Luminosity simulation with Guinea-Pig(++)

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HELMHOLTZ

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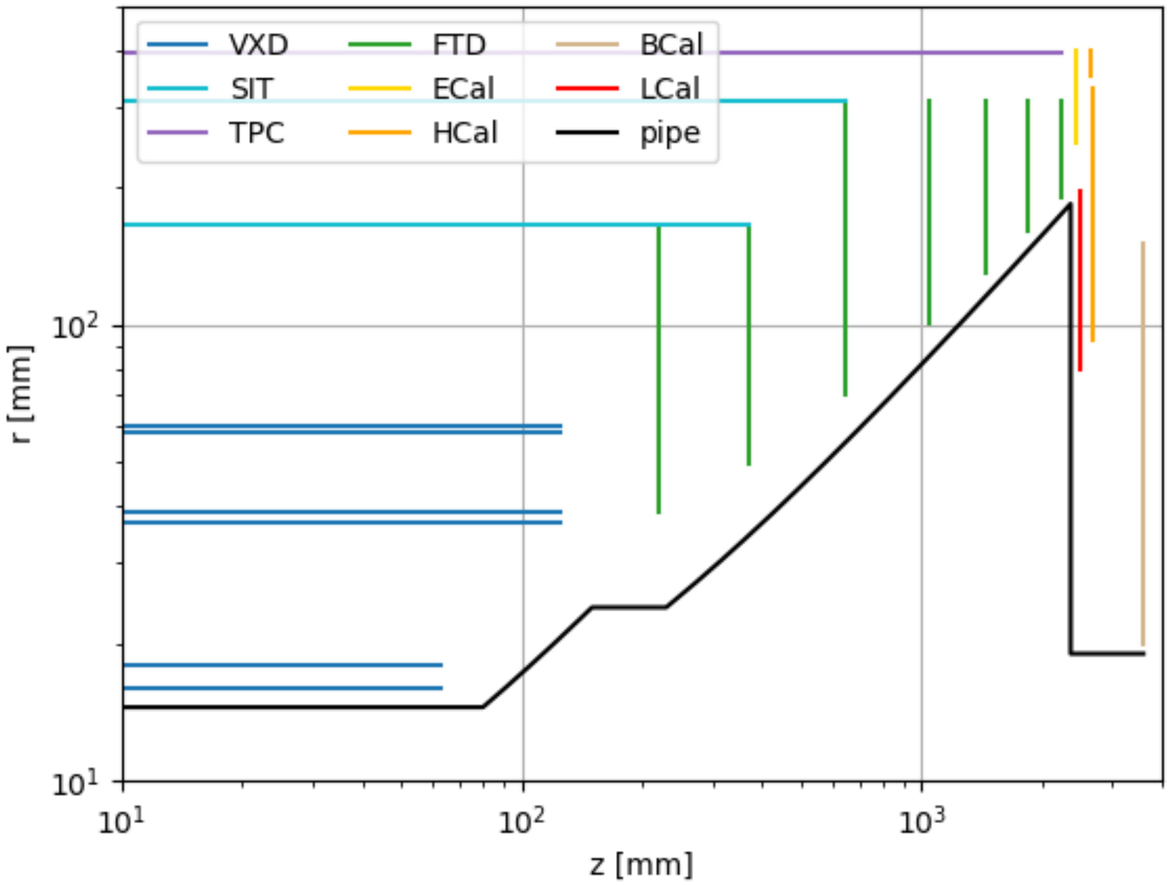
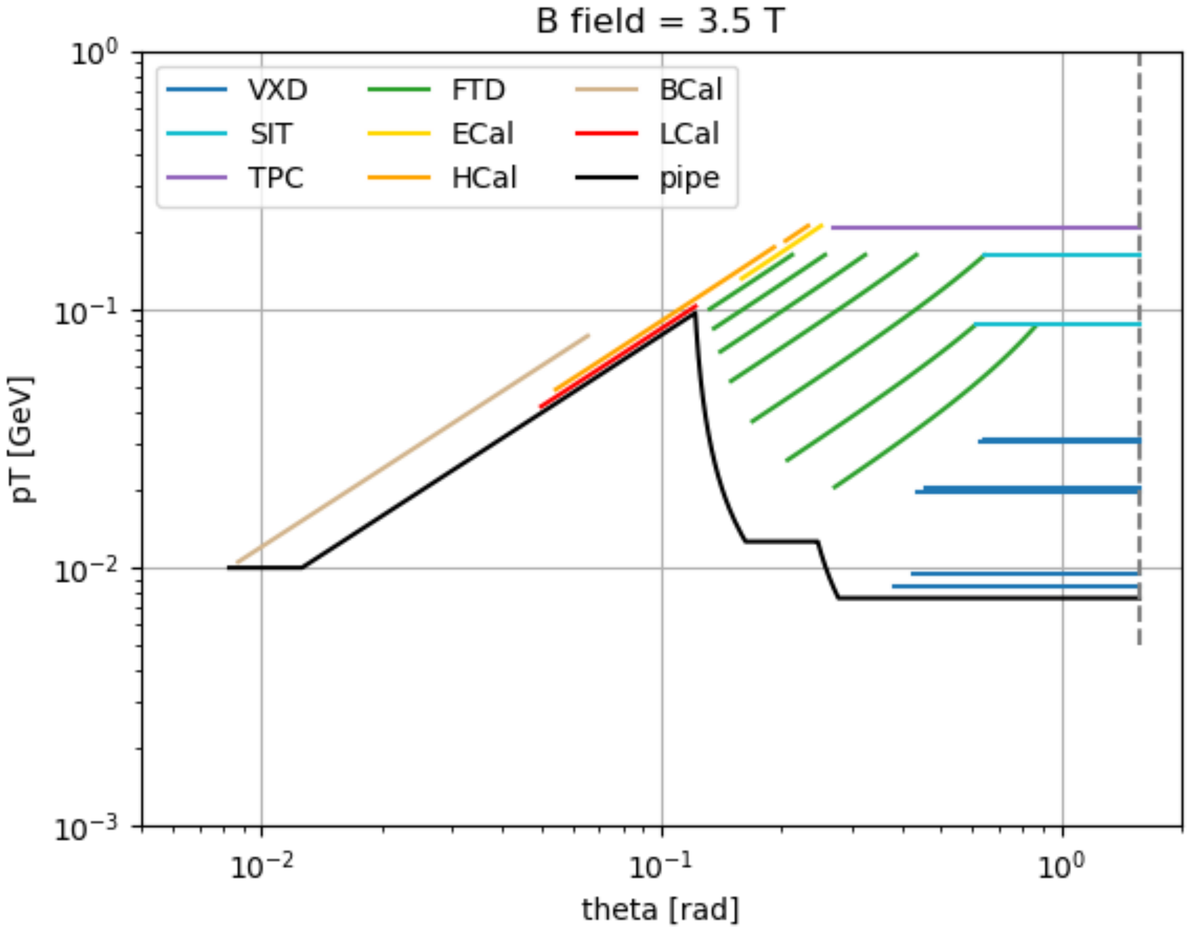
DESY.

Detector representation

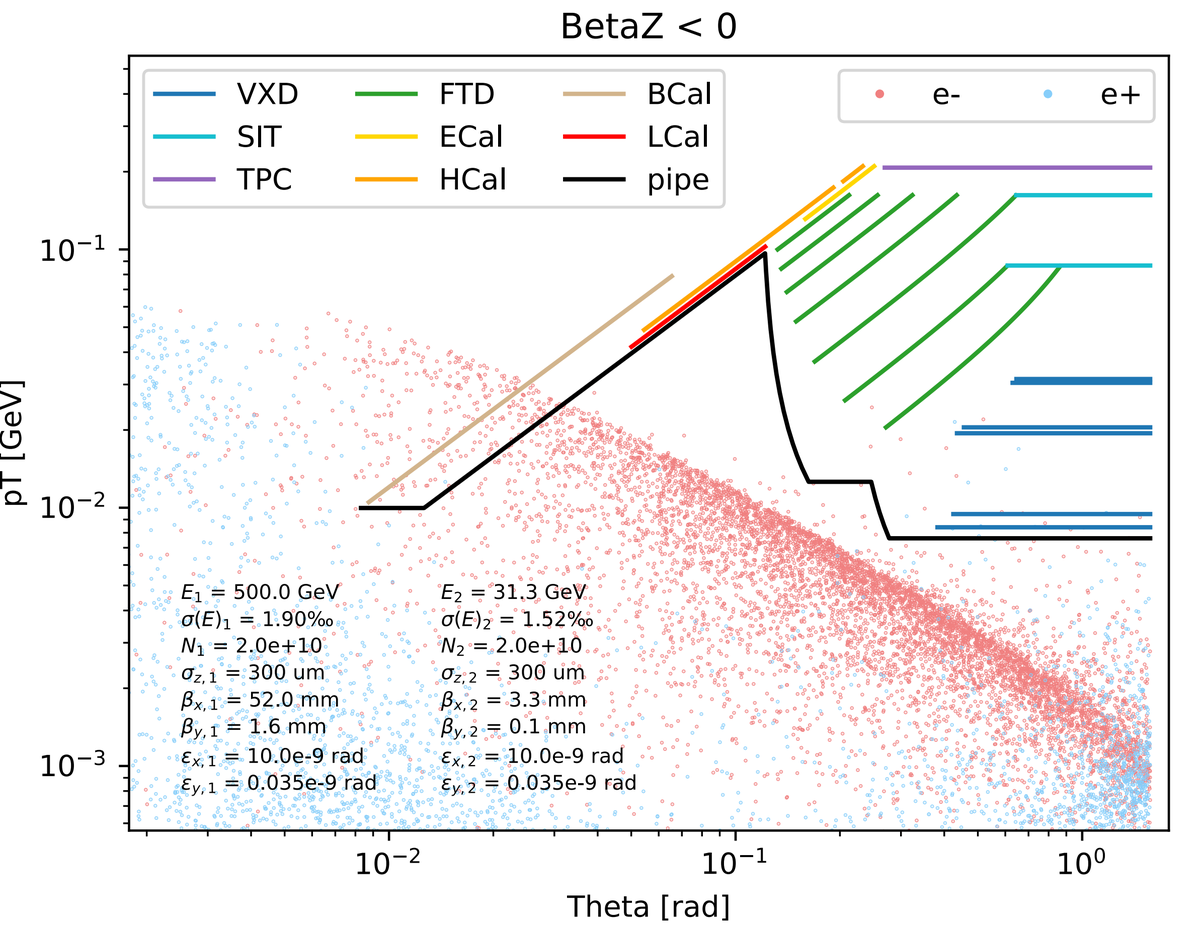


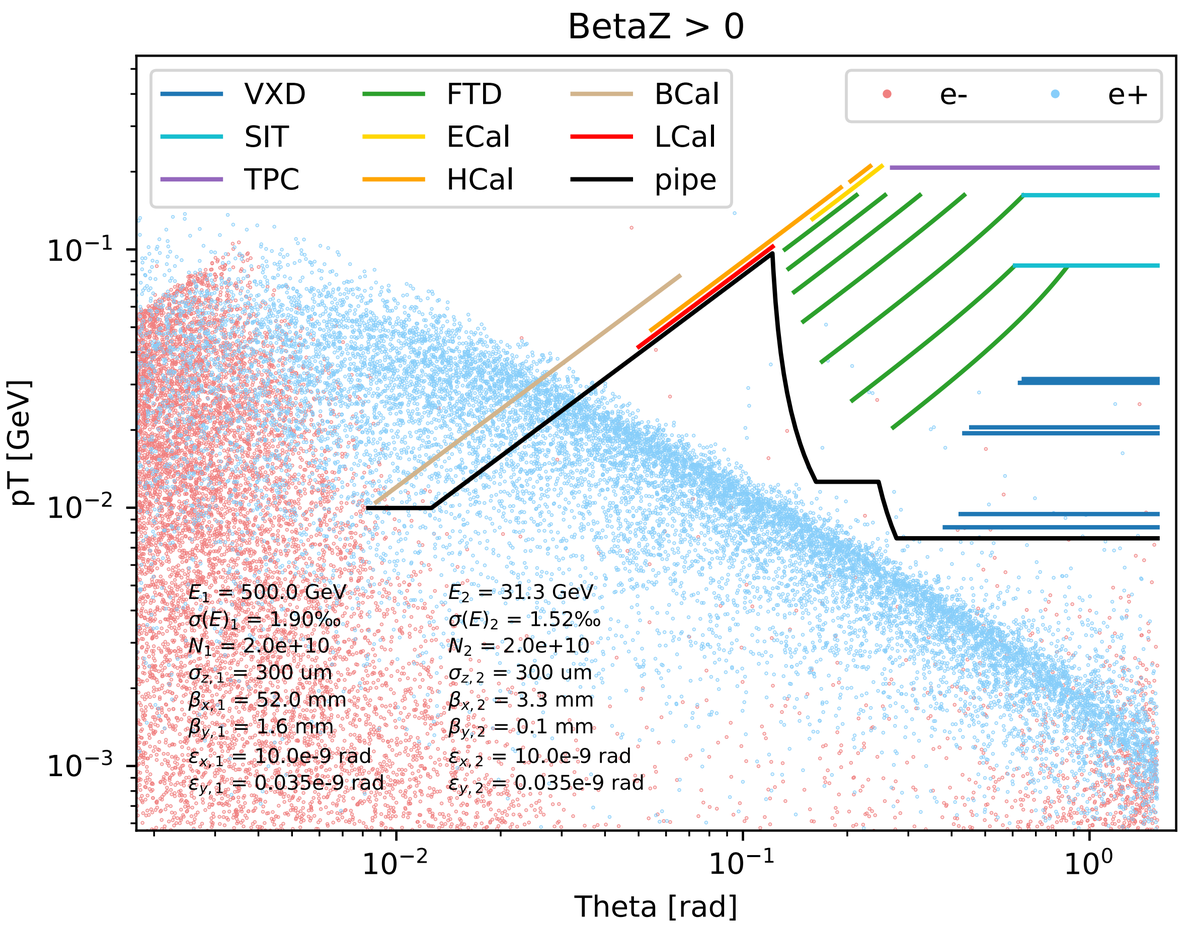
z-r space



theta-pT space

Fixed the pT/theta plot!





- Results consistent with Mikael's!
- See slide 3 (page 6 and 7) of this presentation (06.07.2023).

A few new results

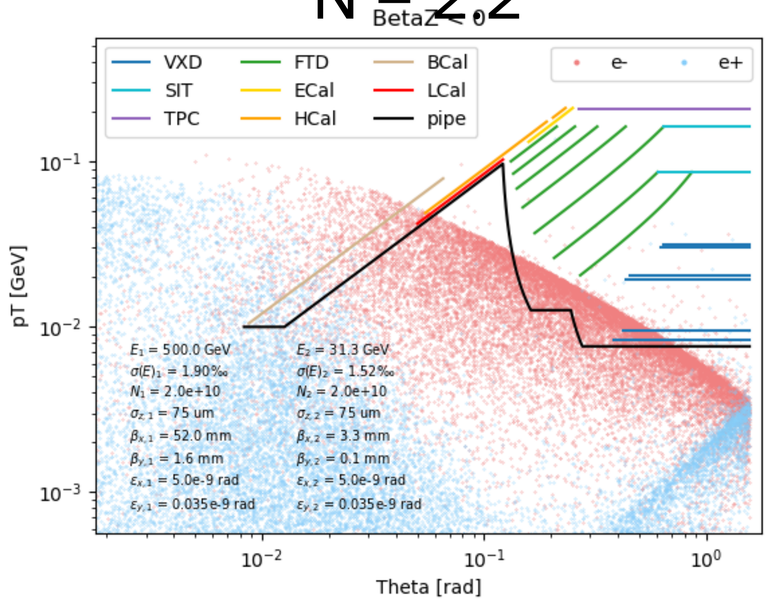
- Question:
  - What is the impact on sigma_z on the pairs?
    - ie: can we play with it to avoid being hit by too many of them?
  - How does it impact the luminosity?

- Common settings:
  - All using C-version of GuineaPig
  - Based on scenario 2 from HALHF proposal
  - E(e-) = 500 GeV, spread 0.19%
  - E(e+) = 31.3 GeV, spread 0.152%
  - ε_x = 5 nrad instead of 10 nrad

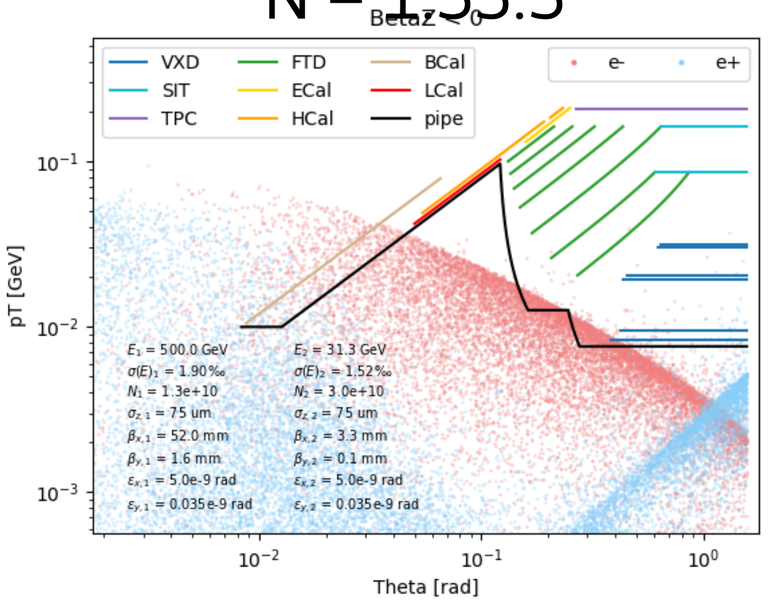
- Varying parameters:
  - beam charge (e-:e+) 2:2, 1.3:3, 1:4
  - sigma_z = 75 / 150 / 300 µm, with sigma_z(e-) > sigma_z(e+)

A few new results, sigma_z = 75:75

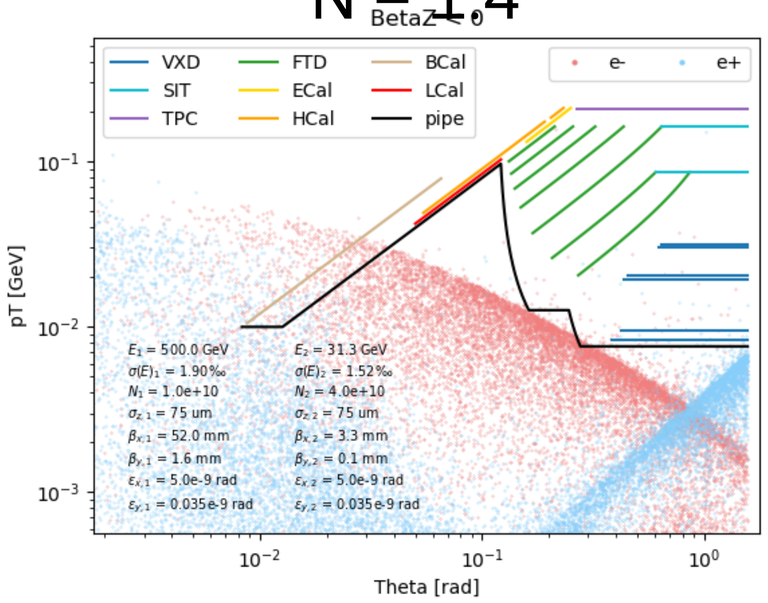
N = 2:2

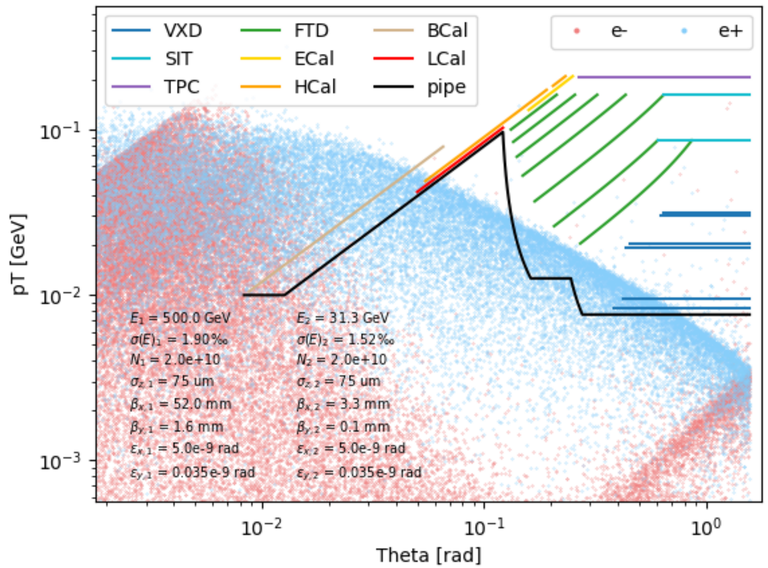


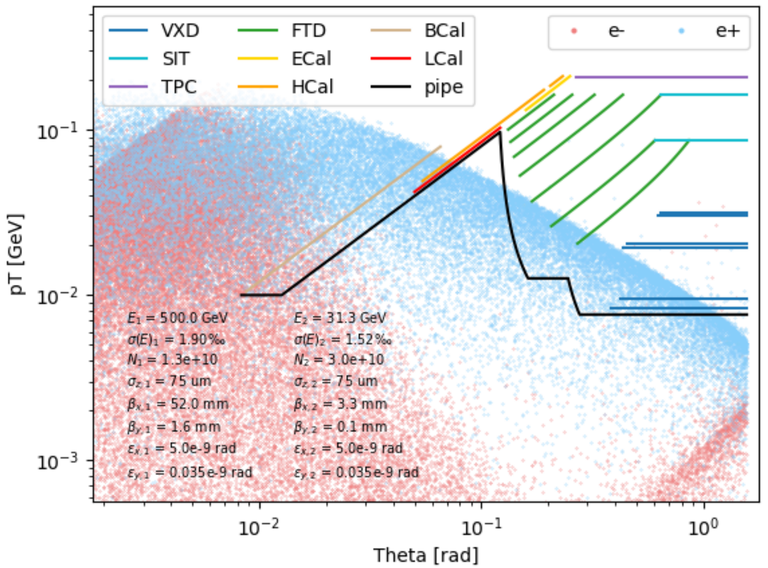
N = 1.33:3

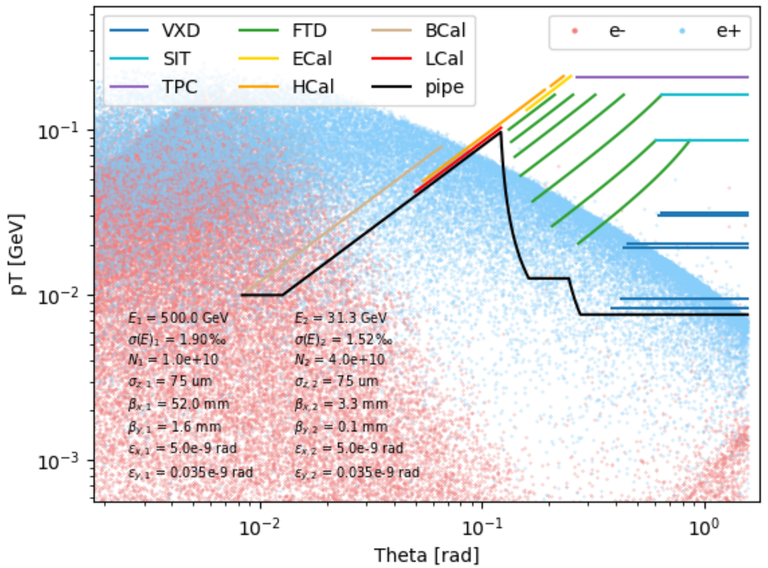


N = 1:4



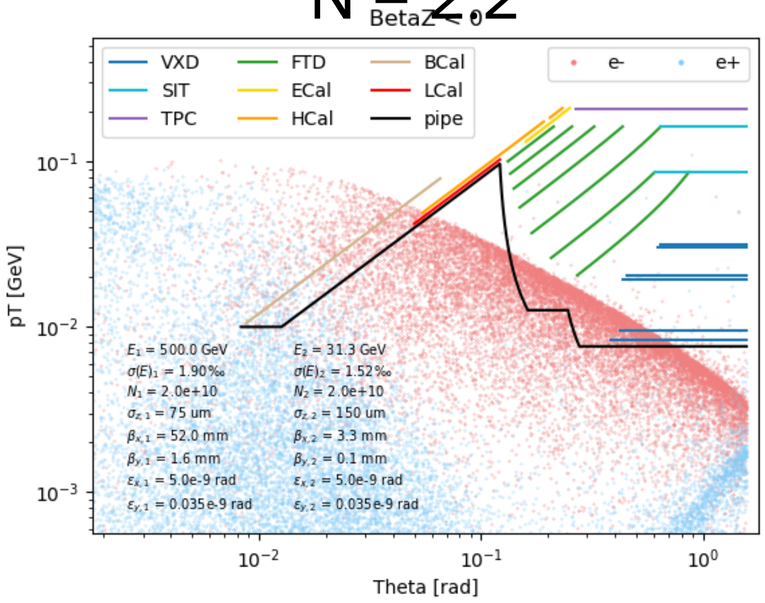




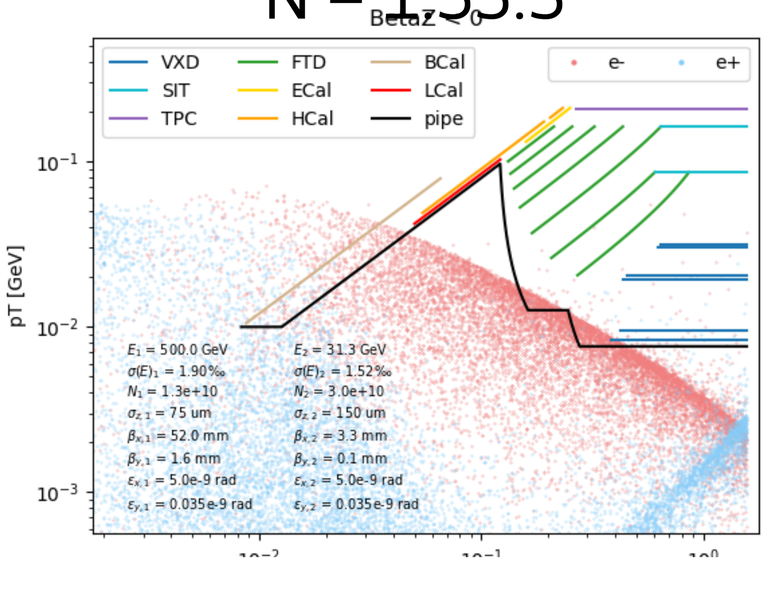


A few new results, sigma_z = 75:150

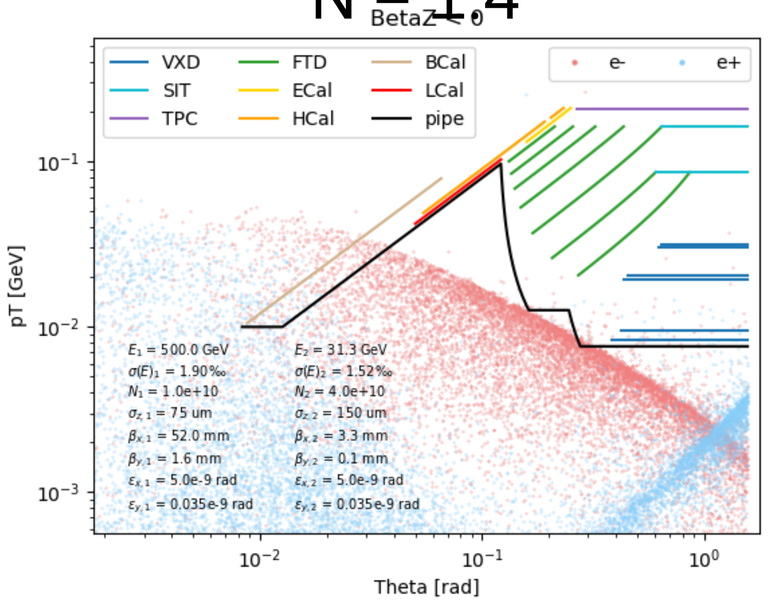
N = 2:2

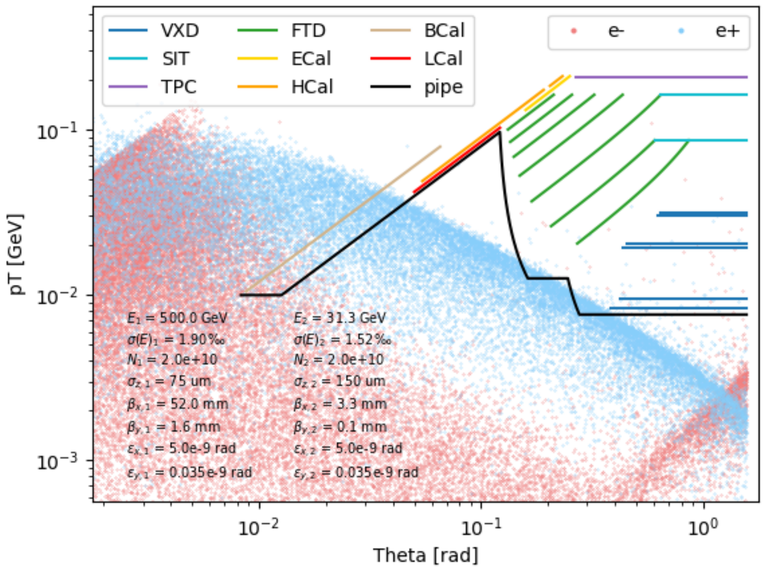


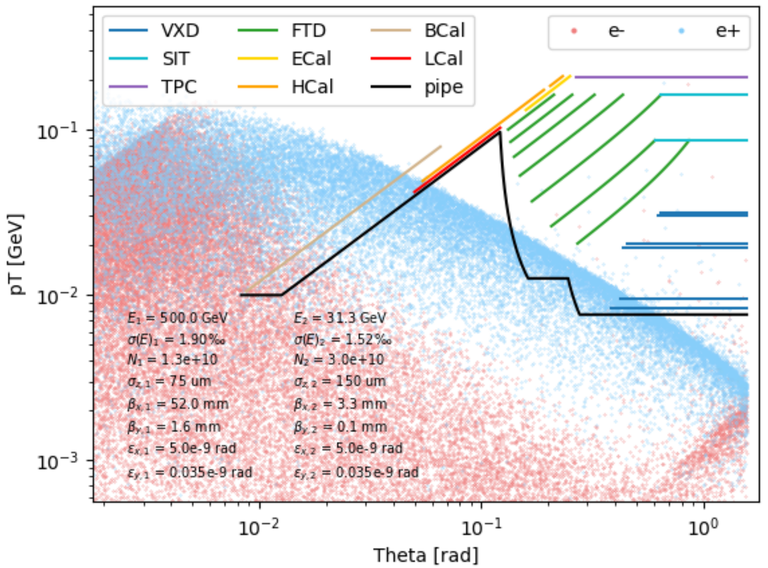
N = 1.33:3

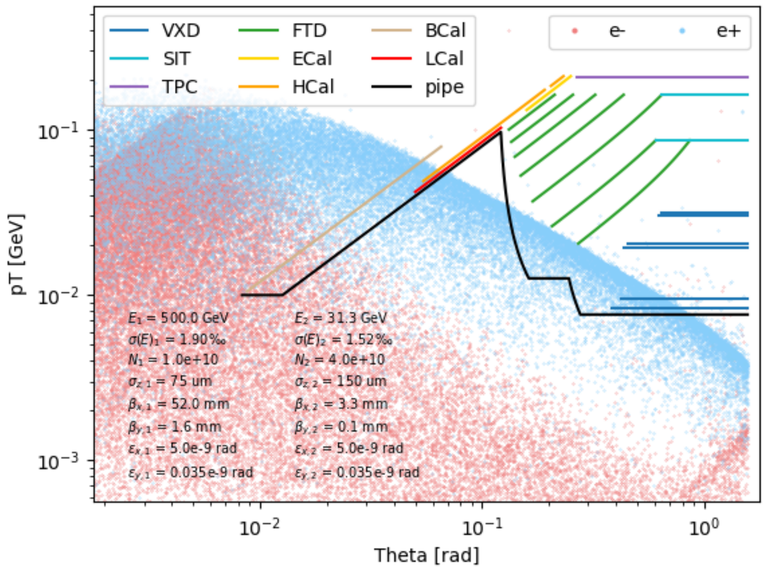


N = 1:4



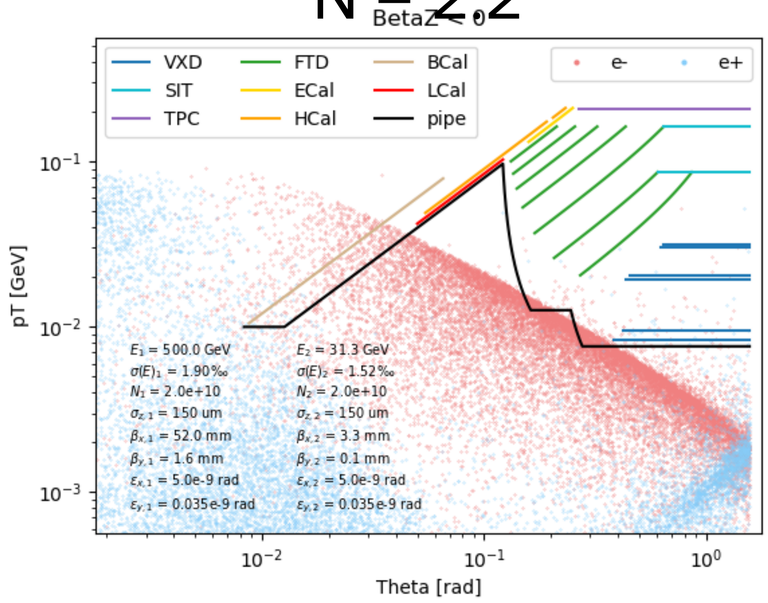




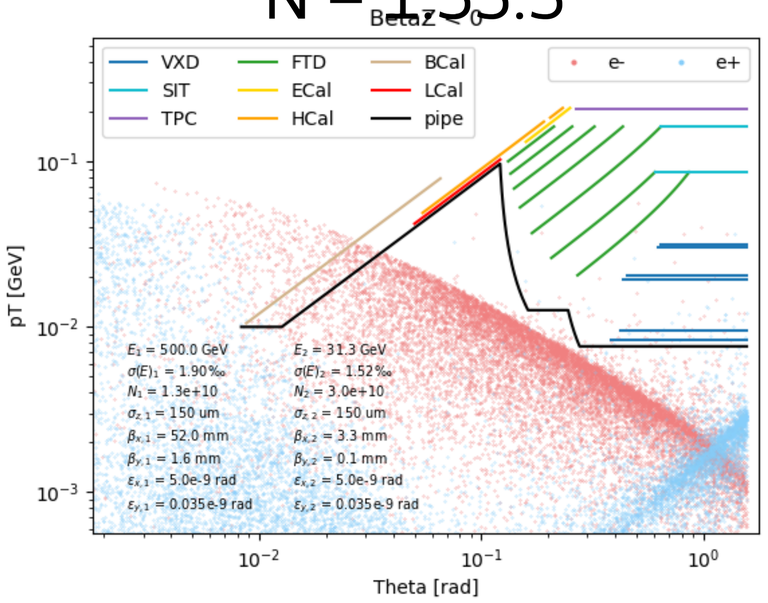


A few new results, sigma_z = 150:150

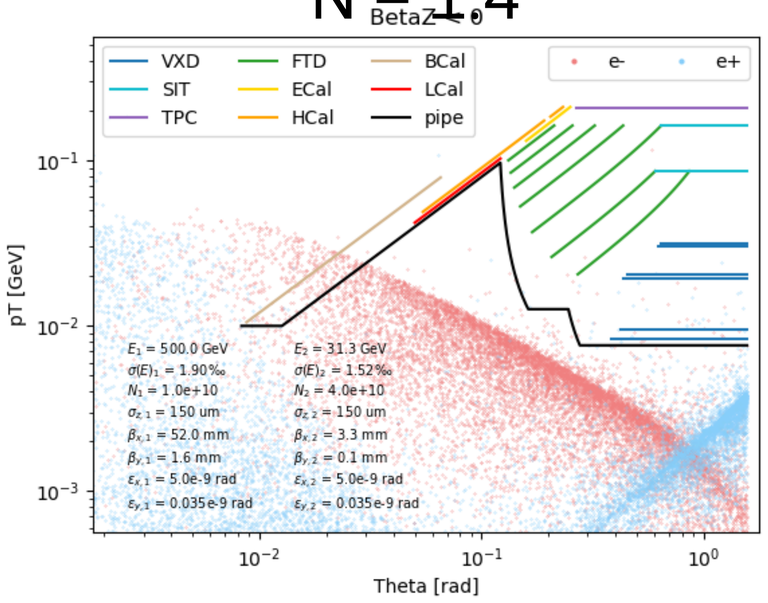
N = 2:2

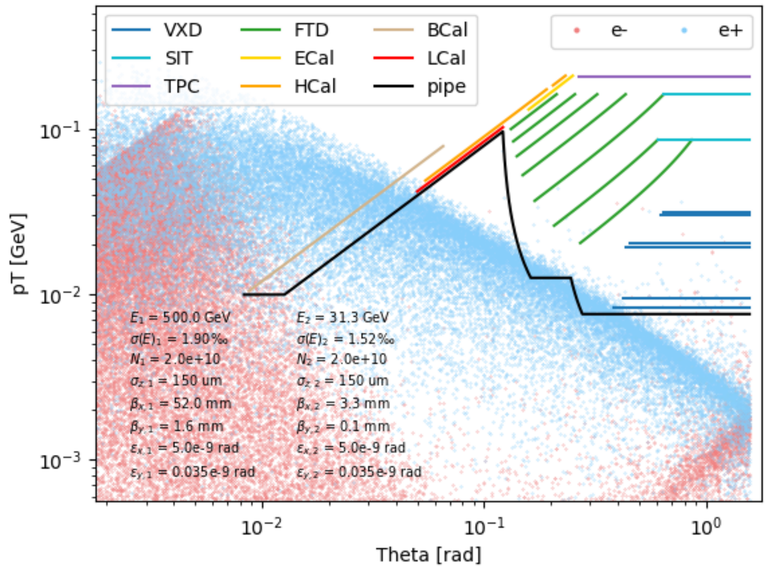


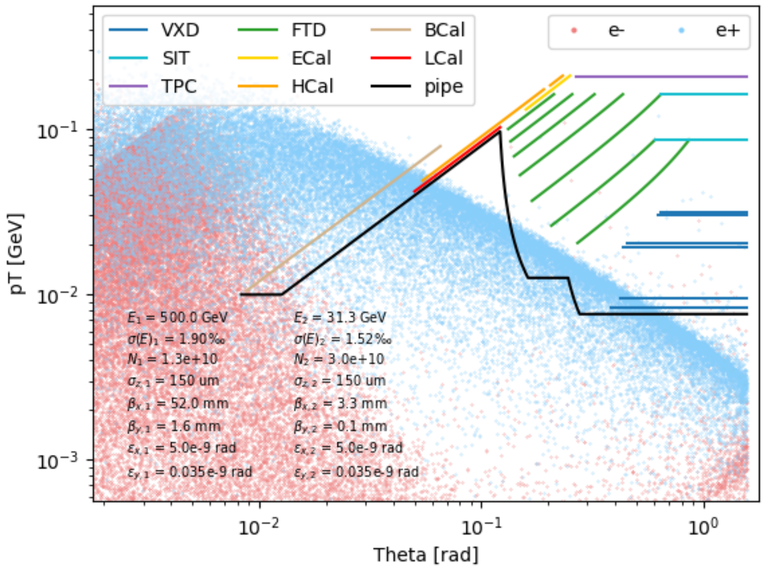
N = 1.33:3

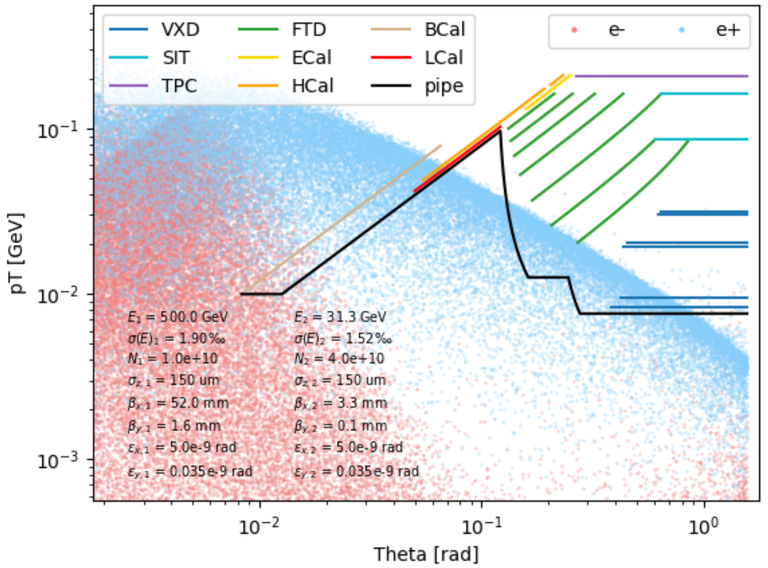


N = 1:4



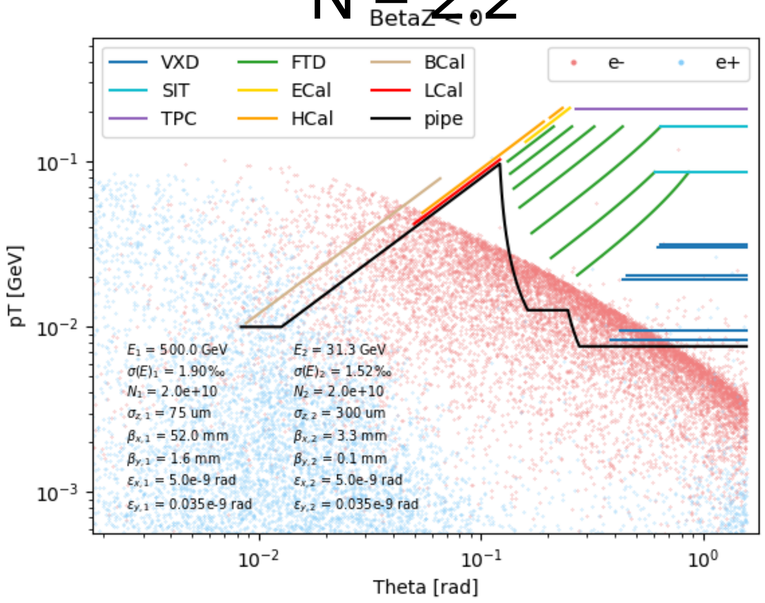




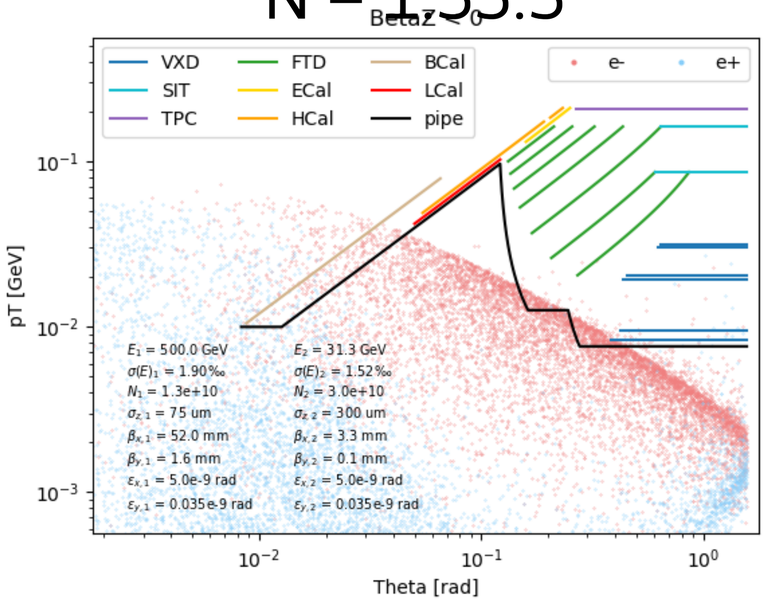


A few new results, sigma_z = 75:300

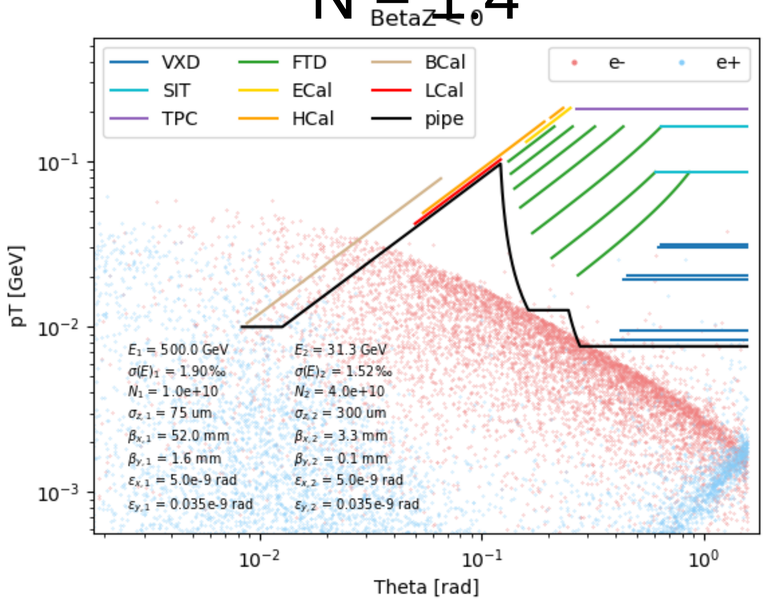
N = 2:2

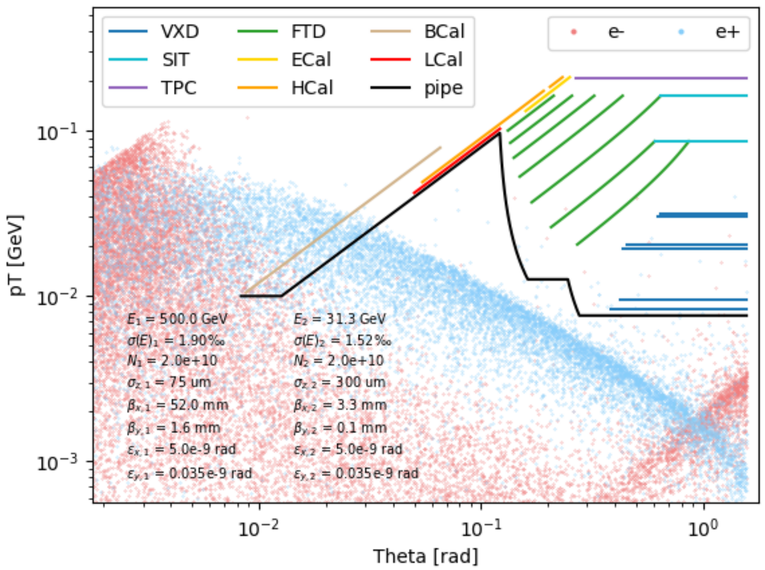


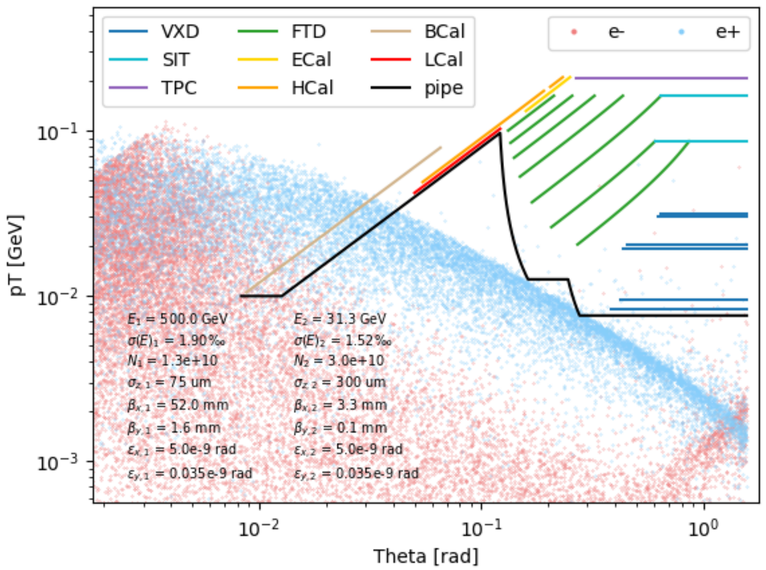
N = 1.33:3

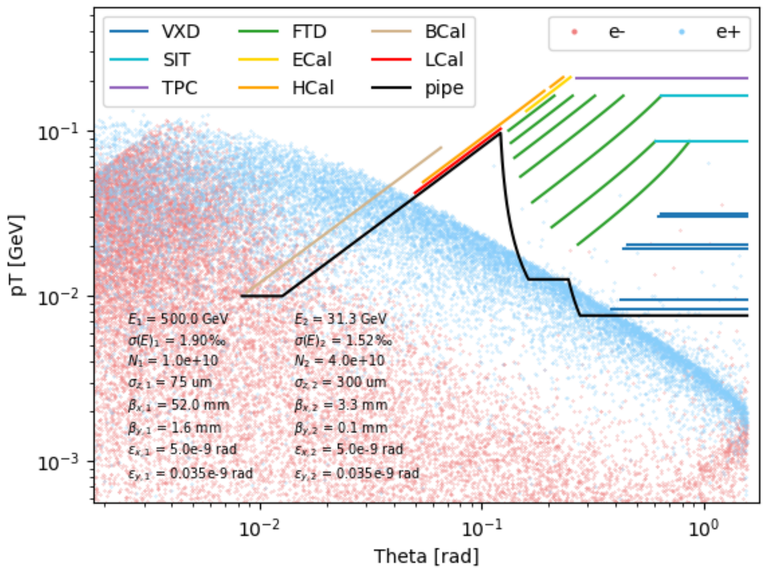


N = 1:4



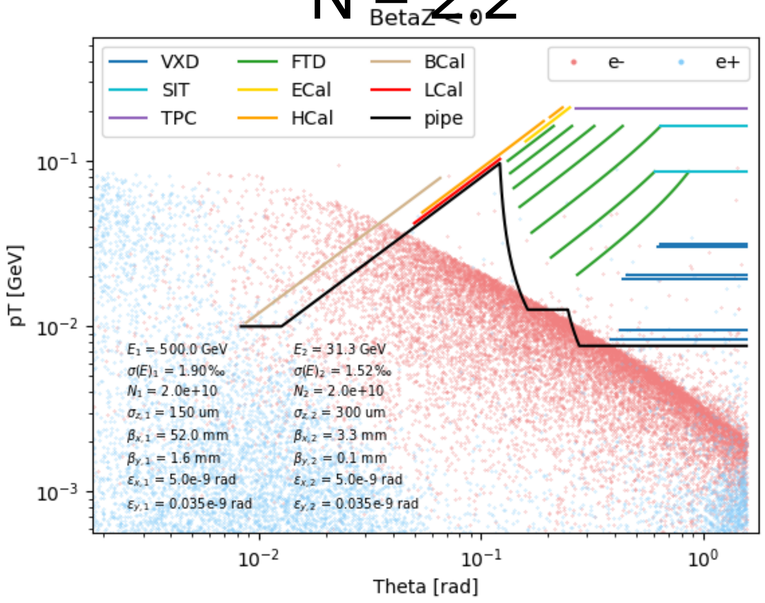






A few new results, sigma_z = 150:300

N = 2:2



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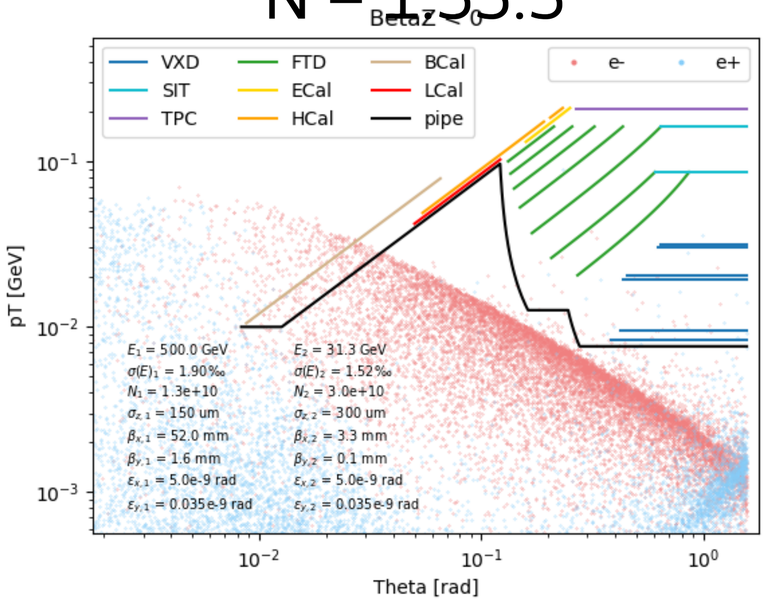

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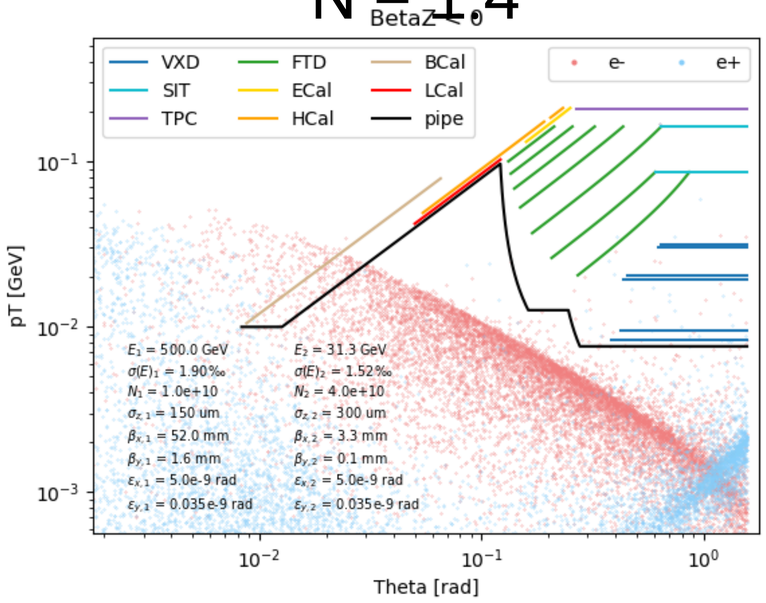
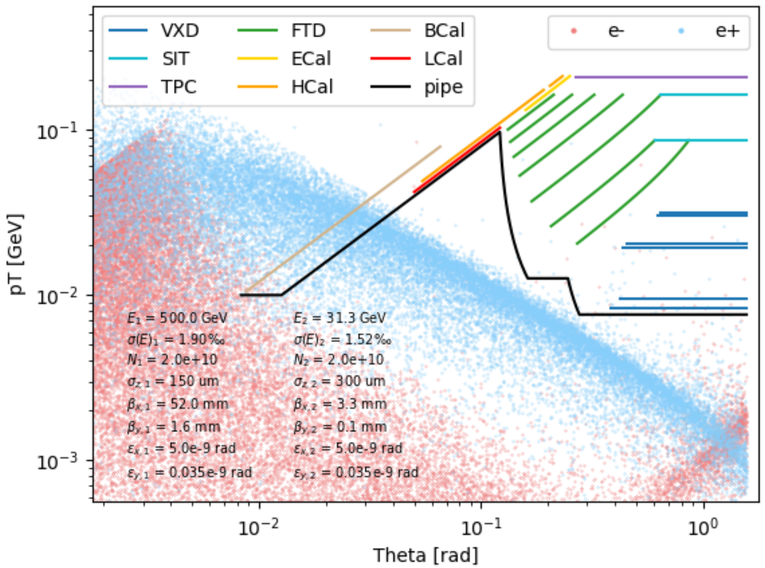
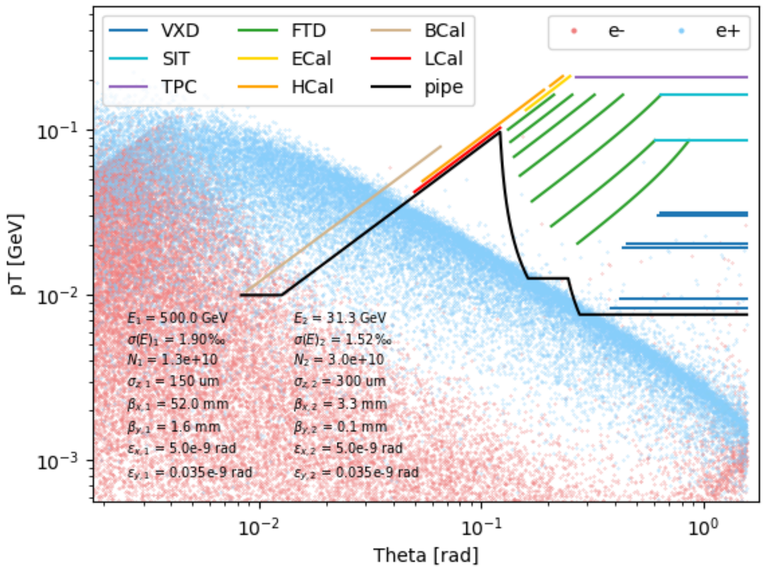
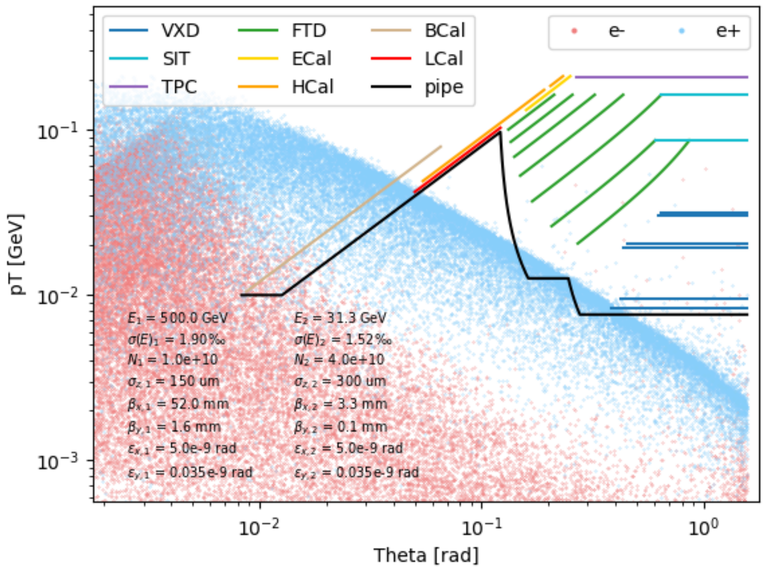


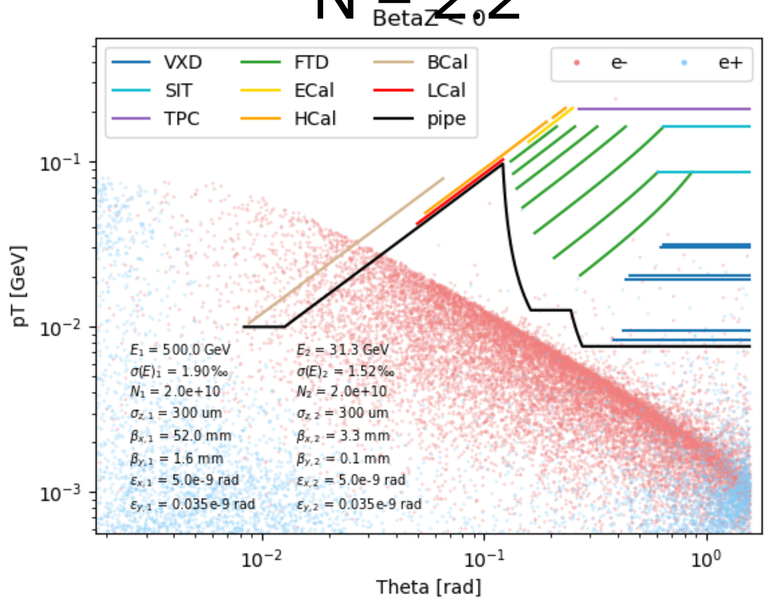




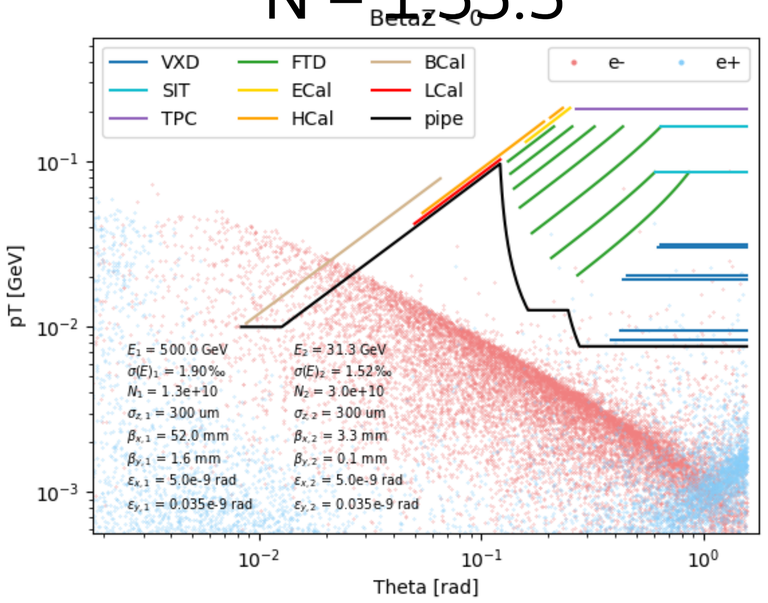


A few new results, sigma_z = 300:300

N = 2:2



N = 1.33:3



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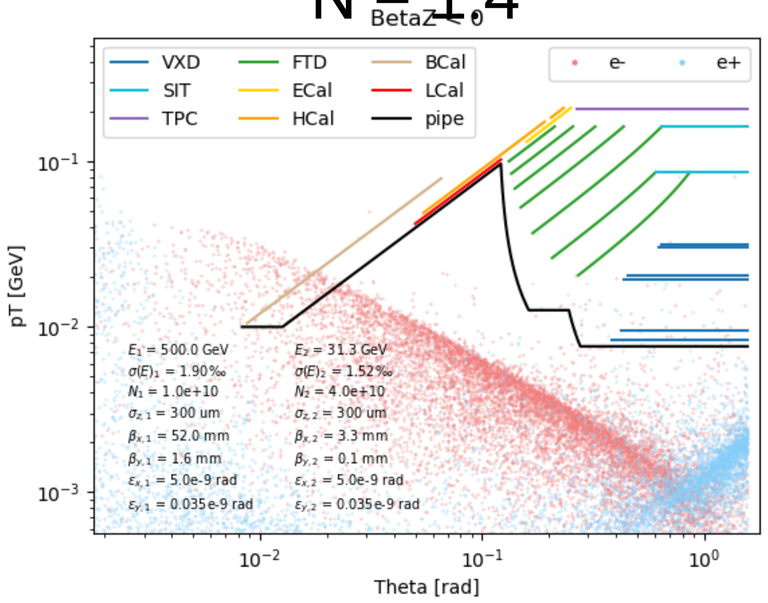
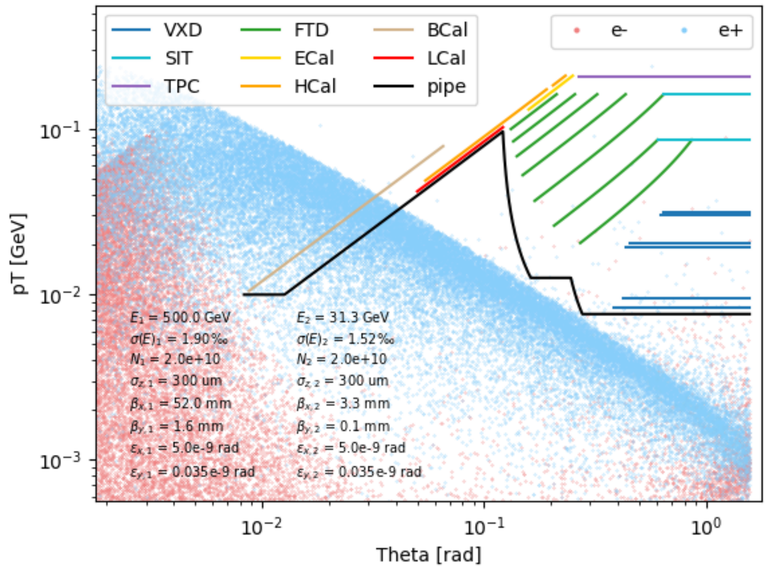
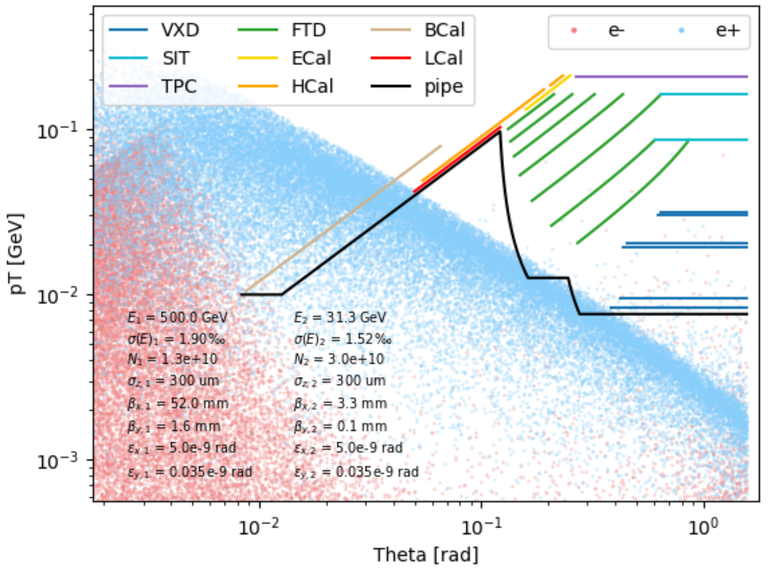
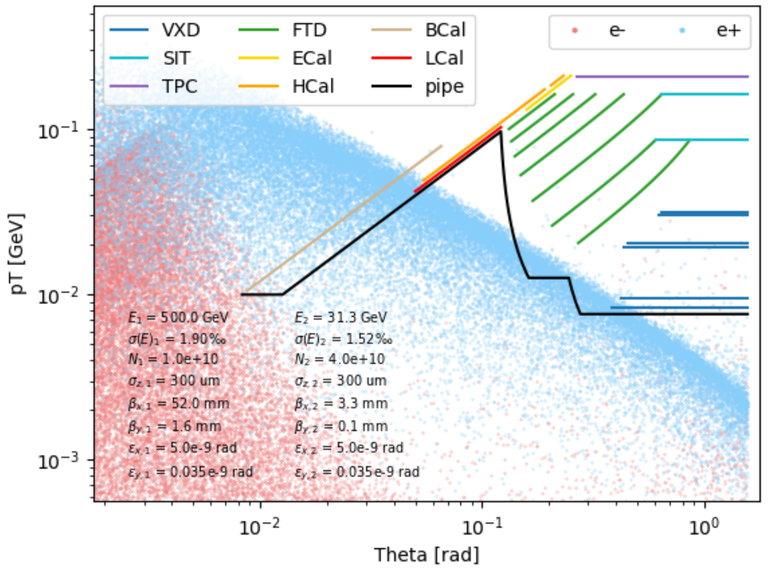




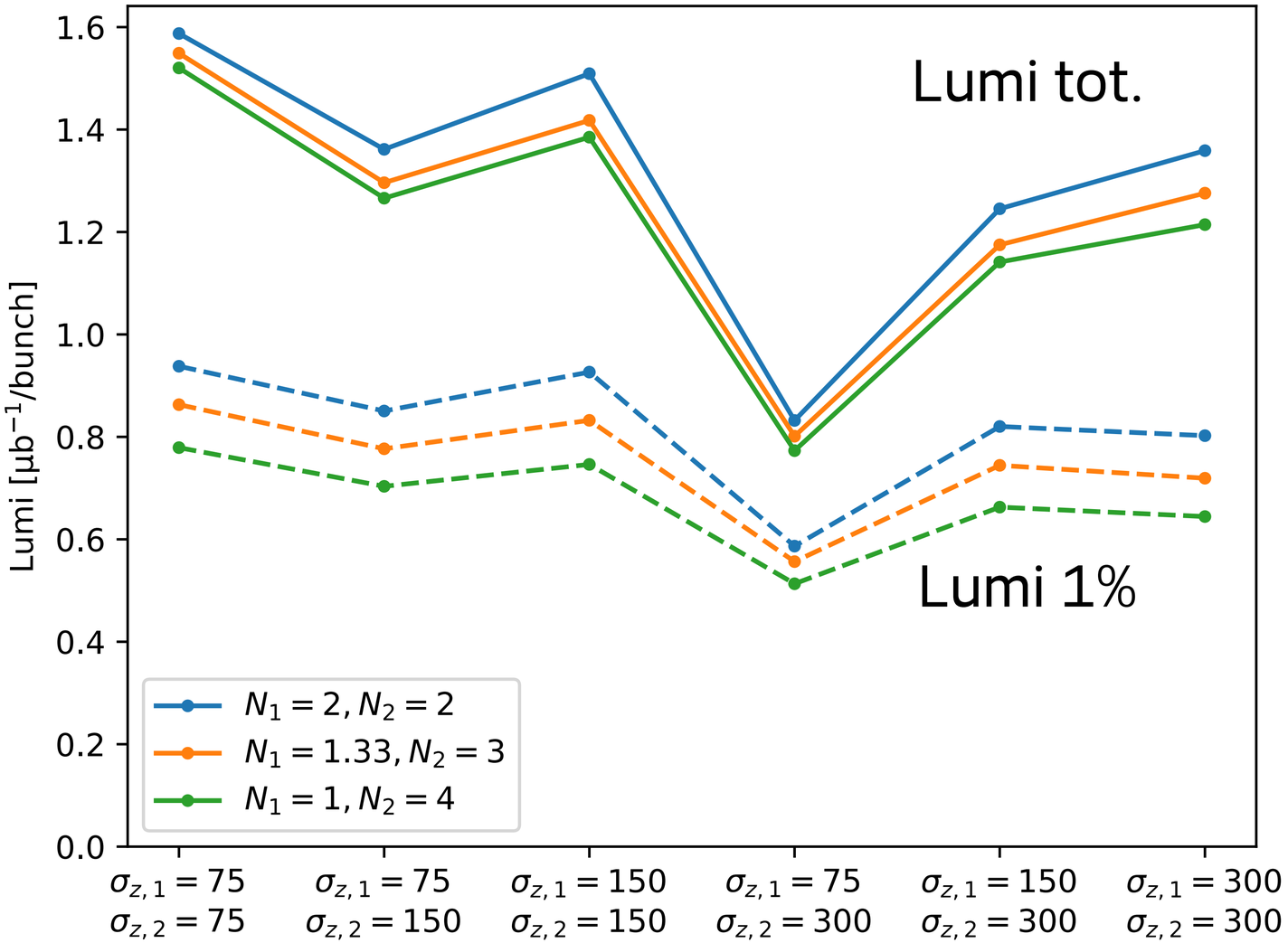


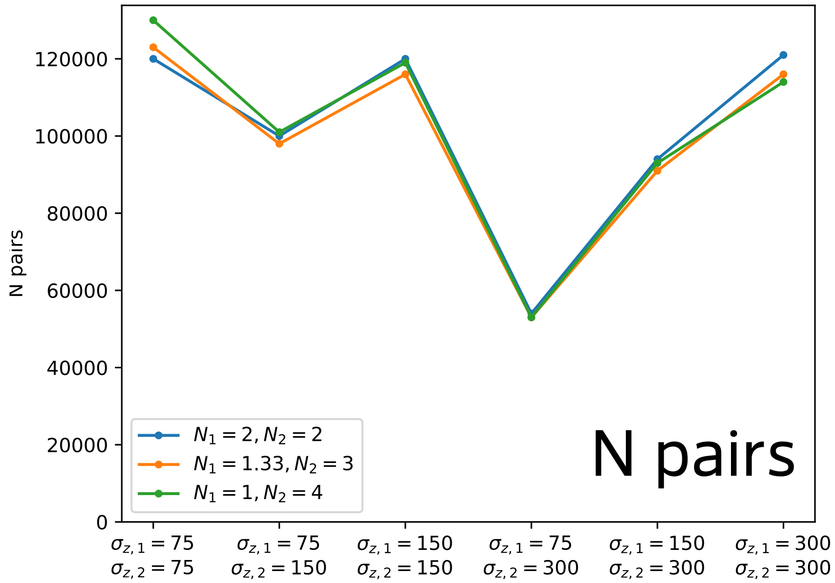


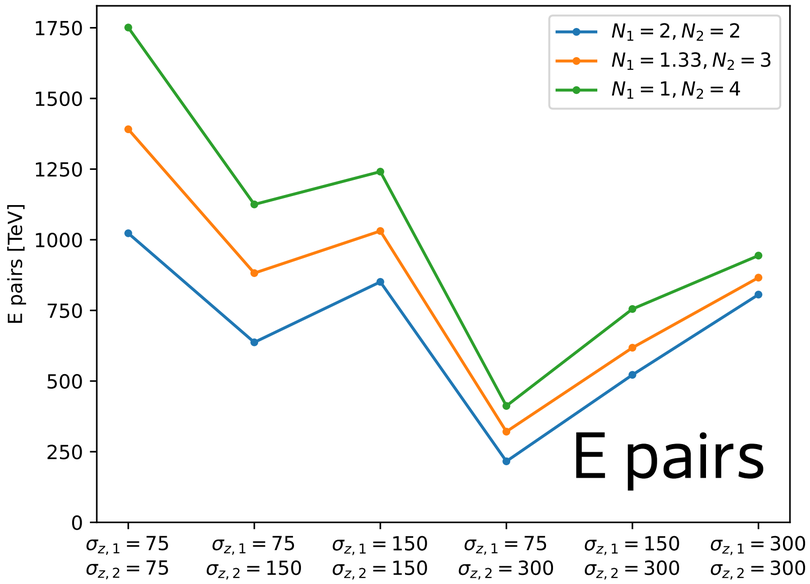
Luminosity / pairs values

	GP				GP++			
	Lumi [μb^{-1} / bunch]	Lumi 1% [μb^{-1} / bunch]	N pairs [x1000]	E pairs [TeV]	Lumi [μb^{-1} / bunch]	Lumi 1% [μb^{-1} / bunch]	N pairs [x1000]	E pairs [TeV]
HALHF scenario 2: N 2, σ_z 300, εx = 10	0.77095	0.62045	49	196	0.75698	0.61642	48	178
N 2:2, σ_z 75:75	1.5875	0.93791	120	1023	1.54117	0.9255	115	960
N 2:2, σ_z 75:150	1.36139	0.85053	100	637	0.2286	0.13721	18	34
N 2:2, σ_z 150:150	1.50915	0.92649	120	851	1.47433	0.9337	115	815
N 2:2, σ_z 75:300	0.83205	0.58673	54	216	0.256	0.18426	20	30
N 2:2, σ_z 150:300	1.24537	0.82031	94	522	0.17112	0.11453	13	19
N 2:2, σ_z 300:300	1.35881	0.80237	121	806	1.32259	0.81671	116	723
N 1.33:3, σ_z 75:75	1.549	0.8629	123	1391	1.50989	0.85562	120	1332
N 1.33:3, σ_z 75:150	1.29624	0.77677	98	882	0.24787	0.15637	19	49
N 1.33:3, σ_z 150:150	1.41796	0.8323	116	1031	1.39401	0.83957	113	984
N 1.33:3, σ_z 75:300	0.80132	0.55647	53	321	0.30116	0.21815	23	42
N 1.33:3, σ_z 150:300	1.17498	0.74441	91	618	0.17259	0.11984	12	25
N 1.33:3, σ_z 300:300	1.27581	0.71929	116	866	1.24249	0.7275	110	800
N 1:4, σ_z 75:75	1.5203	0.779	130	1751	1.48253	0.77521	126	1697
N 1:4, σ_z 75:150	1.26602	0.70345	101	1125	0.25484	0.16007	19	63
N 1:4, σ_z 150:150	1.38511	0.74623	119	1241	1.36185	0.75384	117	1168
N 1:4, σ_z 75:300	0.77312	0.51326	53	412	0.323	0.22523	25	64
N 1:4, σ_z 150:300	1.14136	0.66283	93	755	0.17113	0.11932	12	26
N 1:4, σ_z 300:300	1.21442	0.64445	114	944	1.18707	0.6518	109	867

Luminosity / pairs values: visual style







Conclusions

- GuineaPig++ sometimes has particles going “outside the grid” (in red on the previous slide),
  - clearly indicated in the log file
  - anyway messes up the rest of the computation (luminosity and pairs)
- **When it runs fine, results are consistent with the C-version**.

- Reminder: **asymmetric N** with inversely asymmetric E (e-:e+ = 500:31.3 GeV)
  - **improves energy efficiency** (N e-:e+ = 2:2 → 2.13 * ILC power | 1:4 → 1.25 * ILC power)
  - **but decreases luminosity**…

- **Longer bunches** (sigma_z):
  - **decrease luminosity** (luminosity at peak energy is less impacted though),
  - but also have a **lesser impact the inner detector region**.

- **Asymmetric bunch lengths** only shift the problem towards one side of the detector
- and can have a **large negative impact on the luminosity**.