Total Radiation Dose Estimate for TLK2711

RIKEN/RBRC

Itaru Nakagawa

[18] J. Asai, et al., arXiv:0710.2676.

Radiation Damage Study for PHENIX Silicon Stripixel Sensors

J. Asai [a], S. Batsouli [b], K. Boyle [c], V. Castillo [d], V. Cianciolo [b], D. Fields [e], C. Haegeman [e], M. Hoeferkamp [e], Y. Hosoi [f], R. Ichimiya [a], Y. Inoue [f], M. Kawashima [f], T. Komatsubara [g], K. Kurita [f], Z. Li [h], D. Lynch [j], M. Nguyen [c], T. Murakami [i], R. Nouicer [j], H. Ohnishi [a], R. Pak [j], K. Sakashita [k], T.-A. Shibata [k], K. Suga [f], A. Taketani [a], J. Tojo [a]

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the strip and the ones attached at the BLMs and chipmunks that were in the area only for part of the run with a delivered luminosity of 12 pb^{-1}. Therefore the accumulated radiation values for these TLDs are higher. The measurements from these TLDs indicate a dependence on the distance from the beam line that is in accordance with the radial dependence in Figure 15. In Figure 15 the nose cone TLD values (blue points), scaled at 12 pb^{-1}, have been overlaid with the values of the rest of the TLDs (red points).

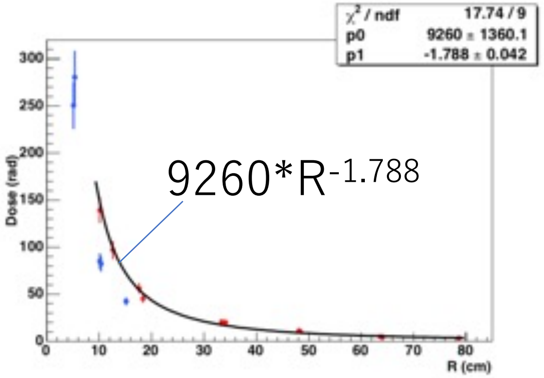


Fig. 15. Red points: TLD radiation measurements versus their distance R from the beam line and fit to the function $p0 * R^{p1}$. Blue points: TLDs placed on the nose cone, scaled to the same luminosity as the red points, versus their distance R from the beam line

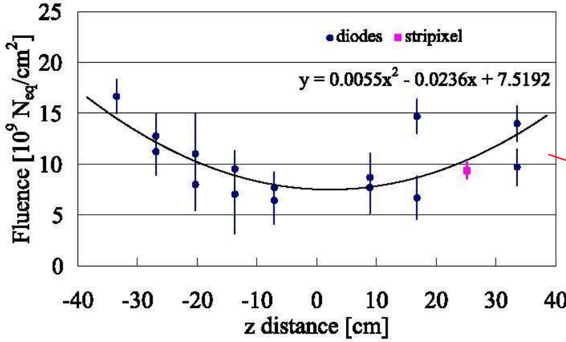
Z=41cm, 42/pb

A stripixel sensor was also irradiated at the PHENIX interaction region (IR) during the 2006 run. We found the same relation between the integrated luminosity and determined fluence from increase of leakage current. The expected fluence is 3-6×10^{12} Φ_{eq}/cm^2 (1 MeV neutron equivalent) in RHIC II operations for 10 years. Due to this expected exposure, setting the operating temperature in PHENIX to T ≤ 0 °C to suppress leakage current is needed to avoid saturation of preamplifiers.

There were two kinds of test diodes with different volumes which were 0.01 cm^3 and 0.004 cm^3. The increase of the leakage current of the diodes and the relevant fluences are summarized in Table 5. Only fifteen diodes are listed since the other diode was found to be defective during the leakage current measurement. The average fluence of the diodes was 1.0×10^{10} N_{eq}/cm^2. The estimated z dependence of the diode fluence is shown in Fig. 17 which is in agreement with the TLDs.

The sensor was irradiated at Z=25.2 cm for about 50 days and the integrated luminosity during this time was 12 pb^{-1}. The current related damage rate α was estimated to be 3.2×10^{-17} A/cm using the temperature history of the temperature loggers in the PHENIX IR. The increase of leakage current of a single strip was 2.2×10^{-10} A/strip as seen in Table 5. Figure 18 shows the IV and CV measurements, where the leakage current and capacitance were measured before and after irradiation. The fluence of irradiated stripixel sensor was estimated to be 9.4×10^{9} N_{eq}/cm^2 which is consistent with the average fluence of the reference diodes.

R=10 cm



Reflection from nose cone

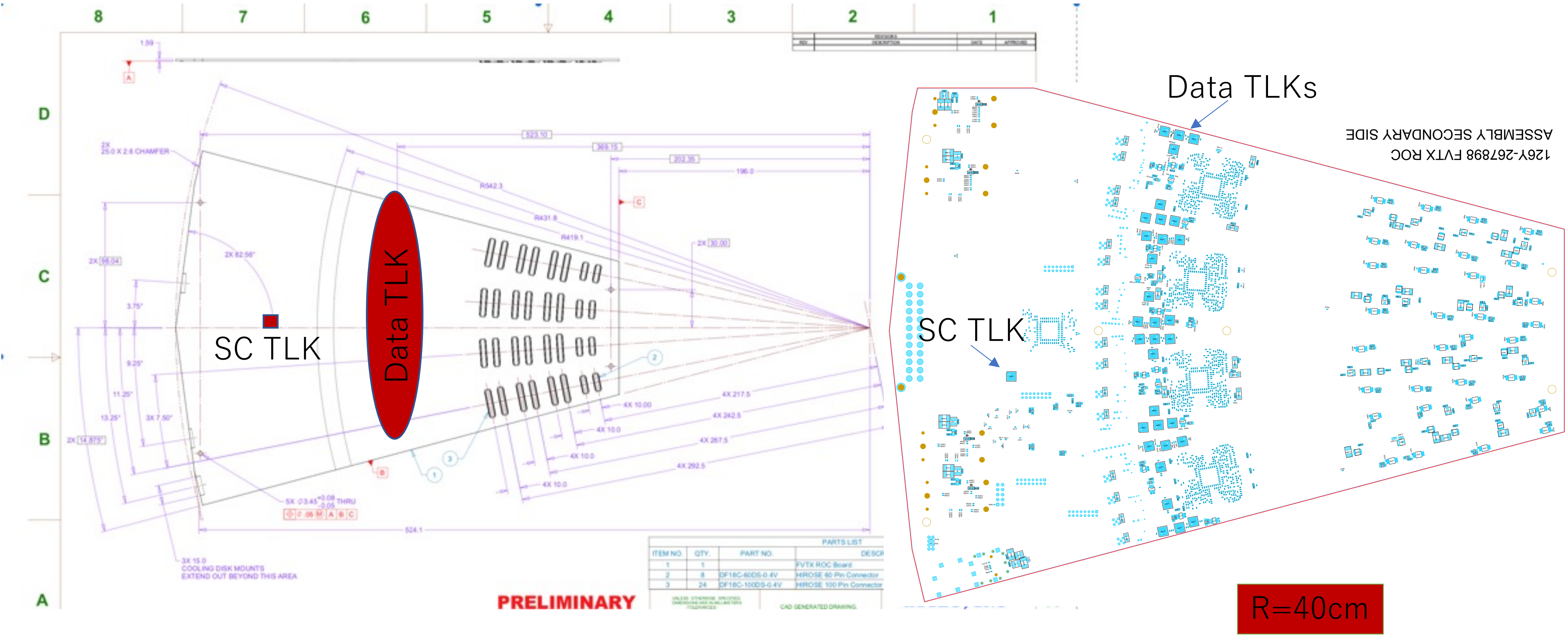
Fig. 17. Fluence of irradiated stripixel sensor and diodes at R=10 cm in PHENIX IR.

Run6 p+p
Delivered Luminosity: 12/pb (50days)
Number of Equivalent Neutrons: $10^{10}/cm^2$
(1 MeV Neutron Equivalent)
Location: R=10cm, z=25cm, η=1.65

Relative Locations

Try to estimate radiation dose at FVTX and INTT ROC positions by scaling from Asai's paper.

Location of TLK Chips in FVTX



FVTX ROC Layout

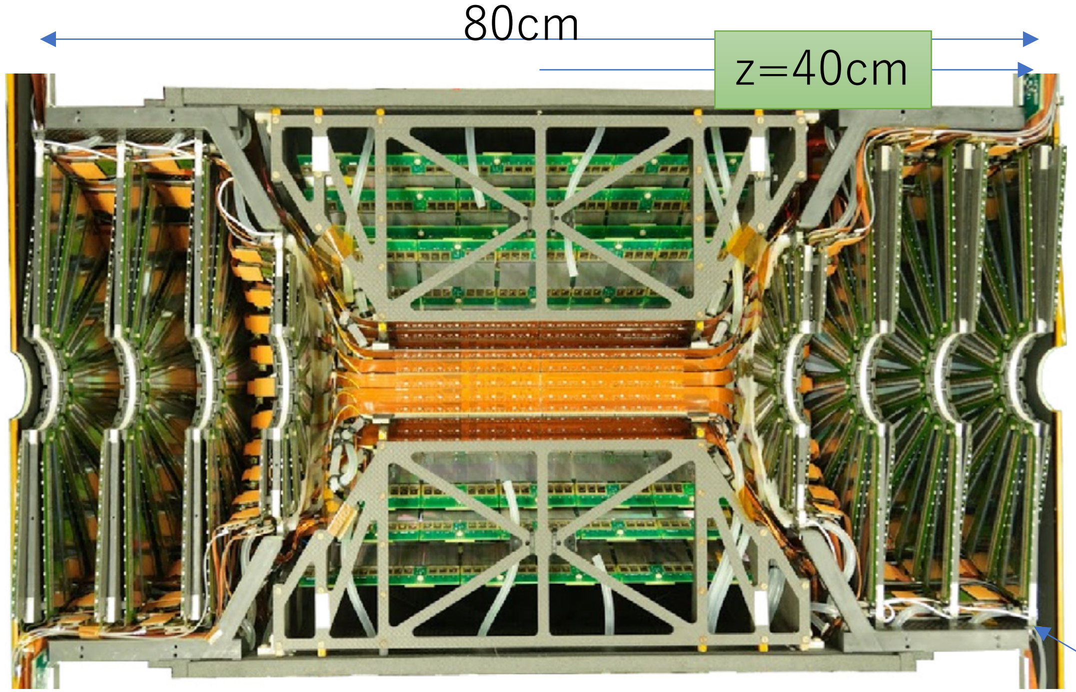
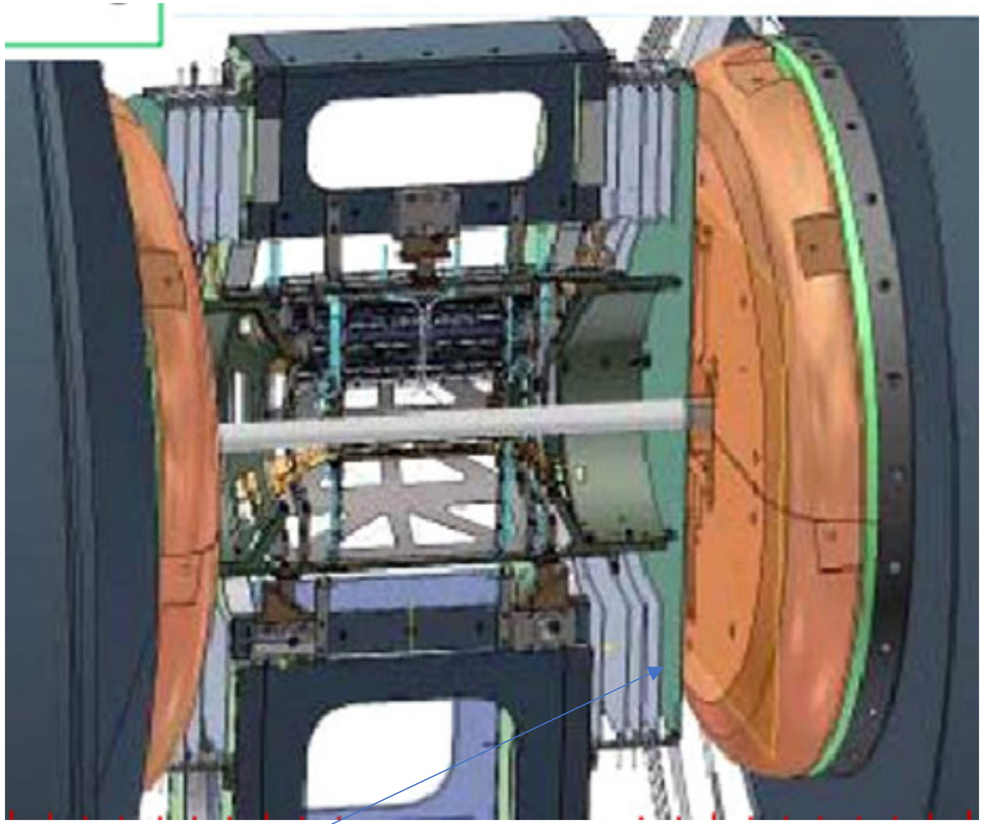
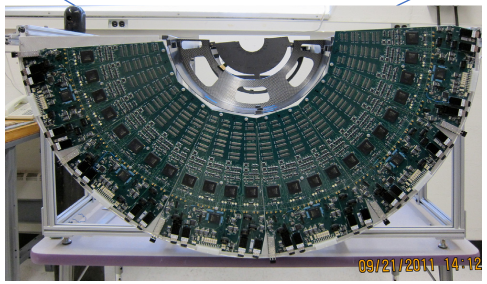


Fig. 20. A completed half-detector, with the VTX barrels in the center, and the two FVTX endcaps on either end. The overall length is 80 cm.





ROC

$R = 40\text{cm}$
$z = 40\text{cm}$
$\eta = 0.88$

Radiation Dose at FVTX-TLK2711 Location

Solid Angle	r [cm]	z[cm]	R [cm]	Ω =1cm^2 /R^2	ε_Ω
J. Asai, et al., arXiv:0710.2676.	10	25	27	1.4e-3	1
TLK (FVTX)	40	40	57	3.1e-4	0.2

ε_Ω : Relative solid angle w.r.t. Asai's

TLK

J. Asai, et al., arXiv:0710.2676.

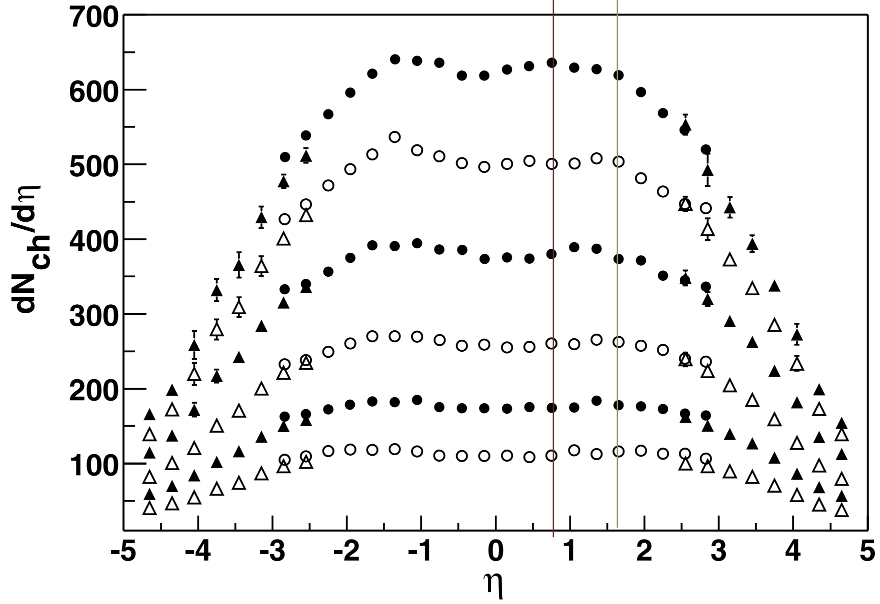


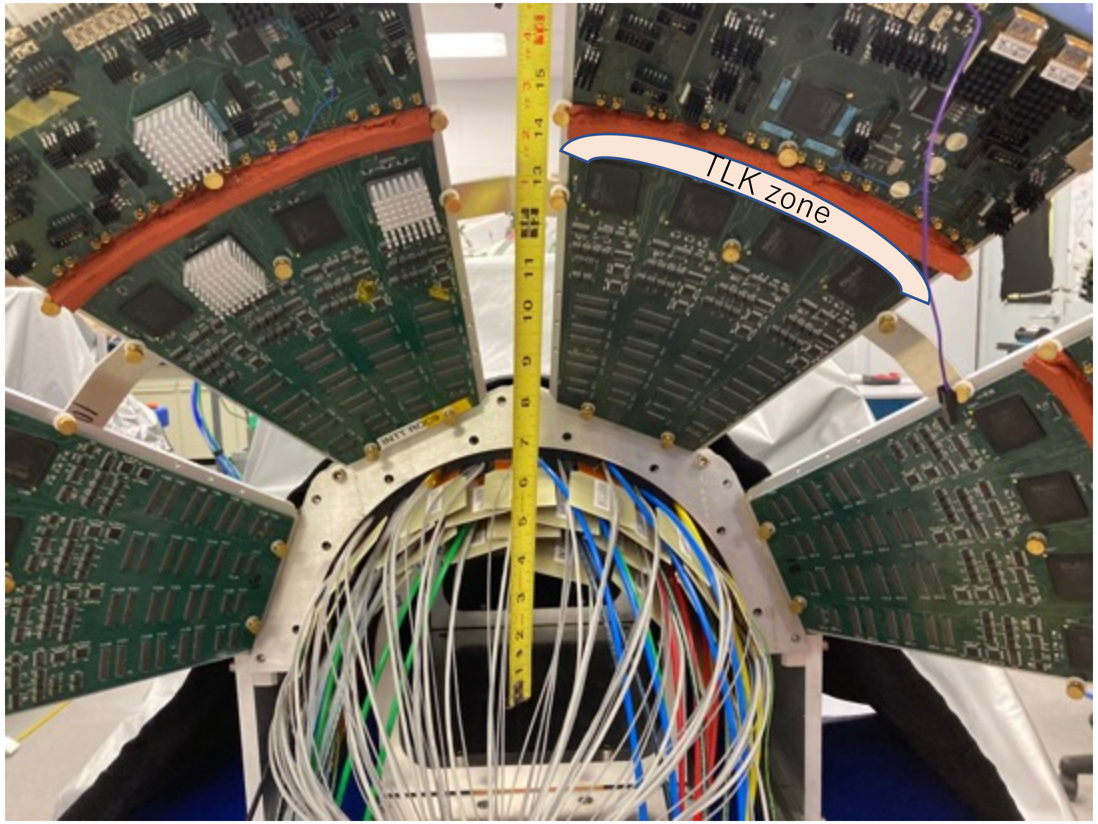
FIG. 1. Distributions of $dN_{ch}/d\eta$ for centrality ranges of, top to bottom, (0−5)%, (5−10)%, (10−20)%, (20−30)%, (30−40)%, and (40−50)%. The SiMA and BBC results are indicated by circles and triangles, respectively. Statistical errors are shown for all points where they are larger than the symbol size.

Phys. Rev. Lett. **88**, 202301

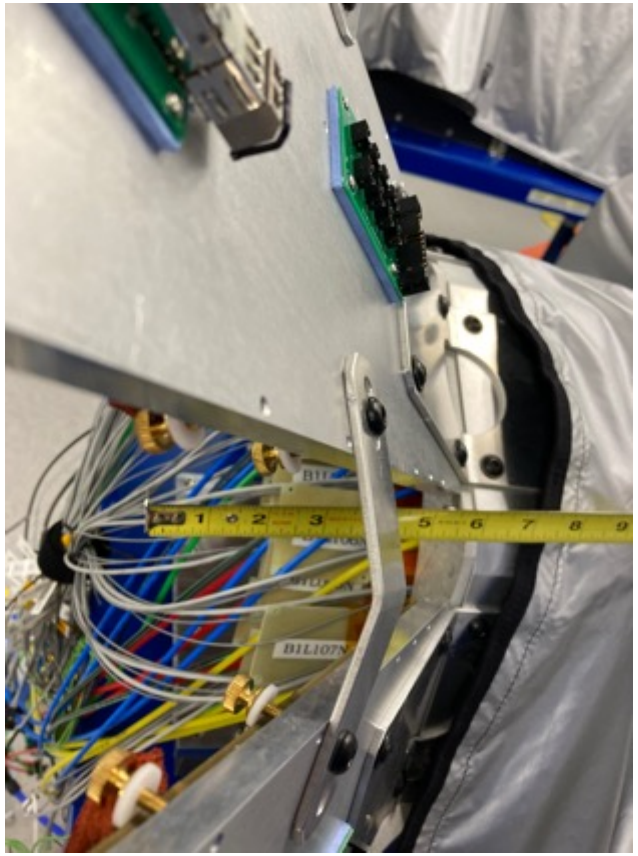
Solid Angle Scale Factor $\varepsilon_\Omega = 0.2$

Rapidity Scale Factor $\varepsilon_\eta = 1$

Location of TLK chips for INTT



R~35cm



z=40cm(HDI)+110cm(BEX)+7.6cm (ROC)
=157.6cm
η=4.5

Radiation Dose at INTT-TLK2711 Location

Solid Angle	r [cm]	z[cm]	R [cm]	Ω =1cm^2 /R^2	ε_Ω
J. Asai, et al., arXiv:0710.2676.	10	25	27	1.4e-3	1
TLK (FVTX)	40	40	57	3.1e-4	0.2
TLK (INTT)	35	157	161	3.9e-5	0.024

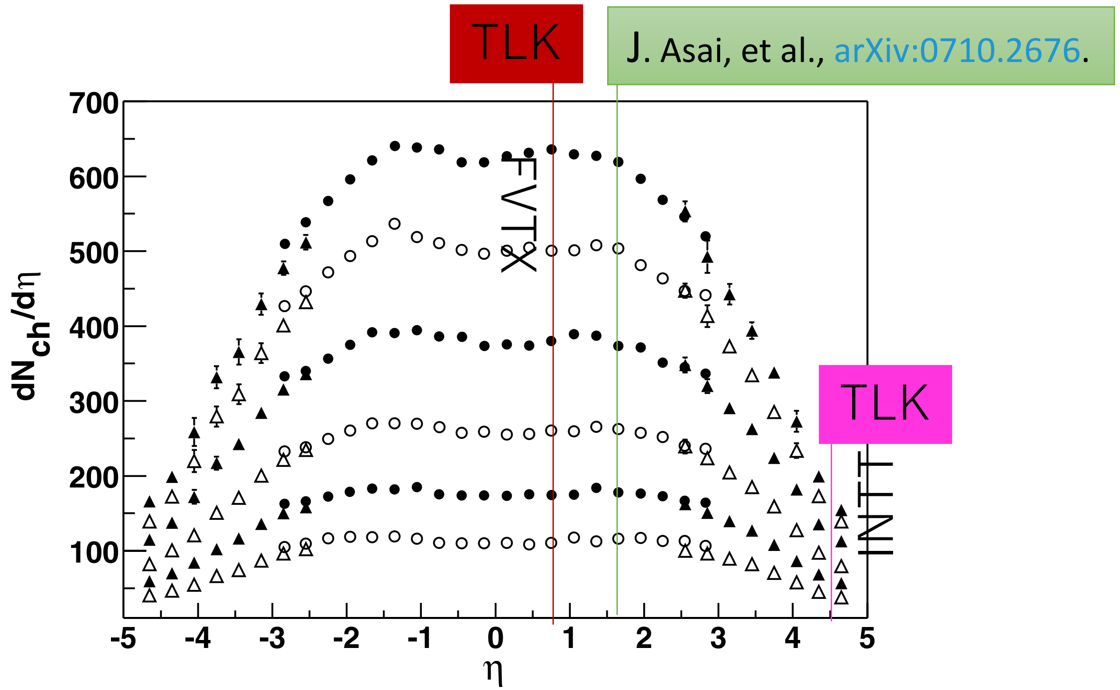


FIG. 1. Distributions of $dN_{ch}/d\eta$ for centrality ranges of, top to bottom, (0−5)%, (5−10)%, (10−20)%, (20−30)%, (30−40)%, and (40−50)%. The SiMA and BBC results are indicated by circles and triangles, respectively. Statistical errors are shown for all points where they are larger than the symbol size.

Phys. Rev. Lett. **88**, 202301

Solid Angle Scale Factor $\varepsilon_\Omega = 0.024$

Rapidity Scale Factor $\varepsilon_\eta = 0.3$

1/3 of radiation exposure compared to FVTX

FVTX Operation Run12 ~ Run16

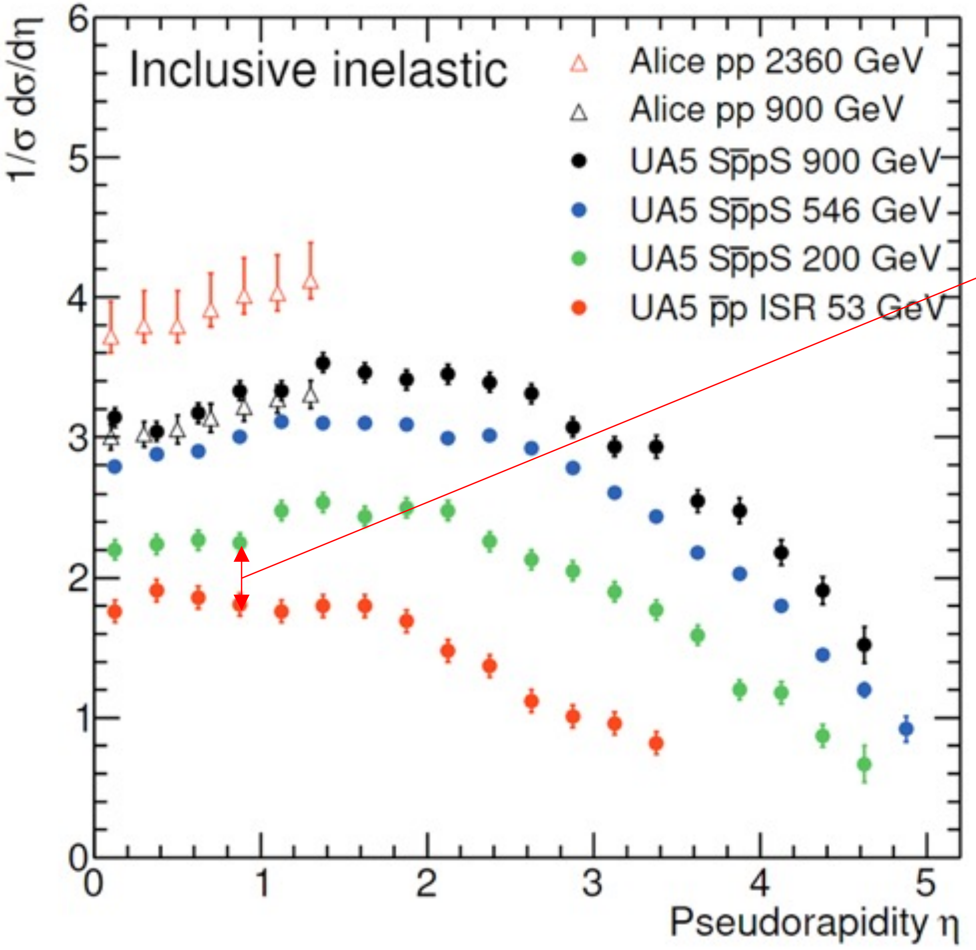
Run	species	total particle energy [GeV/nucleon]	calendar time in physics	total delivered luminosity	average store polarization, (H-jet)*
Run-12 CY2011/12, FY2012 22.9 cryo-weeks	polarized p + p	100.2	4.4 weeks	74.0 pb^{-1}	59%
	polarized p + p	254.9	4.9 weeks	283 pb^{-1}	52%
	$^{238}U^{92+} + ^{238}U^{92+}$	96.4	3.1 weeks	736 μb^{-1}	–
	$^{63}Cu^{29+} + ^{197}Au^{79+}$	99.9 + 100.0	5.4 weeks	27.0 nb^{-1}	–
Run-13 CY2012/13, FY2013 17.0 cryo-weeks	polarized p + p	254.9	13.3 weeks	1.04 fb^{-1}	53%
Run-14 CY2013/14, FY2014 22.0 cryo-weeks	$^{197}Au^{79+} + ^{197}Au^{79+}$	7.3	3.4 weeks	44.2 μb^{-1}	–
	$^{197}Au^{79+} + ^{197}Au^{79+}$	100.0	13.3 weeks	43.9 nb^{-1}	–
	$h + ^{197}Au^{79+}$	103.5 + 100.0	2.4 weeks	134 nb^{-1}	–
Run-15 CY2014/15, FY2015 22.4 cryo-weeks	polarized p + p	100.2	10.9 weeks	382 pb^{-1}	55%
	polarized $p + ^{197}Au^{79+}$	103.9 + 98.6	5.1 weeks	1.27 pb^{-1}	60%
	polarized $p + ^{27}Al^{13+}$	103.9 + 98.7	1.9 weeks	3.87 pb^{-1}	54%
Run-16 CY2015/16, FY2016 23.3 cryo-weeks	$^{197}Au^{79+} + ^{197}Au^{79+}$	100.0	14.4 weeks	52.2 nb^{-1}	–
	$d + ^{197}Au^{79+}$	100.7 + 100.0	8 days	289 nb^{-1}	–
	$d + ^{197}Au^{79+}$	31.3 + 31.1	6 days	44.0 nb^{-1}	–
	$d + ^{197}Au^{79+}$	9.9 + 9.8	11 days	7.20 nb^{-1}	–
	$d + ^{197}Au^{79+}$	19.6 + 19.4	7 days	19.5 nb^{-1}	–

Total Delivered Luminosity = 1785/pb without correction

$$L_{AuAu}^{Delivered} = L_{pp}^{Delivered}(100GeV) \times \epsilon_{Species} \times \epsilon_{energy}$$

https://www.rhichome.bnl.gov/RHIC/Runs/

Energy Correction in p+p



$$\varepsilon_{energy} = \frac{\sigma_{Sp\bar{p}S}\ 546GeV}{\sigma_{Sp\bar{p}S}\ 200GeV} \sim 1.2$$

at η=0.88 where TLK chips of ROC are in FVTX

Species Correction

Species	p	d	3He	Al	Cu	Au	U
Mass Number A	1	2	3	27	63.5	197	238

$$\varepsilon_{species} = \frac{A_{A*A}}{A_{p*p}}$$

Example: Au+Au = 197*197
p+Au = 197*1

$$\varepsilon_{participants} = \frac{N_{collision}}{N_{participants}} \sim \frac{260}{110} \sim 2.5$$

PHENIX Total Delivered Lumi Estimation w/ Corrections

Run	species	Species Correction	Beam Energy	Energy Correction	Integrated Luminosicy	Unit	Integ Lumi [/pb]	Delivered Lumi	Unit	Delivered Lumi [/pb]	Delivered Lumi*Species*Energy corrections [/pb]
12	p+p	1	100	1	38	/pb	38	74	/pb	74	74.0
	p+p	1	250	1.2	133	/pb	133	283	/pb	283	339.6
	U+U	22658	96	0.96	368	/ub	0.000368	736	/ub	0.000736	16.0
	Cu+Au	5004	100	1	13.5	/nb	0.0135	27	/nb	0.027	135.1
13	p+p	1	250	1.2	543	/pb	543	1.04	/fb	1040	**1248.0**
14	Au+Au	15524	7.3	0.073*	23	/ub	0.000023	44.2	/ub	0.0000442	0.1
	Au+Au	15524	100	1	23	/nb	0.023	43.9	/nb	0.0439	**681.5**
	3he+Au	591	100	1	72	/nb	0.072	134	/nb	0.134	79.2
15	p+p	1	100	1	196.7	/pb	196.7	382	/pb	382	382.0
	p+Au	197	100	1	63	/pb	63	1.27	/pb	1.27	250.2
	p+Al	27	100	1	2.3	/pb	2.3	3.87	/pb	3.87	104.5
16	Au+Au	15524	100	1	52	/nb	0.000052	52.2	/nb	0.0522	**810.3**
	d+Au	394	100	1	155	/nb	0.155	289	/nb	0.289	113.9
	d+Au	394	31	0.31*	22.8	/nb	0.0228	44	/nb	0.044	5.4
	d+Au	394	10	0.1*	3.75	/nb	0.00375	7.2	/nb	0.0072	0.3
	d+Au	394	19.5	0.195*	9.5	/nb	0.0095	19.5	/nb	0.0195	1.5
Total							**976**			**1785**	**4241**

sPHENIX_IntegLumi.xlsx

$$L_{AuAu}^{Delivered} = L_{pp}^{Delivered}(100GeV) \times \epsilon_{Species} \times \epsilon_{energy}$$

*Linear scale assumed for low energy runs (negligible contribution anyway)

sPHENIX Delivered Luminosity Estimate

RHIC Collider Projections (FY 2023 – FY 2025)

W. Fischer, A. Drees, H. Huang, M. Minty, D. Raparia, T. Shrey, and M. Valette

Last update: 3 May 2022

Table 2: Demonstrated and projected luminosities for 100 GeV/nucleon Au+Au runs.

Parameter	Unit	FY2007	2010	2011	2014	2016	2023E	2025E
No of bunches k_b	…	103	111	111	111	111	111	111
Ions/bunch, initial N_b	10^9	1.1	1.1	1.3	1.6	2.0	2.4	2.90
Average beam current/ring I_{avg}	mA	112	121	147	176	224	265	319
Stored beam energy	MJ	0.36	0.39	0.47	0.56	0.71	0.84	1.0
Envelope function at IP β^*	m	0.85	0.75	0.75	0.70	0.70	0.70	0.65
Beam-beam parameter ξ/IP	10^{-3}	-1.7	-1.5	-2.1	-2.5	-3.9	-4.6	-5.6
Initial luminosity L_{init}	**10^{26} cm^{-2}s^{-1}**	**30**	**40**	**50**	**80**	**155**	**215**	**336**
Events per bunch-bunch crossing μ	…	0.08	0.10	0.13	0.21	0.40	0.55	0.86
Average/initial luminosity	%	40	50	60	62	56	58	60
Average store luminosity L_{avg}	**10^{26} cm^{-2}s^{-1}**	**12**	**20**	**30**	**50**	**87**	**125**	**200**
Time in store	%	48	53	59	68	65	60	60
Max. luminosity/week	μb^{-1}	380	650	1000	2200	3000	4530	7260
Min. luminosity/week	μb^{-1}						3000	3000

Table 3: Demonstrated and max projected luminosities and polarization for p↑+p↑ and p↑+Au runs at 100 GeV.

		p↑+p↑					p↑+Au	
Parameter	Unit	FY2008	2009	2012	2015	2024E	FY2015	2024E
No of colliding bunches k_b	…	109	109	109	111	111	111	111
Protons/bunch, initial N_b	10^{11}	1.5	1.3	1.6	2.25	2.5	225/1.6	250/2.4
Average beam current/ring I_{avg}	mA	198	179	214	312	347	313/176	348/266
Stored beam energy	MJ	0.25	0.23	0.27	0.40	0.45	0.40/0.56	0.45/0.84
Envelope function at IP β^*	m	1.00	0.70	0.85	0.85	0.85	0.85/0.70	0.85/0.70
Hourglass factor H	…	0.77	0.72	0.74	0.75	0.84	0.72	0.72
Beam-beam parameter ξ/IP	10^{-3}	-5.3	-6.3	-5.8	-9.7	-11.7	-5.3/-4.1	-11.7/-4.3
Initial luminosity L_{init}	**10^{30} cm^{-2}s^{-1}**	**35**	**50**	**46**	**115**	**176**	**0.88**	**1.68**
Events per bunch-bunch crossing μ	…	0.2	0.3	0.3	0.7	1.1		
Average/initial luminosity	%	65	56	71	55	57	51	54
Average store luminosity L_{avg}	**10^{30} cm^{-2}s^{-1}**	**23**	**28**	**33**	**63**	**100**	**0.45**	**0.90**
Time in store	%	60	53	59	64	60	65	60
Max. luminosity/week	pb^{-1}	7.5	8.3	9.3	25	36	0.140	0.326
Min. luminosity/week	pb^{-1}					25		0.140
L within $\lvert z\rvert$<10 cm, θ = 0 mrad, r_0/r_θ*	%					22/22		29/29
L within $\lvert z\rvert$<10 cm, θ = 2 mrad, r_0/r_θ*	%					9/69		4/75
AGS extraction, P_{max}	%	55	65	72	68	68	68	68
RHIC store average, P_{max}	**%**	**45**	**56**	**59**	**57**	**60**	**60**	**60**
RHIC store average, P_{min}	%					57		57

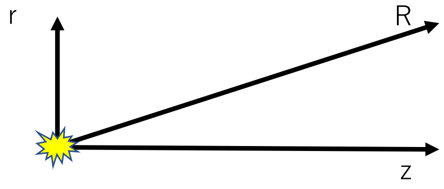
Year	Species	Species Correction	Energy [GeV]	Energy Correction Factor	Max. Deliv. Lumi / Week [/nb]	Cryo Week	Year Total [/nb]	Year Total [/pb]	Year Ttotal *Species *Energy corrections [/pb]
2023	Au+Au	15523.6	200	1	4.53	28	126.84	0.1	1969
2024	p+p	1	200	1	3.60E+04	21	7.68E+05	768.0	768
	p+Au	197	200	1	3.26E+02	7	2.17E+03	2.2	428
2025	Au+Au	15523.6	200	1	7.26	28	203.28	0.2	3156
Total Dose	sPHENIX_IntegLumi.xlsx								**6321**

Total Radiation Dose Estimate

	Delivered Luminosity [/pb]	r [cm]	z [cm]	η	Ω [str]	ε_η	ε_Ω	N_{eq} [/cm^2]	Dose [Gy]
Asai et al.	12	10	25	3.2	1.4×10^{-3}	1	1	10^{10}	3.8
FVTX TLK	**4241**	40	40	0.88	3.1×10^{-4}	1	0.23	8.0×10^{11}	**300**
INTT TLK	**6321**	35	157	4.5	3.9×10^{-5}	0.3	0.028	4.4×10^{10}	**16.6**

sPHENIX_IntegLumi.xlsx

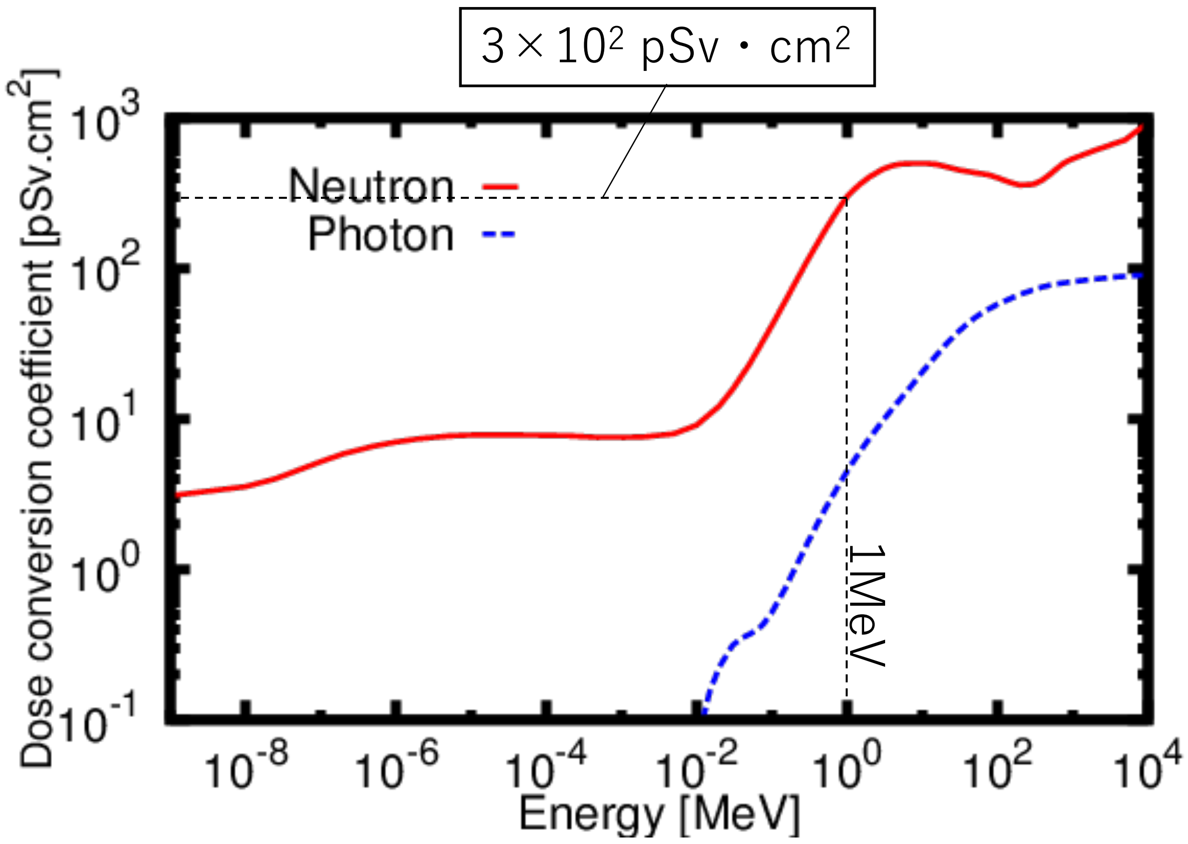
$$Dose = N_{eq}[1/cm^2]\times(3.75\times10^{-10})[Gy\cdot cm^2]$$



$$N_{eq}^{FVTX,INTT} = N_{eq}^{Asai}\times\epsilon_\eta\times\epsilon_\Omega$$

The expected radiation dose of TLKs during INTT operation is about **5%** of accumulated dose during FVTX. Mainly because of far distance from the vertex in *z* of INTT ROC boards.

N_{eq} →Sv Conversion Coefficient



$$Dose = N_{eq}[1/cm^2] \times (3 \times 10^2)[pSv \cdot cm^2]$$
$$= N_{eq}[1/cm^2] \times (3.75 \times 10^{-10})[Gy \cdot cm^2]$$

N_{eq} [/cm²]	Dose [Gy]
7.0 x 10^{11}	260
3.8 x 10^{10}	14

https://www.icrp.org/docs/P116_Japanese.pdf

Radiation Tolerance of TLK2711

Why quite a few ROCs are suffered from the fiber latch issue?

Product Folder | Order Now | Technical Documents | Tools & Software | Support & Community

TEXAS INSTRUMENTS

TLK2711-SP

SGLS307P – JULY 2006 – REVISED FEBRUARY 2018

TLK2711-SP 1.6-Gbps to 2.5-Gbps Class V Transceiver

1 Features

- 1.6 to 2.5-Gbps (Gigabits Per Second) Serializer/Deserializer
- Hot-Plug Protection
- High-Performance 68-Pin Ceramic Quad Flat Pack Package (HFG)
- Low-Power Operation
- Programmable Preemphasis Levels on Serial Output
- Interfaces to Backplane, Copper Cables, or Optical Converters
- On-Chip 8-Bit/10-Bit Encoding/Decoding, Comma Detect
- On-Chip PLL Provides Clock Synthesis From Low-Speed Reference
- Low Power: < 500 mW
- 3-V Tolerance on Parallel Data Input Signals
- 16-Bit Parallel TTL-Compatible Data Interface
- Ideal for High-Speed Backplane Interconnect and Point-to-Point Data Link
- Military Temperature Range (–55°C to 125°C T_{case})
- Loss of Signal (LOS) Detection
- Integrated 50-Ω Termination Resistors on RX
- Engineering Evaluation (/EM) Samples are Available (1)

2 Applications

- Point-to-Point High-Speed I/O
- Data Acquisition
- Data Processing

3 Description

The TLK2711-SP is a member of the WizardLink transceiver family of multigigabit transceivers, intended for use in ultra-high-speed bidirectional point-to-point data transmission systems. The TLK2711-SP supports an effective serial interface speed of 1.6 Gbps to 2.5 Gbps, providing up to 2 Gbps of data bandwidth.

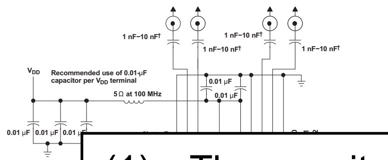
The primary application of the TLK2711-SP is to provide high-speed I/O data channels for point-to-point baseband data transmission over controlled impedance media of approximately 50 Ω. The transmission media can be printed circuit board, copper cables, or fiber-optic cable. The maximum rate and distance of data transfer is dependent upon the attenuation characteristics of the media and the noise coupling to the environment.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TLK2711-SP	CFP (68)	13.97 mm × 13.97 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

External Component Interconnection



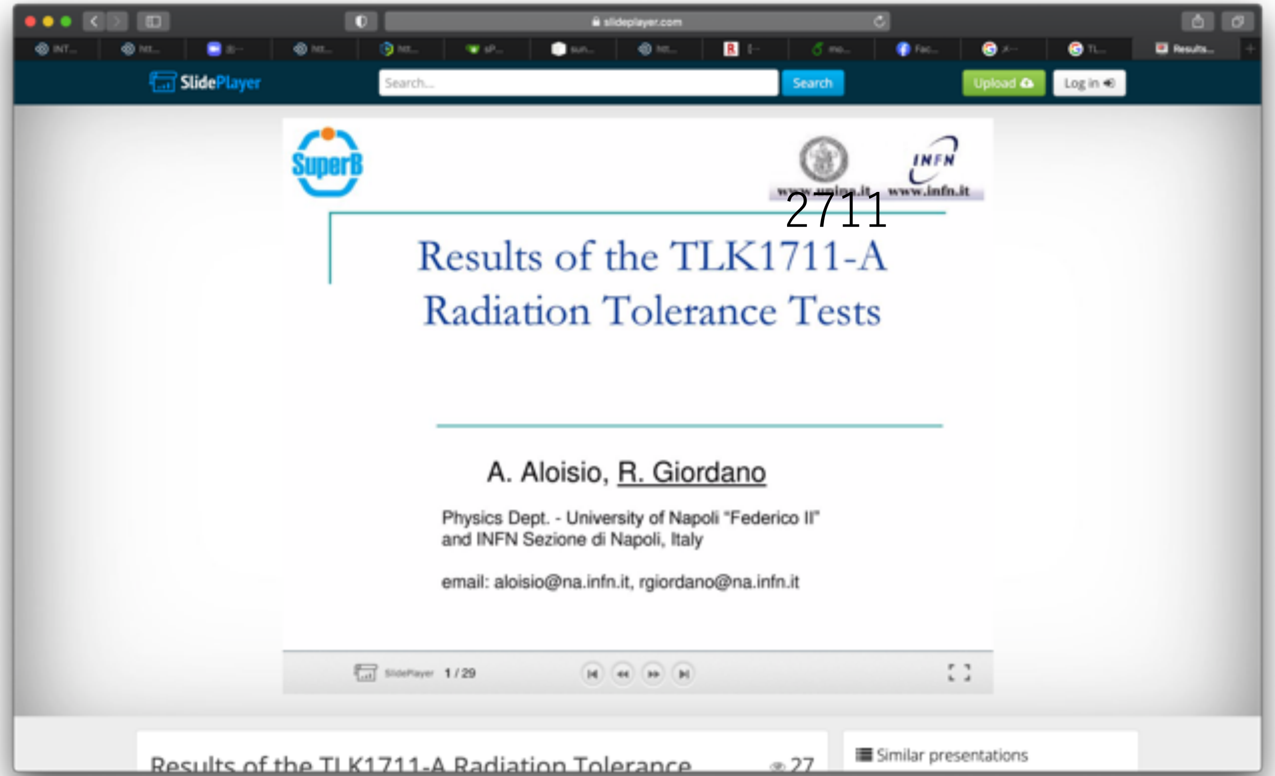
† For ac coupling

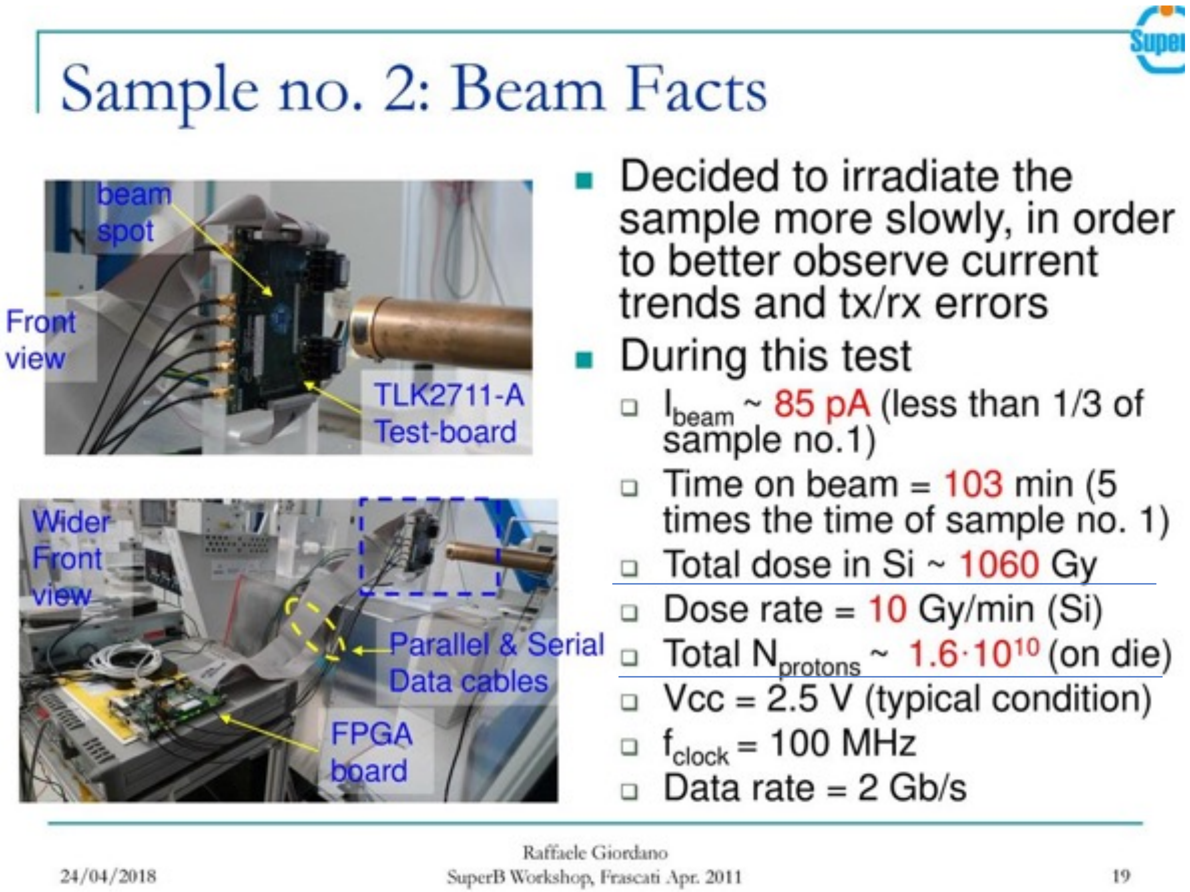
(1) These units are intended for engineering evaluation only. They are processed to a non-compliant flow (for example, no burn-in, and so forth) and are tested to temperature rating of 25°C only. These units are not suitable for qualification, production, radiation testing, or flight use. Parts are not warranted for performance on full MIL specified temperature range of –55°C to 125°C or operating life.

- Radiation damage?
- If so, we have higher chances to be suffered new cases during the beam operation than FVTX since we start from already accumulated dose during FVTX operation.
- We better be prepared.

(1) These units are intended for engineering evaluation only. They are processed to a non-compliant flow (for example, no burn-in, and so forth) and are tested to temperature rating of 25°C only. These units are not suitable for qualification, production, radiation testing, or flight use. Parts are not warranted for performance on full MIL specified temperature range of –55°C to 125°C or operating life.

Radiation Damage Study by INFN

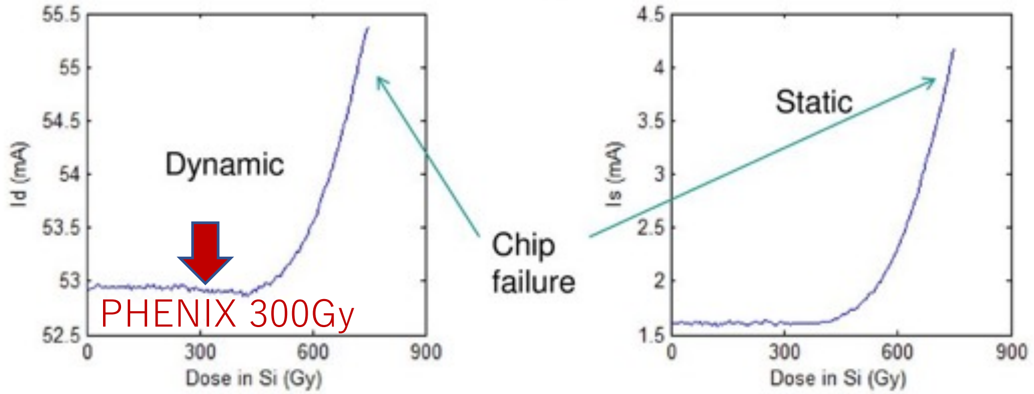




https://slideplayer.com/slide/12764619/

Radiation Damage Study by INFN

Sample no. 1: Analog Current Trend



- Moderate dynamic current increase from 53 mA to 55 mA
- Power down current increment from 1.6 to 4.2 mA, more than 300%

Sample no. 2 : Error Results

- First error appeared at dose = 280 Gy (Si)
- # Tx errors = 2 single and 1 burst (7 consecutive errored symbols)

  $\sigma_{tx(single)}$=4.3 10^{-12} cm^2

  $\sigma_{tx(burst)}$=2.1 10^{-12} cm^2

- # Rx errors = 0 single and 2 burst (12,11 consecutive symbols)

  $\sigma_{rx(burst)}$= 4.3 10^{-12} cm^2

- At dose = 800 Gy (Si), the device underwent functional failure

https://slideplayer.com/slide/12764619/

ROC Status Updated

- Good
- Good, but occasional failure
- No data at all

C : Problem in **C**alibration pulse
F : Problem in data **F**iber sync
P : Problem in **P**ower supply
R : **R**ecovered

Index	ROC #	FVTX	Regulator Upgrade	Location	Class	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3	Issue	Status
1	6	NW2	✓	BNL	1														
2	13	NE4	✓	BNL	1														
3	18	NE1	✓	BNL	1														
4	26	SE3	✓	BNL	1														
5	28	SE0	✓	BNL	1														
6	29	-	✓	BNL	1														
7	20	SW5	✓	BNL	1														
8	22	SE2	✓	BNL	1														
9	23	SE1	✓	BNL	1														
10	31	NW1	✓	BNL	1	R	R	R											
11	32	NE2	✓	BNL	1							R	R	R					
12	9	-	✓	BNL	1			R											
13	10	-	✓	BNL	1					R		R							
14	27	SE5	✓	BNL	1							R			R	R	R		L12 Replaced at Column-D
15	19	NE5	✓	BNL	3										F				TLK2711 Replaced
16	24	SE4	✓	BNL	2			F							F			Fiber Sync	
17	16	NE3	✓	BNL	3				C	C	C							Calib Pulse	Waiting for SC-FPGA downlaod
18	15	NE0	✓	RIKEN	2	R									F	F		Fiber Sync	
18	2	NW4	✓	RIKEN	3					R		R			F	R		Fiber Sync	
19	7	-	✓	RIKEN	3		R	R			R				R				Replaced all DF18
20	21	-	✓	REPIC	3	R			R		R		R	F	R			Fiber Sync	
21	17	NW3	✓	RIKEN	3				F							R		Fiber Sync	
22	3	NW5	✓	RIKEN	3	R		R								R	F	Fiber Sync	
24	14	NE1	✓	REPIC	3					R		C	R	R	P	P	P	Calib Pulse	L12 to be replaced at Column-D

- There are 7 ROC boards (9 ports) won't latch the fiber.
- 7 bad/24 ROCs = 30% of ROCs
- 9 bad TLKs /24ROCs x 2x4 =9/792 ~ 1%

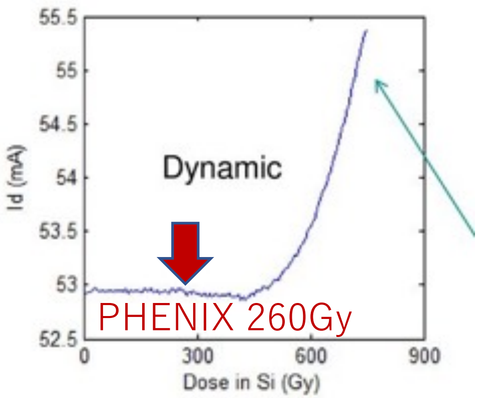
Fiber Latch Failure History

	Port 2		Port 3		Port 0		Port 1	
	0	1	2	3	4	5	6	7
NW3 (A)			×					
NW3 (B)							×	
NW3 (D)					×	×	×	
NW4 (C)							×	
NW4 (D)		×		×	×		×	
NW5 (A)		×	×	×	×	×	×	
NW5 (B)				×				
NW5 (C)			×					
NW5 (D)			×			×		
SE1 (D)						×		
SE2 (D)					×		×	
SE4 (A)		×	×					
SE4 (D)							×	
NE0 (A)					×	×		×
NE0 (D)			×				×	
NE5 (D)							×	
ROC7 (B)				×				
ROC7 (D)	×	×		×	×	×	×	
ROC9 (A)			×					
ROC21 (B)			×					

List of ports which has failed in fiber latch at least once during ROC testing process. (K. Fujiki)

Total 42

Total	Severe	Suspicious
792	9	33
Fraction	1%	4%



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6	29	-	✓	BNL	1														
7	20	SW5	✓	BNL	1														
8	22	SE2	✓	BNL	1	F													Fiber Issue 2022/12/8
9	23	SE1	✓	BNL	1														
10	31	NW1	✓	BNL	1	R	R	R											
11	32	NE2	✓	BNL	1							R	R	R					
12	9	-	✓	BNL	1			R											
13	10	-	✓	BNL	1					R		R							
14	27	SE5	✓	BNL	1							R			R	R	R		L12 Replaced at Column-D
15	19	NE5	✓	BNL	3										R				TLK2711 Replaced
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19	7	-	✓	RIKEN	3		R	R			R				R				Replaced all DF18
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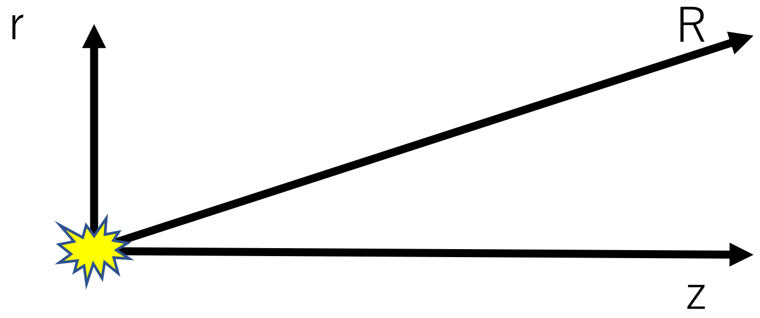
- There are 7 ROC boards (9 ports) won't latch the fiber.
- 7 bad/24 ROCs = 30% of ROCs
- 9 bad TLKs /24ROCs x 2x3ports/column x 4 +1SC=9TLKs/600TLKs ~ 1%

New SE2 A Port 1 (severe)

Summary

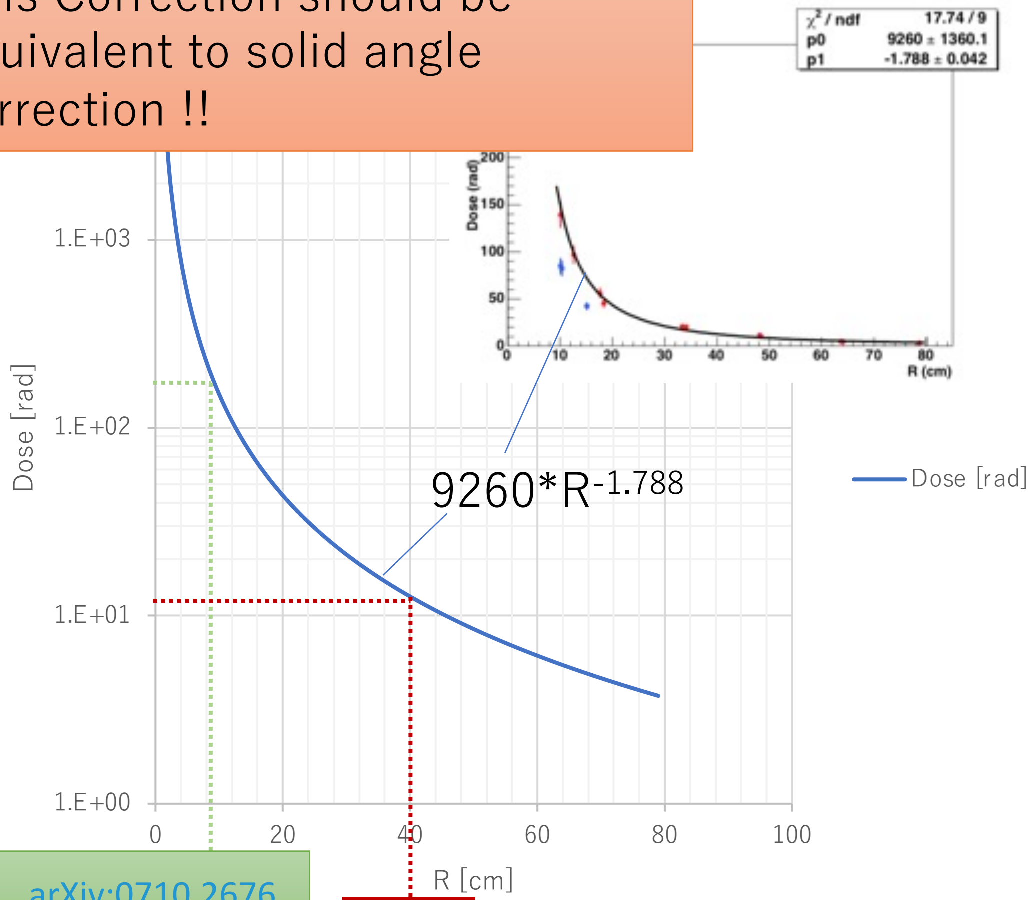
- Accumulated radiation dose for TLK chips throughout 5 years of FVTX operation.
- The calculated radiation dose 300Gy is ~ 2/3 of slope change of the leakage current of TLK.
- At this dose, 1% TLKs are severely damaged. 3% of TLKs show in unstable behavior.
- The expected radiation dose during INTT operation is 5% of that of FVTX's.
- We may not be encountered by drastic failures during INTT operation thanks to moderate exposure of ROC position for INTT. (If I am not making any fatal error in my calculation).

Backup


r
R
z

Radiation Dose at FVTX-TLK2711 Location

This Correction should be equivalent to solid angle correction !!



J. Asai, et al., arXiv:0710.2676.

TLK

Radius Scale Factor $\varepsilon_R = 0.08$

TLK

J. Asai, et al., arXiv:0710.2676.

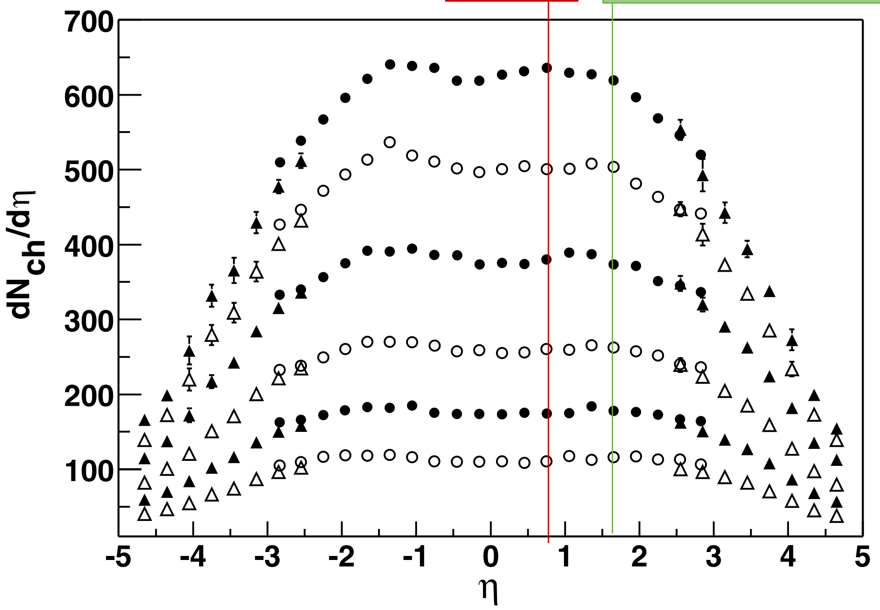
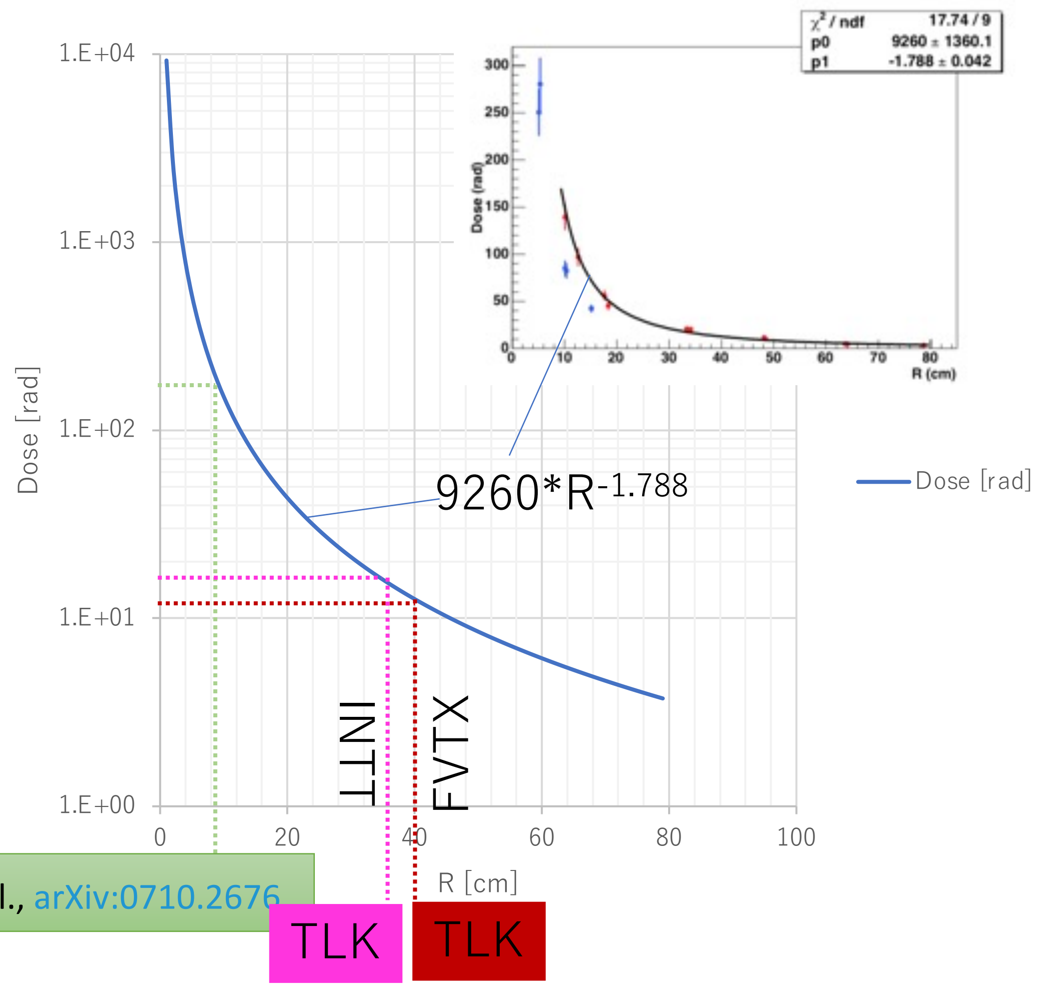


FIG. 1. Distributions of $dN_{ch}/d\eta$ for centrality ranges of, top to bottom, (0−5)%, (5−10)%, (10−20)%, (20−30)%, (30−40)%, and (40−50)%. The SiMA and BBC results are indicated by circles and triangles, respectively. Statistical errors are shown for all points where they are larger than the symbol size.

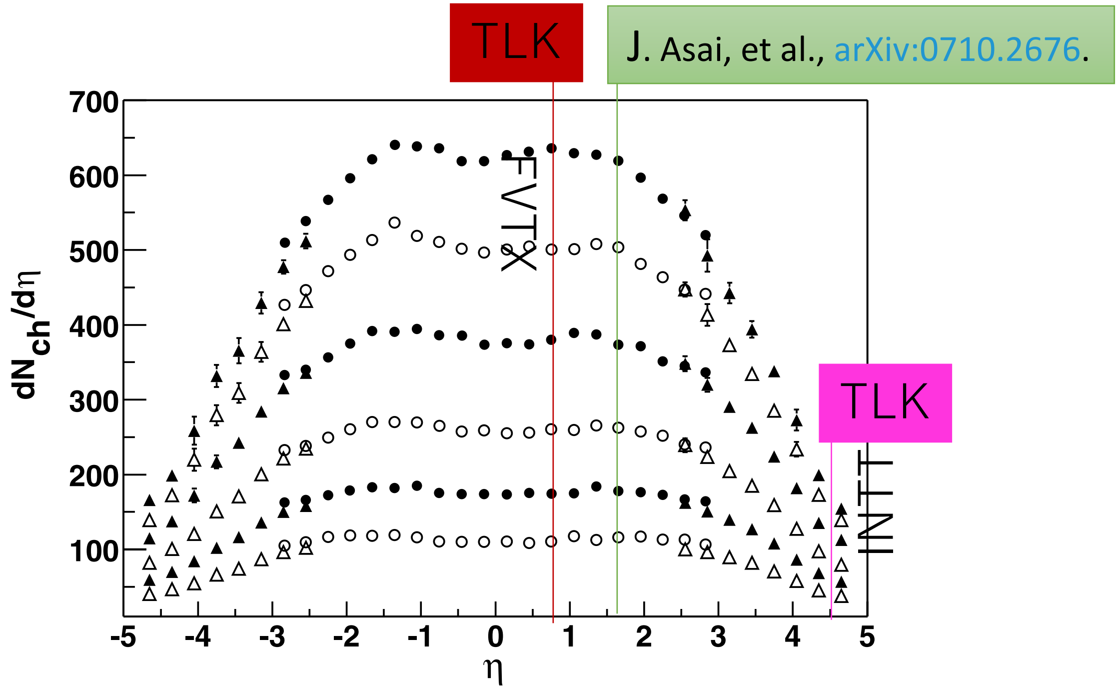
Phys. Rev. Lett. **88**, 202301

Rapidity Scale Factor $\varepsilon_\eta = 1$

Radiation Dose at INTT-TLK2711 Location



Radius Scale Factor $\varepsilon_R = 0.11$



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Phys. Rev. Lett. **88**, 202301

Rapidity Scale Factor $\varepsilon_\eta = 0.3$

sPHENIX Delivered Luminosity Estimate

RHIC Collider Projections (FY 2023 – FY 2025)

W. Fischer, A. Drees, H. Huang, M. Minty, D. Raparia, T. Shrey, and M. Valette

Last update: 3 May 2022

Table 2: Demonstrated and projected luminosities for 100 GeV/nucleon Au+Au runs.

Parameter	Unit	FY2007	2010	2011	2014	2016	2023E	2025E
No of bunches k_b	…	103	111	111	111	111	111	111
Ions/bunch, initial N_b	10^9	1.1	1.1	1.3	1.6	2.0	2.4	2.90
Average beam current/ring I_{avg}	mA	112	121	147	176	224	265	319
Stored beam energy	MJ	0.36	0.39	0.47	0.56	0.71	0.84	1.0
Envelope function at IP β^*	m	0.85	0.75	0.75	0.70	0.70	0.70	0.65
Beam-beam parameter ξ/IP	10^{-3}	-1.7	-1.5	-2.1	-2.5	-3.9	-4.6	-5.6
Initial luminosity L_{init}	**10^{26} cm^{-2}s^{-1}**	**30**	**40**	**50**	**80**	**155**	**215**	**336**
Events per bunch-bunch crossing μ	…	0.08	0.10	0.13	0.21	0.40	0.55	0.86
Average/initial luminosity	%	40	50	60	62	56	58	60
Average store luminosity L_{avg}	**10^{26} cm^{-2}s^{-1}**	**12**	**20**	**30**	**50**	**87**	**125**	**200**
Time in store	%	48	53	59	68	65	60	60
Max. luminosity/week	μb^{-1}	380	650	1000	2200	3000	4530	7260
Min. luminosity/week	μb^{-1}						3000	3000
L within $\|z\|$<10 cm, θ = 0 mrad, r_0/r_θ*	%						39/39	39/39
L within $\|z\|$<10 cm, θ = 2 mrad, r_0/r_θ*	%						31/81	31/81

* Luminosity $L(z,\theta)$ within vertex cut $|z|$ for full crossing angle θ. The values r_0/r_θ are $r_0 = L(z,0)/L(10\text{ m},0)$ and $r_\theta = L(z,\theta)/L(10\text{ m},\theta)$.

Table 3: Demonstrated and max projected luminosities and polarization for p↑+p↑ and p↑+Au runs at 100 GeV.

		p↑+p↑					p↑+Au	
Parameter	Unit	FY2008	2009	2012	2015	2024E	FY2015	2024E
No of colliding bunches k_b	…	109	109	109	111	111	111	111
Protons/bunch, initial N_b	10^{11}	1.5	1.3	1.6	2.25	2.5	225/1.6	250/2.4
Average beam current/ring I_{avg}	mA	198	179	214	312	347	313/176	348/266
Stored beam energy	MJ	0.25	0.23	0.27	0.40	0.45	0.40/0.56	0.45/0.84
Envelope function at IP β^*	m	1.00	0.70	0.85	0.85	0.85	0.85/0.70	0.85/0.70
Hourglass factor H	…	0.77	0.72	0.74	0.75	0.84	0.72	0.72
Beam-beam parameter ξ/IP	10^{-3}	-5.3	-6.3	-5.8	-9.7	-11.7	-5.3/-4.1	-11.7/-4.3
Initial luminosity L_{init}	**10^{30} cm^{-2}s^{-1}**	**35**	**50**	**46**	**115**	**176**	**0.88**	**1.68**
Events per bunch-bunch crossing μ	…	0.2	0.3	0.3	0.7	1.1		
Average/initial luminosity	%	65	56	71	55	57	51	54
Average store luminosity L_{avg}	**10^{30} cm^{-2}s^{-1}**	**23**	**28**	**33**	**63**	**100**	**0.45**	**0.90**
Time in store	%	60	53	59	64	60	65	60
Max. luminosity/week	pb^{-1}	7.5	8.3	9.3	25	36	0.140	0.326
Min. luminosity/week	pb^{-1}					25		0.140
L within $\|z\|$<10 cm, θ = 0 mrad, r_0/r_θ*	%					22/22		29/29
L within $\|z\|$<10 cm, θ = 2 mrad, r_0/r_θ*	%					19/69		24/75
AGS extraction, P_{max}	%	55	65	72	68	68	68	68
RHIC store average, P_{max}	**%**	**45**	**56**	**59**	**57**	**60**	**60**	**60**
RHIC store average, P_{min}	%					57		57

* Luminosity $L(z,\theta)$ within vertex cut $|z|$ for full crossing angle θ. The values r_0/r_θ are $r_0 = L(z,0)/L(10\text{ m},0)$ and $r_\theta = L(z,\theta)/L(10\text{ m},\theta)$.

Year	Species	Max Lumi/Week	28 weeks Year Total
2023	Au+Au	4.53 /nb	0.1/pb
2024	p+p	36 /pb	768/pb
	p+Au	0.326 /pb	2.17/pb
2025	Au+Au	7.26 /nb	0.2/pb

Integrated Luminosity

770/pb