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VXD testbeam simulation and reconstruction

Peter Kvasnička, Tadeáš Bilka

IPNP, Charles University, Prague

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Overview

- **Task:** Implement simulation and reconstruction of the combined PXD+SVD testbeam in basf2
- **Purpose:** Test and validate PXD/SVD simulation and reconstruction on a simpler experiment
- **Status:**
  - ✔Testbeam geometry implemented in various configurations, including EUDET telescopes
  - ✔Tracking works out-of-the box, some modifications needed to accommodate EUDET telescopes (see next slides)
  - ✔Testbeam code available in basf2 svn.
- **In this talk:**
  - ➔Geometry optimization
  - ➔Event display
  - ➔Tracking / reconstruction

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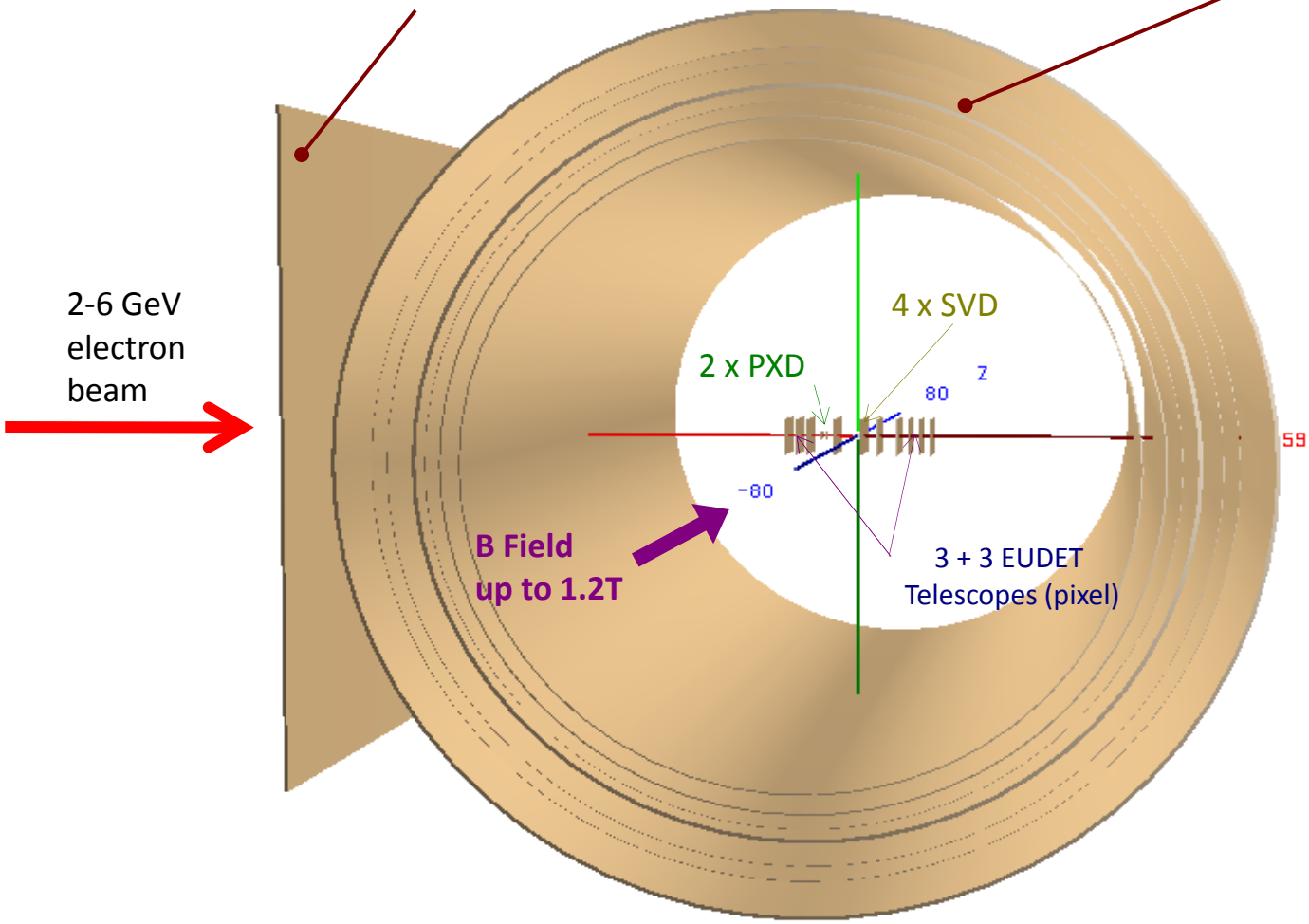
Geometry: Illustration

PCMAG magnet:
Immitated by a combination of Al layers to reproduce total X0=0.19

1 cm plexiglass protection shield:
To prevent human contact with cold parts of the magnet



Sensor positions along beamline, in mm, 0 on magnet axis

Tel 1	107
Tel 2	90
Tel 3	73
PXD 1	56
PXD 2	48
SVD 1	31,84
SVD 2	-10,16
SVD 3	-35,16
SVD 4	-65,16
Tel 4	-82,16
Tel 5	-99,16
Tel 6	-116,16

"3TelVXD3Tel Centered Middle" configuration

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Geometry: Configurations

Optimal Middle 6TelVXD

	Tel1	Tel2	Tel3	Tel4	Tel5	Tel6	PXD1	PXD2	SVD1	SVD2	SVD3	SVD4
H-center	**158**	**141**	**124**	**107**	**90**	**73**	**56**	**48**	**31,84**	**-10,16**	**-35,16**	**-65,16**
V-center	-5,60	-5,60	-5,60	-5,60	-5,60	-5,60	-4,25	-4,25	-23,9	-23,9	-23,9	-23,9
Top edge	5	5	5	5	5	5	2	2	5	5	5	5
Bottom edge	-16,20	-16,20	-16,20	-16,20	-16,20	-16,20	-10,5	-10,5	-52,72	-52,72	-52,72	-52,72

Optimal Near 6TelVXD

	Tel1	Tel2	Tel3	Tel4	Tel5	Tel6	PXD1	PXD2	SVD1	SVD2	SVD3	SVD4
H-center	**358**	**341**	**324**	**307**	**290**	**273**	**256**	**248**	**231,84**	**189,84**	**164,84**	**134,84**
V-center	-5,60	-5,60	-5,60	-5,60	-5,60	-5,60	-4,25	-4,25	-23,9	-23,9	-23,9	-23,9
Top edge	5	5	5	5	5	5	2	2	5	5	5	5
Bottom edge	-16,20	-16,20	-16,20	-16,20	-16,20	-16,20	-10,5	-10,5	-52,72	-52,72	-52,72	-52,72

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Geometry: Configurations

Optimal Middle 3TelVXD3Tel

	Tel1	Tel2	Tel3	PXD1	PXD2	SVD1	SVD2	SVD3	SVD4	Tel4	Tel5	Tel6
H-center	107	90	73	56	48	31,84	-10,16	-35,16	-65,16	-82,16	-99,16	-116,16
V-center	-5,60	-5,60	-5,60	-4,25	-4,25	-23,86	-23,86	-23,86	-23,86	-5,60	-5,60	-5,60
Top edge	5	5	5	2	2	5	5	5	5	5	5	5
Bottom edge	-16,20	-16,20	-16,20	-10,5	-10,5	-52,72	-52,72	-52,72	-52,72	-16,20	-16,20	-16,20

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Geometry: Configurations

Centered Middle 3TelVXD3Tel – Big Telescopes

	Tel1	Tel2	Tel3	PXD1	PXD2	SVD1	SVD2	SVD3	SVD4	Tel4	Tel5	Tel6
H-center	107	90	73	56	48	31,84	-10,16	-35,16	-65,16	-82,16	-99,16	-116,16
V-center	0	0	0	0	0	0	0	0	0	0	0	0
Top edge	28,86	28,86	28,86	6,25	6,25	28,86	28,86	28,86	28,86	28,86	28,86	28,86
Bottom edge	-28,86	-28,86	-28,86	-6,25	-6,25	-28,86	-28,86	-28,86	-28,86	-28,86	-28,86	-28,86

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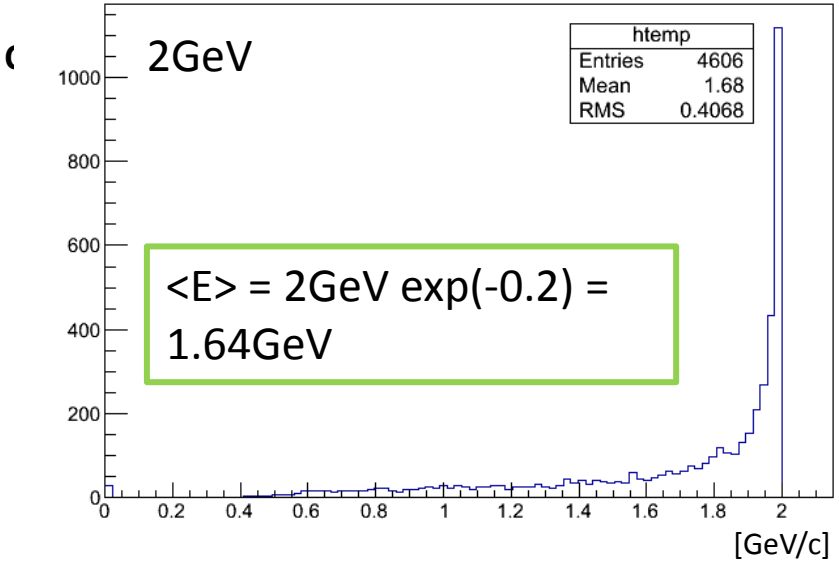
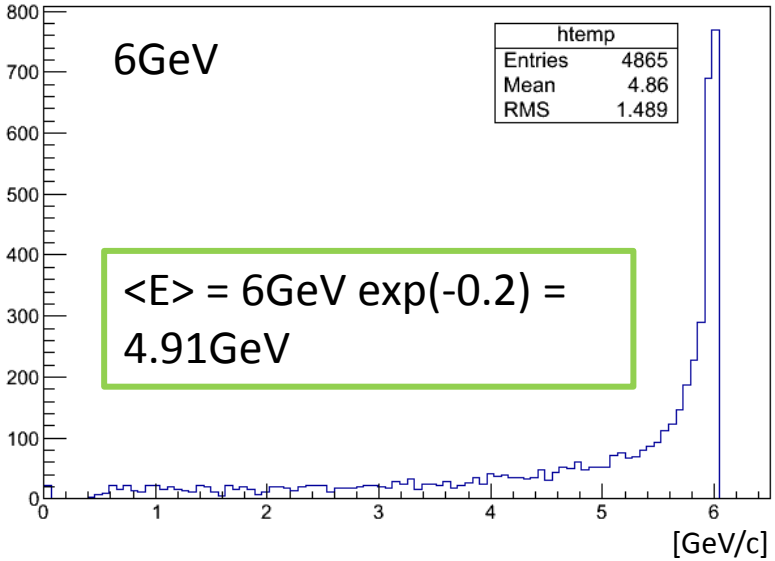
Simulations: General

- **Standard basf2 simulation:**
  - Testbeam geometry with magnetic field map, testbeam geometry creator
  - Particle gun as source of electrons (no divergence, point source)
  - FullSim Geant4 simulation
  - Special data types and smearing digitizer/clusterizer for the telescopes
  - Standard provisions for PXD and SVD

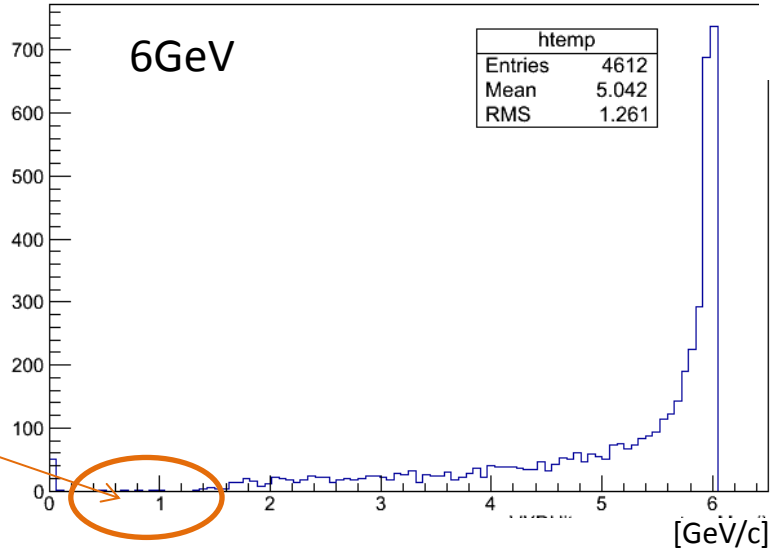
- **EventDisplay + tracking:**
  - basf2 TEve-based event display works for PXD and SVD, now also for the magnetic field (credits Christian Pulvermacher)
  - MCTrackFinder and GenFitter modules work out-of-the-box for PXD and SVD in testbeam geometry.
  - Inclusion of telescopes will need some modifications.

Simulations: Momenta of primaries





Tel1 (6TelVXD)



PXD1 (6TelVXD)

Lower momentum particles too deflected in magnetic field

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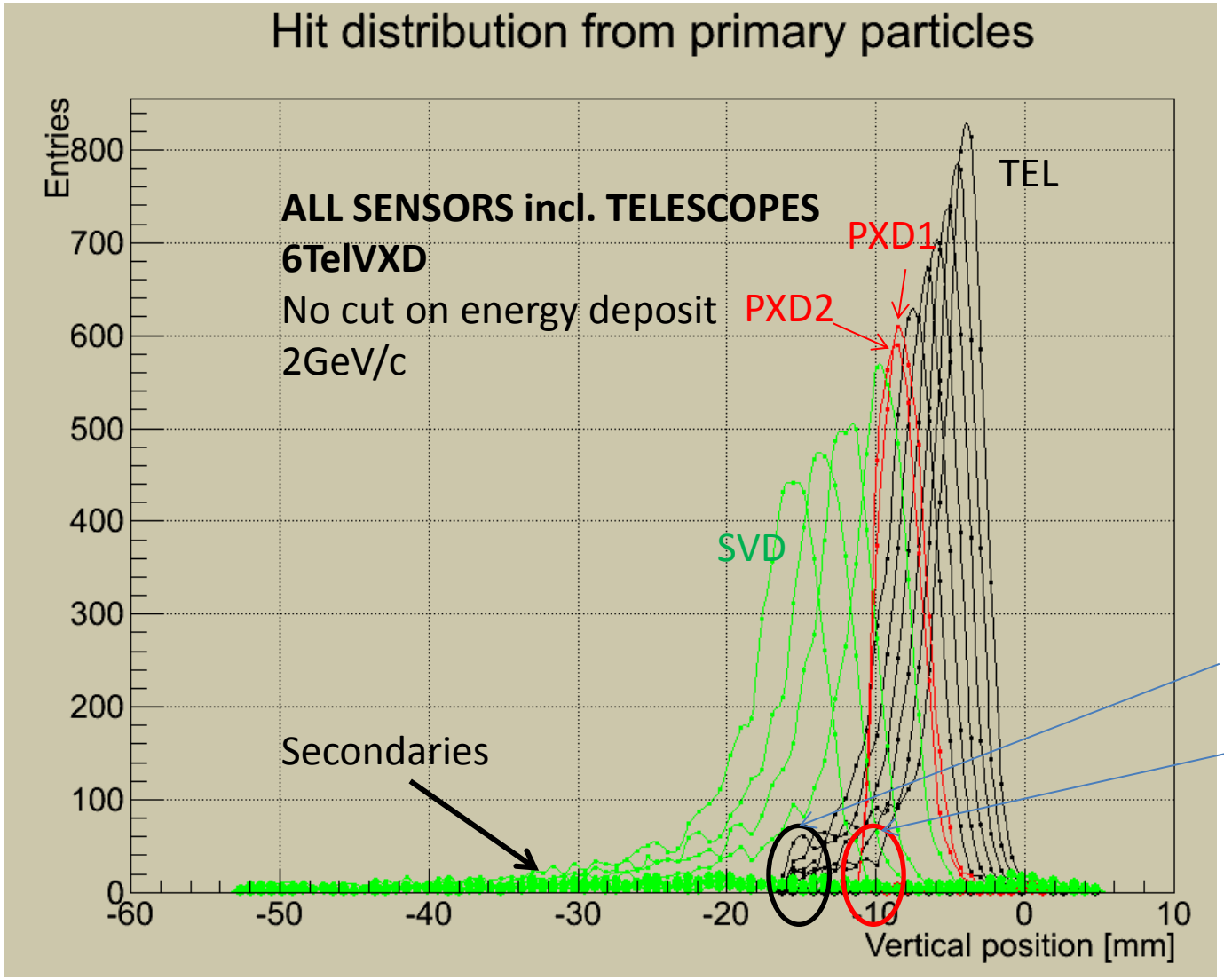
Simulations: Distribution of primaries



Edge of telescopes

Edge of PXD

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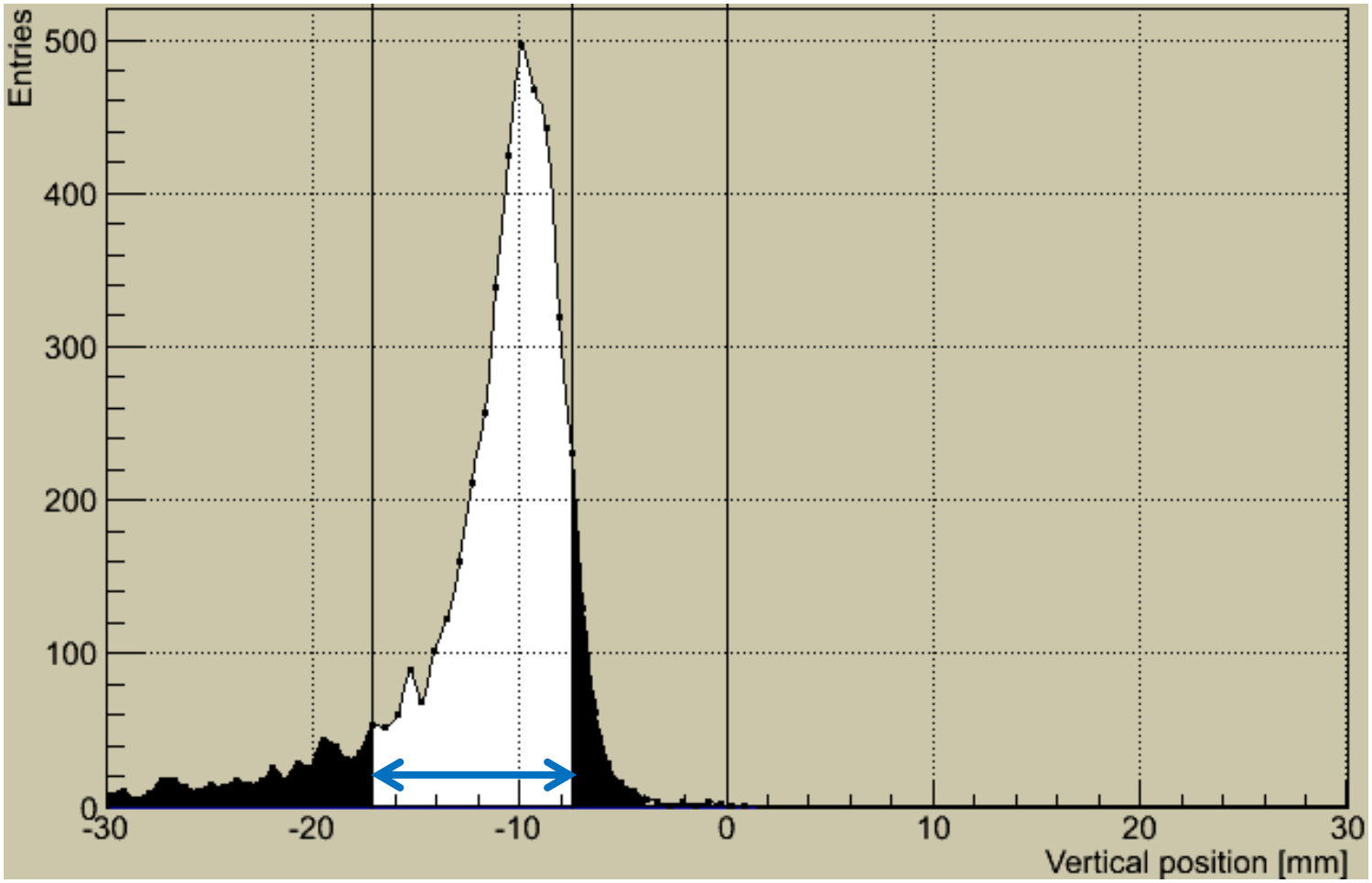
Simulations: Beam envelope

Beam Envelope
(80% of tracks)



Low edge (tail)
10% cut

High edge
10% cut

Simulation: Beam envelope

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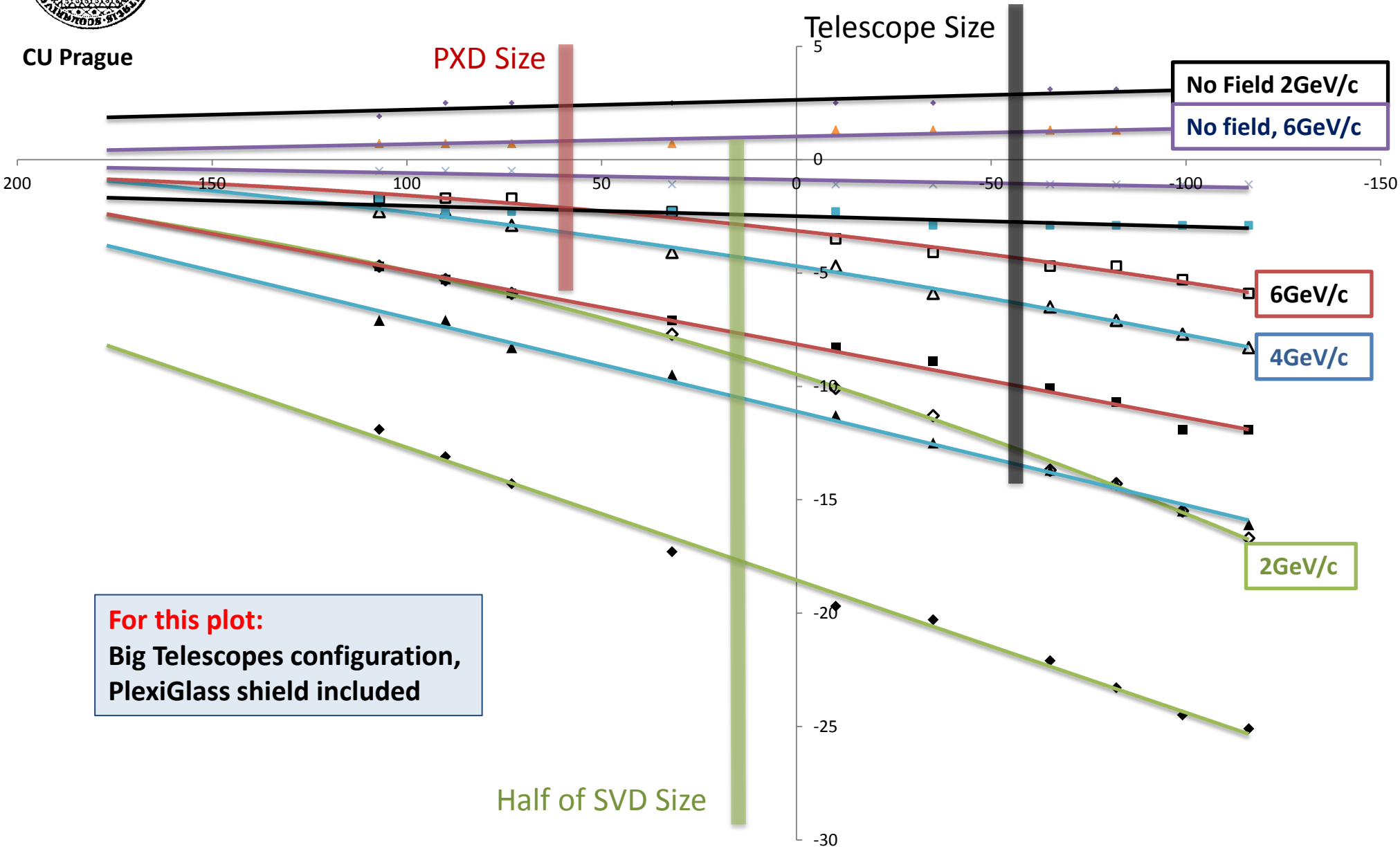

For this plot:
Big Telescopes configuration, PlexiGlass shield included

Geometry: Track efficiencies

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Full Tracks	%										
Primaries with hits in all detectors (12) / Primaries generated											
		No Field					No Field				
Exp. Conditions											
Magnetic Field		OFF	OFF	**ON**	**ON**	**ON**	OFF	OFF	**ON**	**ON**	**ON**
PlexiGlass Wall		OFF	**ON**	**ON**	OFF	**ON**	OFF	**ON**	**ON**	OFF	**ON**
Aluminium Windows		OFF	OFF	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	**ON**
		*Centered - Middle					Optimal - Middle				
		Big Telescopes 3TelVXD3Tel					**EUDET 6TelVXD**				
Beam Momentum [GeV/c]	2	98	97	4	3			83	60		62
	4	99	98	75	79			94	87		88
	6	99	99	85	86			98	91		92
		Optimal - Middle					Optimal - Near				
		Big Telescopes 3TelVXD3Tel					**EUDET 6TelVXD**				
	2	88	85	59				93	95		95
	4	97	95	88				98	98		98
	6	98	97	92				99	98		99
							Optimal - Middle				
							EUDET 3TelVXD3Tel				
	2						85		5	4	4
	4						96		80	83	82
	6						98		88	90	89

Beam outside PXD

Beam outside back telescopes

EventDisplay and tracking

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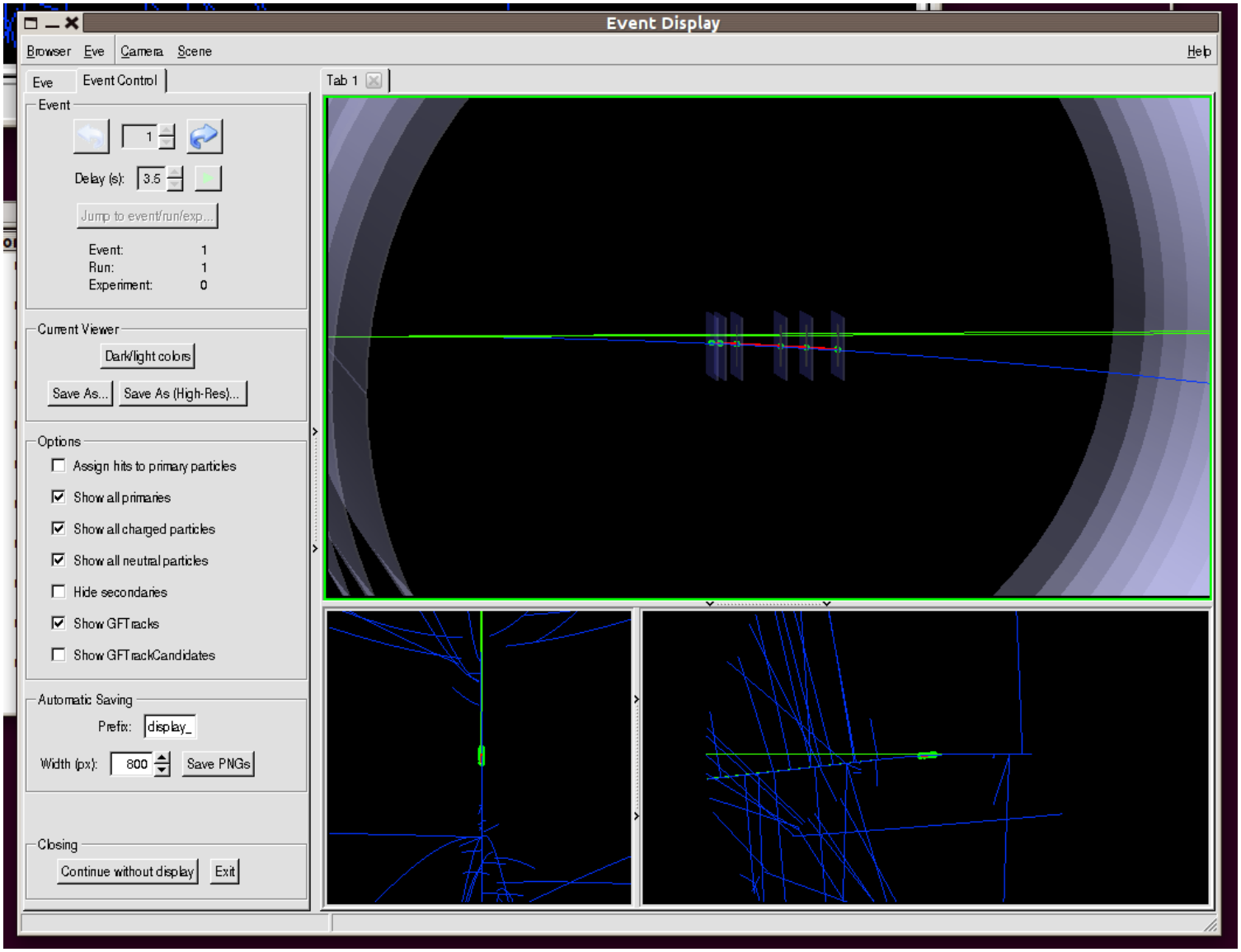

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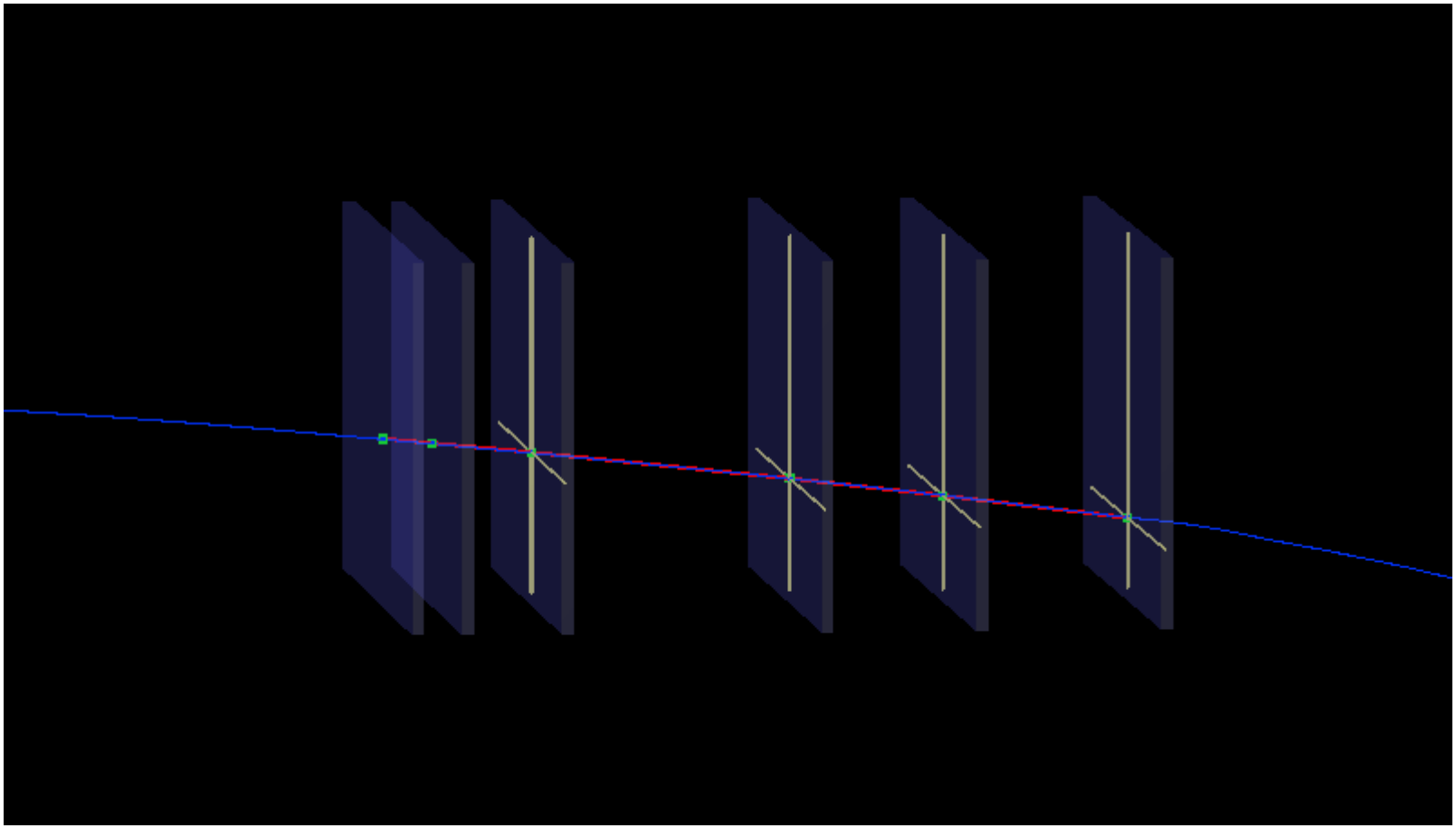
EventDisplay and tracking



Plans / Open issues

- Testbeam:
  - Still collecting data on setup
  - Will we use EUDET telescopes?
- EventDisplay:
  - Make EventDisplay work with the telescopes.
- Pattern Reco:
  - The MCTrackFInder will have to be modified to accept telescopes.
  - SVD/PXD pattern reco developed by Vienna will be used for the testbeam.
- Alignment:
  - Re-use (and test) the VXD implementation of (mis-)alignment.
  - The Belle II alignment group will develop testbeam alignment
- Tracking:
  - Modifications for telescopes
  - Modifications for testbeam

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Conclusions

- Testbeam code corrently covers:
  - Simulation of all configurations, including telescopes
  - Tracking of PXD+SVD+Tel setups
  - EventDisplay of PXD+SVD setups (without telescopes)
- Tracking and EventDisplay need testbeam versions to accept telescopes.
- Other parts of the reconstruction chain in development.