

# CHIMERA AT GSI ?????

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**EXL/R3B meeting**

**Milano-3:6 October 2006**



**\* For the CHIMERA collaboration**

## **Outlook:**

**-Introduction :PRESENT STATUS**

**(Physics Case, Few about the detector, Selected Example of Physical analysis)**

**-Basic Idea LAND-CHIMERA (FUTURE )**

**-Time schedule (proposed)**

**(FERMI ENERGY)**

**-Phase Transition - Multifragmentation**

**-Dynamical Instability**

**- EOS (es: A4) (LOW DENSITY REGION)**

**WHY++**

The word 'WHY++' is written in large, bold, orange letters. From the bottom-left corner of the 'Y', a black arrow points horizontally to the left towards the text '-Phase Transition - Multifragmentation'. Another black arrow points diagonally down and to the left towards the text '- EOS (es: A4) (LOW DENSITY REGION)'.

**In a next future, Beams having N/Z far from stability (RIB) will be abundantly available**

**This opportunity will allow to study important physics that is strongly dependent on the isospin degree of freedom(\*)**

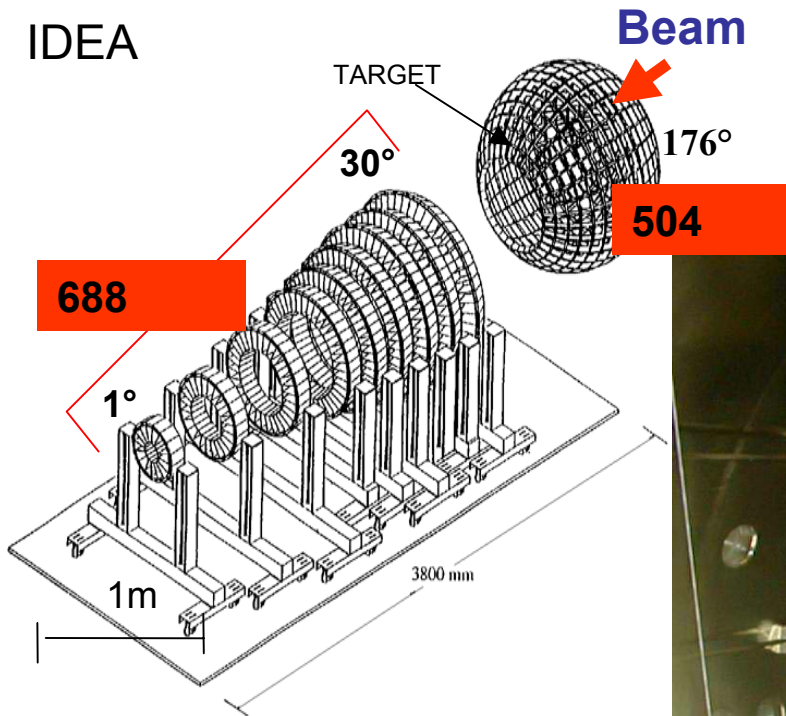
(\*) - Isospin Physics in Heavy Ion Collisions at Intermediate Energies, Ed. by Bao An Li and W. Udo Schröder, ISBN 1-56072-888-4, Nova Science Publ. Inc., New York (2001)

- P.Chomaz, C.R. Physique 4(2003)

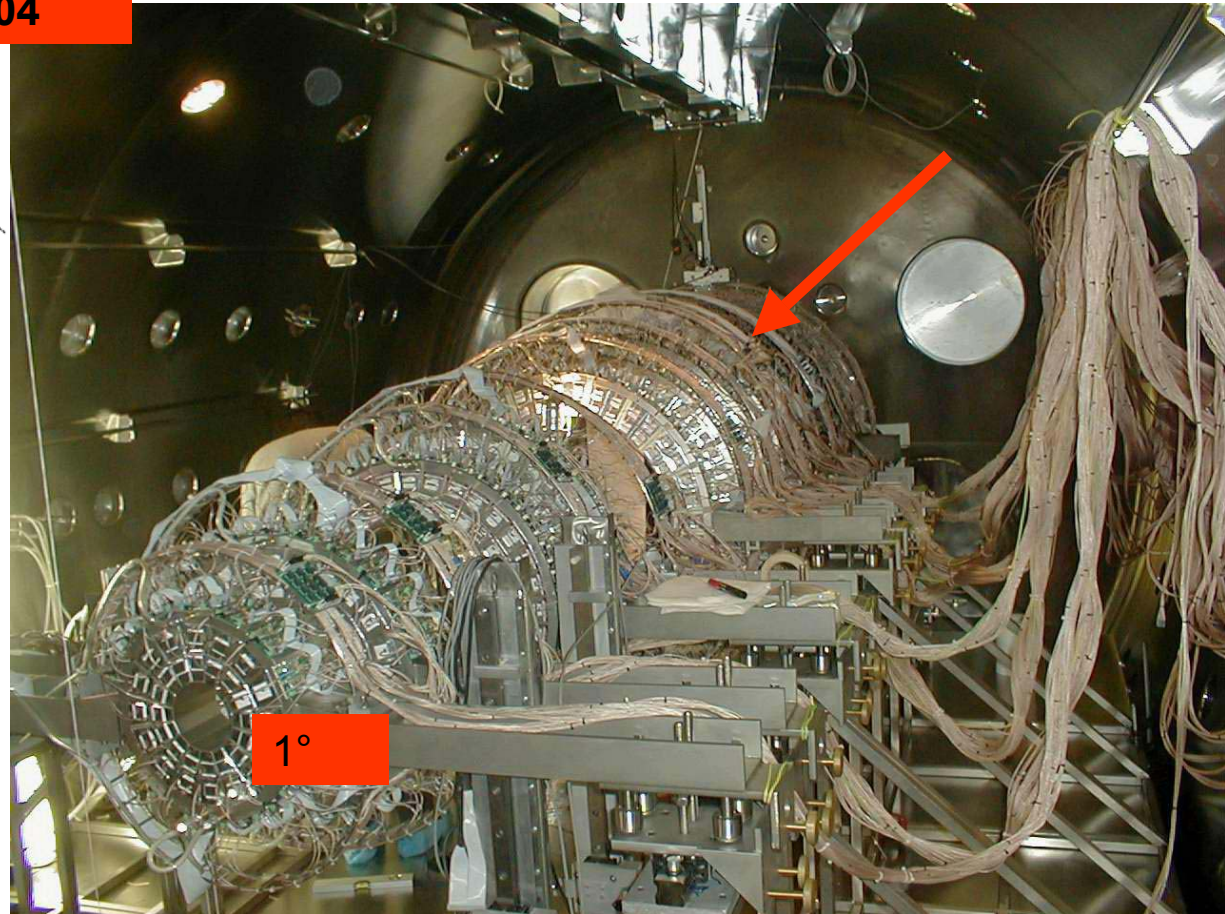
(\*\*) Proc. Of the IWM2005, Conf . Proc. SIF, Vol 91, 2006 Catania 28 nov.1  
Dic, 2005

# The CHIMERA detector at LNS in Catania

IDEA



2003 CHIMERA-1192 Si-CsI(Tl) telescopes



UNIQUE DEVICE FOR:

- Granularity (1192 mod.)
- Threshold ( ~ 250 A.KeV for H.I.)
- Efficiency ( ~ 95% )

Large scattering chamber

MAGNEX



CATANA

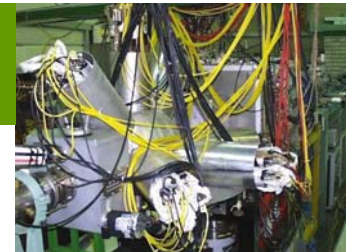


80%

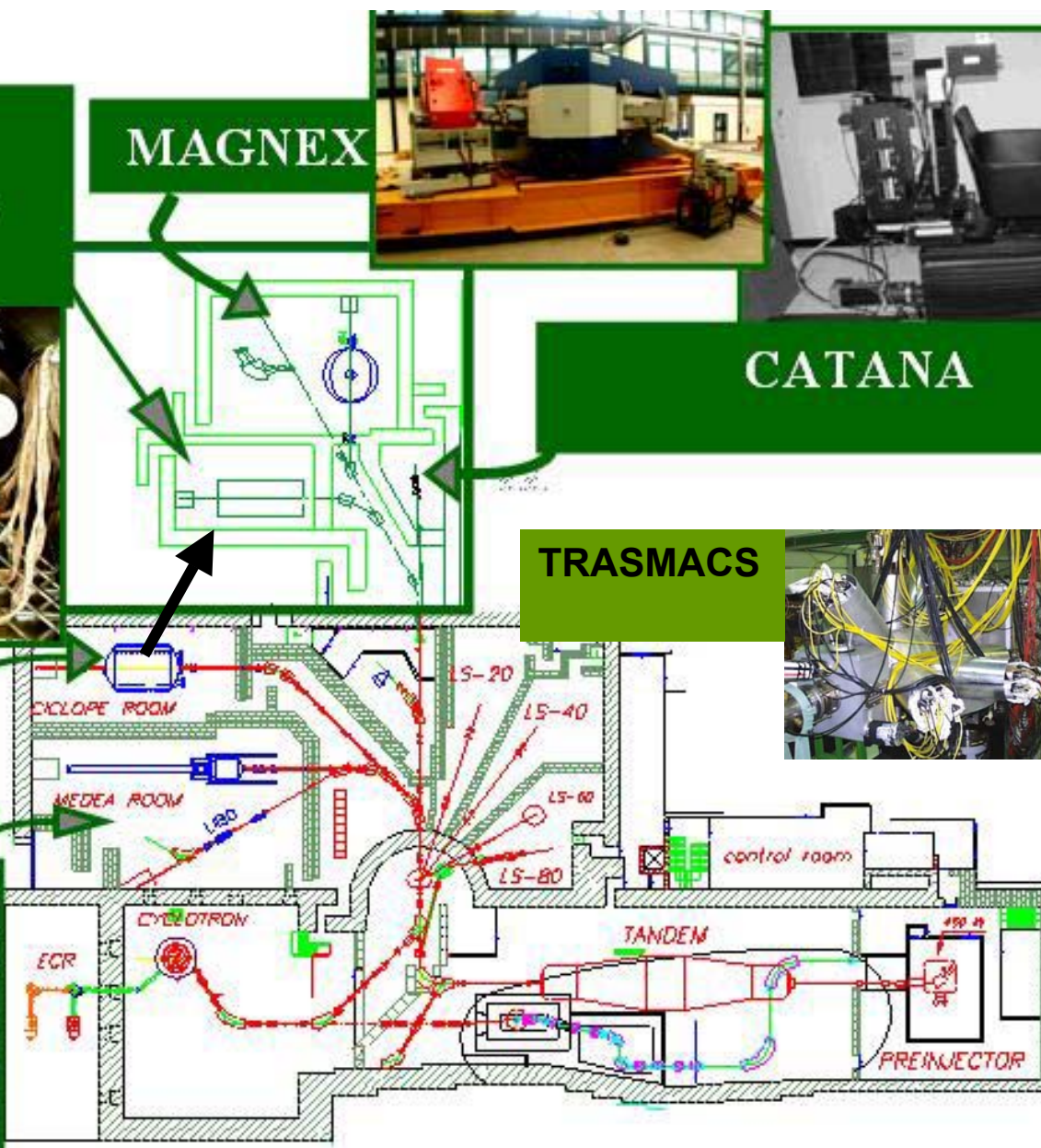
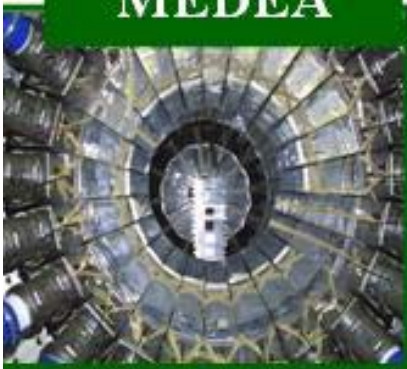


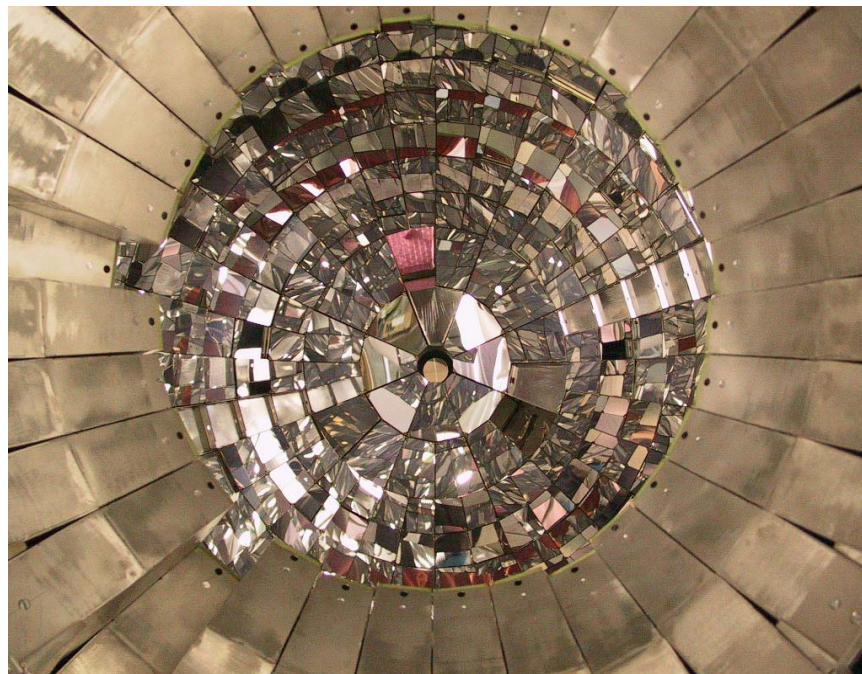
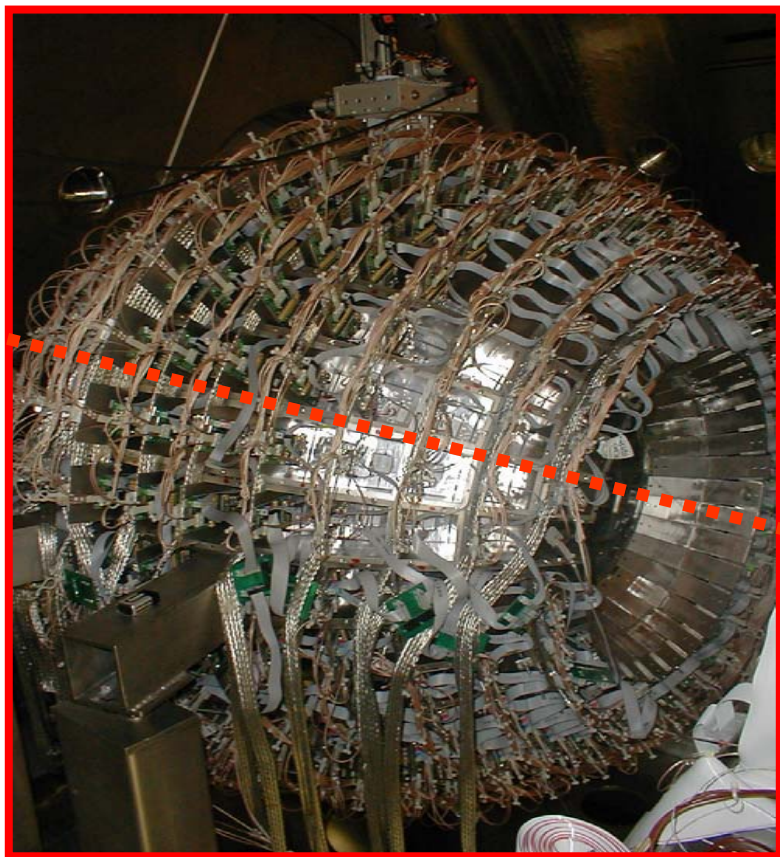
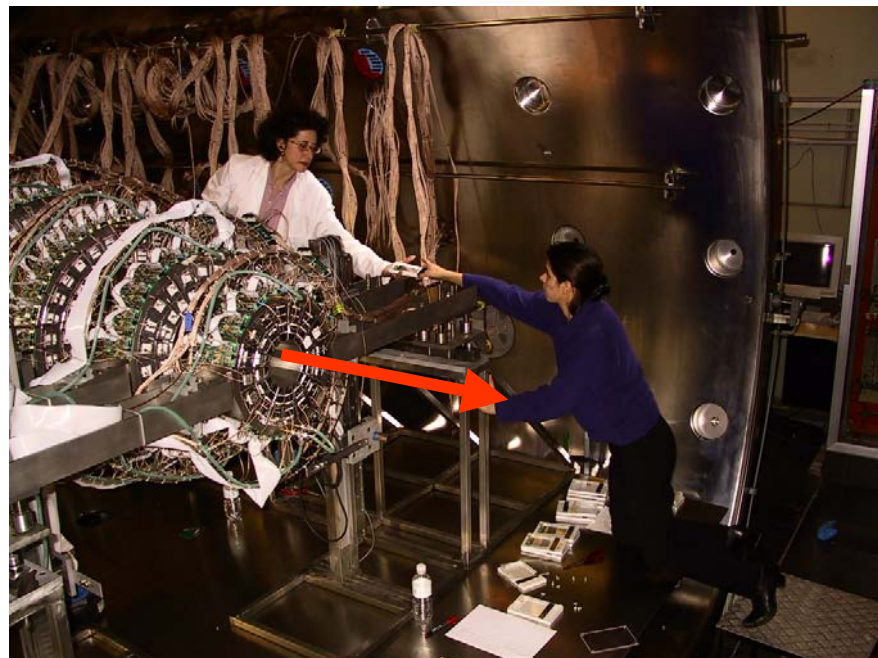
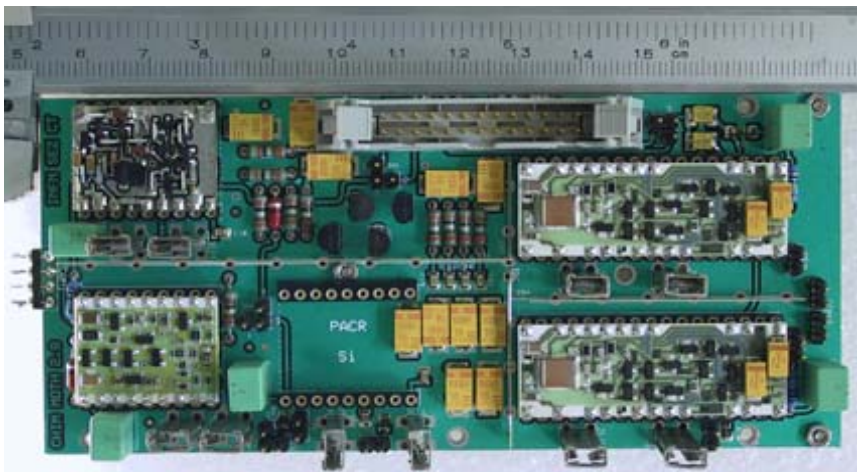
CHIMERA

TRASMACS



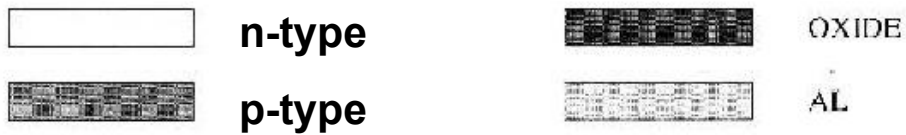
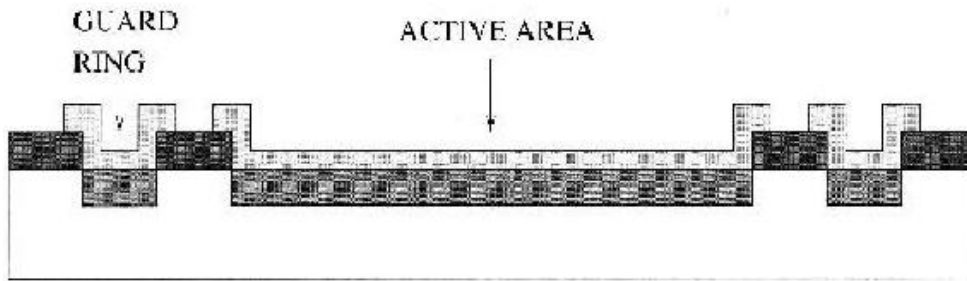
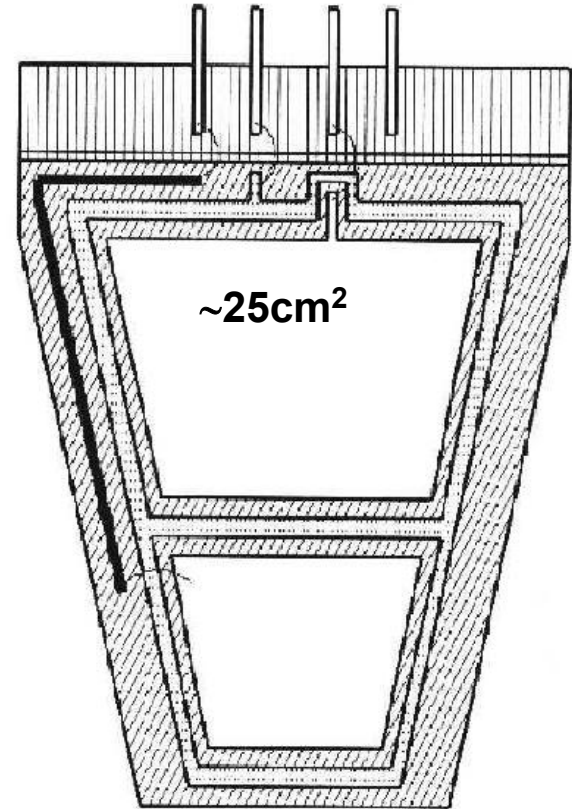
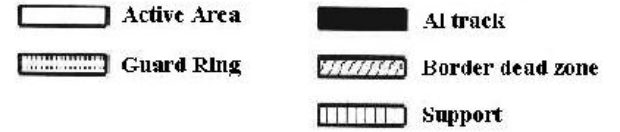
MEDEA



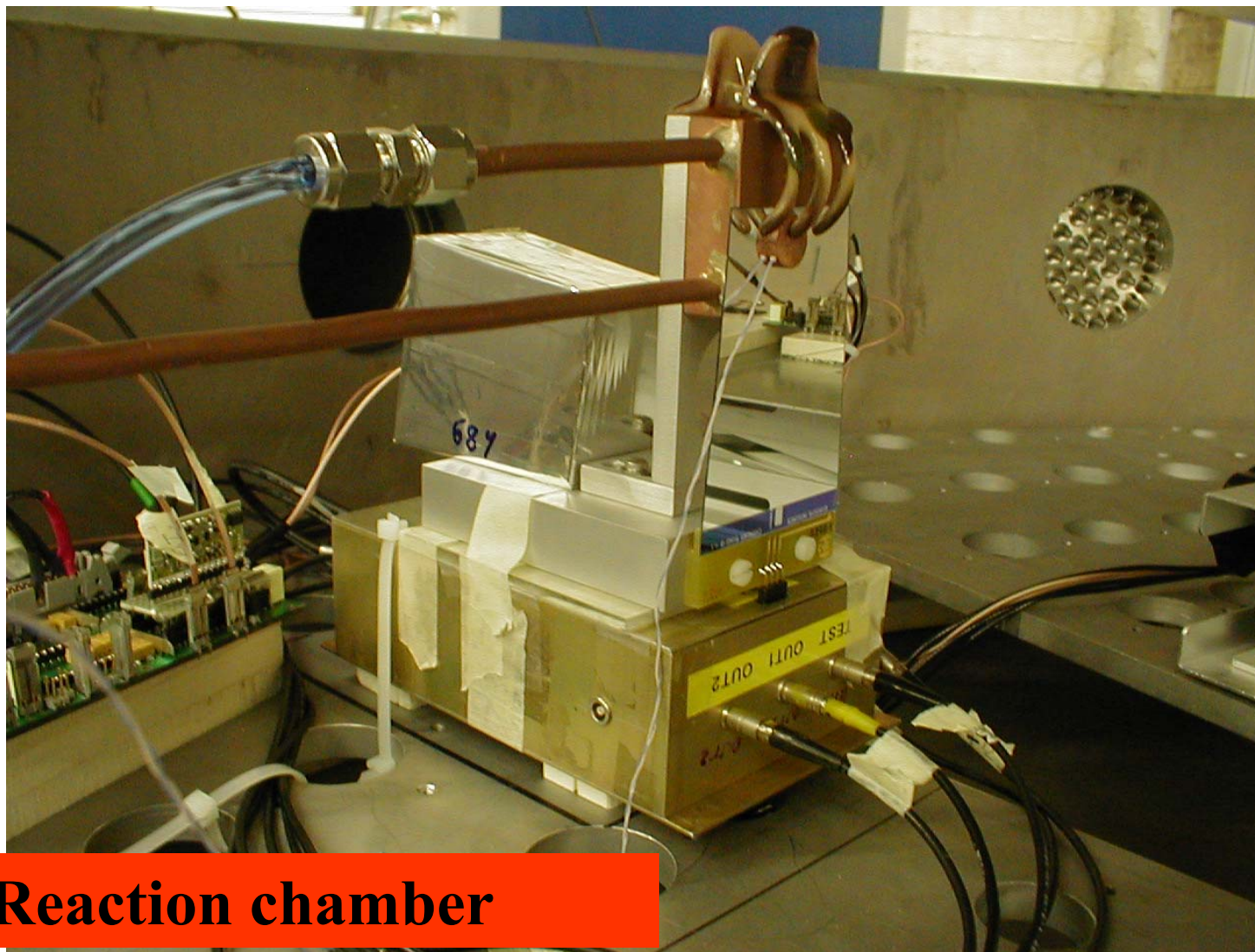




12cm



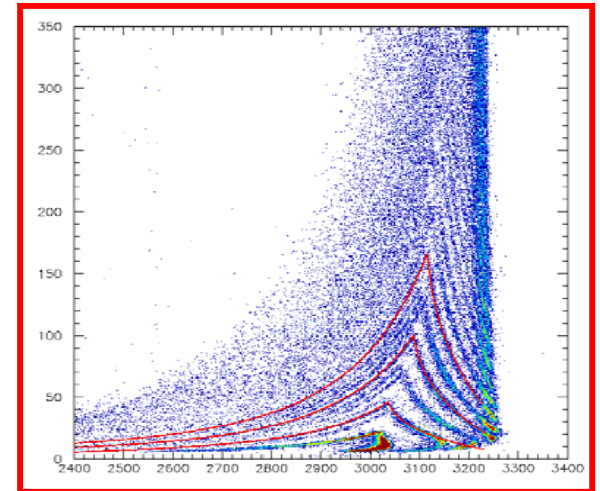
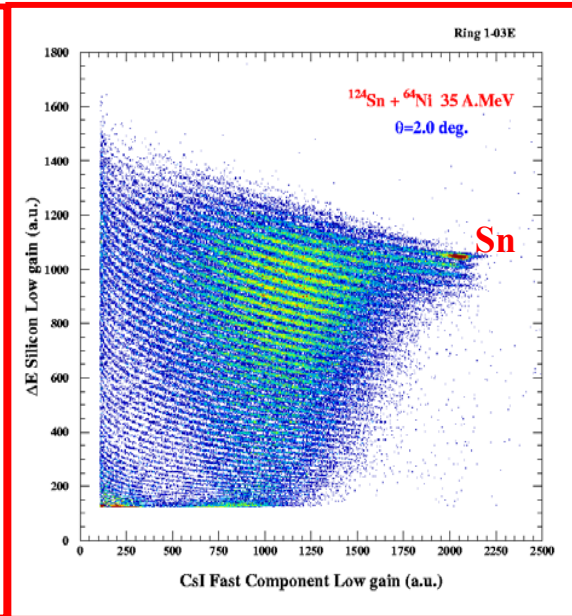
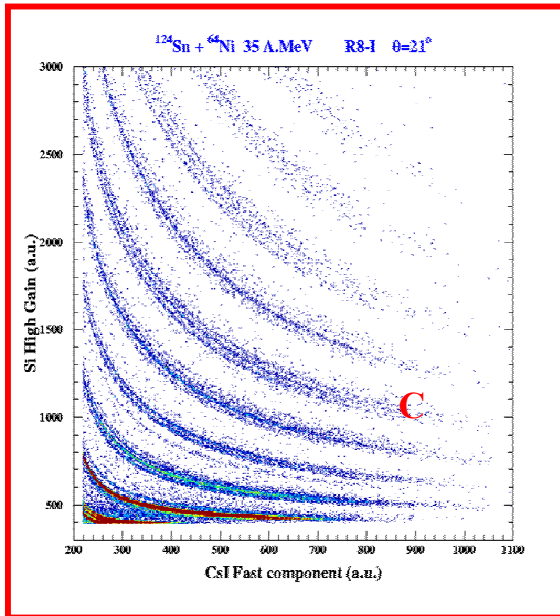
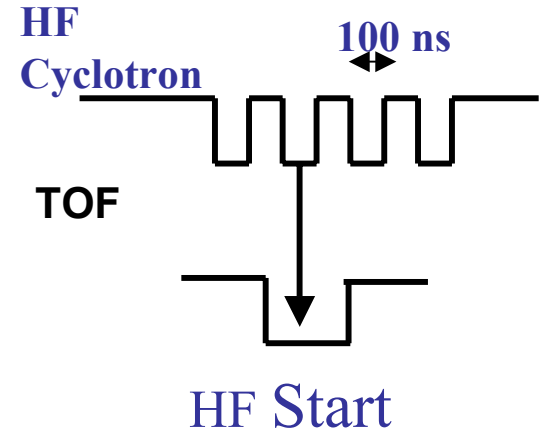
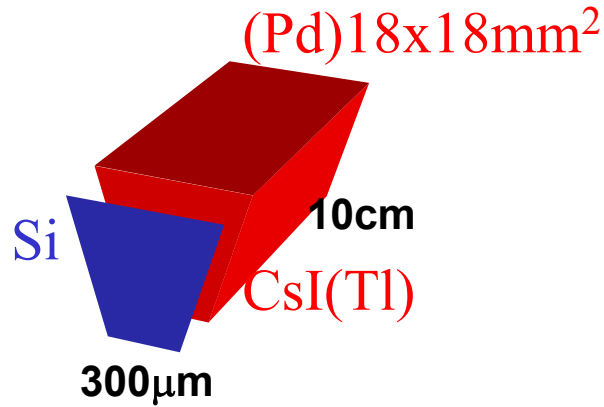
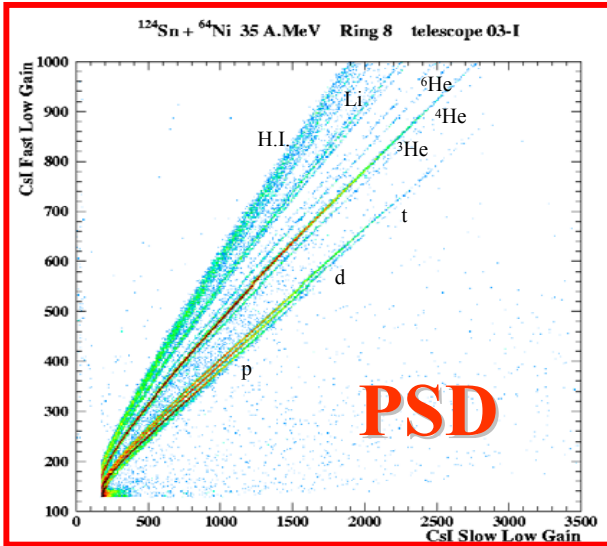
# Tandem Experiment AT -LNS-CATANIA



**2000 Reaction chamber**



# Identification method

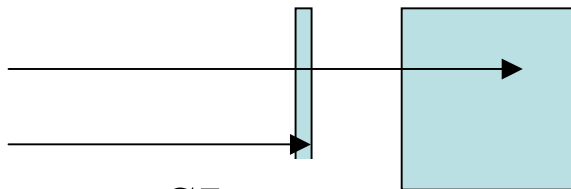
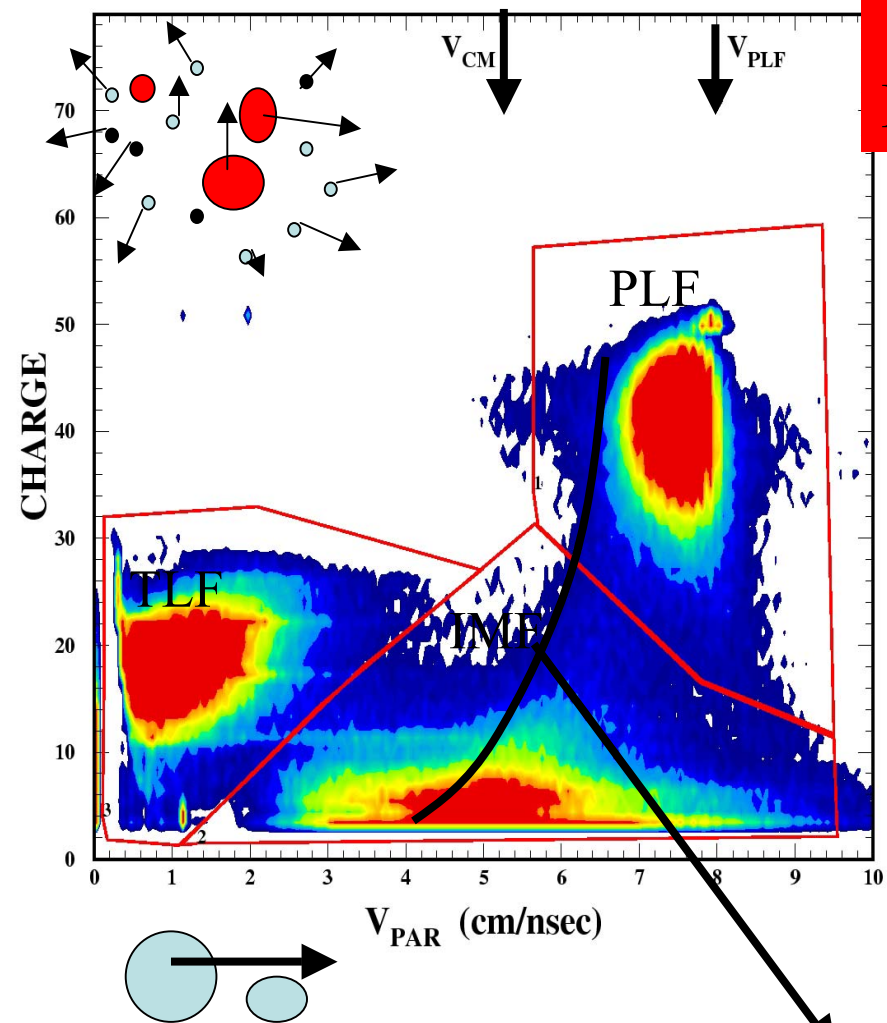


$\Delta E$ -E  $\longrightarrow$  Z,E  $(dE/dx \propto AZ^2/E)$

$\Delta E$ -TOF  $\longrightarrow$  M,E

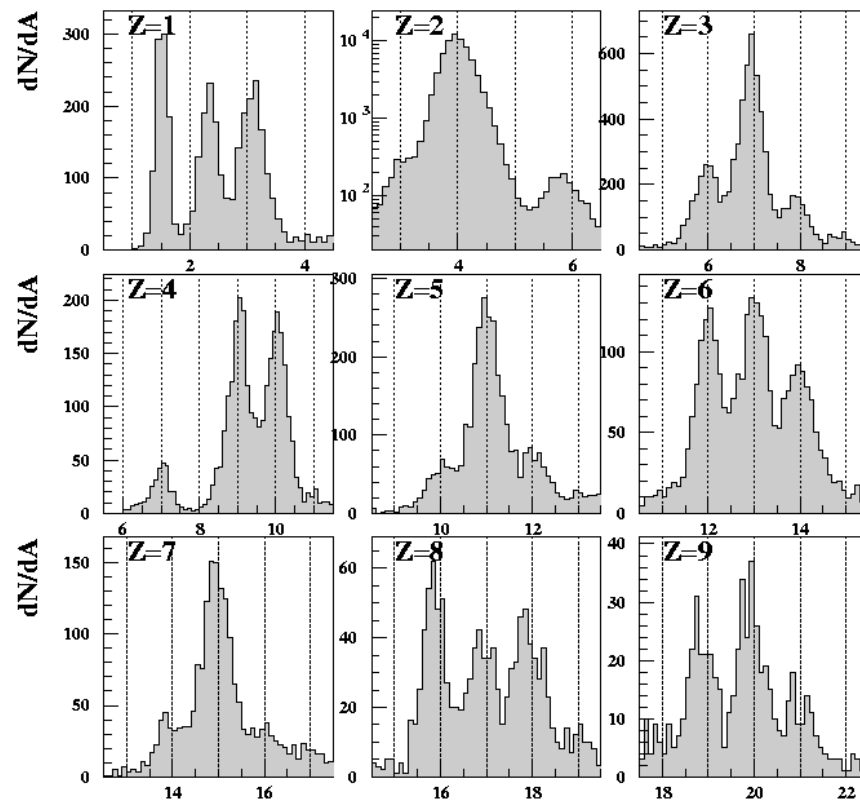
$^{112,124}\text{Sn} + ^{58,64}\text{Ni}$

$E(^{124}\text{Sn}) = 35 \text{ A.MeV}$



SI  
300  $\mu\text{m}$

CsI(Tl)  
10cm

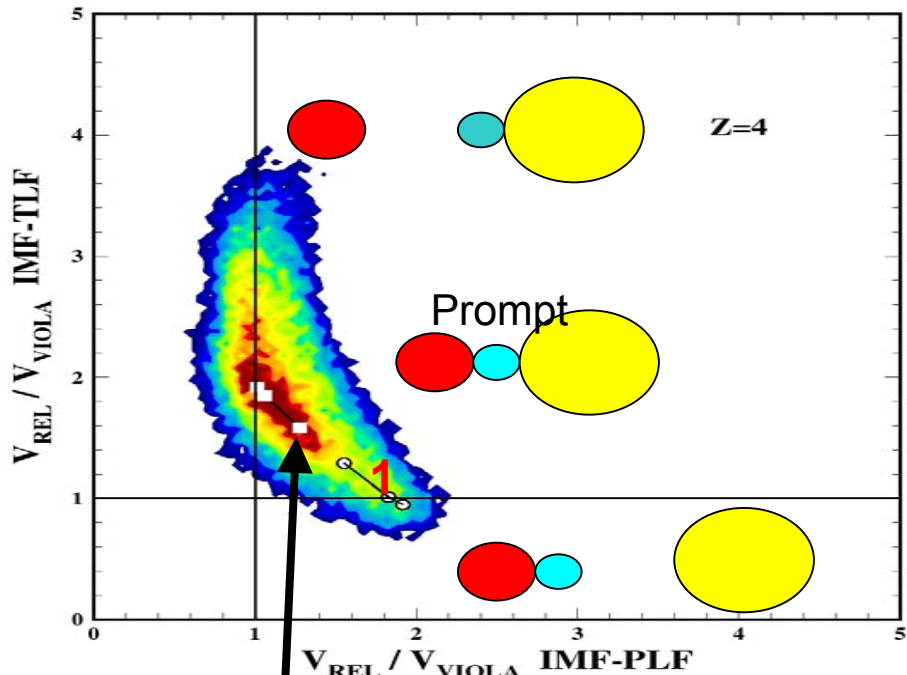
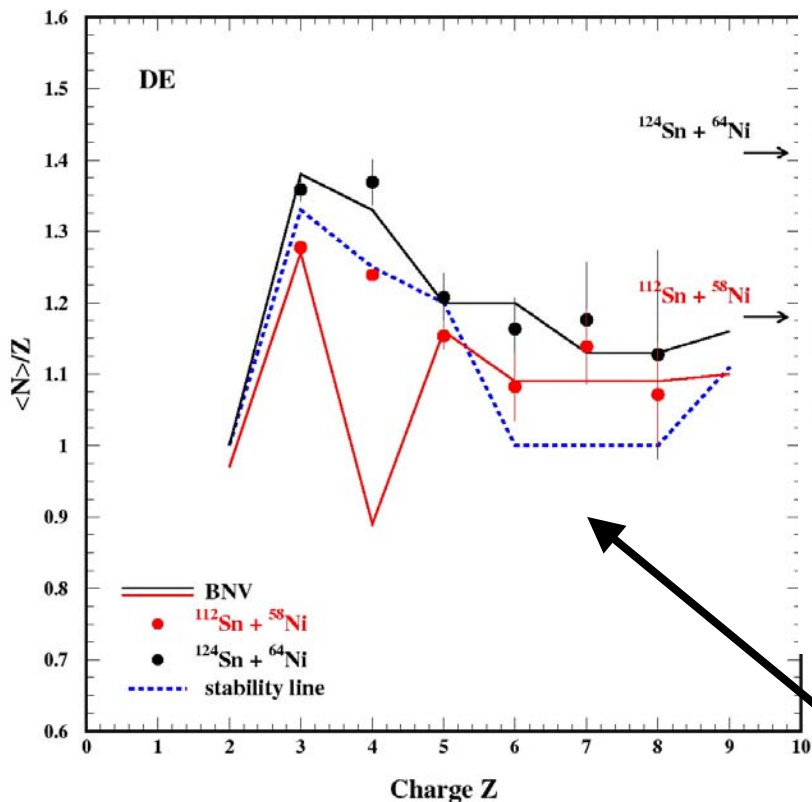


IMF -A,Z

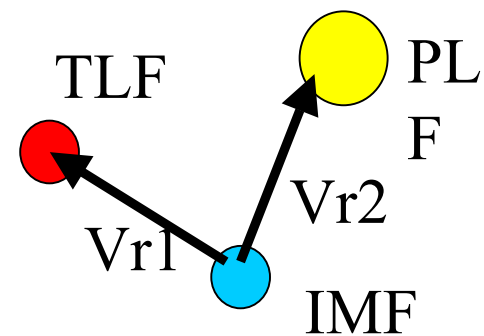
Energy threshold by  $\Delta E-E$

$\sim 10 \text{ MeV/A}$  for  $Z=10$

# Exemple I: $\langle N/Z \rangle$ : Characterization of isotopic ratio for light IMF for both dynamical ( $t < 100\text{fm}$ ) and sequential decay ( $t \gg 1000\text{fm}$ )



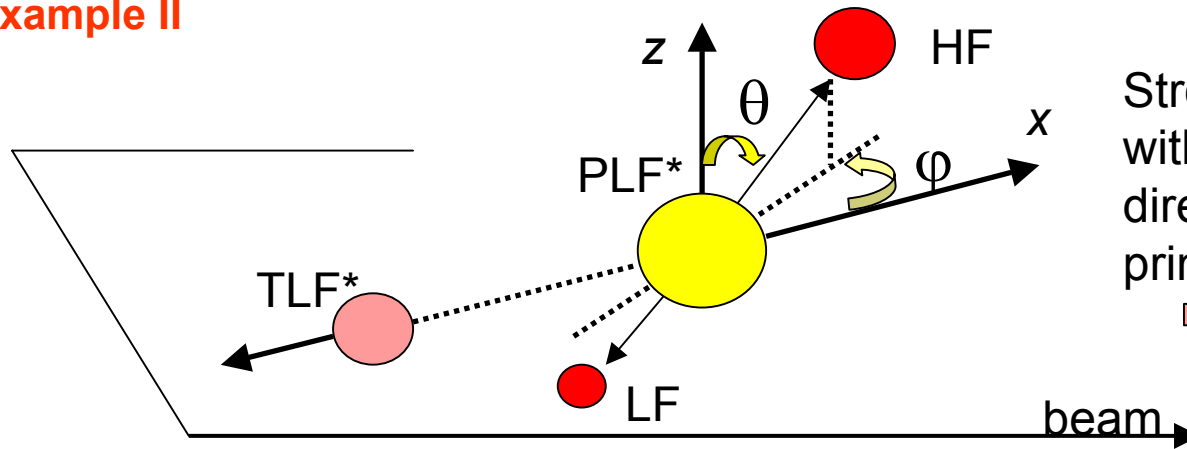
1	40 fm/c
2	80 fm/c
3	120 fm/c



**GOAL:**

**Constraints for Transport model calculations!!!!**

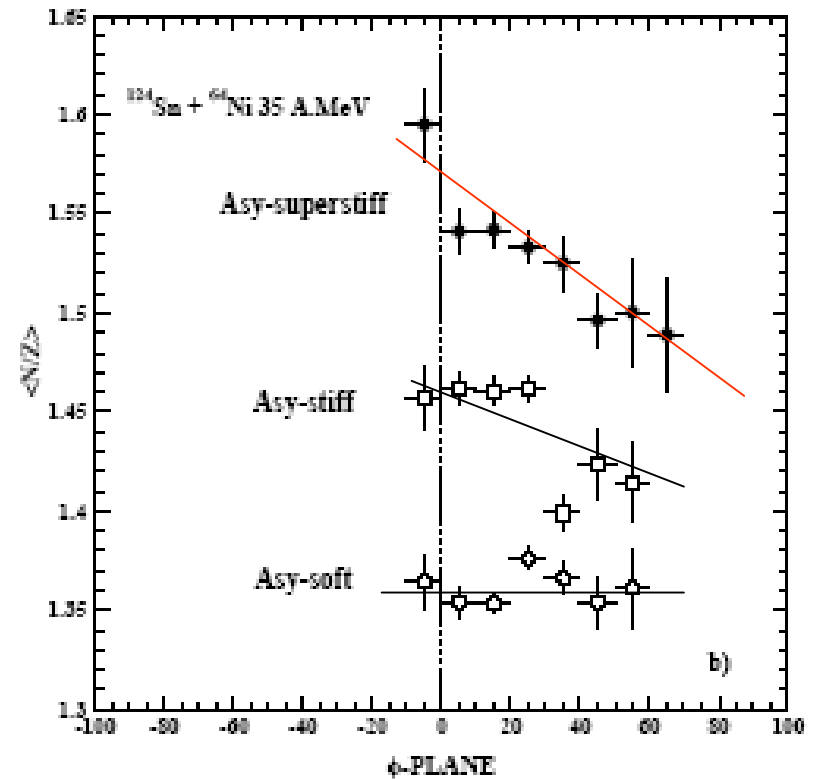
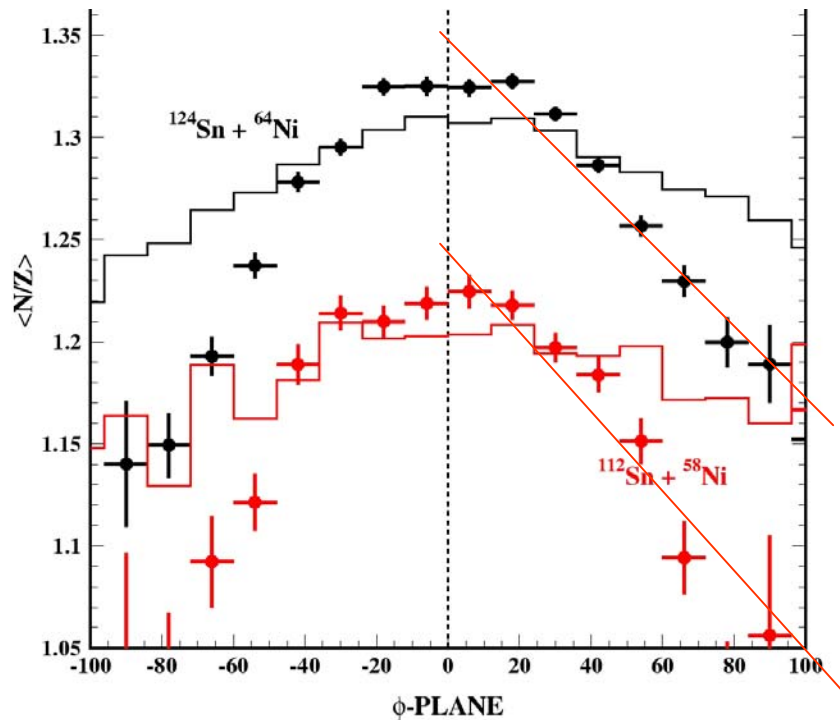
## Example II



Strong alignment with the separation direction of the two primary fragments:

$\phi=0$

## GET INFORMATION ABOUT THE SYMMETRY ENERGY OF EOS AT LOW DENSITY



### Example III: Isoscaling

$$R_{21}(N, Z) = \frac{Y_{124}^{Sn+64 Ni}(N, Z)}{Y_{112}^{Sn+58 Ni}(N, Z)} \approx C \left( \frac{\rho_{n,2}}{\rho_{n,1}} \right)^N \left( \frac{\rho_{p,2}}{\rho_{p,1}} \right)^Z = C \hat{\rho}_n^N \hat{\rho}_p^Z$$

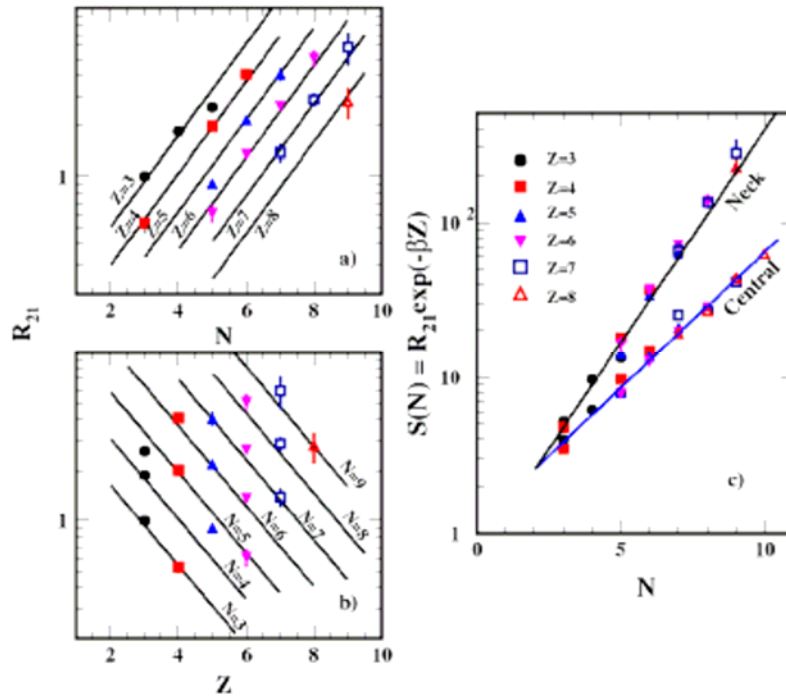
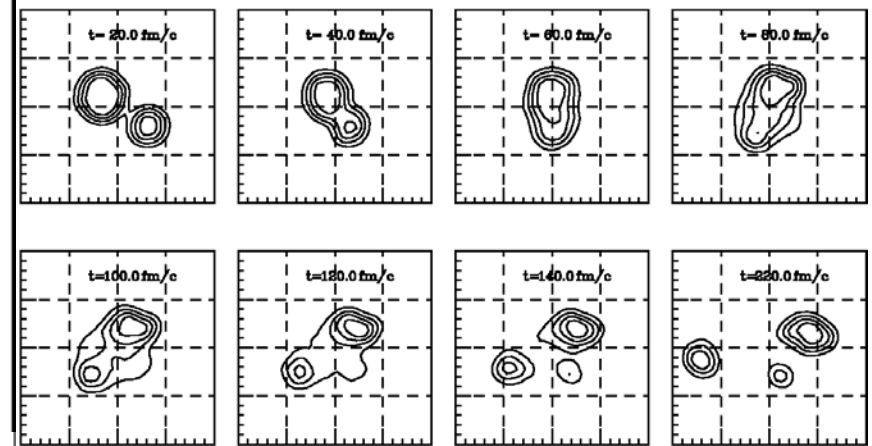
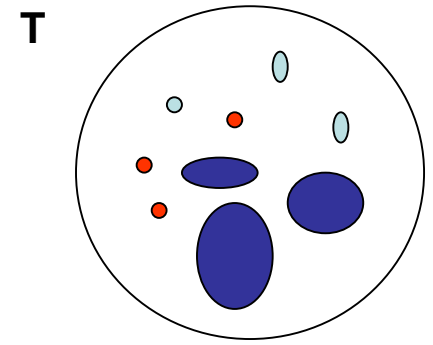


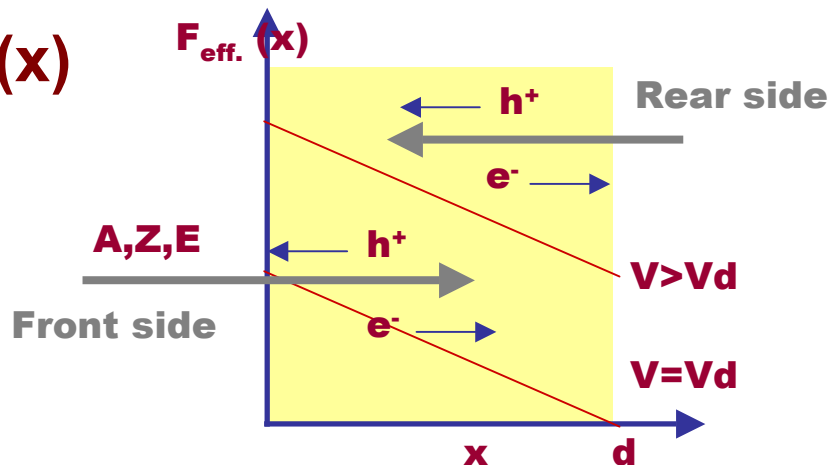
Fig. 2: a) Isotopic ratios  $R_{21}$  as a function of the neutron number of selected IMF; b) Isotopic ratios  $R_{21}$  as a function of the proton number of selected IMFs; c) Combined presentation of the isoscaling, plotted as a function of the neutron number. Data labelled "central" are taken from Ref. [10].



RECENTLY (2005-2007) CHARGE IDENTIFICATION HAS BEEN EXTENDED TO PARTICLE STOPPED IN SILICON DETECTOR:

The signal shape of **Si** depends on **e<sup>-</sup>/h<sup>+</sup>** collection

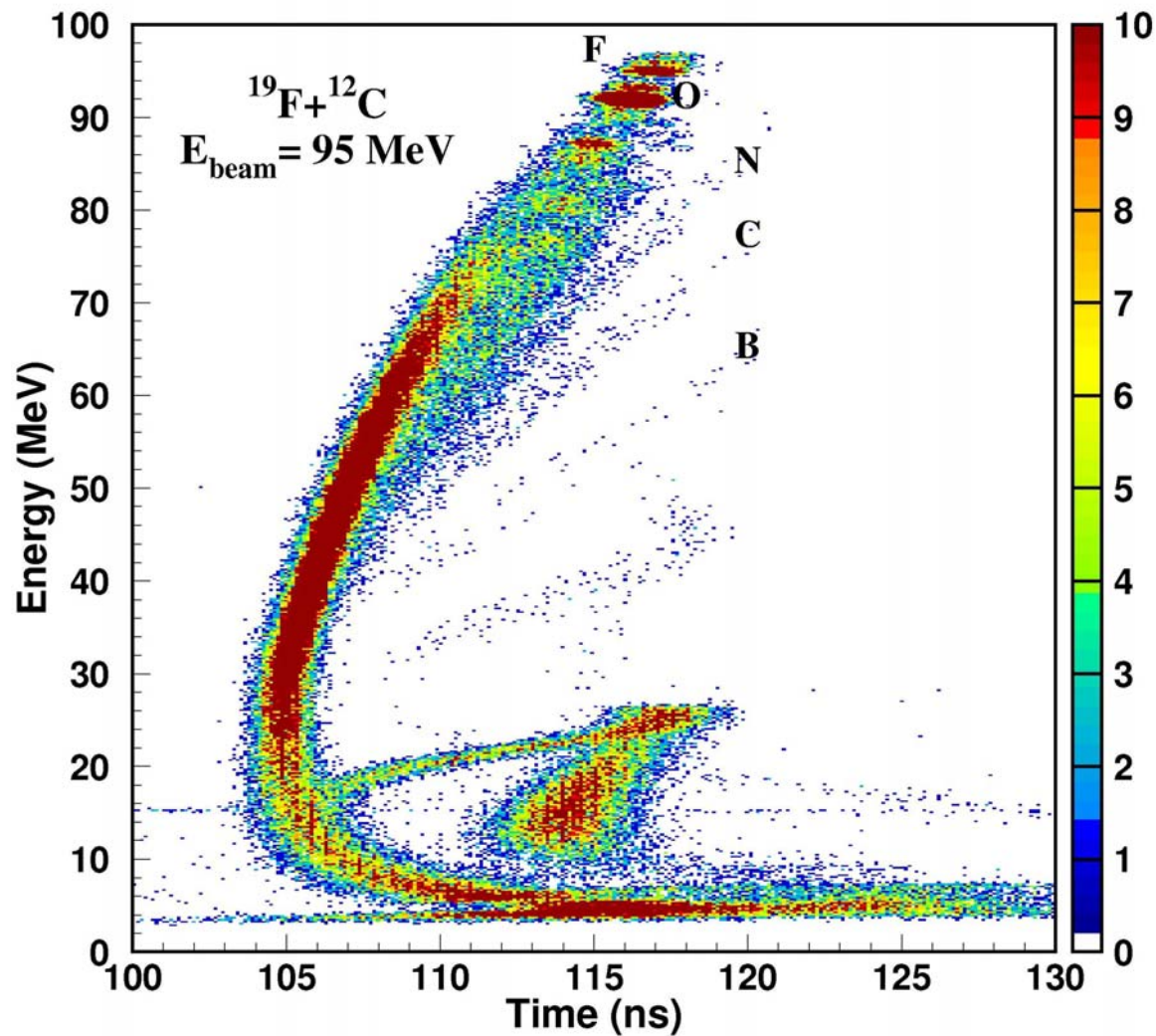
- shape and strength of **F(x)**
- range -> **A Z E**
- entrance side



Pulse shape discrimination on **Si**  
Hardware measurement of Rise Time

Digitalization of the signal

**Silicon detector CHIMERA  
300mu (FRONT SIDE)**



# Energy threshold for particle identification

Front injection Int = 20 ns Diff = 50 ns

Atomic Number	Threshold (MeV/A)	
	Delay 90%=20 ns	Delay 90%=60 ns
6	3.75	3.75
7	3.70	3.32
8	3.75	3.23

Rear injection Int = 20 ns Diff = 100 ns

Atomic Number	Threshold (MeV/A)	
	Delay 90%=125 ns	Delay 90%=147 ns
6	3.44	3.66
7	3.49	3.26
8	3.51	3.41

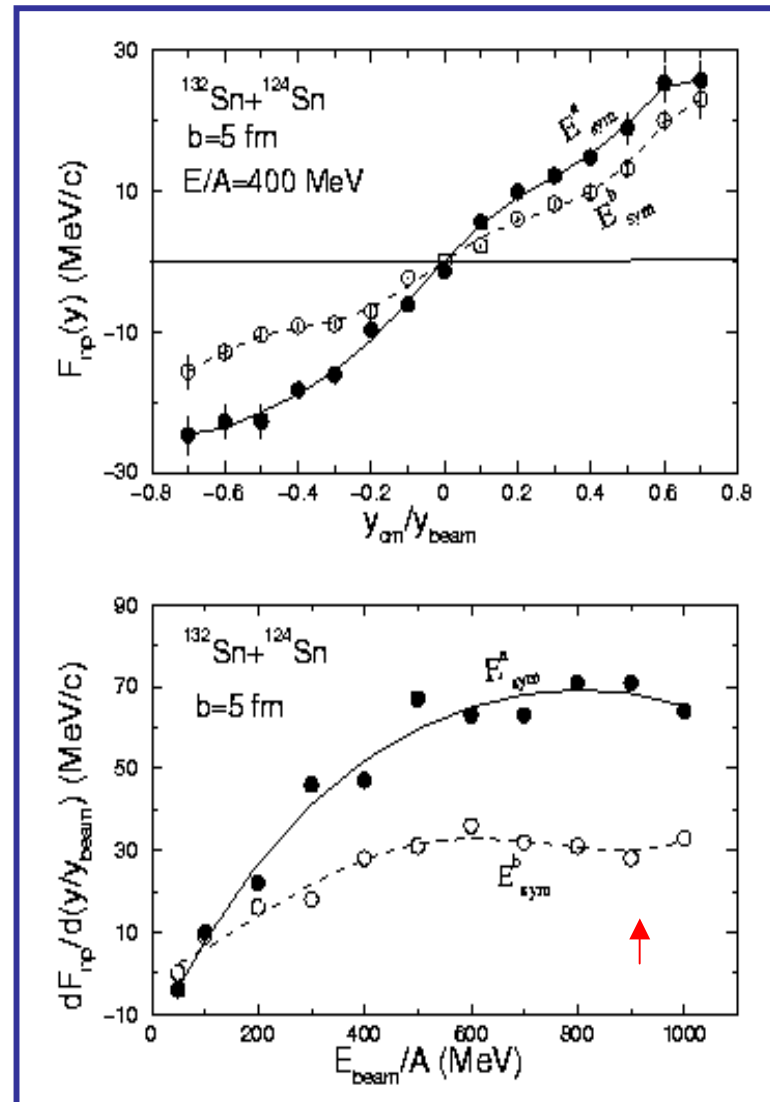
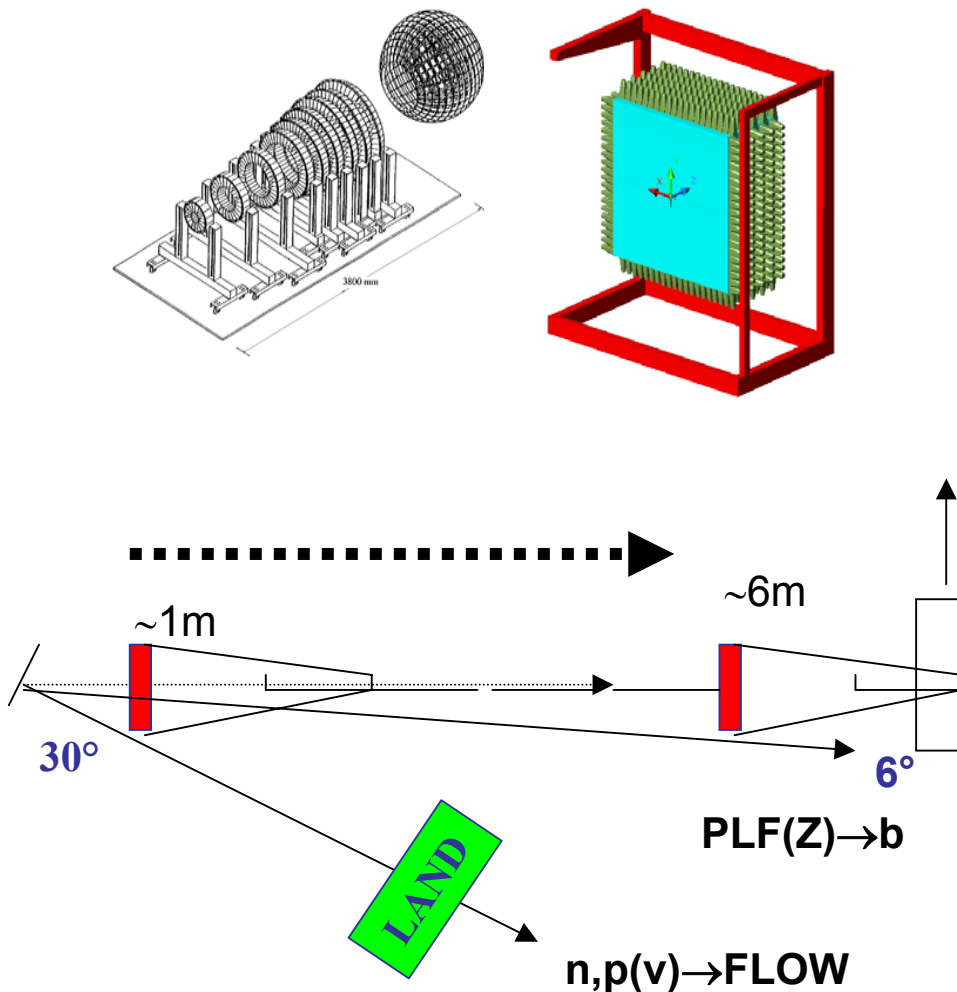
Front and rear shows similar energy thresholds in PSD

**IEEE Trans. Nucl. Sci. 52 (2005) 1624**



# CHIMERA-LAND COINCIDENCE Exp. (.....A.Pagano - W.Trautmann,.....):

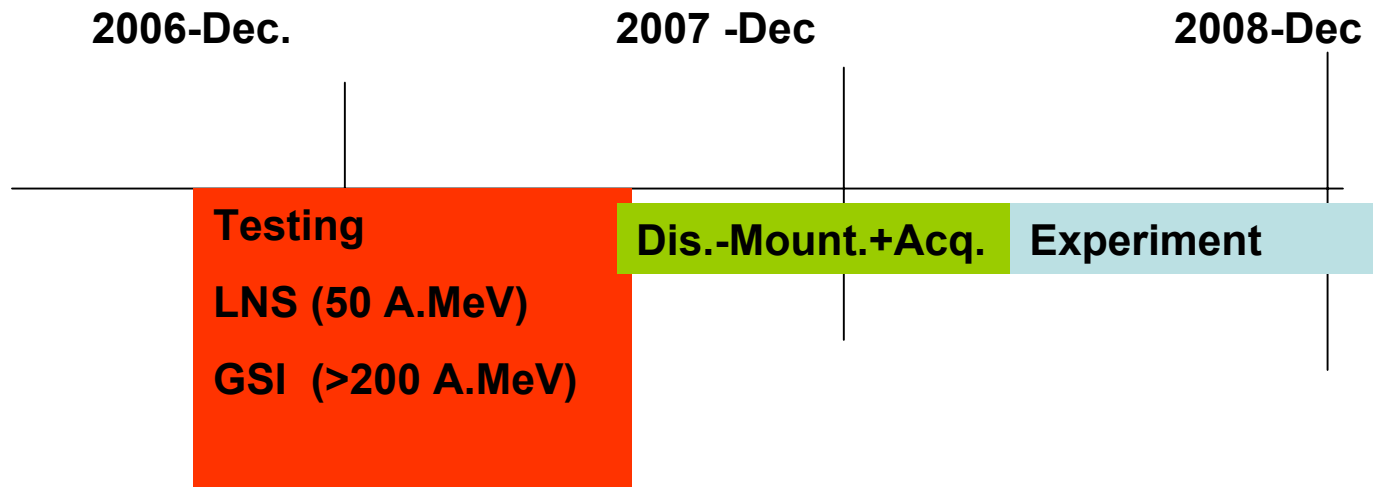
Reactions: **Au, Sn, Al, +X @ 0.4÷2.0 GeV/A** flow measurements **np (LAND)** and charged fragments (**CHIMERA**): to obtain information about **Esym of EOS** at high density ( $\rho > 1.5$ ).



Bao-An Li, PRL 88,192701, (2002)

- Preliminary proposal already submitted to CSNIII-INFN (2006 September )
- we have some money to perform simple tests at GSI(2006/2007)

-proposed time schedule:



**10 cm di  
Csl**

IONE	Z	A	$E_{INC}/A$ (MeV)	$E_{INC}$ (MeV)	$E_{LOST}$ in 10cm-Csl (MeV) <b>eloise</b>	$E_{res}$ after Csl (MeV) <b>eloise</b>	$E_{res}/A$ after Csl (MeV) <b>eloise</b>	Range (cm) <b>srin</b>
He	2	4	400	1600	344	1256	314,1	>10
Be	4	9	400	3600	1460	2140	237,8	>10
B	5	11	400	4400	2411	1989	180,9	>10
C	6	12	400	4800	4092	708	59,0	>10
O	8	16	400	6400	6400	<b>0</b>	<b>0,0</b>	<b>7,9</b>
Ne	10	20	400	8000	8000	<b>0</b>	<b>0,0</b>	<b>6,4</b>
P	15	31	400	12400	12400	<b>0</b>	<b>0,0</b>	<b>4,3</b>
Ca	20	40	400	16000	16000	<b>0</b>	<b>0,0</b>	<b>3,2</b>
Cr	24	52	400	20800	20800	<b>0</b>	<b>0,0</b>	<b>2,9</b>
Ni	28	58	400	23200	23200	<b>0</b>	<b>0,0</b>	<b>2,4</b>
Ga	31	69	400	27600	27600	<b>0</b>	<b>0,0</b>	<b>2,3</b>
Kr	36	84	400	33600	33600	<b>0</b>	<b>0,0</b>	<b>2,1</b>
Zr	40	90	400	36000	36000	<b>0</b>	<b>0,0</b>	<b>1,9</b>
Ag	47	107	400	42800	42800	<b>0</b>	<b>0,0</b>	<b>1,6</b>

**E=1 GeV/A**

IONE	Z	A	$E_{INC}/A$ (MeV)	$E_{INC}$ (MeV)	$E_{LOST}$ in 10cm-CsI (MeV) <b>eloise</b>	$E_{res}$ after CsI (MeV) <b>eloise</b>	$E_{res}/A$ after CsI (MeV) <b>eloise</b>	Range (cm) <b>srin</b>
He	2	4	1000	4000	245	3755	938,9	>10
Be	4	9	1000	9000	983	8017	890,7	>10
B	5	11	1000	11000	1542	9458	859,8	>10
C	6	12	1000	12000	2232	9768	814,0	>10
O	8	16	1000	16000	4002	11998	749,9	>10
Ne	10	20	1000	20000	6314	13686	684,3	>10
P	15	31	1000	31000	14626	16374	528,2	>10
Ca	20	40	1000	40000	27664	12336	308,4	>10
Cr	24	52	1000	52000	41738	10262	197,4	>10
Ni	28	58	1000	58000	58000	0	0,0	9,2
Ga	31	69	1000	69000	69000	0	0,0	8,9
Kr	36	84	1000	84000	84000	0	0,0	7,9
Zr	40	90	1000	90000	90000	0	0,0	6,9
Ag	47	107	1000	107000	107000	0	0,0	5,9

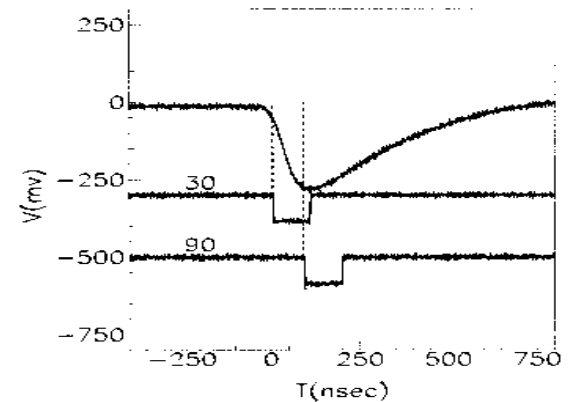
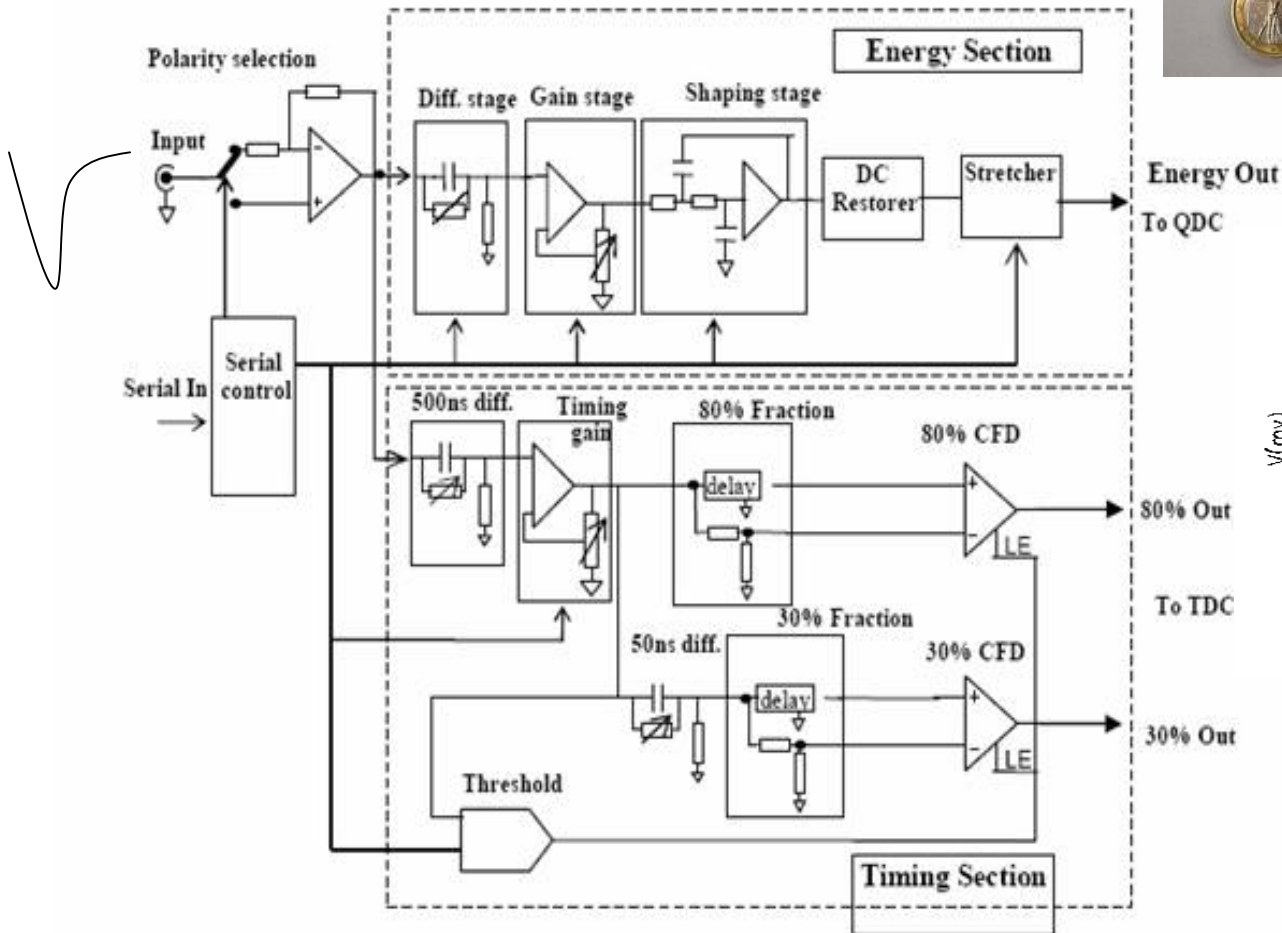
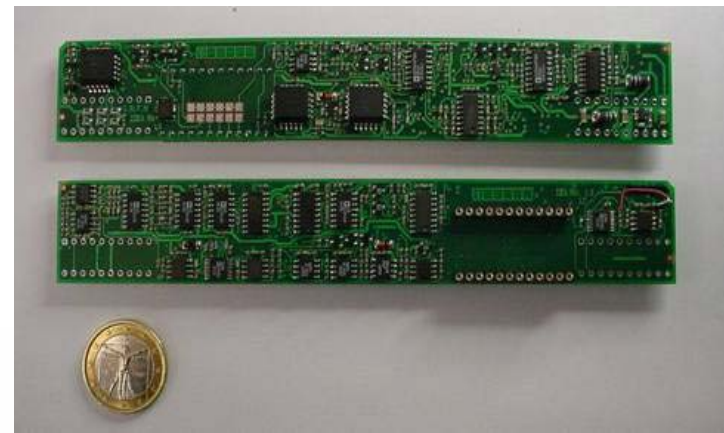
arrestati nel CsI

**E=2 GeV/A**

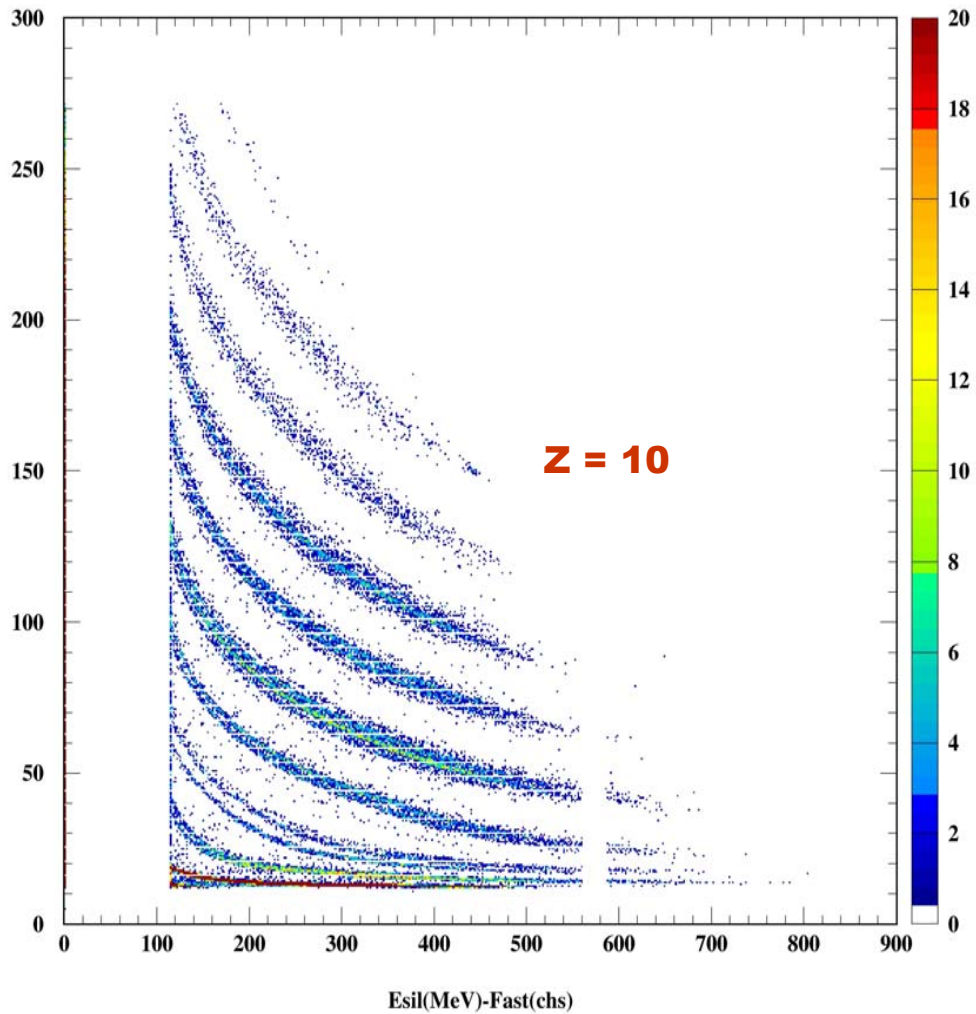
IONE	Z	A	$E_{INC}/A$ (MeV)	$E_{INC}$ (MeV)	$E_{LOST}$ in 10cm-Csl (MeV) eloise	$E_{res}$ after Csl (MeV) eloise	$E_{res}/A$ after Csl (MeV) eloise	Range (cm) srim
He	2	4	2000	8000	230	7770	1942,6	>10
Be	4	9	2000	18000	919	17081	1897,9	>10
B	5	11	2000	22000	1436	20564	1869,5	>10
C	6	12	2000	24000	2067	21933	1827,7	>10
O	8	16	2000	32000	3676	28324	1770,3	>10
Ne	10	20	2000	40000	5745	34255	1712,7	>10
P	15	31	2000	62000	12940	49060	1582,6	>10
Ca	20	40	2000	80000	23048	56952	1423,8	>10
Cr	24	52	2000	104000	33221	70779	1361,1	>10
Ni	28	58	2000	116000	45356	70644	1218,0	>10
Ga	31	69	2000	138000	55627	82373	1193,8	>10
Kr	36	84	2000	168000	75210	92790	1104,6	>10
Zr	40	90	2000	180000	93350	86650	962,8	>10
Ag	47	107	2000	214000	130093	83907	784,2	>10

# Layout Elettronica

## Modulo di PSD(E, TOF1, TOF2)

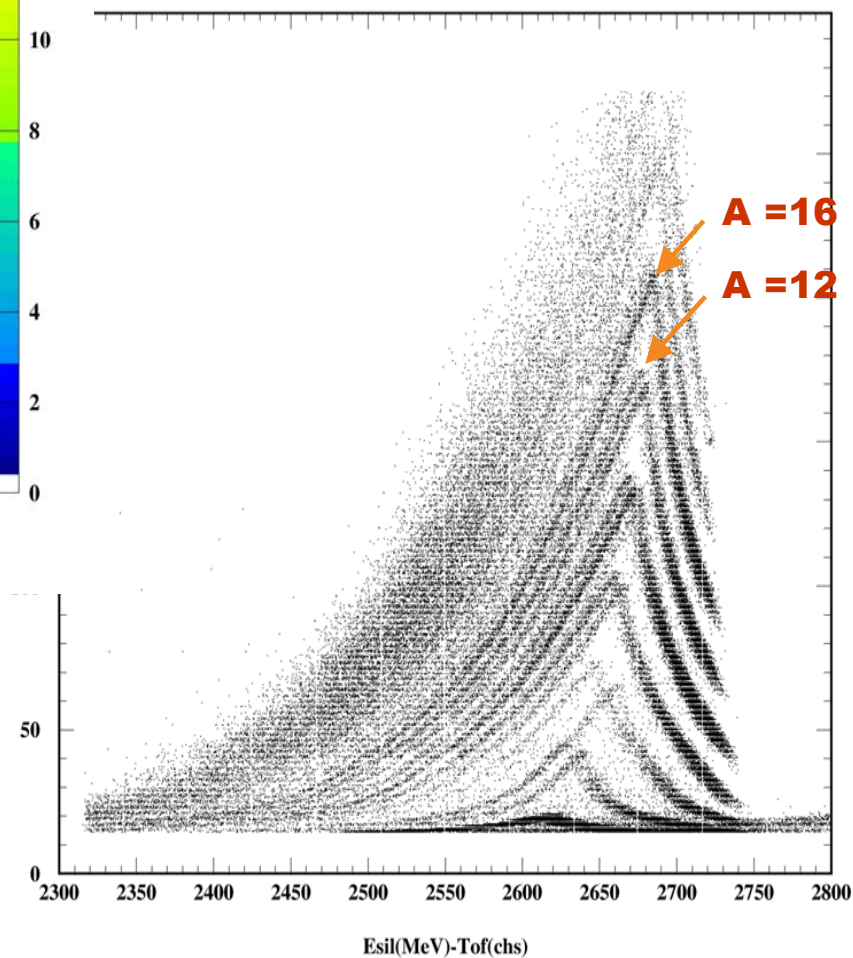


R.Bassini, C.Boiano,  
A.Pagano, et al. IEEE 2006  
work in progress

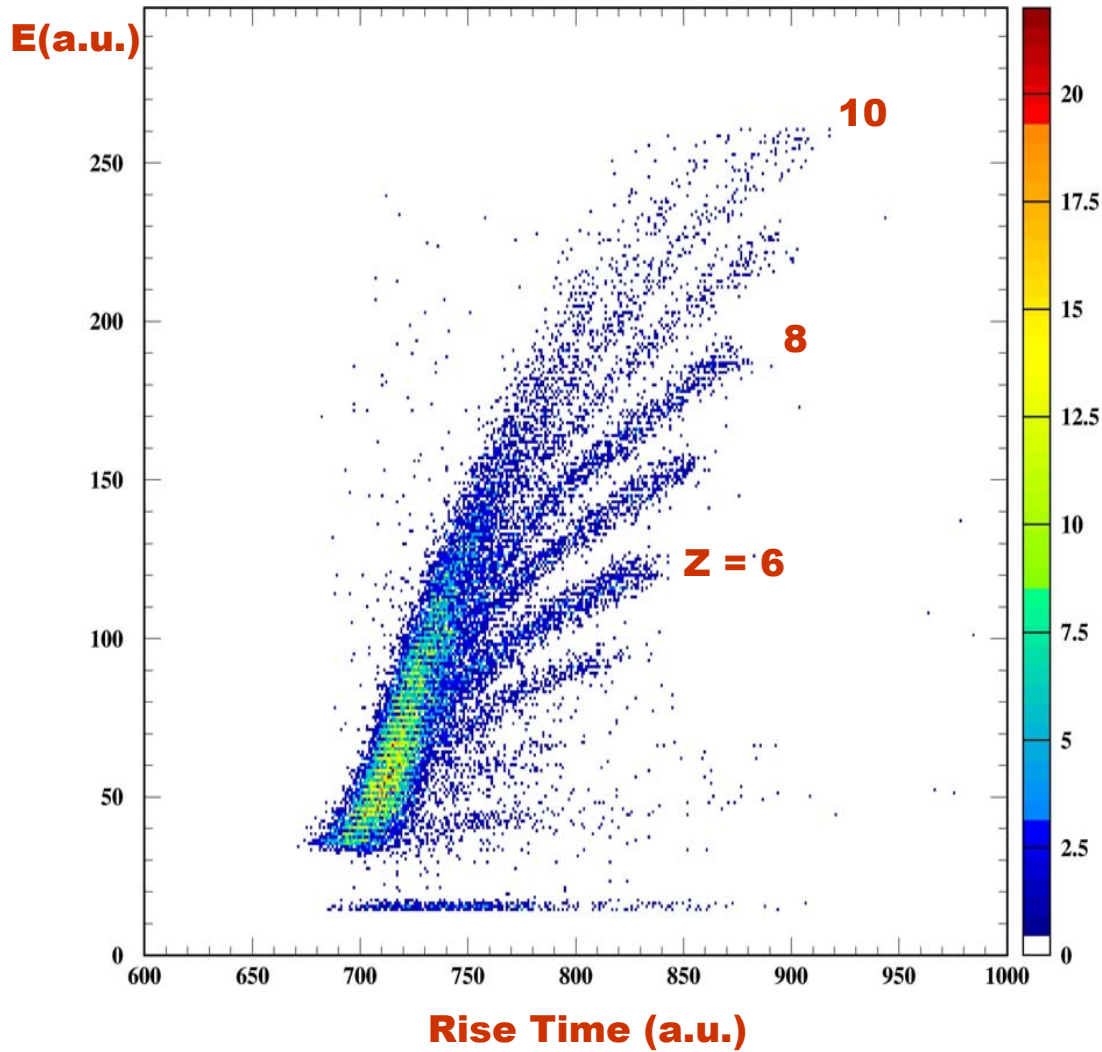


Ne+Al 20 MeV/A

$\Delta E - TOF$  plot



# PSD results



<b>Z</b>	<b><math>E_{th}</math> (MeV/A)</b>	<b><math>E_{min} / A</math> (<math>300\mu\text{m}</math>)</b>
<b>3</b>	<b>&lt; 4.0</b>	<b>6.4</b>
<b>4</b>	<b>3.4</b>	<b>7.7</b>
<b>5</b>	<b>4.1</b>	<b>10.0</b>
<b>6</b>	<b>4.4</b>	<b>10.8</b>
<b>7</b>	<b>4.6</b>	<b>11.4</b>
<b>8</b>	<b>5.1</b>	<b>11.8</b>
<b>9</b>	<b>5.9</b>	<b>12.1</b>
<b>10</b>	<b>6.2</b>	<b>13.0</b>