Elastic Neural Net for standalone RICH ring finding

Sergey Gorbunov

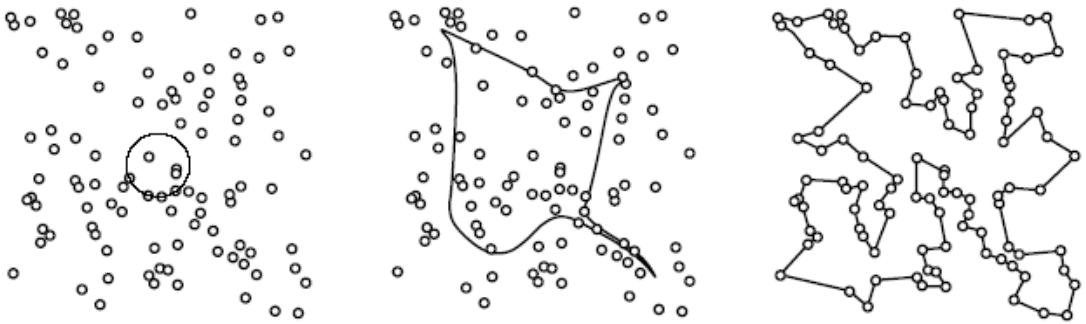
DESY, Zeuthen

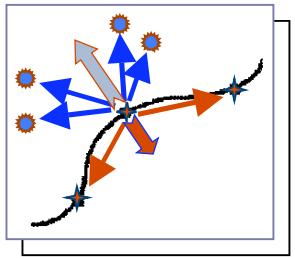
Ivan Kisel

KIP, Uni-Heidelberg

ACAT 2005, DESY, Zeuthen
May 22-27, 2005

EN – Traveling Salesman Problem





$$E(s_{ia},\vec{y}_a) = \sum_{ia} s_{ia}\cdot|\vec{x}_i-\vec{y}_a|^2 + \gamma\cdot\sum_{a}|\vec{y}_a-\vec{y}_{a+1}|^2$$

$$\Delta\vec{y}_a = \eta\left[2\sum_{i} v_{ia}\cdot(\vec{x}_i-\vec{y}_a) + \gamma\cdot(\vec{y}_{a+1}-2\vec{y}_a+\vec{y}_{a-1})\right]$$

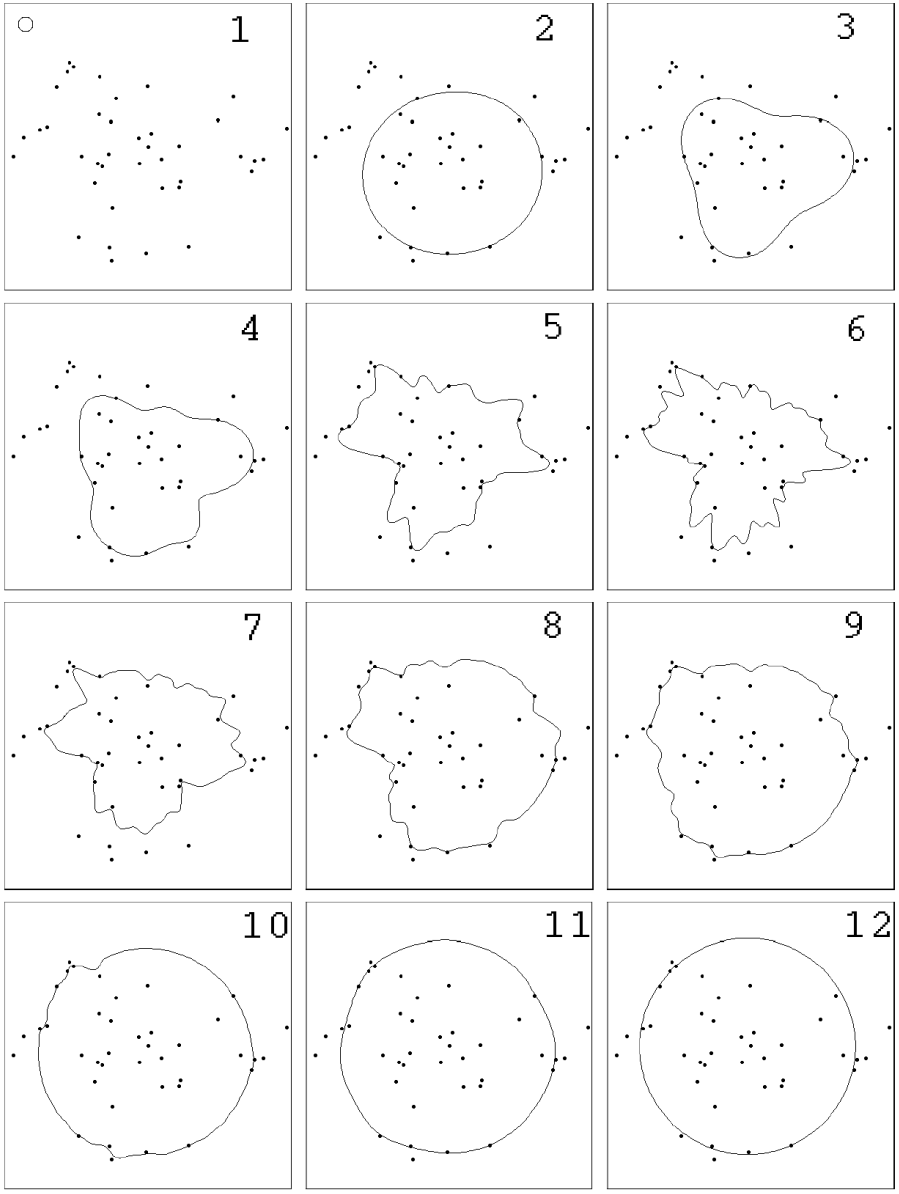
Discrete EN

File name	Number of cities	Extra path (%)	Time, ms	Time per city, μs
berlin52	52	0.00	0.98	19
st70	70	4.27	1.27	18
kroA100	100	3.03	1.46	15
lin105	105	0.78	1.84	18
ch130	130	5.59	2.56	20
tsp225	225	5.34	4.36	19
pcb442	442	8.37	12.35	28
pr1002	1002	6.12	24.94	25
pr2392	2392	8.42	58.53	24

(*) Pentium IV/2.4 GHz

Nature, 326 (1987) 689

EN – Ring Search : Idea



Features:

- External forces - minimizing distances
- Internal forces - constraint on Fourier coefficients

CHEP'01, Beijing (2001) 162

EN – Ring Search : Implementation

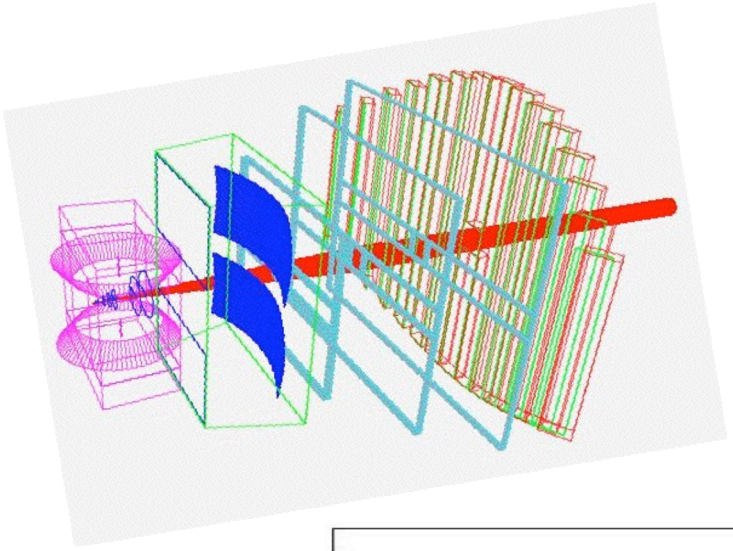
Scheme:

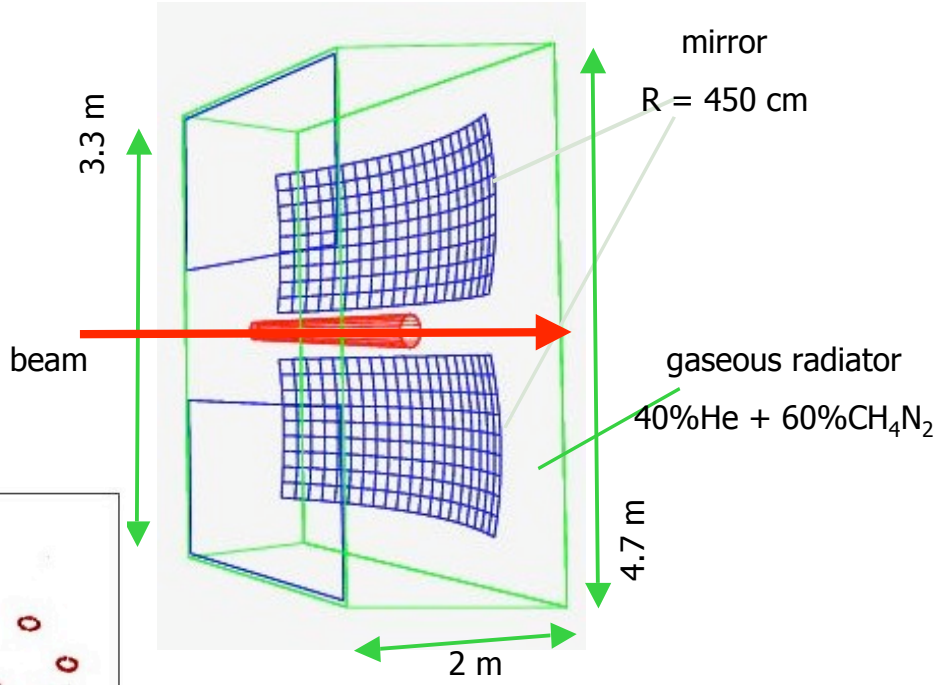
- Loop over hits
- Finding a ring in a local area around the hit
- Sorting of the found rings

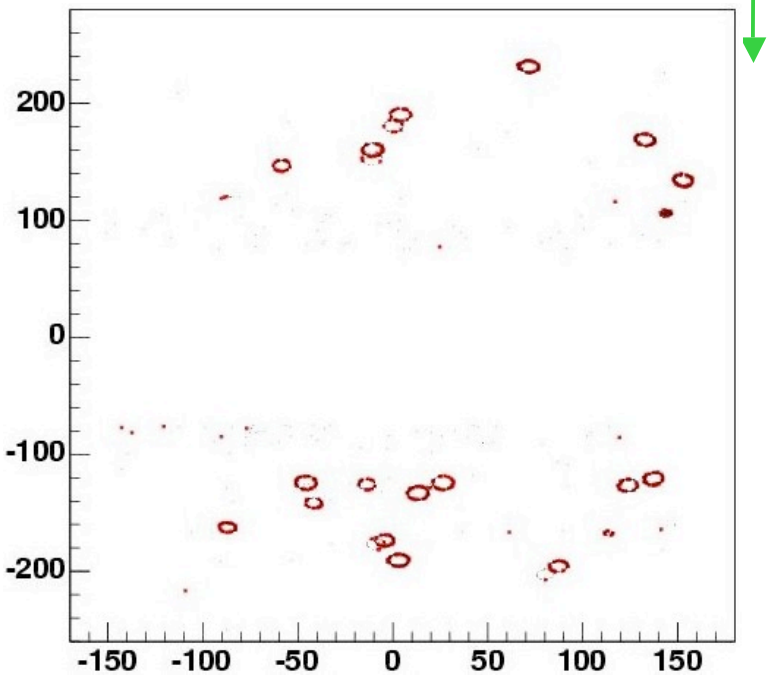
Details:

- No internal forces - fixed ring shape (circle)
- External forces - minimize distances
- Discrete ring evolution - direct finding of the minimum in 2-3 iterations
- Time ~ total number of hits

RICH Detector in the CBM Experiment at GSI







1 central Au+Au collision, 25 AGeV (UrQMD)

38 rings/event

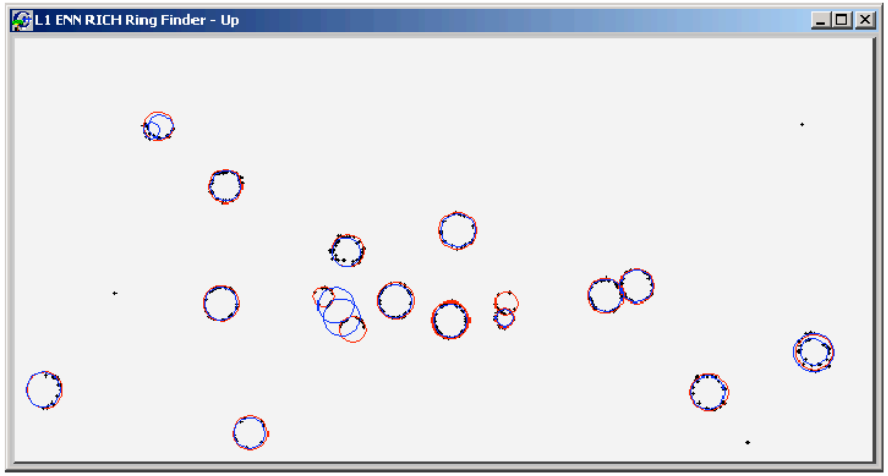
33 electrons

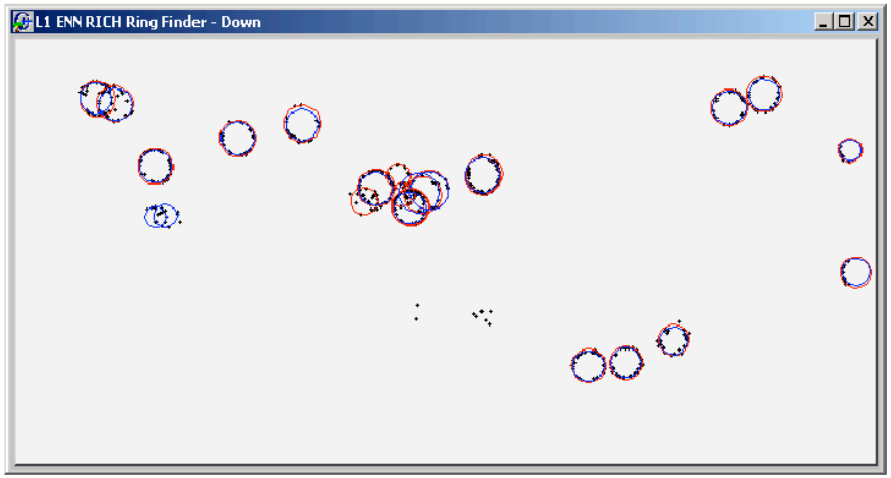
5 pions

12.6 e from primary vertex

5 □ from primary vertex

EN – Performance





All set: N hits ≥ 5
Ref set: N hits ≥ 15
Extra set: 5 ≤ N hits < 15
Reconstructed: ≥ 70% hits from the same MC
Clone: MC reconstructed few times
Ghost: < 70% hits from the same MC

Rings set	Performance (%)	Number of rings
Reference set efficiency	92.21	1425
All set efficiency	80.52	4179
Extra set efficiency	74.47	2754
Clone rate	3.26	142
Ghost rate	14.98	652
Found MC rings/event	33	
Time/event (ms)	1.07	

Conclusion

- **Efficient** ring finder based on the elastic net
- **Standalone** – no track guidance necessary
- **Simple** – suitable for hardware implementation
- **Fast** – can be used for triggering