

SHAPED CHARGE JET STANAG

Propositions for an updated edition

IMEMG's Expert Working Group on
Hazard Assessment & Classification

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www.imemg.org

INTRODUCTION

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- European Organisation assembling twenty leading armament groups working with Insensitive Munitions technologies



Express the armament industry's viewpoint with regards to relevant transnational regulations and requirements.

Expert Working Groups:

- Computer Models for IM Performance,
- Cost & Benefit Analysis,
- Effects of Ageing,
- Fast Cook-off Test Procedure,
- Hazard Assessment & Classification.

*Hazard Assessment & Classification Expert Working Group
to present this analysis*

CONTEXT

STANAG 4526 ed2

"SHAPED CHARGE JET – MUNITIONS TEST PROCEDURE"

→ not a real standardized reference:

- not ratified by all Nations,
- 50 mm Rockeye Shaped Charge not readily available,
- Performance not correctly defined for determination of an equivalent Shaped Charge,
- test set-up not clearly defined (conditioning plate, target nose, ...),
- each test center to use own Shaped Charge and test procedure.

- *Recent feedback from Afghanistan and Iraq*

➔ **Threat Hazard Analysis review :**

Standard Shaped Charges design which would be representative of numerous RPG7 types:

- **USA** MIL-STD-2105(D) specifies a standardised LX-14 81mm Shaped Charge.
- **France** has designed CCEB 62,
- **Germany** is developing PG-7 replica;
- ***Presentation to introduce industrial experts points-of-view to the IM community.***
- ***This paper could feed discussions for the 2014 MSIAC Workshop dedicated to SCJ STANAG.***

CURRENT SITUATION

STANAG 4439 Ed3 & AOP 39 Ed3

- STANAG 4439 ed3

- Threat : Shaped Charge weapon attack → Requirement: **Type III,**
- Shaped Charge Jet, Munitions Test Procedure → **STANAG 4526 Ed2.**

STANAG 4439 Ed3 & AOP 39 Ed3

- AOP 39

- The *Baseline Threat Range*

- » shaped charge caliber up to 85 mm diameter (AOP39 table 1).

- For the purpose of IM:

- » shaped charge to be "**broadly representative of Rocket Propelled Grenades and top attacks bomblets**" (AOP39 annex F)

- *Test conditions* (AOP39 annex H):

- » 50mm Rockeye or equivalent v^2d charge,

- » Use of conditioning plate not defined.

TEST PROCEDURE STANAG

- STANAG 4526 ed2

SHAPED CHARGE JET – MUNITIONS TEST PROCEDURE

- » designed for "*determining the degree of reaction of a munition when hit by typical top attack bomblet shaped charge jet*"
 - » **not ratified** by all NATO nations
 - » specified charge (50mm Rockeye) not readily available in many countries, therefore **not used** in IMEMG's Nations

TEST PROCEDURE STANAG

- STANAG 4526 (Ed2)

SHAPED CHARGE JET – MUNITION TEST PROCEDURES (cont'd)

- » test set-up **not precisely defined** (potential use of conditioning plate)
- » **inconsistent values** about 50mm Rockeye (confirmed during MSIAC IM Technology Gaps Workshop - June 2011)
- » paper: "*Rocket Propelled Grenade Shaped Charge Initiation Test Configuration for IM Threat Testing*" by Ernest L. Baker and al.

IMPLEMENTATION DIFFICULTIES

- The v^2d values is the link between different shaped charges
 - various shaped charges allowed, if same v^2d
 - values noted in STANAG 4526 Table 1 **much too high** by at least a factor of **> 2**

Threat	Representative V^2D ($\text{mm}^3/\mu\text{s}^2$)
Top Attack Bomblet	200
SCJ with characteristics of 50mm Rockeye	360
Rocket Propelled Grenade	430
Anti-Tank Guided Missile	800

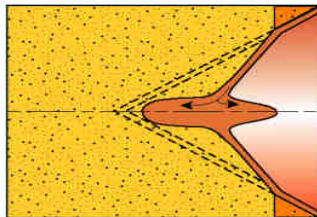
IMPLEMENTATION DIFFICULTIES

- For example RPG-7
 - typical measured values for the Shaped Charge Jet tip:
 $v \sim 7.5 \text{ mm}/\mu\text{s}$ and $d \sim 3 \text{ mm}$ gives a v^2d value of $\sim 170 \text{ mm}^3/\mu\text{s}^2$
 - **different from** $430 \text{ mm}^3/\mu\text{s}^2$ as noted in the table
 - $430/170 = 2.5$ too large

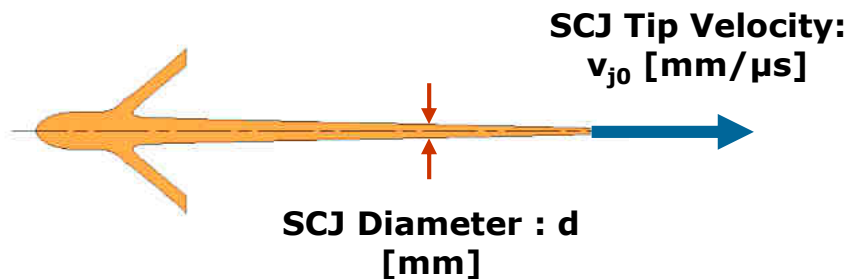
IMPLEMENTATION DIFFICULTIES

- As v^2d is the link between different shaped charges
 - » very important to **define exactly** how **v** and **d** should be measured as below;
 - » Both numbers **v** and **d** are **not constant but variably** over the Shaped Charge Jet length;
 - » the **scattering** within the measurements should be taken into account.

Shaped Charge



Shaped Charge Jet Formation



COMPARISON OF IM SIGNATURES

- Conditioning plate often use to :
 - adjust v^2d value according to specific Threat Hazard Analysis,
 - avoid the rear slug effect discrepancies.
- » a munition to pass the STANAG 4526 but which is the **real stimulus** ?
- In-service Shaped Charge are equipped with target nose
 - » i.e. for RPG7, target nose can **reduce significantly** the v^2d with the "same" charge

COMPARISON OF IM SIGNATURES

- *Main parameters to be known*

- **Shaped Charges**

- » Diameter from 45 mm to 120 mm,
 - » In-service charge: with or without target nose,
 - » High performance (tapered & fast) jet /// un-optimized and cheap serial charge,

- **Conditioning plate use,**

- **Stand-off value,**

- **Break-up time,**

- **Penetration capability.**

COMMENTS ON CURRENT CHANGES

NEW THREAT DEFINITION

- Recent feedback from Afghanistan and Iraq led to a Threat Hazard Analysis review
 - » RPG-7 is now the sole considered Shaped Charge Threat,
 - » RPG7-V has been measured at $141 \text{ mm}^3/\mu\text{s}^2$
 - » Due to lack of RPG-7 reliability across various manufacturers, it is necessary to develop RPG-7 surrogate,

NEW THREAT DEFINITION

Many nations are designing their own RPG-7 surrogate and/or Standardised Shaped Charge

- **USA** : LX-14 81mm Shaped Charge (MIL-STD-2105(D) requirement)
- **France** : CCEB 62
- **Germany** : 75 mm Shaped Charge "PG-7 German replica"

- CCEB 62 » the French Standardized Shaped Charge for IM Signature assessment
 - MoD Instruction N°211893/DEF/DGA/INSP/IPE **July 21, 2011**
 - **STANAG 4526 implemented** with CCEB62
 - **Test Procedure defined** in French Standard: NF T70-511
 - CCEB62 performances characteristics **are available**
 - But these are currently re-checked for new production phase validation

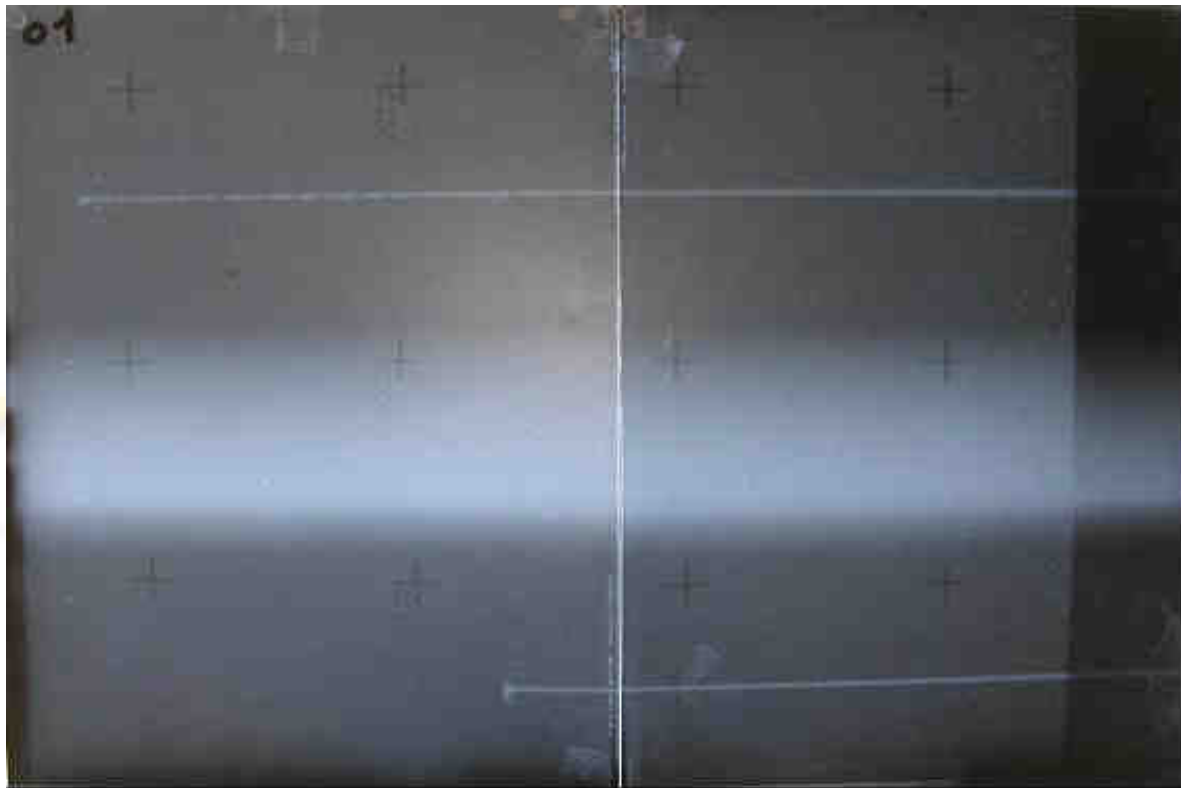


**CCEB62 manufactured
by NEXTER Munitions**

- Conditioning mild steel plates can be used
 - Critical V^2d determination: detonation/no detonation for PBXs characterization
 - Adjust V^2d to specified value (customer requirements)

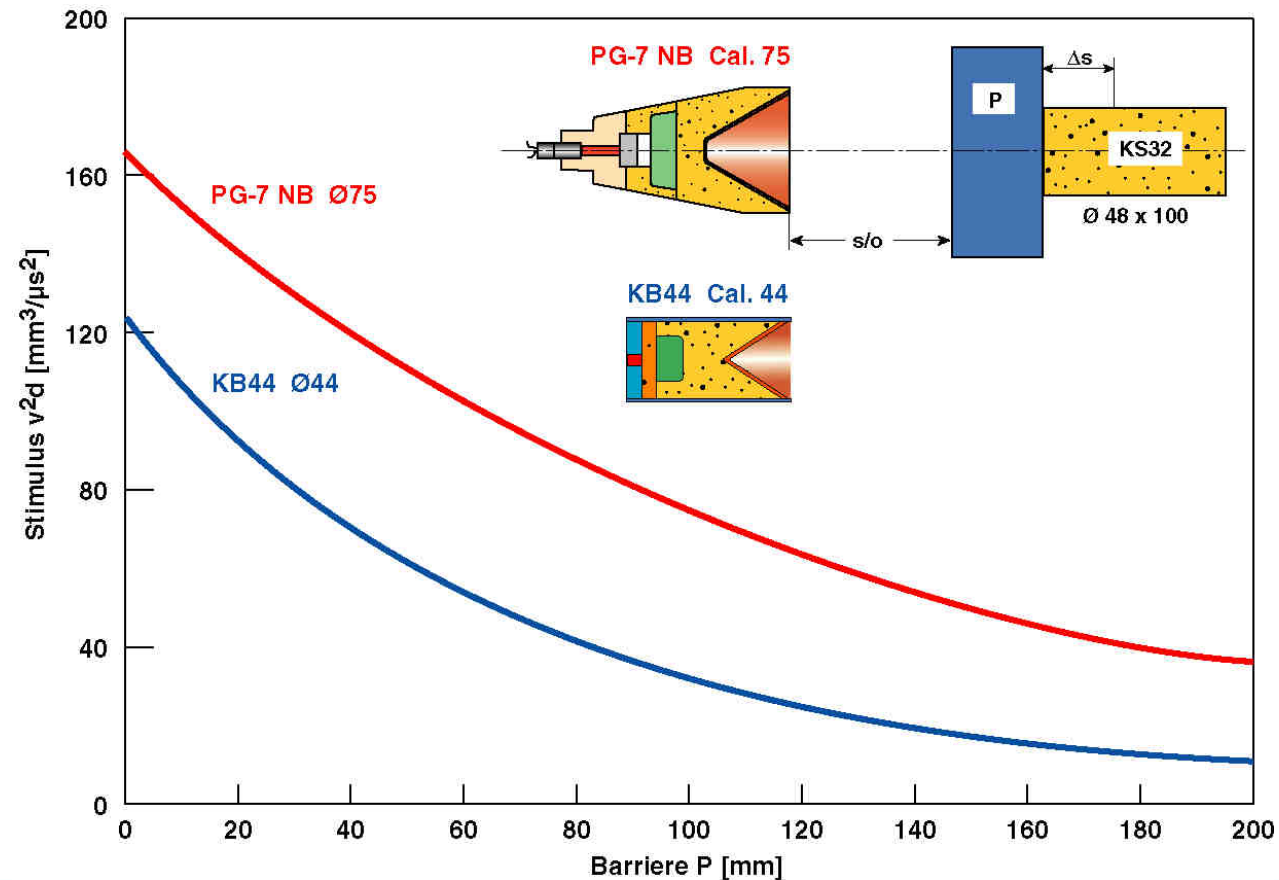
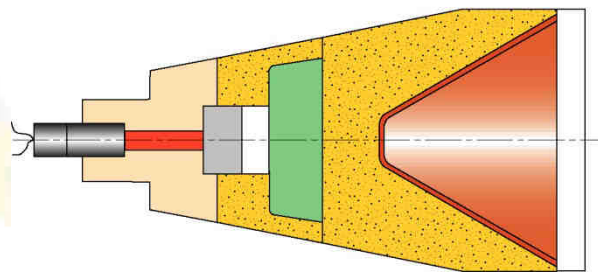
V^2d ($\text{mm}^3/\mu\text{s}^2$)	203	103	93	82.5	72	62	41.5	52	31	21
Steel Plate thickness (mm)	0	20	25	40	60	80	110	150	200	280

- CCEB 62 : Example of Free Jet X-Ray pictures (at two successive times)
 - Note straightness diameter



**X-Ray picture
by SAFRAN Herakles**

- PG-7 replica would become German standard
 - PG-7 replica (75 mm) manufactured by Dynamit Nobel.



- LX-14 81mm appears as US Standard Shaped Charge
 - MIL-STD-2105(D) **requirement**
 - Charge design and performances **are available** (E. L. Baker's Paper)
 - Tests seem to be **always carried out** with a 4" aluminum conditioning block, in that situation
 - » the $v^2d = 141 \text{ mm}^3/\mu\text{s}^2$,
 - » tolerance about this value **not given**

- LX-14 81mm appears as US Standard Shaped Charge (cont'd)
 - the LX14 explosive charge characteristics are not precisely defined:
 - » **no real guarantee** that various LX14 batches **if** manufactured by different producers will have the same performance,
 - » real performance of each producer would be checked.



IMEMG CONCERNS & COMMENTS

HARMONISATION NEEDS

- **Concerned** by the lack of consistency in various test procedures.
- **Difficult** to compare munitions responses to Shaped Charge Jet attack.
- NATO standards **should be agreed** and practicable with reproducibility by all member countries.
- IMEMG experts intend to **support** current harmonization efforts and wish to highlight the fact that next STANAG 4526 should list a very **limited number of approved** Shaped Charges types and test set-up to each nation.

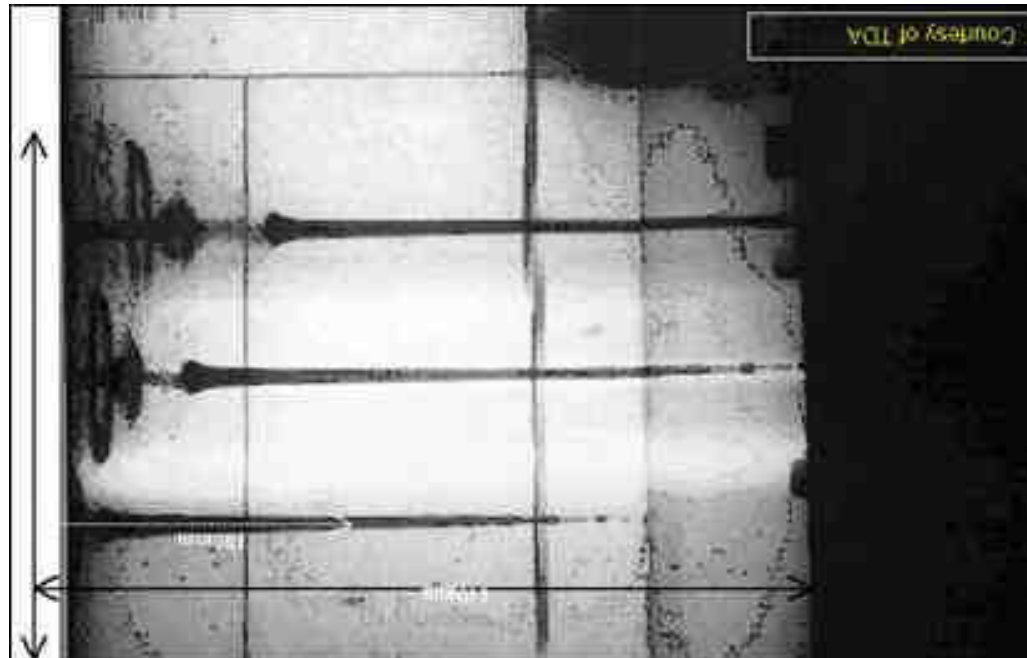
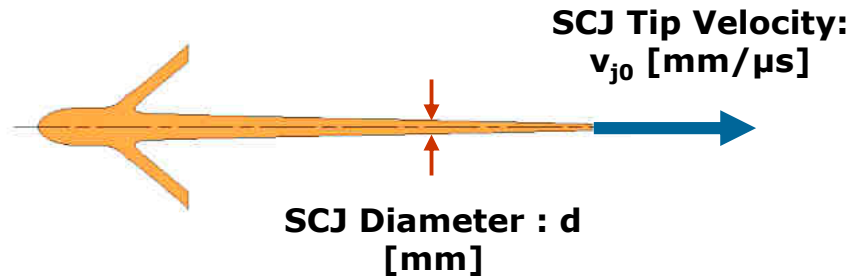
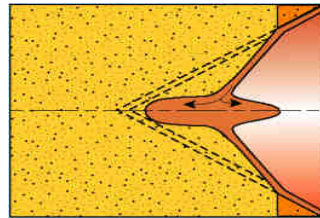
STANDARDIZED SHAPED CHARGES

- Shaped charge jet harmonization has really begun, even if charges are different for each nation:
 - LX-14 81 mm, CCEB 62, PG-7 Replica
 - with v^2d that could be closed to $141 \text{ mm}^3/\mu\text{s}^2$
- Each Shaped Charge referred to should have an **available and comprehensive technical data pack.**

SHAPED CHARGES PERFORMANCES CHARACTERISATION

Shaped Charge

Shaped Charge Jet Formation



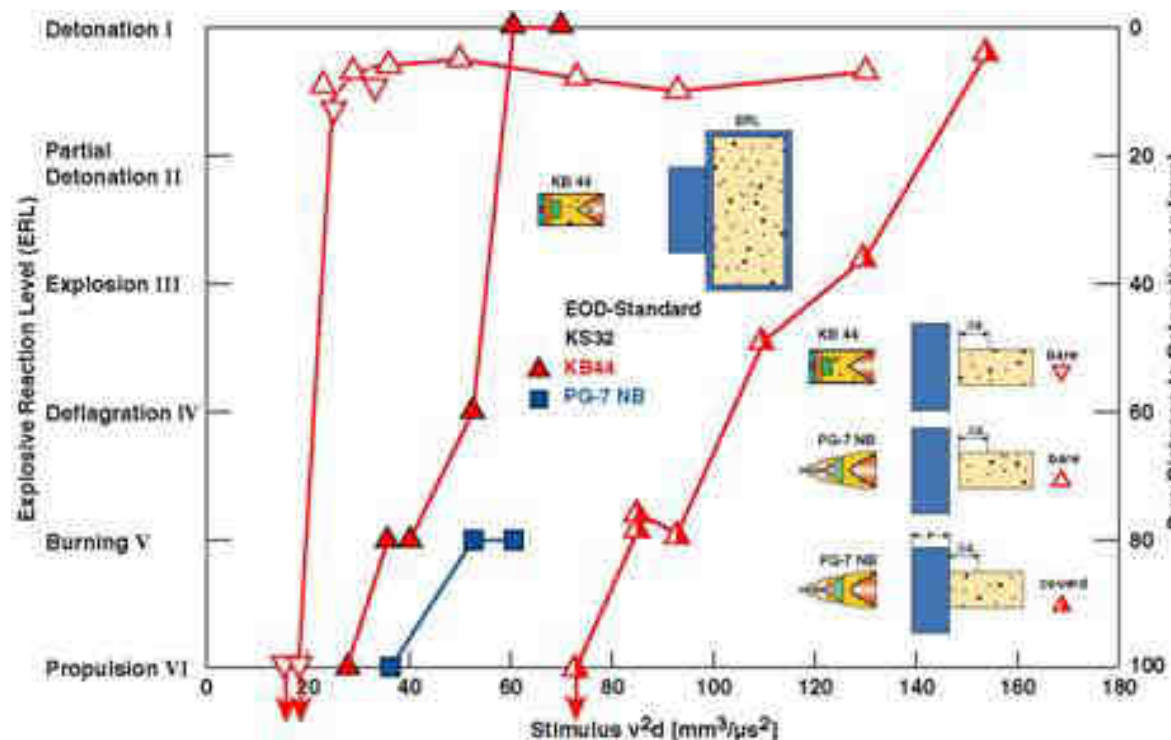
X-Ray picture
by TDA Armaments

SHAPED CHARGES PERFORMANCES CHARACTERISATION

- Measuring v^2d not easy or trivial :
 - Diameter to be considered
 - » Tip diameter ?
 - » Average diameter between fixed positions ?
 - Velocity to be considered
 - Stand-off value
 - V^2d tolerance +/- 10 % ?

STANDARDISED TEST PROCEDURES

- Same stimulus of v^2d around 55 / 60 $\text{mm}^3/\mu\text{s}^2$
- low order "burning" or "Propulsion" (Explosive Reaction Level ERL = V r VI) is observed if the shoot is done with PG-7 (blue squares),
- full detonation (ERL = I) is observed if the KB44 (red triangles) is used.



Experiments
by MBDA-TDW GmbH

STANDARDISED TEST PROCEDURES

- Similar observations were done on propellants.
 - not only v^2d is important for the reaction level but also v and d themselves.
 - Future standard STANAG Shaped Charge should not vary too much in caliber.
 - Reason why it is necessary to standardize the STANAG shaped charge and also the test set-up in the next STANAG 4526 edition.
- *kind of Round Robin tests should be organized under NATO or MSIAC authority, in order to compare the three described shaped charges against the same target / explosive arrangement.*
- *to prove that there is no bias, depending on a given shaped charge and thus would give more reliability in data comparisons.*

ALTERNATE v^2d VALUE

- v^2d stimulus of $141 \text{ mm}^3/\mu\text{s}^2$ would be much too high:
 - » most charges (including insensitive PBX) would detonate, **only few EIS would survive** (Extremely Insensitive Substance in accordance with UN HD 1.6).
 - » STANAG to **define different stimuli** according to Life Cycle and Threat Hazard Assessment
- If standard procedure is defined with the stimulus:
 v^2d is $141 \text{ mm}^3/\mu\text{s}^2$ then,
alternative procedure could consider stimulus around 60 to $70 \text{ mm}^3/\mu\text{s}^2$.*

CONCLUSIONS

CONCLUSION

*See you in Brest, France,
12-16 May 2014*

➤ MSIAC Workshop !!!



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