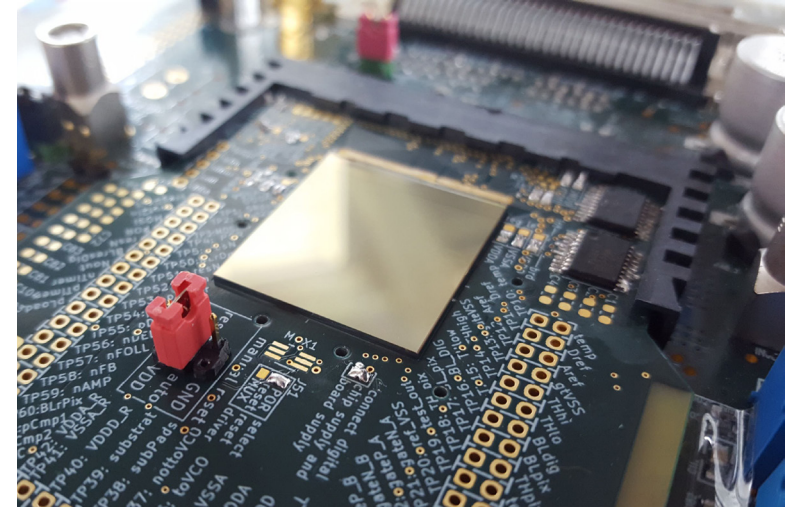




HVMAPS



High-Voltage Monolithic Active Pixel Sensors for Hadrons

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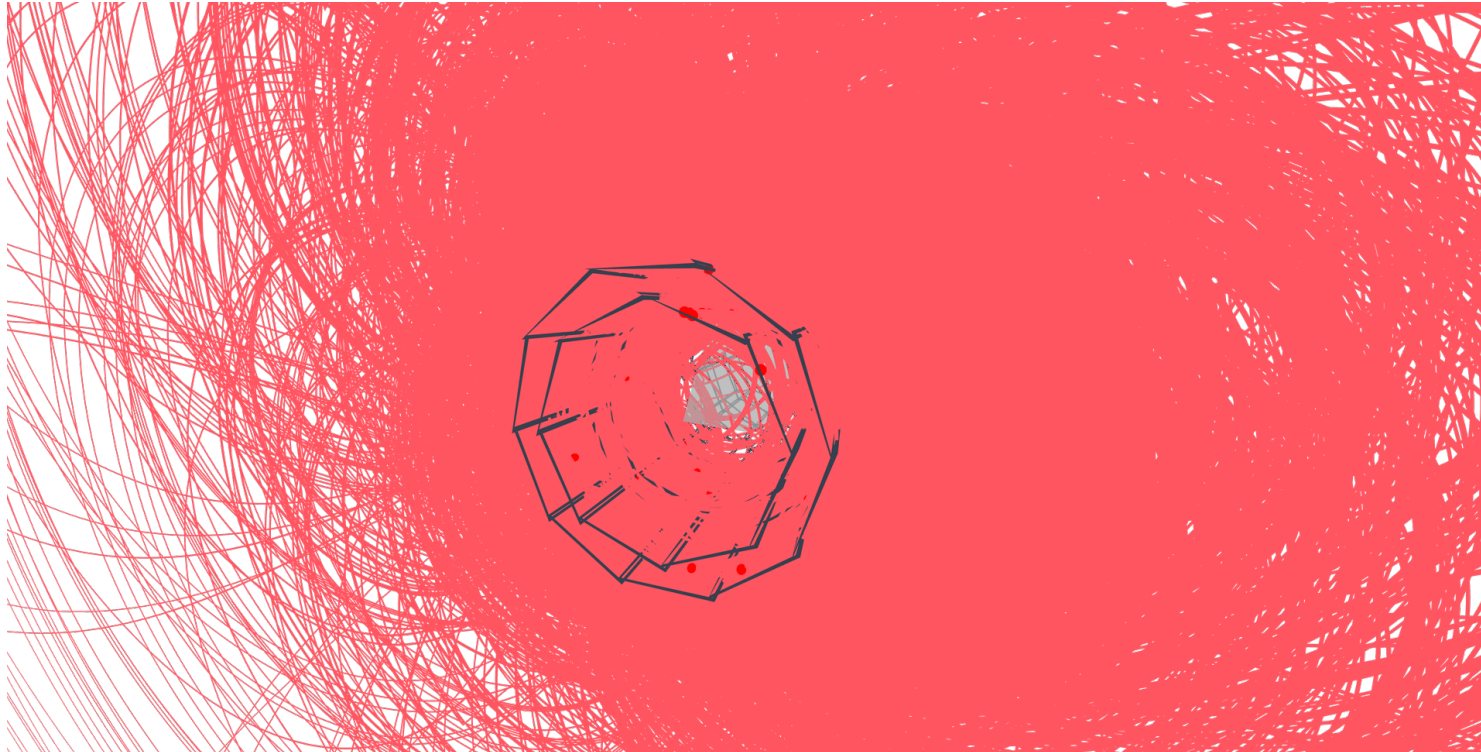
July 2025

The need for fast, thin, radiation hard, granular sensors

Many experiments in hadron physics at the
intensity and precision frontier

Requires sensors that can stand very high
rates and that allow for precision tracking

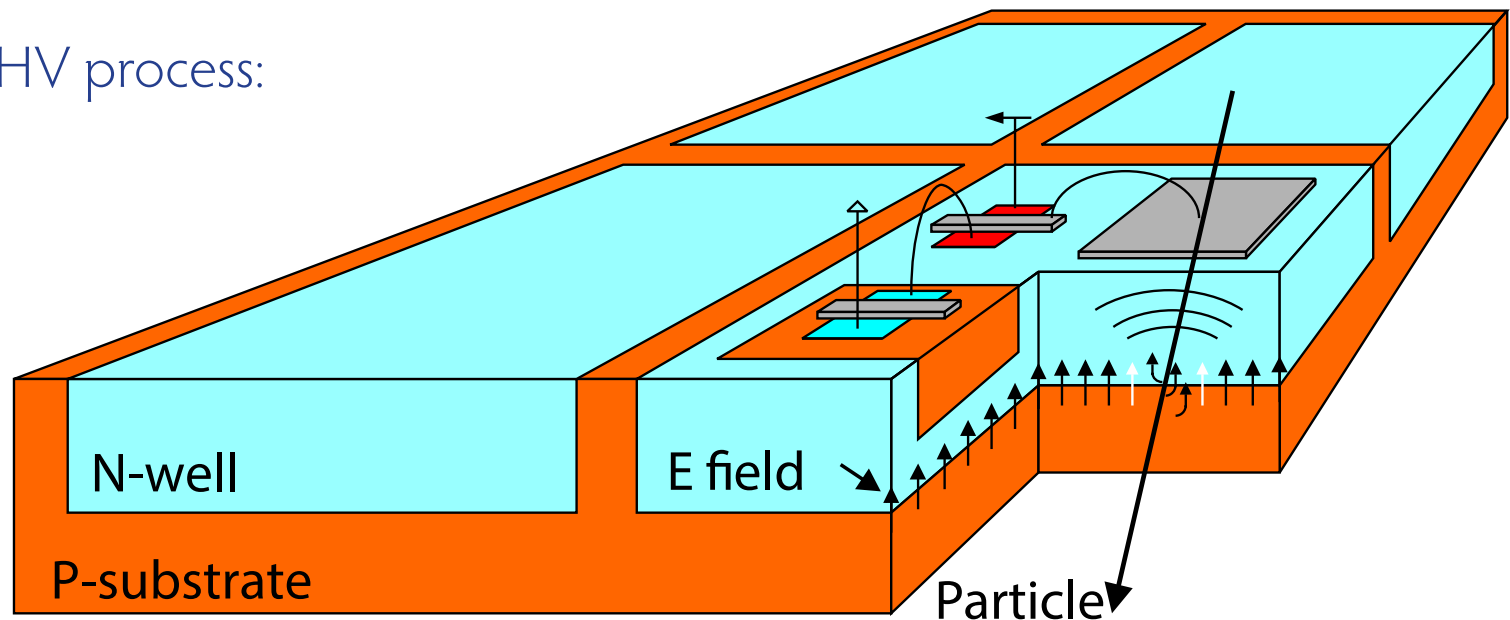
- High granularity (occupancy)
- Fast (occupancy)
- Thin (low multiple scattering, good momentum resolution)
- Radiation hard (lifetime)



High-Voltage Monolithic Active Pixel Sensors

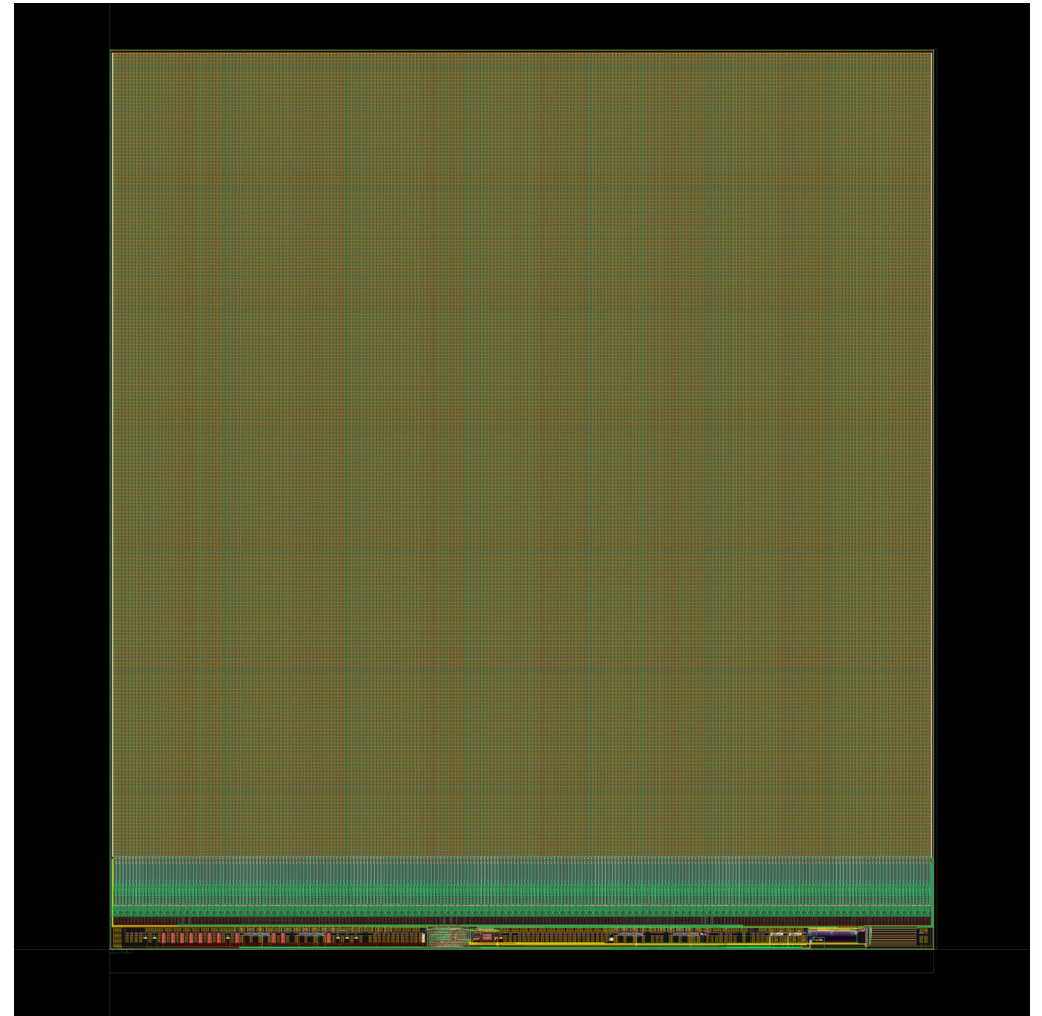
HVMAPS offer all this:

- Thin sensors down to $50\text{ }\mu\text{m}$
 - Time resolution $O(10\text{ ns})$
 - $80\text{ }\mu\text{m}$ pixels
 - Shown to be radiation hard
 - Use a commercial HV process: affordable
- Developed in the *Mu3e* experiment
 - Proposed uses in PANDA, MOLLER, P2, Polarimetry, LHCb, ...
 - Novel technology with huge potential



P2Pix

- P2Pix is the current HVMAPS iteration after a forced change of foundry to amsOSRAM (Austria)
- Result of more than a decade of our development and tests- **the best HV-MAPS so far**
- First samples delivered as we speak
- Should be available in large quantities by 2026
- Is currently **the only** production HV-MAPS sensor - unique opportunity for the community



Using the chip...

- Requires a suitable DAQ system
- And tuning hundreds of parameters
- Cooling, glueing, bonding, handling thin chips,..

Can be daunting, especially for small experiments
We have experience with all these aspects collected
over the last decade



Analog & Digital		Configuration bits	
MP: 0 [hex]		MP: 0 [hex]	
BLResPix	5	VPVCO	16
VNPix	14	VNVCO	17
VNFBPix	4	VPDeDclMux	20
VNFollPix	c	VNDeDclMux	20
VNPix2	0	VPDeDcl	20
VNBiasPix	0	VNDeDcl	20
VPLoadPix	a	VPDePreEmp	20
VNOutPix	a	VNDePreEmp	20
VNDeI	a	VPDcl	1e
VPComp1	0	VNDcl	f
VPDAC	0	VNLVDS	10
BLResDig	5	VNLVDSDeI	0
VPComp2	5	VPPump	3f
VPTimerDeI	1	invert	0
VNTimerDeI	14	SelEx	0

Save Configuration q/config/dacs/mp10_default.json Set Chip DACs

Load Configuration ☐ load tunes Configure

TWC Mode Bandgap and Biasblock Test Outputs

☐ ToT ☐ enable BG 1 1 ☒ Hitbus

☒ ≥ Threshold ☒ enable Biasblock 1 1 ☒ AmpOut

☐ Ramp ☐ enable BG 2 0 ☐ Injection

☐ Fun Mode ☒ enable Biasblock 2

MP: 0 [hex]		MP: 0 [hex]	
ref_Vss	0	Threshold_High	0
Baseline	47	Threshold_Low	0
ThLow	4c	Threshold_Pix	0
ThHigh	0	TDiode_Current	0
ThPix	0	TDiode ADC	0

☐ _DACs ☐ Board Dacs ☒ both Set Board DACs

PLL

Proposed program

- Develop a simple, portable data acquisition system for P2Pix
- Fully characterize P2Pix
- Develop tunes for P2Pix optimizing for speed, efficiency, power
- Make this unique, novel technology available for small experiments and test set-ups
- Bring very advanced sensor technology and operational experience to the hadron community

Required resources:

1 Postdoc for 4 years: 320 KEUR

50 KEUR for DAQ electronics

20 KEUR for travel to test beams

Direct cost: 390 KEUR

Total cost: 497.5 KEUR

