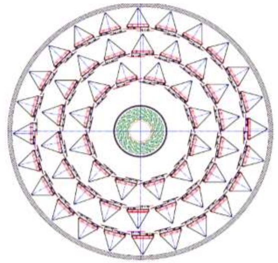


Детекторные системы РЯФ сегодня и завтра

Ю.Мурин   ЛФВЭ, ОИЯИ

Доклад на сессии ОЯФ РАН,

Москва 19 октября, 2025

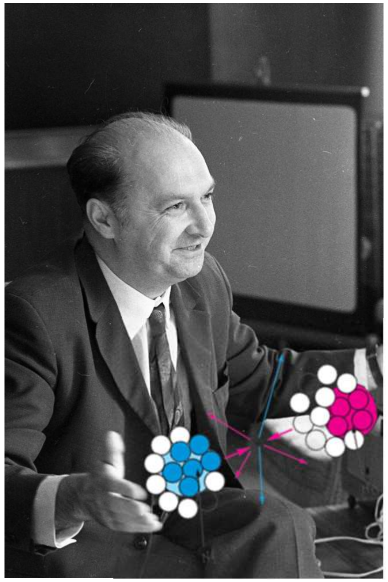
On impact of VLSI ASIC chips export ban to Russia on ability to perform HEP experiments homeland

"A chain is only as strong as its weakest link "
«Там где тонко, там и рвётся»

- Scientific background: brief history of experimental relativistic nuclear physics highlighting the silicon tracking systems.
- The ongoing silicon revolution in HEP experiments/ Future is being made today!
- The NICA MPD ITS project experience.
- Three possible ways for remedy the problem.
- pCT scanner demonstrator as a spin-off the MPD ITS project.
- RAS central role in the implementation of the problem solution.
- Conclusions and outlook.

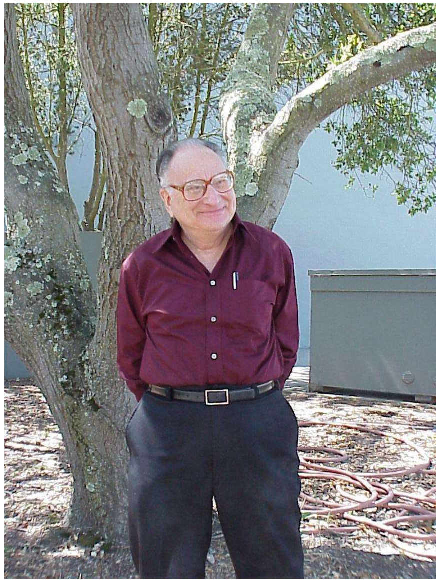
Relativistic Nuclear Physics childhood – 1970th-1993

А.М.Балдин (ФИАН-ОИЯИ)



1926-1978

A.Poskanzer (BNL-LBL)



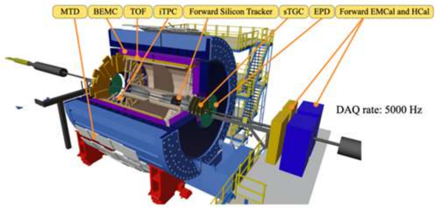
1931-2021

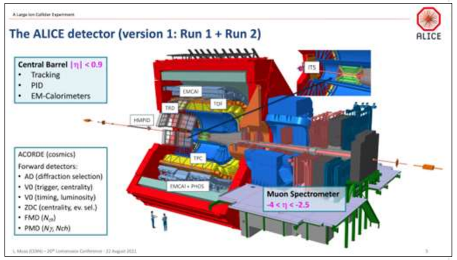
H.Gutbrod (LBL-CERN-GSI)

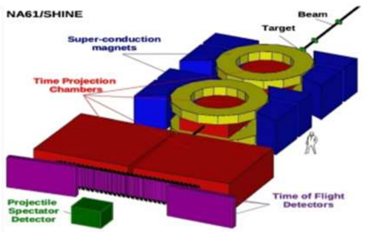
1943 -

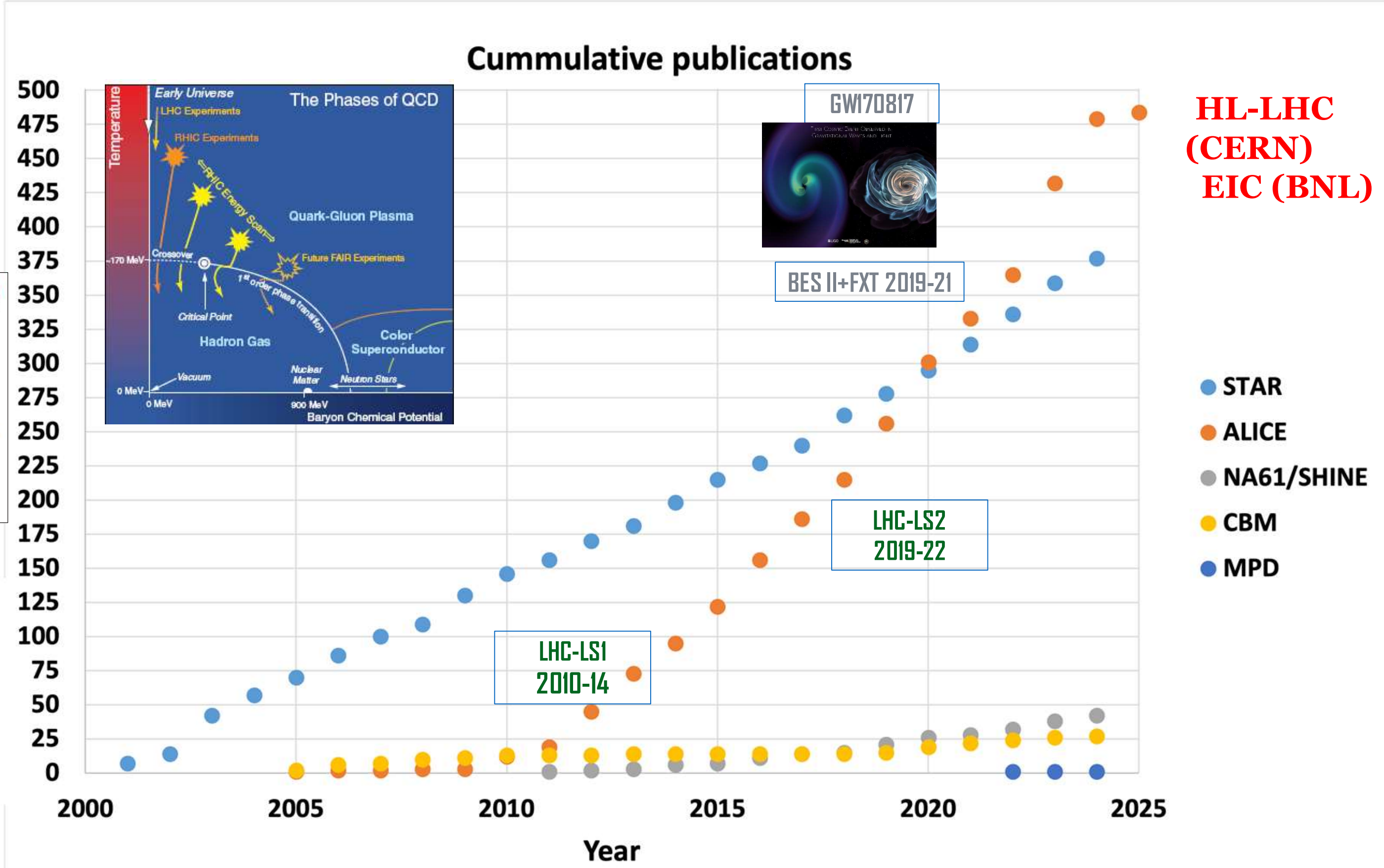
Предложение проекта и начало НИОКР новых технологий для постройки НУКЛОТРОНА (1987-1993 -)

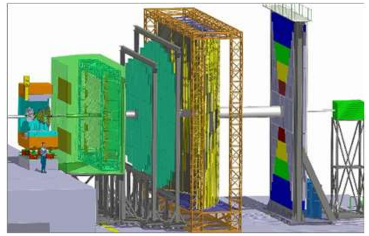
Plastic Ball @ BEVALAC (1972-1993) обнаружение коллективных потоков

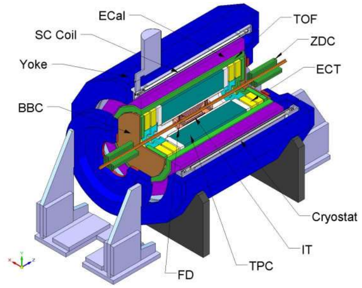












STAR Publications and Data (https://drupal.star.bnl.gov/STAR/publications/filter)

ALICE Publications (https://alice-publications.web.cern.ch/statistics)

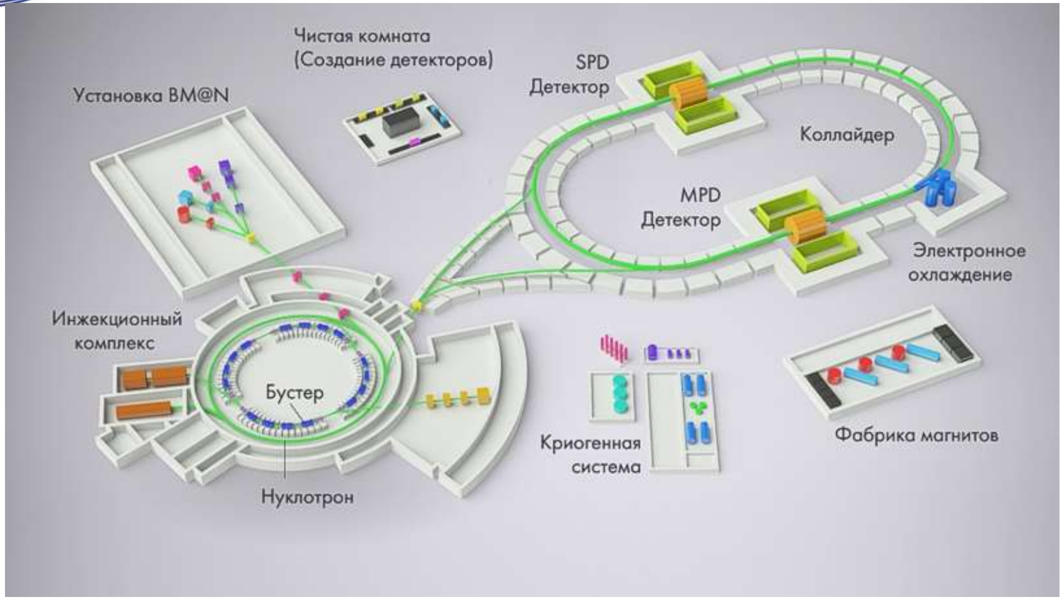
CERN Document Server NA61/SHINE Papers

(https://cds.cern.ch/search?p=&cc=NA61+Papers&f=&sf=&so=a&of=hb&rg=10&as=1&ln=en&p1=&p2=&p3=&f1=&f2=&f3=&m1=e&m2=a&m3=a&op1=a&op2=a&sc=0&d1y=2010&d1m=0&d1d=0&d2y=0&d2m=0&d2d=0&dt=&jrec=1)

Inspire-hep CBM Pubications (https://inspirehep.net/literature?sort=mostrecent&size=25&page=1&q=collaboration%3ACBM&doc_type=published)

MPD Collaboration Publications (https://mpd.jinr.ru/collaboration-publications/)

NICA at JINR



NICA start in 2013

First beam in 2025

- **The NICA challenge for study of new state of matter in $\sqrt{Snn}$ = 3÷11,5 GeV Bi+Bi L= 10^{27}cm $^{-2}$ sec $^{-1}$**

NICA MPD-Inner Tracking System based on ALICE ITS-2 technology

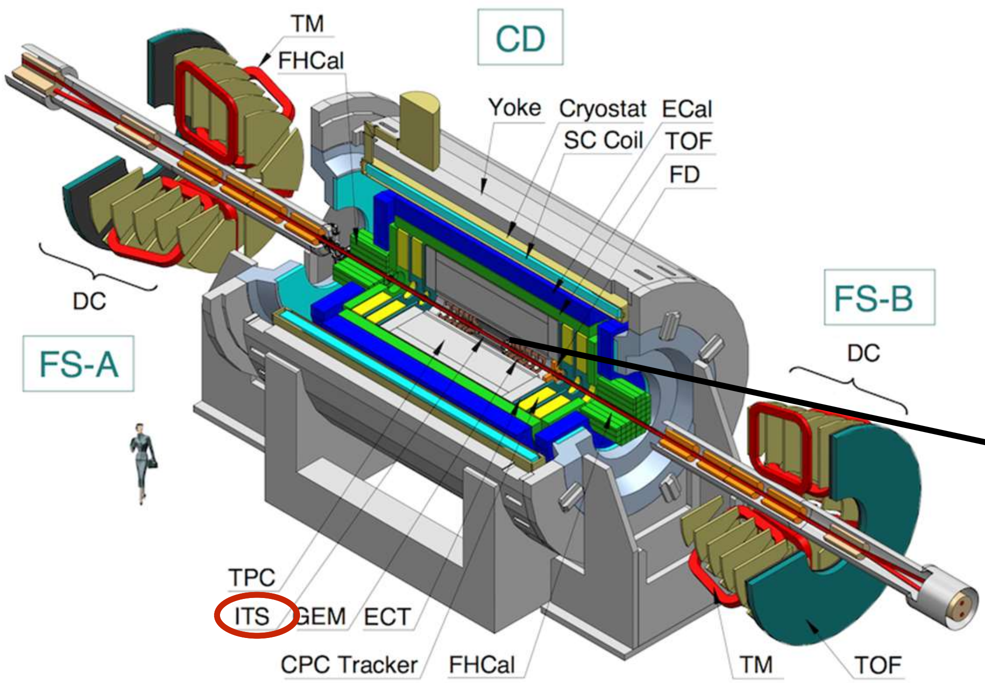
MPD-ITS structure: 3-layers Inner Barrel + 3-layers Outer Barrel .

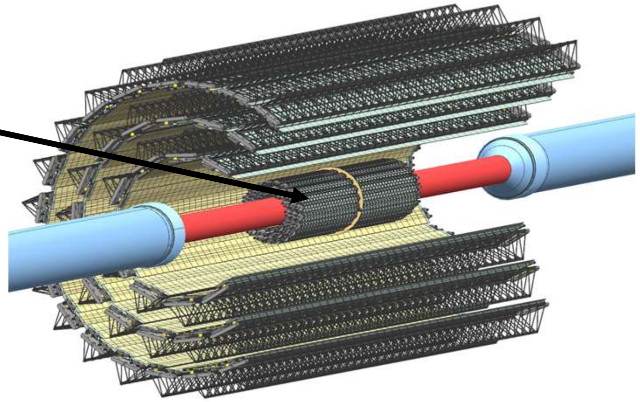
Looking for needle in a haystack

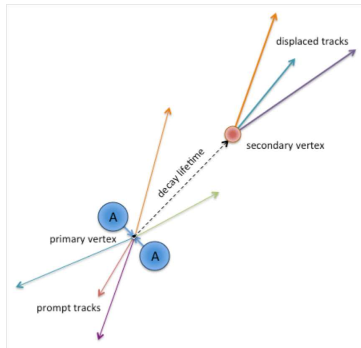
It will supplement the TPC for the precise tracking, momentum determination and vertex reconstruction for **low Pt momenta hyperons** (Λ, Ξ, Ω) and identification of **D-mesons.**

Some of the MPD-ITS requirements:

- **Fast, high granularity CMOS pixel sensors with low noise level.**
- **Spatial resolution of track coordinate registration at the level of ~5–10 μm.**
- **Material budget as low as possible.**
- **Positioned as close as possible to the interaction diamond**



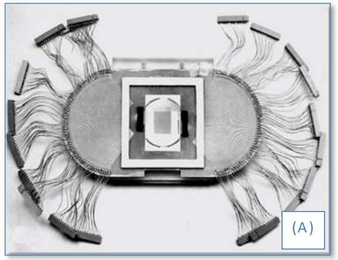




Yu. A. Murin and C. Ceballos, ***"The Inner Tracking System for the MPD Setup of the NICA Collider"***, Phys. Part. Nuclei 52, 742–751 (2021).

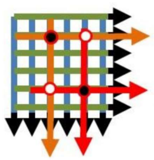
Начало применения кремниевых детекторов в ФВЭ

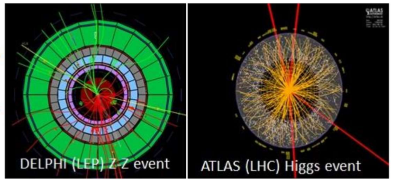
Конец 1970-х: начало НИОКР устройств для идентификации короткоживущих частиц в ЦЕРН и Пизе
1980: Производство первых микростриповых детекторов по технологии PIN-диодов
1981-1982: Первое использование микростриповых детекторов в ЦЕРН (NA11) и ФНАЛ(E706)

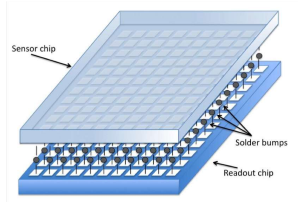


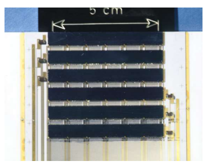
NA11 : 6 плоскостей (24х36 мм^2),
2-3ком,280 мкм, шаг 20 мкм
E706 : 4 плоскости (3х3 см^2)+
2 плоскости (5х5 см^2)

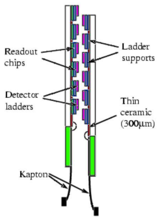
1989-1990: ЦЕРН(DELPHI,ALEPH,OPAL,L3)
→ проблема наложений и деградации свойств
Решение: Использование пиксельных детекторов
и систем считывания на VLSI электронике (WA97, DELPHI)



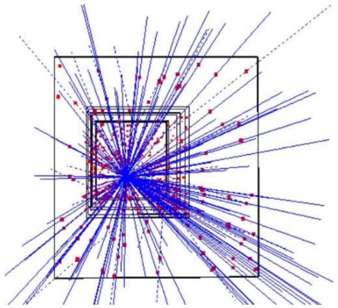


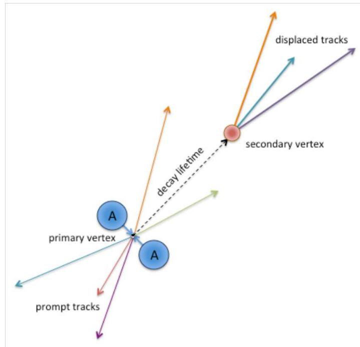






Площадь – (5х5 см^2)
Число плоскостей – 7
Число пикселей – 0.5M
Размер пикселей – 75х500 мкм^2
Частота триггера – 1 кГц
Имя СИМС – Omega2

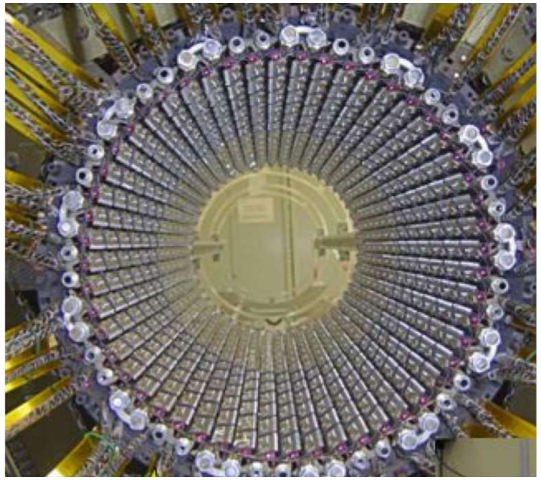
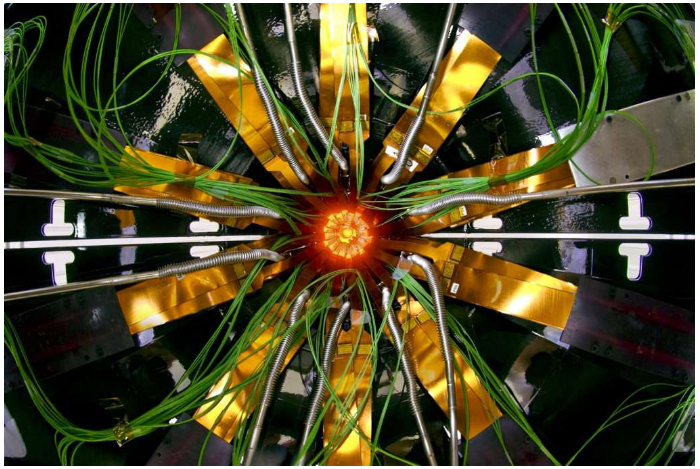




Пиксельные системы LHC Run#1

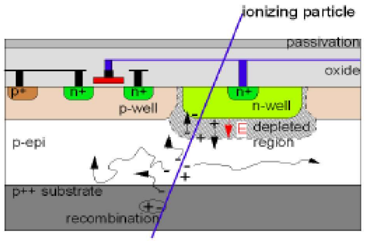
MPD - ITS

Начало 2000-х: внутренние трековые системы включают в себя пиксельные слои трех базовых установок

ATLAS	CMS	ALICE
		

	ATLAS	CMS	ALICE
ло слоёв:	2	3	3
ло пикселей:	9.8M	80M	66M
щадь, м²:	0.21	1.17	1.0
мер пикселя, мкм²	50x425	50x400	100x150
щина (Si+ASIC), X/Xo [%]	0.21+0.16	0.27+0.19	0.30+0.19

Mimosa series – IPHC Strasbourg - Move to standard CMOS

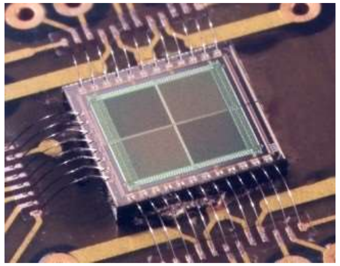


A monolithic active pixel sensor for charged particle tracking and imaging using standard VLSI CMOS technology

R. Turchetta[a,*], J.D. Berst[a], B. Casadei[a], G. Claus[a], C. Colledani[a], W. Dulinski[a], Y. Hu[a], D. Husson[a], J.P. Le Normand[a], J.L. Riester[a], G. Deptuch[a,1], U. Goerlach[a], S. Higueret[a], M. Winter[a]

NIM A 458 (2001) 677-689

Mimosa1 – 1999
AMS 0.6 µm

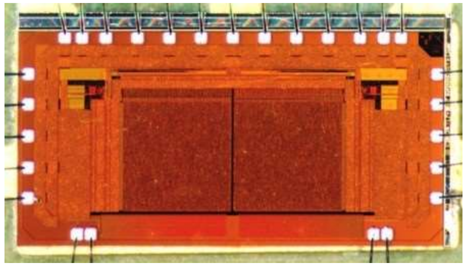


20um pixel

Mimosa2 – 2000
MIETEC 0.35 µm

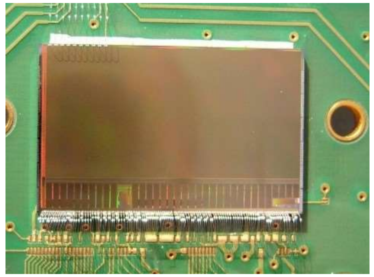
20um pixel

Mimosa3 – 2001
IBM 0.25 µm



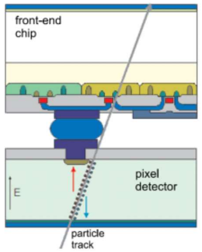
....

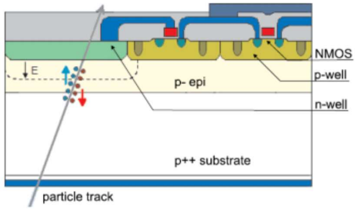
Mimosa26 – 2008
AMS 0.35 µm



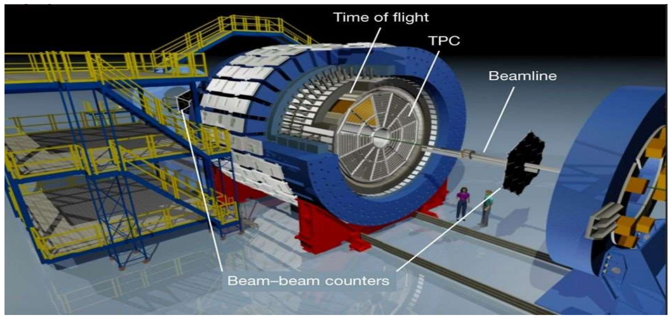
18.4um pixel

....

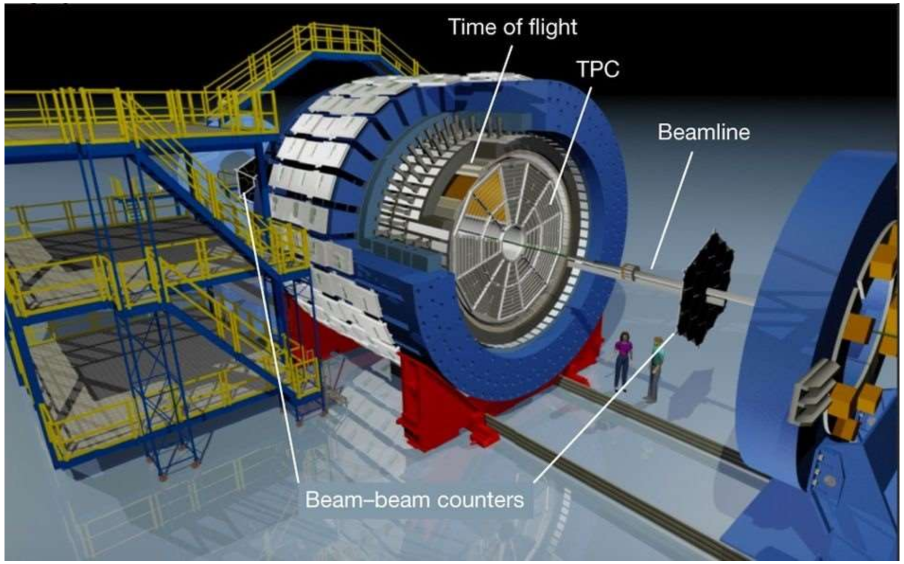




12 years from idea to first results STAR !



FIRST MAPS in HEP: MIMOSA28 (ULTIMATE) in STAR PXL



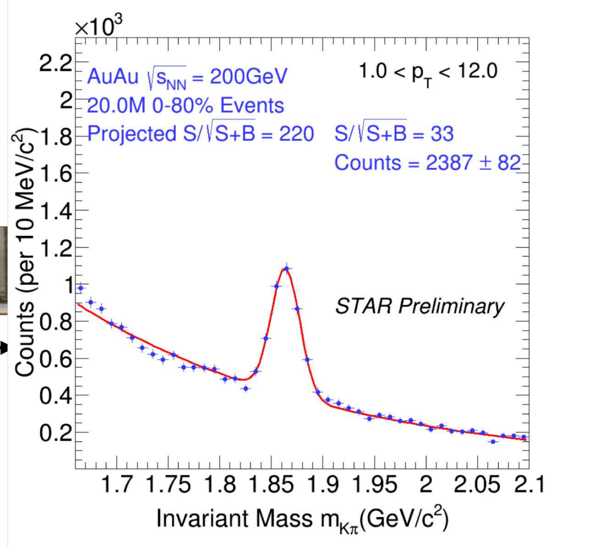
Full detector Jan 2014

Physics Runs in 2015-2016

- 2 layers (2.8 and 8 cm radii)
- 10 sectors total (in 2 halves)
- 4 ladders/sector
- Radiation length (1st layer)
- x/X0 = 0.39% (Al conductor flex)

Ladder with 10 MAPS sensors

2-layer kapton flex cable with Al traces



MIMOSA28 (ULTIMATE) – 2011

First MAPS system in HEP

Twin well 0.35 μm CMOS (AMS)

- 18.4 μm pitch
- 576x1152 pixels, 20.2 x 22.7 mm^2
- Integration time 190 μs
- No reverse bias -> NIEL ~ 10^{12} n_{eq}/cm^2
- Rolling shutter readout

The INMAPS process: STFC development, in collaboration with TowerJazz: a game changer Additional deep p-well implant allows full CMOS in the pixel and 100 % fill factor

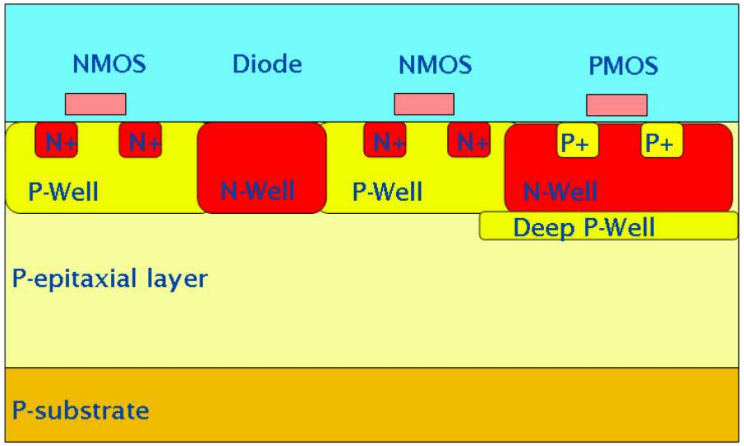
Monolithic Active Pixel Sensors (MAPS) in a Quadruple Well Technology for Nearly 100% Fill Factor and Full CMOS Pixels

Jamie Alexander Ballin [2], Jamie Phillip Crooks [1], Paul Dominic Dauncey [2], Anne-Marie Magnan [2], Yoshinari Mikami [3,], Owen Daniel Miller [1,3], Matthew Noy [2], Vladimir Rajovic [3,***], Marcel Stanitzki [1], Konstantin Stefanov [1], Renato Turchetta [1,*], Mike Tyndel [1], Enrico Giulio Villani [1], Nigel Keith Watson [3], John Allan Wilson [3]**

[1] Rutherford Appleton Laboratory, Science and Technology Facilities Council (STFC), Harwell Science and Innovation Campus, Didcot, OX11 0QX, U.K

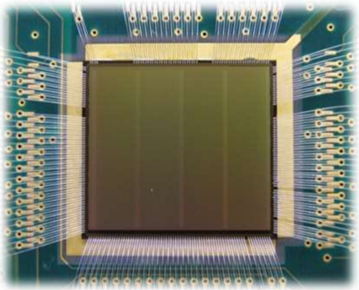
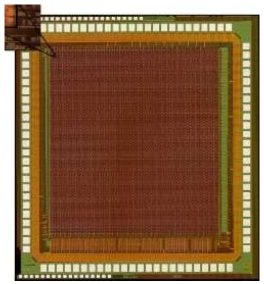
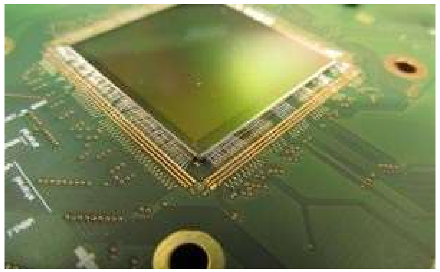
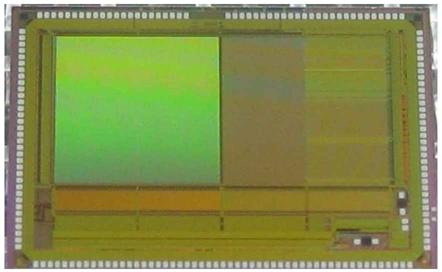
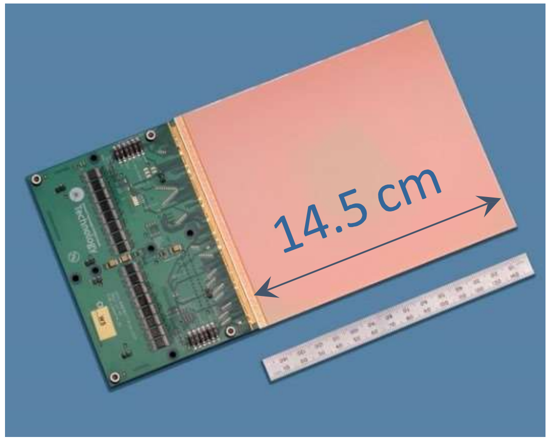
[2] Department of Physics, Blackett Laboratory, Imperial College London, London, SW7 2AZ, U.K

[3] School of Physics and Astronomy, University of Birmingham, Birmingham, B15 2TT, U.K



Sensors 2008 (8) 5336, DOI:10.3390/s8095336

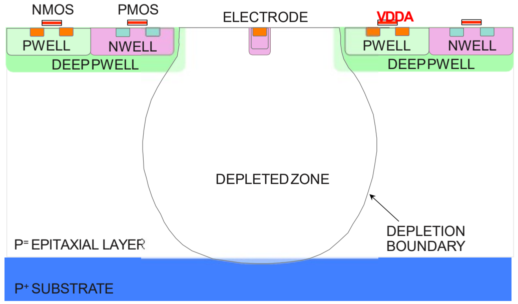
New generation of CMOS sensors for scientific applications in TowerJazz CIS 180nm

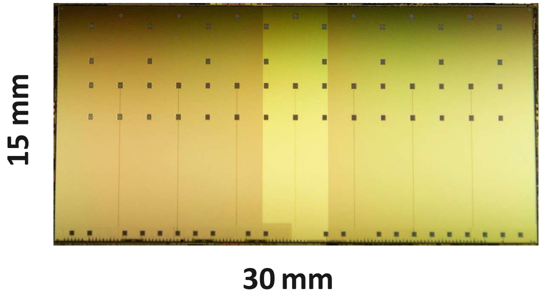
TPAC ILC ECAL (CALICE)	DECAL Calorimetry	PIMMS TOF mass spectroscopy	CHERWELL Calorimetry/Tracking	
				
50 um pixel	50 um pixel	70 um pixel	48 um x 96um ixel	50um pixel, waferscale

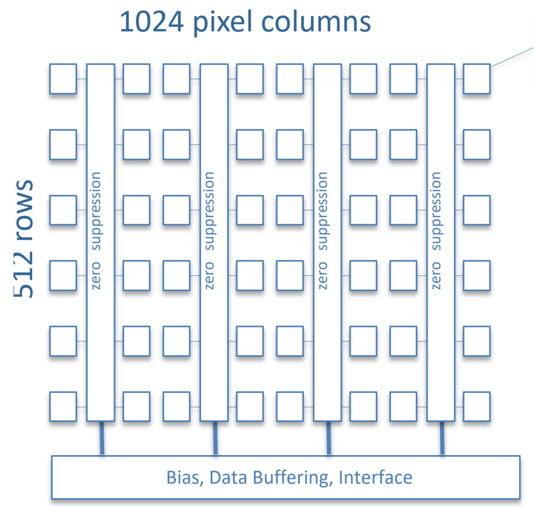
ALPIDE

Zero-suppressed readout, no hits no digital power

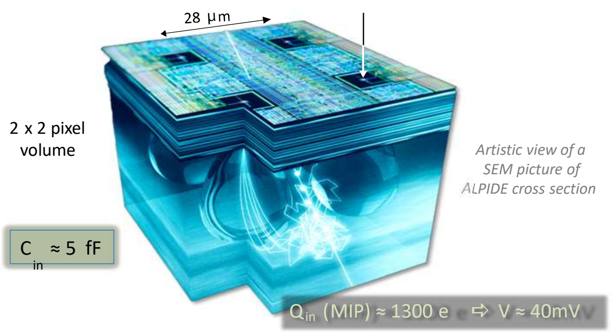
G. Aglieri et al. NIM A 845 (2017) 583-587



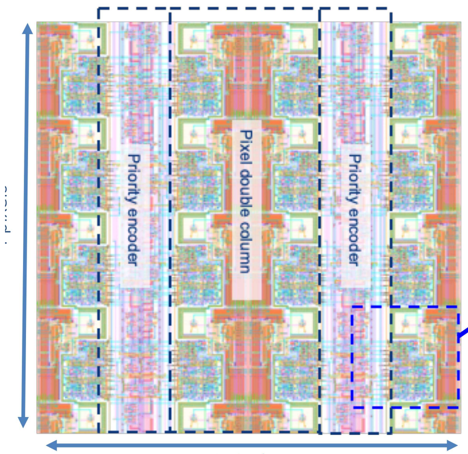




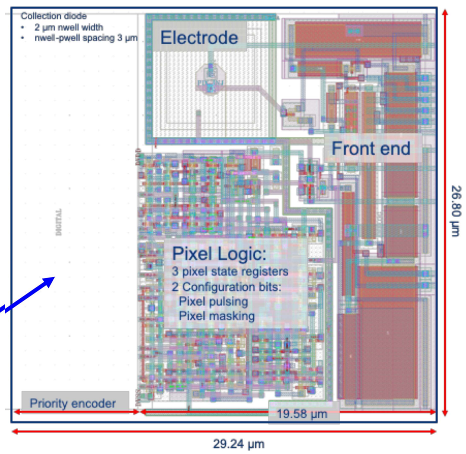
- 130,000 pixels / cm² 27x29x25 μm³
- charge collection time <30ns (V_{bb} = -3V)
- Max particle rate: 100 MHz/cm²
- fake-hit rate: < 1 Hz/ cm²
- power : ≈300 nW /pixel (<40mW/cm²)



Matrix Layout



Pixel Layout



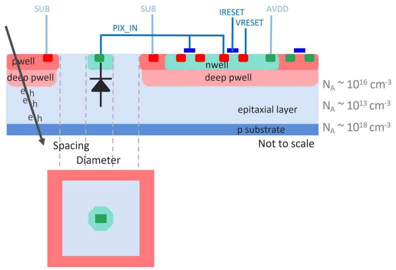
, 8-11 Jan 2019

Design team: G. Aglieri, C. Cavicchioli, Y. Degerli, C. Flouzat, D. Gajanana, C. Gao, F. Guilloux, S. Hristozkov, D. Kim, T. Kugathasan, A. Lattuca, S. Lee, M. Lupi, D. Marras, C.A. Marin Tobon, G. Mazza, H. Mugnier, J. Rousset, G. Usai, A. Dorokhov, H. Pham, P. Yang, W. Snoeys (Institutes: CERN, INFN, CCNU, YONSEI, NIKHEF, IRFU, IPHC) and comparable team for test

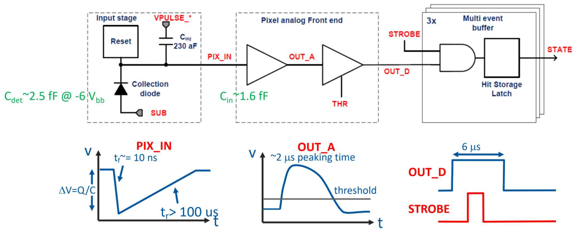
1 MPW run and 5 engineering runs 2012-2016, production 2017-2018

Basic ALPIDE signal processing and data management features

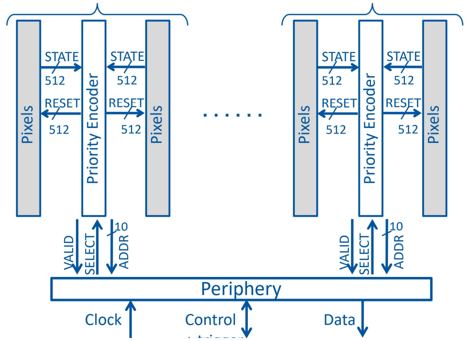
Extremely high sensitivity



Analogue delay memory



Clockless priority encoding



Analog front-end and discriminator continuously active

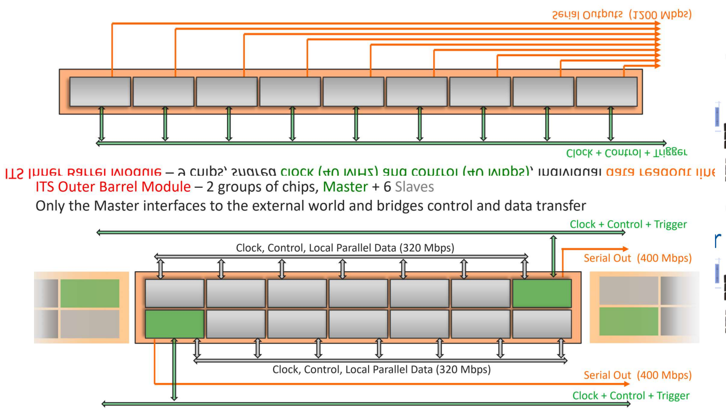
- Non-linear and operating in weak inversion. Ultra-low power: 40 nW/pixel
- The front-end acts as analogue delay line
- Test pulse charge injection circuitry
- Global threshold for discrimination -> binary pulse OUT_D

Front End Characteristics	
Gain (small signal) [mV/e]	4
ENC [e]	3.9
Threshold [e]	92 ± 2

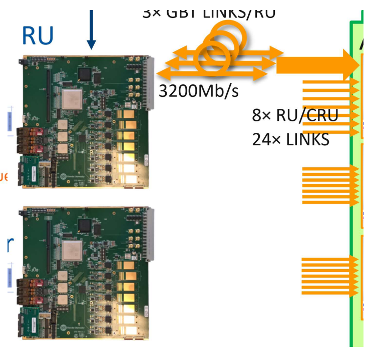
The Priority Encoder sequentially provides the addresses of all hit pixels in a double column

- Combinatorial digital circuit steered by peripheral sequential circuits during readout of a frame
- No free running clock over matrix. No activity if there are no hits
- Energy per hit: E_h ~= 100 pJ -> ~3 mW for nominal occupancy and readout rate
- Buffering and distribution of global signals (STROBE, MEMSEL, PIXEL RESET)

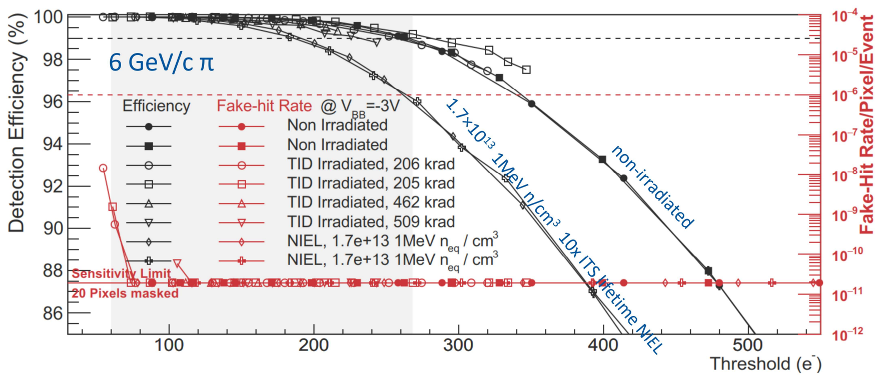
Smart data management and Control



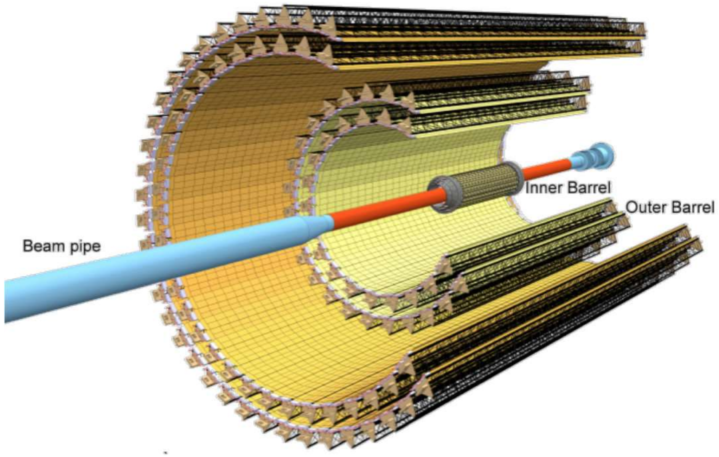
GBT interface



Sufficient adiation hardness with reverse bias -> NIEL ~ 3 ·$10^{13} n_{eq}/cm^2$



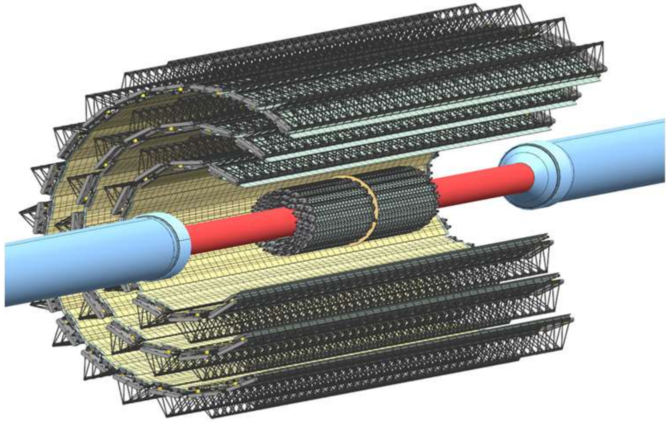
ALPIDE usage at CERN and JINR (planned)



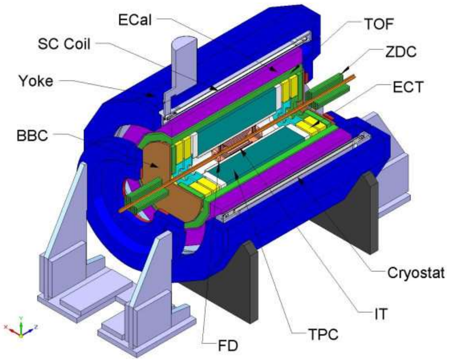
ALPIDE – 2017-2018

Twin well 0.180 μm CMOS (INMAPS)

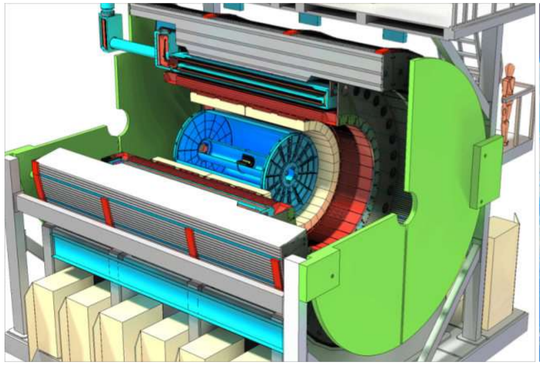
- 29 x 27 μm pitch
- 512x1024 pixels, 29 x 27 mm^2
- Integration time 6 μs (190 μs)
- No reverse bias -> NIEL ~ 3 ·10^{13} n_{eq}/cm^2
- Global shutter readout (TRO or SRO)



MPD (planned!)

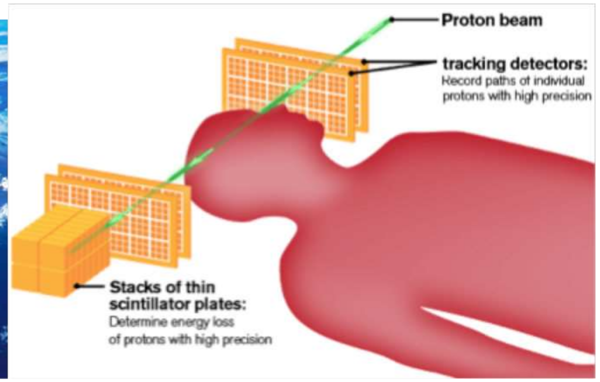


SUPERPHENIX(under construction)



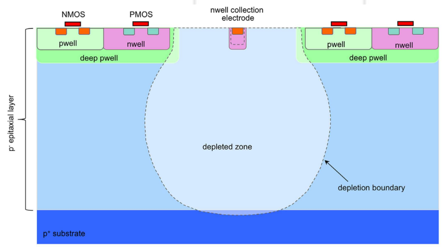
CSES-LIMADOU (launched Dec 2024)

BERGEN pCT (to commissioned 2025)



R@D for increase of radiation hardness and timing

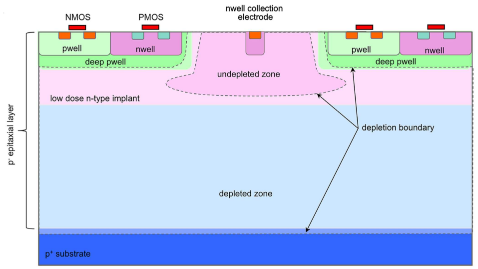
Standard pixel design



it is difficult to deplete the epitaxial layer over its full width

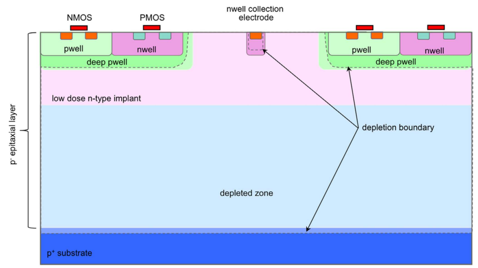
~ 10^{13} 1 MeV n_{eq}/cm² temperature

Modified with gap



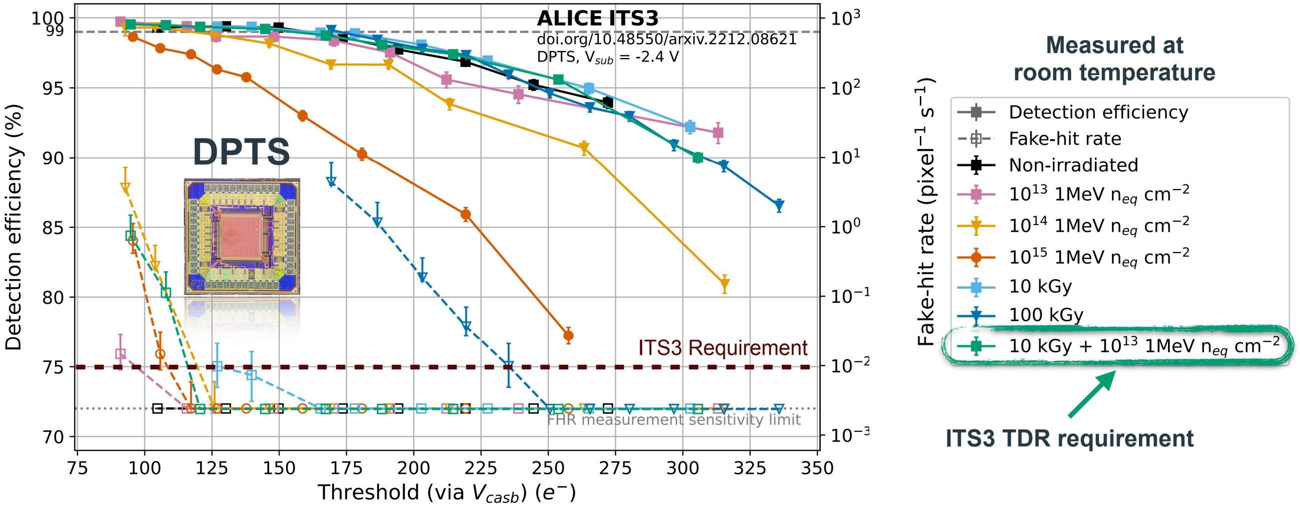
without bias

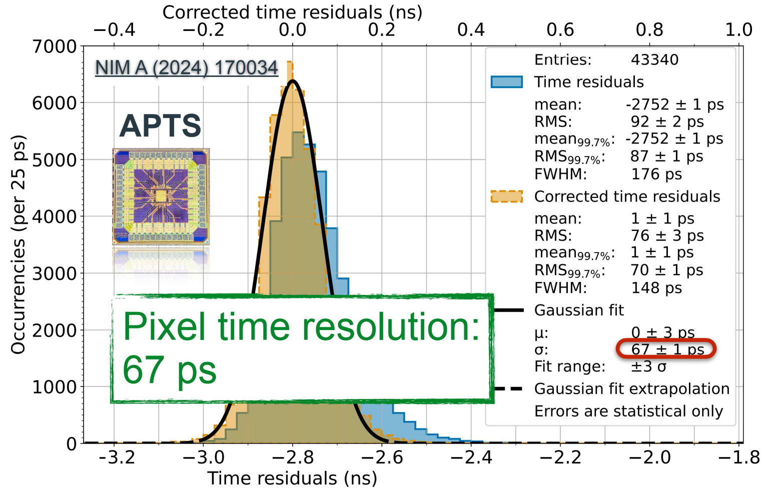
~ 10^{14} 1 MeV n_{eq}/cm² (180 nm)



with bias

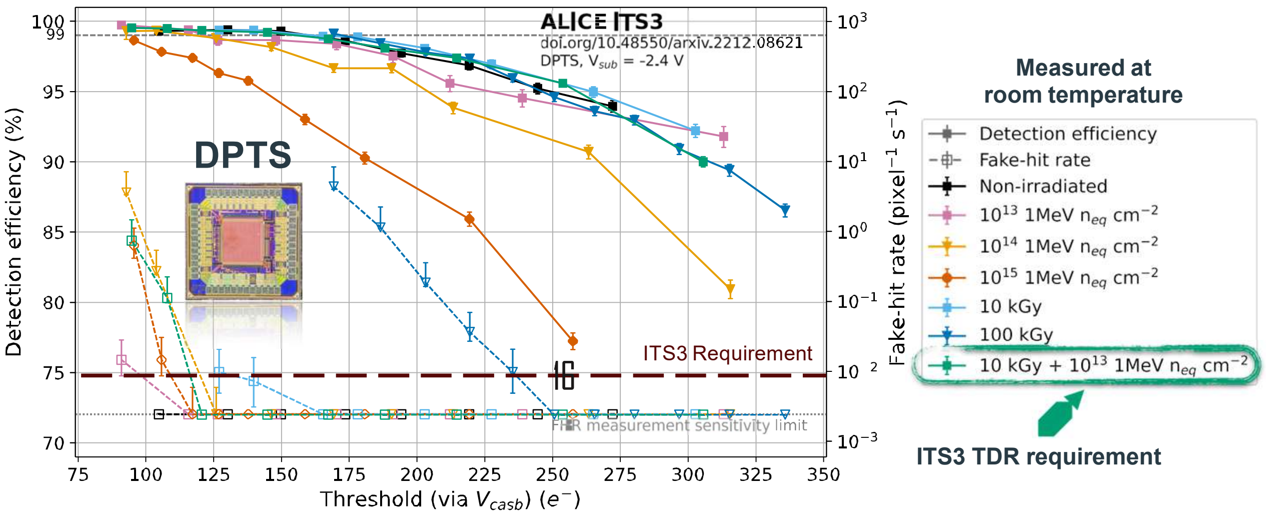
~ 10^{15} 1 MeV n_{eq}/cm² (65 nm) at room

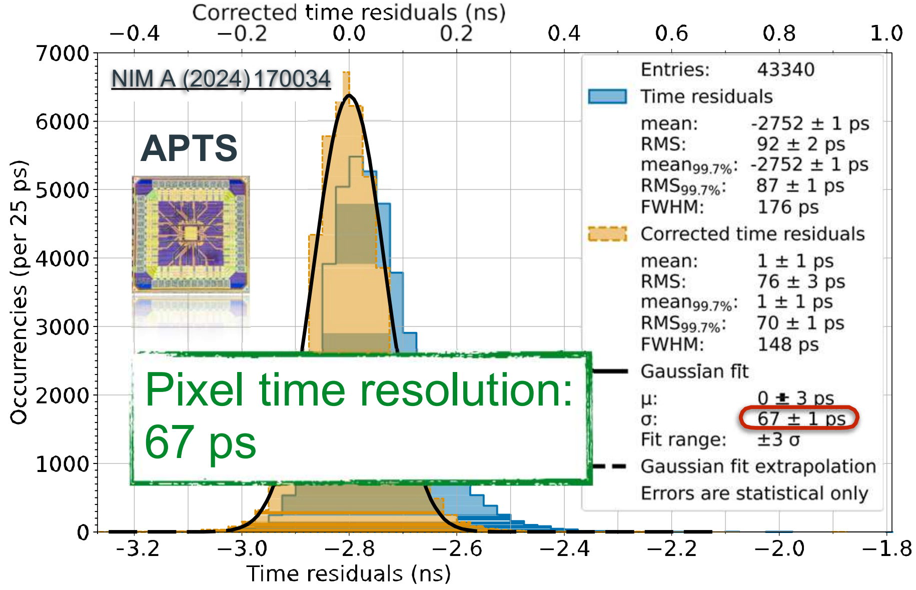




TPSCo 65 nm technology qualification — pixel prototype chips (selection)

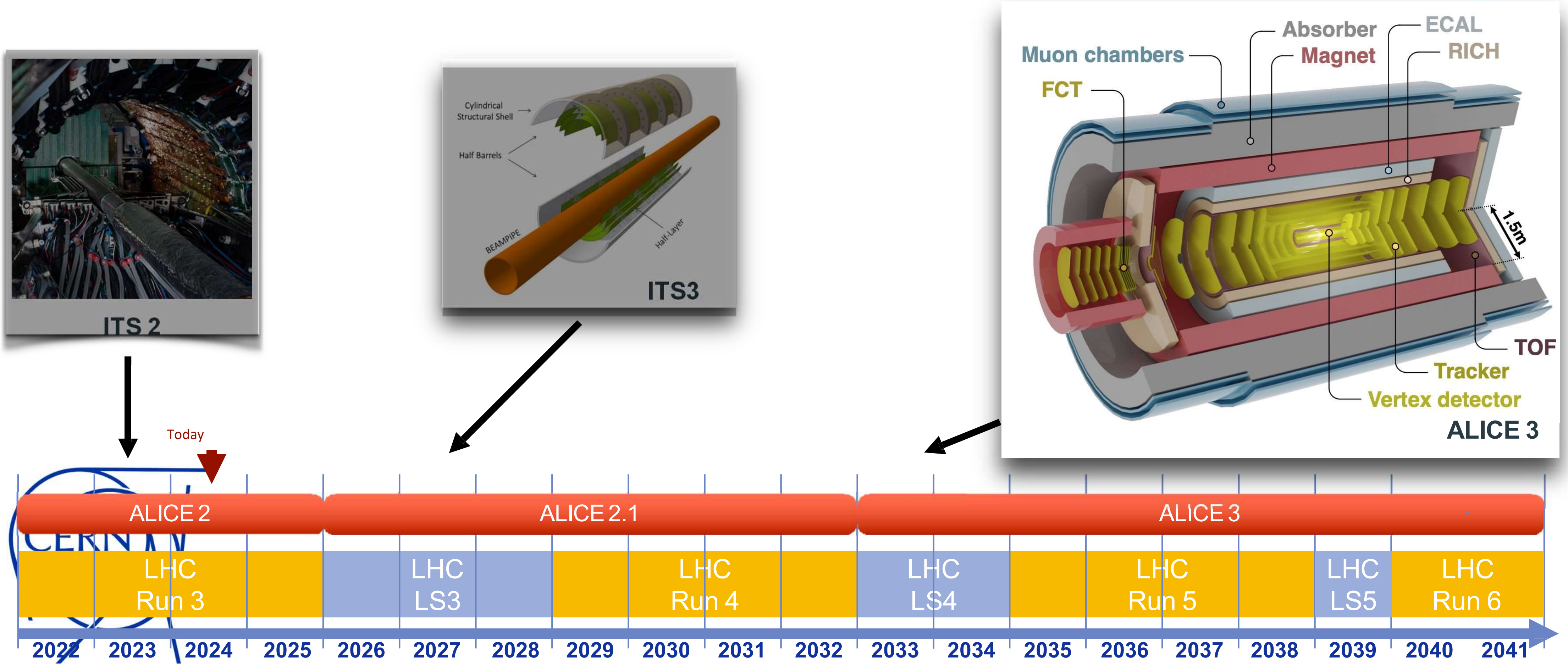
ALICE





- Technology explored far beyond the requirements of ITS3 in terms of radiation hardness and time resolution Promising also for future applications like ALICE 3 Vertex Detector and FCC-ee
- Various small scale prototypes with pixel matrices and ancillary circuitry
- **Multi-Layer Reticle 1 (MLR-1):** common effort by ALICE ITS3 and CERN EP R&D

ALICE 3


ITS 2
Cylindrical Structural Shell
Half Barrels
BEAMPIPE
Half-Layer
ITS3
Muon chambers
Absorber
ECAL
Magnet
RICH
FCT
1.5m
TOF
Tracker
Vertex detector
ALICE 3
Today
ALICE 2
ALICE 2.1
ALICE 3
LHC Run 3
LHC LS3
LHC Run 4
LHC LS4
LHC Run 5
LHC LS5
LHC Run 6
2022
2023
2024
2025
2026
2027
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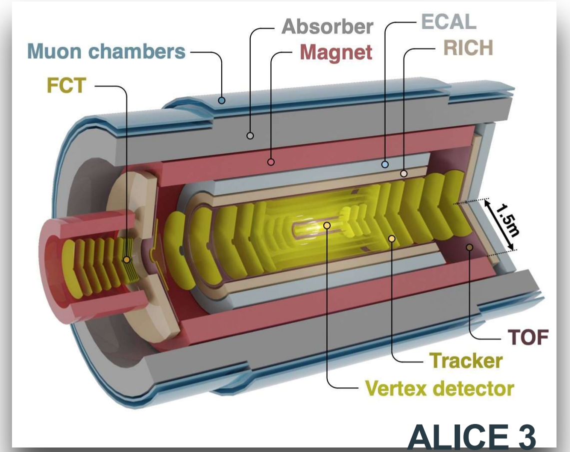
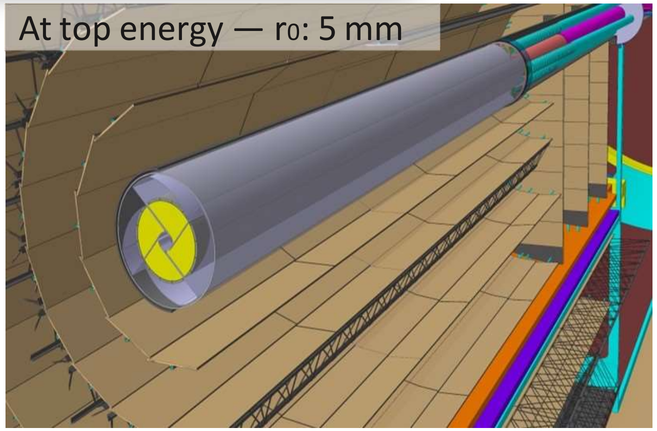
ALICE 3:



https://arxiv.org/pdf/2211.02491.pdf

Detector concept

- Compact, low-mass all-silicon tracker
- Retractable vertex detector
- Excellent vertex reconstruction and PID capabilities
- Large acceptance
- Super conduction magnet system
- Continuous readout and online processing and cooling



Vertex detector: key characteristics

- 3 detection layers
- Retractable: r_0 = 5 mm
- Material budget: 0.1% X0 / layer
- Spatial resolution 2.5 µm

main R & D challenges

- 10 µm pixel pitch
- Hit rate in the inner layer 100 MHz/mm^2 for a 50 cm barrel
- Tolerant to 10^{16} 1 MeV n_{eq}/cm^2 + 300 Mrad
- Light-weight in-vacuum mechanics and cooling

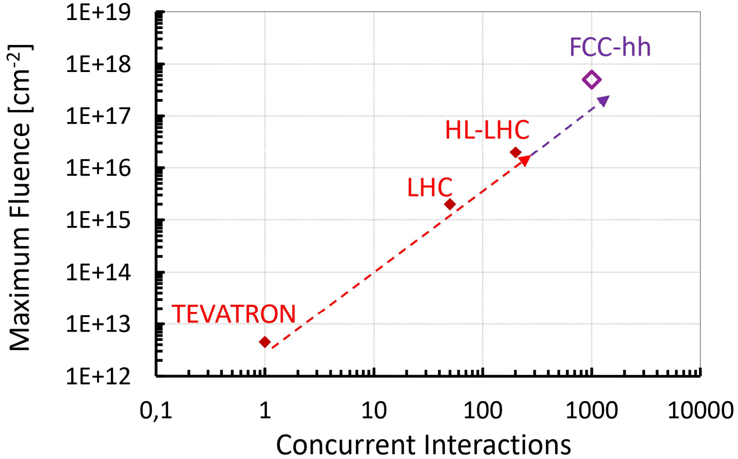
Specifications of tracker/vertex detector very similar/equivalent to those of FCCee, except at higher radiation levels.

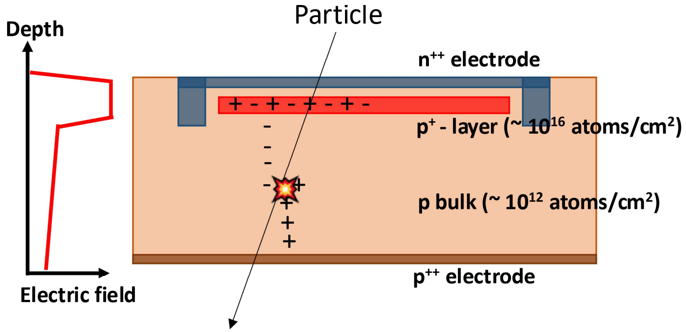
Ideal as a stepping stone towards an FCCee detector.

See also MAPS for FCCee workshop

https://indico.cern.ch/event/1417976/timetable/

Enabling 4D tracking with planar silicon sensors up to the fluence of $2\cdot 10^{16}$ n_{eq}/cm²





LGADs are n-in-p planar silicon sensors with internal moderate gain (20−30) controlled by the external bias ($E_{field} \geq 300$ kV/cm generated by gain implant)

gain implant (p^{+}-layer) obtained by the implantation of acceptor in a confined volume underneath the n^{++} electrode

	Wafer number	Good sensors
IHEP-IME	58	~1,700
USTC-IME	9	~200

LGAD performance

- **Timing ~ 30ps**
- **Tracking (TI-LGAD, RSD) ~ 10-20 µm**
- **Radiation resistance up to fluence of ~3E15 n_{eq}/cm²**

State of the art of silicon sensor performance in hadron colliders:

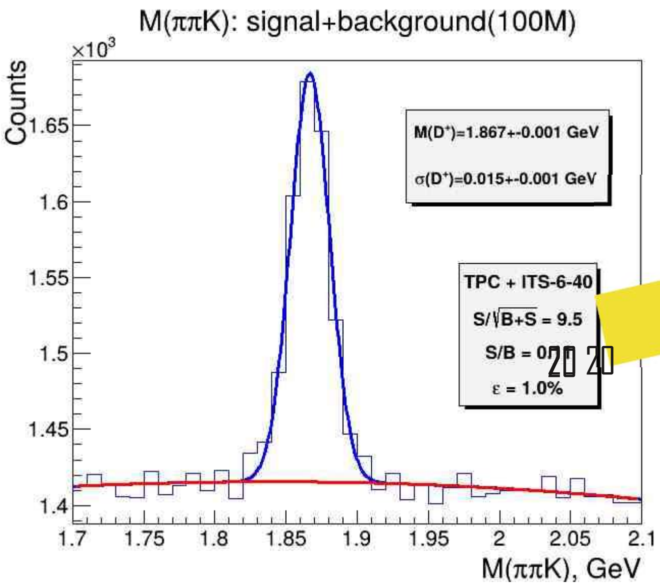
- Precise tracking down to ~ 10 µm → 1 fC up to $2\cdot 10^{16}$ n_{eq}/cm^2
- Precise timing down to ~ 30 ps → 5 fC up to $3\cdot 10^{15}$ n_{eq}/cm^2

MPD ITS computer simulations predictions for open charm identification

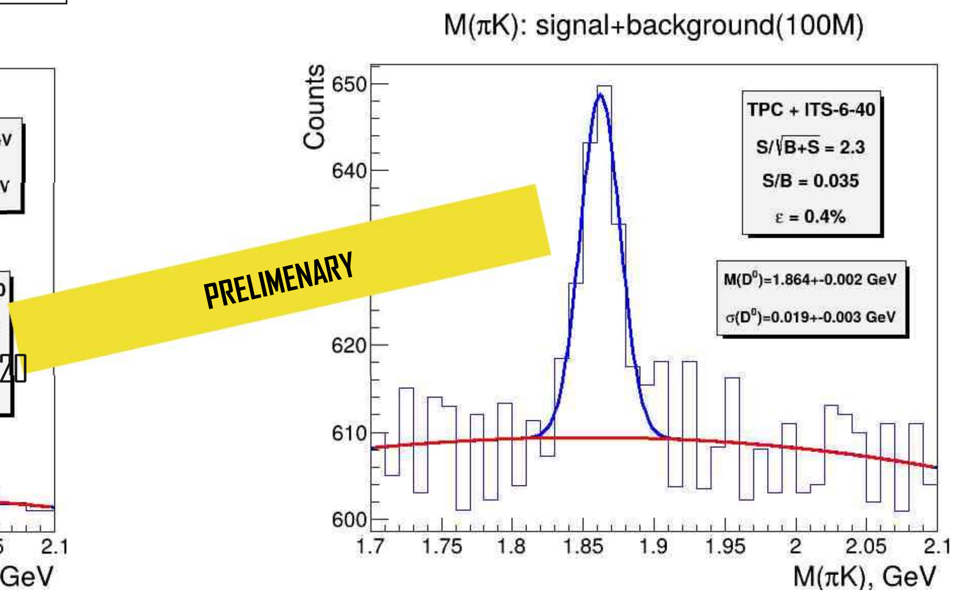
MPD - ITS

10,8 GeV Bi+Bi: D^+ and D^0 reconstruction using KF with TPC-TOF PID

$D^+ \rightarrow K^- + \pi^+ + \pi^+$



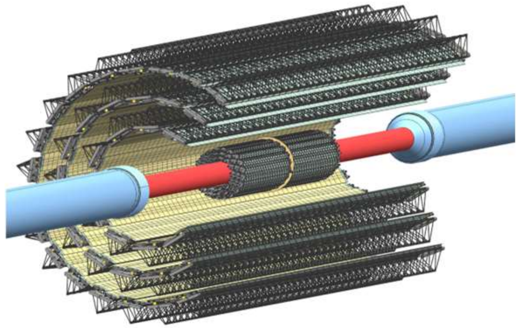
$D^0 \rightarrow K^- + \pi^+$

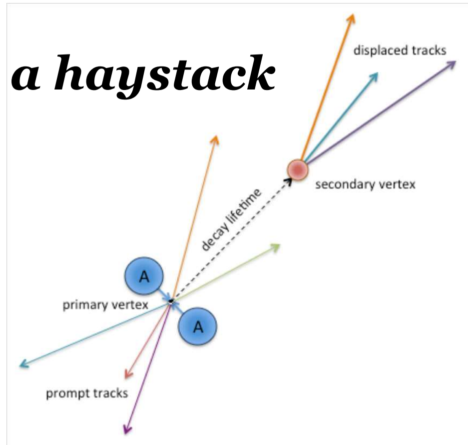


Particle	Decay Channel	cτ (μm)
D^0	$K^- \pi^+$ (3.8%)	123
D^+	$K^- \pi^+ \pi^+$ (9.5%)	312
D_s^+	$K^+ K^- \pi^+$ (5.2%)	150
Λ_c^+	$p K^- \pi^+$ (5.0%)	60

N_D = 19 000 mesons/month for D^+
N_D = 3 200 mesons/month for D^0

Looking for a needle in a haystack





Using the optimal BDT cut allows to reconstruct D^+ and D^0 with an efficiency of **1.0%** and **0.4%** respectively.

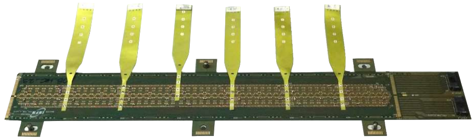
Development of module assembly capability at JINR - by 2022

Full technological transfer from ALICE to MPD

- Complete KnowHow
- Detector assembly and testing hardware/software
- Supervision and support from ALICE specialists

} Setup at JINR of the full detector assembly line from chips to detector layers

FPC

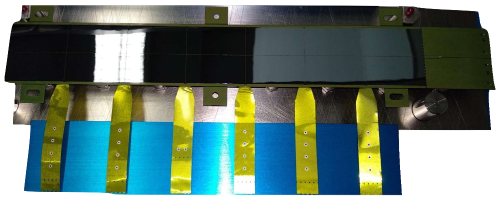


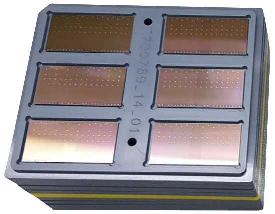
+

MAPS

↓

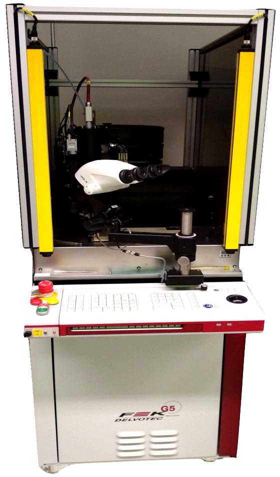
HIC



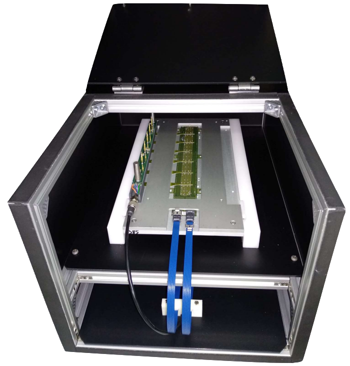


Chips selection

Chips alignment and gluing



Ultrasonic bonding Chips - FPC



HIC testing

Equipment acquired from ALICE/CERN and elsewhere

Full technological transfer from ALICE to MPD

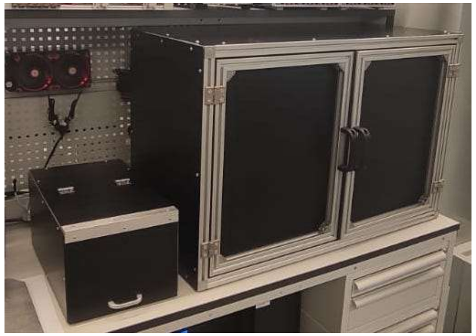
HIC testing

Same technology as ALICE-ITS

Carrier Plates

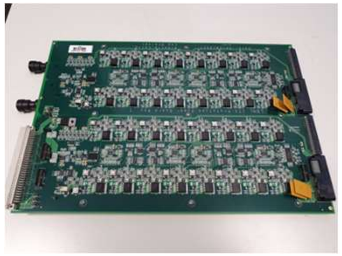
Peel test station

Visual inspection Station



Qualification and Endurance test boxes

MOSAIC boards



Power boards

(*) Power Boards BoB to be produced

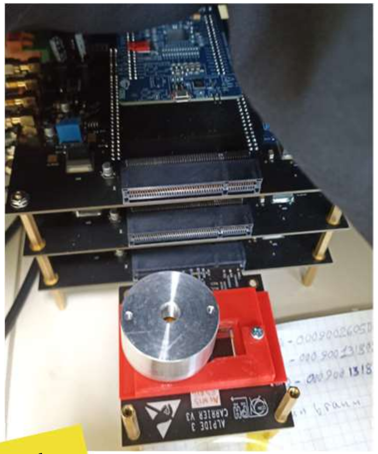
Pull test station

Preparations for the in-beam tests MICA chip in 2023-2024

Preparation for sensor bench & in- beam tests

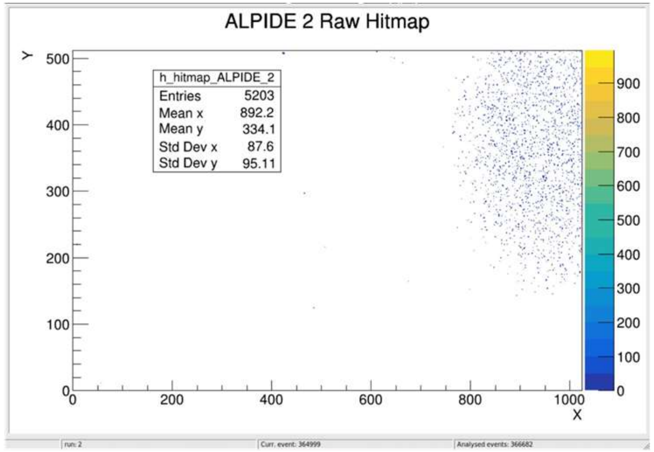
CERN-Equivalent DAQ boards and MAPS carrier-plates
Made in JINR

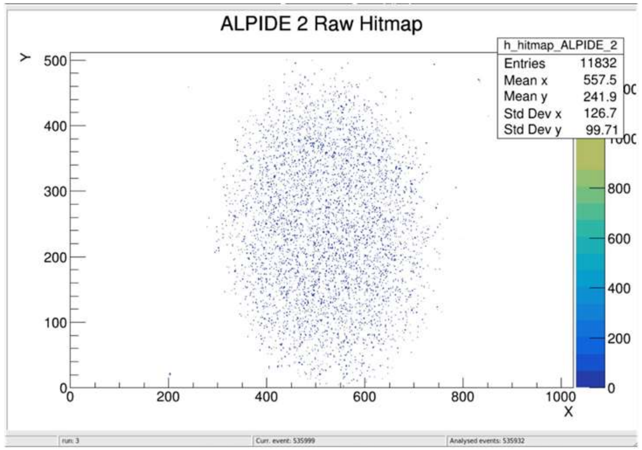
Electronics



MAPS courtesy of SPbSU

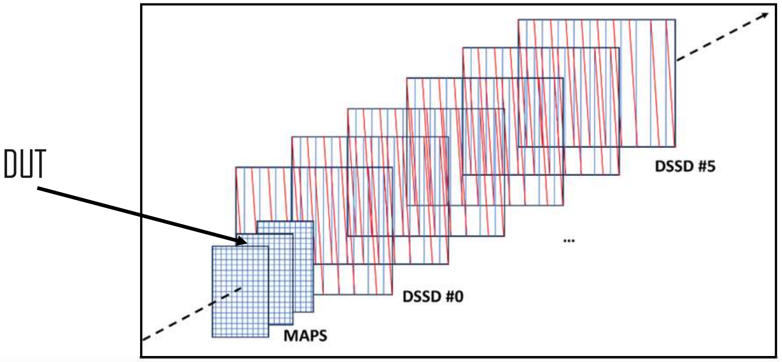
^{55}Fe source with Aluminum collimator



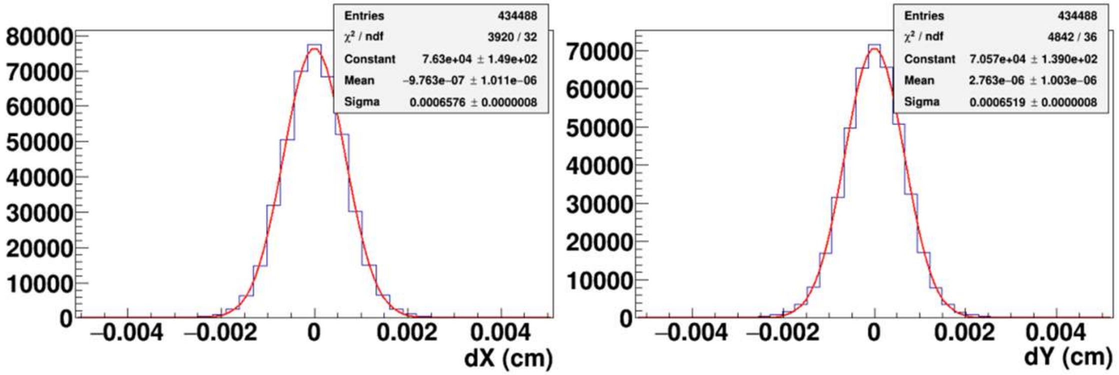


In-beam test with 1 GeV protons at PNPI in Gatchina

Tests with 1 GeV proton beam in Gatchina



Residuals

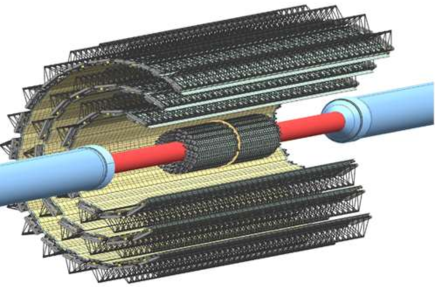


Residual X/Y = 6.58 um / 6.52 um;

Spatial resolution X/Y = 4.1±0.4 um /4.06 ± 0.4 um;

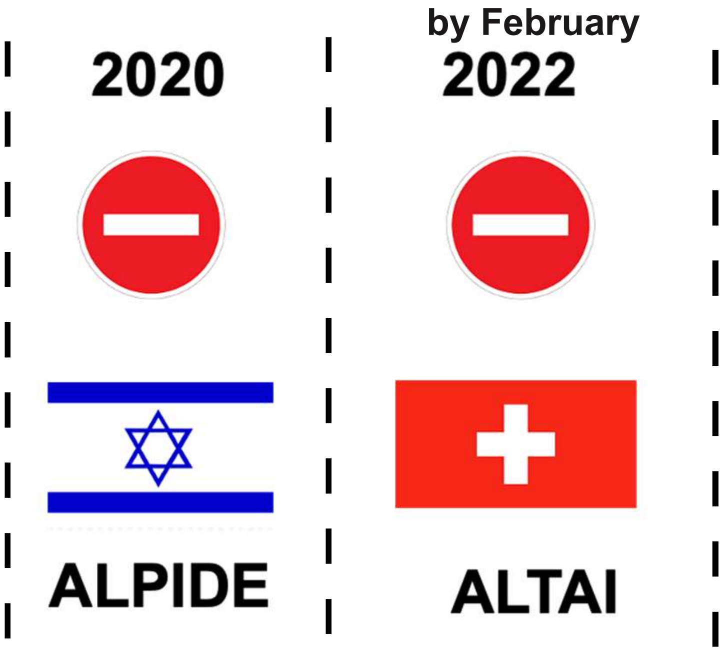
Efficiency > 99 %

The MPD ITS project and the ban of export of the ALPIDE chip to Russia



By 2021 we had been fighting for a year for receiving the already paid ALPIDE MAPS (~ 1.8 MCHF).

CERN agreed to create a non radiation-hard version: the ALTAI



We fought for another year trying to get the ALTAI chips…and failed

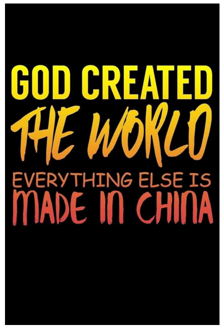
Highly prioritized tasks:

- Strengthen the international cooperation (specially with China).
- Solve the microelectronic limitations (due to sanctions).
- Finish the mechanics on time for the commissioning of the MPD.

Looking for the ways around the bans of "unfriendly countries"

Do nothing, waiting for the problem
to be resolved by itself or by someone.

Go to China and develop the required ASICs, produce them
and *export them to Russia in large quantities*.



*Develop the chips in Russia to secure technological independence
and wide-range availability*.

We propose to follow the last two options. One of them is already in motion.

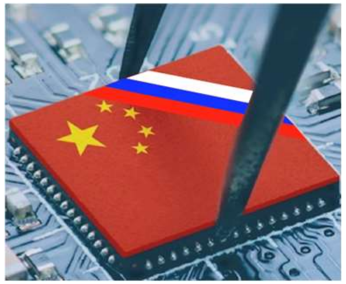
The China connections

NICA

The long-term sustainable proposal

NICA-MPD/ITS Seminar on China-Russia Cooperation, Wuhan, 2023.06.15-16

2023



MICA

Participants: JINR, CCNU, USTC, IHEP and IMP.

It was agreed: A joint development and construction of Monolithic Active Pixel Sensors **(MAPS)** for fundamental and applied science experiments **including front-end electronics** to make this technology **freely accessible** to China and Russia.

Yu. A. Murin, C. Ceballos Sanchez for the MPD-ITS Collaboration, *"Modern Microelectronics for MPD-ITS. Monolithic Active Pixel Sensors and Readout System"*, accepted for publication in the 4th issue of Phys. Part. and Nucl. in 2024

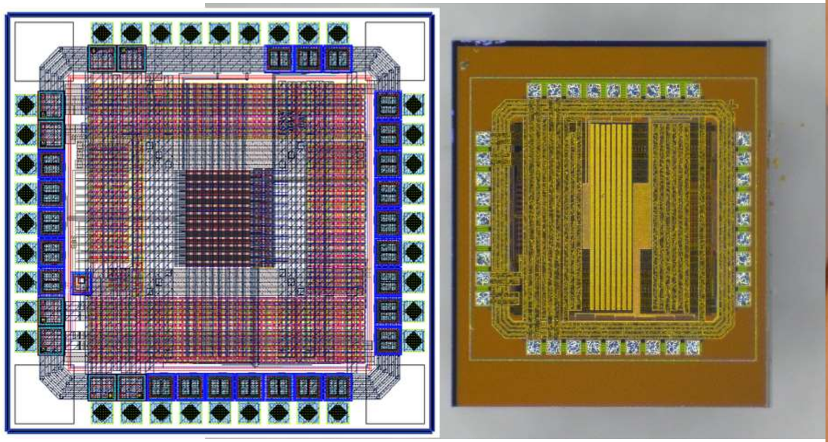
Summary MPW Pixel Technology Research

^{90}Sr test	55 nm CIS technology	180 nm High Voltage technology 0V bias	180 nm High Voltage technology -9V bias	130 nm Bulk CMOS process Low resistance substrate	130 nm Bulk CMOS process High resistance substrate 0V bias	130 nm Bulk CMOS process High resistance substrate -9V bias
MPV (ADC Value)	10(178e^-)	10 (462e^-)	To be tested	6.5	8.5	12
Case rate (per hour)	4100	1440	To be tested	840	2760	11700
Pixel size	24u×24u	30u x 30u		40u x 40u		

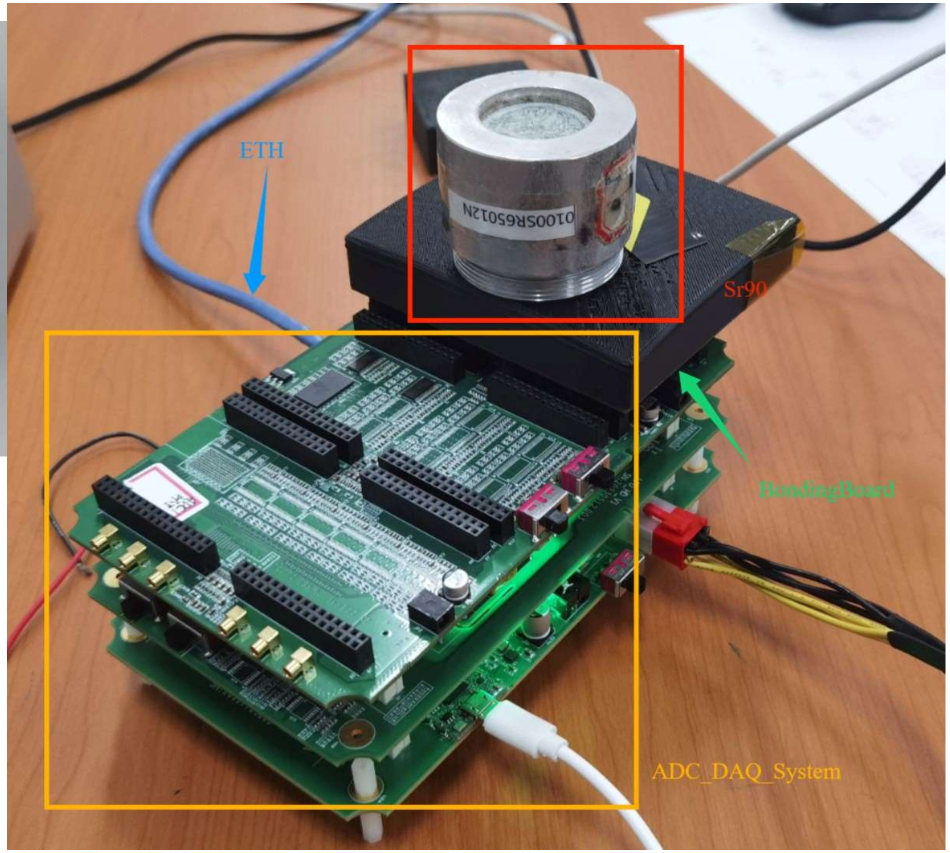
Courtesy of Prof. Xiangming Sun (CNNU)

Research on 180 nm High Voltage Process Pixel Chip—Chip Test

Pixel Array Testing Chip



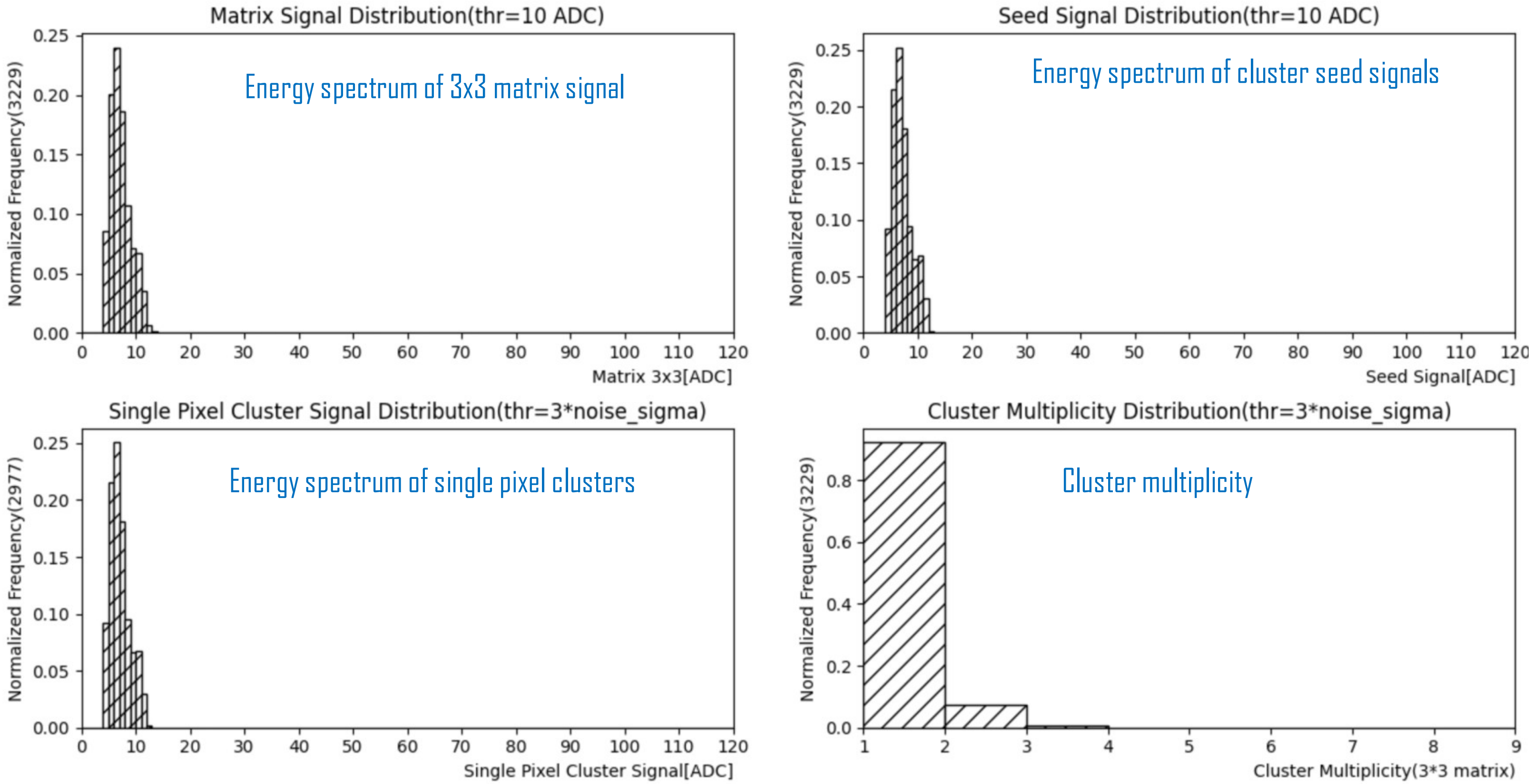
- Pixel Structure ： Diode + SF
- Pixel Size ： 30 × 30 um
- Array Size ： （4 × 4） × 6
- Chip Size ： 1580um × 1550um
- PXL<0:7> : DIODE RESET
- PXL<8:15> : PMOS RESET



Testing System

Research on 130nm Bulk CMOS Process Pixel Chip——Chip Test

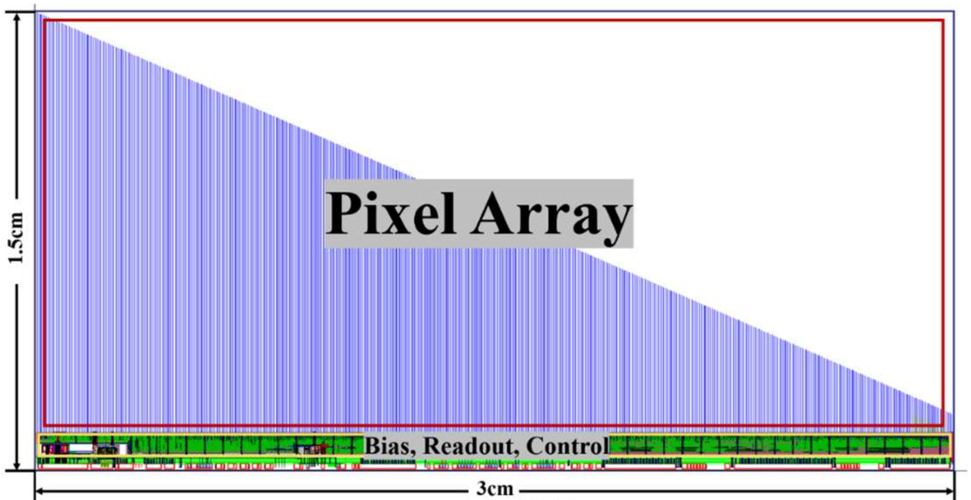
^{55}Fe Energy Spectrum (High Resistance Substrate -9V Bias

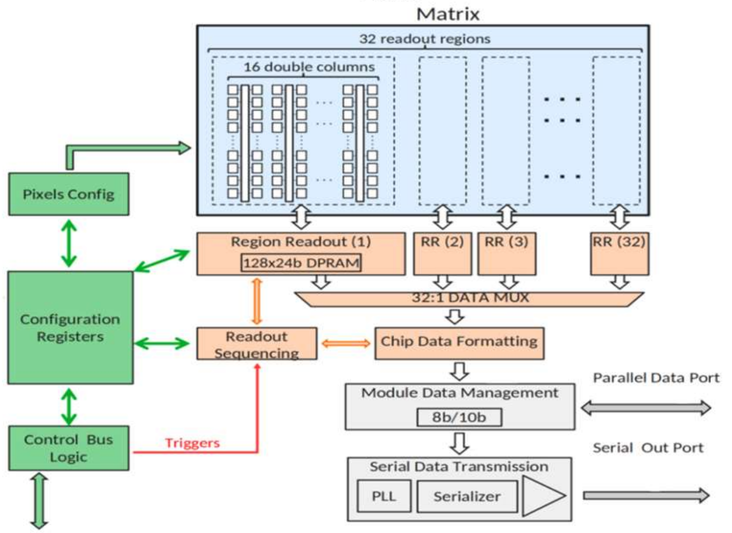


The signal of ^{55}Fe source did not fully reach the sensing area, and no calibration peak was measured.

Courtesy of Prof. Xiangming Sun (CNNU)

Research on 130nm Bulk CMOS Process Pixel Chip——MIC6_V3



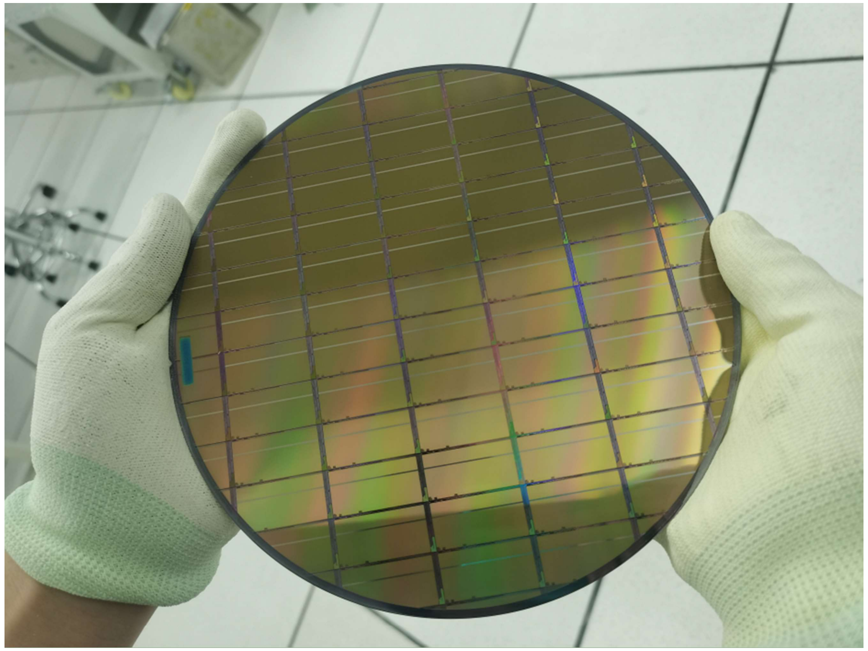


Fully functional MAPS chip MIC6_V3

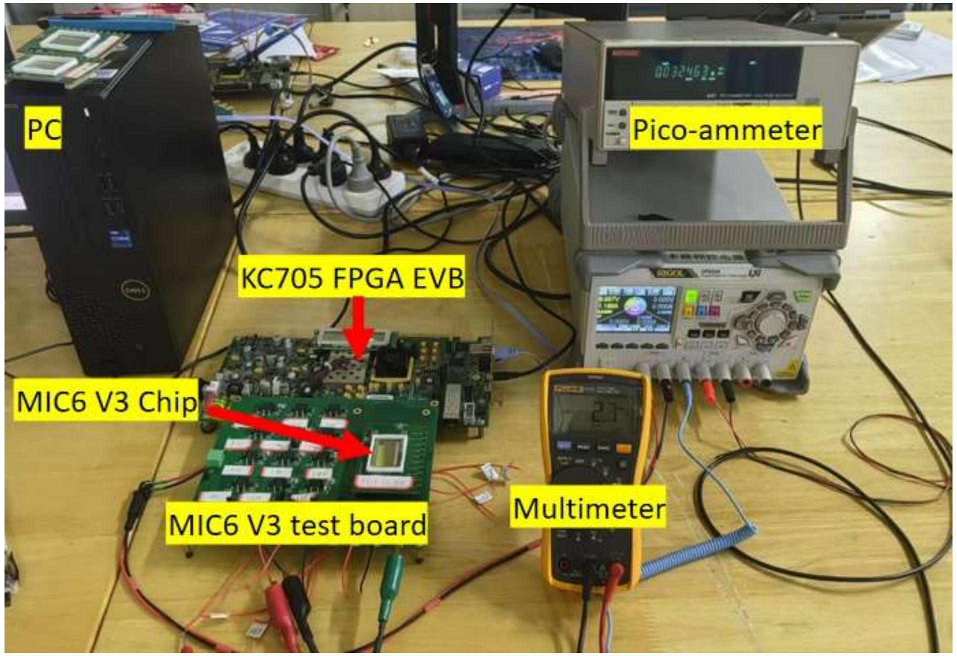
- Process: 130 nm bulk CMOS
- Chip Size: 15mm x 30mm
- Pixel Array: 512 × 1024
- Pixel Size: 30.53 μ m × 26.8 μ m
- Peaking Time: < 1us
- Integral Time: 5-10 us
- Parallel Data Port: 80 MHz I/O CMOS 3.3 V
- High Speed Serial Data Port: 1.1 Gb/s, 8B10B encoding
- Configuration Interface: SPI
- Two Readout Modes: trigger mode and continuous mode
- Single pixel can be masked; Pixel includes built-in testing functionality
- Zero Compression Readout

Courtesy of Prof. Xiangming Sun (CNNU)

Research on 130nm Bulk CMOS Process Pixel Chip——MIC6_V3



MIC6 V3 Wafer photo



MIC6 V3 Test Platform

Courtesy of Prof. Xiangming Sun (CNNU)

On possibility of ALPIDE-like chip manufacturing in Russia

“”Если раньше передовые технологии можно было купить за рубежом, то сегодня перед Россией стоит задача обретения научно-технологической независимости. И здесь мы должны рассчитывать на свои силы.” ***Г.Я.Красников, 2024***

Complexity of the task is not only in technical but mostly organizational challenge to

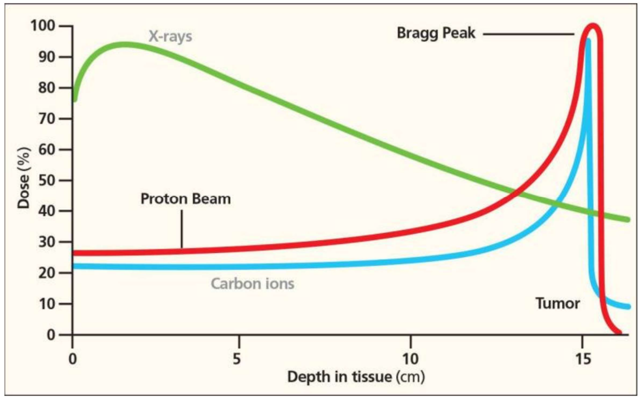
- Identify and coordinate the potential consumers of a chip to prevent duplication of developing chips with the same functionality (a typical error of the former years)
- Establish working cooperation between consumers, designers and foundries
- Guarantee the future usage of new technology by adding new courses to the existing educational programs for training young researchers and engineers
- Gain support from the country top medical experts to the application for financing the pCT demonstrator project as additional source of funding of the project

RAS seems to be the best choice as a coordinator for pursuing these goals!

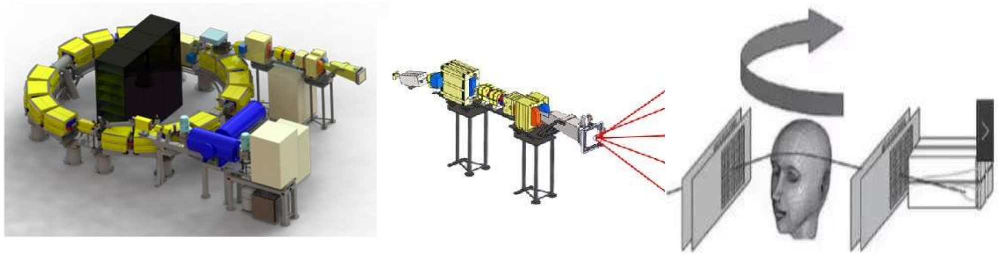
The pCT demonstrator based on ALPIDE-like chip?

Current state

- Planning with x-rays, treating with protons
- X-ray attenuation is not directly related to proton RSP
- Errors in planning decrease advantages of proton therapy
- Currently WET errors up to 5%



Gordon Isaacs – first patient to be treated in USA in 1957…



Proton Imaging

- **Same particle source for imaging and treatment**
- **Image metallic implants without artifacts**
- **Capable of daily range checks and patient alignment:**
  - **From 10 to100 x lower dose to the patient compared to x-ray**
  - **Verify Anatomical changes before every fraction**
- **Significant reduction of uncertainty margin (WET errors below 1%) enables accurate treatment delivery**

Conclusions and the outlook

- The increasing use of custom-designed VLSI microelectronics in HEP experiments is fundamentally changing the way of constructing experimental setups allowing for getting much more data, containing much more information, in less time.

- Unfortunately, at present and at any foreseen future this modern technology (ASICs) is and will be denied to reach Russia.

- Such a situation in fact dooms the Russian megaprojects to use 20-years-old outdated technical solutions that jeopardize the achievement of the goals they were created for. This brings the necessity to develop such technology in homeland.

- The ALPIDE-like Monolithic Active Pixel Sensor seems to be a good choice to start with due to its perspective of use both in fundamental science and medical application.

RAS seems to be the best choice to act as the coordinator of the project pursuing these goals!

THANK YOU !