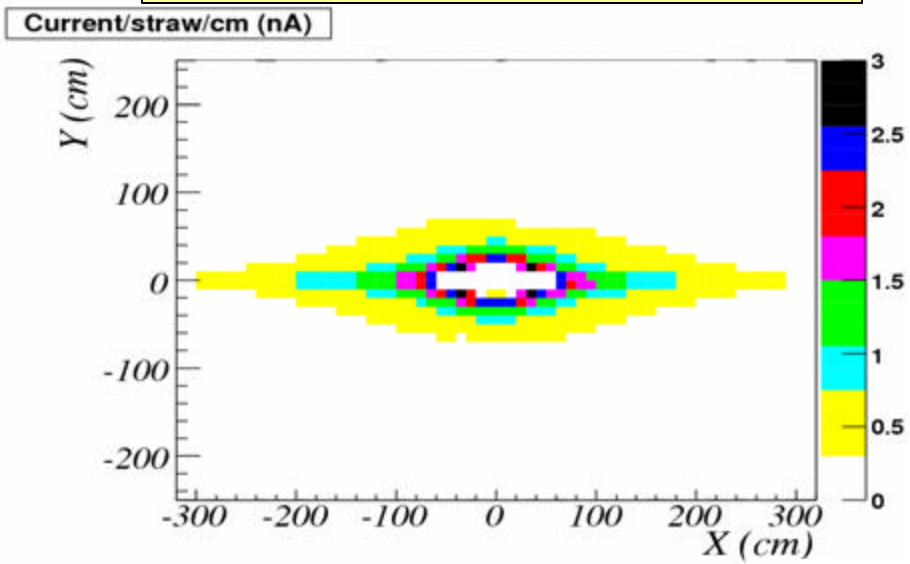
Estimate the lifetime
January 2007

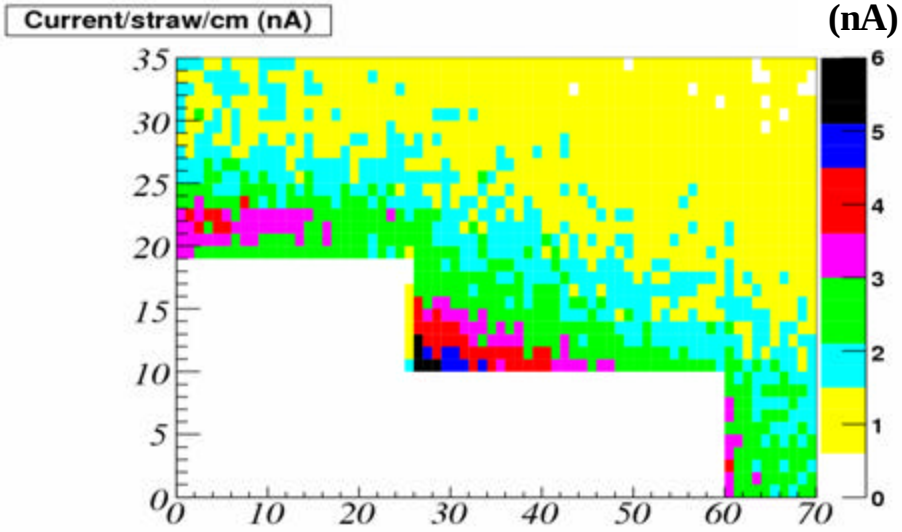
Ingredients:

1) Relate source to LHCb
2) Effect of irradiation on Gain
   - Damage vs intensity: where is the damage?
   - Extrapolate to 5.10^7s
3) Gain vs single-cell efficiency
   - Testbeam LHCb 2005-076
4) Single-cell efficiency vs tracking performance
   - Tracking Performance and Robustness Tests LHCb 2003-020

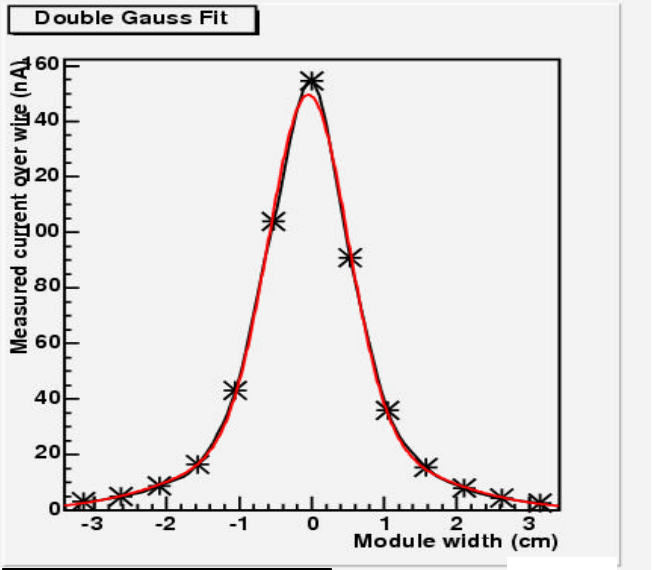
1) Relate source to LHCb
(Acceleration Factor)

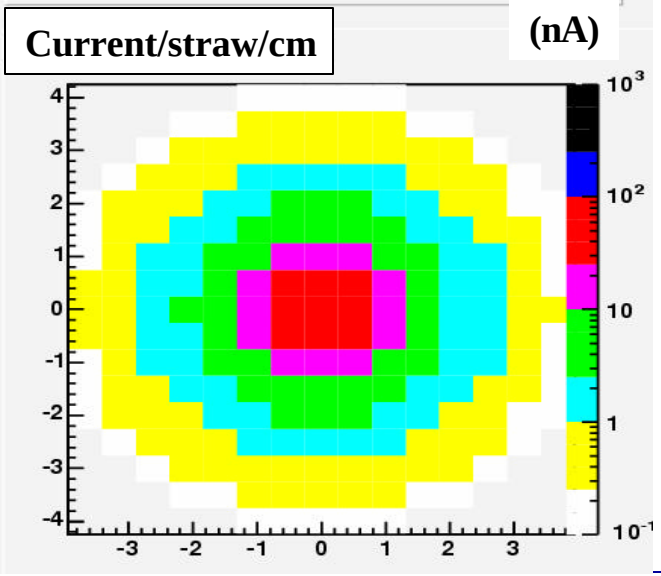
LHCb: (See J.Amoraal 29/11/2006)





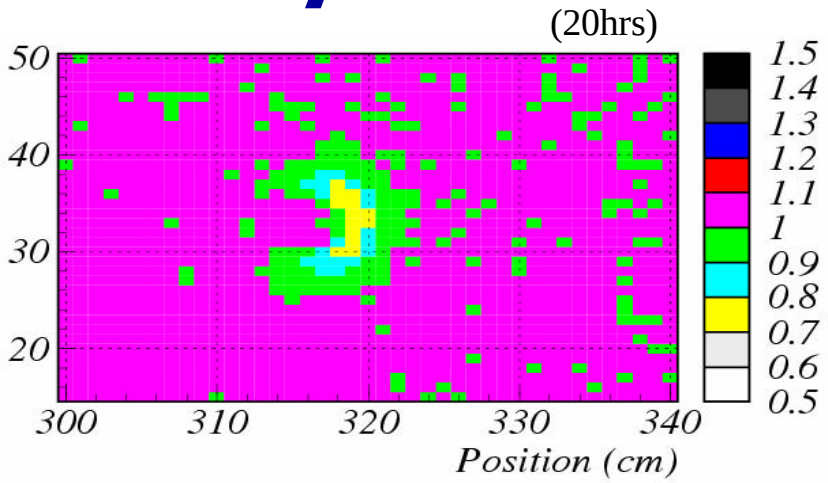
Irradiation Tests (2mCu ^{90}Sr):



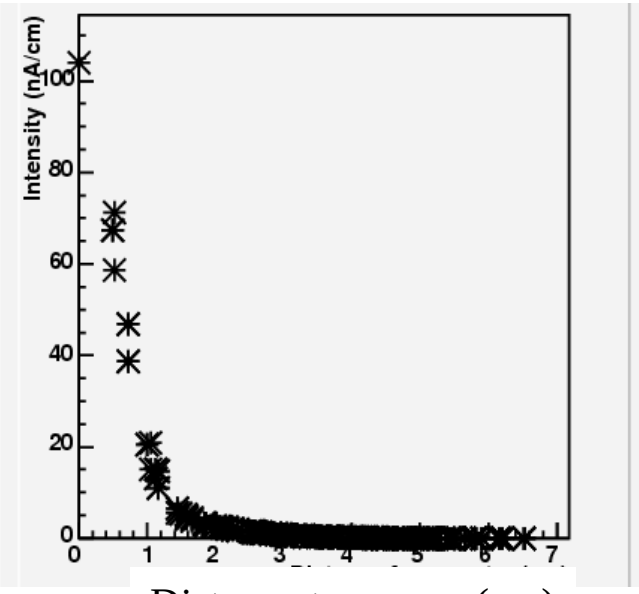


2) Damage vs Intensity

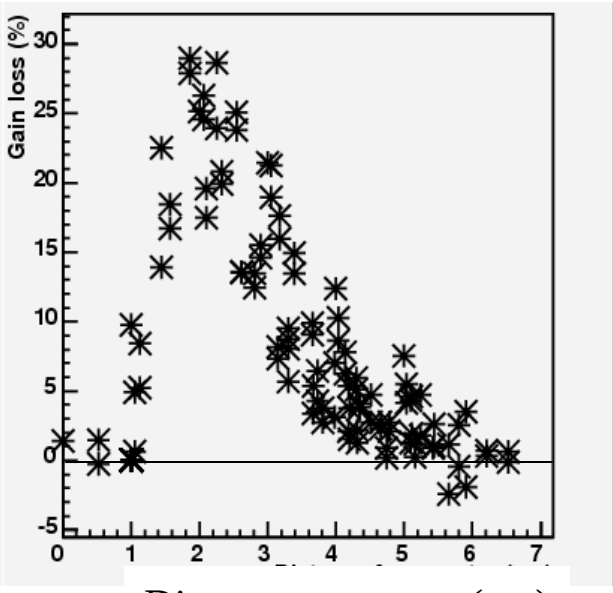
- Maximum damage around 3 nA/cm/straw
- Below 3 nA/cm/straw, the damage scales with the accumulated charge?



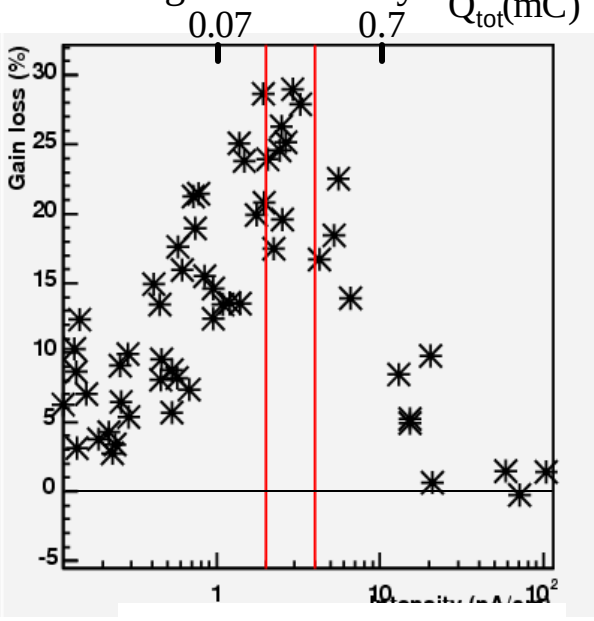
Intensity vs Radius



Damage vs Radius

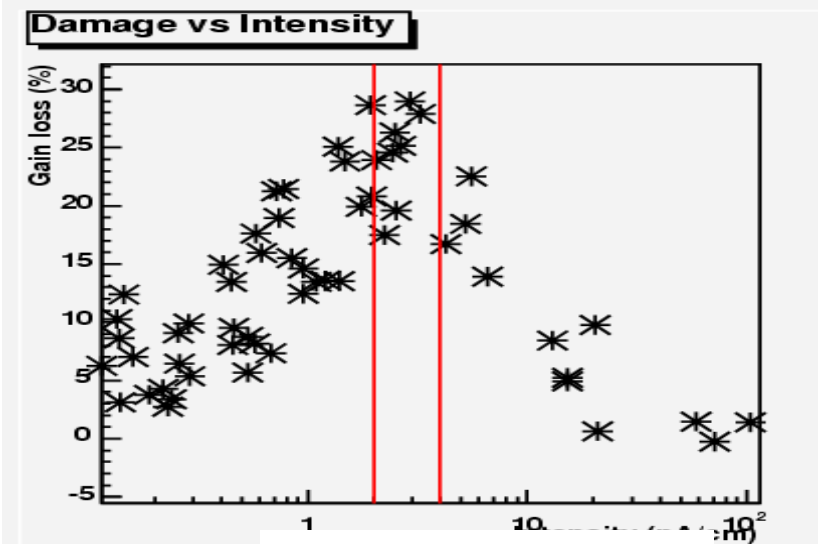


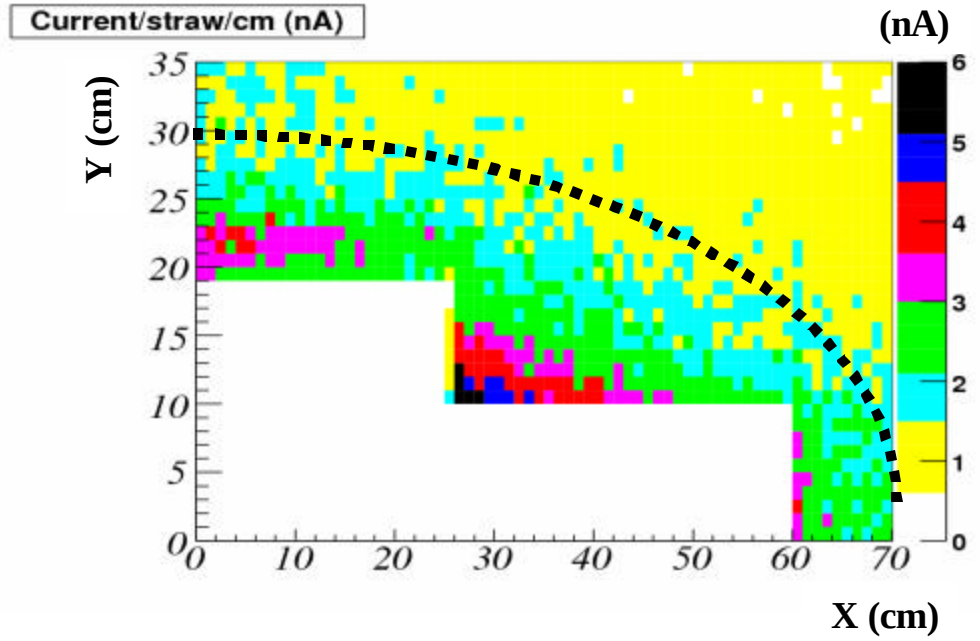
Damage vs Intensity



2) Where is the damage in LHCb?

- Hottest spot in LHCb is spot with maximal damage
- 10 cm away from hottest edge (~1 nA/straw/cm) helps factor 2-3





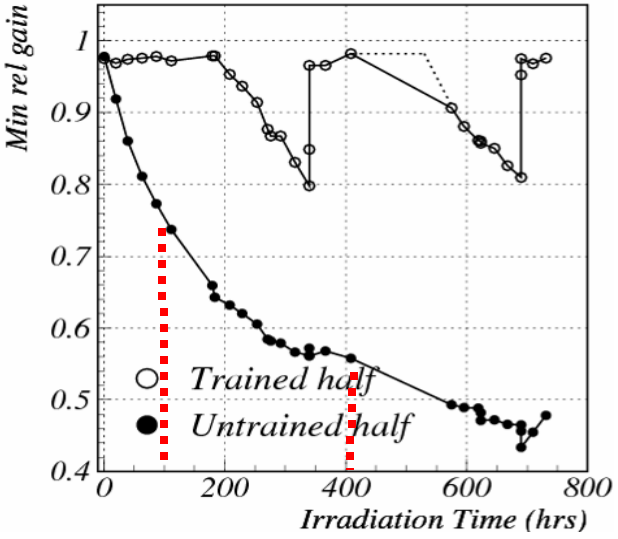
2) How to extrapolate the damage to 5.10^7s?

- 4x longer irradiation: 2x damage?
- ➢ Exponential time dependence?

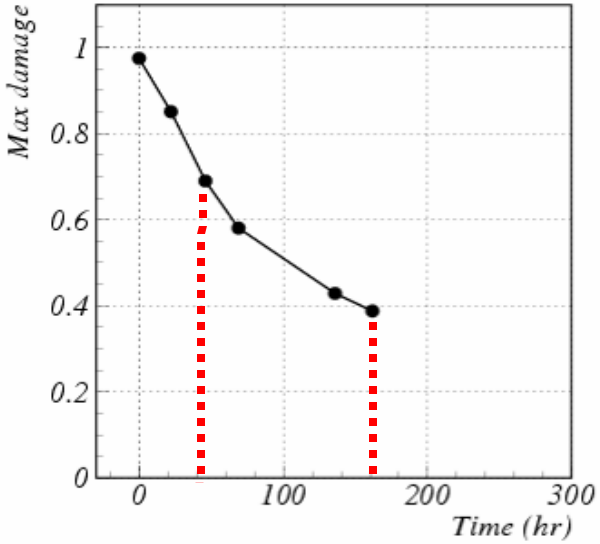
Time	Max dam		Avg dam	
100	-25%		-18%	
400	-45%	x1.8	-35%	x1.9

Time	Max dam		Avg dam	
40	-30%		-15%	
160	-60%	x2.0	-35%	x2.3

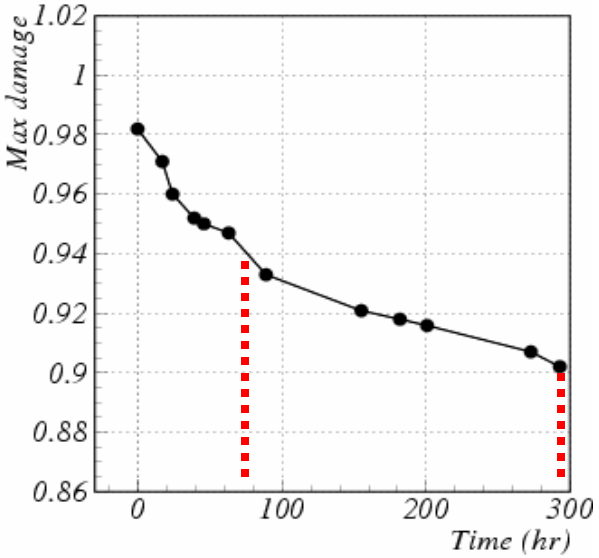
Time	Max dam		Avg dam	
75	-6%		-5%	
300	-10%	x1.7	-8%	x1.6



Mod 3A, half trained (Sep '06)

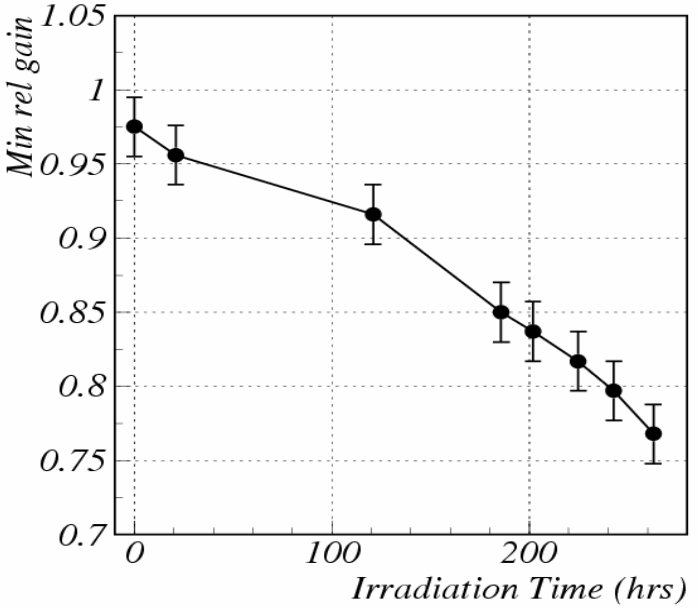


Mod 3A, at side (Mar '06)



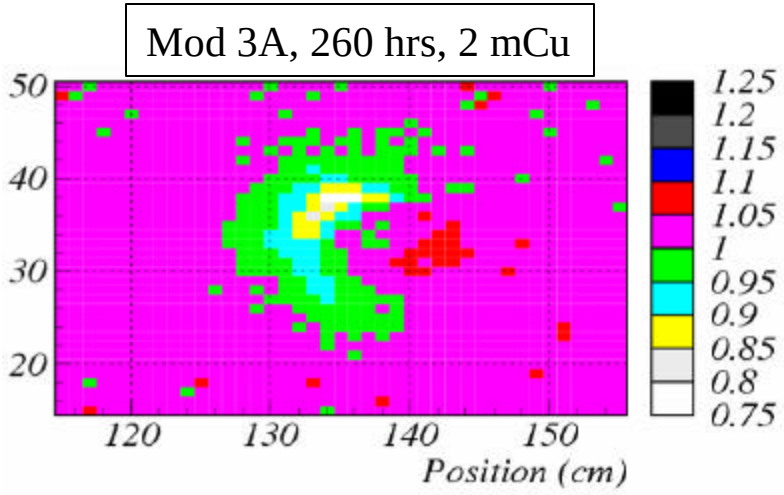
HD test Mod (Mar '06)

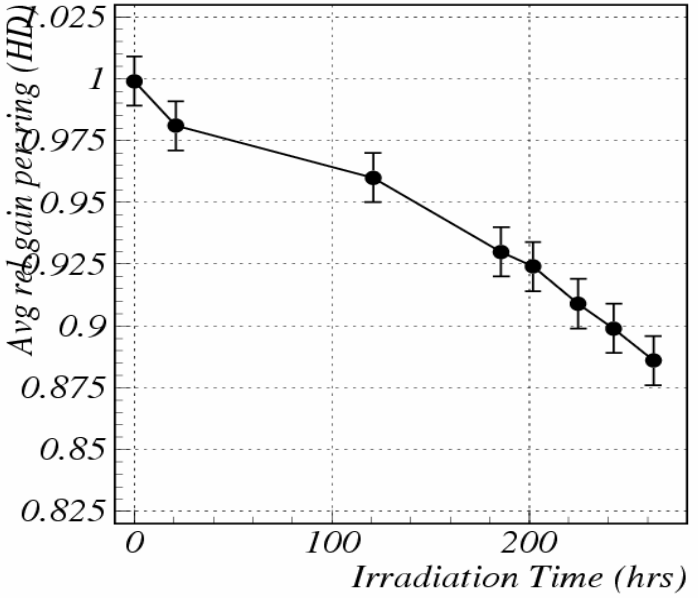
2) How to extrapolate the damage to 5.10^7s?



However: (Irradiation of mod 3A over Christmas)

- Linear time dependence?





2) Estimate gain loss after 5.10^7s

Assumptions:

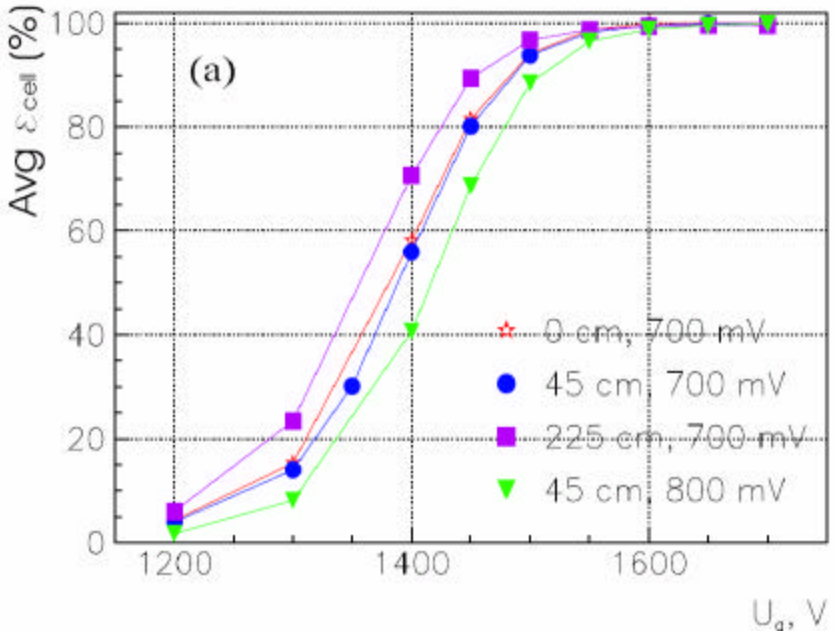
- Gas flow (x3) and oxygen (x2) help in multiplicative way
- Acceleration factor of irradiation: ~1
- Maximum damage at 3 nA/cm
- The numbers quoted below, is for the region with maximum damage

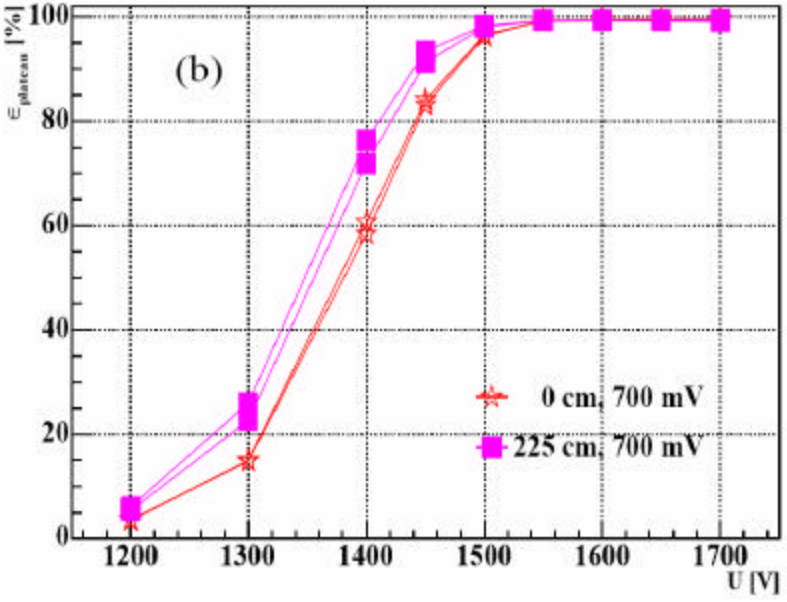
Scenario	20 hrs ^{90}Sr	320 hrs ^{90}Sr (=10^6 s)	Gas flow+O_2	Extrapolate linearly to 5.10^7s	Extrapolate exponentially to 5.10^7s
			x1/6	x50	x12
Flushed (NI-mod 3)	5%	35%	6%	Need HV training	72%
Heated (HD-mod 20)	0%	2%	0.3%	15%	3.5%

NB: 10 cm from the edge, helps a factor 2-3

3) Gain vs Single-cell efficiency

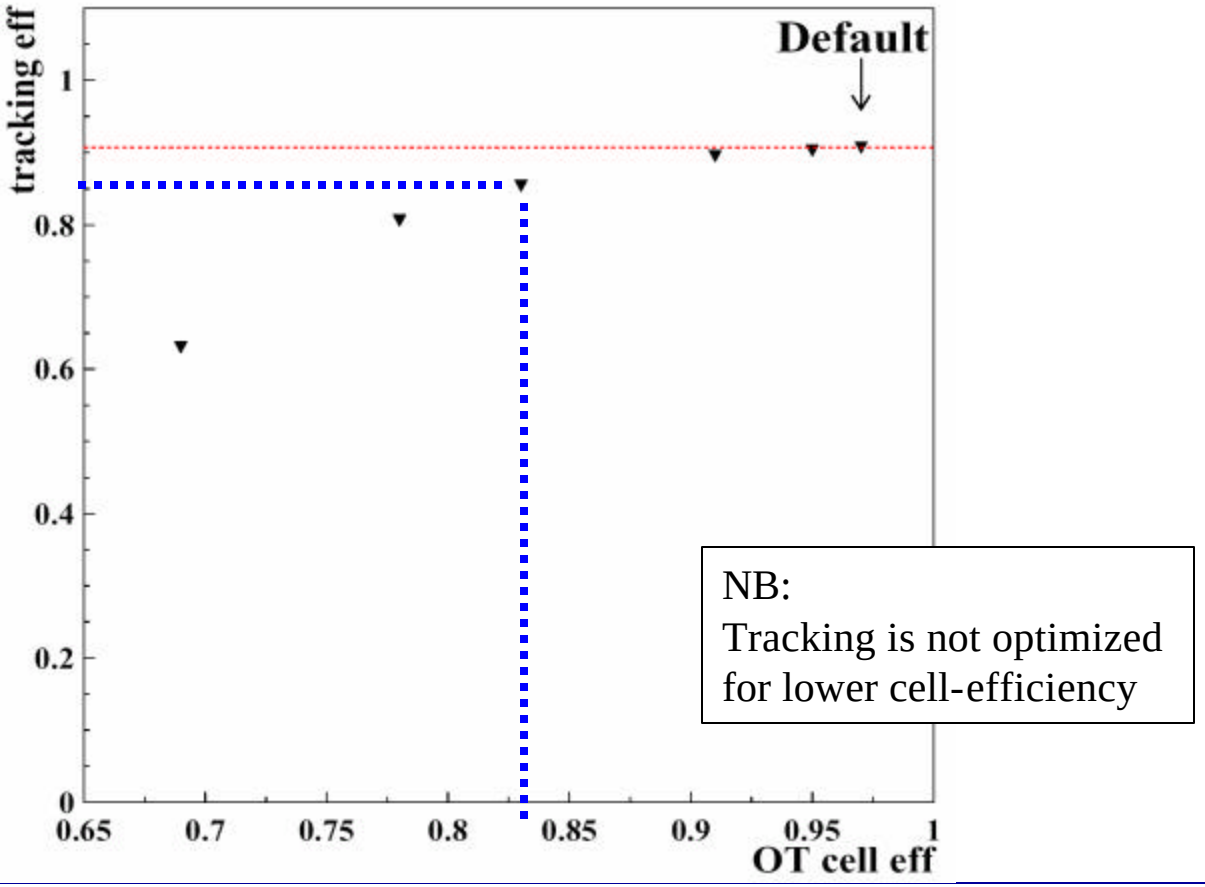
- A gain drop of 50% is equivalent to a HV drop of ~70 V
- Suppose a starting voltage of 1520 V
- The single cell efficiency at 1450 V is 10-15% lower





4) Single-cell efficiency vs Tracking performance

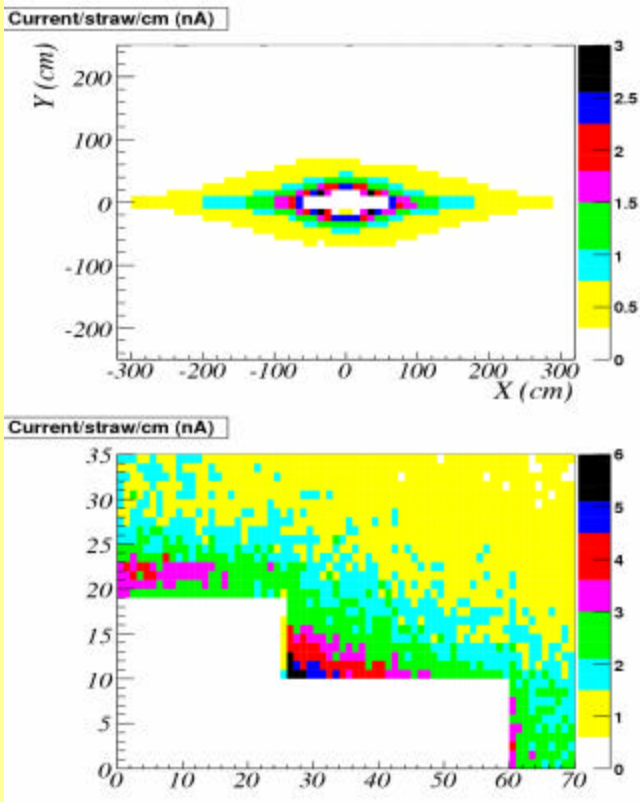
- The single cell efficiency at 1450 V is 10-15% lower
- If the single-cell efficiency would be 15% lower in the entire detector, then the corresponding tracking efficiency will be 5% lower



NB:
Tracking is not optimized for lower cell-efficiency

Conclusions

1) Relate source to LHCb
   - Biggest damage in first 10 cm
2) Effect of irradiation on Gain
   - Extrapolate to 5.10^7s depends on extrapolation and module quality: Damage between 3% and 72%.
   - → Assume 50%
3) Gain vs single-cell efficiency
   - 50% gain loss corresponds to 70 V drop in HV.
   - Assume a drop from 1520 to 1450 V
   - → single-cell efficiency 10-15% lower
4) Single-cell efficiency vs tracking performance
   - Assume 10-15% lower cell-efficiency in entire detector
   - → tracking efficiency drops from 91% to 85%

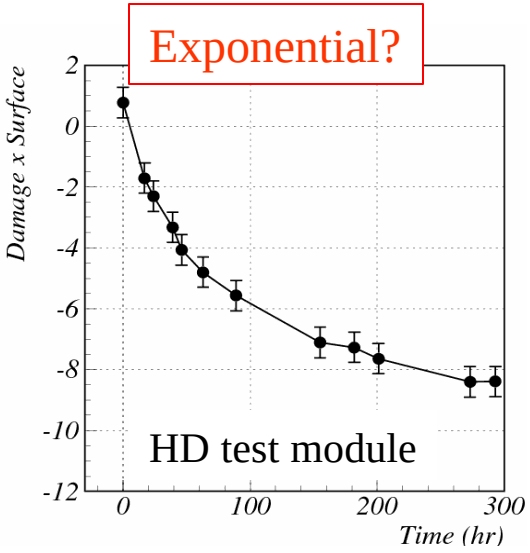


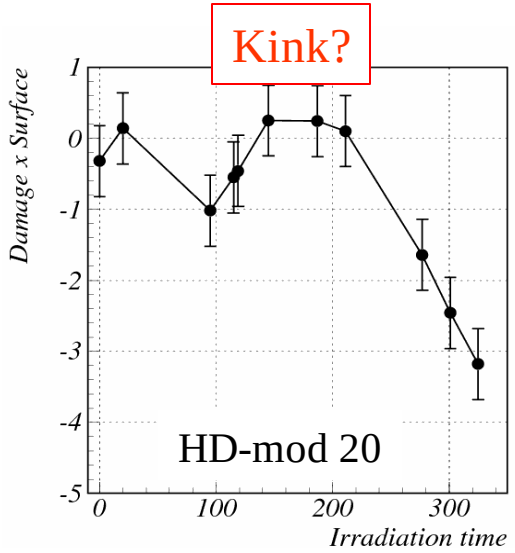
Caveats

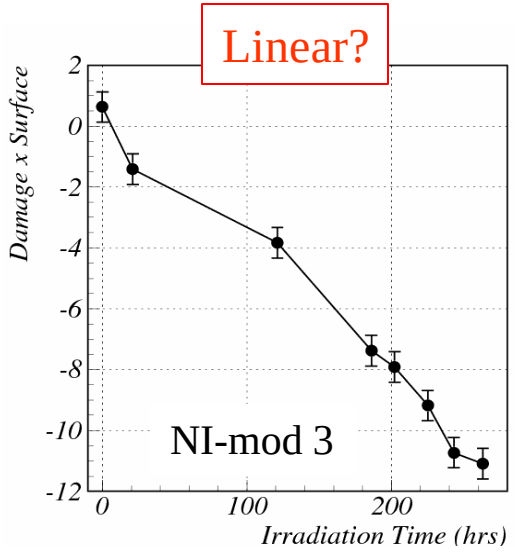
1) Does heating really help?
2) How does damage evolve with time?

- Heating of module 30 was unsuccessful
- Heating of module 123 was partially successful
- Wait for result of module 58?

- How to extrapolate to 5.10^7 s? Three examples of irradiation (280hrs=10^6 s):



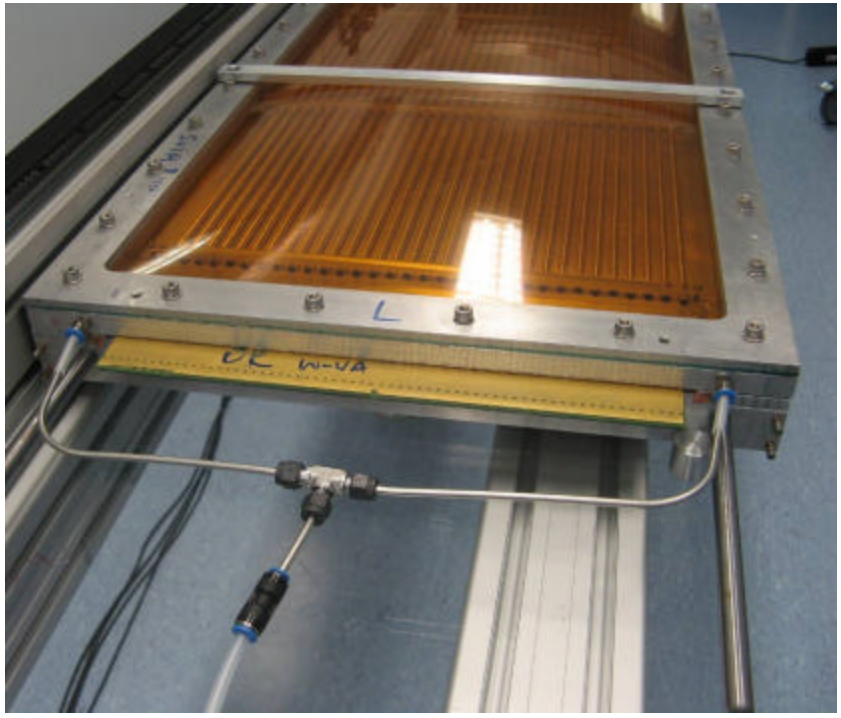




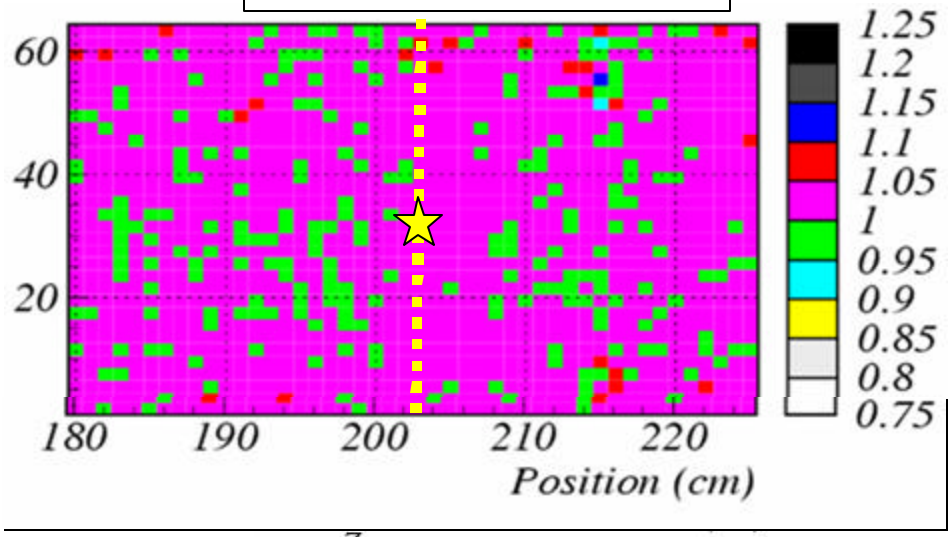
Find the Component:
1) Irradiate only straws

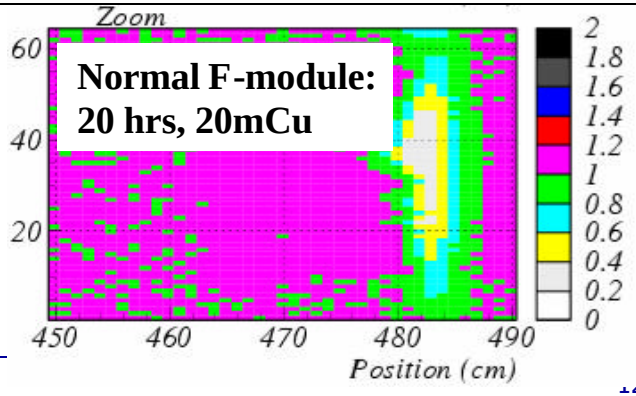
Philosophy:

- Create module without glue (Adam Nawrot).
- Add component by component, until it ages.



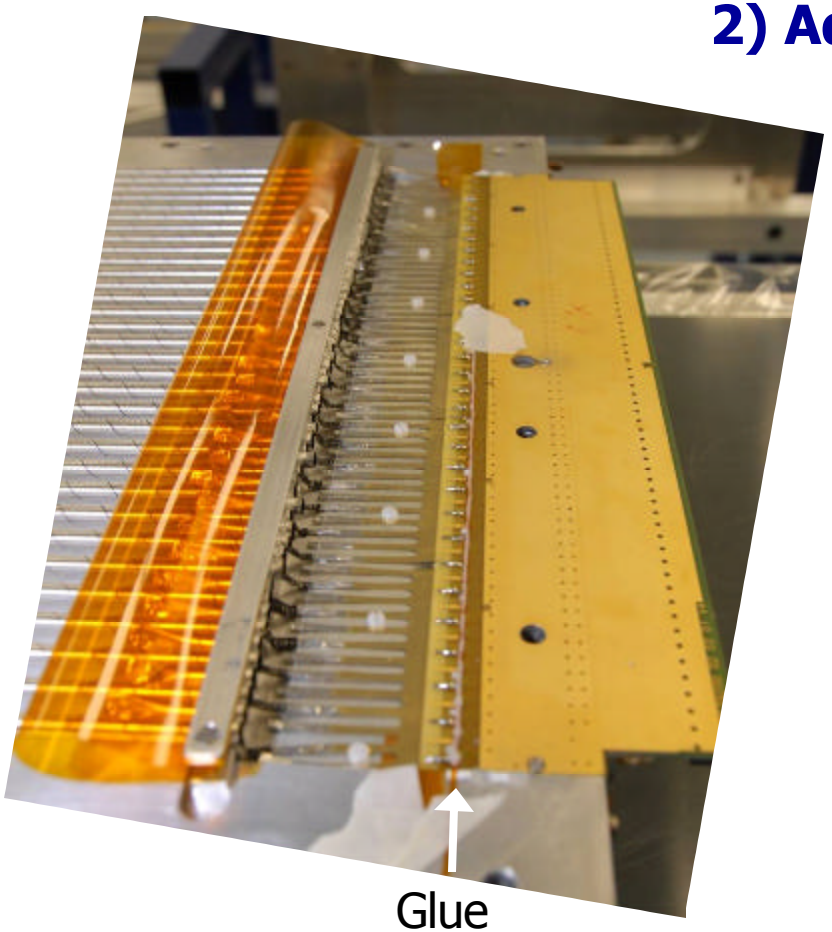
Test module (straws): 480 hrs, 20mCu



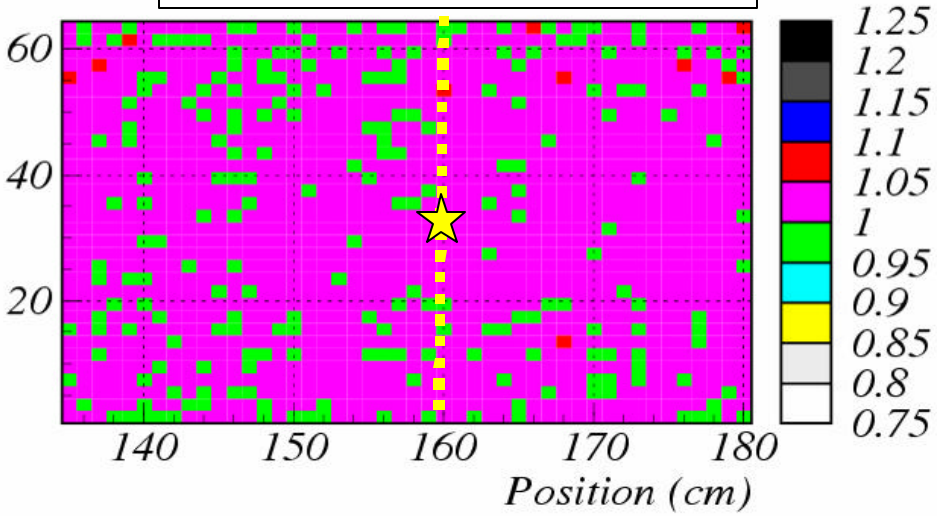


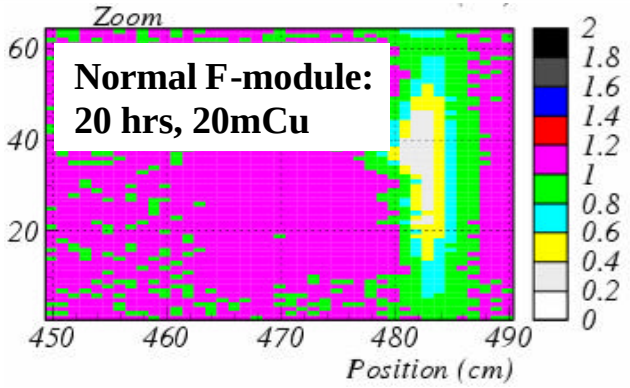
Find the Component:

2) Add bit of glue



Test module (straws+glue):
120 hrs, 20mCu





Next steps:

1) Add panel
2) Add more glue