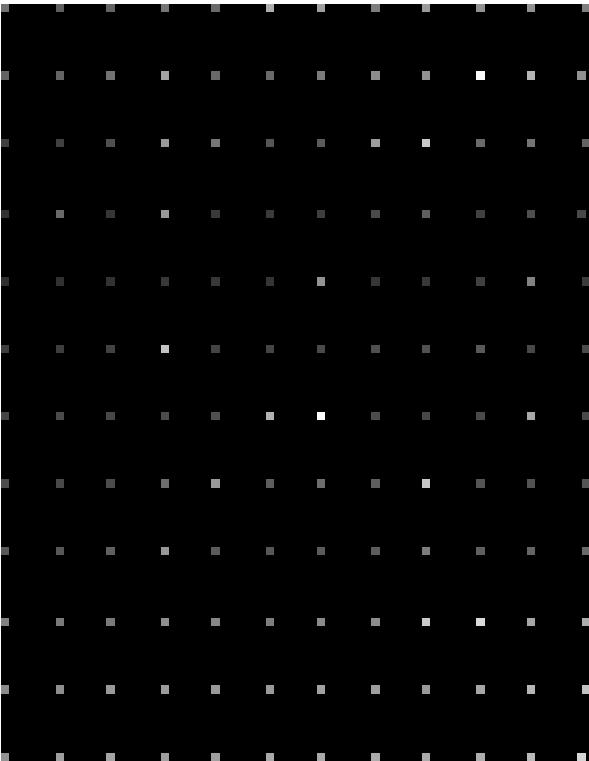
Gate Timing Image



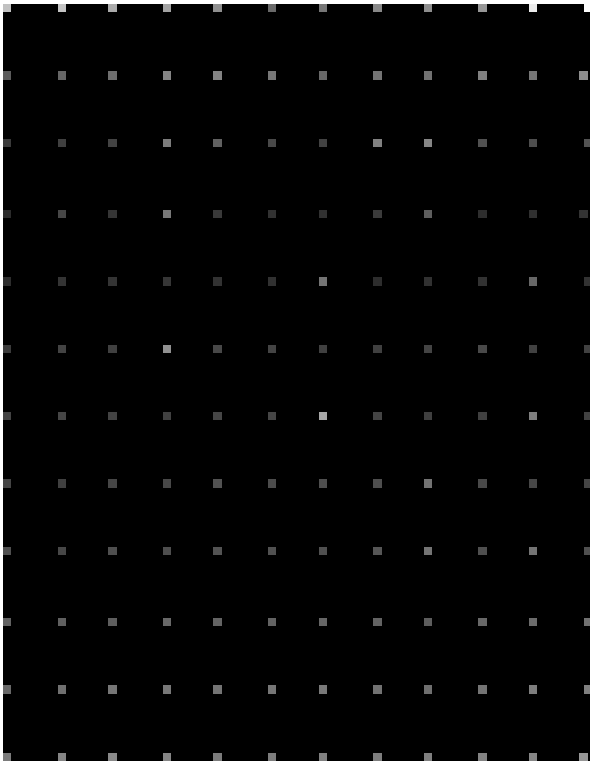
Kirk_Bank_1



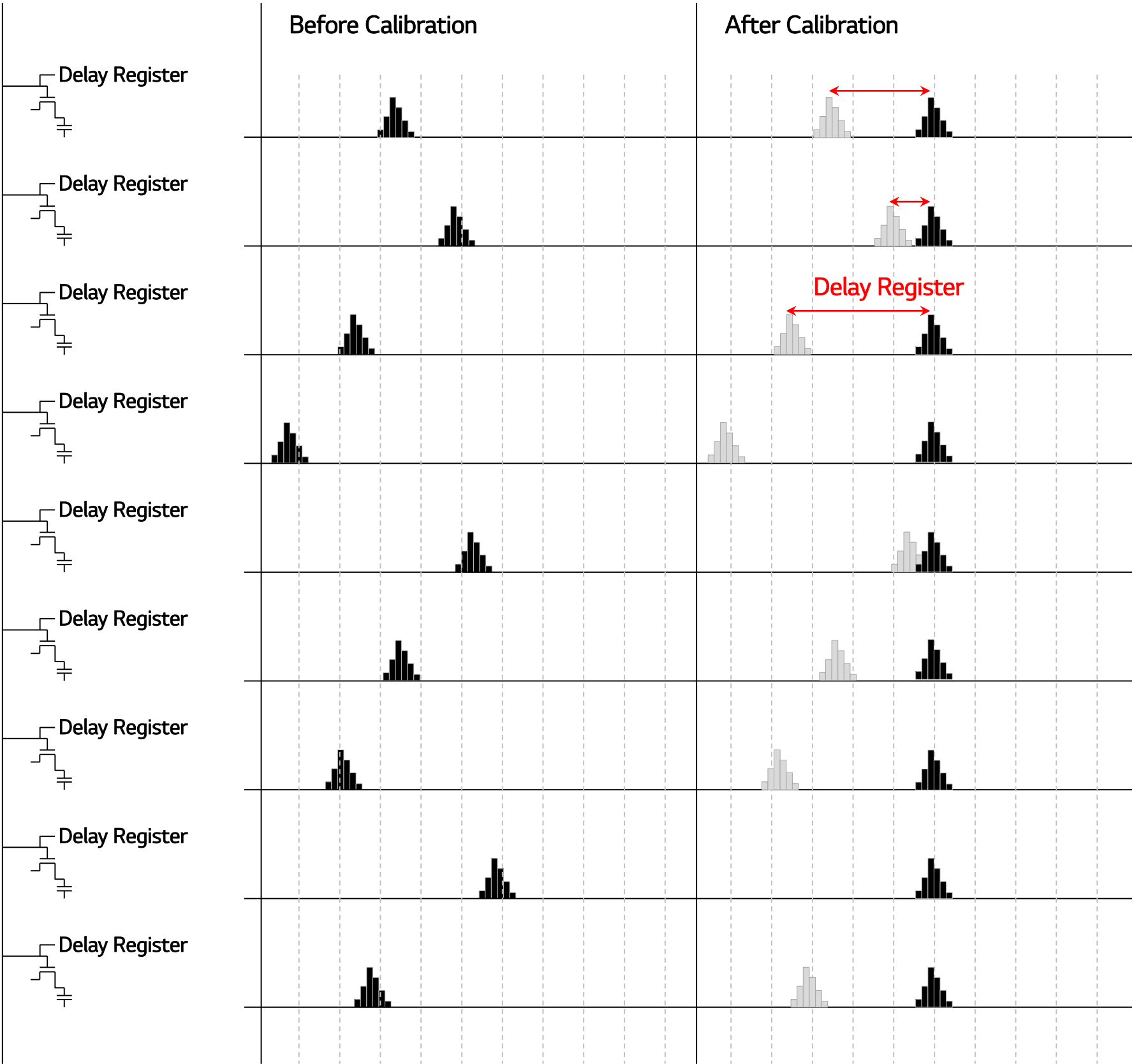
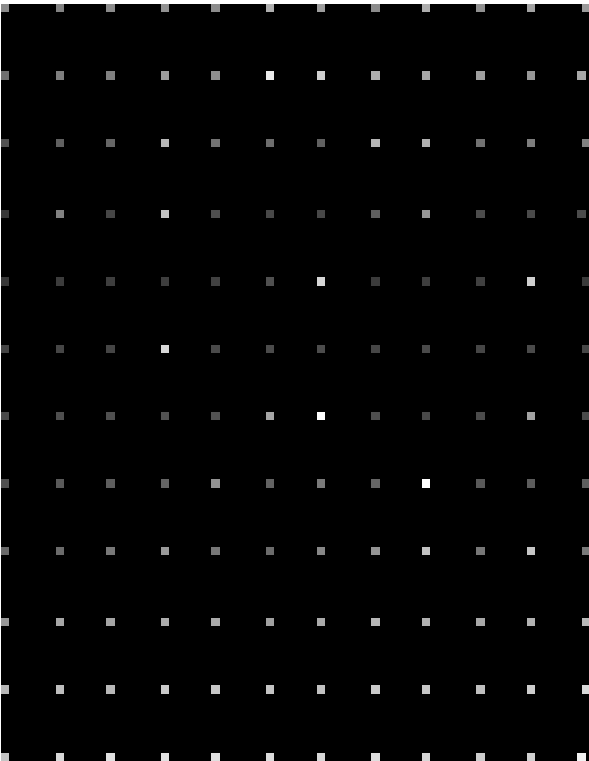
Kirk_Bank_2



Kirk_Bank_3



Kirk_Bank_4

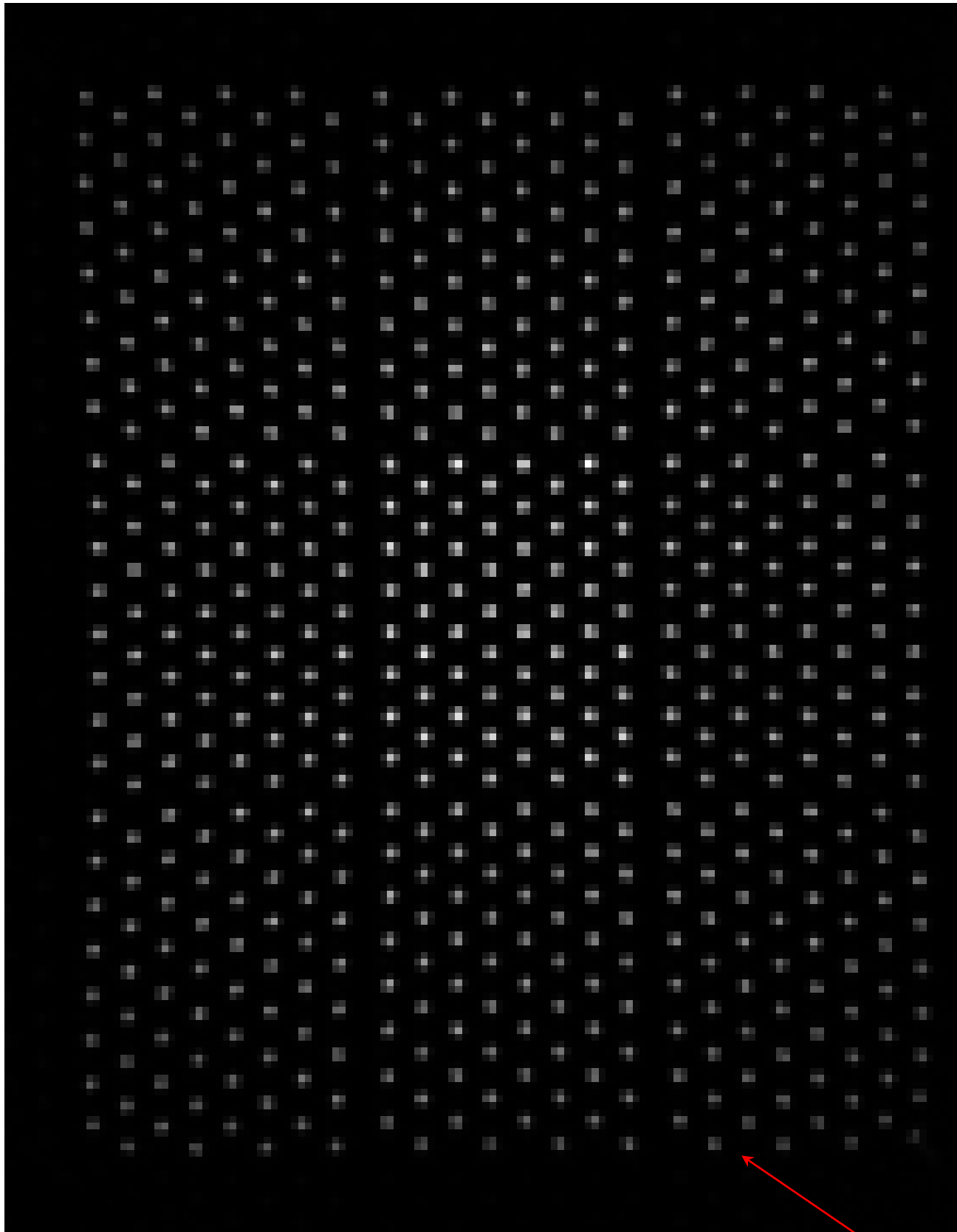


3. Test Sequence; Dark_Box – ImageX4_DarkBox

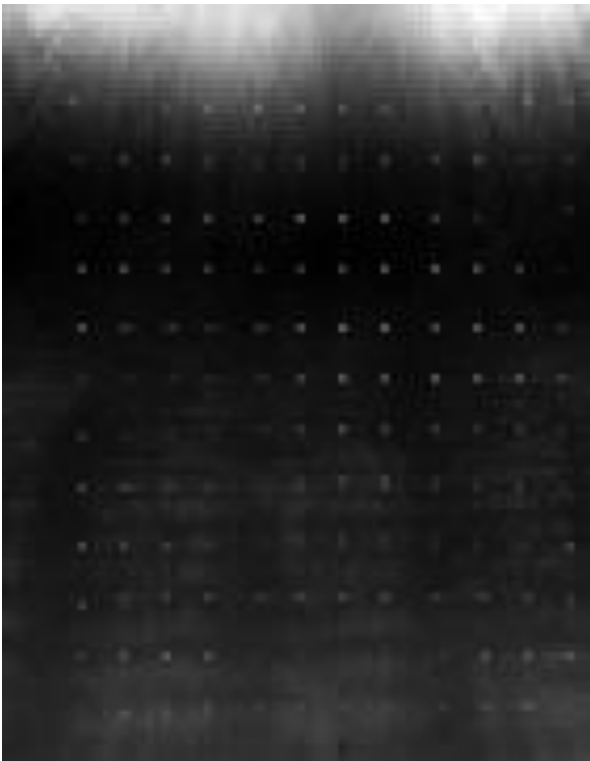
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	ImageX4_DarkBox	30cm	N	Y	N	0x0F	Spot Finder

ImageX4 Image



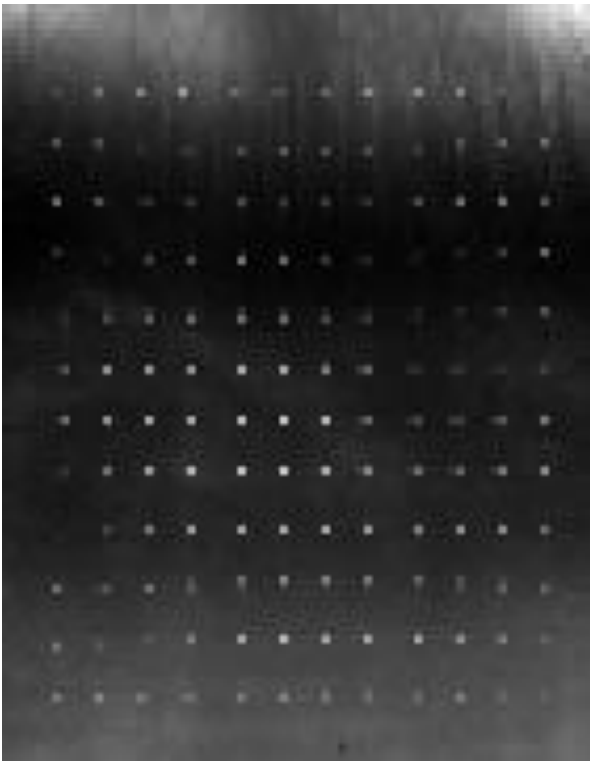
Kirk_Bank_1



Kirk_Bank_2



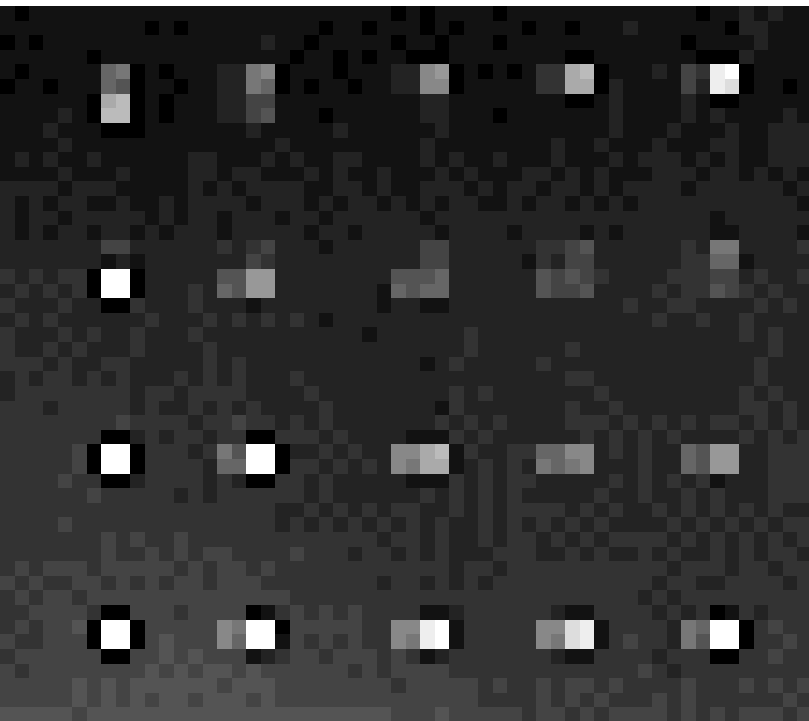
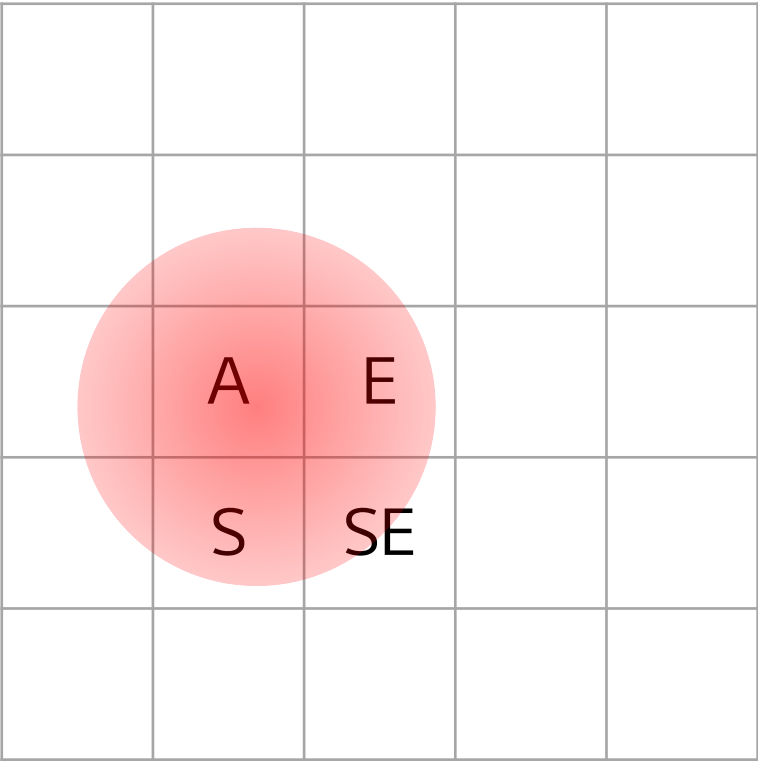
Kirk_Bank_3



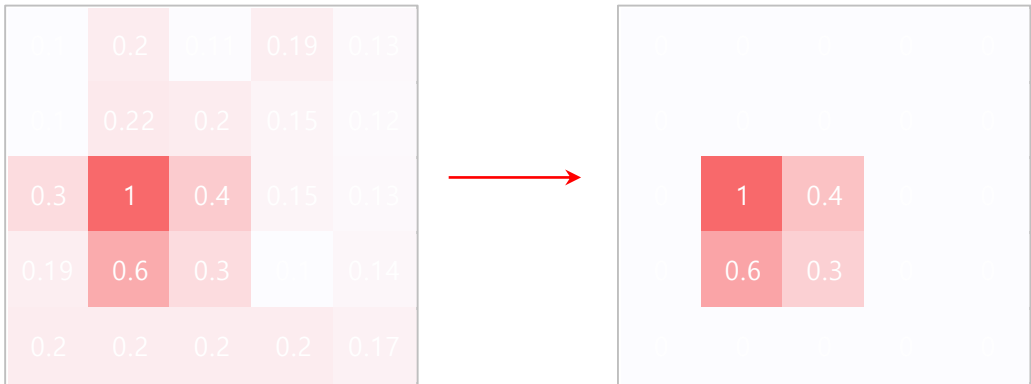
Kirk_Bank_4



1. Define the Spot position (A,E,S and SE)



2. 576-Spot x 4-Pixel → Spot data (9.14%)



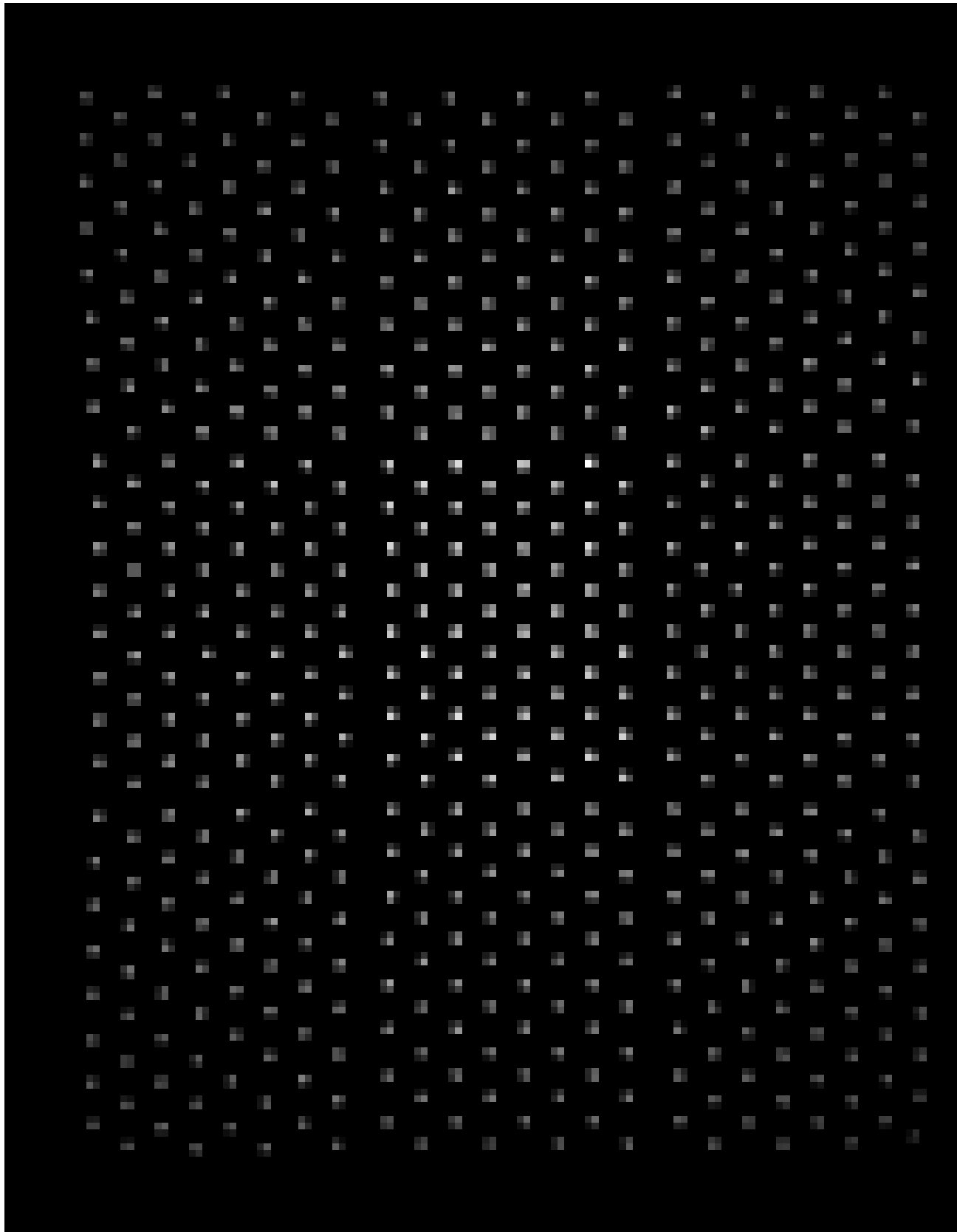
Empty Pixel

3. Test Sequence; Dark_Box – TOF_OP_DarkBox

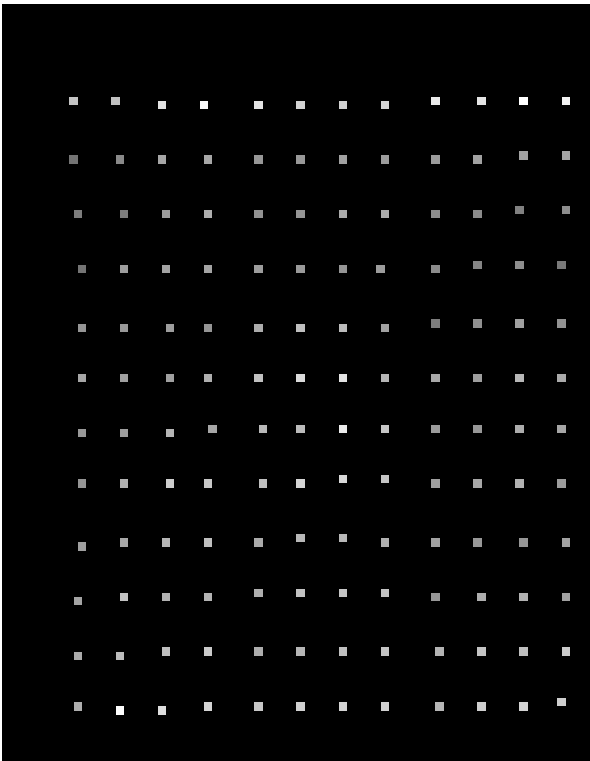
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	TOF_DarkBox_OP	30cm	Y	Y	N	0x0F	Depth quality (*Related with ToF 60cm)

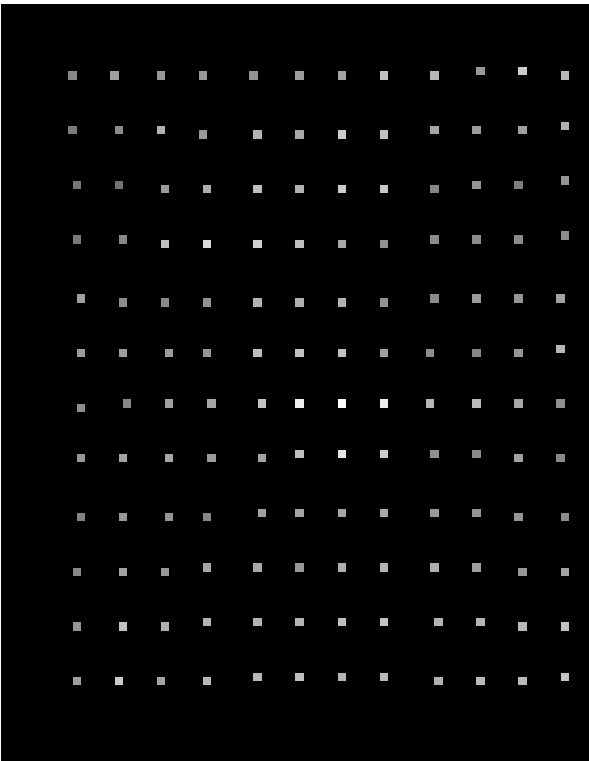
TOF_DarkBox_OP Image



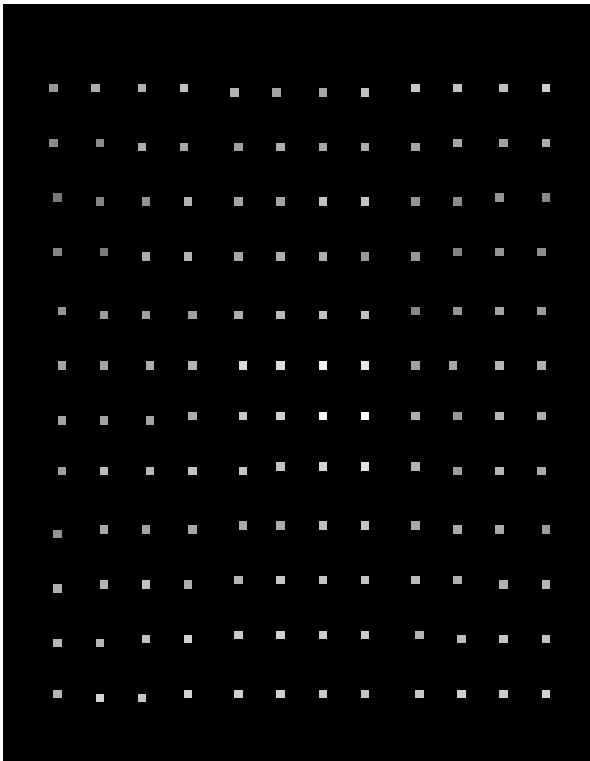
Kirk_Bank_1



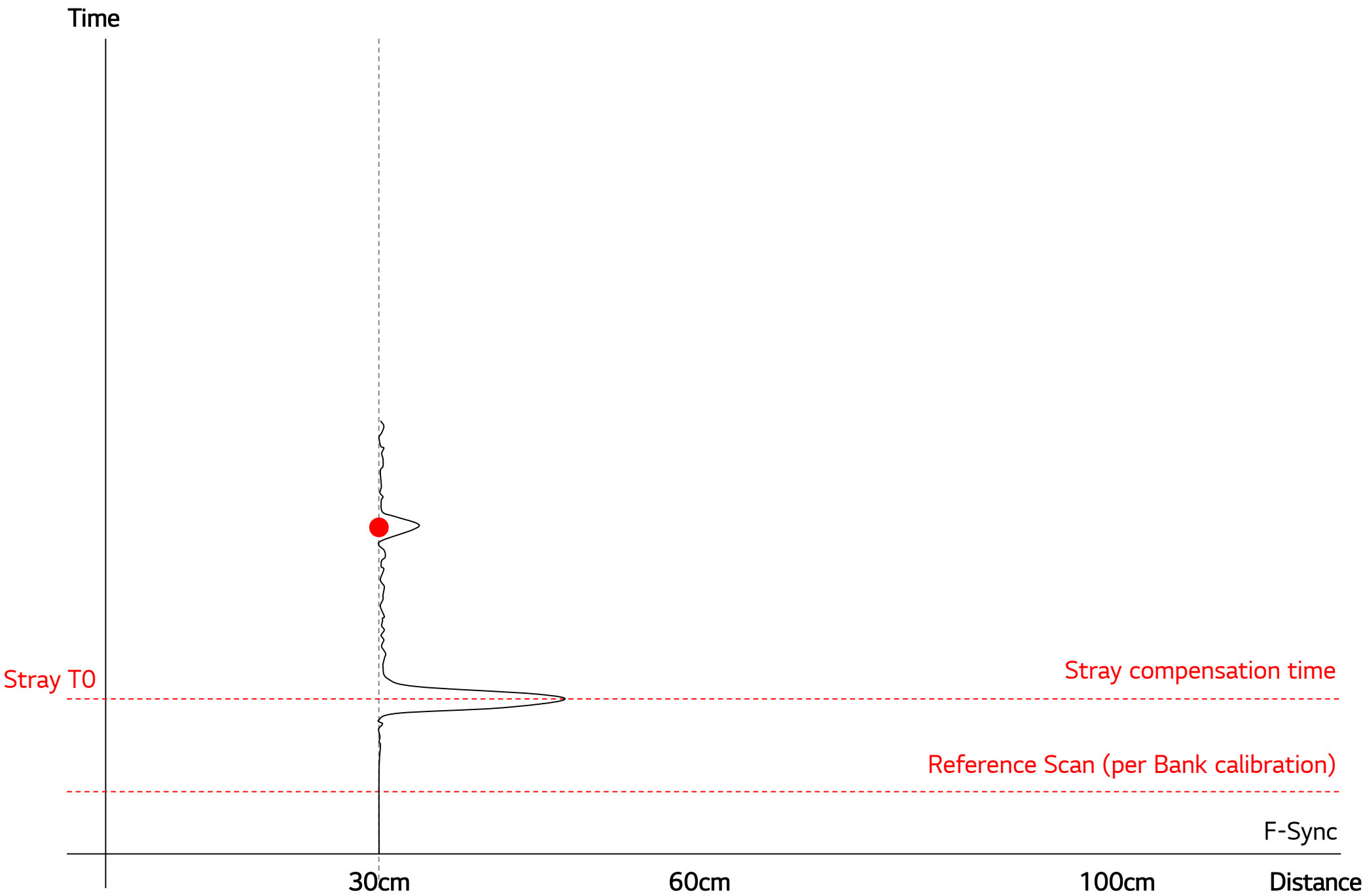
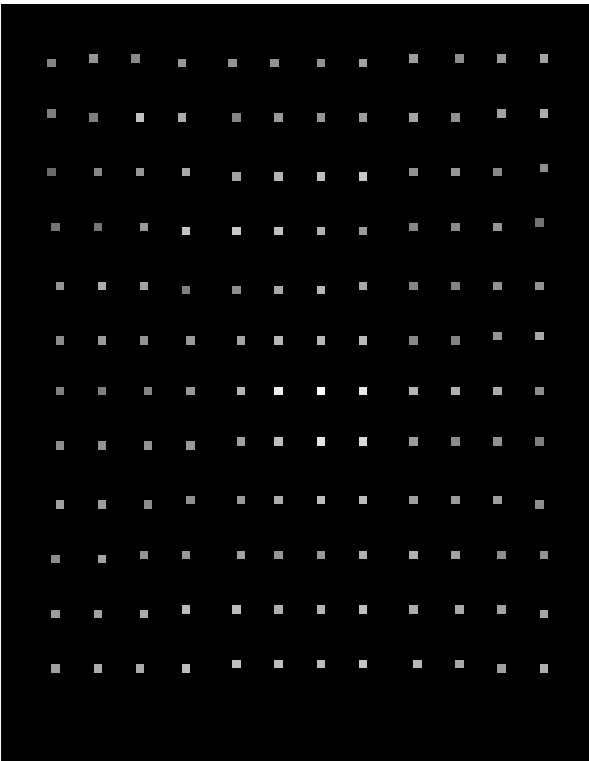
Kirk_Bank_2



Kirk_Bank_3



Kirk_Bank_4



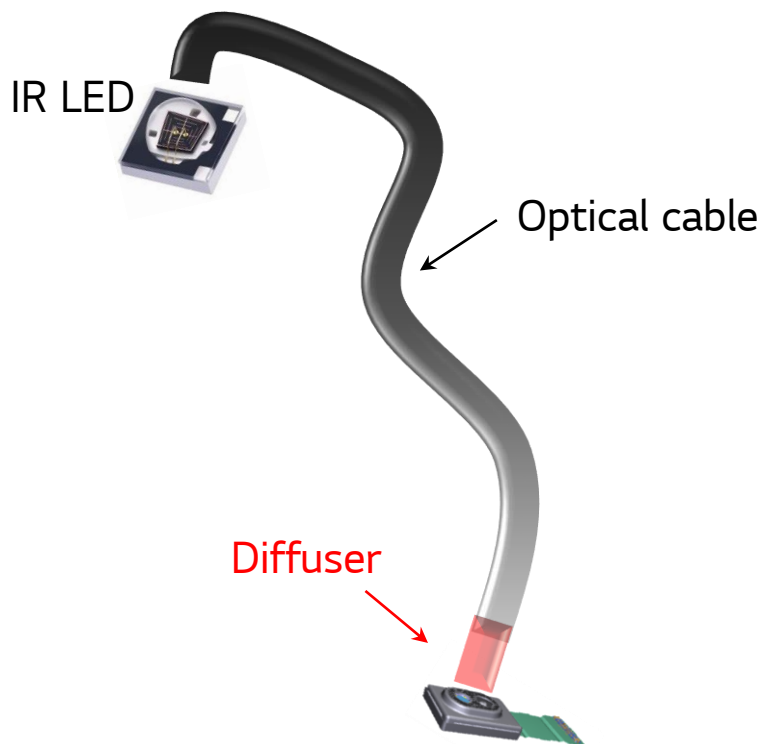
LPFF

3. Test Sequence; LPFF

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
LPFF	Image_FFLP	-	Y	N	Y	0x0F	FFLP RI Symmetry
	DNL_CW_ShortRange	-	Y	N	Y	0x0F	Differential Non Linearity
	DNL_CW_Normal	-	Y	N	Y	0x0F	
	DNL_Short_BIST	-	Y	N	N	0x0F	Built in Self Test
	DNL_Normal_A_BIST	-	Y	N	N	0x0F	

Test condition



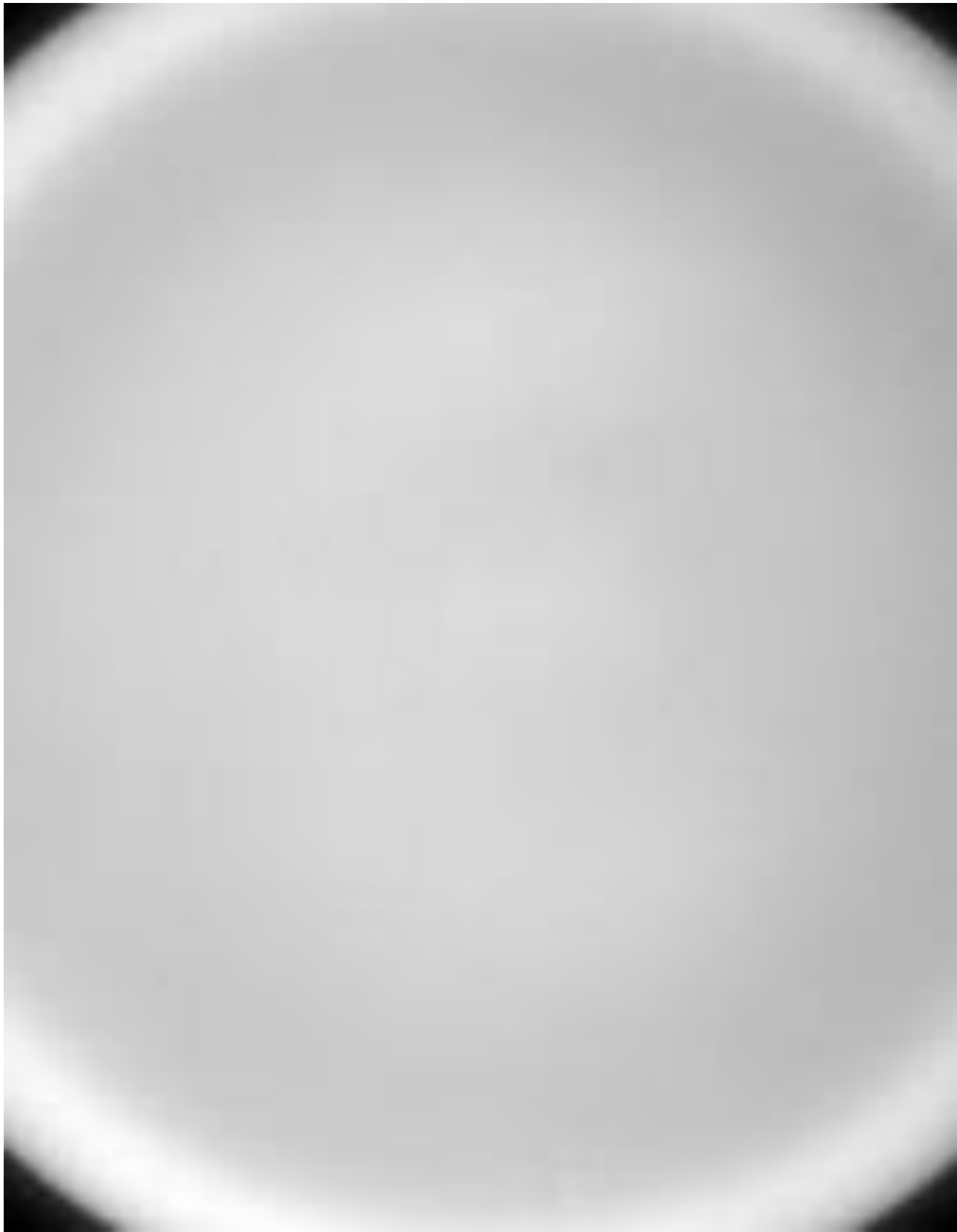
	Distance
Optical length	Less then 1m
Diffuser sheet	2ea
Light uniformity	95% ↑
IR LED Intensity	Fixed current operation (Set-up Spec.)

3. Test Sequence; LPFF – DNL / FFLP

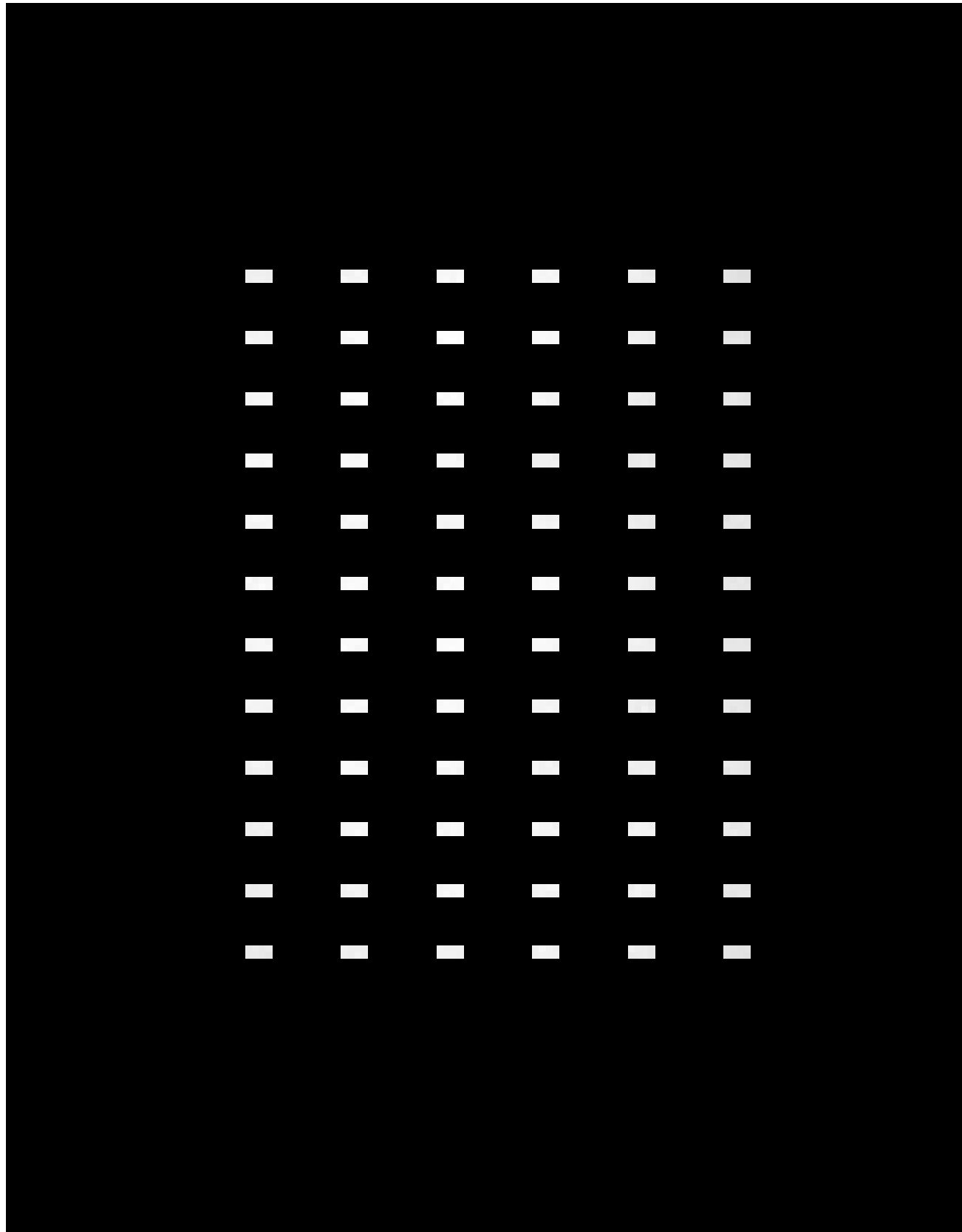
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
LPFF	Image_FFLP	-	Y	N	Y	0x0F	FFLP RI Symmetry
LPFF	DNL_CW_*	-	Y	N	Y	0x0F	Differential Non Linearity

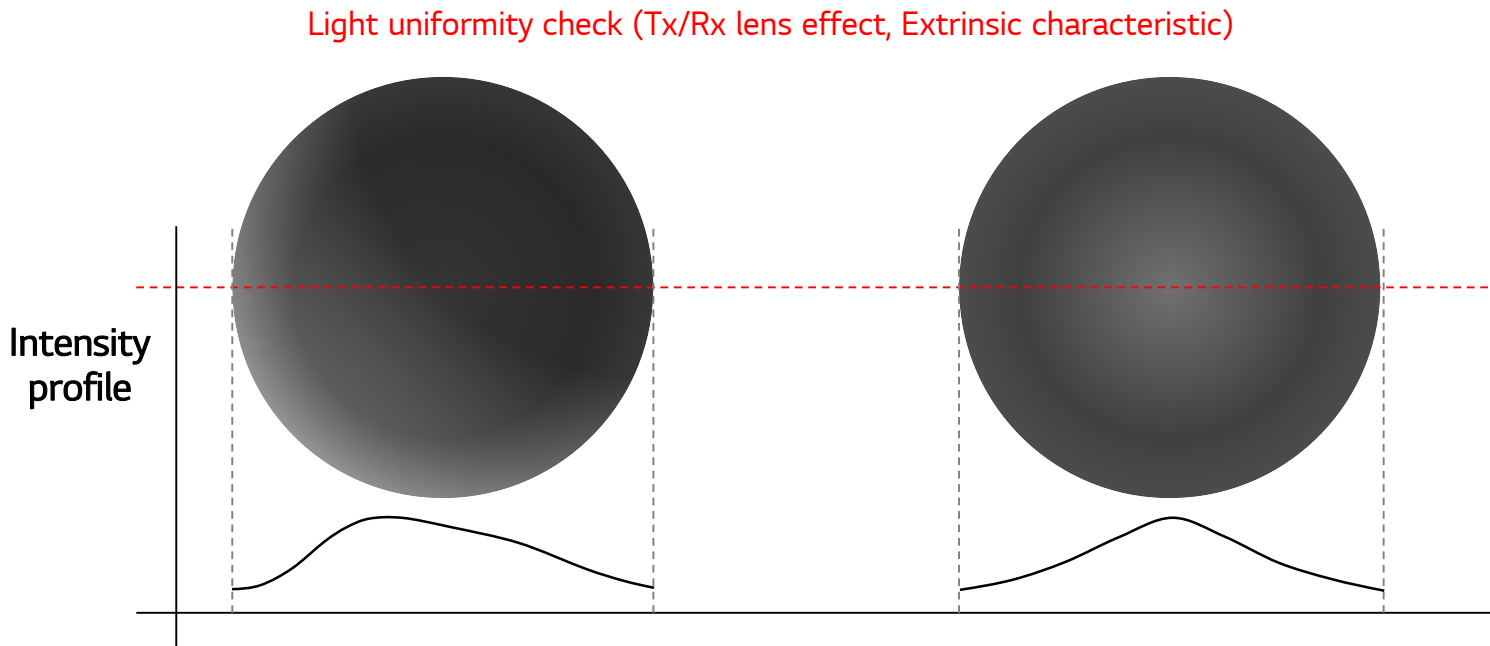
LPFF Image



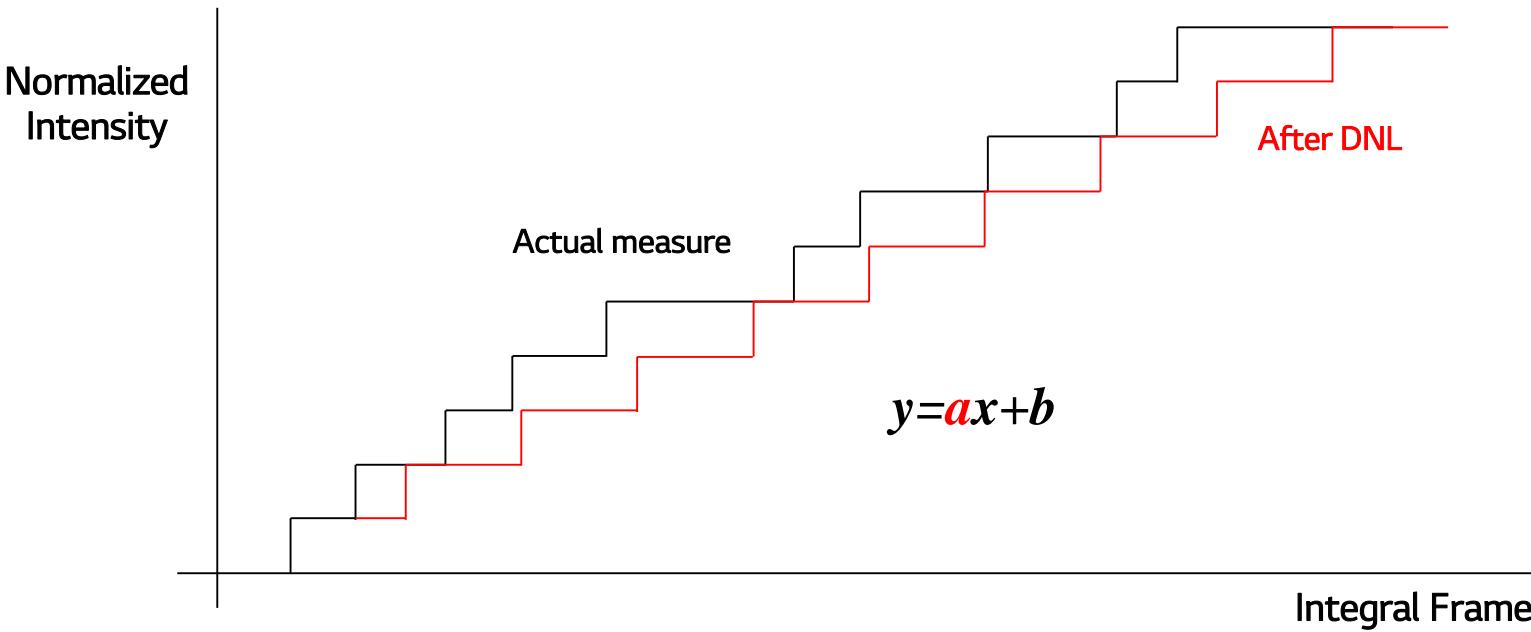
DNL Image



RI Symmetry



Differential Non linearity for light power



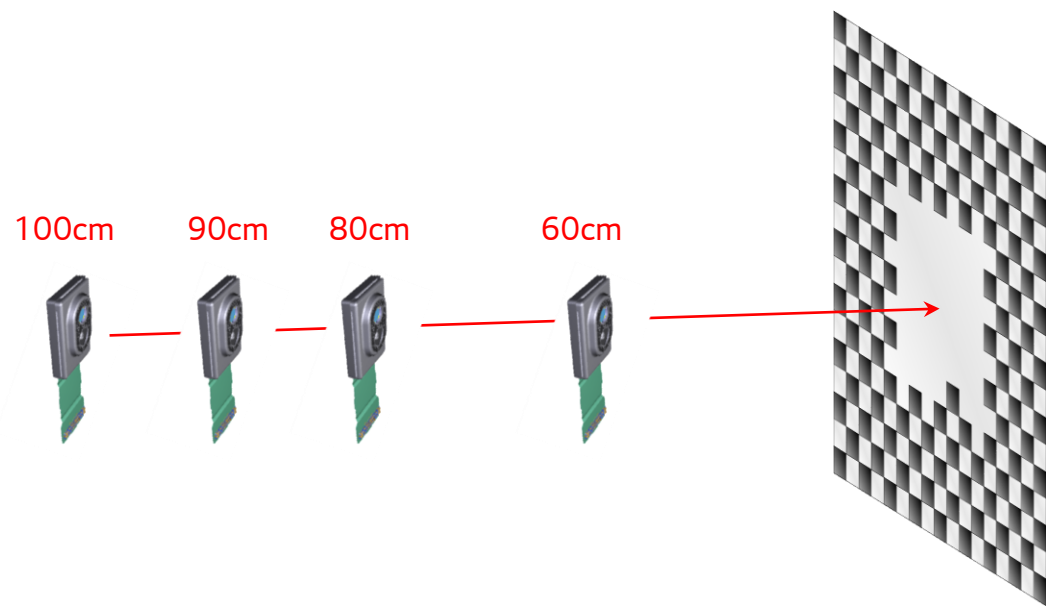
Rail (Depth)

3. Test Sequence; Rail

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Depth	ImageX4_100cm	100cm	N	Y	N	0x0F	Spot quality
	TOP_100cm_OP	100cm	Y	Y	N	0x0F	Depth quality, Calibration quality
	Image_100cm	100cm	Y	N	Y	0x01	Intrinsic calibration Pulse shape quality (Image_100cm)
	Image_90cm	90cm	Y	N	Y	0x01	
	Image_80cm	80cm	Y	N	Y	0x01	
	TOF_60cm_OP	60cm	Y	Y	N	0x0F	Depth calibration

Test condition



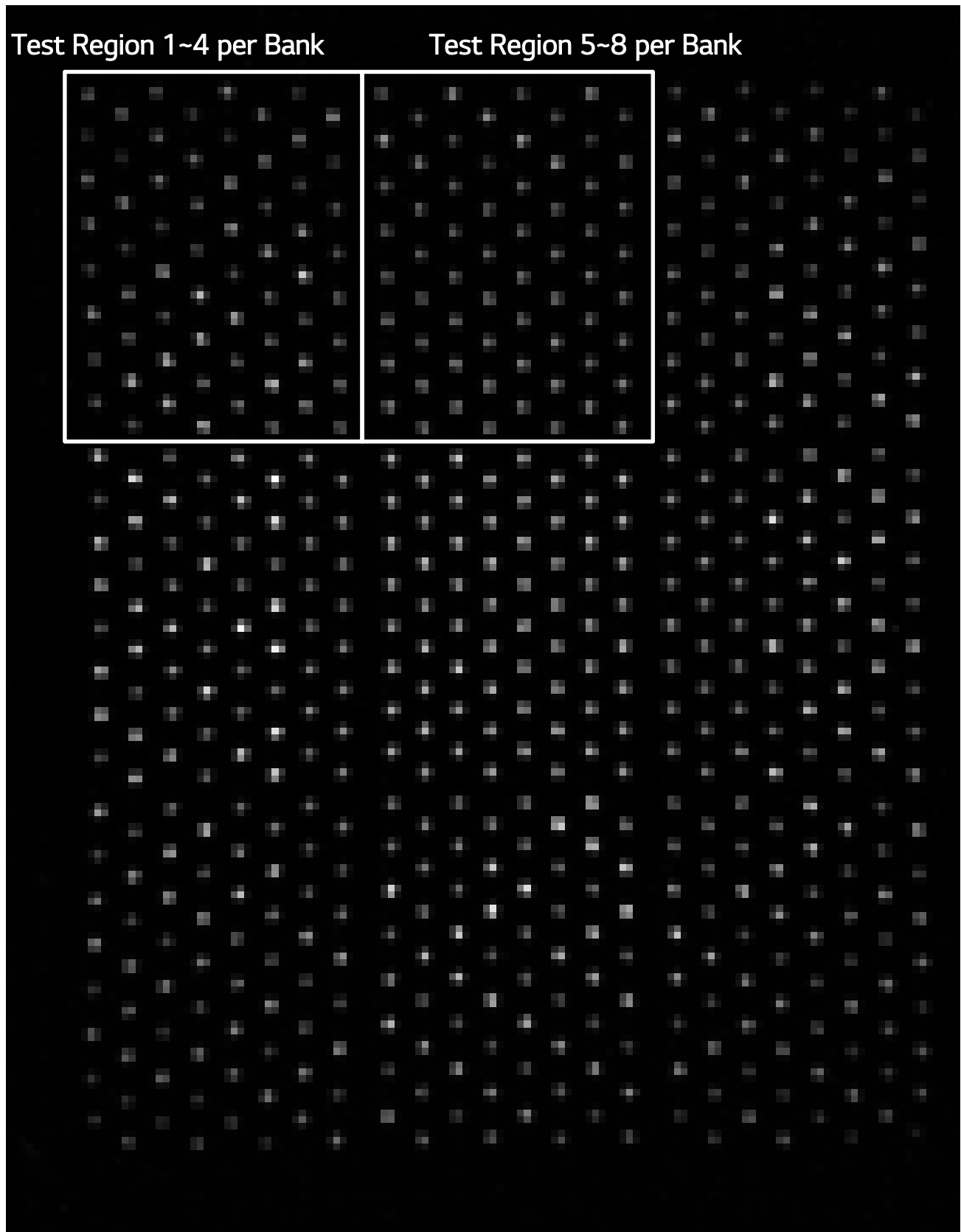
	Distance
Test Depth	100/90/80/60 ± 0.1 cm
Chart uniformity	90% ↑ (Actual setting ~95%)
Char parallelism	0 ± 0.1 ° (Set-up Spec.)
IR LED Intensity	Fixed current operation (Set-up Spec.)

3. Test Sequence; Rail – ImageX4_100cm

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	ImageX4_DarkBox	30cm	N	Y	N	0x0F	Spot Finder
Rail	ImageX4_100cm	100cm	N	Y	N	0x0F	Spot quality, Stray quality, Pulse shape quality

ImageX4_100cm Image



Kirk_Bank_1



Kirk_Bank_2



Kirk_Bank_3

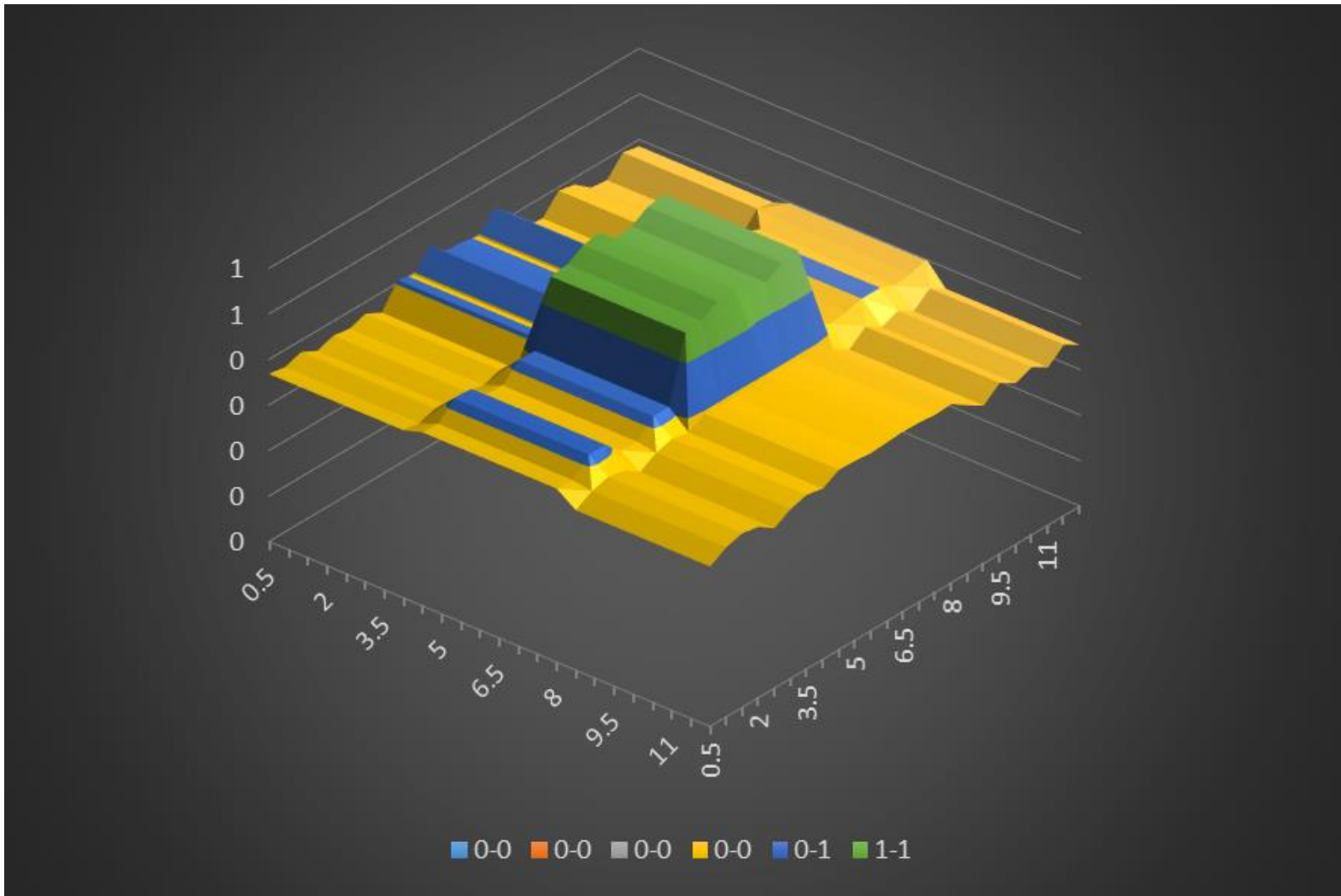


Kirk_Bank_4



CALU_SQ_p_normal_4x4_median_per_region_100cm_01~36

- 16 Spots optical power for each region.
- Test results is reflected the chart reflectance.

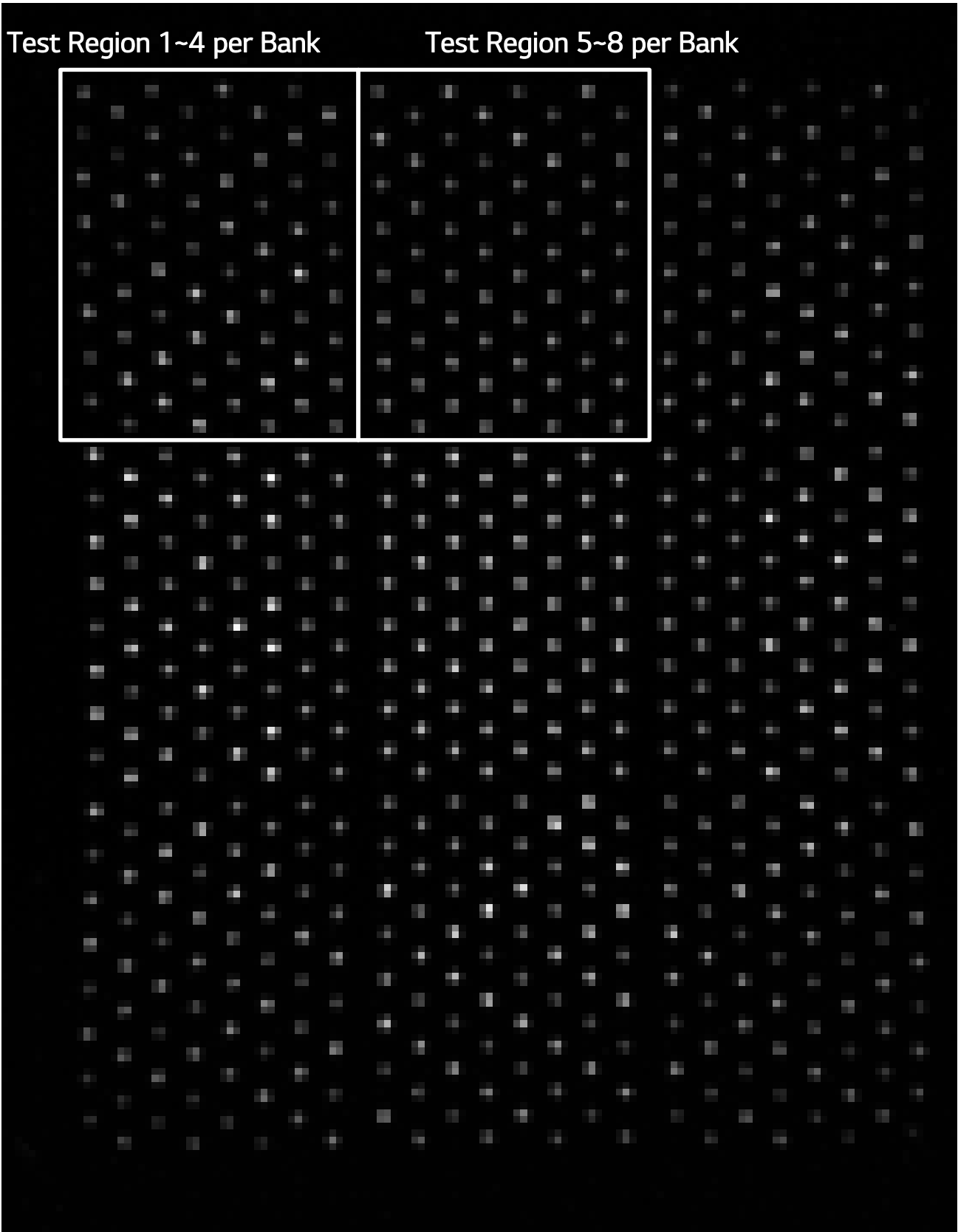


3. Test Sequence; Rail – ImageX4_100cm

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	ImageX4_DarkBox	30cm	N	Y	N	0x0F	Spot Finder
Rail	ImageX4_100cm	100cm	N	Y	N	0x0F	Spot quality, Stray quality, Pulse shape quality

ImageX4_100cm Image



Kirk_Bank_1



Kirk_Bank_2



Kirk_Bank_3

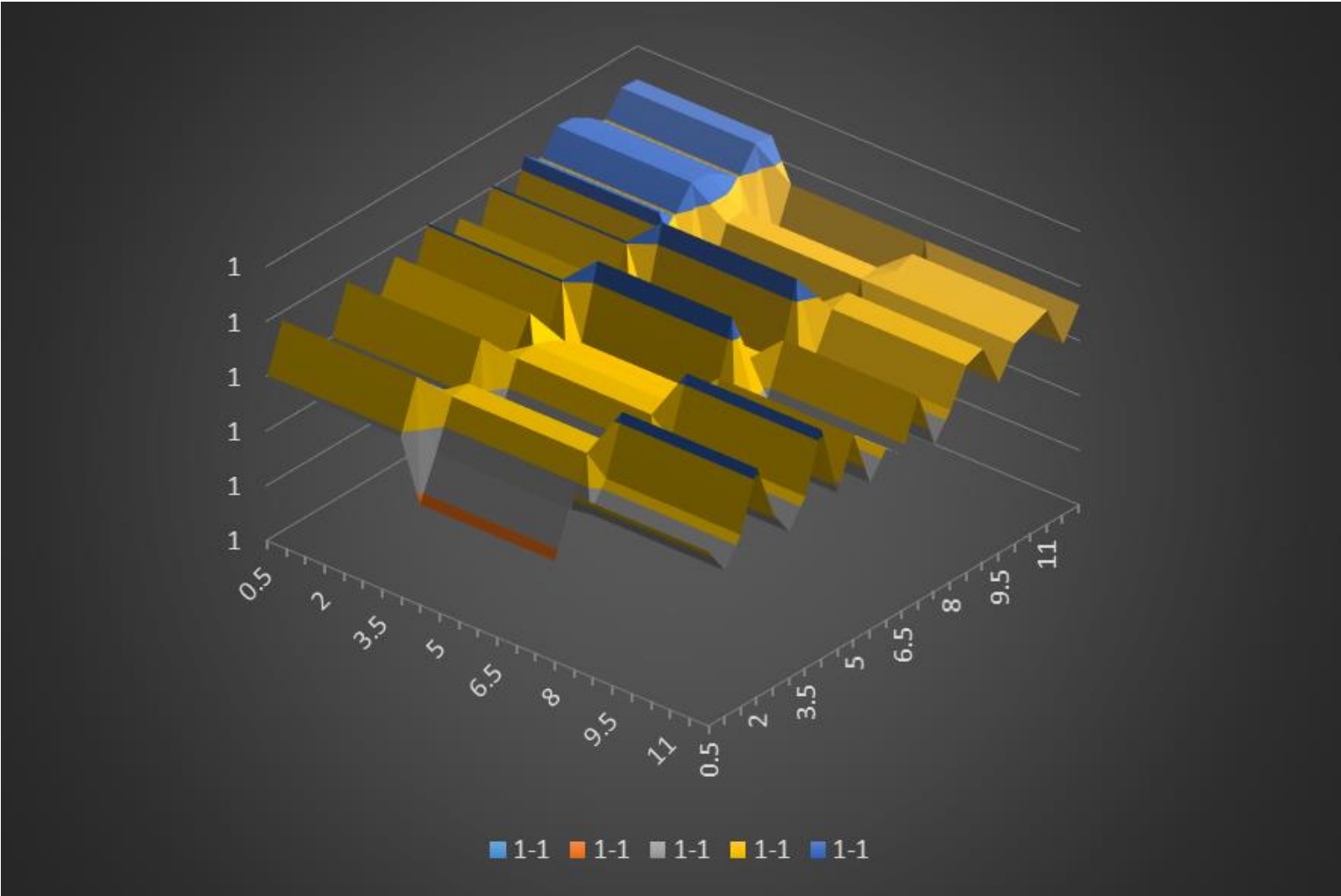


Kirk_Bank_4



CALU_SQ_contrast_median_per_region_100cm_01~36

- 16 Spots contrast ratio for each region.
- Test results is reflected both the chart reflectance and bank characteristic.

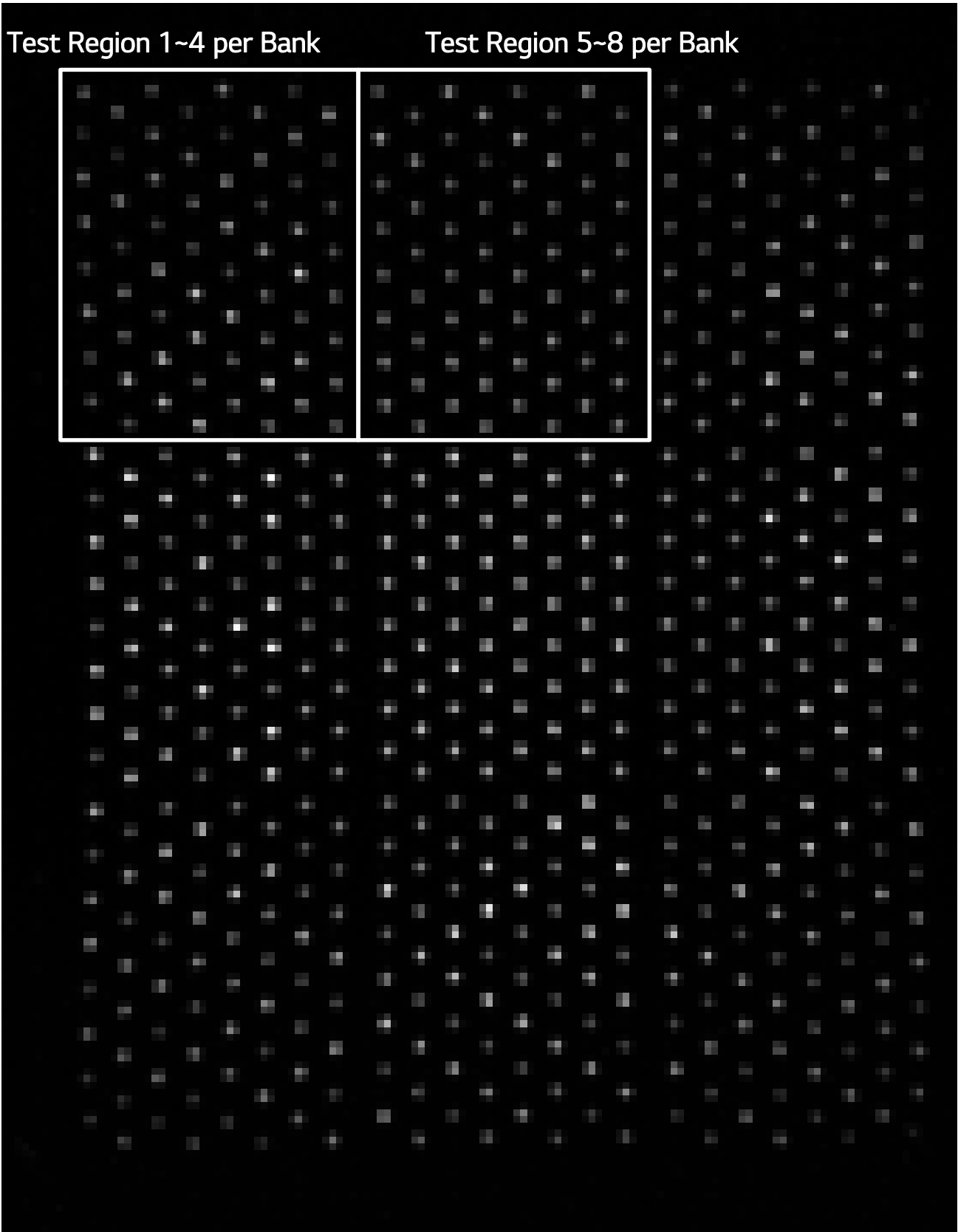


3. Test Sequence; Rail – ImageX4_100cm

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	ImageX4_DarkBox	30cm	N	Y	N	0x0F	Spot Finder
Rail	ImageX4_100cm	100cm	N	Y	N	0x0F	Spot quality, Stray quality , Pulse shape quality

ImageX4_100cm Image



Kirk_Bank_1



Kirk_Bank_2



Kirk_Bank_3

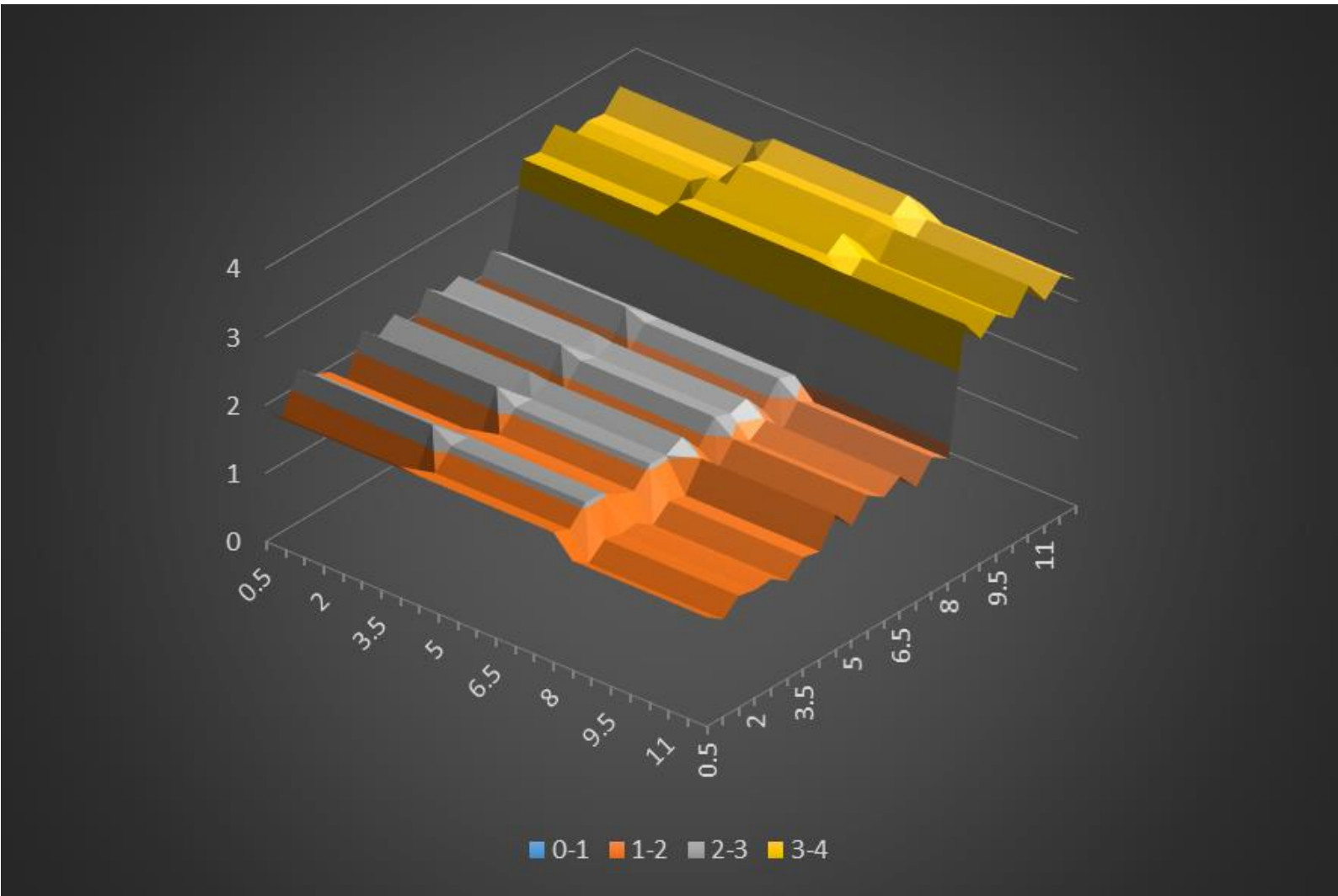


Kirk_Bank_4



CALU_ST_stray_photons_median_per_region_01~36

- 16 Spots stray power for each region.
- Test results is reflected the spatial characteristic both Kirk and Periscope.

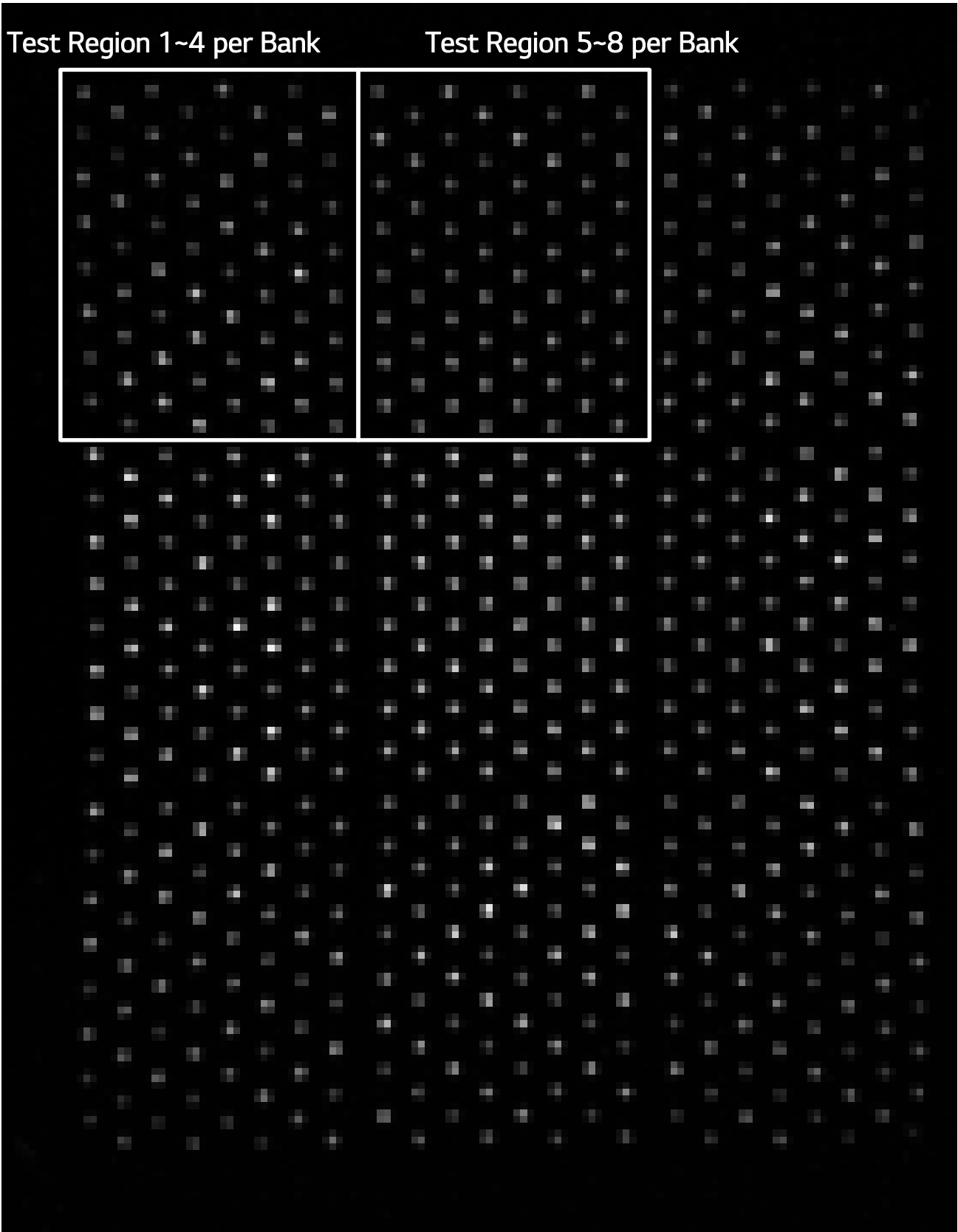


3. Test Sequence; Rail – ImageX4_100cm

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Dark Box	ImageX4_DarkBox	30cm	N	Y	N	0x0F	Spot Finder
Rail	ImageX4_100cm	100cm	N	Y	N	0x0F	Spot quality, Stray quality, Pulse shape quality

ImageX4_100cm Image



Kirk_Bank_1



Kirk_Bank_2



Kirk_Bank_3

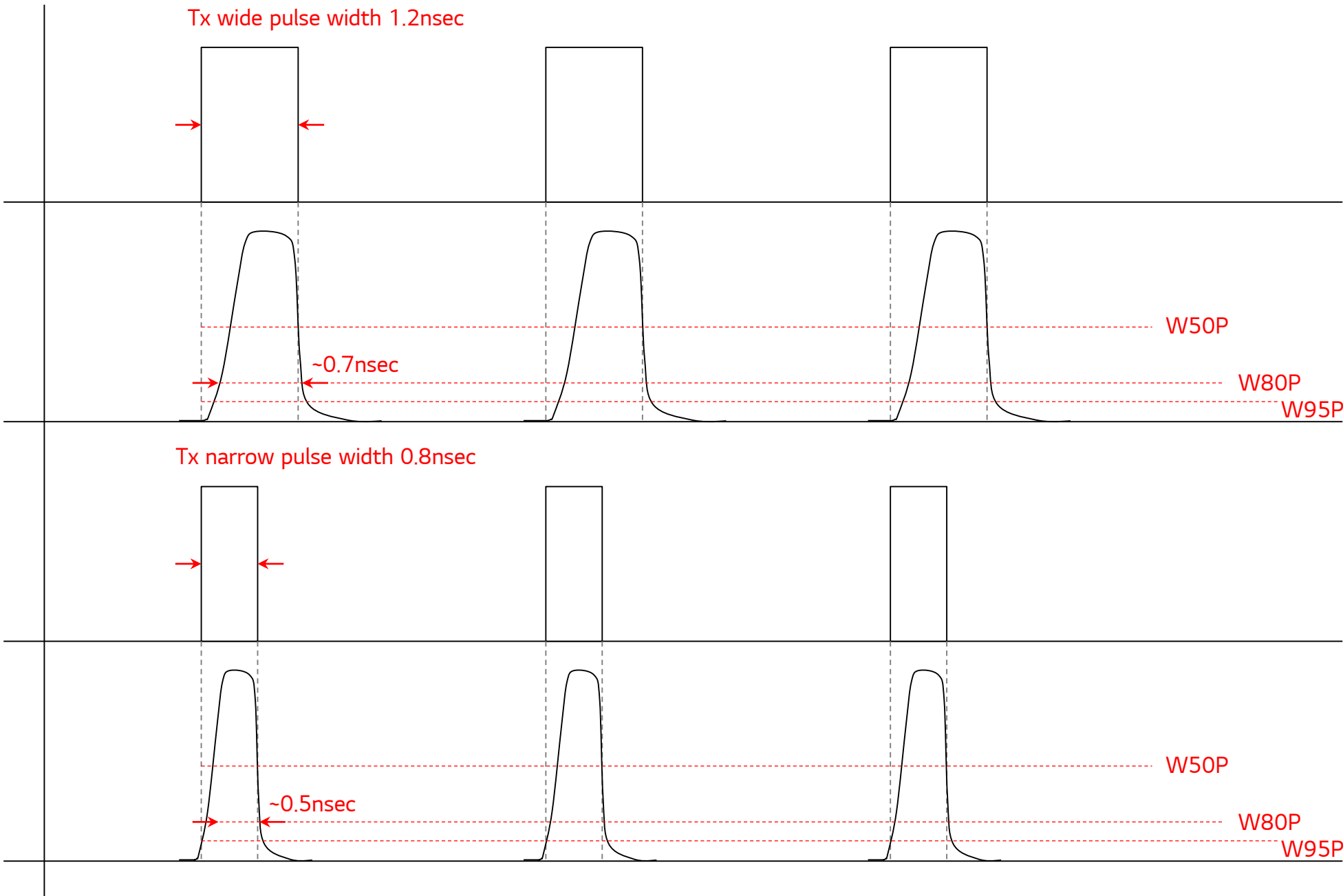
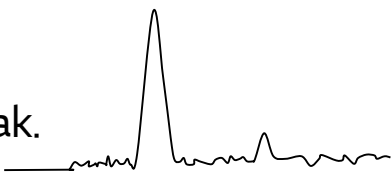


Kirk_Bank_4



CALU_PSQ_W98/95/90/85/80/50P_ wide/narrow_1~4

- Pulse width measurement by Periscope using 100cm reflected Echo peak.

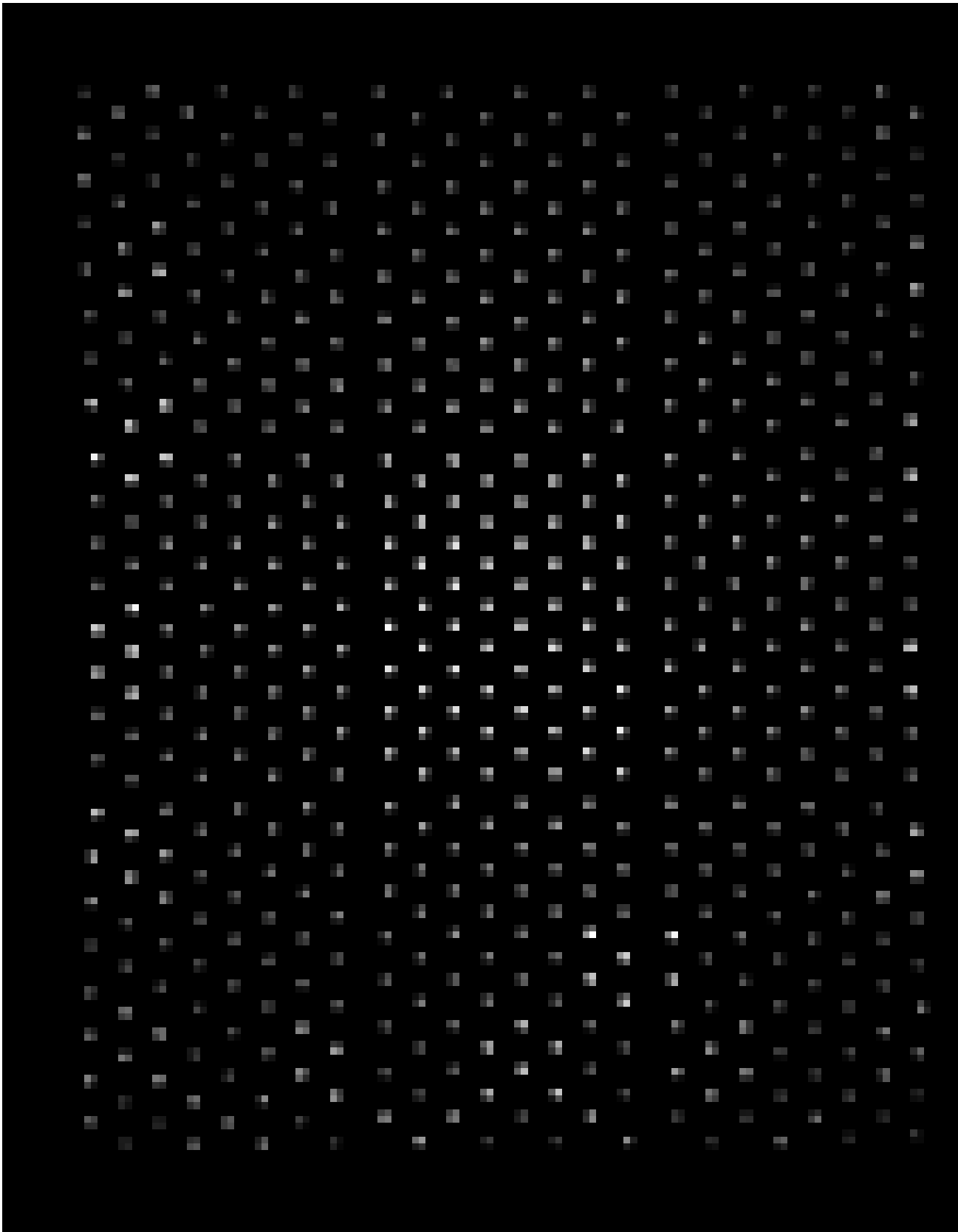


3. Test Sequence; Rail – TOF_60/100cm

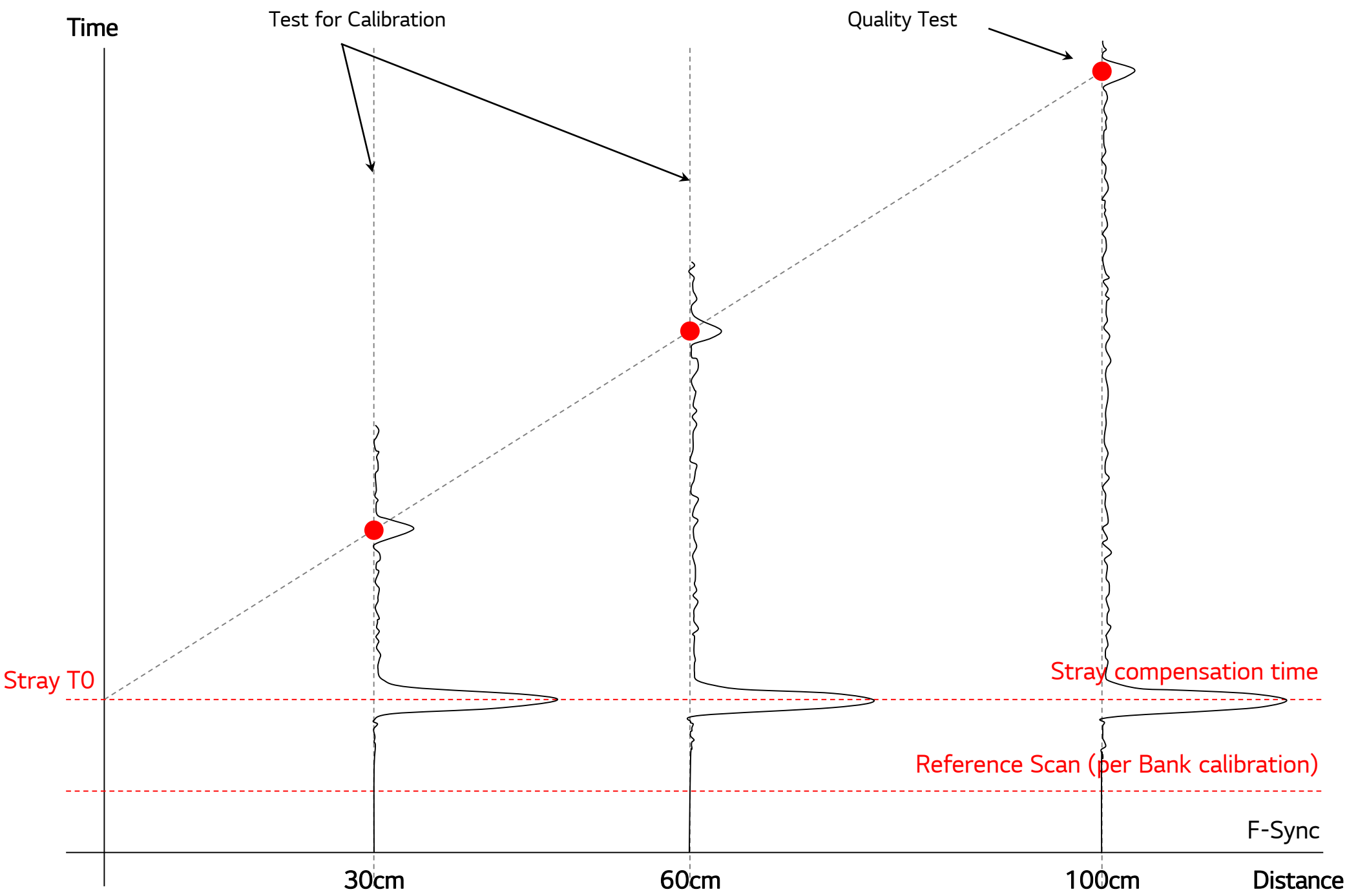
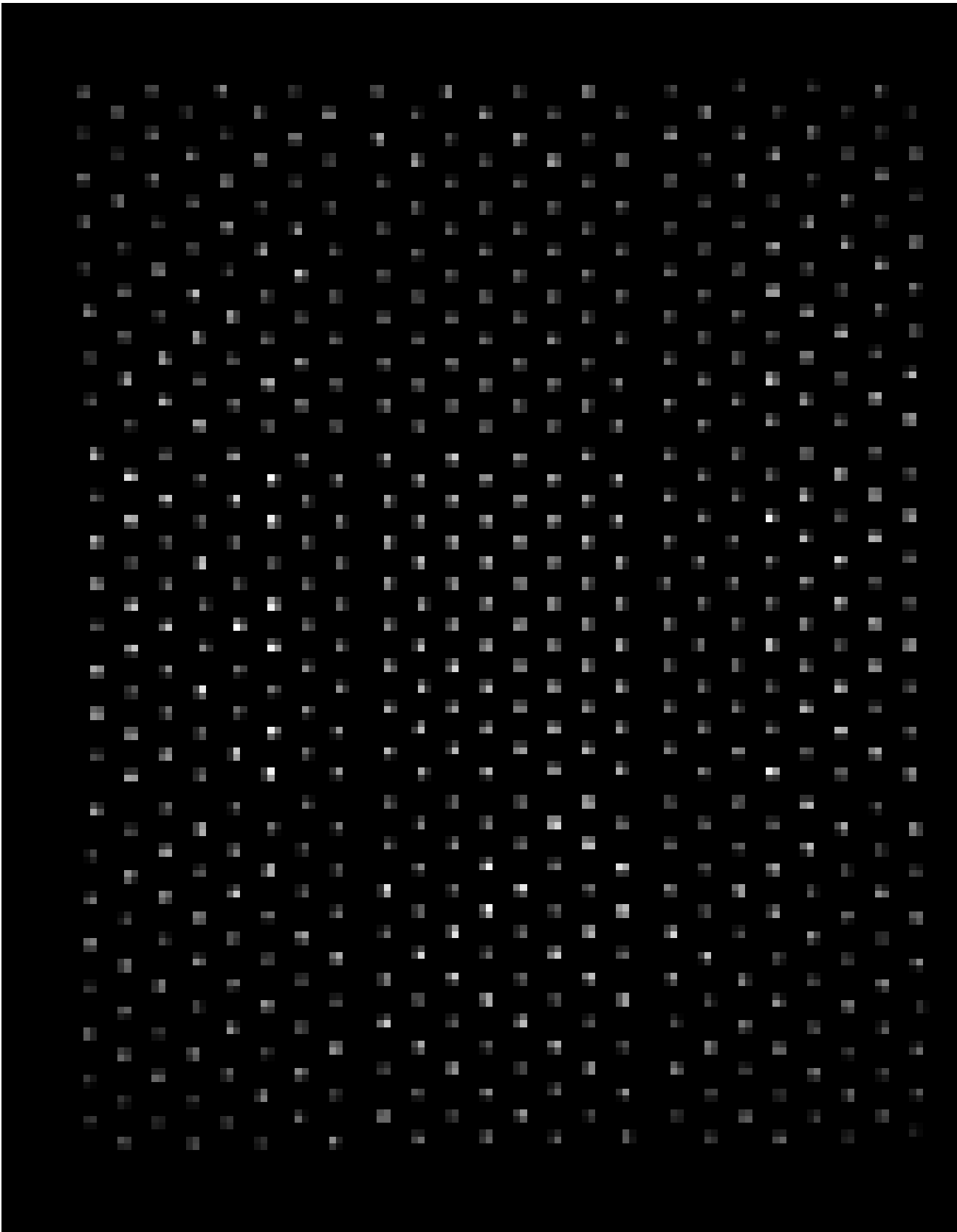
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Rail	TOP_100cm_OP	100cm	Y	Y	N	0x0F	Depth quality, Calibration quality
Rail	TOF_60cm_OP	60cm	Y	Y	N	0x0F	Depth calibration

TOF_60cm_OP Image



TOF_100cm_OP Image



3. Test Sequence; Rail – Image_100/90/80cm

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Rail	Image_100/90/80cm	-	Y	N	Y	0x01	Intrinsic calibration

Image_100cm Image



Image_90cm Image



Image_80cm Image



3. Test Sequence; Rail – Image_100/90/80cm

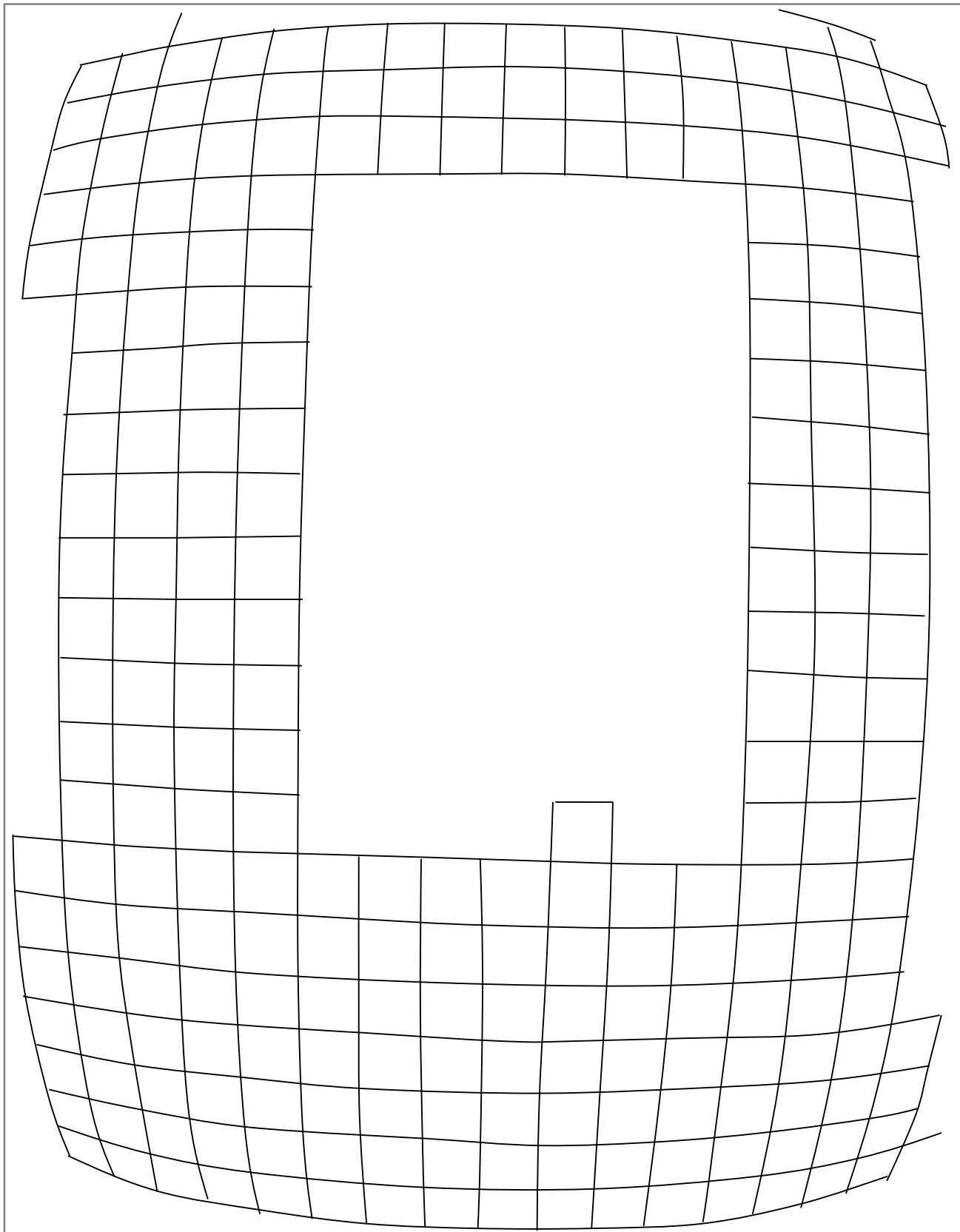
How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Rail	Image_100/90/80cm	-	Y	N	Y	0x01	Intrinsic calibration

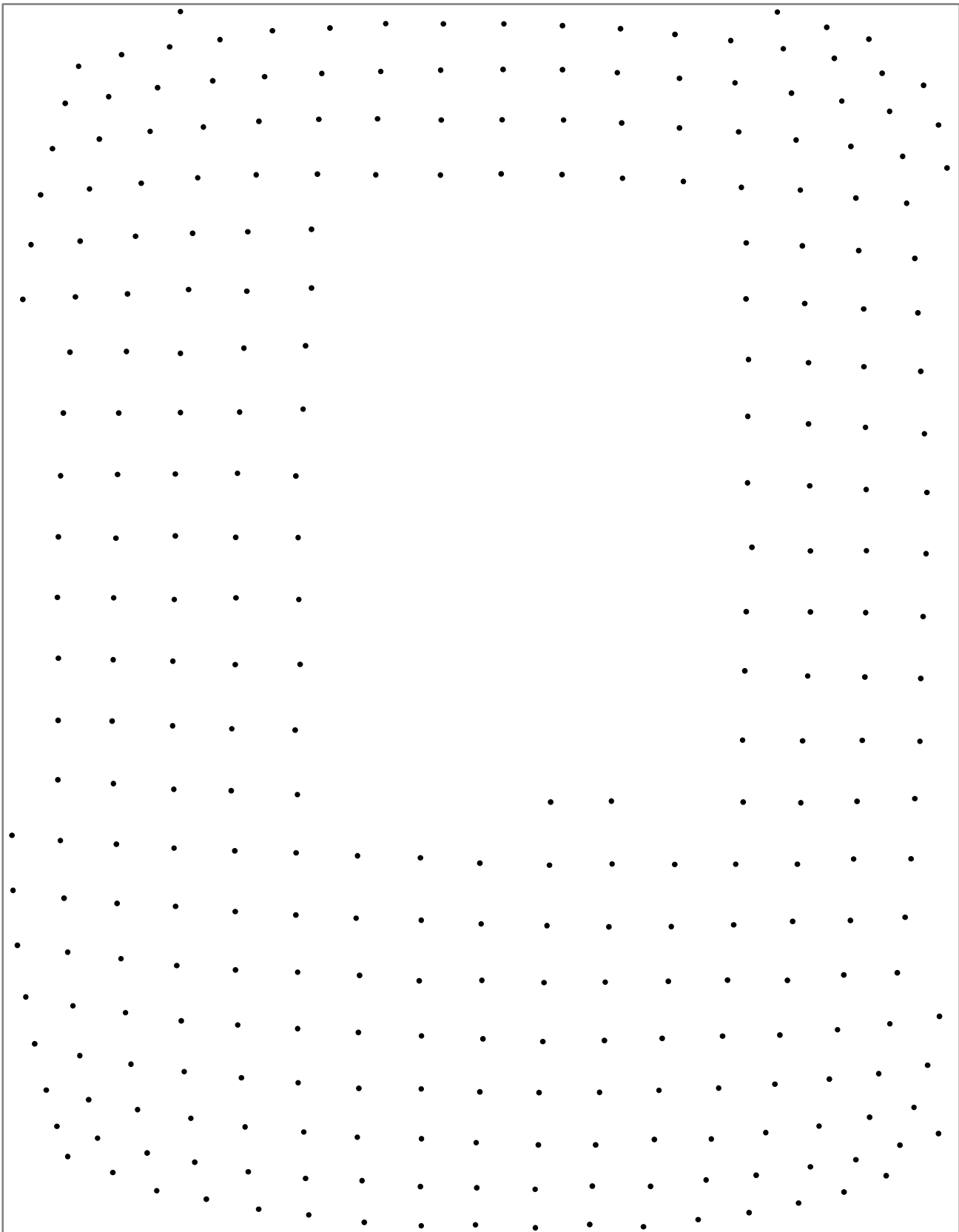
Image_100cm Image



Profile



Feature Image



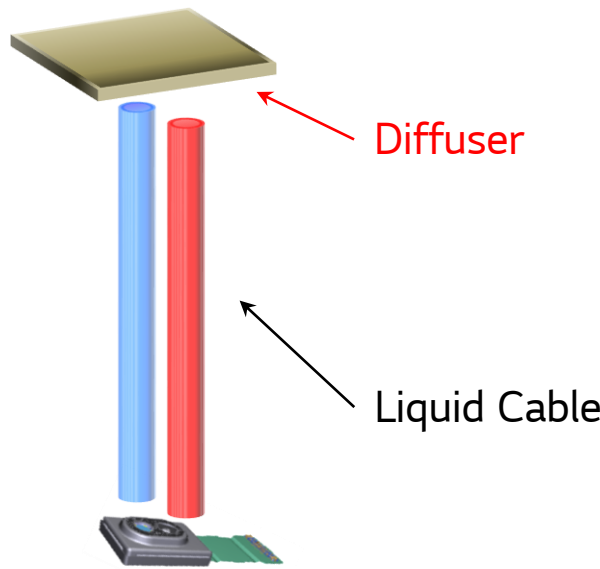
P2P

3. Test Sequence; Rail

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
P2P (NVM)	P2P_Scan	-	Y	Y	N	0x01	Rx pixel to Pixel time calibration

Test condition



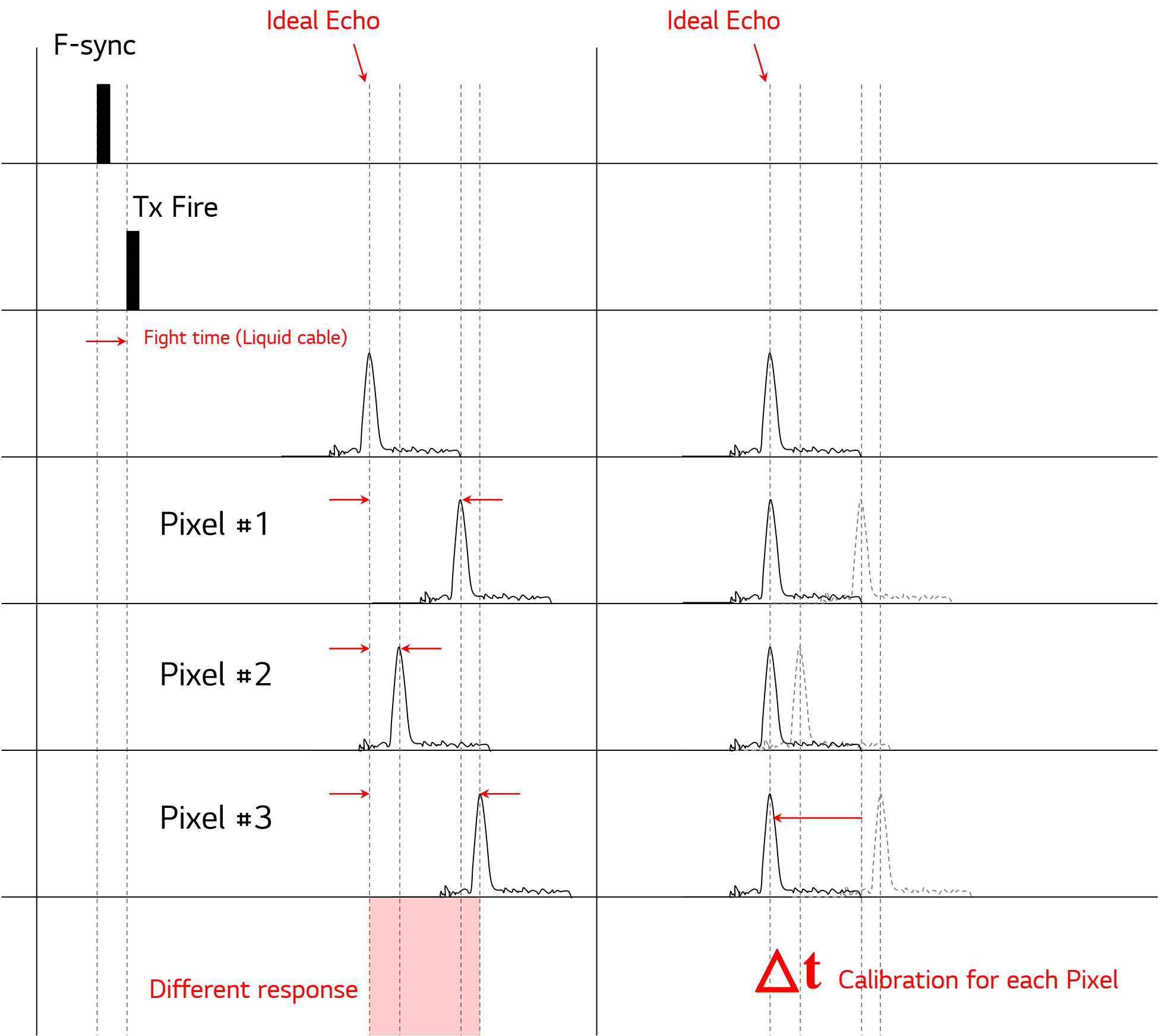
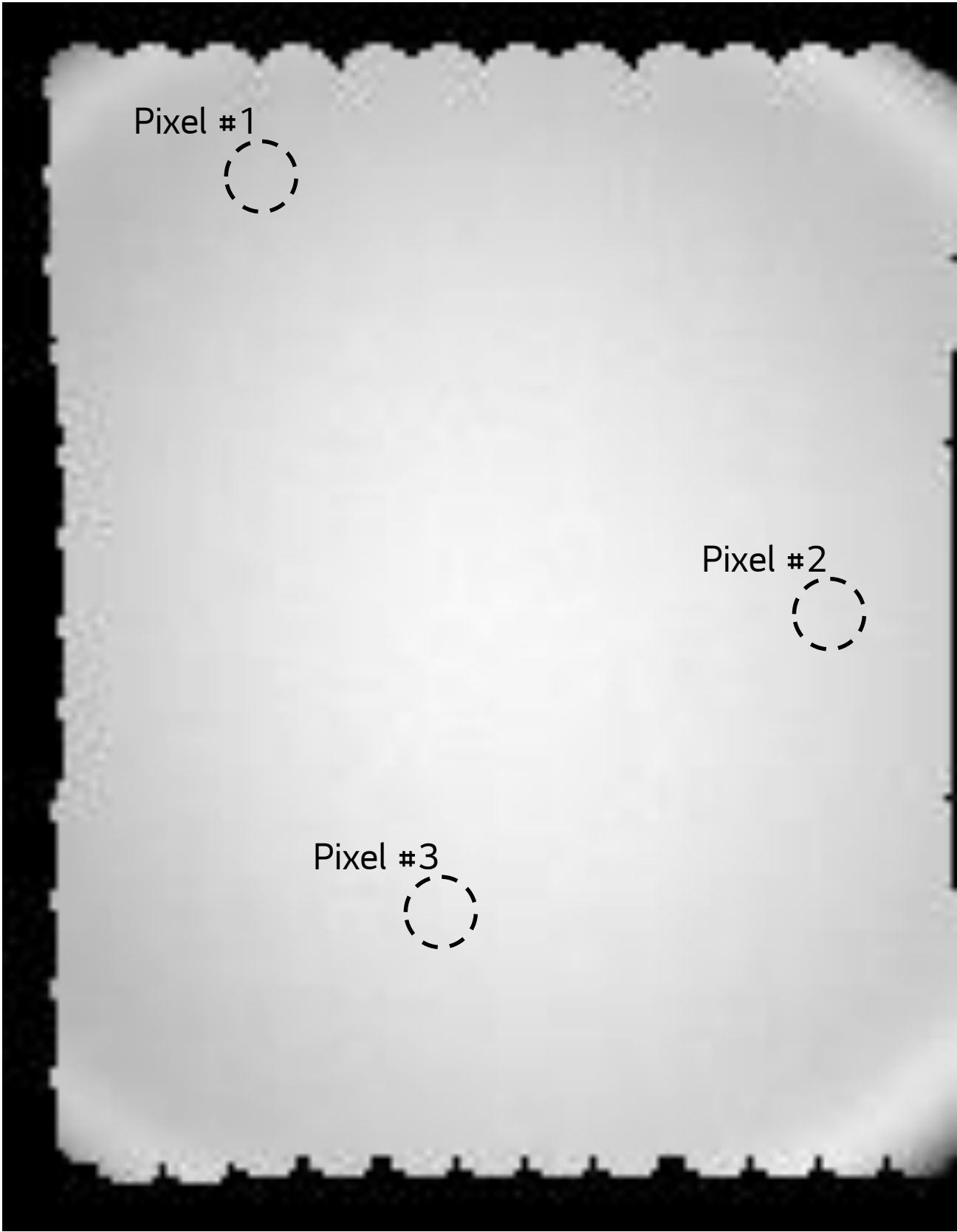
	Distance
Cable type	Liquid cable (Hi-OH; high reflective index)
Optical length	52.14 cm x 2-times
Light source	Tx (Spot) + Diffuser → Plane light source
Interleaved	None

3. Test Sequence; P2P – P2P Scan

How to measure

Zone	Test Sequence	Distance	Parallel Capture	Tx enable	External Light Source	Bank Interleaved	Related Item
Rail	P2P_Scan	-	Y	Y	N	0x01	Rx pixel to Pixel time calibration

P2P Scan Image



Full Sequence Summary

4. Full Sequence Summary

