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Application of EUDET telescope for neutron source calibration at Cadarache (Provence, Fr)

Wojciech Dulinski on behalf of IPHC

Outline

- Short presentation of Cadarache Research Center
- Practical information concerning possible tests there
- The goal of exercise: set of transparencies prepared by Daniel Husson (IPHC), our contact-man

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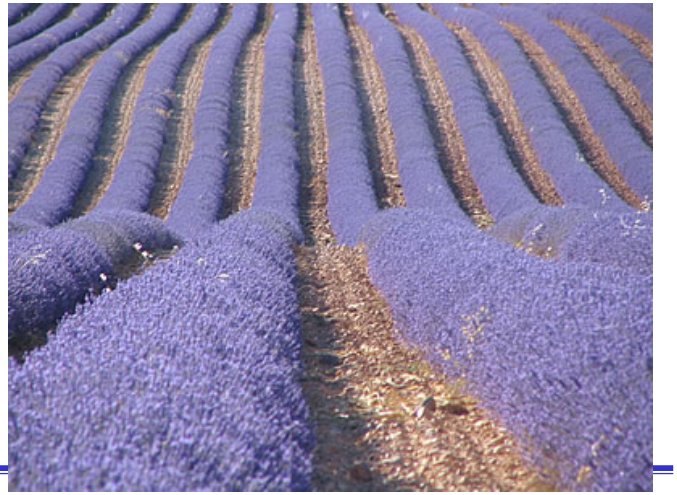
Cadarache: one of nine research centers of French Atomic Energy Comission (CEA)



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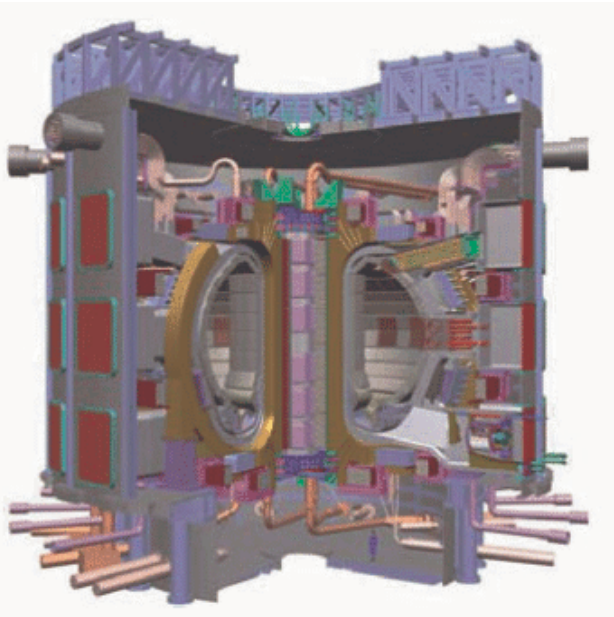
Cadarache Home Page…



The future: ITER

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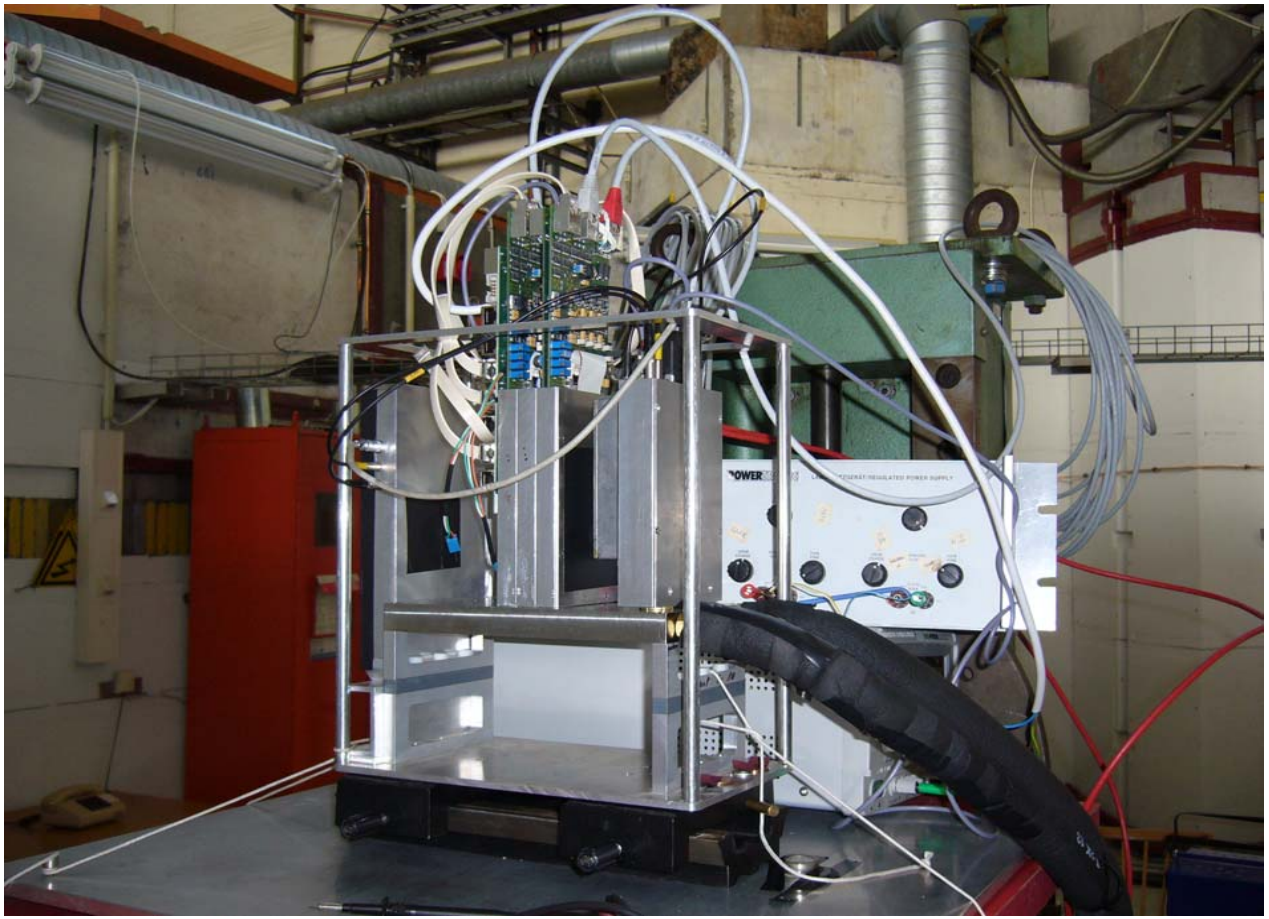
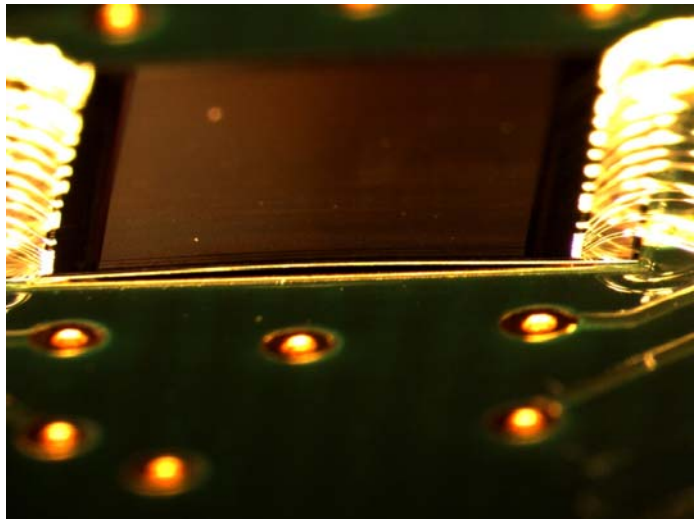
Plans: use of TAPI : TElescope a Pixels equipped with four reference planes based on M18 thinned to 50 µm, together with EUDET DAQ system





W.Dulinski, G.Claus, M.Goffe

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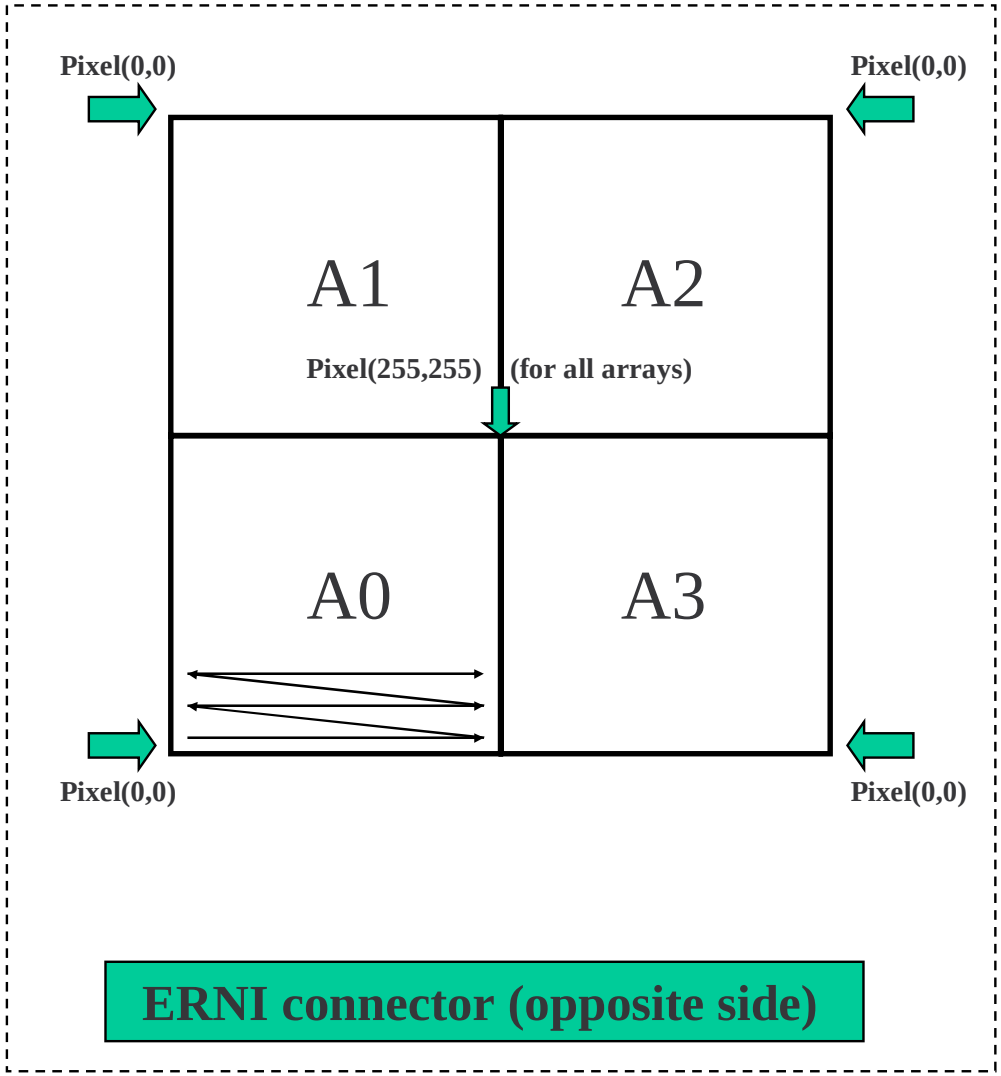
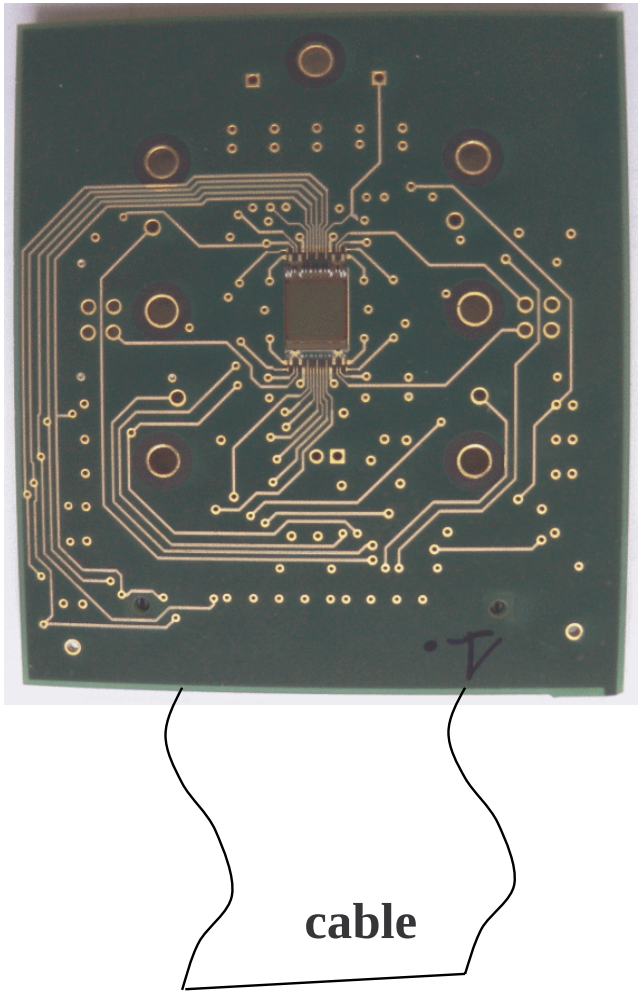
Mimosa18: 512x512 pixel array, 10 µm pitch)





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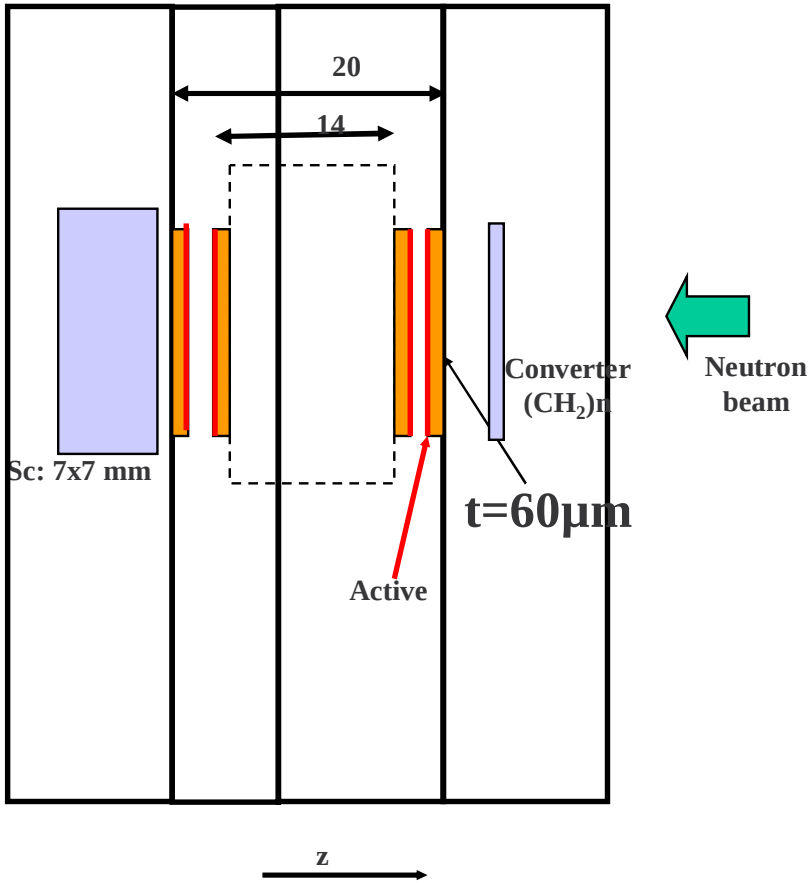
4-plane M18 µTelescope: very compact set-up for Cadarache



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Practical information

- **Tentative date: 21 April 2008**
- **Test period: one or two weeks**
- **Neutron flux in the beam: 6000 n/s/cm^2 → 6 protons/s/cm2**
- **Official working hours (to be absolutely respected): 8 am till 4 pm. But automatic tests may continue through the night!**
- **<u>All persons planning participation must apply for the entrance permit several (>6) weeks before</u>**
- **Cadarache may contribute in the costs**

CMOS chips as neutron detectors

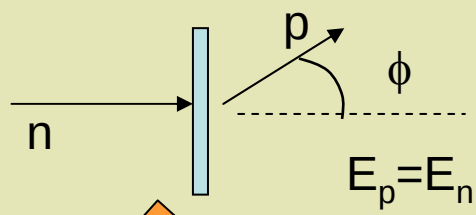
Detecting Neutrons

Which secondary charged partic?

1) α,d, t (slow neutrons ~1meV-10 keV)
2) p for fast neutrons ~10 keV-100 MeV

$n + Li/B \longrightarrow \alpha\ (+d/t)$

$n + CH_n \longrightarrow p$



$E_p = E_n.\cos^2(\phi)$

Fantastic advantage of <u>thin</u>* Si:
~100% γ transparency !
(**15 μm epi*)

low E photons = low E e-
high E photons go through..

CMOS **pixels**
(MimoV/XVII)
xy resol.

Fast counting:
αRad chip !
~3 10^9 n/cm^2/s

γ-transparent !

AMANDE facility, Cadarache(Fr)

LDMN=Lab.Dosimetry and Metrology of Neutr.
(National Institute for Radioprotection IRSN)

ISO certif.

AMANDE: monoenergetic fields, (thermal-20 MeV)

Metrological quality ⟷ Reference facility

High Performance **Detectors** !

Low E: μTPC (^{4}He)

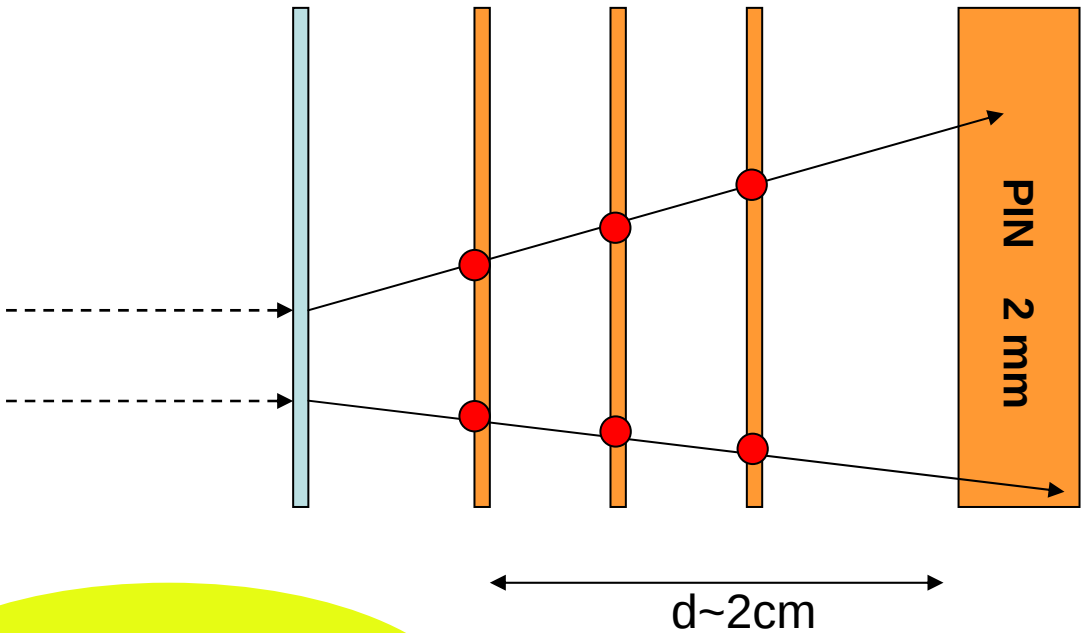
(Grenoble)

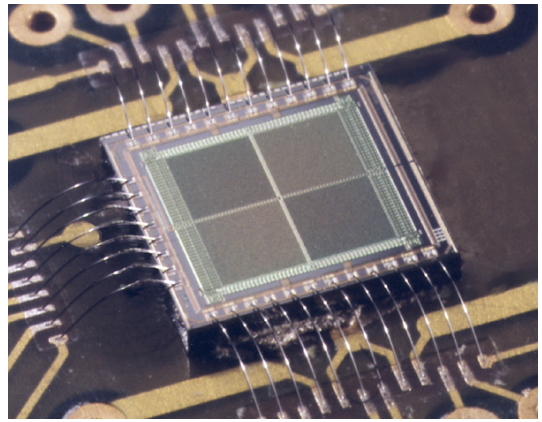
Recoil Protons Telescope

Strasbourg

TPR Si/CMOS

$E_{neutrons}$ = 14-20 MeV





$\sigma_{xy} < 30\ \mu m/(12)^{1/2}$

$\Rightarrow \sigma_{\vartheta} < 4\ 10^{-4}$

Thinned CMOS
(e=50-100 μm)

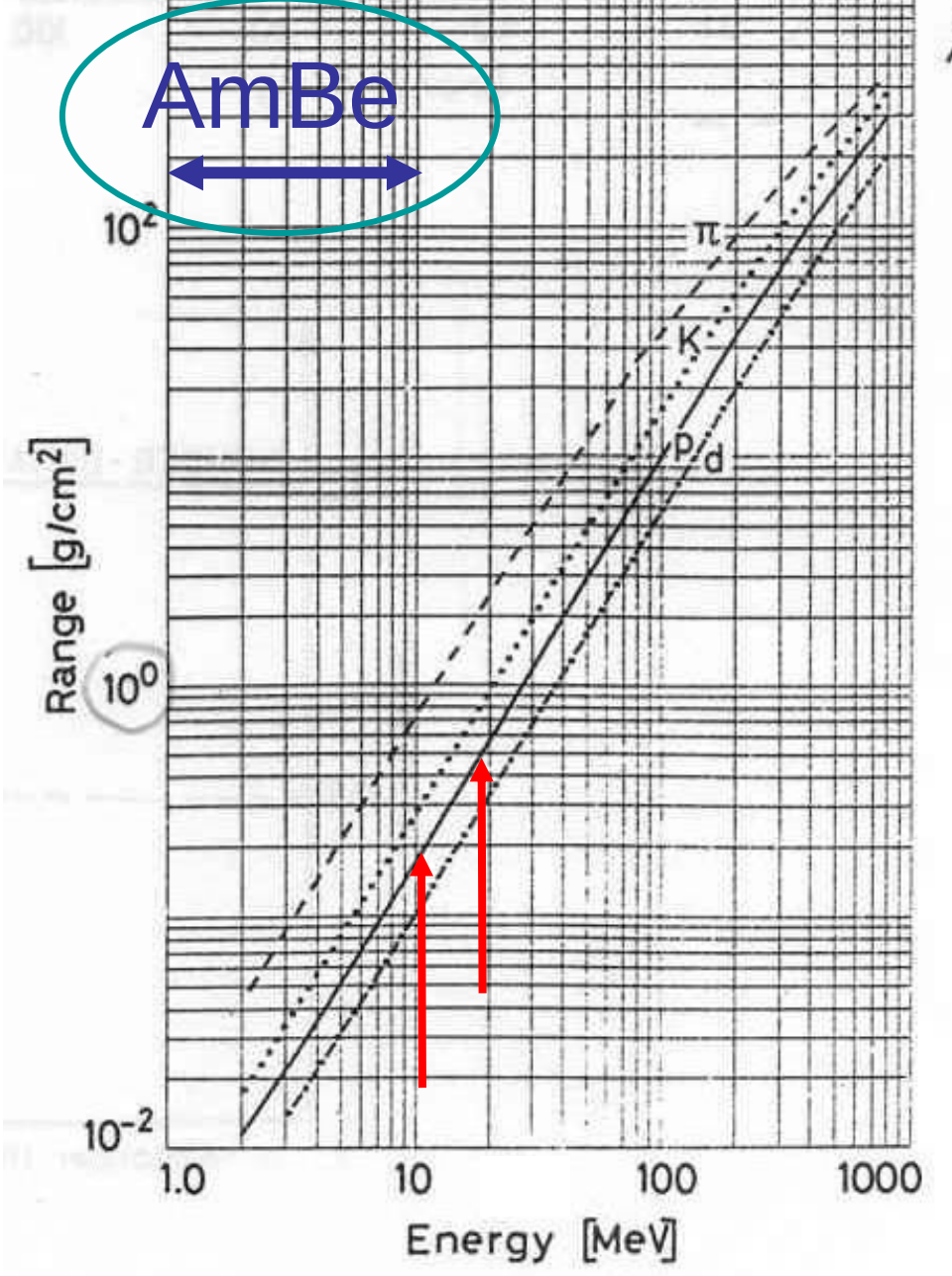
Simul: A.Allaoua
(LMDN/IRSN Cadarache)
Hardware:
IPHC-RaMSeS

Range of PROTONS

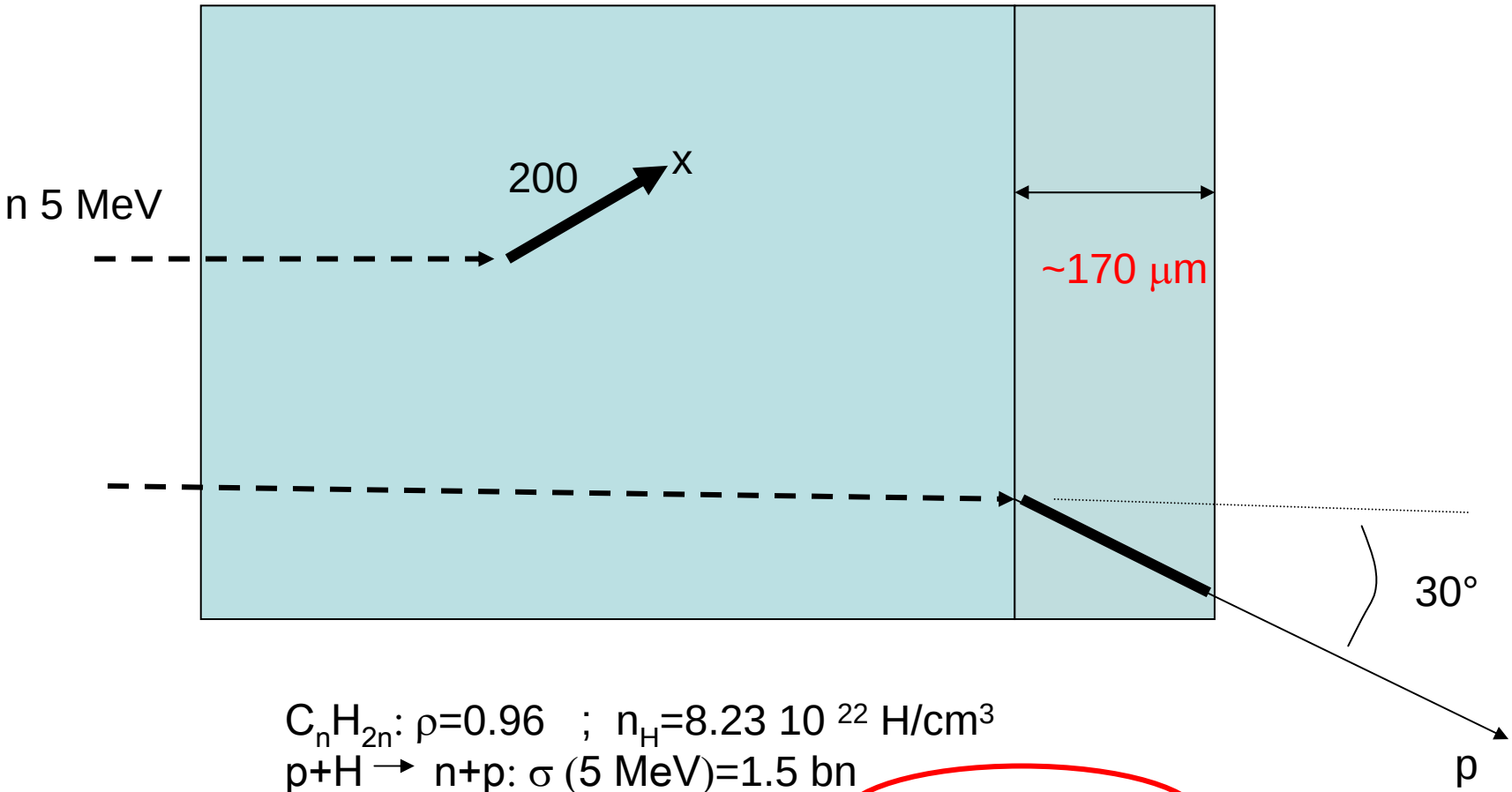
	C_nH_{2n}	Si	
3.75 MeV	200	100	μm
10 MeV	2	1	*mm*
20 MeV	6	3	*mm*

$E_p = E_n * \cos^2(30°) = 3/4\ E_n$

mean scatt.angle



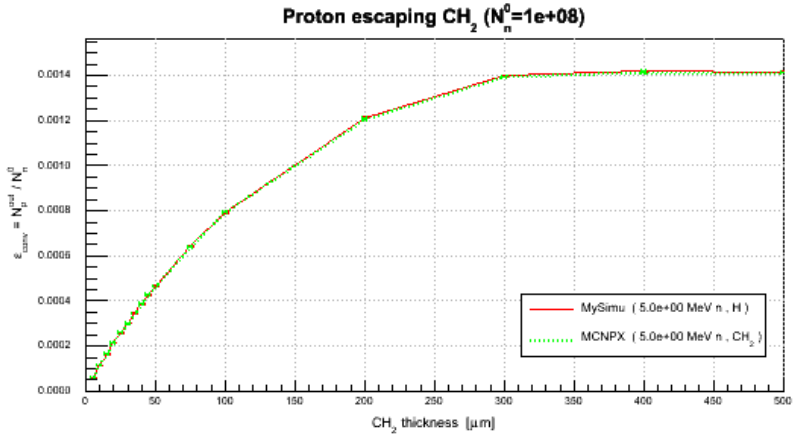
Effective convertor thickness

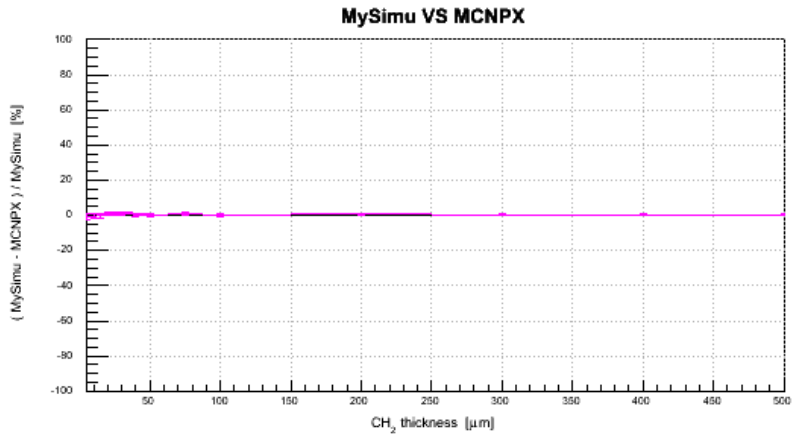


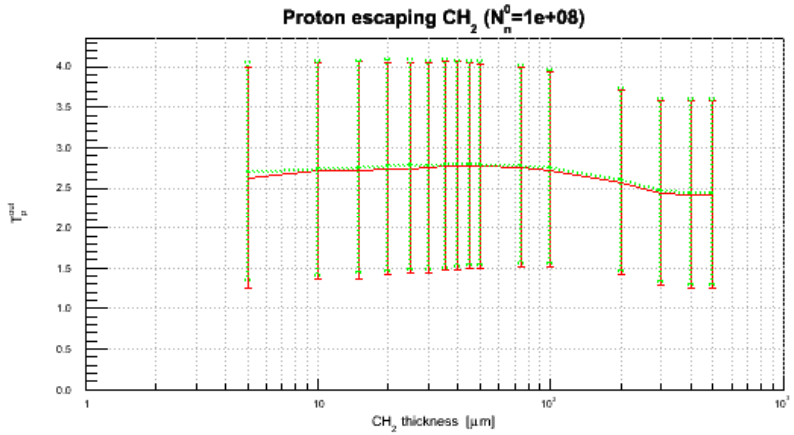
C_nH_{2n}: ρ=0.96 ; n_H=8.23 10 ^{22} H/cm^3

p+H → n+p: σ (5 MeV)=1.5 bn

$\mu=\sigma.n_H$= 0.12 cm^{-1} = 1.2 10^{-3} / 100 μm


Proton escaping CH2 (N0n=1e+08)
MySimu (5.0e+00 MeV n , H)
MCNPX (5.0e+00 MeV n , CH2)
CH2 thickness [μm]


MySimu VS MCNPX
(MySimu - MCNPX) / MySimu [%]
CH2 thickness [μm]


Proton escaping CH2 (N0n=1e+08)
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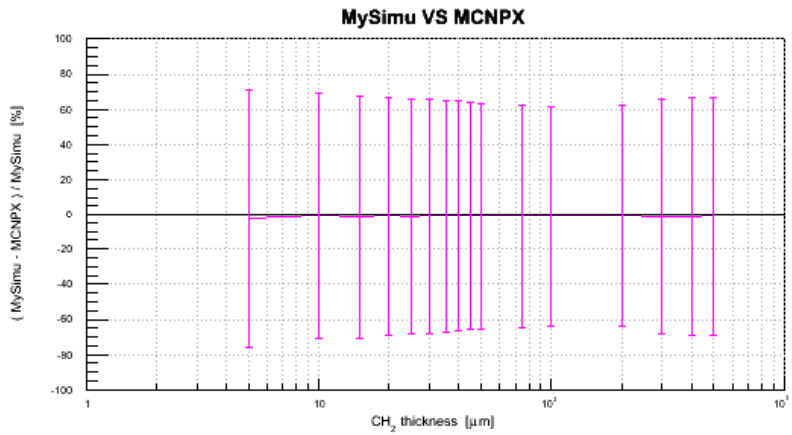
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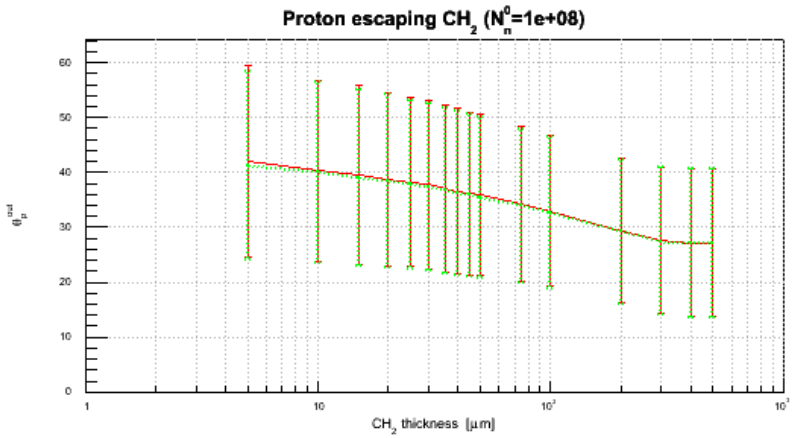
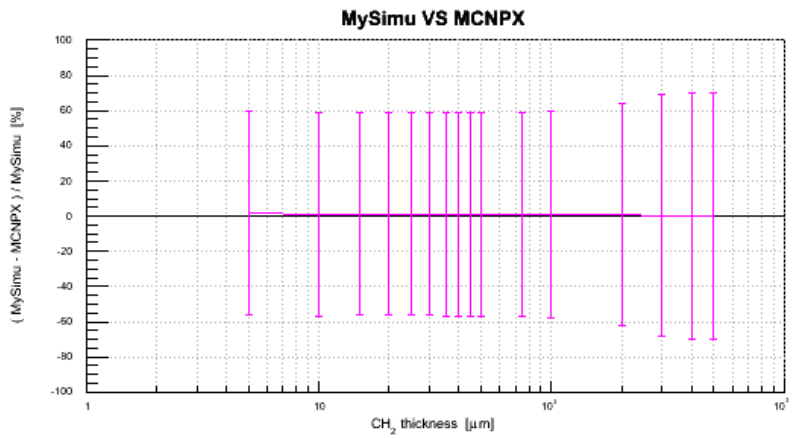
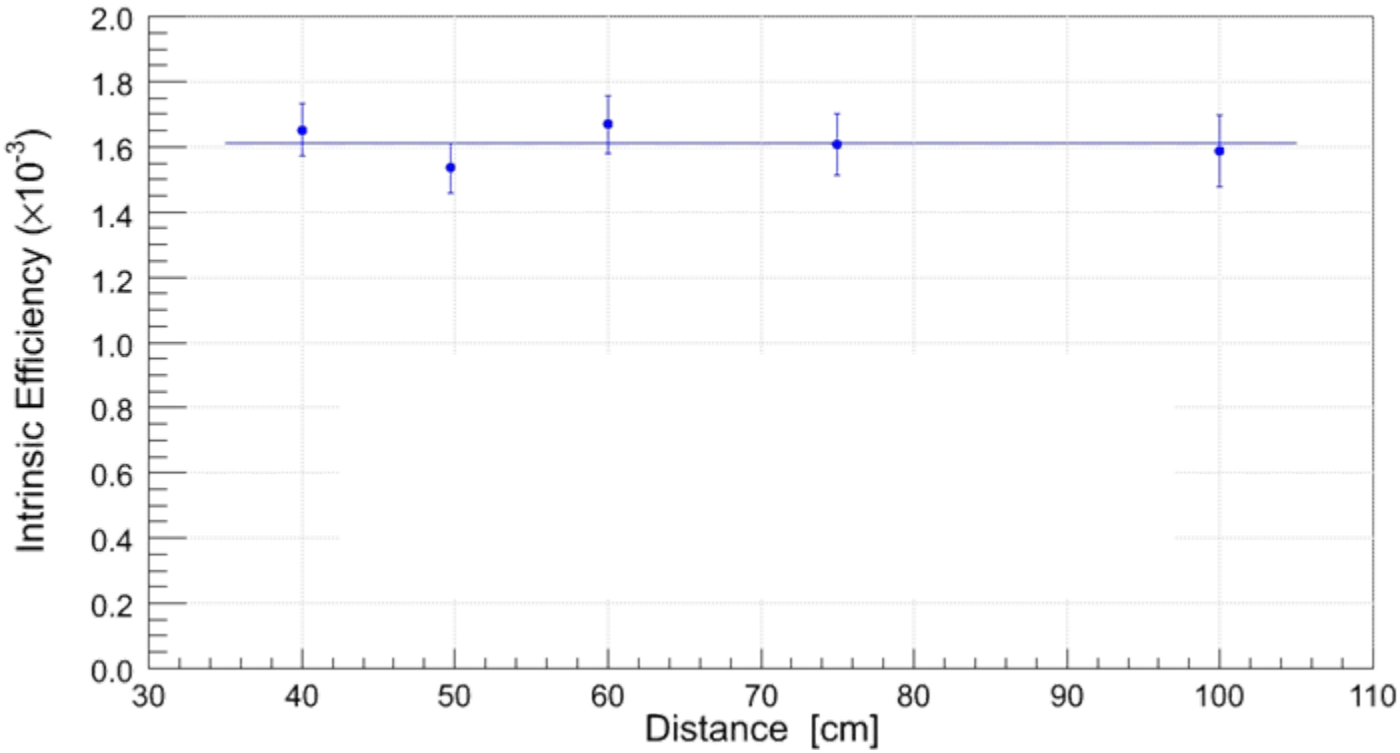

Proton escaping CH2 (N0n=1e+08)
CH2 thickness [μm]

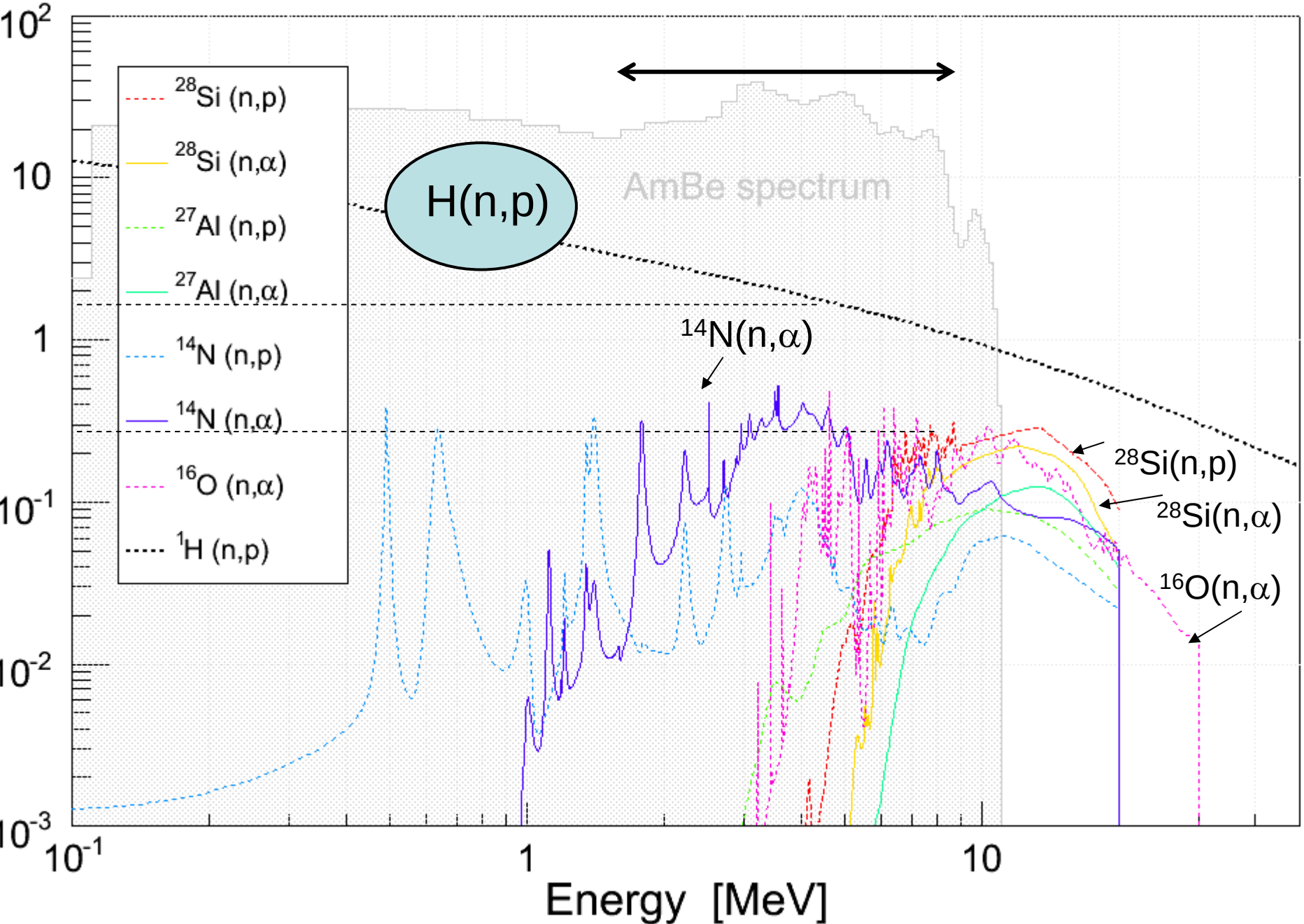

MySimu VS MCNPX
(MySimu - MCNPX) / MySimu [%]
CH2 thickness [μm]

Mesured efficiency
(MimoV in AmBe)

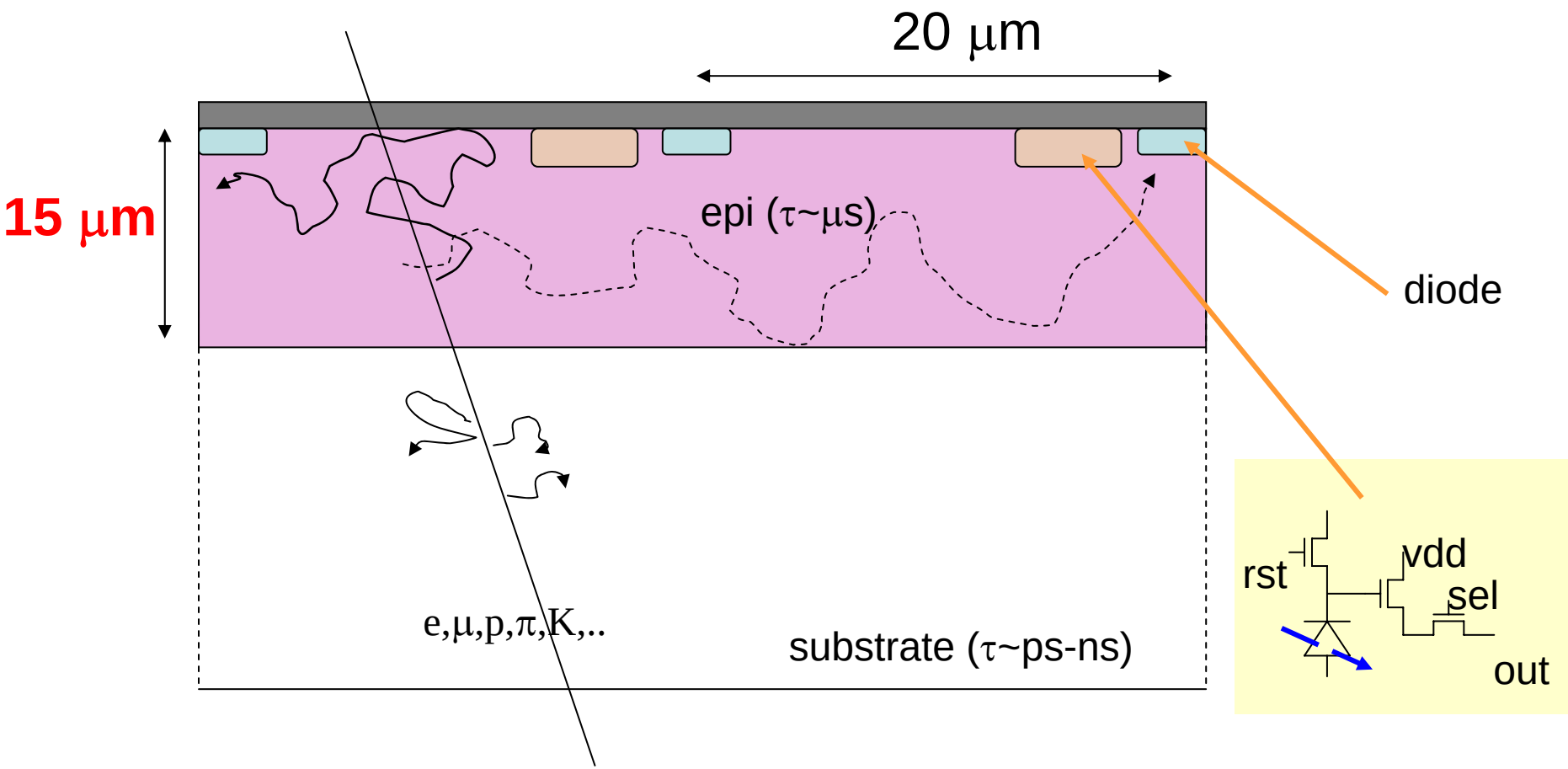


D.Husson, M.Trocmé et al. (2006)

Main contamination channels (JEFF 3.1)



The MIMOSA concept



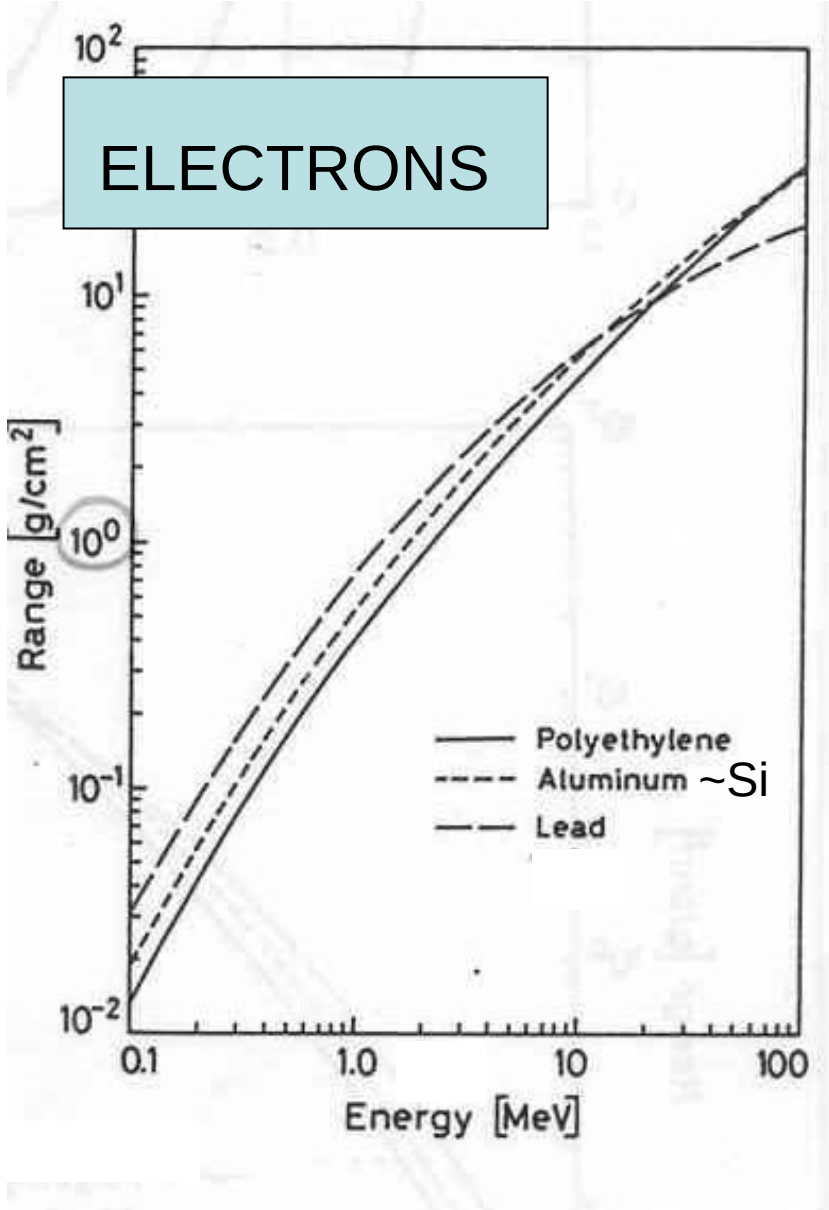
High γ-transparency of a 10 μm Si layer

neutron 14 MeV
→ proton ~10 MeV:

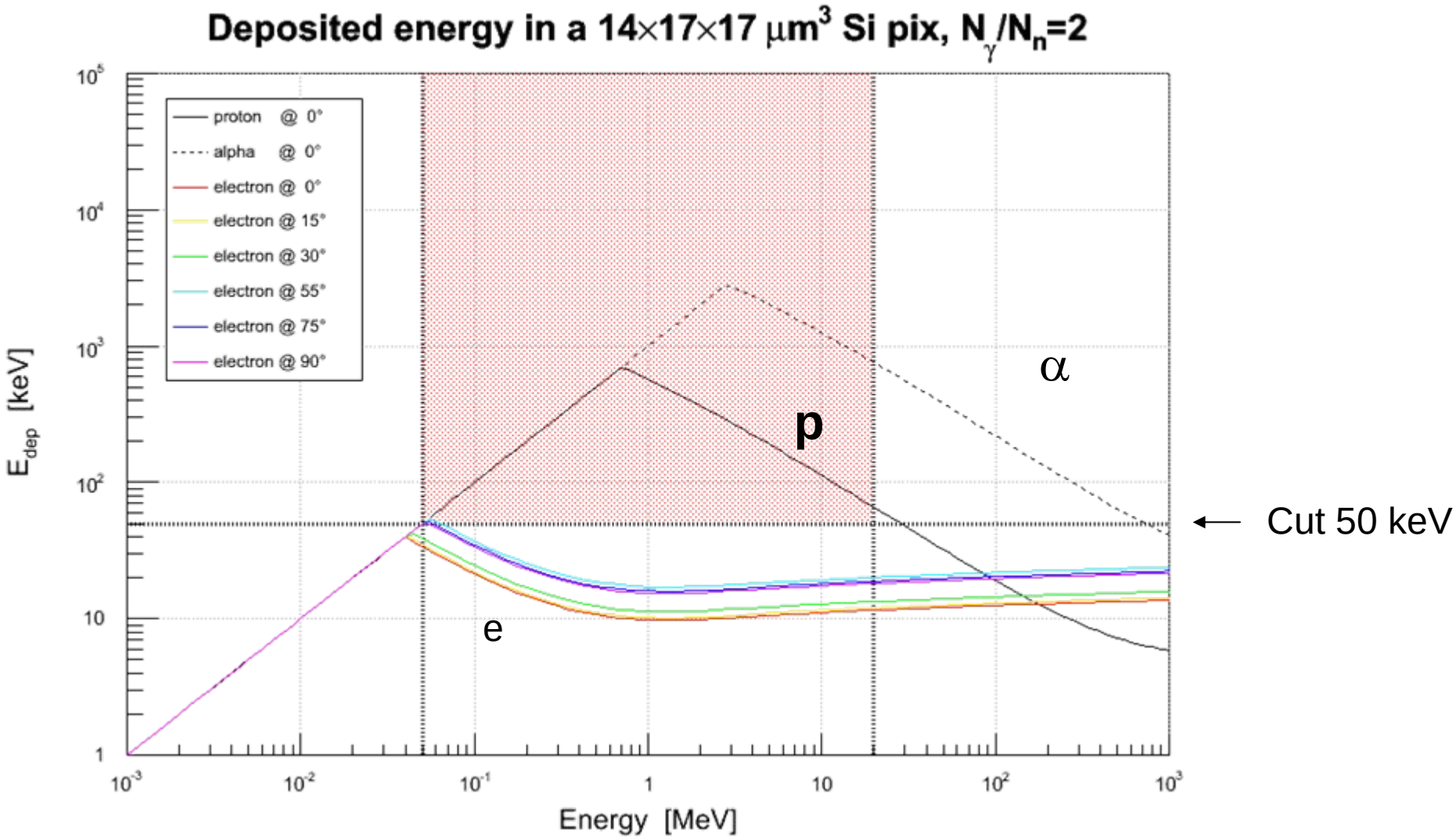
dEdX= **30** keV / 10 μm Si

γ 2 MeV → e ~ 1MeV
= MIP

dEdX = **2.4** keV / 10 μm Si
L_{abs}(Si) = 2 mm



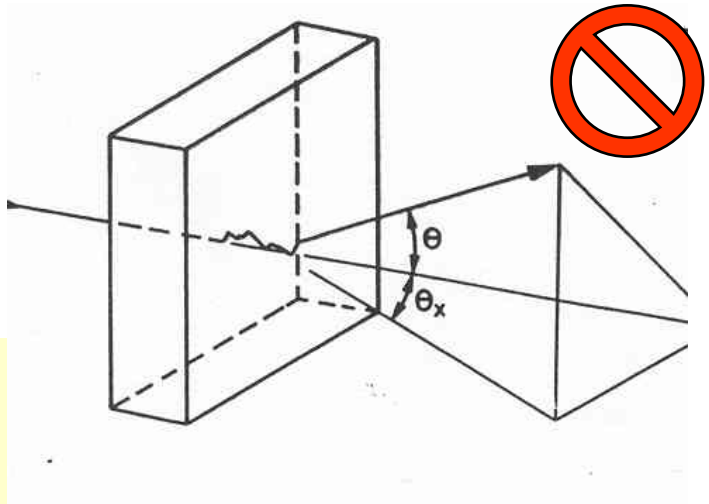
Gamma-transp



Why thinned CMOS ?

- Multiple scattering
- Unmeasured dEdX < 7 %

Multiple scattering

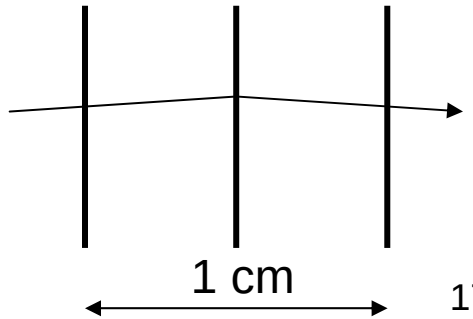


$\sigma_\theta \sim 20$ MeV/c.(1/pβ).$(z/X_0)^{1/2}$

(*X_0=9.36 cm for Si)*

→ $\sigma \sim 40$ mrad for E_p=10 MeV/c and z_{Si}=40 μm

→ dx=r.dθ= 0.5 cm * 4.10^{-2} rad = 200 μm ~ 6 pix…



Thinned CMOS:agenda

- 21/04/08 :EUDET test bench *(+trigger)*
  - ⇨ 4 chips M18: p=10, 250kpix, S=0.5x0.5, e=50-60μm
  - ⇨ to start analysis: track_correl, track reco, σ_ϑ
- 06/2008: 3 planes MimoStar3L (p=30 μm; Rad-Tol, S=2x1 cm) + 1 PIN diode (1cm^2, e=3 mm)

  4 chips avail., 10 PCB (+void),acq board 4 ADC

  ➡ to be thinned ….. ⬅